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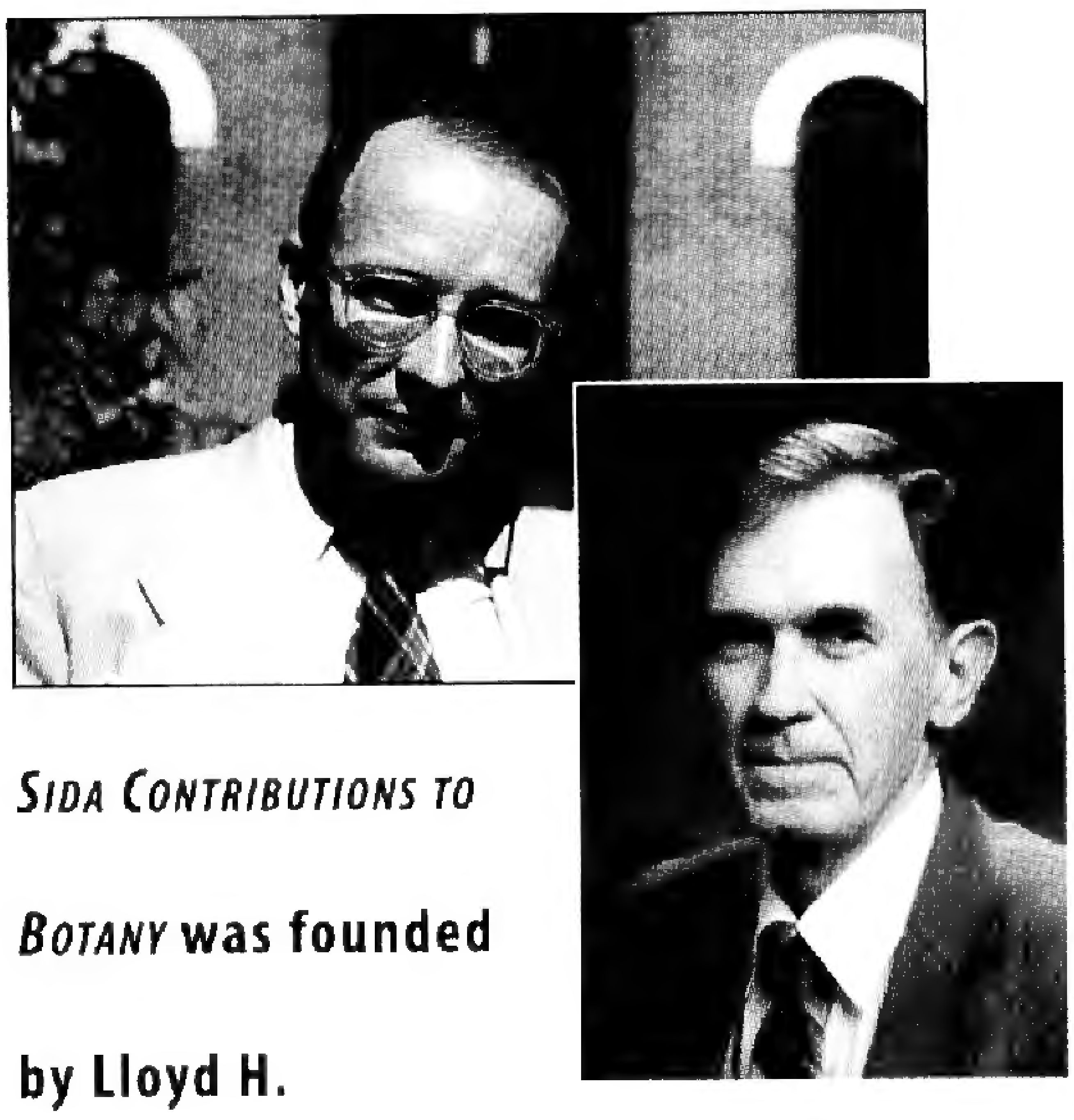

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Barney L. Lipscomb, Editor
Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, USA
817 332-4441 / 817 332-4112 FAX
Electronic mail: sida@brit.org
Home page at the URL: http://www.brit.org/sida/

John W. Thieret, Associate Editor
Dept. of Biological Sciences
Northern Kentucky University
Highland Heights, KY 41099 USA

Félix Llamas, Contributing Spanish Editor
Dpto. de Botánica, Facultad de Biologia
Universidad de León
E-2471 León, SPAIN

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A FLORISTIC AND ETHNOBOTANICAL ACCOUNT OF THE JOSEPHSTAAL FOREST MANAGEMENT AGREEMENT AREA, PAPUA NEW GUINEA

W. Takeuchi

Botanical Research Institute of Texas (BRIT)
c/o Lae National Herbarium and Papua New Guinea Forest Research Institute
P.O. Box 314, Lae, Morobe Province 411, PAPUA NEW GUINEA

ABSTRACT

Botanical survey results are presented from the Josephstaal Forest Management Agreement Area, a venue currently under planning evaluation for several development contingencies. Four new species are formally described: *Aglaia saxonii* (Meliaceae), *Barringtonia josephstaalensis* (Barringtoniaceae), *Calycosia mamosei* (Rubiaceae), and *Psychotria mayana* (Rubiaceae). A substantial number of distributional records and discoveries of rare taxa are reported. Compilations of Maian plant names and uses are also included.

The findings suggest that Josephstaal habitats are refugia for restricted endemics which have been eliminated from other parts of their historical range. Judicious planning is necessary when evaluating the land-use options for this area. Populations of several susceptible taxa may constitute the only existing colonies.

Key Words: *Aglaia*, *Barringtonia*, botanical survey, endangered species, *Calycosia*, Josephstaal, Papuasia, *Psychotria*

ABSTRACT

現在、その土地利用及び開発が検討中であるジョセフスタール森林管理協定地区における植物調査の結果を報告する。調査において発見された４つの新種については、その描写が本文中に行われている。それらの新種は *Aglaia saxonii*（センダン科）、*Barringtonia josephstaalensis*（サガリバナ科）、*Calycosia mamosei*（アカネ科）、*Psychotria mayana*（アカネ科）である。調査結果には現地名や利用方法などの民族植物学的見地からの情報も含まれている。
ジョセフスタール地域は、かつての分布地域から消え去ってしまった幾つかの固有種のレフェジアであることが調査結果から推測される。この地域の土地利用計画の作成には慎重な検討を重ねる必要がある。ジョセフスタール地域が幾つかの影響を受けやすい植物群の、現存する最後のコロニーである可能性があるからである。

INTRODUCTION

The Josephstaal Forest Management Agreement Area (JFMAA) is an intended venue for logging operations based on the reduced-impact formats known as 'ecoforestry.' Prior

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to the project's implementation, botanical surveys were considered necessary to establish biological baselines for the concessional areas. An ecological reconnaissance of the JFMAA (Fig. 1) was thus conducted by the Nature Conservancy (TNC) between September 9 and 17, 1998, followed by a general floristic evaluation during the period from July 26 to August 25, 1999. The following paper is a synopsis of the initial findings from these investigations.

SITE SUMMARY

The survey tract is located for the most part, within territory covered by the Annanberg topographic sheet, but also overlaps the adjacent Adelbert, Manam, and Nubia map units (cf. Australian Survey Corps 1973, 1974a, 1974b, 1974c: 7888, 7889, 7988, 7989). This general area is part of the Mugumat-Yakiba Census Division of Bogia Subdistrict; and includes the principal villages of Dumadum, Moresada, Mugumat, Roumirap, Wadaginum, and Wagadab (Dept. of District Administration 1968: 88–89).

The 1999 survey was based at three camps established sequentially at map coordinates (GPS) 9504560 N × 281407 E; 9497596 N × 280100 E; and 9498679 N × 284829 E; at elevations from ca. 50 to 160 m. There was mature growth foothill forest at Camp 1, and alluvial terrace communities at Camps 2 and 3. The latter bases provided convenient access to both riverine and foothill vegetation.

All investigated sites are within northern Papua New Guinea's (PNG) lowland forest life zone, where mean annual rainfall is 2,000 to 3,500 mm. The wettest months generally occur during January to April, when prevailing winds are northwesterly, and the driest in May to August when southeasterly trades become effective (McAlpine et al. 1983: 65). Even during the relative dry season, average monthly rainfalls are still generally around 200 mm, so the vegetation is only infrequently subjected to soil moisture deficiencies under normal conditions (ibid: 140). Most climatic classifications would categorize the project sites as tropical everwet, perhumid, or some other equivalent descriptor emphasizing the overall absence of water deficits.

The survey sites are typical for a PNG wilderness area, in that information-gathering services are sporadic or altogether lacking. Meteorological summaries are necessarily developed by extrapolation from stations which may not be representative. Although the nearest station with published tables (Madang A/S) shows high annual rainfalls with moderate seasonality, severe droughts have been known to occur in this general region. Episodes of widespread fires and forest destruction have been documented (Johns 1986: 349–351, 359).

From a geological perspective, the Josephstaal Physiographic Province represents the crustal remnants of an island arc which collided with the Australian plate about 10 m.y. BP (Pigram & Davies 1987). Parent substrates are generally derived from basalt volcanics of this now-disappeared arc (Jaques & Robinson 1975: 12). Severe earthquakes occur frequently within the area covered by the TNC project, so plant speciation is probably being encouraged by landslide-induced isolation of populations, particularly at the higher elevations (cf. Balgooy et al. 1996: 201–02).

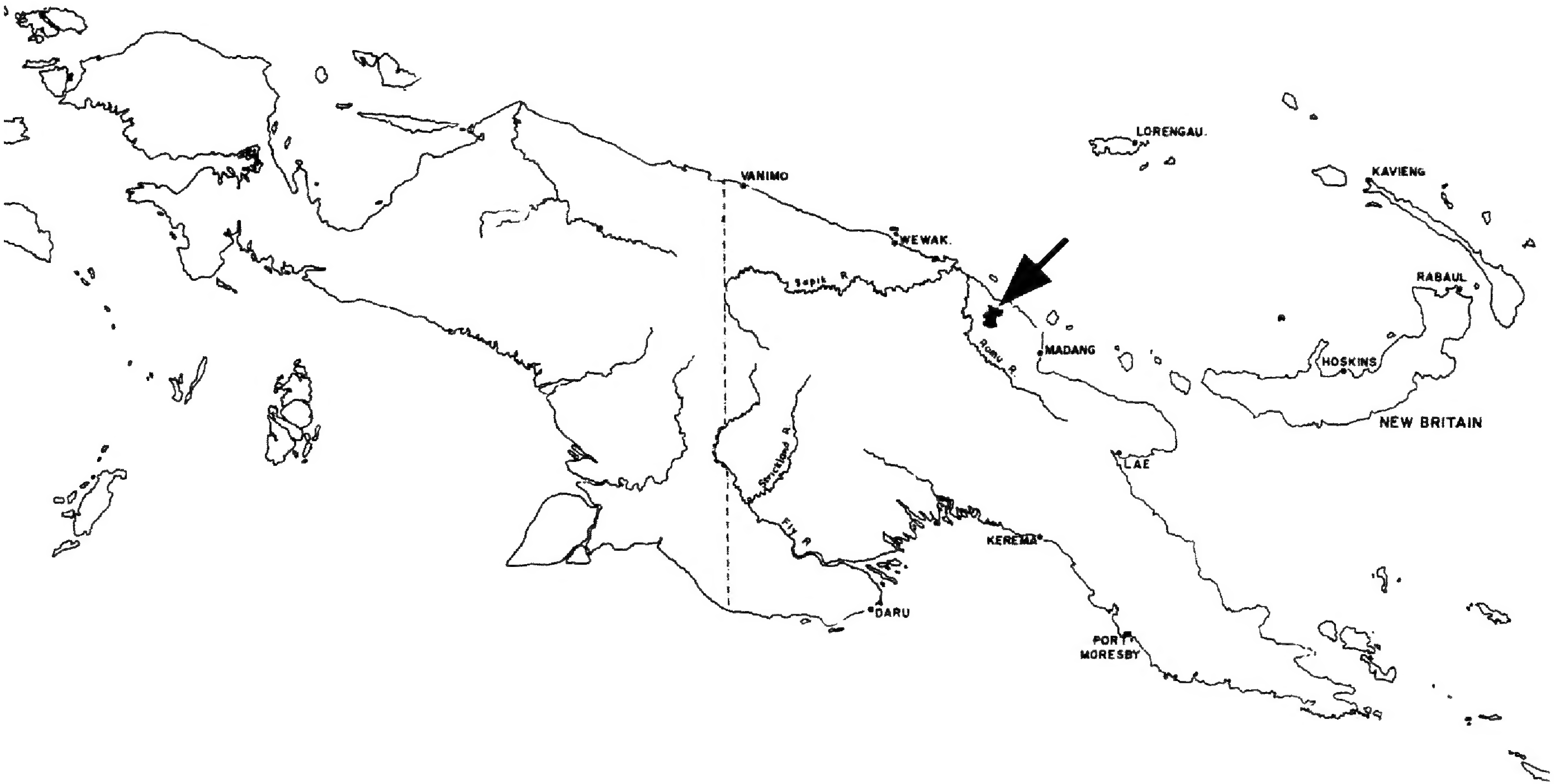

Fig. 1. Island of New Guinea. Arrow: Josephstaal Forest Management Agreement Area (JFMAA).

Soils of the Bogia Subdistrict (including Josephstaal) are dystropepts and eutropepts, a group characteristic of lowland habitats and comprising the most common soil type in Papua New Guinea (Bleeker 1983: 98–9). There are no ultramafic or other specialized edaphic environments within the surveyed tract.

HISTORY OF BOTANICAL ACTIVITY AT JOSEPHSTAAL

Botanical work on the Josephstaal flora has been sporadic and opportunistic in nature, with involvement by a limited number of specialist collectors. Prior to the TNC surveys, the largest collection was the set made by K.J. White during the period September 1 to 15, 1958. White obtained a total of 103 numbers under the NGF (New Guinea Force) series, from which three collections were later designated as type specimens (*Endiandra magnilimba* Kosterm., *Horsfieldia basifissa* de Wilde, and *Syzygium madangense* Hartley & Perry).

Contemporary efforts at identification of historical localities have been generally complicated by the oftentimes limited data provided by earlier botanists in Papuasia. The K.J. White numbers are thus somewhat uncharacteristic for the period, since for all sheets the point of reference is clearly specified as 'Josephstaal,' at 'L. 4 45 S and Lat. 145 00 E.' The elevation is consistently given as '250 feet' and repeatedly indicates riverine or alluvial habitats. Pondoma, Naikum, and Tumbundi villages are mentioned on some labels (e.g., *Thespesia fissicalyx* in *NGF 10297*; *Maniltoa rosea* in *NGF 10226*; and *Cryptocarya weinlandii* in *NGF 10306*, respectively). From the information provided on White's gatherings, there are consistent indications he was working in the lower basin connected to the Guam River. For at least part of the time, White was probably accompanied by R.G. Robbins, as suggested by an independent number (*Endiandra squarrosa* in *Robbins 1625*), which is cross-referenced against *White's NGF 10252*, and which refers to the latter as a duplicate. Robbins's locality is specified as 'Josephstaal, lower Ramu-Atitau area, Madang District.' *Robbins 1667* (*Barringtonia apiculata*) adds further: 'near Josephstaal 400 ft.'

White's specimens have been intensively studied over the years, and the determinations assigned to them by specialists indicate the sort of taxa that would be expected from the JFMAA on general distributional and ecological grounds. The K.J. White collections have been incorporated into the survey documentation (Appendix 1) because the species involved are present within and immediately around TNC's project area.

During the herbarium work phase, specimens collected by R. Pullen were also examined from the vicinity of Josephstaal. A typical label from *Pullen 1188* (*Alocasia brancifolia*), gives the collection site as 1/4 mi south of Josephstaal airstrip. Although the Pullen numbers are from comparable lowland habitats, they were collected slightly outside the project area and are mentioned only incidentally in the following summaries. In any event, comparatively few Pullen specimens are present at the PNG National Herbarium (LAE); the NGF sheets comprise a decidedly larger set.

Other botanists with collections from the Josephstaal tract include J. Womersley, B.S. Parris, and J.P. Croxall. The Parris and Croxall numbers are specialist pteridological collections made along the unimproved road to Josephstaal in 1980. Most of their fern records have been replicated by the surveys' results. Womersley's numbers from the

Wanuma area (*NGF 48651-48678* from 600 to 950 m elevation in 1974) are substantially removed from the project site but are notable for being among the few sets taken from the Adelbert summit range.

By far the most comprehensive specimen series for Josephstaal are the collections from the TNC-sponsored botanical surveys of 1998 and 1999. A total of 973 numbers were added to the national herbarium from these efforts; 62 from the 1998 ecological reconnaissance and 911 from the recently-concluded expedition. The combined tally increases the plant documentation for Josephstaal by nearly an order of magnitude over what was previously available. Due to the surveys' exclusive focus on the elevational interval below 400 m, the herbarium coverage for the JFMAA is now among the best for any lowland wilderness in Papuasia.

METHODS

The 1999 survey consisted of general exploration and collecting around three expedition camps, primarily using established footpaths or following the secondary channels comprising the Guam drainage. The botanical collections were conducted by an integrated team consisting of M. Gorrez, W. Takeuchi, A. Towati, and J. Wiakabu. During the selection of specimens, deliberate attention was directed to groups usually spurned by botanists because of their inherent repellent qualities or other difficulties associated with their processing. Palms, aroids, stinging nettles, grasses, alien weeds, etc. were secured when suitable specimens were encountered, in contrast to the general reluctance for collecting such plants. Multiple gatherings of certain taxa were also made, when their significance was already apparent in the field, in order to allow evaluation of population variation. Survey protocols were consistent with the principal objective of developing a representative floristic profile of the project area within the allocated one-month period.

Ethnobotanical polling was conducted separately by survey biologists J. Wiakabu and M. Gorrez, through group interviews with village elders. Names and uses of specific plants were recorded, with special attention paid to culturally sensitive taxa. All vouchers were field-pressed in 70% surgical alcohol and subsequently transported to the PNG Forest Research Institute (PNGFRI) for processing and determination. Materials for exsiccatae were often accompanied by bottled, carpological, and xylarium accessory collections when these were necessary for identification.

The Lae National Herbarium (LAE) is the repository for first sets from the vouchers. Distribution of duplicate sets will follow LAE's exchange sequence, on which Kew (K), Rijksherbarium (L), and Harvard (A), are the principal receiving institutions. Residual sets will be allocated in conformity to preexisting agreements or in compliance with future TNC requirements. Whenever possible, specimens were named using the current taxonomic revisions, or from a combination of authoritatively annotated sheets and original descriptions. Some collections could only be assigned with doubt to a species group or section. In a number of cases, submissions were made to international specialists. Taxa encountered only in sterile condition or otherwise not collectable, were enumerated as a sight record when the plant was known with certainty to the writer.

GENERAL DESCRIPTION OF THE VEGETATION

Two principal forest-structural divisions (alluvial forest on riverine terraces, and foothill forest on well-drained slopes), were discerned during the initial 1998 reconnaissance. The opportunity for detailed examination afforded by the 1999 survey, subsequently showed that many community types are included under these two formations.

The margins of large streambeds in the Josephstaal area are marked by a distinctive riverine facies dominated by lianes, heliophytes, and rheophytic taxa. This edge community is generally absent from smaller streams with closed canopies. In swampy situations, the interior alluvial stands are typically species depauperate, *Metroxylon*-dominant, and with poor vertical development. On better-drained alluvia the forest becomes more floristically and structurally diverse, eventually forming a varied community with interlocking canopy layers and clear understories. There are intermediate communities apparently linked to diminishing rhizosphere stagnation. However in places with a linear series of staggered terraces, such intermediates are interpretable as a successional sequence resulting from progressive changes in streamcourse (Saxon, pers. comm.). Superimposed over the matrix of variation are smaller units in various stages of regrowth, which have been caused by large treefalls, attritional senescence, catastrophic storms, etc. While the alluvial forest is for the most part assigned to structural code 'Fri' in Hammermaster and Saunders (1995a), there is clearly a continuum of communities within this category.

From examination of understory and subcanopy taxa, the forest on hillsides and ridgelines was initially regarded as homogeneous. Herbs and subarborescent plants appear to range through the foothill habitat without obvious distributional separations. However Weterings (pers. comm.) noted pronounced contrasts in canopy compositions between ridgelines and lower slopes during the independently-conducted timber assessment. His observation is supported by the known autecological patterns of arborescent genera, as for example the preference of dipterocarps for ridgecrest environments (Johns 1977; Paijmans 1976). Like the alluvial zone, there is very probably a fragmentation of the foothill formation into subtypes, though the differentiation may be primarily reflected in overstory structure, while with the riverine communities, it is discernable in the near-ground compositions. Characterization of the hill forest communities will require surveys of greater intensity than the one just concluded, employing a combination of transects and random collecting. This suggestion is supported by recent findings from similar rapid-assessment surveys in other parts of Papuasia (e.g., Mack 1998).

The Josephstaal foothill communities fall primarily under forest structural code 'Hm' and are known to intergrade with alluvial formations (Hammermaster & Saunders 1995a: 11). The 'Hm' category is the major merchantable forest unit in the existing JFMAA (Hammermaster & Saunders 1995b: SB 55-1 Bogia overlay). On the earlier classifications of Paijmans (1975) and Saunders (1993), the project sites are placed respectively under structural codes 'FHm' and 'Hm.' Due to similarities in terminology employed by each author, the different typing sytems yield comparable floristic descriptions. The Josephstaal tract is essentially a typical medium-crowned forest from low elevation environments.

However the wide variation within this forest type obscures the commercial valuations assignable to specific subunits.

ETHNOBOTANICAL COMPILATIONS

The plant names provided by respondents are derived from the traditional Maia (Maya) language spoken by villagers within the project area. Clan elders Francis Muoimuado and Josef Sigagopa were principal sources for the information summarized in Appendices 2 and 3. Ethnobotanical questioning usually occurred in the presence of a village audience, with the clan elders serving as a central authority or facilitator. A consensus was thus established. The group interviews provided a means for identifying the assets requiring protection from ecoforestry operations. Because the survey objectives were primarily taxonomic, ethnobotanical inquiry was subordinated to the main itinerary, and rapid appraisal procedures were adopted in place of rigorously analytic methods. All aspects of the ethnobotanical inquiry will require critical evaluation against established benchmark studies, when the present investigations are extended into other parts of the Adelbert Range.

Despite these limitations, certain patterns are evident from the compilations. Unlike the nomenclature of formal science, with its simple and rigorously applied binomial protocol, the botanical classification employed by Josephstaal villagers is multifarious and idiosyncratic. Most Maian plant names appear to be descriptively based, and if translated will probably be seen as alluding to particular features of a plant, in the manner of pre-Linnean botany. Although it is obviously not a two-element nomenclature, Maian plant names can occasionally exhibit functional resemblances to a binomial system. In such instances 'generic' units are usually indicated with a common designator at the front of a complete name, the 'species' then being specified with a qualifying phrase or word following the generic mark. Examples include: 'warubu-nganam,' 'warubu-sopasop,' and 'warubu-taleba;' corresponding respectively to *Glochidion* sp. aff. *chondrocarpum*, *Dysoxylum brassii*, and *Dysoxylum pettigrewianum*. Various taxa in *Strobilanthes* (*Hemigraphis*) are similarly designated as variants of 'sagag;' i.e. 'sagag-gosmun,' 'sagag-u-goga-umun,' and 'sagag-ugosum.' The conventions are comparable to findings reported by Petir et al. (1998), from a study conducted in another part of the Adelbert Range.

In most cases, similarities in gross appearance are apparently the major criteria for application of names. This is demonstrated by the woody shrubs *Lepisanthes senegalensis* (Sapindaceae), *Ixora* sp. sect. *Hypsophyllum* (Rubiaceae), and *Phaleria coccinea* (Thymelaeaceae), which are all identified as 'kibi-kibale' despite obvious contrasts in their fertile aspect. The gross equivalence in habit and leaf form is seemingly sufficient for combining these taxa under one concept. The Maian 'maberu' is similarly applied to *Cleistanthus* sp. aff. *papuanus*, *Erythrospermum candidum*, and *Rhyticaryum longifolium*, showing again that names are assigned on the basis of superficial aspect rather than by awareness of specific structural distinctions. The rationale may be less clear however, in cases where the members of a nomenclatural group have little in common even in regards to general form. Other than the fact that they all represent pinnately constructed ferns, *Microsorum membranifolium*, *Asplenium* cf. *affine*, *Lindsaea tenuifolia*, *Bolbitis quoyana*, and *Pleocnemia macrodonta*, are obviously different plants, yet are relegated at least in part, to the one name 'lasa-lasa.' The differences among the referents of 'dagol-dagol' are even more striking; including such diverse taxa as *Asplenium* cf. *amboinense*, *Lindsaea obtusa*, and *Liparis condylobulbon*. From the fact that these plants are so obviously different, the Maian classification surely is not founded on judgments of taxonomic equivalence in the Western sense, but must be proceeding from some other logic; possibly involving a principle of utility.

In floristically rich environments such as are generally present in Papuasia, only a fraction of the botanical diversity will enter the cultural consciousness. Many plants recorded by the recent surveys do not have a local (tokples) name; or at least the respondents were unable to provide one. Of those taxa which find tokples assignment, a very small percentage are actually of ethnographic significance (Appendix 3). When a plant is of high usage-value, it is accorded a unique designation and the phonetic root for that name is often not transferred to other plants. In general the converse relationship is also true; Maian names with heterogeneous group membership are generally composed of 'useless' elements (e.g., 'lasa-lasa') for which there are no clearly defined applications. Where plants of diverse appearance are placed together under common designation, the species involved are not of particular value, so from the traditional-cultural perspective there may be no imperative for distinguishing them anyway. Maian botany is arguably grounded on practical principles. As an information retrieval system, it expends efforts toward the identification of resources with specific cultural application, and tends to consign everything else to loosely defined sets. In cultures without a written tradition, such economy is probably necessary to restrict the amount of ethnological data to limits amenable to oral transmission and retention. While the Maian plant classification is typically artificial and inappropriate as an adjunct to formal floristic research, it appears to represent a system closely adapted to local interests and requirements.

The fact that very different species are often placed under the same Maian name, will complicate TNC's intentions to train forest stewards from traditional landowner groups. Especially in speciose families such as Sapindaceae and Annonaceae, where identifications are largely dependent on an understanding of reproductive structures, Maian botany will be unable to contend with many discriminations even at generic level. This discourages use of the Maian system as a basis for cross-cultural instruction, and necessitates introduction of Western concepts into the training process.

The frequent lack of tokples specificity also argues against reliance on villagers for plant identifications in floristic enumerations. Such dependence would result in information loss and underestimates of diversity. There is no effective substitute for employment of high-resolution taxonomic concepts during botanical inventories; the commentary by Kartawinata (1990:125) regarding the unreliability of local names, is especially relevant.

DESCRIPTIONS OF NEW SPECIES

BARRINGTONIACEAE

Barringtonia josephstaalensis Takeuchi, sp. nov. (**Fig. 2**). TYPE: PAPUA NEW GUINEA. MADANG PROVINCE: Josephstaal FMA area, Guam River, alluvial forest on riverine terraces, between GPS coordinates 9497596 N, 280100 E, and 9496.322 N, 274.601 E, 80 m, 9 Aug 1999 (fl), *W. Takeuchi, J. Wiakabu, M. Gorrez, & A. Towati 13,796* (HOLOTYPE: LAE; ISOTYPES: A, BRIT, K).

Inter species *Barringtoniae* singularis ob folia lineari-loriformia, 47–84 cm longa, 16–38 mm lata, apice acutata, basi sensim angustata.

Understory shrub; monoaxial or branched, to 2 m tall, entirely glabrous. *Branchlets* terete, apically and discontinuously fistulose, otherwise pithy, periderm crustaceous, exfoliating in flakes. *Leaves* spirally congested in terminal rosettes, blades herbaceous or fleshy, adaxially medium green, abaxially light green, obliquely ascending in the lower half, drooping in the upper half, linear or ligulate, 47–84 cm × 16–38 mm (200–310 × longer than broad), attenuate at both ends, margins serrulate, the serrulations with an antrorse process inserted on the leading edge and following the forward margin; venation pinnate, secondaries 50–65 pairs, 8–12 mm apart, arcuate, ±brochidodromous but anastomosing freely beyond the commissural loops, tertiary nervation conspicuously and bifacially areolate, prominulous, midribs prominent on both surfaces; petioles slender, adaxially plane, rounded beneath, proximally swollen, to ca. 9 cm length but obscurely distinguished from the lamina and occasionally with the decurrent leaf base nearly reaching the stem; stipules linear-acuminate, typically 9–18 × 1.5–2.0 mm, falling early, costate, the rib excurrently prolonged to a filiform cauda. *Inflorescence* cauligerous or ramigerous, cernuous, racemose, at times corymbiform, pauciflorous from a rachis 2.0–3.5 cm long; peduncular bracts stipuliform, to 14 × 1 mm, involute; bracteoles minute, linear, not or barely exceeding 1 mm length; pedicels 7–11 mm, articulated at the base. *Flowers* (measurements from rehydrated specimen) globose in bud, initially brownish-purple, later green and red-suffused; calyx tube turbinate, not angulate nor alate, the limb membranaceous, completely connate, at first enclosing the other parts, mucronulate or infrequently with an apical orifice, rupturing at anthesis into 2(–3) subequal lobes, these approximately plinerved, parting nearly to the base, suborbicular, ca. 14 × 13 mm; petals 4, narrowly obovate to oblanceolate, to 24 mm long for buds nearing anthesis, concave, venose; androecium multiseriate, staminal column 13 × 4–5 mm, stamens inserted on the outer side, the lowermost stamens arising 8–9 mm from the base, anantherous, ca. 35 mm long, antheriferous stamens 15–20 mm long, crowded above the lower staminodial ones, the tube rim crowned by a fringing whorl of staminodes ca. 2–3 mm long; ovary (3–)4 celled, ovules several per locule, apically inserted, pendulous, irregularly obovoid; style capillary, 28–32 mm long, exceeding the petals but remaining enfolded until loss of the corolla, thereafter persistent, basally dilated into a conical stylopodium 3 × 3 mm; stigma weakly capitate. *Fruits* unknown.

Distribution and ecology.—Known thus far only from the Josephstaal tract. *Barringtonia josephstaalensis* is a facultative helophyte from seasonally flooded riverine

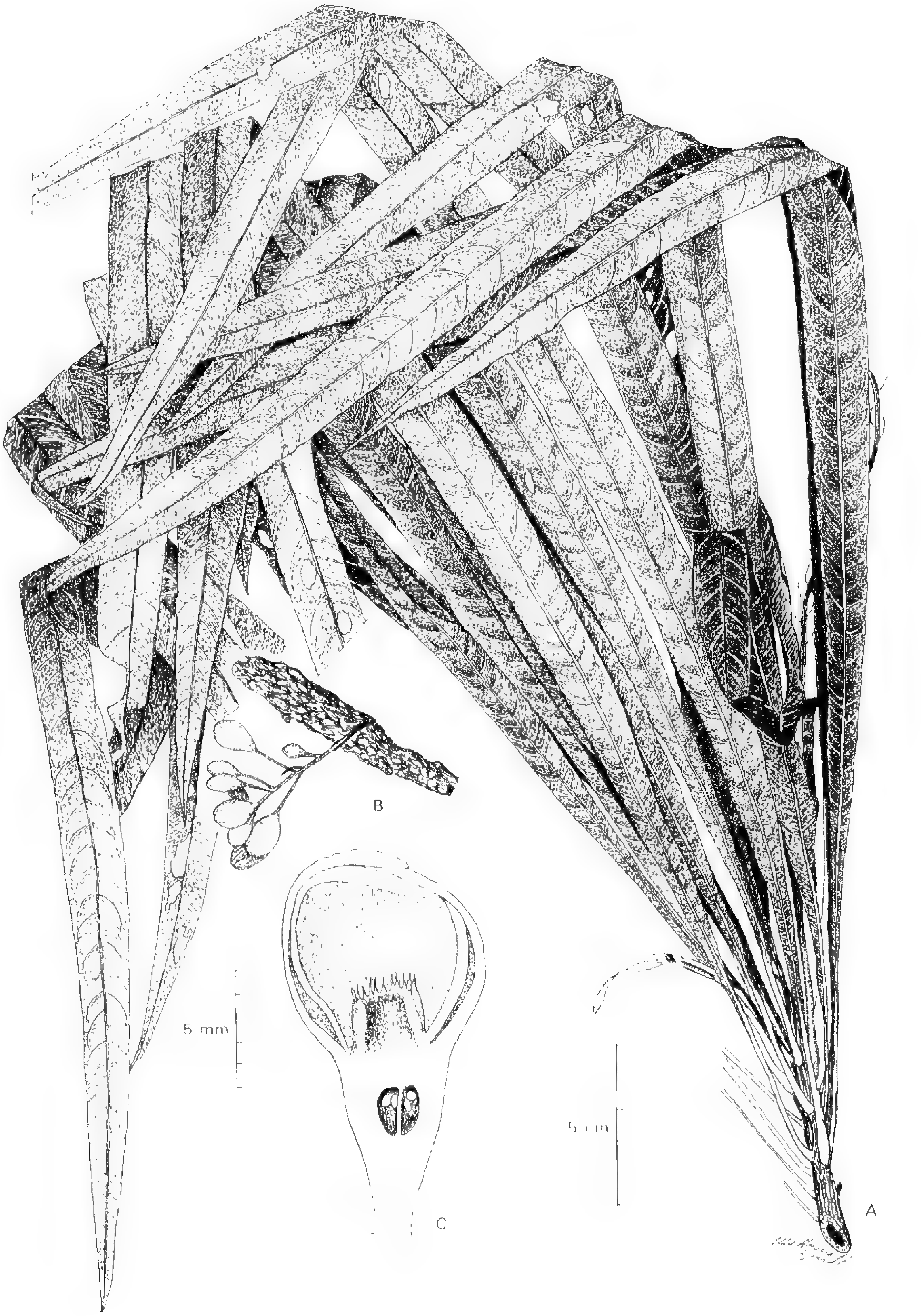

Fig. 2. *Barringtonia josephstaalensis* Takeuchi, sp. nov. A. Vegetative habit. B. Raceme attached to stem section. C. Flower bud; longitudinal and schematicized view across the adaxial surface of the staminal cylinder. Fertile stamens, outer staminodes, and style removed for clarity. Scale bars: A–B, 5 cm; C, 5 mm. Drawn from the type by N.H.S. Howcroft.

flats and the lower slopes of foothill forest. It is apparently not common, at least within the area covered by recent assessment.

Etymology.—The new binomial commemorates the Josephstaal type locality.

Paratypes: PAPUA NEW GUINEA. Madang Province: Josephstaal FMA area, Guam River near expedition Camp 2, lower slopes of natural-growth foothill forest, near GPS coordinates 9497596 N, 280100 E, 50–100 m, 13 Aug 1999 (fl), *W. Takeuchi, J. Wiakabu, M. Gorrez, & A. Towati 13,973* (LAE, NY).

The connate calyces clearly indicate membership in section *Barringtonia*, within which the new species is easily distinguished by its linear leaves. However it is not as certain whether *B. josephstaalensis* is naturally branched; the type collection was made along a forest track so the branches may be the result of bayonnet reiteration.

The monadelphous androecium is marked by the unusual presence of both an outer and inner staminodial whorl. Although the inner series is highly reduced, the outermost structures are conspicuously longer than the fertile stamens. In Payens's (1967: 164) revision, the staminodes of all species are always clearly vestigial and only disposed in adaxial whorls. The existence of outer-marginal staminodes and their prolongation in *B. josephstaalensis*, are thus highly unusual elements. Together with the linear leaves, the character combination for this species is unprecedented. Although the plant's appearance is very deviant, the racemiform inflorescence and apical insertion of ovules are otherwise consistent with *Barringtonia*.

The new species is known by the Maian name 'kun-joob,' and its bark is reportedly used to poison fish in the manner of *Derris* (Fabaceae). Ethnobotanical application of this sort had been reported previously for the sympatric *Barringtonia calyptrocalyx* var. *mollis* (Payens 1967: 212). The latter taxon is identified by the separate Maian name 'gairamalapta.'

Barringtonia josephstaalensis will key to fork 23 in Payens (1967: 180) before reaching an impasse. It can be accommodated by interposing the following couplet between the existing couplets 22 and 23:

Blades 200–310 × longer than broad; lamina ligulate ________ **Barringtonia josephstaalensis** Takeuchi
Blades 1.75–31 × longer than broad; lamina various but not ligulate ____________ to couplet 23

MELIACEAE

Aglaia saxonii Takeuchi, sp. nov. (**Fig. 3**). Type: PAPUA NEW GUINEA. Madang Province: Josephstaal FMA area, along track to Morasapa W of expedition Camp 1 ('Kumamdeber'), mature growth foothill forest, between GPS coordinates 9504560 N, 281407 E, and 950285 N, 28030 E, ca. 160 m, 1 Aug 1999 (fr, carpological), *W. Takeuchi, J. Wiakabu, M. Gorrez, & A. Towati 13,712* (holotype: LAE; isotypes: A, BRIT, K, L).

Species haec *Aglaia subsessili* Pannell affinis sed fructu non longitudinaliter porcatu, loculis 2, denique semine in quoque loculo solitario.

Subcanopy tree to 15 m height. *Branchlets* elactiferous, moderately robust, 6–8 mm diam., the periderm weakly sulcate or irregularly cracking in brittle flakes, at first with an orange-brown indument of dimorphically stellate hairs, the larger hairs appressed or obliquely

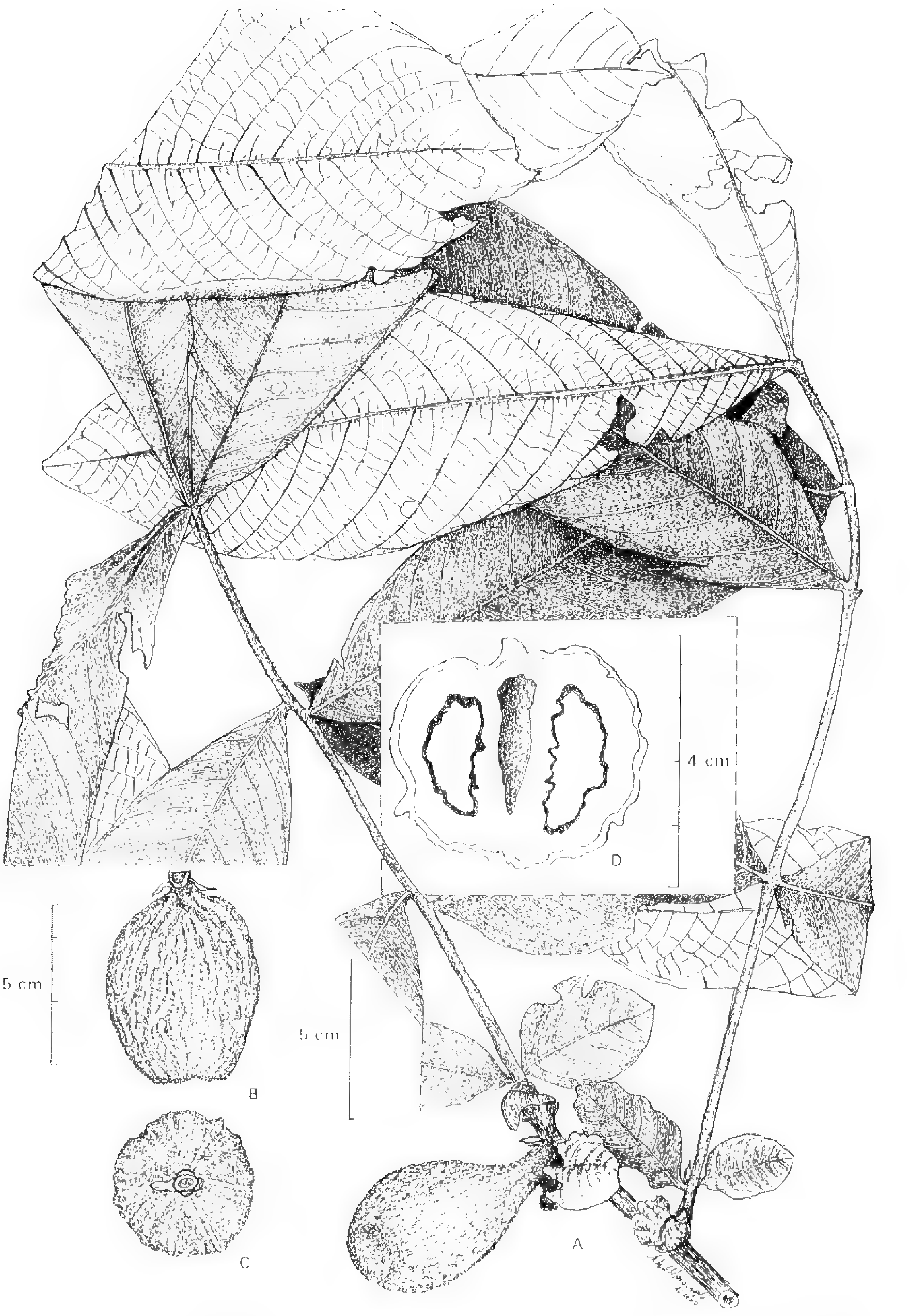

Fig. 3. *Aglaia saxonii* Takeuchi, sp. nov. A. Fruiting branchlet. B. Fruit, side view. C. Fruit, proximal polar view. D. Fruit, cross-section showing two seeds and a central lacuna. Scale bars: A, 5 cm; B–C, 5 cm; D, 4 cm. Drawn from the type by N.H.S. Howcroft.

patent, sometimes crisped, hyaline, arms 10 or more, acicular-setiform, ca. 1 mm long; minor hairs compact, rays coarse, congested, 0.1–0.2 mm long; stem surfaces early glabrescent and then entirely glabrous below the leaf spray. *Leaves* imparipinnate, 3–5 jugate, spiral, terminally congested, sessile, 41–57 × 42–70 cm at maturity, rugose, herbaceous or papery, adaxially opaque dark green, abaxially medium to light green, upper surfaces with hairs restricted to a costal channel and resembling the large hairs on rachis and branchlets, undersurfaces pustulate, indument lax, the abaxial hairs usually 0.5–1.0 mm diam., following veins, intermixing with smaller stelliform scales especially on the midrib, dark glandular pits bifacially scattered; leaf rachis with indumentum like the branchlets; leaflets opposite, decrescent, heteromorphous, the terminal one oblanceolate, basipetally elliptic-oblong then ovate-orbicular, the proximal pair auriculate and amplexicaulous, auricles ca. 1.5 cm diam., subapical leaflets often the largest, oblanceolate, 19.5–33 × 6.0–11.5 cm, shortly acuminate at the apex, basally cuneate; venation pinnate, inconsistently camptodromous or (brochidodromous), secondaries in 16–25 pairs on major leaflets, 5–7 pairs on small leaflets, diverging 45–75° from the midrib then gradually arcuate toward the margin, partial intersecondary veins frequently present, tertiary nerves scalariform or not, reticulum coarsely areolate, veins impressed on upper surfaces, the midrib immersed, beneath with all veins raised; petiolule absent or the leaflets subsessile and costae swollen at the insertion to rachis. *Inflorescence* unknown. *Infructescence* axillary, emerging from foliate nodes, rachis 6–11 × 5 mm, with hairs like the branchlets, bracteate. *Fruits* indehiscent, solitary, rarely two together, obovoid or globose-oblongoid, to 66 × 48 mm; style semi-persistent, stellately hairy at the base, glabrous above; exocarp completely obscured by dense tomentum, the vesture initially orange-brown, later reddish-brown, mealy to the naked eye, only with magnification discernable as thickened stellate tufts; developing fruits stipitate, the sepals foliaceous, disintegrating, adhering to the exocarp, covered by appressed scales with pale setiform rays resembling cystoliths; pericarp woody, indurate, odorous, 6–7 mm thick, locules 2, each cell monospermous; seed surface distinctly sinuate in transection.

Distribution and ecology.—*Aglaia saxonii* is known only from the subcanopy of advanced growth forest at Josephstaal, where it is locally common on foothill slopes. All populations were seen in submature or ripe fruit, suggesting that the species may exhibit big bang flowering.

The plant's stature and distinctive features make it a conspicuous component of the Josephstaal vegetation. Its susceptibility to proposed logging operations is unknown, but as a fairly tall tree species, *A. saxonii* would probably be adversely affected by selective forest removal.

Etymology.—It is a pleasure to name the new species after Dr. Earl Saxon, the Asia-Pacific regional ecologist for the Nature Conservancy (TNC) and the project's senior scientific investigator.

PARATYPES: PAPUA NEW GUINEA. MADANG PROVINCE: Josephstaal FMA area, along track to Morasapa W of expedition Camp 1 ('Kumamdeber'), mature growth foothill forest, near GPS coordinates 9504560 N, 281407 E, 160 m, 29 Jul 1999 (fr), *W. Takeuchi, J. Wiakabu, M. Gorrez, & A. Towati 13,462* (CANB, LAE);

Josephstaal FMA area, between expedition Camp 1 ('Kumamdeber') at GPS coordinates 9504560 N, 281407 E and Manag Wara at GPS coordinates 950629 N, 28052 E, ca. 160 m, 5 Aug 1999 (fr), *W. Takeuchi, J. Wiakabu, M. Gorrez, & A. Towati 13,765* (K, LAE, NY).

The sessile leaves of *A. saxonii* immediately distinguish it from all the Papuasian congeners. The thickly woody pericarp is also atypical. As noted by Pannell (1992: 11) *Aglaia* species generally have brittle to coriaceous pericarps, but the fruits of *A. saxonii* are obviously lignified and required considerable effort to section with a hacksaw.

The novelty's affinity is to *A. subsessilis* of Borneo, but the latter clearly differs in its larger infructescences, thin pericarp, and unilocular-monospermous fruits.

Aglaia saxonii will key to fork 136 in Pannell (1992: 56–57). It can then be integrated to the existing treatment by inserting the following couplet in place of the present couplet 136 (ibid):

Leaves sessile; leaflets sessile or pulvinate ________________________ **Aglaia saxonii** Takeuchi
Leaves petiolate; leaflets clearly petiolulate ________________________ to the existing fork 136

RUBIACEAE

Calycosia mamosei Takeuchi, sp. nov. (**Fig. 4**). TYPE: PAPUA NEW GUINEA. MADANG PROVINCE: Josephstaal FMA area, streambed flowing to SW of expedition Camp 1 ('Kumamdeber'), mature growth foothill forest with occasional landslip communities, near GPS coordinates 9504560 N, 281407 E, 160 m, 28 Jul 1999 (fl, fr), *W. Takeuchi, J. Wiakabu, M. Gorrez, & A. Towati 13,404* (HOLOTYPE: LAE; ISOTYPES: A, BRIT, CANB, K, L, NY).

Species haec ab *C. kajewskio* Merr. & Perry stipulis minoribus (usque ad 32 mm longis), laminis subter furfuraceo-tomentosis indutis, denique nervis lateralibus paucioribus (18–24-jugis) differt.

Understory shrub, 2.5–3.0 m tall. *Branchlets* plagiotropic, foliated only near the ends, twigs terete *in vivo*, compressed when dried, furfuraceous at nodes, the scales primarily in axils, crowded, reddish-brown and setiform, resembling colleters, other stem surfaces puberulous or glabrescent, internodes usually 2–5 cm long. *Leaves* decussate, elliptic or oblanceolate, 23–38 × 5.0–9.8 cm, apically with a short acumen to 1.5 cm long, margins entire, base attenuate and equal; venation regularly pinnatiform, camptodromous, secondaries 18–24 pairs, arcuate, the central ones diverging 55–60° from the midrib, major veins raised above, more prominent below, reticulations prominulous on both surfaces; blades fleshy, adaxially opaque very dark green, abaxially pale green, frequently discolorous on drying: grayish-green or olivaceous above and brownish-red underneath; upper sides glabrous, minutely tuberculate (?cystoliths), undersides furfuraceous on principal veins, otherwise appressedly scalelike-hairy on the remaining surface; petioles 2–5 cm long, puberulent, adaxially channelled or plane, rounded beneath; stipules acuminate, 22–32 × 9–14 mm, basally connate for ca. 1/4 the overall length, caducous, often disintegrating irregularly and leaving a scarious residue, externally pilosulous or glabrous, adaxially furfuraceous at the base. *Inflorescence* capituliform, generally monocephalic, terminating branchlets, infrequently also from subapical axils but then depauperate, heads sessile, hemispherical or depressedly globose, 40–55 mm diam. when fully developed; receptacle discoid, densely shaggy; bracts herbaceous, dull, pink to orange, numerous, crowded, costate and with anastomosing venation, occasionally marked by linear cys-

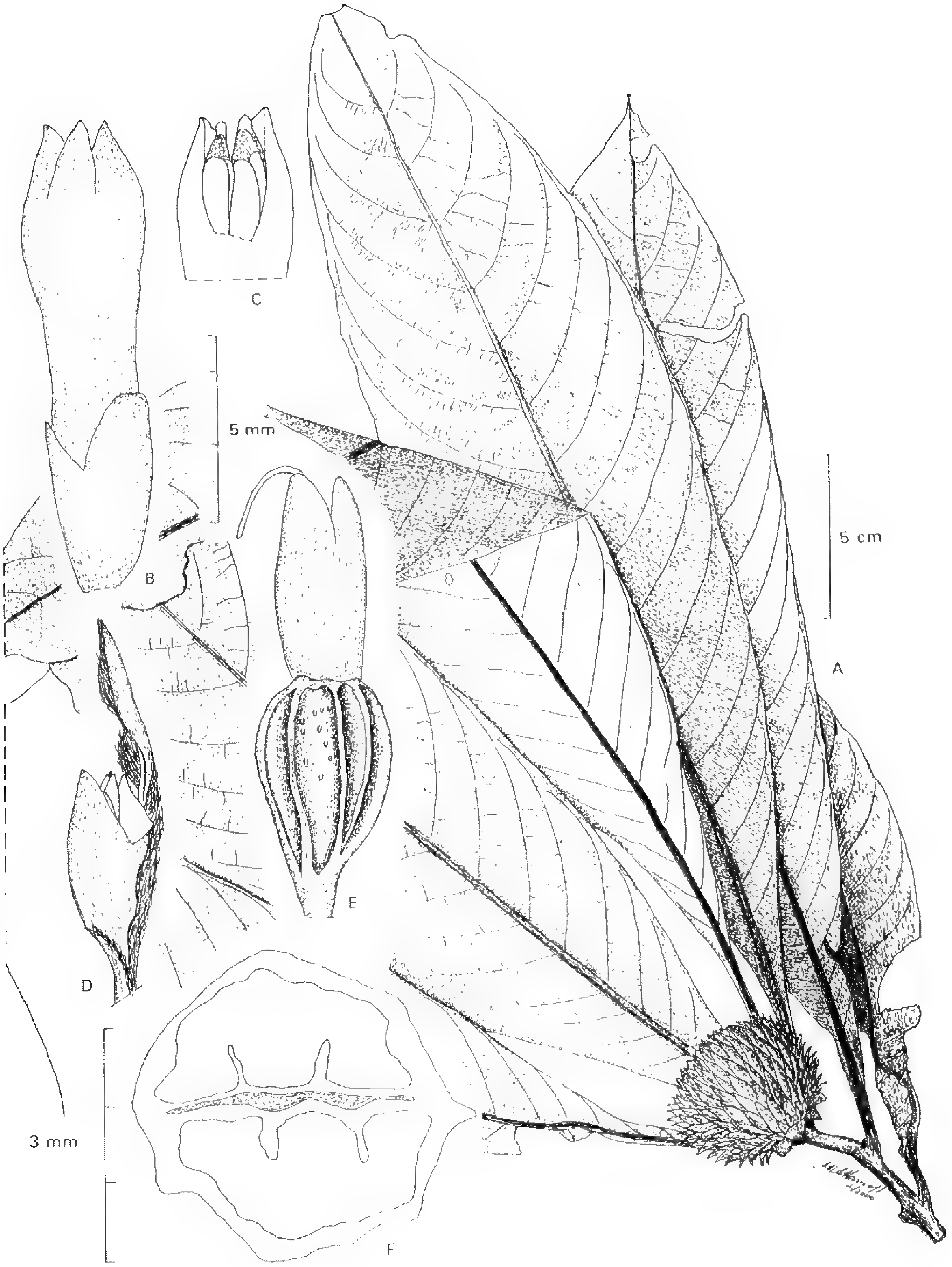

FIG. 4. *Calycosia mamosei* Takeuchi, sp. nov. A. Fertile branchlet. B. Flower from side. C. Corolla limb; one lobe removed. D. Flower bud with subtending bracteole. E. Submature fruit. F. Pyrenes in cross-section. Scale bars: A, 5 cm; B–E, 5 mm; F, 3 mm. Drawn from the type by N.H.S. Howcroft.

toliths, the outer involucral bracts largest, lanceolate to ovate-orbicular, 20–28 × 14–27 mm, usually deciduous before fruit set, internal bracts persistent, highly variable in shape and size: linear, elliptic, oblong, to broadly oblanceolate, 11.5–26 × 1.5–10 mm, lanate on margins and base; floral bracteoles oblanceolate, induplicative, bearded with a central line of hyaline filaments. *Flowers* (rehydrated measurements) obscured by the bracts, glabrous on all exterior surfaces, pedicels 1.0–1.5 mm long, pilose; calyx synsepalous, infundibular, 5.0–5.3 × 2.5–3.0 mm, lobes 2 or 3, obtuse, equal or not, 0.8–2.5 mm long, tube adaxially pilose; corolla valvate, pentamerous, cylindrical, 12.5–15.0 × 3.0 mm, lobes acute, 2.1–2.5 mm long, inner tube pilose for 2–3 mm below the throat; stamens 5, included, inserted 2 mm below the sinuses, anthers linear-sagittate, dorsifixed, 1.7–1.8 mm long, filaments 2.0–2.1 mm, provided with indument like the corolla throat; ovary bilocular, completely inferior; stigma 2-fid, lobes oblongish, 1 mm, fimbriate, style 8 × 0.2 mm, glabrous, filiform, simple; disk coarsely rugose. *Fruits* 8-sulcate or smooth, obovoid, 8–9 × 4–5 mm, exocarp opaquely yellow-orange and glabrous; pyrenes 2, planoconvex, dorsally somewhat irregular but not clearly ridged, the commissural face with two linear invaginations into each seed, albumen lacking ruminations.

Distribution and ecology.—*Calycosia mamosei* is a shade-adapted species of mature forest understories. Numerous individuals were seen on the latest survey, particularly in the elevational interval from ca. 80–200 m. The plant favors well-drained substrates but is also occasionally found on seasonally flooded ground.

The new species is endemic to PNG's northern (Mamose) region, being represented by collections from Madang, East Sepik, and West Sepik Provinces. Although abundant at Josephstaal, *C. mamosei* is probably uncommon in its other localities of occurrence.

Etymology.—The epithet reflects the plant's presently known range.

Other specimens examined: **PAPUA NEW GUINEA. West Sepik Province:** Bewani Subprovince, 12 km N of Bewani, about 40 km SSW of Vanimo, lowland rainforest, lat. 3° 01' S, long. 141° 10' E, 160 m, 28 Aug 1982 (fl), *J. Wiakabu et al. in LAE 73,773* (L, LAE). **East Sepik Province:** Angoram, primary rainforest, lat. 4° 04' S, long. 144° 04' E, 25 Jul 1985 (fl, fr), *L. Harkink 2* (K, L, LAE). **Madang Province:** Bogia Subprovince, Tanvid River, inland of Malolo Hotel, regrowth forest in moderately swampy area, lat. 4° 45' S, long. 145° 24' E, 200 m, 18 May 1986 (fl), *O.G. Gideon & R.J. Johns in LAE 57,325* (L, LAE); Josephstaal FMA area, Guam River near expedition Camp 2, lower slopes of natural-growth foothill forest, GPS coordinates 9497596 N, 280100 E, ca. 50 m, 11 Aug 1999 (fr), *W. Takeuchi, J. Wiakabu, M. Gorrez, & A. Towati 13,877* (K, LAE); Josephstaal FMA area, Guam River, low ridge above expedition Camp 3, S of Dumadum village, natural-growth foothill forest, GPS coordinates 9498679 N, 284829 E, ca. 80 m, 21 Aug 1999 (fr), *W. Takeuchi, J. Wiakabu, M. Gorrez, & A. Towati 14,215* (LAE).

Calycosia is distinguished by large leaves, relatively long infundibular calyces, and a capitate inflorescence surrounded by numerous bracts. It was earlier regarded as ranging from Samoa to the Solomons (Darwin 1979: 38–9). The genus has certain similarities to *Cephaelis*, and also approaches *Psychotria condensata* under Sohmer's broad concept of that genus. The Josephstaal type keys closest to *Calycosia* in Darwin (1979: 34–35).

Calycosia usually has a regularly 5-lobed calyx but in *C. mamosei* it is 2(–3) lobed. The calyx limb and inflorescence bracts are also reportedly deciduous (ibid: 38–39), but they are subpersistent in the new species. *Calycosia mamosei* is otherwise similar to the assigned genus on other characters, particularly with respect to the long-tubular calyx and the capitate, numerously bracteate inflorescence.

The only other species of Papuasian *Calycosia* is the Solomon endemic *C. kajewskii* Merr. & Perry, from which the new species can be readily separated by a host of characters, the most obvious of these being differences in indument, stipule size, and number of lateral veins.

RUBIACEAE

Psychotria mayana Takeuchi, sp. nov. (**Fig. 5**). TYPE: PAPUA NEW GUINEA. MADANG PROVINCE: Josephstaal FMA area, Guam River near expedition Camp 2, lower slopes of natural-growth foothill forest, GPS coordinates 9497596 N, 280100 E, 50–100 m, 12 Aug 1999 (fr), *W. Takeuchi, J. Wiakabu, M. Gorrez, & A. Towati 13,940* (HOLOTYPE: LAE; ISOTYPES: A, BRIT, K, L).

Species haec ab *P. melanocarpae* Merr. & Perry fructibus albis differt.

Branched understory shrub, or subarborescent to 5 m height. *Branchlets* terete, 3.0–5.5 mm diam., glabrescent, subapically smooth and green, on exsiccatae collapsing and compressed, fuscous. *Leaves* fleshy, rugose, adaxially very dark green and glabrous, abaxially medium green, lamina discolorous with drying: on both sides orange-brown to rufescent, rarely olivaceous, underleaf indument subappressed on costae, otherwise mostly patent, occasionally simple, more typically stellately branched or in stelliform fascicles; blades oblanceolate, 22–33 × 6–12.5 cm when mature, apex shortly acuminate, at most subcuspidate, base attenuate, equal; venation pinnate, upper surfaces inconsistently immersed-rugose, manifestly prominent beneath, secondaries equispaced, 12–24, on the large laminae always exceeding 15 pairs, straight, diverging at ca. 45–60° from the midrib, supramedially arcuate toward the margin whether or not with closing commissural loops, tertiaries subscalariform, obliquely directed at the midrib; domatia absent; petioles 2–5 cm, adaxially plane, convex beneath, glabrescent; stipules valvate, caducous, lanceolate to ovate, 14–20 × 4–10 mm, bifurcately cleft, each lobe 5–9 mm aristate, externally marked by medial ridges insensibly confluent with the aristae, coarsely shaggy, inner surfaces densely appressed-hairy. *Flowers* unknown. *Infructescence* strictly terminal, to 11.5 cm long, ebracteate, paniculiform, ramifications verticillately developed through 2–3 orders, the ultimate rachillae cymose, peduncle 1.5–4.0 cm, cernuous, all axial surfaces entirely white, with a reddish-brown vestiture of papillate or subulate hairs, these mostly spreading, often crisped. *Drupes* globose or obovoid, 9–10 × 8–9 mm, subsessile, nitid green, opaquely white when ripe, exocarp glabrescent but with lax hairs persisting at the apex and base; calyx coarsely puberulent. *Pyrenes* 2, equal or not, planoconvex, lacking dorsal crests; endosperm with a central lumen, ruminate by irregular transversal folds.

Distribution and ecology.—*Psychotria mayana* is a small tree growing in stands with multistoried canopy. It is apparently restricted to the Josephstaal area and was collected only from the foothill zone.

Etymology.—It is a pleasure to name the new species after Maya Gorrez, a biologist currently serving with the Washington office of the Nature Conservancy.

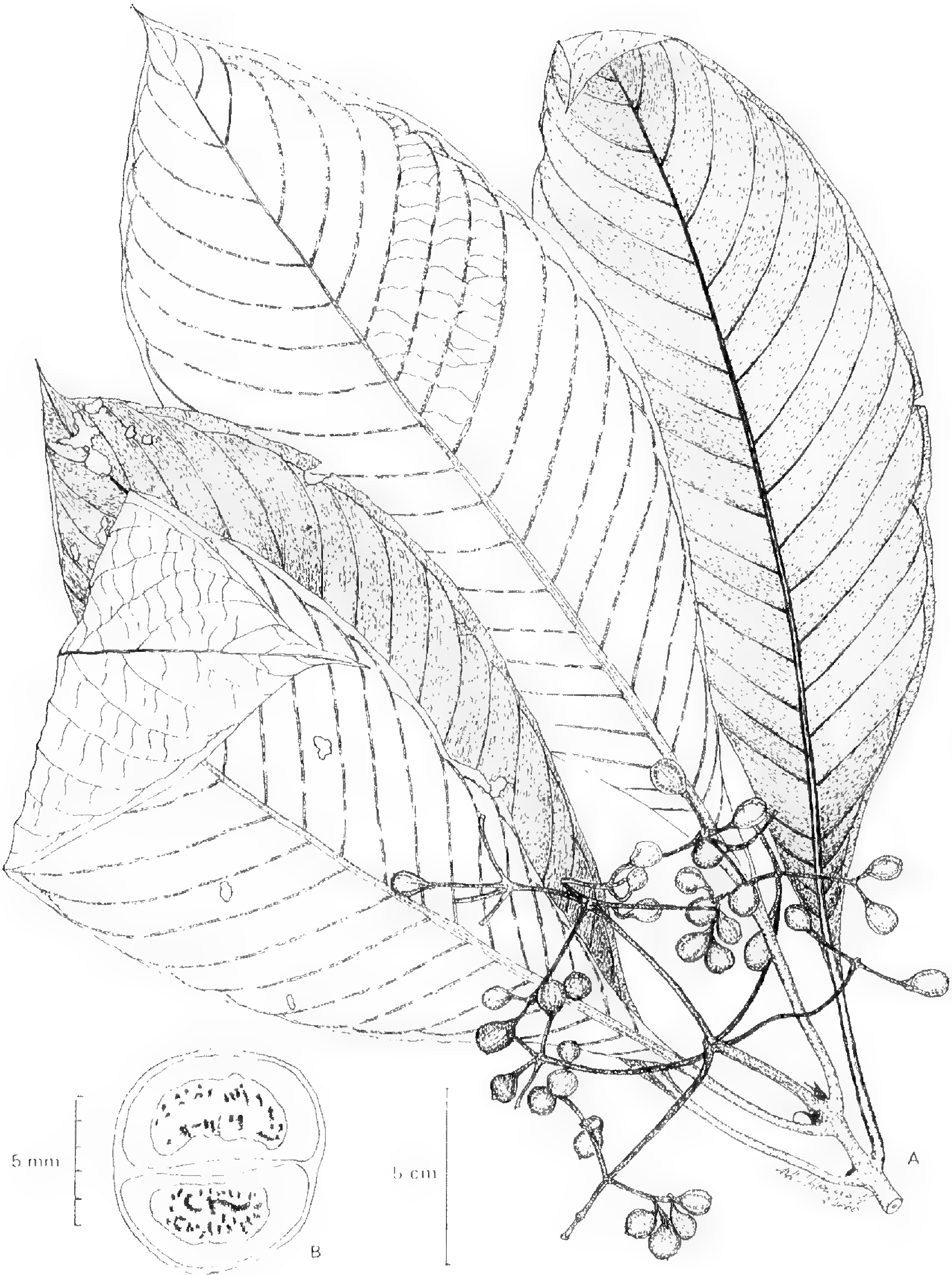

Fig. 5. *Psychotria mayana* Takeuchi, sp. nov. A. Fruiting branchlet. B. Drupe in cross-section. Scale bars: A, 5 cm; B, 5 mm. Drawn from the type by N.H.S. Howcroft.

Paratypes: PAPUA NEW GUINEA. Madang Province: Josephstaal FMA area, along trail to Morasapa W of expedition Camp 1 ('Kumamdeber'), mature growth foothill forest, near GPS coordinates 9504560 N, 281407 E, 160 m, 30 Jul 1999 (fr), *W. Takeuchi, J. Wiakabu, M. Gorrez, & A. Towati 13,585* (BRIT, LAE); Josephstaal FMA area, Guam River near expedition Camp 2, lower slopes of natural-growth foothill forest, GPS coordinates 9497596 N, 280100 E, ca. 50–100 m, 12 Aug 1999 (fr), *W. Takeuchi, J. Wiakabu, M. Gorrez, & A. Towati 13,944* (K, LAE, NY).

Among Papuasian representatives of *Psychotria*, the underleaf hairs assembled in stelliform fascicles (or also basally branching) is a character shared only by *P. melanocarpa* Merr. & Perry. The large fruits to ca. 10 mm diameter and the biaristate stipules are also characteristic of both species. As suggested by its epithet however, *P. melanocarpa* has black fruits, while in *P. mayana* the entire infructescence is white. *Psychotria melanocarpa* is presently known only from Western Province, and *P. mayana* only from Madang Province. They are apparently geographically-separated sister species from opposite sides of the Dividing Ranges.

Psychotria mayana will key to couplet 87 (Sohmer 1988: 24) and to a group of 5 species consisting of *P. sphaerothyrsa*, *P. kaniensis*, *P. multicostata*, *P. dolichantha*, and *P. ramadecumbens*, but is not related to those species. Because *P. melanocarpa* differs from *P. mayana* in fruit color, the two are far apart on the Sohmer key and their relationship is thus not immediately apparent.

The new plant can be incorporated into the existing treatment by interposing the following couplet between forks 86 and 87 (ibid: 24) and then continuing on with the same decision train:

Underleaf indument of stelliform hairs; stipules clearly biaristate __________ **Psychotria mayana** Takeuchi

Underleaf glabrous, or pubescent with simple hairs; stipules usually cleft, but not aristate __________ to fork 87

DISTRIBUTIONAL RECORDS AND OTHER NOTEWORTHY COLLECTIONS

APOCYNACEAE

Rauvolfia moluccana Markgraf; coll. *14262*. Hendrian and Middleton (1999: 457) cite three specimens from the Bismarck Archipelago in their recent revision. Most specimens originate from Indonesia; the species being rarely recorded in the eastern half of New Guinea. Lae Herbarium previously had only one mainland collection in *Rauvolfia*.

ARACEAE

Alocasia lancifolia Engl.; colls. *13852, 14097, 14216*. A common aroid species, but not previously recorded for Madang Province (Hay & Wise 1991: 522).

Homalomena magna A. Hay; coll. *13849*. Previously known with certainty only from W. Sepik Province, in the Vanimo and Amanab areas (Hay 1999: 51).

The species is readily identified by the reddish spathes and dimerous male flowers (ibid: 53); characters exhibited by the Josephstaal voucher.

COSTACEAE

Tapeinochilos recurvatum K. Schum.; coll. *13700*. The plant is a highly restricted endemic, previously known from ten specimens obtained in the Gogol and South Naru drainages near Madang. Clear-cut logging is presently endangering the survival of historical populations (Gideon 1998: 325). The Josephstaal provenance represents the only occurrence whose habitat is not under immediate threat.

Tapeinochilos sp. nov.; coll. *13743*. Gideon (1998: 291) regarded this species as an undescribed *Tapeinochilos* endemic to the central part of northern New Guinea. It was previously known from four locations. The Josephstaal population extends the range significantly eastwards and is the fifth documented provenance for the novelty.

The Adelbert foothills around Madang township had earlier been thought to contain only *T. hollrungii*, *T. pubescens*, and *T. recurvatum*. The discovery of an undescribed *Tapeinochilos* from accessible terrain is yet another indication of the comparatively unexplored status of the Adelbert Range.

EUPHORBIACEAE

Cleistanthus sp., aff. ?**papuanus** (Laut.) Jabl.; coll. *13672*. Possibly new. The collection will not key on any combination of characters using Airy Shaw (1980: 58–9). It much resembles *C. insignis* in aspect, but the fruits are strigose and the vegetative indument is different from that of the latter species.

Glochidion chondrocarpum Airy Shaw, or aff.; coll. *13691*. Previously known only from several specimens obtained at Mt. Bosavi in southern PNG (Airy Shaw 1978: 372–73). Possibly rare. Now recorded on the northern side of the mainland.

The Josephstaal collection is similar to *G. chondrocarpum*, but is ramiflorous, unlike any of the species in the *G. chondrocarpum-decorum-rugulosum* group. The survey voucher is also vegetatively similar to glaucous, large-leaved species like *G. chlamydogyne*. In its ramiflory, the Josephstaal species seems to form a connection between all the preceding taxa and the strictly cauliflorous *G. beehlerii*, and could represent a new species. However the paratypes to *G. chondrocarpum* (i.e., *Jacobs 9107 & 9107A*) have fruits in dense clusters emerging near the main stem, suggesting a transition to cauliflory. Some lumping may eventually become necessary in this complex of species with similar facies, so it is prudent to preliminarily assign the name of the closest taxon to the present collection.

FLACOURTIACEAE

Casearia erythrocarpa Sleumer; coll. *13481*. Originally known only from the type specimen collected on the Fly River (Sleumer 1954: 87) but more recently discovered in the Oomsis-Gabensis areas near Lae (i.e., *Henty in NGF 16501*, and *Takeuchi 7114*).

The species has not been reported in the literature since the time of the *Flora Malesiana* revision (ibid). Its habit as an understory shrub should ordinarily make the plant easy to find, so the scarcity of herbarium specimens probably reflects actual rarity rather than simple undercollecting. With discovery of the Josephstaal population, the species' known distribution consists of three disjunct stations with (probably) low frequencies at each locality.

ICACINACEAE

Rhyticaryum novoguineense (Warburg) Sleumer; colls. *13947, 14192. Rhyticaryum novoguineense* is easily distinguished from congeners by the paniculate inflorescences. The plant is restricted to Madang and Morobe Provinces, and at the time of the latest revision (Sleumer 1971) was represented in herbaria by three specimens. LAE has only two sheets of this taxon.

PROTEACEAE

Helicia affinis Sleumer; coll. *13997.* An arborescent species known only from lowland environments in Madang Province. As a restricted endemic, *H. affinis* is the kind of plant likely to be endangered by introduction of logging operations to the management area.

The expedition voucher is a fruiting collection and thus cannot be keyed on existing treatments (Foreman 1976, 1995; Sleumer 1955). It resembles both *H. latifolia* and *H. finisterrae* in aspect, but the appressedly puberulous underleaf is more similar to *H. latifolia*. The surface scrape on the drupe is conspicuously purple, a feature exhibited by several Papuasian congeners, though not previously noted for this particular species.

RUBIACEAE

Psychotria dipteropoda Laut. & K. Schum.; colls. *13831, 13869, 14045, 14200. Psychotria dipteropoda* had not been seen for nearly a century until its rediscovery during the TNC surveys. The type collection was obtained in the Gogol drainage in 1890, but was subsequently lost during the WWII destruction of Berlin Herbarium. The most recent of the surviving collections was obtained in 1907, even though many botanists have visited and collected from the plant's former localities.

Psychotria dipteropoda occurs only in tall-growth stands beneath intact canopy, on the alluvial flats adjacent to flowing streams. This kind of plant is likely to be highly susceptible to anthropogenic disturbance; firstly, because riverine borders are environments easily altered by human entry into wilderness habitats, and secondly, because its consistent association with advanced growth shows this plant does not flourish in seral situations. Though not a rheophyte, *P. dipteropoda* is apparently adapted to conditions in the seasonal surge zone on river verges. The Gogol and Ramu drainages have been seriously impacted by habitat alteration since the early 1900s, and this is almost certainly the cause for the plant's disappearance from its historical range.

Although the Josephstaal colonies represent the only known occurrences of the species, it is moderately frequent within the Guam drainage. Most sightings were of sterile individuals, but could still be identified because of the undulate blades and the plant's consistent association with a narrowly defined habitat.

The ripe fruit on *P. dipteropoda* is unexpectedly yellow. Fruits of *P. talasensis* have a yellow or orange phase, but the drupe matures to a conventional red (Sohmer 1988: 278), while in *P. dipteropoda* yellow is apparently the ripe color.

Psychotria sp. nov.; coll. *13514.* An undescribed monocaulous species with a marked resemblance to *Maschalodesme*, except that the fruit has two pyrenes.

Psychotria sp. ?nov.; colls. *13451*, *13756*. A vining species. The lianous *Psychotria* are unrevised for Papuasia, having been last treated by Valeton (1927).

The Josephstaal collections are unusual for their extremely membranous leaves and the oblong cystoliths densely marking all surfaces, including the inflorescence. The flowers are small, sessile, and glomerulate on lax rachides. Although possibly new, the status of this plant can be definitely established only through revision of the vining taxa.

Versteegia grandifolia Valeton; coll. *13405*. A rare species from the pachycaul alliance, previously represented by three specimens from West Irian. In their synopsis of the genus, Ridsdale et al. (1972: 340) had specified the plant's distribution only as 'mainland New Guinea.' Collection *13405* keys directly to the above binomial and conforms precisely to Valeton's (1911: tab LXXIII) plate. Although Lae Herbarium has no specimens of this species for comparison, the taxon's distinctive characteristics permit identification from the literature.

The Josephstaal plants were identified as 'wanam-barewa' by village respondents. When the stems are used as a planting implement, they are said to increase crop yields (Wiakabu and Gorrez, field notes).

Josephstaal villagers are also aware of the distinction between this species and the more common *V. cauliflora*, as indicated by their conferral of the different name 'waipa' to the latter. In this particular instance, traditional knowledge conforms to formal taxonomic concepts in Western science. The belief that *V. grandifolia* is connected to increased crop yields is possibly related to its more robust habit in comparison to *V. cauliflora*. It can be surmised that the oversized leaves from the *grandifolia* facies have become associated with a special capacity for growth, which is then transferred when the larger species is used as a planting tool.

RUTACEAE

Wenzelia dolichophylla (Laut. & K. Schum.) Tanaka; colls. *13594, 13623. Wenzelia* is a member of the subfamily Aurantioideae and remains imperfectly understood despite the potential horticultural value of its alliance. Only six collections of *W. dolichophylla* were known at the time of the last published commentary on these plants (Stone 1985).

Swingle (1967) established two subgenera but was unable to assign *W. dolichophylla* into either one due to lack of adequate material. In the ripe fruiting specimens now at hand from Josephstaal, the thin seeds with irregular hyaline margins make it clear that *W. dolichophylla* belongs to his subgenus *Papualimo*. Stone (1985: 214–15) did not provide a subgeneric affinity for *W. dolichophylla* and expressed doubt whether Swingle's seed characters were sufficient for recognition of subgenera.

The Josephstaal plants have wide leaves with prominent and anastomosing secondaries similar to those from the Sepik populations. However the bicolorous blades with divaricate laterals otherwise agree with features more generally characteristic of *W. dolichophylla*. The red hesperidium (salmon-pink on *13594* and pinkish-red on *13623*) is distinctive; other aurantioid taxa are usually orange-yellow. Since most collections of *W. dolichophylla* originate from the Ramu-Gogol drainage, it is very likely that the survey vouchers are correctly placed under this binomial.

Zanthoxylum conspersipunctatum Merr. & Perry; coll. *13636*. The tree is a montane species from elevations above 1500 m (Hartley 1966: 205) and is primarily known from the Highlands Provinces. The expedition gathering is a first record for Madang Province. More significantly, the elevation of collection at ca. 160 m is anomalous and represents a significant extension of the species' vertical range.

The Josephstaal voucher has a number of atypical characters which initially obscured its generic identity. At the time of collection, spines were not visible on the branchlets, the leaflets were epunctate, and the foliage showed no evidence of resinous content. *In sicco*, spiculate excrescences only became evident after collapse of the branchlet. The taxonomic concept for *Z. conspersipunctatum* sensu Hartley is that of a polymorphic complex, since the species consists of numerous distinctive forms which cannot be assembled into discretely repeating units. Although the Josephstaal specimen keys to *Z. conspersipunctatum*, it does not match any conspecific LAE sheet in appearance, so its status is uncertain.

STILAGINACEAE

Antidesma katikii Airy Shaw; coll. *13729*. The species is represented in herbaria by few collections, having been discovered only fairly recently (i.e., 1968 by *Katik in NGF 32762*). All gatherings have originated in the Ramu-Gogol basins. During the 1995 Bismarck Mts. expedition, large populations were recorded and documented near the 600 m level and the species did not appear to be as rare as the small number of collections might suggest (Takeuchi 1999a: 763). With its discovery at Josephstaal, the distribution of *A. katikii* now extends across both sides of the Ramu drainage and the plant is certainly more common than previously supposed, though remaining endemic to Madang Province.

The recency of its discovery, and the uncertainties over the conservation status of *A. katikii*, are circumstances applicable to many other Papuasian taxa. This situation is a natural outcome of the uneven state of floristic exploration in PNG. Botanical collecting in Madang Province has been heavily focused on the Gogol and Ramu basins, yet the Josephstaal populations are within a mere half-day walk from the principal coastal highway. Clearly, there is much work remaining to be done in the floristic documentation even of accessible areas.

TILIACEAE

Microcos sp. ?nov.; colls. *13469, 13562, 13732, 13830, 14104*. The Josephstaal specimens apparently represent a new species distinguished by a bilayered indument of erect simple hairs with smaller stellate hairs underneath (most Papuasian taxa are lepidote). The plant has been collected in several of the north coast districts and possibly also from the Gulf region of PNG. Although undescribed, this is attributable to taxonomic neglect of the genus rather than to biological scarcity.

ZINGIBERACEAE

Etlingera sp. ?nov. (series **Polyanthae**); coll. *13985*. A nomenclatural conspectus of the genus by R.M. Smith (1986) made many transfers from *Achasma*, *Geanthus*, and *Nicolaea*. Most of the Papuasian species were treated by Valeton (1913, 1914) as *Geanthus*, and were depicted with excellent illustrations in early issues of *Nova Guinea*.

The flowers of the Josephstaal collection are unlike those from any species formerly included in *Geanthus* sensu Valeton. Obvious points of distinction are the unusual subfoliaceous wings at the top of the staminal column and the flat paired nectaries at the style base.

THE JOSEPHSTAAL FLORA IN OVERVIEW

Although the Gogol basin near Josephstaal represents one of PNG's better-explored localities, its vegetation has been extensively degraded in recent decades by clear-cut logging. During the severe drought of 1941, a major part of the Gogol was destroyed by fire (Johns 1986: 351) so it is reasonable to assume that a significant but unknown part of the former flora has already been eliminated, especially when past events are considered in light of the alterations occurring today.

Josephstaal is the largest lowland wilderness remaining near Gogol, and not unexpectedly contains many taxa recorded from the latter locality. The records for *Psychotria dipteropoda*, *Rhyticaryum novoguineense*, and *Tapeinochilos recurvatum*, exemplify the similarities between the Josephstaal and Gogol floras. These similarities can be understood in terms of new evidence showing that distributions of New Guinea endemics are correlated to geohistorical phases of terrane accretion (Balgooy et al. 1996: 201 and fig. 16). On the basis of the geological relationship, additional linkages can be anticipated between Josephstaal and the adjacent Gogol-Ramu drainages, because the localities were all part of the same accretional phase in New Guinea's paleohistory. *Illigera novoguineensis* is thus more likely to be rediscovered at Josephstaal than from the now-disturbed historical habitats in the Madang-Ramu area. The species is still known from only three collections dating to ca. 1900 (Croft 1981: 201; Duyfjes 1996: 759). With further exploration of the project tract, other narrow endemics like *Cynometra katikii* might also be found. There is a distinct possibility that *Lauterbachia* will finally be recovered within the JFMAA.

From compilation of completed revisions in the *Flora Malesiana* series, Balgooy et al. (1996: 198) concluded that the number of endemic species from northern New Guinea is higher than from other Malesian areas. It follows from their conclusion, that exploration of poorly surveyed parts of the northern sector is likely to uncover substantial numbers of previously unknown taxa. The discoveries from the recent TNC surveys are consistent with the Adelbert's position in the NE quarter of the Island and the high endemicity associated with northern New Guinea as a whole (ibid). There are general grounds for predicting that future exploration will yield additional discoveries, especially since the higher elevations at Josephstaal have not been examined. Most Papuasian endemics are montane species, though from the past emphasis on montane exploration, it is apparent that the higher-elevation percentages are overstated in relation to the lowland component (ibid: 200; Conn 1994: 125, 128). The discoveries within the project tract are partly a consequence of the poor attention historically devoted to lowland environments.

Because many endemic taxa are shared between the Gogol and Josephstaal localities, it is natural to ask why the new plants had not been found during previous surveys of the Gogol and Ramu drainages. The novelties are visually conspicuous and with attributes which should ordinarily have ensured earlier discovery. If the new taxa had indeed once ranged into similar habitats in the Gogol-Ramu basins, they were probably eliminated there by the environmental upsets of the 1900s, otherwise they would have already entered the botanical record. Circumstances are consistent with the premise that population extinctions are occurring in the modern period without the populations ever being detected.

The TNC surveys point to a possibility that Josephstaal environments are refugia for remnant populations extirpated from other parts of their range. Future work should be deliberately structured in ways to evaluate this presumed status. However the perceptions arising from the recent surveys also need to be weighed against the inadequacy of existing information on the New Guinea flora. Despite its status as a center for biotic diversification, PNG has the dubious distinction of being one of Malesia's worst surveyed nations (Stevens 1989: 127). On a regional comparison, only the Celebes and Sumatra have comparably low collection densities (ibid). While it is generally conceded that certain mountainous areas are hotspots for floristic endemism, the low-elevation centers are not easy to identify. When documentation coverage is so incomplete, it is difficult to be sure if patterns determined by current surveys are real. It may be just as plausible to argue that presumed connections between Josephstaal and adjacent areas might be overturned, if more information were available on the surrounding region.

A total of 139 families, 445 genera, and 730 distinct morphospecies, have been collected at Josephstaal (Appendix 1). An unknown proportion of the flora remains undocumented. The 41 alien species (exclusive of cultivated plants) recorded by the surveys represent 5.6 % of the checklist. For a Papuasian wilderness tract, this is a comparatively high count, which can be attributed to Josephstaal's proximity to provincial population centers and the resulting exposure to anthropogenic influence. The presence of dirt roads into the project sites has no doubt facilitated entry of introduced plants. An instructive contrast can be drawn between these alien elements at Josephstaal and those from more isolated sites accessible only by air travel. Remote landlocked areas in the Lakekamu basin and Bismarck-Ramu Range were recently assessed on the same protocols (including attention to weeds) as the Josephstaal inventory; and with an equivalent search investment of one-month duration. These latter evaluations produced an alien naturalized count of 8 species (1.2% of the total) for Lakekamu (Reich 1998; Takeuchi & Kulang 1998), and 9 species (1.5 %) for Bismarck-Ramu (Takeuchi 1999a). At Crater Mt. a more intensive survey found 24 alien species comprising 1.8% of all recorded taxa (Takeuchi 1999b). These figures suggest that collection of alien plants can be profitably integrated into future schedules as an independent means for determining the relative quality of evaluated habitats. Investigators have an understandable preference for focusing on indigens during site assessments, but the adventives may actually provide a more practical indicator of habitat preservation and isolation.

None of the weeds recorded at Josephstaal poses any threat to the environment, with most of the introductions consisting of benign herbs restricted to repetitively disturbed ground (*Piper aduncum* excepted). The presence of anthropogenous plants is an unwanted condition in any wilderness habitat, but alien occurrences are inevitable whenever an area is relatively easy to enter. Within PNG, conservation easements and land units comparable to Josephstaal are usually very isolated environments, and thus logistically difficult to botanize. The accessibility of Josephstaal's high-value habitats is a marked contrast to these other venues. Although proximity to urban centers causes greater exposure to unwanted factors, it can also foster scientific research and community-based development, because of the comparative ease of operations afforded by convenient access. The combination of biodiverse wilderness with low cost logistics, will enable consideration and implementation of a wide range of planning alternatives for the project tract.

APPENDIX 1

LIST OF PLANT TAXA FROM JOSEPHSTAAL

Voucher source for occurrence record: NGF = collections from the New Guinea Force series, P&C = B.S. Parris and J.P. Croxall, T = W. Takeuchi, J. Wiakabu, M. Gorrez, and A. Towati, T&S = W. Takeuchi and E. Saxon, sn = sin numéro (without number), SR = sight record of taxon known to the project botanist. Other collectors indicated by name. Determinations by WT unless otherwise noted.

FERNS AND FERN ALLIES

ADIANTACEAE

Adiantum philippense L.; *T 13436, 14254*

ASPLENIACEAE

Asplenium affine Swartz, '*affine-cuneatum* group' (cf. Copeland 1949: 220–221, Sledge 1962: 408); *T 13490*

Asplenium cf. *amboinense* Willd., '*amboinense-papuanum* group' (cf. Copeland 1949: 212); *T 13649, 13745, 13893*

Asplenium cuneatum Lamk, '*affine-cuneatum* group'; *T 14255*

Asplenium nidus L. var. nidus; *T 13943*

Asplenium phyllitidus Don ssp. *malesicum* Holttum; *T 13590*

Asplenium subemarginatum Rosenst.; *T 13928*

Asplenium tenerum Forst.; *T 14181*

Diplora d'urvillaei (Bory) C. Chr.; *T 13450, 13800, 14241*

ATHYRIACEAE

Callipteris prolifera (Lamk) Bory; *T 13605, 13843,* also *P&C 8401*

Callipteris spinulosa (Blume) J. Smith; *T 13919*

Callipteris sp., aff. *spinulosa* (Blume) J. Smith; *P&C 8400*

Diplazium sp.; *T 13662*

BLECHNACEAE

Stenochlaena milnei Underw.; *T 13891*

CYATHEACEAE

Cyathea sp.; *T 14118*

DAVALLIACEAE

Davallia solida (Forst.) Swartz; SR, occasional throughout area

Davallia sp., section *Humata*; SR, sterile, throughout area

Davallia sp.; *K.J. White in NGF 10285*, cited in NGF files but not found at LAE

DENNSTAEDTIACEAE
Dennstaedtia scandens (Blume) T. Moore; *T 14072*
Microlepia speluncae (L.) T. Moore; *T 14107*

EQUISETACEAE
Equisetum ramosissimum Desf. ssp. *debile* (Vauch.) Hauke; *T 13873, 14242*

GLEICHENIACEAE
Dicranopteris linearis (Burm. f.) Underw.; SR, burn areas near Roumirap

HYMENOPHYLLACEAE
Cephalomanes atrovirens Presl; *T 13546, 13903, 14170*

LINDSAEA GROUP
Lindsaea obtusa J. Smith; *T 13540, 13894, 13904, 13935, 14180*
Lindsaea tenuifolia Blume; *T 13489, 13529, 13924, 14182*
Sphenomeris retusa (Cav.) Maxon; *T 14138*

LOMARIOPSIDACEAE
Bolbitis heteroclita (Presl) Ching; *T 13883*
Bolbitis quoyana (Gaud.) Ching; *T 13589, 13657*
Bolbitis cf. *quoyana* (Gaud.) Ching; *T 13488, 13615*
Lomagramma cf. *sinuata* C. Chr., closer to *sinuata* than *L. melanolepis* v.A.v.R.; *T 13865*, cf. *P&C 8361*
Lomariopsis kingii (Copel.) Holttum; *T 13665*

LYCOPODIACEAE
Huperzia cf. *squarrosa* (Forst. f.) Trevisan; *T 13693*
Palhinhaea cernua (L.) Vasc. & Franco; SR, foothill forest

MARATTIACEAE
Angiopteris evecta (Forst.) Hoffm.; SR, Guam River

OLEANDRACEAE
Nephrolepis biserrata (Swartz) Schott; *T 14078*
Nephrolepis (close to) *biserrata* (Swartz) Schott; *T 13962*

OPHIOGLOSSACEAE
Helminthostachys zeylanica (L.) Hooker; *T 14080*
Ophioglossum nudicaule L. f.; *T 14299*
Ophioglossum pendulum L.; SR, foothill forest

POLYPODIACEAE
Aglaomorpha drynarioides (Hooker) Roos; *T 13872*
Aglaomorpha heraclea (Kunze) Copel.; *T 14010*
Drynaria sparsisora (Desv.) T. Moore; *T 13978*
Goniophlebium percussum (Cav.) Wagner & Grether; *T 14281*
Lemmaphyllum accedens (Blume) Donk; *T 13435, 13611*
Microsorum linguiforme (Mett.) Copel.; *T 13651, 13900*
Microsorum membranifolium (R. Br.) Ching; *T 13431, 13996*
Microsorum papuanum (Baker) Parris; *T 13975*
Microsorum punctatum (L.) Copel.; SR, alluvial forest
Platycerium wandae Racib.; SR, alluvial forest and near Roumirap
Pyrrosia lanceolata (L.) Farwell; *T 14018*
Pyrrosia princeps (Mett.) Morton; *T 13515, 13660, 13983*

PSILOTACEAE
Psilotum nudum (L.) Palisot de Beauvois; *T 14000*

PTERIDACEAE
Pteris ensiformis Burm. f.; *T 14253*
Pteris gardneri (Fée) Hooker; *T 14099*
Pteris ligulata Gaud.; *T 13626, T 13953*, also *P&C 8398*
Pteris pacifica Hieron.; *P&C 8387*
Pteris cf. *torricelliana* Christ, '*P. excelsa* Gaud. facies'; *T 14256*
Pteris tripartita Swartz; *T 13650, 14039*
Pteris warburgii Christ; *T 13632*, also *P&C 8385*

SCHIZAEACEAE
Lygodium circinnatum (Burm. f.) Swartz; *T 13493, 14204*
Lygodium dimorphum Copel.; *T 14081*
Schizaea dichotoma (L.) Sm.; *T 13528*

SELAGINELLACEAE
Selaginella cf. *longiciliata* Hieron.; *T 14146*
Selaginella cf. *velutina* Cesati; *T 13539*
Selaginella sp., aff. ?*hieronymiana* v.A.v.R.; *T 13531, 13906*

TECTARIA GROUP
Pleocnemia macrodonta (Fée) Holttum; *T 13492, 13684*
Tectaria bamleriana (Rosenst.) C. Chr.; *T 14002*
Tectaria menyanthidis (Presl) Copel.; *T 13454*
Tectaria pleiosora (Alderw.) C. Chr.; *P&C 8384*
Tectaria repanda (Willd.) Holttum; *T 14074*
Tectaria sp., aff. ?*teratocarpa* (Alderw.) C. Chr.; *T 14079*

THELYPTERIDACEAE
Plesioneuron tuberculatum (Cesati) Holttum; *T 13633*
Pneumatopteris sogerensis (Gepp) Holttum; *T 13604*
Pneumatopteris sp., aff. *keysseriana* (Rosenst.) Holttum; *T 13882*
Pronephrium micropinnatum Holttum; *T 13412*, also *P&C 8395*

Sphaerostephanos acrostichoides (Desv.) Holttum; *T 14259*

Sphaerostephanos (closest to) *acrostichoides* (Desv.) Holttum; *T 13664*

Sphaerostephanos arfakianus (Baker) Holttum; *T 13416*, also *P&C 8402*

Sphaerostephanos invisus (Forst. f.) Holttum; *T 14001, 14144*

Sphaerostephanos pilososquamatus (v.A.v.R.) Holttum; *T 13690*

Sphaerostephanos unitus (L.) Holttum var. *mucronatus* (Christ) Holttum; *T 14109*

VITTARIACEAE

Antrophyum cf. *reticulatum* (Forst.) Kaulf., '*callifolium-reticulatum* complex' (cf. Holttum 1954: 605); *T 13902*

Vittaria elongata Swartz var. *elongata*; *T 13656, 14017*

GYMNOSPERMS

CYCADACEAE

Cycas schumanniana Laut.; SR, ridge near Wagadab

GNETACEAE

Gnetum costatum K. Schum.; *T 13725, 13964, 14106*

Gnetum gnemon L.; *T 13758*

Gnetum gnemonoides Brongn.; *T 13439*

Gnetum sp.; *K.J. White in NGF 10255*, cited in herbarium log but not found at LAE

PODOCARPACEAE

Podocarpus rumphii Blume; *K.J. White in NGF 10293*, det. D. de Laubenfels

Podocarpus cf. *rumphii* Blume; *T 13492*

DICOTS

ACANTHACEAE

Blechum brownei Juss.; *T 14051*

Calycacanthus magnusianum K. Schum.; *T&S 13086, T 13574*

Dicliptera papuana Warburg; *T 13859*

Graptophyllum pictum (L.) Griff.; *T&S 13070, 13084, T 13720*

Hulemacanthus novoguineensis (Lindau) Bremek.; *T 13730*

Hypoestes floribunda R. Br. var. *neoguineensis* R.M. Barker; *T 13544*

Justicia gendarussa Burm. f.; *T 13655*

Justicia sp.; *T 13429, 13434, 14203*

Lepidagathis cf. *royenii* Bremek.; *T&S 13079*

Odontonema cuspidatum (Nees) Kuntze; *T 14135*

Pseuderanthemum sp., cf. '*variabile* group' sensu Barker (1986: 146–156); *T 13678*

Ptyssiglottis pubisepala (Lindau) B. Hansen; *T 13413, 13658*, also *Pullen 1067*, det. B. Hansen

Ruellia sp. (*Leptosiphonium*); *T 13427, 13738*

Rungia sp., aff. ?*klossii* S. Moore; *T 14272*

Strobilanthes sensu lato, *Hemigraphis primulifolia* (Nees) F. Vill. facies; *T 13889, T 14147*

Strobilanthes sensu lato (*Hemigraphis* sp.); *T 13453, 13583, 13587, 13679*

ACTINIDIACEAE

Saurauia conferta Warburg; *T 13981*

Saurauia schumanniana Diels, or aff.; *T 14285*

Saurauia sp., series *Obvallatae*, aff. ?*stichophlebia* Diels; *T 14117*

ALANGIACEAE

Alangium villosum (Blume) Wangerin ssp. *ferrugineum* (C.T. White) Bloembergen; *T&S 13103, T 13674, 13828*

AMARANTHACEAE

Achyranthes bidentata Blume; *T 13898*

Amaranthus dubius Thell.; *T 13874*

Celosia argentea L.; SR, Guam R. streambed and margins

ANACARDIACEAE

Buchanania macrocarpa Laut.; *T 13598*

Dracontomelon lenticulatum Wilkinson; *T 14012*, also *K.J. White in NGF 10312*, det. D. Frodin

Mangifera minor Blume; SR, Guam alluvial forest

Rhus taitensis Guillemin; *K.J. White in NGF 10309*, det. Ding Hou; also SR at Camp 2

Semecarpus brachystachys Merr. & Perry; *T 13740*

Semecarpus forstenii Blume; *T 13832, 14171, 14250*

Semecarpus magnificus K. Schum.; *T 14217*

ANNONACEAE

Cananga odorata Hooker f. & Thoms.; SR, Guam River

Cyathocalyx papuanus Diels, or aff.; *T 13507*

Cyathocalyx sp. ?nov.; *T 13458*

Goniothalamus aruensis Scheffer; *K.J. White in NGF 10228*, det. K. Salleh

Goniothalamus cf. *aruensis* Scheffer; *T&S 13093*

Goniothalamus cf. *imbricatus* Scheffer; *T 13475, 13639, 13840, 13948, 13950, 14172, 14186*

Goniothalamus sp.; *T&S 13058, T 13695, 14093*

Haplostichanthus longirostris (Scheffer) van Heusden; *T 13835, 14233*

Petalolophus sp., aff. *megalopus* K. Schum.; *T 13754, 13769*

Popowia sp., aff. *pisocarpa* (Blume) Endl.; *T 13447, 13773*

Popowia sp.; *T 13748*

Pseuduvaria sp., aff. ?*versteegii* (Diels) Merr.; *T 13500*

Pseuduvaria sp. A; *T 13751, 13857, 14061, 14070*

Pseuduvaria sp. B; *T&S 13054, T 13423, 13733, 13856*
Pseuduvaria sp. C.; *T 13507*
cf. *Xylopia* sp.; *T&S 13064*, also *K.J. White in NGF 10272*

APOCYNACEAE
Alstonia scholaris (L.) R. Br.; SR, foothill forest
Anodendron oblongifolium Hemsl.; *T 13659*
Cerbera floribunda K. Schum.; *T 13518, 13990*
Melodinus cf. *acutus* (Markgraf) Markgraf; *T 13494*
Melodinus forbesii Fawc.; *T 14309*
Neisosperma citrodorum (Laut. & K. Schum.) Fosb. & Sach.; *T 13907, 14207*, also *K.J. White in NGF 10227*, det. F. Markgraf
Ochrosia coccinea (Teijsm. & Binn.) Miq.; *T 13998*
Parsonsia curvisepala K. Schum.; *K.J. White in NGF 10318*, det. P.I. Forster
Parsonsia lata Markgraf; *T 14297*
Parsonsia oligantha (K. Schum.) D.J. Middleton; *T 14123, 14263*
Rauvolfia moluccana Markgraf; *T 14262*
Tabernaemontana aurantiaca Gaud.; *T 13510, 13802*
Tabernaemontana orientalis R. Br.; *T 13887*
Tabernaemontana pandacaqui Lam., sensu Forster (1992: 528–529); *T&S 13080, T 14205*
Voacanga grandifolia (Miq.) Rolfe; *T 14290*

ARALIACEAE
Gastonia spectabilis (Harms) Philipson; *T 13498*
Mackinlaya celebica (Harms) Philipson; *T 13570*
Osmoxylon boerlagei (Warburg) Philipson; *T 14279*
Osmoxylon novoguineense (Scheffer) Becc.; SR, disturbed areas near Roumirap
Osmoxylon sessiliflorum (Laut.) Philipson; *T 13912*
Osmoxylon (closest to) *sessiliflorum* (Laut.) Philipson; *T&S 10353-B, T 13836*
Schefflera sp.; SR, high epiphyte in overstory of foothill forest

ARISTOLOCHIACEAE
Pararistolochia schlechteri (Laut.) M.J. Parsons; *T 13926*

ASCLEPIADACEAE
(dets. by P.I. Forster unless otherwise indicated)
Asclepias curassavica L.; *T 14245*, det. WT
Hoya anulata Schltr.; *T 14284*
Hoya pottsii Traill; *T 13536, 14289*
Hoya sp.; *K.J. White in NGF 10323*
Marsdenia velutina R. Br.; *T 14229*
genera indet.; *T 13786, 14124*

ASTERACEAE
Ageratum conyzoides L.; *T 13718*
Bidens pilosa L. var. *minor* (Blume) Sherff; *T 14131*
Blumea arfakiana Martelli; *T 13419, 13612, 13791*
Blumea riparia (Blume) DC.; *T 13669*
Blumea riparia (Blume) DC. f. *riparia*; *K.J. White in NGF 10319*, det. J. Koster
Cosmos caudatus HBK; *T&S 13073*
Crassocephalum crepidioides (Benth.) S. Moore; *T 13648*
Eclipta prostrata (L.) L.; *T 13793, 13861, 14088*
Emilia sonchifolia (L.) DC. var. *javanica* (Burm.) Mattfeld; *T 14244*
Erechtites valerianifolia (Wolf) DC.; *T 13815*
Mikania cordata (Burm. f.) B.L. Rob. forma *villosa* Koster; *T 13654*
Synedrella nodiflora (L.) Gaertner; *T 13772, 14236*
Vernonia arborea Ham. var. *mollissima* (Ridl.) Koster; *T&S 13085, T 14261*
Wedelia biflora (L.) DC.; *T 13809*

BALSAMINACEAE
Impatiens hawkeri Bull; *T 13790*

BARRINGTONIACEAE
Barringtonia apiculata Laut.; *Robbins 1667*
Barringtonia calyptrocalyx K. Schum. var. *mollis* Laut.; *T&S 13067, T 13567, 13576*
Barringtonia josephstaalensis Takeuchi; *T 13796, 13973*
Planchonia papuana Knuth; *K.J. White in NGF 10250*, det. K. Kartawinata

BEGONIACEAE
Begonia papuana Warburg; *T 13417, 13543, 13545, 13884*
Begonia pseudolateralis Warburg; *T 14420, 14422*

BIGNONIACEAE
Pandorea cf. *pandorana* (Andr.) Steen.; *T 14246*, det. K. Damas
Tecomanthe dendrophila (Blume) K. Schum.; *T 13766, 14060*

BIXACEAE
Bixa orellana L.; SR, cultivated

BOMBACACEAE
Bombax ceiba L.; SR, foothill forest

BORAGINACEAE
Tournefortia sarmentosa Lamk; *T 14193*

BURSERACEAE
Canarium acutifolium (DC.) Merr. var. *acutifolium*; *K.J. White in NGF 10254*
Canarium vitiense A. Gray; *T&S 13109, T 14234*, also *K.J. White in NGF 10325*
Haplolobus floribundus (K. Schum.) H.J. Lam; *K.J. White in NGF 10275*, cited in Leiden determination lists but specimen not found at LAE

CAESALPINIACEAE

Bauhinia ampla Span.; *T 14044*
Caesalpinia bonduc (L.) Roxb.; *T 14042*
Caesalpinia sumatrana Roxb.; SR, across river from Camp 2
Cassia alata L.; *T 13797*
Intsia bijuga (Colebr.) Kuntze; *T 13692*
Kingiodendron alternifolium (Elmer) Merr. & Rolfe; *T 14126*
Maniltoa cynometroides Merr. & Perry; *K.J. White in NGF 12095*, det. B. Verdcourt
Maniltoa plurijuga Merr. & Perry; *T 13984*
Maniltoa rosea (K. Schum.) Meeuwen; *K.J. White in NGF 10226, 10301*, det. M. van Meeuwen
Maniltoa schefferi K. Schum. & Hollrung; *T 13571, 13783, 14011*

CARICACEAE

Carica papaya L.; SR, ?naturalized

CARYOPHYLLACEAE

Drymaria cordata (L.) Willd. ex Roem & Schult.; SR, Guam R.

CECROPIACEAE

Poikilospermum amboinense Zipp. ex Miq.; *T 13804, 13977*
Poikilospermum (probably) *amboinense* Zipp. ex Miq.; *T 14041*, also *K.J. White in NGF 10244*

CELASTRACEAE

Salacia erythrocarpa K. Schum.; *T 14240*

CHLORANTHACEAE

Chloranthus erectus (Buch.-Ham.) Verdcourt; *T 13752*

CLUSIACEAE

Calophyllum sp.; SR, scattered sightings of sterile individuals throughout area
Garcinia cf. *celebica* L.; *T 14159*
Garcinia dulcis (Roxb.) Kurz; *T 13839*
Garcinia hollrungii Laut.; *K.J. White in NGF 10313*, det. P.F. Stevens
Garcinia klinkii Laut., or aff.; *K.J. White in NGF 10267*, det. P.F. Stevens
Garcinia maluensis Laut.; *T&S 13083, T 13477, 13511*
Garcinia sp.; *K.J. White in NGF 10257*

COMBRETACEAE

Terminalia complanata K. Schum.; *T 13991*, also *K.J. White in NGF 10266*, det. M.J.E. Coode
Terminalia impediens Coode; *T 13951, 13952*

CONVOLVULACEAE

Ipomoea congesta R. Br.; *T 13722*
Merremia peltata (L.) Merr.; *T 13726*
Operculina riedeliana (Oliv.) Oostroom; *T 14235*

CUCURBITACEAE

Alsomitra macrocarpa (Blume) Roem.; SR, Camp 3, cf. *Pullen 1096*
Cucurbita sp.; *T 13871*
Trichosanthes sp., '*longiflora-bracteata* group' (cf. Harms 1925: 159); *T 13910*
Zehneria mucronata (Blume) Miq.; *T 13609, 13954*

DATISCACEAE

Octomeles sumatrana Miq.; SR, very common emergent in alluvial zone

DICHAPETALACEAE

Dichapetalum sessiliflorum Leenh.; *T 13851, 14065*

DILLENIACEAE

Dillenia castaneifolia (Miq.) Martelli ex Dur. & Jacks.; *T&S 13050, T 14268*
Tetracera nordtiana F.v.M.; *T 13905*

DIPTEROCARPACEAE

Vatica rassak (Korth.) Blume; *T 14208*

EBENACEAE

Diospyros papuana Valeton ex Bakh.; *T 13577, 13915*
Diospyros pulchra Bakh.; *K.J. White in NGF 10261*
Diospyros rostrata (Merr.) Bakh.; *T 13764*, det. K. Damas

ELAEOCARPACEAE

Aceratium ledermannii Schltr.; *T 13671, 13946*
Elaeocarpus amplifolius Schltr.; *K.J. White in NGF 10256*, det. M.J.E. Coode
Elaeocarpus sphaericus (Gaertn.) K. Schum.; SR, Camp 2
Sloanea sogerensis Baker f.; *T 14063*

EUPHORBIACEAE

Acalypha grandis Benth.; *T 14303*
Acalypha hellwigii Warburg cf. var. *mollis* (Warburg) K. Schum. & Laut; *T 14288*
Actephila lindleyi (Steud.) Airy Shaw; *T 13668*
Aporosa (probably) *papuana* Pax & Hoffm.; *T 13890*
Breynia cernua (Poir.) Muell. Arg.; *T 13614, 13723, 14048*
Bridelia macrocarpa Airy Shaw; *K.J. White in NGF 10280*, det. J.R. Croft
Cleistanthus sp., aff. ?*papuanus* (Laut.) Jabl.; *T 13672*
Codiaeum variegatum (L.) Blume var. *moluccanum* (Decne) Muell. Arg.; *T 13746, 14300*
Codiaeum sp.; *T 13742, 14035*, det. K. Damas
Drypetes longifolia (Blume) Pax & Hoffm.; *K.J. White in NGF 10313A*
Endospermum moluccanum (Teijsm. & Binn.) Kurz; *T 13863, 13980*

Euphorbia heterophylla L.; *T 14089*
Euphorbia hirta L.; *T 13798*
Euphorbia plumerioides Teijsm. ex Hassk. var. *acuminata* J.J. Sm.; *T 14139*
Fahrenheitia sp. ?nov.; *T 13689*
Glochidion chondrocarpum Airy Shaw, or aff.; *T 13691*
Glochidion granulare Airy Shaw; *T 13557, 13734, 13966*
Glochidion lobocarpum (Benth.) Bailey; *T&S 13092-B*
Glochidion novoguineense K. Schum.; *T 14125, 14155*
Glochidion (close to) *perakense* Hooker f. var. *supra-axillare* (Benth.) Airy Shaw, '*lanceilimbum-perakense* complex' (cf. Airy Shaw 1975: 125, 1980: 106–107); *T 14073*
Macaranga aleuritoides F.v.M.; *T 14160-B*
Macaranga fallacina Pax & Hoffm.; *T 13541*
Macaranga polyadenia Pax & Hoffm.; *K.J. White in NGF 10314*, this staminate specimen may be conspecific with *T 14105, M. subpeltata*
Macaranga quadriglandulosa Warburg var. *quadriglandulosa*; *T 13960, 14062*
Macaranga subpeltata Laut. & K. Schum.; *T 14105*
Macaranga sp.; *K.J. White in NGF 10260*
Manihot esculenta Crantz; *T 13785*
Melanolepis multiglandulosa (Reinw. ex Blume) Reichb f. & Zoll.; *T 14036*
Omalanthus novoguineensis (Warburg) K. Schum.; *T 13956, 14071*
Omphalea queenslandiae F.M. Bailey; *T 13572, 14136*
Phyllanthus rubriflorus J.J. Sm.; *T 13688, 13752*
Phyllanthus urinaria L.; *T 14237*
Pimelodendron amboinicum Hassk.; *T 13923*
Ricinus communis L.; *T 14022*

EUPOMATIACEAE
Eupomatia laurina R. Br.; SR, occasional in foothill forest

FABACEAE
Abrus pulchellus Thwaites ssp. *pulchellus*; *T 13724*
Calopogonium mucunoides Desv.; *T 13799*
Centrosema pubescens Benth.; *T 13805, 13814*
Crotalaria pallida Aiton; *T 13775, 14015, 14140*
Crotalaria retusa L.; *T 14149*
Derris koolgibberah F.M. Bailey ssp. *koolgibberah*; *T 14221*
Desmodium ormocarpoides DC.; *T&S 13090, T 14296*
Desmodium umbellatum (L.) DC.; *T 14129*
Flemingia macrophylla (Willd.) Merr.; *T 14132*
Flemingia strobilifera (L.) R. Br. ex Aiton f.; *T 14265*
Inocarpus fagifer (Parkinson) Fosb.; *T 13560, 13914, K.J. White in NGF 10284*, det. P. van Royen
Inocarpus sp. ?nov., '*rubidus*' morphotype fide Verdcourt (1979: 304 305); *T 13823, 14210*
Mucuna cyanosperma K. Schum.; *T 13829*
Mucuna novoguineensis Scheffer; *T 14174*
Phaseolus lunatus L.; *T 14257*
Phylacium bracteosum Benn.; *T 13909*
Pterocarpus indicus Willd.; SR, frequent sightings throughout area
Pueraria phaseoloides (Roxb.) Benth. var. *javanica* (Benth.) Baker; *T 14069*
Pueraria phaseoloides (Roxb.) Benth. var. *phaseoloides*; *T 14243*
Pueraria pulcherrima (Koorders) Koorders-Schumacher; *T&S 13072, T 13838*

FLACOURTIACEAE
Casearia erythrocarpa Sleumer; *T 13481*
Casearia macrantha Gilg, or aff.; *T 13517, 13619*
Casearia sp. ?nov.; *T 14150, 14173*
Erythrospermum candidum (Becc.) Becc.; *T&S 13060, T 13495*, also *K.J. White in NGF 10229* and *10326*
Flacourtia inermis Roxb.; *T 13502, 14176*
Homalium foetidum (Roxb.) Benth.; SR, alluvial forest, flowers present on *T 13940*
Osmelia philippina (Turcz.) Benth.; *T 13922, 14046, 14090*, also *K.J. White in NGF 10281*
Pangium edule Reinw.; *T 13646*

GENTIANACEAE
Cotylanthera tenuis Blume; *T 13524, 13911*

GESNERIACEAE
Cyrtandra bracteata Warburg; *T 13989*
Cyrtandra sp., section *Centrosiphon*; *T 13731, 13834, 13888, 13901, 13958, 14230*
Cyrtandra sp., between sections *Centrosiphon* and *Loxanthe*; *T 13433, 14177*
Rhynchoglossum papuae Schltr.; *T 13613, 14148*

HERNANDIACEAE
Hernandia ovigera L.; SR, Guam R., fruits and leaves on ground near Camps 2 & 3

ICACINACEAE
Medusanthera laxiflora (Miers) Howard; *T 13588, 14199*
Polyporandra scandens Becc.; *T 14276*, cf. *Pullen 1064*
Pseudobotrys cauliflora (Pulle) Sleumer; *K.J. White in NGF 10298*, det. J. Womersley
Pseudobotrys dorae Moeser; *T&S 13055, T 13945*
Rhyticaryum longifolium K. Schum. & Laut.; *T 13537*
Rhyticaryum novoguineense (Warburg) Sleumer; *T 13947, 14192*

LAMIACEAE
Faradaya splendida F.v.M.; *T 14054*
Hyptis capitata Jacq.; *T 13663, 13774*
Ocimum gratissimum L.; *T 13813*

LAURACEAE
Actinodaphne sp., (possibly) *nitida* Teschner; SR, foothill forest
Alseodaphne archboldiana (Allen) Kosterm.; *J.C. Saunders 946*
Cryptocarya laevigata Blume; *T 13486, 13599, 13753, 14187*
Cryptocarya massoy (Oken) Kosterm.; SR, Wagadab transect
Cryptocarya multinervis Teschner; *T 14282*
Cryptocarya weinlandii K. Schum.; *K.J. White in NGF 10243, 10306*, dets. A. Kostermans
Endiandra grandiflora Teschner; *K.J. White in NGF 10269*, det. A. Kostermans
Endiandra magnilimba Kosterm.; *T 14114, K.J. White in NGF 10270* (type), *10293*, det. A. Kostermans
Endiandra squarrosa Kosterm.; *K.J. White in NGF 10252, 10307*, also *R. G. Robbins 1625*
Litsea sp., '*L. calophyllantha* K. Schum. facies'; SR, foothill forest
genus indet.; *T 13763*

LEEACEAE
Leea (closer to) *coryphantha* Laut., '*coryphantha-heterodoxa* group' (cf. Ridsdale 1974: 78–79); *T 13581, 13624, 13982*
Leea heterodoxa K. Schum. & Laut.; *T 13446, 13452*
Leea indica (Burm. f.) Merr.; *T 13421, 13959*
Leea zippeliana Miq.; *T 14032, 14201*

LOGANIACEAE
Fagraea ceilanica Thunb.; *T 13673*
Fagraea elliptica Roxb.; SR, foothill forest around Camp 1
Fagraea racemosa Jack ex Wall.; SR, alluvial forests along Guam R.
Geniostoma rupestre J.R. & G. Forst. (closest to) var. *rupestre*; *T 13484, 13538, 13593*
Neuburgia corynocarpa (A. Gray) Leenh. var. *corynocarpa*; *T 13866*, also *K.J. White in NGF 10299*, det. B. Conn
Neuburgia rumphiana Leenh.; *T 13696, 14029*

LORANTHACEAE
Amyema seemeniana (K. Schum.) Danser ssp. *seemeniana*; *T 14260*
Decaisnina hollrungii (K. Schum.) Barlow; SR, hill forest
Dendrophthoe curvata (Blume) Miq.; SR, near Roumirap

LYTHRACEAE
Lagerstroemia cf. *piriformis* Koehne; *T&S 13100*

MAGNOLIACEAE
Elmerrillia tsiampaca (L.) Dandy ssp. *tsiampaca* var. *tsiampaca*; SR, foothill forest

MALVACEAE
Hibiscus archboldianus Borss.; SR, from lepidote fragments on ground, foothill forest
Hibiscus ellipticifolius Borss.; *T 13509*
Hibiscus tiliaceus L.; SR, transect at Wagadab
Sida rhombifolia L. ssp. *rhombifolia*; *T 14014*
Thespesia fissicalyx Borss.; *T 13739*, also *K.J. White in NGF 10297*, det. P. Fryxell

MELASTOMATACEAE
Medinilla musofo Laut. & K. Schum.; *T 14108*
Medinilla triplinervia Cogn., '*musofo-triplinervia* group' (cf. Mansfeld 1925: 116); *T 13418, 14228*
Medinilla sp., aff. *tenuipedicellata* Baker f.; *T 13566, 13617, 13867*
Memecylon schraderbergense Mansf.; *T&S 13052*
Memecylon sp., aff. ?*papuanum* Merr. & Perry, '*excelsum floribundum* group' (cf. Merrill Perry 1943: 439); *T&S 13052*
Otanthera bracteata Korth.; *T 13968, 14271*

MELIACEAE
Aglaia agglomerata Merr. & Perry, small fruited form; *T 13685*
Aglaia argentea Blume; *T&S 13071*
Aglaia cuspidata C. DC.; *T 13918*, also *K.J. White in NGF 10248*
Aglaia lepidopetala Harms; *T 13470, 13584, 13694, 14100*
Aglaia cf. *lepiorrhachis* Harms; *T 13976*
Aglaia sapindina (F.v.M.) Harms; *T&S 13092-A, T 13687*
Aglaia saxonii Takeuchi; *T 13462, 13712, 13765*
Aglaia sp., aff. *agglomerata* Merr. & Perry; *T 13833, 14102*
Aglaia sp.; *T&S 13113*
Aphanamixis polystachya (Wall.) R.N. Parker; *T&S 13110, T 13501, 13582, 13736*
Chisocheton ceramicus (Miq.) C. DC.; *K.J. White in NGF 10253*, det. D. Mabberley
Chisocheton lasiocarpus (Miq.) Valeton; *T&S 13112*
Chisocheton pohlianus Harms; *T 13424, 13474, 13482, 13485, 13999*
Dysoxylum brassii Merr. & Perry; *T 13715*
Dysoxylum excelsum Blume; *T 14301*
Dysoxylum latifolium Benth.; *T 14098*
Dysoxylum pettigrewianum F.M. Bailey; *T 13601, 13784, 14220*, also *K.J. White in NGF 10320*, det. D. Mabberley

Dysoxylum sparsiflorum Mabberley; *T 13556, 13806, 13827, 14056, 14247*
Dysoxylum variabile Harms; *T 14298*
Dysoxylum sp.; *T 14306*

MENISPERMACEAE

Arcangelisia flava (L.) Merr.; *T 13761*
Chlaenandra ovata Miq.; *T 13519, 13777*
Parabaena tuberculata Becc.; *T 14027*
Pycnarrhena sp., '*novoguineensis-tumefacta* group' (cf. Forman 1986: 173); *T 14019*
Tinomiscium petiolare Hooker f. & Thoms.; *T 14047*

MIMOSACEAE

Archidendron aruense (Warburg) de Wit; *T 13526, 13603, 14021, 14191*, also *K.J. White in NGF 10286*
Archidendron cf. *aruense* (Warburg) de Wit; *T&S 13066*
Archidendron bellum Harms; *T 13707*
Archidendron lucyi F.v.M.; *T 14028*
Entada phaseoloides (L.) Merr.; *T 13607*
Leucaena leucocephala (Lamk) de Wit; *T 14143*
Mimosa diplotricha C. Wright ex Sauvalle var. *diplotricha*; SR, Guam R.
Mimosa pudica L.; SR, Guam R.
Paraserianthes falcataria (L.) Nielsen, closest to ssp. *falcataria*; *T 13737*

MONIMIACEAE

Steganthera dentata (Valeton) Kaneh. & Hatus.; *T 13934, 13939*
Steganthera hirsuta (Warburg) Perkins; *T 13670*
Steganthera hospitans (Becc.) Kaneh. & Hatus.; *T&S 13095, T 13822*

MORACEAE

Antiaropsis decipiens K. Schum.; *T&S 13099, T 13550*
Artocarpus communis J.R. & G. Forst.; *T 13848, 14160-A*
Artocarpus vriesianus Miq. var. *refractus* (Becc.) Jarrett; *T 14006*
Ficus ampelas Burm. f.; *T 13727*
Ficus arbuscula Laut. & K. Schum.; SR, Guam R.
Ficus bernaysii King; *T 13713, 14219*
Ficus botryocarpa Miq. var. *subalbidoramea* (Elmer) Corner; *T 13634, 14225*
Ficus comitis King; *T 13993*
Ficus congesta Roxb.; *T 13600, 14164*
Ficus conocephalifolia Ridl.; *T 13597*
Ficus copiosa Steud.; *T 14043*
Ficus crassiramea Miq. var. *patellifera* (Warburg) Corner; *T 14212*
Ficus dammaropsis Diels var. *obtusa* Corner; *T 13913*
Ficus erythrosperma Miq.; *T 13108*
Ficus gul Laut. & K. Schum.; *T 14134*
Ficus hesperidiiformis King; *T 13979, 14278*
Ficus hystricicarpa Warburg; *T 13520, 13792*
Ficus mollior Benth.; *T 13925*
Ficus odoardi King; *T 13714, 13916*
Ficus pachyrrachis Laut. & K. Schum.; *K.J. White in NGF 10308*, det. E. Corner
Ficus pachyrrachis Laut. & K. Schum. var. *pachyrrachis*; *T 14092*
Ficus phaeosyce Laut. & K. Schum.; *T 13967, 13971*
Ficus polyantha Warburg; *T&S 13103, T 14161*
Ficus primaria Corner; *K.J. White in NGF 10274*, det. E. Corner
Ficus primaria Corner, or aff.; *T 14162*
Ficus pungens Reinw. ex Blume; *T 13880, 14116*
Ficus subcuneata Miq.; *T&S 13107, T 14189*
Ficus subulata Blume; *T 13818, 13995, 14266*, also *K.J. White in NGF 10273*, det. E. Corner
Ficus wassa Roxb.; *T 13549, 13760*
Ficus sp. A, does not key; *T 14020*
Ficus sp. B; *T 14194*
Parartocarpus venenosus (Zoll. & Mor.) Becc. ssp. *papuanus* (Becc.) Jarrett; *T 14059*
Prainea papuana Becc.; *K.J. White in NGF 10230*, det. by K.J. White

MYRISTICACEAE

Endocomia macrocoma (Miq.) de Wilde ssp. *prainii* (King) de Wilde; *T 14112*
Gymnacranthera farquhariana (Hooker f. & Thoms.) Warburg var. *zippeliana* (Miq.) R. Schouten; SR, Wagadab transect in hill forest
Horsfieldia basifissa de Wilde; *T 13762*, also *K.J. White in NGF 10242* (type)
Horsfieldia hellwigii (Warburg) Warburg; *T&S 13065* (sterile)
Horsfieldia hellwigii (Warburg) Warburg var. *brachycarpa* de Wilde; *K.J. White in NGF 10258*
Horsfieldia laevigata (Blume) Warburg cf. var. *novobritannica* (J. Sincl.) de Wilde; *K.J. White in NGF 10263*
Horsfieldia cf. *pulverulenta* Warburg; *T&S 13101* (sterile)
Horsfieldia sepikensis Markgraf; *K.J. White in NGF 10237*, fide de Wilde's (1985: 81) synonymy
Horsfieldia subtilis (Miq.) Warburg; *T 13787, 14050*
Horsfieldia subtilis (Miq.) Warburg var. *subtilis*; *T 13432, 13445, 13508, 14183*
Horsfieldia sylvestris (Houtt.) Warburg; *K.J. White in NGF 10262*, det. J. Sinclair
Myristica buchneriana Warburg; *T&S 13078, T 14295*, also *K.J. White in NGF 10259*
Myristica cylindrocarpa J. Sincl.; *K.J. White in NGF 10288*, det. J. Sinclair, conf. D. Foreman
Myristica fissiflora de Wilde ssp. *fissiflora*; *T 13986, 14037, 14184*

Myristica lancifolia Poir. ssp. *lancifolia*; *T 13497, 13637, 13824*, also *K.J. White in NGF 10235, 10265*
Myristica subalulata Miq. var. *subalulata*; *T 13644*, also *K.J. White in NGF 10251*
Myristica tristis Warburg, or aff.; *T 13487, 13770*

MYRSINACEAE
Ardisia imperialis K. Schum.; *T 13461*
Conandrium polyanthum (Laut. & K. Schum.) Mez; *T&S 13106*
Maesa rufo-villosa Mez; *T&S 13091, T 14198*

MYRTACEAE
Decaspermum bracteatum (Roxb.) A.J. Scott var. *bracteatum*; *T 13819*
Decaspermum neurophyllum Laut. & K. Schum.; *T&S 13087*
Octamyrtus behrmannii Diels; *T 14119*
Syzygium aeoranthum (Diels) Merr. & Perry; *T 13666, 13858*
Syzygium cf. *amplum* Hartley & Perry; *T 13430, 14226*
Syzygium buettnerianum (K. Schum.) Niedenzu; SR, Camp 3
Syzygium coalitum (Greves) Hartley & Perry; *T 14142*
Syzygium hylophilum (Laut. & K. Schum.) Merr. & Perry, or aff.; *T 13564*, also *Pullen 1094* as cf. *hylophilum*, det. T.G. Hartley
Syzygium longipes Merr. & Perry; *T 13875*
Syzygium madangense Hartley & Perry; *K.J. White in NGF 10300* (type)
Syzygium nutans (K. Schum.) Merr. & Perry; *T 13661, 14003*
Syzygium pteropodum (Laut. & K. Schum.) Merr. & Perry; *T 13855*, also *K.J. White in NGF 10264*, det. T.G. Hartley
Syzygium trachyanthum (Diels) Merr. & Perry; *T 13680*
Syzygium trivene (Ridl.) Merr. & Perry; *T 14110*
Syzygium versteegii (Laut.) Merr. & Perry; *K.J. White in NGF 10245*, det. T.G. Hartley
Syzygium sp., aff. *goniopterum* (Diels) Merr. & Perry; *T 13459*
Syzygium sp. nov., aff. *megistophyllum* Merr. & Perry; *T&S 13068*
Syzygium sp.; *T 13437, 14214*, probably conspecific
Syzygium sp.; *K.J. White in NGF 10239*, cited in herbarium log but not found at LAE

NYCTAGINACEAE
Pisonia longirostris Teijsm. & Binn.; *T 13561, 13563, 13837, 14040*
Pisonia müelleriana Warburg; *T 13667*
Pisonia umbellifera (J.R. Forst.) Seemann; *Pullen 1063*, det. D. Frodin

OCHNACEAE
Schuurmansia henningsii K. Schum.; SR, occasional throughout area

OLACACEAE
Anacolosa cf. papuana Schellenb., *T 13868*, det. K. Damas

OLEACEAE
Chionanthus ramiflorus Roxb.; *T 14308*

ONAGRACEAE
Ludwigia octovalvis (Jacq.) Raven; *T 14025*

OPILIACEAE
Opilia amentacea Roxb.; *T 13735*

OXALIDACEAE
Averrhoa bilimbi L.; *T 13547, 13931*

PASSIFLORACEAE
Adenia heterophylla (Blume) Koorders; SR, near Wagadab
Passiflora foetida L.; *T 13961*

PIPERACEAE
Piper aduncum L.; SR, Guam R. and foothill forest
Piper betle L.; SR, cultivated
Piper caninum Blume; *T 13820, 14120*
Piper cf. *caninum* Blume; *T 13810*
Piper celtidiforme Opiz; *T 14030, 14058, 14292*
Piper decumanum (Rumph.) L.; *T 13575, 13942, 14196*
Piper macropiper Pennant; *T 14016*
Piper (probably) *macropiper* Pennant; *T 14122*
Piper majusculum Blume; *T 13704, 13965*
Piper mestonii F.M. Bailey; *T 13801*
Piper plagiophyllum K. Schum. & Laut.; *T 13610*
Piper pseudoamboinense C. DC.; *T 13552, 14024*
Piper cf. *pseudoamboinense* C. DC.; *T 14084*
Piper pullibaccum Trelease; *T 13677, 13970, 14166*
Piper versteegii C. DC.; SR, Guam R.

PITTOSPORACEAE
Pittosporum ferrugineum Aiton f. ssp. *laxiflorum* Schodde; *T 14294*
Pittosporum sinuatum Blume; *K.J. White in NGF 10238*, det. R. Schodde
Pittosporum sinuatum Blume var. *sinuatum*; *T 13441, 13471*

POLYGALACEAE
Eriandra fragrans van Royen & Steen.; *T 13455*, det. K. Damas
Xanthophyllum papuanum Whitm. ex Meijden; *T 14154*, also *K.J. White in NGF 10292*, det. T.C. Whitmore

PROTEACEAE
Finschia chloroxantha Diels var. *macrocarpa*

Sleumer; *K.J. White in NGF 10322*, det. K.J. White

Helicia affinis Sleumer; *T 13602, 13997*

RHAMNACEAE

Alphitonia excelsa (Fenzl) Reiss. ex Endl., sensu Schirarend (1995: 308–311); SR, common in regrowth

Gouania cf. *javanica* Miq.; *T 13721*

Ziziphus angustifolius (Miq.) Hatus.; SR, infrequent in hill forest

Ziziphus djamuensis Laut.; *T 13938*

RHIZOPHORACEAE

Gynotroches axillaris Blume; SR, throughout area

ROSACEAE

Prunus dolichobotrys (K. Schum. & Laut.) Kalkman; *T 14232*

Rubus moluccanus L. var. *discolor* (Blume) Kalkman; *T 13842, 14111*

RUBIACEAE

Airosperma psychotrioides Laut. & K. Schum.; *T 13449, 13504, 13969*

Amaracarpus grandifolius Valeton, or aff.; *T&S 13082, T 13551, 13586*

Amaracarpus sp., aff. '*attenuatus-heteropus* group', but not those species, cf. Merrill and Perry's (1946: 221) group 1; *T 13456*

Amaracarpus sp., aff. *longifolius* Valeton; *T 13479, 13682, 13932*

Amaracarpus sp., Merrill and Perry's (1946: 221) group 2; *T 14273, 14277*

?*Amaracarpus* spp.; *T 13767, 13929*

Calycosia mamosei Takeuchi; *T 13404, 13877, 14215*

Canthium sp.; *T 13438, 13744*, also *K.J. White in NGF 10249*, det. C. Ridsdale

Hedyotis sp., cf. *H. auricularia* L., or *H. lapeyrousii* DC.; *T 13415, 13620*

Hydnophytum radicans Becc.; *T 14005, 14283*

Ixora sp., section *Hypsophyllum*; *T 13728, 13972*

Lasianthus chlorocarpus K. Schum.; *T 13480, 14185*

Mastixiodendron pachyclados (K. Schum.) Melch. var. *pachyclados*; *T 14248*, also *K.J. White in NGF 10305*, det. S. Darwin

Morinda bracteata Roxb.; *K.J. White in NGF 10232*

Morinda umbellata L. var. *papuana* Valeton; *T 13789, 13921*

Mussaenda cylindrocarpa Burck; *T 13627, 13706, 13817*

Mussaenda scratchleyi Wernh.; SR, Guam R.

Mycetia javanica (Blume) Reinw. ex Korth.; *T 13444, 13616*

Nauclea orientalis L.; SR, Guam R.

cf. *Neonauclea* sp.; *K.J. White in NGF 10243*

Porterandia sp.; *T 14133*, also *K.J. White in NGF 10311*

Psychotria amplithyrsa Valeton; *T 13411, 14076*

Psychotria dipteropoda Laut. & K. Schum.; *T 13831, 13869, 14045, 14200*

Psychotria leptothyrsa Miq. var. *leptothyrsa*; *T&S 13062, T 13476, 14158*

Psychotria mayana Takeuchi; *T 13585, 13940, 13944*

Psychotria membranifolia Bartl. ex DC.; *T 13521, 13553, 13747*

Psychotria micralabastra (Laut. & K. Schum.) Valeton; *T&S 13098, T 13776*

Psychotria micrococca (Laut. & K. Schum.) Valeton; *T&S 13088*

Psychotria olivacea Valeton; SR, foothill forest

Psychotria phaeochlamys (Laut. & K. Schum.) Valeton; *T 13625, 13631, 13781, 13937*

Psychotria sp., aff. *micralabastra* (Laut. & K. Schum.) Valeton; *T 13629, 13920, 14085*

Psychotria sp. nov.; *T 13514*

Psychotria sp. (vining, possibly nov.); *T 13451, 13756*

'*Randia*' sp., '*decora* Val., or *sphaerocarpa* K. Schum. facies', the genus is now recognized only for the neotropics (cf. Puff & Wong: 1993: 29); *T 13516*

'*Randia*' sp., cf. or aff. *schumanniana* Merr. & Perry (*R. speciosa* K. Schum.); *K.J. White in NGF 10236, 10302*, dets. C. Ridsdale

Saprosma subrepandum (K. Schum. & Laut.) Valeton; *T 13930, 14169*

Spermacoce assurgens Ruiz & Pavon.; *T 14153*

Tarenna gülcheriana (K. Schum.) Valeton; *T 13483, 13749, 13788, 13864*

Timonius timon (Spreng.) Merr. var. *timon*; *T 14115*

Timonius sp., aff. *densiflorus* Valeton; *T 14270*

Trukia sp., aff. *dryadum* (S. Moore) Fosb.; *T&S 13089*

Uncaria bernaysii F.v.M.; *T 14249*

Uncaria lanosa Wall.; *T 14127*

Urophyllum sp.; *T 14167*

Versteegia cauliflora (K. Schum. & Laut.) Valeton; *T&S 13061, T 13460, 13949*

Versteegia grandifolia Valeton; *T 13405*

RUTACEAE

Euodia hortensis J.R. & G. Forst.; *T 13608*, also *K.J. White in NGF 10278, 10279*

Lunasia amara Blanco var. *amara*; *T&S 13069, T 13448*

Melicope sp., cf. *M. burttiana* Stone or *M. grandifolia* B.L. Burtt; *T 13936*

Micromelum minutum (Forst.f.) Wight & Walker-Arnott; *T 13811*

Wenzelia dolichophylla (Laut. & K. Schum.) Tanaka; *T 13594, 13623*
Zanthoxylum conspersipunctatum Merr. & Perry; *T 13636*

SABIACEAE
Meliosma pinnata (Roxb.) Maxim. ssp. *macrophylla* (Merr.) Beus.; SR, foothill forest
Sabia pauciflora Blume; *T 13897, 14165*

SANTALACEAE
Scleropyrum aurantiacum (Laut. & K. Schum.) Pilger; *T 14052*

SAPINDACEAE
Allophylus cobbe (L.) Raeuschel; SR, alluvial forest
Arytera sp., aff. *litoralis* Blume, '*litoralis* complex' (cf. Turner 1994: 474); *T 13472, 13596*
Cardiospermum halicacabum L.; SR, infrequent in regrowth
Cupaniopsis macropetala Radlk.; *T 13465, 13591*
Dictyoneura obtusa Blume; *T 14227*
Elattostachys obliquinervis Radlk.; *T 13741*
Guioa comesperma Radlk.; *T 14188*
Guioa rigidiuscula Radlk., or '*rigidiuscula* complex' (cf. Welzen 1994: 593); *T 14305*
Harpullia crustacea Radlk.; *T 13681, 14307*
Harpullia ramiflora Radlk.; *T 13759, 13821*
Lepisanthes senegalensis (Poir.) Leenh.; *T 13683, 13699, 13933, 13941*, also *K.J. White in NGF 10247*, det. D. Frodin
Pometia pinnata Forst.; *T 14275*

SAPOTACEAE
Pouteria maclayana (F.v.M.) Baehni; *T 14287*

SCROPHULARIACEAE
Limnophila rugosa (Roth) Merr.; *T 13895*
Lindernia anagallis (Burm. f.) Pennell; *T 13794-A*
Lindernia crustacea (L.) F.v.M.; *T 13794-B, 14151*

SOLANACEAE
Capsicum annuum L. var. *annuum*; SR, cultivated
Nicotiana tabacum L.; SR, cultivated
Physalis minima L.; *T 14238*
Solanum torvum Swartz; *T 13807, 14157*

STERCULIACEAE
Commersonia bartramia (L.) Merr.; *T 14101*
Kleinhovia hospita L.; SR, along Guam R.
Melochia umbellata (Houtt.) Stapf; *T 14293*
Pterocymbium beccarii K. Schum.; *T&S 13097*, also *Pullen 1071* (cited by P. van Royen 1964: 26) but possibly a K.J. White coll., specimen not seen
Sterculia (closest to) *ampla* Baker f.; *T 13768, 14251*
Sterculia edelfeltii F.v.M.; *K.J. White in NGF 10321*, det. P. van Royen
Sterculia schumanniana (Laut.) Mildbr.; *T 13466, 13542, 14096*

STILAGINACEAE
Antidesma katikii Airy Shaw; *T 13729*
Antidesma rhynchophyllum K. Schum.; *T 14033*

THYMELAEACEAE
Phaleria coccinea (Gaud.) F.v.M.; *T 13499, 13503, 13506, 13782, 14137, 14175, 14202, 14231, 14239*

TILIACEAE
Microcos argentata Burrett; *K.J. White in NGF 10234*, det. P. van Royen
Microcos cf. *argentata* Burrett; *K.J. White in NGF 10271*, label reads 'same as *10234*'
Microcos sp. ?nov.; *T 13469, 13562, 13732, 13830, 14104*, also *K.J. White in NGF 10231*
Microcos sp.; *K.J. White in NGF 10231, 10271*, different from previous spp.
Trichospermum tripixis (K. Schum.) Kosterm.; *T 14156*
Triumfetta rhomboidea Jacq.; *T 14091*

ULMACEAE
Celtis latifolia (Blume) Planch.; *T&S 13102, T 13987*

URTICACEAE
cf. *Boehmeria platyphylla* D. Don; *T 14087*
Cypholophus cf. *nummularis* Winkler; *T 14049*
Dendrocnide cf. *corallodesme* (Laut.) Chew; *T 14026*
Dendrocnide cordata (Warburg ex Winkler) Chew; *T 13992*
Dendrocnide nervosa (Winkler) Chew; *T&S 13105*
Dendrocnide schlechteri (Winkler) Chew; *T 14067*
Dendrocnide ternatensis (Miq.) Chew; *T 13803*
Elatostema cf. *beccarii* Schroeter; *T 14055*
Elatostema macrophyllum Brongn.; *T 14274*
Elatostema novoguineense Warburg, or aff.; *T 13676, 13899*
Elatostema sp., aff. *macrophyllum* Brongn.; *T 13414, 14053*
Elatostema sp.; *T 14258*
Laportea decumana (Roxb.) Wedd.; *T 13698*
Leucosyke cf. *capitellata* (Poir.) Chew; *T 13841, 14121*
Nothocnide repanda (Blume) Blume; *T 14013, 14083*
Pipturus argenteus (Forst. f.) Wedd.; *T 13630, 13779, 13812, 13974, 13994*
Pouzolzia cf. *hirta* (Blume) Hassk.; *T 14130, 14267*
Procris sp., aff. *pedunculata* (Forst.) Wedd.; *T 14190*
Villebrunea rubescens (Blume) Blume; *T 14031*

VERBENACEAE

Callicarpa cumingiana (Schauer) Rolfe; *T 13963*
Callicarpa longifolia Lamk; *T 13428*
Clerodendrum porphyrocalyx Laut. & K. Schum.; *T 13425, 13653*
Stachytarpheta cayennensis (Rich.) M. Vahl; *T 13708, 14034*
Teijsmanniodendron bogoriense Koorders; *T&S 13114, K.J. White in NGF 10294*, det. J. Womersley, also in *NGF 10349*
Vitex cofassus Reinw. ex Blume; *T 14086*

VIOLACEAE

Rinorea horneri (Korth.) O.K.; *T&S 13063, T 13554, 13710*

VITACEAE

Cayratia geniculata (Blume) Gagn.; *T 13559*
Cayratia japonica (Thunb.) Gagn.; *T&S 13077, T 14163*
Cissus javana DC.; *K.J. White in NGF 10317*
Tetrastigma lauterbachianum Gilg; *T 13686, 14223*

WINTERACEAE

Zygogynum sp.; *T 14195*

MONOCOTS

AGAVACEAE

Cordyline fruticosa (L.) A. Chev.; *T 13565, 14280*

AMARYLLIDACEAE

Crinum asiaticum L.; *T 13844*
Proiphys amboinensis (L.) Herbert; *T&S 13081, T 14264*

ARACEAE

Aglaonema marantifolium Blume; *T 13534*
Alocasia aequiloba N.E. Br.; *T 13595, 13854, 13892*, also *K.J. White in NGF 10276*, det. A. Hay
Alocasia brancifolia (Schott) A. Hay; *T 13573*, also *K.J. White in NGF 10277*, and *Pullen 1088*, dets. A. Hay
Alocasia cf. *hollrungii* Engl.; *T 13717*
Alocasia lancifolia Engl.; *T 13852, 14097, 14216*
Alocasia lauterbachiana (Engl.) A. Hay; *T 13846, 14113*
Amorphophallus galbra F.M. Bailey; SR, foothill forest
Amorphophallus paeoniifolius (Dennst.) Nicolson; SR, road to Roumirap
Colocasia esculenta (L.) Schott; *T 13640*
Cyrtosperma cuspidispathum Alderw.; *T 13917*, also *K.J. White in NGF 10241*, det. A. Hay
Cyrtosperma cf. *macrotum* Becc. ex Engl.; *T 13705*
Holochlamys beccarii Engl.; *T 13478, 13850, 14218*
Homalomena magna A. Hay; *T 13849*
Homalomena cf. *magna* A. Hay; *T 13402*
Pothos papuanus Becc. ex Engl.; *T 13675*
Pothos rumphii Schott; *T 13580*
Rhaphidophora korthalsii Schott; *T 13879, 14007*
Rhaphidophora versteegii Engl. & Krause; *T 13701*, also *K.J. White in NGF 10290*, det. D. Nicolson
Rhaphidophora sp.; *T 13701*
Schismatoglottis sp. A; *T 13410, 13876, 14103*
Schismatoglottis sp. B; *T 13635*
genus indet.; *K.J. White in NGF 10246*

ARECACEAE

Areca catechu L.; SR, cultivated
Areca macrocalyx Zipp. ex Blume; *T&S 13056, T 13638*
Areca cf. *macrocalyx* Zipp. ex Blume; *T 13464*
Brassiophoenix schumannii (Becc.) Essig; *T 13513*
Calamus hollrungii Becc.; SR, infrequent near expedition Camps 2 and 3
Calamus humboldtianus Becc.; *T 13512-B*
Calamus schlechterianus Becc.; *T 14286*
Calyptrocalyx albertisianus Becc.; *T 13641*
Calyptrocalyx hollrungii Becc.; *T&S 13059, T 13401*
Caryota rumphiana Mart.; SR, throughout project area
Cocos nucifera L.; SR, cultivated
Gulubia costata (Becc.) Becc.; *T 13522*
Hydriastele cf. *microspadix* (Becc.) Burrett; *T 13523*
Korthalsia ?zippelii Blume; SR, Guam R., sterile
Licuala beccariana Furtado; *T 13512-A, 13716*
Licuala cf. *lauterbachii* Dammer & K. Schum.; *T&S 13111*
Metroxylon sagu Rottb.; SR, common in alluvial forest
Orania macropetala Laut. & K. Schum.; *T&S 13057, T 13643*
Ptychococcus sp., '*elatus-paradoxus* group' (cf. Essig 1977: 19); *T 14252*

COMMELINACEAE

Amischotolype mollissima Hassk.; *T 13578, 13826*
Aneilema vitiense Seem.; *T 13885*
Aneilema sp., aff. ?*humile* Warburg; *T 13860*
Aneilema sp.; *T 13530, 14082*
Pollia cf. *hasskarlii* Rolla Rao; *T 13408, 13621*
Pollia thyrsiflora (Blume) Steud.; *T 13618*
genus indet., but probably *Floscopa scandens* Lour.; SR, Guam R.

COSTACEAE

Costus speciosus (Koen.) J. Smith; *T 13702, 14095*
Tapeinochilos hollrungii K. Schum.; *T 14009*
Tapeinochilos recurvatum K. Schum.; *T 13700*
Tapeinochilos sp. nov.; *T 13743*

CYPERACEAE

Cyperus diffusus Vahl var. *diffusus*; *T 13870*

Cyperus kyllingia Endl.; *T 13881, 14141*
Fimbristylis dichotoma (L.) Vahl ssp. *dichotoma*; *T 14038*
Mapania macrocephala (Gaud.) K. Schum. ssp. *macrocephala*; *T 13750*, also *Pullen 1095*, det. D. Simpson
Scleria polycarpa Boeck.; *T 13719*, also *Mills s.n.* (March 20, 1961)

DIOSCOREACEAE

Dioscorea esculenta (Lour.) Burk.; SR, cultivated throughout area

DRACAENACEAE

Dracaena angustifolia Roxb.; *T 13555*

FLAGELLARIACEAE

Flagellaria indica L.; SR, Guam River

HELICONIACEAE

Heliconia papuana W.J. Kress; *T&S 13094, T 13400*

HYPOXIDACEAE

Curculigo capitulata (Lour.) Kuntze; *T 13628*

LILIACEAE

Dianella ensifolia (L.) DC.; *T 13442*

MARANTACEAE

Cominsia gigantea (Scheff.) K. Schum.; *T 13579*
Cominsia cf. *minor* Valeton; *T 13845*
Donax cannaeformis (Forst.f.) K. Schum.; *T 13473, 13491*
Phrynium cf. *macrocephalum* K. Schum.; *T 13468, 13496*
Phrynium pedunculatum Warburg, or aff.; *T&S 13053-A, T 13568, 13878, 13988, 14209*
Phrynium sp.; *T 13443, 14197*

MUSACEAE

Musa banksii F.v.M.; *T 13642, 14004*
Musa schizocarpa Simmonds; SR, scattered throughout area

ORCHIDACEAE

(dets. by N.H.S. Howcroft unless otherwise indicated)
Bulbophyllum ?mimiense Schltr. (section *Micromonanthe*); *T 13647*
Bulbophyllum sp.; *T 13647* (mixed coll.)
Corymborkis veratrifolia (Reinw.) Blume; *T 14057, 14077*
Dendrobium macrophyllum A. Rich.; *T 13825*
Dipodium pandanum Bail.; SR, alluvial forest
Grammatophyllum papuanum J.J. Sm.; *T 14291*
Habenaria chloroleuca Schltr.; *T 13525*
Hetaeria oblongifolia Blume, s.l.; *T 13527*, det. L. Juswara
Liparis condylobulbon Reichb f.; *T 13457, 14094*
Nervilia sp.; *K.J. White in NGF 10240*, det. A. Dockrill
Oeceoclades pulchra (Thouars) Cribb & Clements; *T 14075*
Peristylus ?papuana J.J. Sm.; *T 13927*
Pholidota imbricata Hooker; *T 14008*
Plocoglottis cf. *moluccana* Schltr.; *T 13908, 14066*
Spathoglottis plicata Blume ssp. *puberula* N.H.S. Howcroft; *T 13403, 13645*
Tropidia disticha Schltr.; *T 13409, 14168*
Vrydagzynea cf. *rivularis* Schltr.; *T 13886*
Zeuxine polygonoides (F.v.M.) Cribb; *T&S 13051*
genus indet.; *T 13505*

PANDANACEAE

Freycinetia spp.; *T 13407, 13778*, currently under study by K.-L. Huynh
Pandanus angiensis Kaneh., or aff.; *T 13847*
Pandanus cf. *cernuifolius* Merr. & Perry, '*beccarii-cernuifolius* group' (cf. Merr. & Perry 1939: 180); *T 14222*
Pandanus lustrorum Stone, or aff.; *T 14224*

POACEAE

Apluda mutica L.; *T&S 13076*, also *K.J. White in NGF 10303*
Axonopus compressus (Swartz) Beauv.; *T 14145*
Bambusa microcephala (Pilger) Holttum; *T 13558, 13622*
Brachiaria mutica (Forsk.) Stapf; SR, Guam R. bridge
Centotheca latifolia (Osb.) Trin.; *T 13532*
Chrysopogon aciculatus (Retz.) Trin.; SR, Roumirap
Coix lachryma-jobi L.; *T 13808*
Cyrtococcum accrescens (Trin.) Stapf; *T 13896*
Dactyloctenium aegyptium (L.) Beauv.; *T 14023*
Eleusine indica (L.) Gaertn.; *T 14068*
Ichnanthus vicinus (F.M. Bailey) Merr.; *T 14304*
Leptaspis banksii R. Br.; *T 14302*, det. K. Damas
Leptaspis urceolata (Roxb.) R. Br.; *T 13467, 13533*
Oplismenus compositus (L.) P. Beauv.; *T 13955*
Panicum sarmentosum Roxb.; *T 13548*
Pennisetum purpureum Schumach.; *T 13780*
Pogonatherum paniceum (Lamk) Hack.; *T 14152*
Polytoca macrophylla Benth.; *T 13709*
Rottboellia exaltata L.f.; *T 13795*
Saccharum officinarum L.; SR, cultivated
Saccharum robustum Brandes & Jeswiet ex Grassl; SR, thickets along Guam R.
Schizostachyum lima (Blanco) Merr.; *Pullen 1117*, det. R. Holttum
Setaria palmifolia (Koenig) Stapf; *T 13957*
Sorghum nitidum (Vahl) Pers.; *K.J. White in NGF 10304*
Sorghum propinquum (Kunth) Hitchc.; *T&S 13074*
Themeda arguens (L.) Hack.; *T&S 13075*

SMILACACEAE

Smilax cf. *australis* R. Br.; *T 13569*

ZINGIBERACEAE

Curcuma cf. *australasica* Hooker f., '*petiolata* group' (cf. Valeton 1918: 10); *T 13703*
Etlingera dekockii (Valeton) R.M. Smith; *T 13535*
Etlingera sp. ?nov. (series *Polyanthae*); *T 13985*
Hornstedtia scottiana (F.v.M.) K. Schum.; *T 14211*
Pleuranthodium sp., ?*trichocalyx* (Valeton) R.M. Smith; *T 13406, 13463*
Riedelia grandiligula Valeton; *T 13853, 14128, 14213*
Riedelia longifolia Valeton; *T 13771*
Riedelia macrantha K. Schum.; *T 13816*
Riedelia sp.; *T 14269*

APPENDIX 2
THE SCIENTIFIC EQUIVALENTS OF MAIAN (TOKPLES) PLANT NAMES

Traditional names are listed with the corresponding binomials determined from the vouchers. Spellings are phonetic. Several taxa are apparently represented by orthographic variants in the Maian language (cf. compilation following main listing). This situation may be due to the lack of a written grammar for the tokples, and the resulting absence of a medium for its standardization.

Maian Name	**Scientific Binomial**	**Family**
an maap	*Micromelum minutum* (Forst. f.) Wight & Walker-Arnott	Rutaceae
ah-mo-rap	*Piper* cf. *caninum* Blume	Piperaceae
ah-nah-sahr	*Decaspermum bracteatum* (Roxb.) A.J. Scott var. *bracteatum*	Myrtaceae
ah-rap	*Coix lachryma-jobi* L.	Poaceae
ai-ke-kav	*Erechtites valerianifolia* (Wolf) DC.	Asteraceae
akakarap-nevermbup	*Asplenium subemarginatum* Rosenst.	Aspleniaceae
ambo-dera-namb	*Ziziphus djamuensis* Laut.	Rhamnaceae
ambup	*Dendrocnide ternatensis* (Miq.) Chew	Urticaceae
amora-kamorap	*Piper decumanum* (Rumph.) L.	Piperaceae
amungcurcuri	*Neisosperma citrodorum* (Laut. & K. Schum.) Fosb. & Sach.	Apocynaceae
anganange-woganamb	*Tetracera nordtiana* F.v.M.	Dilleniaceae
angkumamb	*Diospyros papuana* Valeton ex Bakh.	Ebenaceae
ango-leb	*Homalomena magna* A. Hay	Araceae
arab	*Leea heterodoxa* K. Schum. & Laut.	Leeaceae
aramitap	*Steganthera hospitans* (Becc.) Kaneh. & Hatus.	Monimiaceae
arap	*Pimelodendron amboinicum* Hassk.	Euphorbiaceae
arep	*Amaracarpus* sp.	Rubiaceae
aru	*Pisonia longirostris* Teijsm. & Binn.	Nyctaginaceae
atep	*Schismatoglottis* sp.	Araceae
ave-namb	*Steganthera dentata* (Valeton) Kaneh. & Hatus.	Monimiaceae
babagalum	*Amaracarpus grandifolius* Valeton	Rubiaceae
babagalum	*Psychotria mayana* Takeuchi	Rubiaceae
babagalum	*Psychotria phaeochlamys* (Laut. & K. Schum.) Valeton	Rubiaceae
babagalum	*Psychotria* sp., aff. *micralabastra* (Laut. & K. Schum.) Valeton	Rubiaceae
badidir	*Elattostachys obliquinervis* Radlk.	Sapindaceae
bago-bagot	*Dianella ensifolia* (L.) DC.	Liliaceae
bailalum	*Steganthera hirsuta* (Warburg) Perkins	Monimiaceae
bailarum	indet.	Orchidaceae
bal-sivar	*Merremia peltata* (L.) Merr.	Convolvulaceae

baliab	*Bambusa microcephala* (Pilger) Holttum	Poaceae
baratep	*Asplenium nidus* L. var. *nidus*	Aspleniaceae
bee-en	*Centrosema pubescens* Benth.	Fabaceae
bial	*Pipturus argenteus* (Forst. f.) Wedd.	Urticaceae
bimur-nganam	*Intsia bijuga* (Colebr.) Kuntze	Caesalpiniaceae
bo-rap	*Solanum torvum* Swartz	Solanaceae
boa-boak	*Lygodium circinnatum* (Burm. f.) Swartz	Schizaeaceae
boagalum	*Airosperma psychotrioides* Laut. & K. Schum.	Rubiaceae
bodog	*Tetrastigma lauterbachianum* Gilg	Vitaceae
bogang-dap	*Terminalia impediens* Coode	Combretaceae
boge-namb	*Morinda umbellata* L. var. *papuana* Valeton	Rubiaceae
bogo-namb	*Pararistolochia schlechteri* (Laut.) M.J. Parsons	Aristolochiaceae
bon	*Thespesia fissicalyx* Borss.	Malvaceae
buasum	*Codiaeum* sp.	Euphorbiaceae
buburat	*Archidendron bellum* Harms	Mimosaceae
buko-bukop	*Equisetum ramosissimum* Desf. ssp. *debile* (Vauch.) Hauke	Equisetaceae
buku	*Aglaia lepidopetala* Harms	Meliaceae
buku	*Aglaia saxonii* Takeuchi	Meliaceae
buku-wabado	*Aglaia lepidopetala* Harms	Meliaceae
bulubul	*Ficus botryocarpa* Miq. var. *subalbidoramea* (Elmer) Corner	Moraceae
da-da-da-dag	*Garcinia maluensis* Laut.	Clusiaceae
da-da-dag	*Syzygium* sp., aff. *goniopterum* (Diels) Merr. & Perry	Myrtaceae
dago-dagol	*Asplenium* cf. *amboinense* Willd.	Aspleniaceae
dago dagol	*Lindsaea obtusa* J. Smith	Lindsaea group
dago-dagol	*Liparis condylobulbon* Reichb f.	Orchidaceae
dai-dai-sivar	*Gouania* cf. *javanica* Miq.	Rhamnaceae
dalulup	*Horsfieldia subtilis* (Miq.) Warburg var. *subtilis*	Myristicaceae
dambotan	*Ficus dammaropsis* Diels var. *obtusa* Corner	Moraceae
damu-kwa	*Begonia papuana* Warburg	Begoniaceae
danga-namb	*Terminalia impediens* Coode	Combretaceae
davaru-guar	*Alangium villosum* (Blume) Wangerin	Alangiaceae
daveh-veh	*Rhyticaryum novoguineense* (Warburg) Sleumer	Icacinaceae
dawab	*Garcinia dulcis* (Roxb.) Kurz	Clusiaceae
dawaba sivar	*Entada phaseoloides* (L.) Merr.	Mimosaceae
dide-lolol	*Abrus pulchellus* Thwaites ssp. *pulchellus*	Fabaceae
diga	*Ficus wassa* Roxb.	Moraceae
dodor	*Archidendron aruense* (Warburg) de Wit	Mimosaceae
duaram	*Dracaena angustifolia* Roxb.	Dracaenaceae
duat-murukun	*Cyrtosperma* cf. *macrotum* Becc. ex Engl.	Araceae
dzam	*Aglaia agglomerata* Merr. & Perry, or aff.	Meliaceae
ese-esea	*Ardisia imperialis* K. Schum.	Myrsinaceae
esg-ese-ya	*Phyllanthus rubriflorus* J.J. Sm.	Euphorbiaceae
eve	*Inocarpus fagifer* (Parkinson) Fosb.	Fabaceae
eve	*Inocarpus* (close to) '*rubidus*' morphotype fide Verdcourt	Fabaceae
ga-tsurup	*Psychotria phaeochlamys* (Laut. & K. Schum.) Valeton	Rubiaceae
gabin	*Alocasia brancifolia* (Schott) A. Hay	Araceae
gaga-bumer	*Plesioneuron tuberculatum* (Cesati) Holttum	Thelypteridaceae
gaga-bumer	*Pteris warburgii* Christ	Pteridaceae
gagab	*Pothos rumphii* Schott	Araceae
gagap	*Rhaphidophora versteegii* Engler & Krause	Araceae

gaira-malapta	*Barringtonia calyptrocalyx* K. Schum. var. *mollis* Laut.	Barringtoniaceae
gawok	*Laportea decumana* (Roxb.) Wedd.	Urticaceae
gemea	*Heliconia papuana* W.J. Kress	Heliconiaceae
gibaiv	*Schismatoglottis* sp.	Araceae
gilagal	*Mapania macrocephala* (Gaud.) K. Schum. ssp. *macrocephala*	Cyperaceae
giliba	*Curculigo capitulata* (Lour.) Kuntze	Hypoxidaceae
giligelum	*Curcuma* cf. *australasica* Hooker f.	Zingiberaceae
giligelum-sivar	*Psychotria* (possibly new vining sp.)	Rubiaceae
go-idi	*Musa banksii* F.v.M.	Musaceae
guragor	*Paraserianthes falcataria* (L.) Nielsen cf. ssp. *falcataria*	Mimosaceae
i pap	*Dysoxylum sparsiflorum* Mabberley	Meliaceae
ibi-ibim	*Piper mestonii* F.M. Bailey	Piperaceae
iaang io	*Ptyssiglottis pubisepala* (Lindau) B. Hansen	Acanthaceae
idi-air	*Medinilla* sp., aff. *tenuipedicellata* Baker f.	Melastomataceae
idi-muyat	*Versteegia cauliflora* (K. Schum. & Laut.) Valeton	Rubiaceae
ikikap	*Tropidia disticha* Schltr.	Orchidaceae
ivang-glu	*Geniostoma rupestre* J.R. & G. Forst.	Loganiaceae
ivanum	*Phaleria coccinea* (Gaud.) F.v.M.	Thymelaeaceae
kabav	*Leea* cf. *coryphantha* Laut.	Leeaceae
kabav	*Leea indica* (Burm. f.) Merr.	Leeaceae
kadimu	*Donax cannaeformis* (Forst. f.) K. Schum.	Marantaceae
kah-bik	*Syzygium pteropodum* (Laut. & K. Schum.) Merr. & Perry	Myrtaceae
kaiam mulava	*Hulemacanthus novoguineensis* (Lindau) Bremek.	Acanthaceae
kaka-kalap	*Bolbitis heteroclita* (Presl) Ching	Lomariopsidaceae
kalagid	*Cordyline fruticosa* (L.) A. Chev.	Agavaceae
kalebuang	*Brassiophoenix schumannii* (Becc.) Essig	Arecaceae
kalikal	*Ipomoea congesta* R. Br.	Convolvulaceae
kamasasak	*Phrynium pedunculatum* Warburg, or aff.	Marantaceae
kamasosak	*Phrynium* sp.	Marantaceae
kamora kamorap	*Piper caninum* Blume	Piperaceae
kaposika	*Macaranga fallacina* Pax & Hoffm.	Euphorbiaceae
kasapa	*Pangium edule* Reinw.	Flacourtiaceae
kasipul	*Schizostachyum lima* (Blanco) Merr.	Poaceae
kasiwar-gili-gilib	*Etlingera dekockii* (Valeton) R.M. Smith	Zingiberaceae
kasiwar-gili-giliba	*Spathoglottis plicata* Blume ssp. *puberula* N.H.S. Howcroft	Orchidaceae
kasuar dadi	*'Randia'* sp., *'decora* Val., or *sphaerocarpa* K. Schum. facies'	Rubiaceae
kasuar-mudu-mado	*Cerbera floribunda* K. Schum.	Apocynaceae
kawari	*Gnetum costatum* K. Schum.	Gnetaceae
keiki	*Amischotolype mollissima* Hassk.	Commelinaceae
keiki	*Costus speciosus* (Koen.) J. Smith	Costaceae
keimang	*Ficus hystricicarpa* Warburg	Moraceae
keiti	*Tapeinochilos recurvatum* K. Schum.	Costaceae
keiti	*Tapeinochilos* sp. nov.	Costaceae
ker-ker-kanamb	*Aneilema vitiense* Seem.	Commelinaceae
ker-ker-kanamb	*Vrydagzynea* cf. *rivularis* Schltr.	Orchidaceae
kibaip	*Homalomena* cf. *magna* A. Hay	Araceae
kibaip	*Schismatoglottis* sp.	Araceae
kibi-kibale	*Ixora* sp., section *Hypsophyllum*	Rubiaceae

kibi kibale	*Lepisanthes senegalensis* (Poir.) Leenh.	Sapindaceae
kibi-kibale	*Phaleria coccinea* (Gaud.) F.v.M.	Thymelaeaceae
kidi-kidi	*Pleuranthodium* sp., ?*trichocalyx* (Valeton) R.M. Smith	Zingiberaceae
kivi-kiva	*Geniostoma rupestre* J.R. & G. Forst.	Loganiaceae
kobos-susul	*Myristica subalulata* Miq. var. *subalulata*	Myristicaceae
kobou-susul	*Horsfieldia subtilis* (Miq.) Warburg var. *subtilis*	Myristicaceae
koita	*Casearia erythrocarpa* Sleumer	Flacourtiaceae
koita	*Glochidion granulare* Airy Shaw	Euphorbiaceae
koitav	*Petalolophus* sp., aff. *megalopus* K. Schum.	Annonaceae
kokam-tol	*Sterculia schumanniana* (Laut.) Mildbr.	Sterculiaceae
kolaben	*Calamus humboldtianus* Becc.	Arecaceae
kolaiv	*Holochlamys beccarii* Engl.	Araceae
kolaiv-nganam	*Pseuduvaria* sp., aff. ?*versteegii* (Diels) Merr.	Annonaceae
komekelak	*Sphaerostephanos arfakianus* (Baker) Holttum	Thelypteridaceae
korang-korang	*Aphanamixis polystachya* (Wall.) R.N. Parker	Meliaceae
kututal	*Psychotria amplithyrsa* Valeton	Rubiaceae
kuvu-kuv	*Elatostema novoguineense* Warburg, or aff.	Urticaceae
kwarikioari	*Gnetum gnemonoides* Brongn.	Gnetaceae
lago-lagod	*Asplenium phyllitidus* Don ssp. *malesicum* Holttum	Aspleniaceae
lala-lala	*Cayratia geniculata* (Blume) Gagn.	Vitaceae
lam	*Euphorbia hirta* L.	Euphorbiaceae
lasa-lasa	*Asplenium* cf. *affine* Swartz, '*affine-cuneatum* group'	Aspleniaceae
lasa-lasa	*Bolbitis quoyana* (Gaud.) Ching	Lomariopsidaceae
lasa lasa	*Lindsaea tenuifolia* Blume	Lindsaea group
lasa-lasa	*Microsorum membranifolium* (R. Br.) Ching	Polypodiaceae
lasa lasa	*Pleocnemia macrodonta* (Fée) Holttum	Tectaria group
lawa lawat	*Semecarpus brachystachys* Merr. & Perry	Anacardiaceae
lawa-lawat	*Semecarpus magnificus* K. Schum.	Anacardiaceae
lawa.ang wiab	*Popowia* sp., aff. *pisocarpa* (Blume) Endl.	Annonaceae
lomal nganam	*Harpullia crustacea* Radlk.	Sapindaceae
ma bairap	*Callipteris prolifera* (Lamk) Bory	Athyriaceae
ma-bairap	*Lomagramma* cf. *sinuata* C. Chr.	Lomariopsidaceae
ma bairap	*Stenochlaena milnei* Underwood	Blechnaceae
ma-kap	*Trichosanthes* sp., '*longiflora-bracteata* group'	Cucurbitaceae
ma-nem-gab	*Holochlamys beccarii* Engl.	Araceae
ma-rab	*Riedelia grandiligula* Valeton	Zingiberaceae
ma-rab	*Riedelia macrantha* K. Schum.	Zingiberaceae
mabarara-dangamb	*Osmelia philippina* (Turcz.) Benth.	Flacourtiaceae
maberu	*Cleistanthus* sp., aff. ?*papuanus* (Laut.) Jabl.	Euphorbiaceae
maberu	*Erythrospermum candidum* (Becc.) Becc.	Flacourtiaceae
maberu	*Rhyticaryum longifolium* K. Schum. & Laut.	Icacinaceae
maboramb	*Ficus odoardi* King	Moraceae
mago-ragor	*Grammatophyllum papuanum* J.J. Sm.	Orchidaceae
mago-ragor	*Pyrrosia princeps* (Mett.) Morton	Polypodiaceae
magule	*Garcinia maluensis* Laut.	Clusiaceae
magule	*Syzygium trachyanthum* (Diels) Merr. & Perry	Myrtaceae
mamba-mambap	*Osmoxylon sessiliflorum* (Laut.) Philipson	Araliaceae
mamba-mambap	*Osmoxylon* (closest to) *sessiliflorum* (Laut.) Philipson	Araliaceae
man-duroop	*Plocoglottis* cf. *moluccana* Schltr.	Orchidaceae
man-gab	*Alocasia lancifolia* Engl.	Araceae
man-trep	*Anacolosa* cf. *papuana* Schellenb.	Olacaceae

manda peb	*Selaginella* sp., aff. ?*hieronymiana* v.A.v.R.	Selaginellaceae
mandurup	indet.	Orchidaceae
mane-kav	*Areca* cf. *macrocalyx* Zipp. ex Blume	Arecaceae
mane-mane-kav	*Lasianthus chlorocarpus* K. Schum.	Rubiaceae
mane-mane-kav	*Medusanthera laxiflora* (Miers) Howard	Icacinaceae
manekap	*Areca macrocalyx* Zipp. ex Blume	Arecaceae
mang-gap	*Alocasia aequiloba* N.E. Br.	Araceae
mang-gap	*Alocasia lauterbachiana* (Engl.) A. Hay	Araceae
mansu-borobor	*Syzygium aeoranthum* (Diels) Merr. & Perry	Myrtaceae
mansu-borobor	*Syzygium longipes* Merr. & Perry	Myrtaceae
mara-marav	*Piper pseudoamboinense* C. DC.	Piperaceae
mara marav	*Piper pullibaccum* Trelease	Piperaceae
marap	*Steganthera dentata* (Valeton) Kaneh. & Hatus.	Monimiaceae
mariap-tobitobi	*Ficus bernaysii* King	Moraceae
mariap-tobitobi	*Ficus conocephalifolia* Ridl.	Moraceae
maruruma	*Wenzelia dolichophylla* (Laut. & K. Schum.) Tanaka	Rutaceae
masa-wun-bandep	*Cyperus diffusus* Vahl var. *diffusus*	Cyperaceae
mavanda-ngamb	*Pseudobotrys dorae* Moeser	Icacinaceae
mekukum	*Hoya pottsii* F.M. Bailey	Asclepiadaceae
migim	*Cyrtandra* sp., section *Centrosiphon*	Gesneriaceae
moimoit	*Scleria polycarpa* Boeck.	Cyperaceae
mondi-minab	*Neuburgia corynocarpa* (A. Gray) Leenh.	Loganiaceae
monia-kiui-kiva	*Averrhoa bilimbi* L.	Oxalidaceae
monia-nasag	*Cryptocarya laevigata* Blume	Lauraceae
mor	*Inocarpus fagifer* (Parkinson) Fosb.	Fabaceae
mora-morava	*Piper majusculum* Blume	Piperaceae
mouko	*Microcos* sp. ?nov.	Tiliaceae
moyab-pooh	*Alocasia aequiloba* N.E. Br.	Araceae
mua-muadi	*Cominsia gigantea* (Scheffer) K. Schum.	Marantaceae
mua-muadi	*Phrynium* cf. *macrocephalum* K. Schum.	Marantaceae
mua-muadi	*Phrynium* sp., aff. *macrocephalum* K. Schum.	Marantaceae
muania kivikiva	*Alocasia* cf. *hollrungii* Engl.	Araceae
muara-muarav	*Piper decumanum* (Rumph.) L.	Piperaceae
muat-upot-ugarum	*Hedyotis* sp., cf. *H. auricularia* L., or *H. lapeyrousii* DC.	Rubiaceae
muat upot ugarum	*Justicia* sp.	Acanthaceae
mugum	*Gastonia spectabilis* (Harms) Philipson	Araliaceae
muiyam	*Melodinus* cf. *acutus* (Markgraf) Markgraf	Apocynaceae
mum-nganam	*Mussaenda cylindrocarpa* Burck	Rubiaceae
mumbutakut	*Psychotria dipteropoda* Laut. & K. Schum.	Rubiaceae
muonia-kivikiva	*Graptophyllum pictum* (L.) Griff.	Acanthaceae
musus	*Ageratum conyzoides* L.	Asteraceae
mutu-ngomb	*Ficus mollior* Benth.	Moraceae
nanggu-nanggu-nam	*Strobilanthes* s.l., *Hemigraphis primulifolia* (Nees) F. Vill. facies	Acanthaceae
nasag	*Amaracarpus grandifolius* Valeton	Rubiaceae
nasag muani	*Lunasia amara* Blanco var. *amara*	Rutaceae
navyia	*Syzygium* cf. *amplum* Hartley & Perry	Myrtaceae
navyia	*Syzygium* sp.	Myrtaceae
ngabu-kuruk	*Zanthoxylum conspersipunctatum* Merr. & Perry	Rutaceae
ngabu-ngabu	*Psychotria leptothyrsa* Miq. var. *leptothyrsa*	Rubiaceae
nganam idir idir	*Medinilla triplinervia* Cogn., '*mufoso-triplinervia* group'	Melastomataceae
ngapar-nganam	*Amaracarpus* sp., aff. *longifolius* Valeton	Rubiaceae
ngaparu-pot	*Sphaerostephanos pilososquamatus* (v.A.v.R.) Holttum	Thelypteridaceae

ngaun nasag	*Aglaia sapindina* (F.v.M.) Harms	Meliaceae
ngavisi	*Helicia affinis* Sleumer	Proteaceae
ngawar-dodoi	*Geniostoma rupestre* J.R. & G. Forst.	Loganiaceae
ngayom-nasag	*Psychotria membranifolia* Bartl. ex DC.	Rubiaceae
ngayom-nasag	*Psychotria* cf. *membranifolia* Bartl. ex DC.	Rubiaceae
ngoku	*Ficus odoardi* King	Moraceae
ngumusinam	*Pueraria pulcherrima* (Koorders) Koorders-Schumacher	Fabaceae
ninara-naumu	*Casearia macrantha* Gilg, or aff.	Flacourtiaceae
ninara-umu	*Rinorea horneri* (Kortn.) O.K.	Violaceae
ooh-rau-rap	*Rhaphidophora korthalsii* Schott	Araceae
oro-momb	*Achyranthes bidentata* Blume	Amaranthaceae
osag-rep	*Psychotria dipteropoda* Laut. & K. Schum.	Rubiaceae
padada	*Syzygium hylophilum* (Laut. & K. Schum.) Merr. & Perry	Myrtaceae
pah-tooey	*Mussaenda cylindrocarpa* Burck	Rubiaceae
pake-koal	*Ficus congesta* Roxb.	Moraceae
pale-palel	*Codiaeum variegatum* (L.) Blume	Euphorbiaceae
palisar	*Dysoxylum sparsiflorum* Mabberley	Meliaceae
pat dagol dagol	*Pronephrium micropinnatum* Holttum	Thelypteridaceae
pat dumudumar	*Eriandra fragrans* van Royen & Steen.	Polygalaceae
pat sani-sani	*Ruellia* sp. (*Leptosiphonium*)	Acanthaceae
puale-pualel	*Mackinlaya celebica* (Harms) Philipson	Araliaceae
pupun-lov	*Selaginella* cf. *velutina* Cesati	Selaginellaceae
quasi-kwas	*Ocimum gratissimum* L.	Lamiaceae
rasapakay	*Harpullia ramiflora* Radlk.	Sapindaceae
rubu-gem-nasag	*Cryptocarya laevigata* Blume	Lauraceae
rubu rubu	*Begonia papuana* Warburg	Begoniaceae
rubu rubu	*Begonia* cf. *papuana* Warburg	Begoniaceae
rubu-rubu	*Begonia pseudolateralis* Warburg	Begoniaceae
rubu-rubu	*Calycosia mamosei* Takeuchi	Rubiaceae
rubu-rubu	*Cyrtandra* sp., section *Centrosiphon*	Gesneriaceae
rubu-rubu	*Elatostema* sp., aff. *macrophyllum* Brongn.	Urticaceae
sa kamb	*Cyrtandra* sp., section *Centrosiphon*	Gesneriaceae
sagag-gosmun	*Strobilanthes* s.l. (*Hemigraphis* sp.)	Acanthaceae
sagag-mum	*Colocasia esculenta* (L.) Schott	Araceae
sagag-u-goga-umun	*Strobilanthes* s.l. (*Hemigraphis* sp.)	Acanthaceae
sagag-ugosum	*Strobilanthes* s.l. (*Hemigraphis* sp.)	Acanthaceae
sagua	*Myristica lancifolia* Poir. ssp. *lancifolia*	Myristicaceae
sagua	*Myristica tristis* Warburg, or aff.	Myristicaceae
sakamb	*Amaracarpus* sp., aff. *longifolius* Valeton	Rubiaceae
sakamb	*Dicliptera papuana* Warburg	Acanthaceae
sakas-sakamb	*Eclipta prostrata* (L.) L.	Asteraceae
sakomb	indet.	indet.
samangi manggib	*Tabernaemontana orientalis* R. Br.	Apocynaceae
sana ngamb	*Pneumatopteris* sp., aff. *keysseriana* (Rosenst.) Holttum	Thelypteridaceae
sang-guab	*Goniothalamus imbricatus* Scheffer	Annonaceae
sang-guab	*Goniothalamus* cf. *imbricatus* Scheffer	Annonaceae
sang-guab	*Myristica lancifolia* Poir. ssp. *lancifolia*	Myristicaceae
sangu-mutup	*Aceratium ledermannii* Schltr.	Elaeocarpaceae
sauga-sivar	*Opilia amentacea* Roxb.	Opiliaceae
sauiak	*Panicum sarmentosum* Roxb.	Poaceae
say-ri-keep	*Mucuna cyanosperma* K. Schum.	Fabaceae
say-veb	*Aneilema* sp., aff. ?*humile* Warburg	Commelinaceae

se-bip	*Lepisanthes senegalensis* (Poir.) Leenh.	Sapindaceae
se-vep	*Cyrtococcum accrescens* (Trin.) Stapf	Poaceae
seger	*Aphanamixis polystachya* (Wall.) R.N. Parker	Meliaceae
seger	*Chisocheton pohlianus* Harms	Meliaceae
seger	*Chisocheton* cf. *pohlianus* Harms	Meliaceae
seger-buga	*Calycacanthus magnusianum* K. Schum.	Acanthaceae
seger-buga	*Flacourtia inermis* Roxb.	Flacourtiaceae
seger-buga	*Phyllanthus rubriflorus* J.J. Sm.	Euphorbiaceae
seger-nanam	*Aglaia agglomerata* Merr. & Perry	Meliaceae
seger-nganam	*Fahrenheitia* sp. ?nov.	Euphorbiaceae
sekera-nasag	*Rinorea horneri* (Kortn.) O.K.	Violaceae
sepi-sepib	*Averrhoa bilimbi* L.	Oxalidaceae
sesambop	*Pisonia longirostris* Teijsm. & Binn.	Nyctaginaceae
sibi-namb	*Asplenium* cf. *amboinense* Willd.	Aspleniaceae
sigawag	*Polytocha macrophylla* Benth.	Poaceae
sigirpa-nganam	*Aceratium ledermannii* Schltr.	Elaeocarpaceae
singi-singgip	*Cephalomanes atrovirens* Presl	Hymenophyllaceae
singi-singgip	*Lindsaea obtusa* J. Smith	Lindsaea group
singi-singgip	*Lindsaea* cf. *obtusa* J. Smith	Lindsaea group
singi-singgip	*Lindsaea tenuifolia* Blume	Lindsaea group
sivar-viav	*Amaracarpus* sp., aff. '*attenuatus-heteropus* group'	Rubiaceae
sivar-viav	*Amaracarpus* sp., aff. *longifolius* Valeton	Rubiaceae
sivar-wiav	*Goniothalamus* cf. *imbricatus* Scheffer	Annonaceae
sivar-wiav	*Popowia* sp.	Annonaceae
sivar-wiav	*Pseuduvaria* sp.	Annonaceae
sivar-yadod	*Pseuduvaria* sp.	Annonaceae
sivaru-guaru	*Goniothalamus* sp.	Annonaceae
sivila	*Omphalea queenslandiae* F.M. Bailey	Euphorbiaceae
sob-barewa	*Psychotria* sp. nov.	Rubiaceae
sob-takevam	*Bolbitis* cf. *quoyana* (Gaud.) Ching	Lomariopsidaceae
sopi-sebip	*Phylacium bracteosum* Benn.	Fabaceae
sretu-ngomb	*Neisosperma citrodorum* (Laut. & K. Schum.) Fosb. & Sach.	Apocynaceae
staylki	*Calopogonium mucunoides* Desv.	Fabaceae
sumbu-wadab	*Elatostema novoguineense* Warburg, or aff.	Urticaceae
sumure	*Strobilanthes* s.l. (*Hemigraphis* sp.)	Acanthaceae
ta-kup	*Ficus pungens* Reinw. ex Blume	Moraceae
ta-wop	*Cominsia* cf. *minor* Valeton	Marantaceae
tagle	*Antiaropsis decipiens* K. Schum.	Moraceae
tagle	*Ficus ampelas* Burm. f.	Moraceae
tah-bop	*Phrynium pedunculatum* Warburg, or aff.	Marantaceae
tai namb	*Amaranthus dubius* Thell.	Amaranthaceae
take-takel	*Aglaia saxonii* Takeuchi	Meliaceae
take-takepa	*Arytera* sp., aff. *litoralis* Blume, '*litoralis* complex'	Sapindaceae
takevam	*Tectaria menyanthides* (Presl) Copeland	Tectaria group
taleba	*Cupaniopsis macropetala* Radlk.	Sapindaceae
tatar-ulalat	*Podocarpus* cf. *rumphii* Blume	Podocarpaceae
televa-nganam	*Pseuderanthemum* sp., cf. '*variabile* group' sensu Barker	Acanthaceae
tibaga	*Orania macropetala* Laut. & K. Schum.	Arecaceae
timaiyag-nav	*Calyptrocalyx albertisianus* Becc.	Arecaceae
timber-digeep	*Pandanus angiensis* Kaneh., or aff.	Pandanaceae
titirigi	*Licuala beccariana* Furtado	Arecaceae
titirigi	*Licuala* cf. *beccariana* Furtado	Arecaceae
tuar	*Callicarpa longifolia* Lamk	Verbenaceae

tuar	*Mycetia javanica* (Blume) Reinw. ex Korth.	Rubiaceae
tukum-avang	*Medinilla* sp., aff. *tenuipedicellata* Baker f.	Melastomataceae
tuturat	*Stachytarpheta cayennensis* (Rich.) M. Vahl	Verbenaceae
uaia	*Tabernaemontana aurantiaca* Gaud.	Apocynaceae
uduat-murukun	*Alocasia aequiloba* N.E. Br.	Araceae
ugag	*Mussaenda cylindrocarpa* Burck	Rubiaceae
ulengkuduv	*Calyptrocalyx hollrungii* Becc.	Arecaceae
umbol-lap	*Sabia pauciflora* Blume	Sabiaceae
umbol-menyap	*Tabernaemontana aurantiaca* Gaud.	Apocynaceae
undu-beb	*Peristylus ?papuana* J.J. Sm.	Orchidaceae
urat	*Canthium* sp.	Rubiaceae
urat	*Neuburgia rumphiana* Leenh.	Loganiaceae
urem dagur	*Hibiscus ellipticifolius* Borss.	Malvaceae
usiman-kekerup	*Diospyros papuana* Valeton ex Bakh.	Ebenaceae
van-tib	*Diplora d'urvillaei* (Bory) C. Chr.	Aspleniaceae
vap	*Amischotolype mollissima* Hassk.	Commelinaceae
varatep	*Dendrobium macrophyllum* A. Reich.	Orchidaceae
vebum	*Callipteris prolifera* (Lamk) Bory	Athyriaceae
vebum	*Pleocnemia macrodonta* (Fée) Holttum	Tectaria group
vebum	*Pneumatopteris sogerensis* (Gepp) Holttum	Thelypteridaceae
vi-yop	*Leucosyke* cf. *capitellata* (Poir.) Chew	Urticaceae
vinisa	*Cryptocarya laevigata* Blume	Lauraceae
voa-baga-bungam	*Dichapetalum sessiliflorum* Leenh.	Dichapetalaceae
vogerdak	*Haplostichanthus longirostris* (Scheffer) van Heusden	Annonaceae
vogo-gon-dab	*Pseuduvaria* sp.	Annonaceae
vokor	*Buchanania macrocarpa* Laut.	Anacardiaceae
vorap	*Rubus moluccanus* L. var. *discolor* (Blume) Kalkman	Rosaceae
wadi diri	*Cupaniopsis macropetala* Radlk.	Sapindaceae
wagu-wagum	*Leptaspis urceolata* (Roxb.) R. Br.	Poaceae
wah ran-gab	*Ficus subulata* Blume	Moraceae
waipa	*Versteegia cauliflora* (K. Schum. & Laut.) Valeton	Rubiaceae
wakup	*Antidesma katikii* Airy Shaw	Stilaginaceae
walo	*Cucurbita* sp.	Cucurbitaceae
wana-barewa	*Psychotria* sp. nov.	Rubiaceae
wanam-barewa	*Versteegia grandifolia* Valeton	Rubiaceae
wanclap	*Melicope* sp., cf. *M. burttiana* Stone or *M. grandifolia* Burtt	Rutaceae
wandarumep	*Cyrtosperma cuspidispathum* Alderw.	Araceae
wang-gep	*Saprosma subrepandum* (K. Schum. & Laut.) Valeton	Rubiaceae
wanga udial	*Cyathocalyx* sp. ?nov.	Annonaceae
wange-abab	*Tarenna gülcheriana* (K. Schum.) Valeton	Rubiaceae
wange warap	*Lepisanthes senegalensis* (Poir.) Leenh.	Sapindaceae
wansalup	*Breynia cernua* (Poir.) Muell. Arg.	Euphorbiaceae
wapa-ruap	*Crinum asiaticum* L.	Amaryllidaceae
wara-tep	*Antrophyum* cf. *reticulatum* (Forst.) Kaulf.	Vittariaceae
wara-tep	*Microsorum linguiforme* (Mett.) Copel.	Polypodiaceae
warang gab	*Poikilospermum amboinense* Zipp. ex Miq.	Cecropiaceae
warang-gap	*Aglaia cuspidata* C. DC.	Meliaceae
warap-tep	*Aglaomorpha drynarioides* (Hooker) Roos	Polypodiaceae
warubu nganam	*Glochidion chondrocarpum* Airy Shaw, or aff.	Euphorbiaceae
warubu-sopasop	*Dysoxylum brassii* Merr. & Perry	Meliaceae
warubu-taleba	*Dysoxylum pettigrewianum* F.M. Bailey	Meliaceae

wasagep	*Psychotria* sp., aff. *micralabastra* (Laut. & K. Schum.) Valeton	Rubiaceae
wasimi	*Diplora d'urvillaei* (Bory) C. Chr.	Aspleniaceae
wat-uduat	*Maniltoa schefferi* K. Schum. & Hollrung	Caesalpiniaceae
wat-ukauel	*Smilax* cf. *australis* R. Br.	Smilacaceae
wat-urimap	*Cyathocalyx papuanus* Diels, or aff.	Annonaceae
wat-virimav	*Arytera* sp., aff. *litoralis* Blume, '*litoralis* complex'	Sapindaceae
wata-katok	*Freycinetia* sp.	Pandanaceae
wato-karok	*Pothos papuanus* Becc. ex Engl.	Araceae
watulam	*Psychotria membranifolia* Bartl. ex DC.	Rubiaceae
wedem-lalaut	*Cephalomanes atrovirens* Presl	Hymenophyllaceae
wegem-lalaut	*Huperzia* cf. *squarrosa* (Forst. f.) Trevisan	Lycopodiaceae
widasag	*Glochidion granulare* Airy Shaw	Euphorbiaceae
wingam	*Semecarpus forstenii* Blume	Anacardiaceae
wo-mamb	*Aporosa* cf. *papuana* Pax & Hoffm.	Euphorbiaceae
wo-roon-botop	*Pipturus argenteus* (Forst. f.) Wedd.	Urticaceae
wo-sarep	*Psychotria mayana* Takeuchi	Rubiaceae
wo-sayep	*Calycosia mamosei* Takeuchi	Rubiaceae
wo-wop	*Callipteris spinulosa* (Blume) J. Smith	Athyriaceae
wonkibung	*Cryptocarya weinlandii* K. Schum.	Lauraceae
wuka-wukap	*Cyperus kyllingia* Endl.	Cyperaceae
wumbu-ngam	*Endospermum moluccanum* (Teijsm. & Binn.) Kurz	Euphorbiaceae
wung-wanam	*Artocarpus communis* J.R. & G. Forst.	Moraceae
wungo-bunyam	*Wedelia biflora* (L.) DC.	Asteraceae
yag-ikikav	*Blumea arfakiana* Martelli	Asteraceae
yag-mara-marav	*Begonia pseudolateralis* Warburg	Begoniaceae
yag-sawea	*Clerodendrum porphyrocalyx* Laut. & K. Schum.	Verbenaceae
yag-tauita	*Tarenna gülcheriana* (K. Schum.) Valeton	Rubiaceae
yavera-ukum	*Fagraea ceilanica* Thunb.	Loganiaceae

Taxa represented by Maian orthographic variants: *Aceratium ledermannii* Schltr., sangu-mutup, sigirpa-nganam; *Aglaia lepidopetala* Harms, buku, buku-wabado; *Aglaia saxonii* Takeuchi, buku, take-takel; *Alocasia aequiloba* N.E. Br., mang-gap, moyab-pooh, uduat-murukun; *Amaracarpus grandifolius* Valeton, babagalum, nasag; *Amaracarpus* sp., aff. *longifolius* Valeton, ngapar-nganam, sakamb, sivar-viav; *Amischotolype mollissima* Hassk., keiki, vap; *Aphanamixis polystachya* (Wall.) R.N. Parker, korang korang, seger; *Arytera* sp., aff. *litoralis* Blume, take-takepa, wat-virimav; *Averrhoa bilimbi* L., monia-kiui-kiva, sepi-sepib; *Begonia papuana* Warburg, damu-kwa, rubu-rubu; *Begonia pseudolateralis* Warburg, rubu-rubu, yag-mara-marav; *Callipteris prolifera* (Lam.) Bory, ma-bairap, vebum; *Calycosia mamosei* Takeuchi, rubu-rubu, wo-sayep; *Cephalomanes atrovirens* Presl, singi-singgip, wedem-lalaut; *Cryptocarya laevigata* Blume, monia-nasag, rubu-gem-nasag, vinisa; *Cupaniopsis macropetala* Radlk., taleba, wadi-diri; *Diospyros papuana* Valeton ex Bakh., angkumamb, usiman-kekerup; *Diplora d'urvillaei* (Bory) C. Chr., van-tib, wasimi; *Dysoxylum sparsiflorum* Mabberley, i-pap, palisar; *Ficus odoardi* King, maboramb, ngoku; *Garcinia maluensis* Laut., da-da-da-dag, magule; *Geniostoma rupestre* J.R. & G. Forst., ivang-glu, kivi-kiva, ngawar-dodol; *Glochidion granulare* Airy Shaw, koita, widasag; *Holochlamys beccarii* Engl., kolaiv, ma-nem-gab; *Horsfieldia subtilis* (Miq.) Warb. var. *subtilis*, dalulup, kobou-susul; *Inocarpus fagifer* (Parkinson) Fosberg, eve, mor; *Lepisanthes senegalensis* (Poir.) Leenh., kibi-kibale, sebip, wange warap; *Lindsaea obtusa* J. Smith, dago-dagol, singi singgip; *Lindsaea tenuifolia* Blume, lasa-lasa, singi-singgip; *Mussaenda cylindrocarpa* Burck, mum-nganam, pah-tooey, ugag; *Myristica lancifolia* Poir. subsp. *lancifolia*, sagua, sang-guab; *Phaleria coccinea* (Gaud.) F.v.M., ivanum, kibi-kibale; *Phrynium pedunculatum* Warburg, or aff., kamasasak, tah-bop; *Phyllanthus rubriflorus* J.J. Sm., esg-ese-ya, seger-buga; *Piper decumanum* (Rumph.) L., amora-kamorap, muara-muarav; *Pipturus argenteus* (Forst. f.) Wedd., bial, wo-roon-botop; *Pisonia longirostris* Teijsm. & Binn., aru, sesambop; *Pleocnemia macrodonta* (Fée) Holttum, lasa-lasa, vebum; *Psychotria dipteropoda* Laut. & K. Schum., mumbutakut, osag-rep; *Psychotria mayana* Takeuchi, babagalum, wo-sarep; *Psychotria membranifolia* Bartl. ex DC., ngayom-nasag, watulam; *Psychotria phaeochlamys* (Laut. & K. Schum.) Valeton, babagalum, ga-tsurup;

Psychotria sp. nov., sob-barewa, wanambarewa; *Rinorea horneri* (Korth.) O.K., ninara-umu, sekera-nasag; *Steganthera dentata* (Valeton) Kaneh. & Hatus., ave-namb, marap; *Tabernaemontana aurantiaca* Gaud., uaia, umbol-menyap; *Tarenna gülcheriana* (K. Schum.) Valeton, wange-abab, yag tauita; *Terminalia impediens* Coode, bogang-dap, danga-namb; *Versteegia cauliflora* (K. Schum. & Laut.) Valeton, idi-muyat, waipa.

APPENDIX 2A

THE SCIENTIFIC EQUIVALENTS OF MAIAN (TOKPLES) PLANT NAMES (ALPHABETICAL BY GENUS)

Maian Name	**Scientific Binomial**	**Family**
dide-lolol	*Abrus pulchellus* Thwaites ssp. *pulchellus*	Fabaceae
sangu-mutup	*Aceratium ledermannii* Schltr.	Elaeocarpaceae
sigirpa nganam	*Aceratium ledermannii* Schltr.	Elaeocarpaceae
oro-momb	*Achyranthes bidentata* Blume	Amaranthaceae
musus	*Ageratum conyzoides* L.	Asteraceae
seger-nanam	*Aglaia agglomerata* Merr. & Perry	Meliaceae
dzam	*Aglaia agglomerata* Merr. & Perry, or aff.	Meliaceae
warang-gap	*Aglaia cuspidata* C. DC.	Meliaceae
buku	*Aglaia lepidopetala* Harms	Meliaceae
buku-wabado	*Aglaia lepidopetala* Harms	Meliaceae
ngaun-nasag	*Aglaia sapindina* (F.v.M.) Harms	Meliaceae
buku	*Aglaia saxonii* Takeuchi	Meliaceae
take-takel	*Aglaia saxonii* Takeuchi	Meliaceae
warap-tep	*Aglaomorpha drynarioides* (Hooker) Roos	Polypodiaceae
boagalum	*Airosperma psychotrioides* Laut. & K. Schum.	Rubiaceae
davaru-guar	*Alangium villosum* (Blume) Wangerin	Alangiaceae
mang-gap	*Alocasia aequiloba* N.E. Br.	Araceae
moyab-pooh	*Alocasia aequiloba* N.E. Br.	Araceae
uduat-murukun	*Alocasia aequiloba* N.E. Br.	Araceae
gabin	*Alocasia brancifolia* (Schott) A. Hay	Araceae
muania-kivikiva	*Alocasia* cf. *hollrungii* Engl.	Araceae
man-gab	*Alocasia lancifolia* Engl.	Araceae
mang-gap	*Alocasia lauterbachiana* (Engl.) A. Hay	Araceae
babagalum	*Amaracarpus grandifolius* Valeton	Rubiaceae
nasag	*Amaracarpus grandifolius* Valeton	Rubiaceae
sivar-viav	*Amaracarpus* sp., aff. '*attenuatus-heteropus* group'	Rubiaceae
ngapar-nganam	*Amaracarpus* sp., aff. *longifolius* Valeton	Rubiaceae
sakamb	*Amaracarpus* sp., aff. *longifolius* Valeton	Rubiaceae
sivar-viav	*Amaracarpus* sp., aff. *longifolius* Valeton	Rubiaceae
arep	*Amaracarpus* sp.	Rubiaceae
tai-namb	*Amaranthus dubius* Thell.	Amaranthaceae
keiki	*Amischotolype mollissima* Hassk.	Commelinaceae
vap	*Amischotolype mollissima* Hassk.	Commelinaceae
man-trep	*Anacolosa* cf. *papuana* Schellenb.	Olacaceae
ker-ker-kanamb	*Aneilema vitiense* Seem.	Commelinaceae
say-veb	*Aneilema* sp., aff. ?*humile* Warburg	Commelinaceae
tagle	*Antiaropsis decipiens* K. Schum.	Moraceae
wakup	*Antidesma katikii* Airy Shaw	Stilaginaceae
wara-tep	*Antrophyum* cf. *reticulatum* (Forst.) Kaulf.	Vittariaceae
korang-korang	*Aphanamixis polystachya* (Wall.) R.N. Parker	Meliaceae
seger	*Aphanamixis polystachya* (Wall.) R.N. Parker	Meliaceae
wo-mamb	*Aporosa* cf. *papuana* Pax & Hoffm.	Euphorbiaceae
dodor	*Archidendron aruense* (Warburg) de Wit	Mimosaceae

buburat	*Archidendron bellum* Harms	Mimosaceae
ese-esea	*Ardisia imperialis* K. Schum.	Myrsinaceae
manekap	*Areca macrocalyx* Zipp. ex Blume	Arecaceae
mane-kav	*Areca* cf. *macrocalyx* Zipp. ex Blume	Arecaceae
wung-wanam	*Artocarpus communis* J.R. & G. Forst.	Moraceae
take-takepa	*Arytera* sp., aff. *litoralis* Blume, '*litoralis* complex'	Sapindaceae
wat-virimav	*Arytera* sp., aff. *litoralis* Blume, '*litoralis* complex'	Sapindaceae
lasa-lasa	*Asplenium* cf. *affine* Swartz, '*affine-cuneatum* group'	Aspleniaceae
dago-dagol	*Asplenium* cf. *amboinense* Willd.	Aspleniaceae
sibi-namb	*Asplenium* cf. *amboinense* Willd.	Aspleniaceae
baratep	*Asplenium nidus* L. var. *nidus*	Aspleniaceae
lago-lagod	*Asplenium phyllitidus* Don ssp. *malesicum* Holttum	Aspleniaceae
akakarap-nevermbup	*Asplenium subemarginatum* Rosenst.	Aspleniaceae
monia-kiui-kiva	*Averrhoa bilimbi* L.	Oxalidaceae
sepi-sepib	*Averrhoa bilimbi* L.	Oxalidaceae
baliab	*Bambusa microcephala* (Pilger) Holttum	Poaceae
gaira-malapta	*Barringtonia calyptrocalyx* K. Schum. var. *mollis* Laut.	Barringtoniaceae
damu-kwa	*Begonia papuana* Warburg	Begoniaceae
rubu-rubu	*Begonia papuana* Warburg	Begoniaceae
rubu-rubu	*Begonia* cf. *papuana* Warburg	Begoniaceae
rubu-rubu	*Begonia pseudolateralis* Warburg	Begoniaceae
yag-mara-marav	*Begonia pseudolateralis* Warburg	Begoniaceae
yag-ik-kav	*Blumea arfakiana* Martelli	Asteraceae
kaka-kalap	*Bolbitis heteroclita* (Presl) Ching	Lomariopsidaceae
lasa-lasa	*Bolbitis quoyana* (Gaud.) Ching	Lomariopsidaceae
sob-takevam	*Bolbitis* cf. *quoyana* (Gaud.) Ching	Lomariopsidaceae
kalebuang	*Brassiophoenix schumannii* (Becc.) Essig	Arecaceae
wansalup	*Breynia cernua* (Poir.) Muell. Arg.	Euphorbiaceae
vokor	*Buchanania macrocarpa* Laut.	Anacardiaceae
kolaben	*Calamus humboldtianus* Becc.	Arecaceae
tuar	*Callicarpa longifolia* Lamk	Verbenaceae
ma-bairap	*Callipteris prolifera* (Lamk) Bory	Athyriaceae
vebum	*Callipteris prolifera* (Lamk) Bory	Athyriaceae
wo-wop	*Callipteris spinulosa* (Blume) J. Smith	Athyriaceae
staylki	*Calopogonium mucunoides* Desv.	Fabaceae
seger-buga	*Calycacanthus magnusianum* K. Schum.	Acanthaceae
rubu-rubu	*Calycosia mamosei* Takeuchi	Rubiaceae
wo-sayep	*Calycosia mamosei* Takeuchi	Rubiaceae
timaiyag-nav	*Calyptrocalyx albertisianus* Becc.	Arecaceae
ulengkuduv	*Calyptrocalyx hollrungii* Becc.	Arecaceae
urat	*Canthium* sp.	Rubiaceae
koita	*Casearia erythrocarpa* Sleumer	Flacourtiaceae
ninara naumu	*Casearia macrantha* Gilg, or aff.	Flacourtiaceae
lala-lala	*Cayratia geniculata* (Blume) Gagn.	Vitaceae
bee-en	*Centrosema pubescens* Benth.	Fabaceae
singi-singgip	*Cephalomanes atrovirens* Presl	Hymenophyllaceae
wedem-lalaut	*Cephalomanes atrovirens* Presl	Hymenophyllaceae
kasuar-mudu-mado	*Cerbera floribunda* K. Schum.	Apocynaceae
seger	*Chisocheton pohlianus* Harms	Meliaceae
seger	*Chisocheton* cf. *pohlianus* Harms	Meliaceae
maberu	*Cleistanthus* sp., aff. ?*papuanus* (Laut.) Jabl.	Euphorbiaceae
yag-sawea	*Clerodendrum porphyrocalyx* Laut. & K. Schum.	Verbenaceae

pale palel	*Codiaeum variegatum* (L.) Blume	Euphorbiaceae
buasum	*Codiaeum* sp.	Euphorbiaceae
ah-rap	*Coix lachryma-jobi* L.	Poaceae
sagag-mum	*Colocasia esculenta* (L.) Schott	Araceae
mua-muadi	*Cominsia gigantea* (Scheffer) K. Schum.	Marantaceae
ta-wop	*Cominsia* cf. *minor* Valeton	Marantaceae
kalagid	*Cordyline fruticosa* (L.) A. Chev.	Agavaceae
keiki	*Costus speciosus* (Koen.) J. Smith	Costaceae
wapa-ruap	*Crinum asiaticum* L.	Amaryllidaceae
monia-nasag	*Cryptocarya laevigata* Blume	Lauraceae
rubu-gem-nasag	*Cryptocarya laevigata* Blume	Lauraceae
vinisa	*Cryptocarya laevigata* Blume	Lauraceae
wonkibung	*Cryptocarya weinlandii* K. Schum.	Lauraceae
walo	*Cucurbita* sp.	Cucurbitaceae
taleba	*Cupaniopsis macropetala* Radlk.	Sapindaceae
wadi-diri	*Cupaniopsis macropetala* Radlk.	Sapindaceae
giliba	*Curculigo capitulata* (Lour.) Kuntze	Hypoxidaceae
giligelum	*Curcuma* cf. *australasica* Hooker f.	Zingiberaceae
wat-urimap	*Cyathocalyx papuanus* Diels, or aff.	Annonaceae
wanga udial	*Cyathocalyx* sp. ?nov.	Annonaceae
masa-wun-bandep	*Cyperus diffusus* Vahl var. *diffusus*	Cyperaceae
wuka-wukap	*Cyperus kyllingia* Endl.	Cyperaceae
migim	*Cyrtandra* sp., section *Centrosiphon*	Gesneriaceae
rubu-rubu	*Cyrtandra* sp., section *Centrosiphon*	Gesneriaceae
sa-kamb	*Cyrtandra* sp., section *Centrosiphon*	Gesneriaceae
se-vep	*Cyrtococcum accrescens* (Trin.) Stapf	Poaceae
wandarumep	*Cyrtosperma cuspidispathum* Alderw.	Araceae
duat-murukun	*Cyrtosperma* cf. *macrotum* Becc. ex Engl.	Araceae
ah-nah-sahr	*Decaspermum bracteatum* (Roxb.) A.J. Scott var. *bracteatum*	Myrtaceae
varatep	*Dendrobium macrophyllum* A. Reich.	Orchidaceae
ambup	*Dendrocnide ternatensis* (Miq.) Chew	Urticaceae
bago-bagot	*Dianella ensifolia* (L.) DC.	Liliaceae
voa-baga-bungam	*Dichapetalum sessiliflorum* Leenh.	Dichapetalaceae
sakamb	*Dicliptera papuana* Warburg	Acanthaceae
angkumamb	*Diospyros papuana* Valeton ex Bakh.	Ebenaceae
usiman-kekerup	*Diospyros papuana* Valeton ex Bakh.	Ebenaceae
vah-tib	*Diplora d'urvillaei* (Bory) C. Chr.	Aspleniaceae
wasimi	*Diplora d'urvillaei* (Bory) C. Chr.	Aspleniaceae
kadimu	*Donax cannaeformis* (Forst. f.) K. Schum.	Marantaceae
duaram	*Dracaena angustifolia* Roxb.	Dracaenaceae
warubu-sopasop	*Dysoxylum brassii* Merr. & Perry	Meliaceae
warubu-taleba	*Dysoxylum pettigrewianum* F.M. Bailey	Meliaceae
i-pap	*Dysoxylum sparsiflorum* Mabberley	Meliaceae
palisar	*Dysoxylum sparsiflorum* Mabberley	Meliaceae
sakas-sakamb	*Eclipta prostrata* (L.) L.	Asteraceae
kuvu-kuv	*Elatostema novoguineense* Warburg, or aff.	Urticaceae
sumbu-wadab	*Elatostema novoguineense* Warburg, or aff.	Urticaceae
rubu-rubu	*Elatostema* sp., aff. *macrophyllum* Brongn.	Urticaceae
badidir	*Elattostachys obliquinervis* Radlk.	Sapindaceae
wumbu-ngam	*Endospermum moluccanum* (Teijsm. & Binn.) Kurz	Euphorbiaceae
dawaba-sivar	*Entada phaseoloides* (L.) Merr.	Mimosaceae
buko-bukop	*Equisetum ramosissimum* Desf. ssp. *debile* (Vauch.) Hauke	Equisetaceae
ai-ke-kav	*Erechtites valerianifolia* (Wolf) DC.	Asteraceae

pat dumudumar	*Eriandra fragrans* van Royen & Steen.	Polygalaceae
maberu	*Erythrospermum candidum* (Becc.) Becc.	Flacourtiaceae
kasiwar-gili-gilib	*Etlingera dekockii* (Valeton) R.M. Smith	Zingiberaceae
lam	*Euphorbia hirta* L.	Euphorbiaceae
yavera-ukum	*Fagraea ceilanica* Thunb.	Loganiaceae
seger-nganam	*Fahrenheitia* sp. ?nov.	Euphorbiaceae
tagle	*Ficus ampelas* Burm. f.	Moraceae
mariap-tobitobi	*Ficus bernaysii* King	Moraceae
bulubul	*Ficus botryocarpa* Miq. var. *subalbidoramea* (Elmer) Corner	Moraceae
pake-koal	*Ficus congesta* Roxb.	Moraceae
mariap-tobitobi	*Ficus conocephalifolia* Ridl.	Moraceae
dambotan	*Ficus dammaropsis* Diels var. *obtusa* Corner	Moraceae
keimang	*Ficus hystricicarpa* Warburg	Moraceae
mutu-ngomb	*Ficus mollior* Benth.	Moraceae
maboramb	*Ficus odoardi* King	Moraceae
ngoku	*Ficus odoardi* King	Moraceae
ta-kup	*Ficus pungens* Reinw. ex Blume	Moraceae
wah-ran-gab	*Ficus subulata* Blume	Moraceae
diga	*Ficus wassa* Roxb.	Moraceae
seger-buga	*Flacourtia inermis* Roxb.	Flacourtiaceae
wata-katok	*Freycinetia* sp.	Pandanaceae
dawab	*Garcinia dulcis* (Roxb.) Kurz	Clusiaceae
da-da-da-dag	*Garcinia maluensis* Laut.	Clusiaceae
magule	*Garcinia maluensis* Laut.	Clusiaceae
mugum	*Gastonia spectabilis* (Harms) Philipson	Araliaceae
ivang-glu	*Geniostoma rupestre* J.R. & G. Forst.	Loganiaceae
kivi-kiva	*Geniostoma rupestre* J.R. & G. Forst.	Loganiaceae
ngawar-dodol	*Geniostoma rupestre* J.R. & G. Forst.	Loganiaceae
warubu-nganam	*Glochidion chondrocarpum* Airy Shaw, or aff.	Euphorbiaceae
koita	*Glochidion granulare* Airy Shaw	Euphorbiaceae
widasag	*Glochidion granulare* Airy Shaw	Euphorbiaceae
kawari	*Gnetum costatum* K. Schum.	Gnetaceae
kwarikioari	*Gnetum gnemonoides* Brongn.	Gnetaceae
sang-guab	*Goniothalamus imbricatus* Scheffer	Annonaceae
sang-guab	*Goniothalamus* cf. *imbricatus* Scheffer	Annonaceae
sivar-wiav	*Goniothalamus* cf. *imbricatus* Scheffer	Annonaceae
sivaru-guaru	*Goniothalamus* sp.	Annonaceae
dai-dai-sivar	*Gouania* cf. *javanica* Miq.	Rhamnaceae
mago-ragor	*Grammatophyllum papuanum* J.J. Sm.	Orchidaceae
muonia-kivikiva	*Graptophyllum pictum* (L.) Griff.	Acanthaceae
vogerdak	*Haplostichanthus longirostris* (Scheffer) van Heusden	Annonaceae
lomal-nganam	*Harpullia crustacea* Radlk.	Sapindaceae
rasapakay	*Harpullia ramiflora* Radlk.	Sapindaceae
muat-upot-ugarum	*Hedyotis* sp., cf. *H. auricularia* L., or *H. lapeyrousii* DC.	Rubiaceae
ngavisi	*Helicia affinis* Sleumer	Proteaceae
gemea	*Heliconia papuana* W.J. Kress	Heliconiaceae
urem dagur	*Hibiscus ellipticifolius* Borss.	Malvaceae
kolaiv	*Holochlamys beccarii* Engl.	Araceae
ma-nem-gab	*Holochlamys beccarii* Engl.	Araceae
ango-leb	*Homalomena magna* A. Hay	Araceae
kibaip	*Homalomena* cf. *magna* A. Hay	Araceae
dalulup	*Horsfieldia subtilis* (Miq.) Warburg var. *subtilis*	Myristicaceae

kobou-susul	*Horsfieldia subtilis* (Miq.) Warburg var. *subtilis*	Myristicaceae
mekukum	*Hoya pottsii* F.M. Bailey	Asclepiadaceae
kaiam-mulava	*Hulemacanthus novoguineensis* (Lindau) Bremek.	Acanthaceae
wegem-lalaut	*Huperzia* cf. *squarrosa* (Forst. f.) Trevisan	Lycopodiaceae
bailarum	indet.	Orchidaceae
mandurup	indet.	Orchidaceae
sakomb	indet.	indet.
eve	*Inocarpus fagifer* (Parkinson) Fosb.	Fabaceae
mor	*Inocarpus fagifer* (Parkinson) Fosb.	Fabaceae
eve	*Inocarpus* (close to) '*rubidus*' morphotype fide Verdcourt	Fabaceae
bimur-nganam	*Intsia bijuga* (Colebr.) Kuntze	Caesalpiniaceae
kalikal	*Ipomoea congesta* R. Br.	Convolvulaceae
kibi-kibale	*Ixora* sp., section *Hypsophyllum*	Rubiaceae
muat-upot-ugarum	*Justicia* sp.	Acanthaceae
gawok	*Laportea decumana* (Roxb.) Wedd.	Urticaceae
mane-mane-kav	*Lasianthus chlorocarpus* K. Schum.	Rubiaceae
kabav	*Leea* cf. *coryphantha* Laut.	Leeaceae
arab	*Leea heterodoxa* K. Schum. & Laut.	Leeaceae
kabav	*Leea indica* (Burm. f.) Merr.	Leeaceae
kibi-kibale	*Lepisanthes senegalensis* (Poir.) Leenh.	Sapindaceae
se-bip	*Lepisanthes senegalensis* (Poir.) Leenh.	Sapindaceae
wange-warap	*Lepisanthes senegalensis* (Poir.) Leenh.	Sapindaceae
wagu-wagum	*Leptaspis urceolata* (Roxb.) R. Br.	Poaceae
vi-yop	*Leucosyke* cf. *capitellata* (Poir.) Chew	Urticaceae
titirigi	*Licuala beccariana* Furtado	Arecaceae
titirigi	*Licuala* cf. *beccariana* Furtado	Arecaceae
dago-dagol	*Lindsaea obtusa* J. Smith	Lindsaea group
singi-singgip	*Lindsaea obtusa* J. Smith	Lindsaea group
singi-singgip	*Lindsaea* cf. *obtusa* J. Smith	Lindsaea group
lasa-lasa	*Lindsaea tenuifolia* Blume	Lindsaea group
singi-singgip	*Lindsaea tenuifolia* Blume	Lindsaea group
dago-dagol	*Liparis condylobulbon* Reichb f.	Orchidaceae
ma-bairap	*Lomagramma* cf. *sinuata* C. Chr.	Lomariopsidaceae
nasag muani	*Lunasia amara* Blanco var. *amara*	Rutaceae
boa-boak	*Lygodium circinnatum* (Burm. f.) Swartz	Schizaeaceae
kaposika	*Macaranga fallacina* Pax & Hoffm.	Euphorbiaceae
puale-pualel	*Mackinlaya celebica* (Harms) Philipson	Araliaceae
wat-uduat	*Maniltoa schefferi* K. Schum. & Hollrung	Caesalpiniaceae
gilagal	*Mapania macrocephala* (Gaud.) K. Schum. ssp. *macrocephala*	Cyperaceae
nganam idir idir	*Medinilla triplinervia* Cogn., '*mufoso-triplinervia* group'	Melastomataceae
idi-dir	*Medinilla* sp., aff. *tenuipedicellata* Baker f.	Melastomataceae
tukum-avang	*Medinilla* sp., aff. *tenuipedicellata* Baker f.	Melastomataceae
mane-mane-kav	*Medusanthera laxiflora* (Miers) Howard	Icacinaceae
wanclap	*Melicope* sp., cf. *M. burttiana* Stone or *M. grandifolia* Burtt	Rutaceae
muiyam	*Melodinus* cf. *acutus* (Markgraf) Markgraf	Apocynaceae
bal-sivar	*Merremia peltata* (L.) Merr.	Convolvulaceae
mouko	*Microcos* sp. ?nov.	Tiliaceae
ah-maap	*Micromelum minutum* (Forst. f.) Wight & Walker Arnott	Rutaceae
wara-tep	*Microsorum linguiforme* (Mett.) Copel.	Polypodiaceae
lasa-lasa	*Microsorum membranifolium* (R. Br.) Ching	Polypodiaceae

boge-namb	*Morinda umbellata* L. var. *papuana* Valeton	Rubiaceae
say-ri-keep	*Mucuna cyanosperma* K. Schum.	Fabaceae
go-idi	*Musa banksii* F.v.M.	Musaceae
mum-nganam	*Mussaenda cylindrocarpa* Burck	Rubiaceae
pah-tooey	*Mussaenda cylindrocarpa* Burck	Rubiaceae
ugag	*Mussaenda cylindrocarpa* Burck	Rubiaceae
tuar	*Mycetia javanica* (Blume) Reinw. ex Korth.	Rubiaceae
sagua	*Myristica lancifolia* Poir. ssp. *lancifolia*	Myristicaceae
sang-guab	*Myristica lancifolia* Poir. ssp. *lancifolia*	Myristicaceae
kobos-susul	*Myristica subalulata* Miq. var. *subalulata*	Myristicaceae
sagua	*Myristica tristis* Warburg, or aff.	Myristicaceae
amungcurcuri	*Neisosperma citrodorum* (Laut. & K. Schum.) Fosb. & Sach.	Apocynaceae
sretu-ngomb	*Neisosperma citrodorum* (Laut. & K. Schum.) Fosb. & Sach.	Apocynaceae
mond'-minab	*Neuburgia corynocarpa* (A. Gray) Leenh.	Loganiaceae
urat	*Neuburgia rumphiana* Leenh.	Loganiaceae
quasi-kwas	*Ocimum gratissimum* L.	Lamiaceae
sivila	*Omphalea queenslandiae* F.M. Bailey	Euphorbiaceae
sauga sivar	*Opilia amentacea* Roxb.	Opiliaceae
tibaga	*Orania macropetala* Laut. & K. Schum.	Arecaceae
mabarara dangamb	*Osmelia philippina* (Turcz.) Benth.	Flacourtiaceae
mamba-mambap	*Osmoxylon sessiliflorum* (Laut.) Philipson	Araliaceae
mamba-mambap	*Osmoxylon* (closest to) *sessiliflorum* (Laut.) Philipson	Araliaceae
timber digeep	*Pandanus angiensis* Kaneh., or aff.	Pandanaceae
kasapa	*Pangium edule* Reinw.	Flacourtiaceae
sauiak	*Panicum sarmentosum* Roxb.	Poaceae
bogo-namb	*Pararistolochia schlechteri* (Laut.) M.J. Parsons	Aristolochiaceae
guragor	*Paraserianthes falcataria* (L.) Nielsen cf. ssp. *falcataria*	Mimosaceae
undu-beb	*Peristylus ?papuana* J.J. Sm.	Orchidaceae
koitav	*Petalolophus* sp., aff. *megalopus* K. Schum.	Annonaceae
ivanum	*Phaleria coccinea* (Gaud.) F.v.M.	Thymelaeaceae
kibi-kibale	*Phaleria coccinea* (Gaud.) F.v.M.	Thymelaeaceae
mua-muadi	*Phrynium* cf. *macrocephalum* K. Schum.	Marantaceae
kamasasak	*Phrynium pedunculatum* Warburg, or aff.	Marantaceae
tah-bop	*Phrynium pedunculatum* Warburg, or aff.	Marantaceae
mua-muadi	*Phrynium* sp., aff. *macrocephalum* K. Schum.	Marantaceae
kamasosak	*Phrynium* sp.	Marantaceae
sopi-sebip	*Phylacium bracteosum* Benn.	Fabaceae
esg-ese-ya	*Phyllanthus rubriflorus* J.J. Sm.	Euphorbiaceae
seger-buga	*Phyllanthus rubriflorus* J.J. Sm.	Euphorbiaceae
arap	*Pimelodendron amboinicum* Hassk.	Euphorbiaceae
kamora-kamorap	*Piper caninum* Blume	Piperaceae
ah-mo-rap	*Piper* cf. *caninum* Blume	Piperaceae
amora-kamorap	*Piper decumanum* (Rumph.) L	Piperaceae
muara-muarav	*Piper decumanum* (Rumph.) L.	Piperaceae
mora-morava	*Piper majusculum* Blume	Piperaceae
ibi-ibim	*Piper mestonii* F.M. Bailey	Piperaceae
mara-marav	*Piper pseudoamboinense* C. DC.	Piperaceae
mara-marav	*Piper pullibaccum* Trelease	Piperaceae
bial	*Pipturus argenteus* (Forst. f.) Wedd.	Urticaceae
wo-roon-botop	*Pipturus argenteus* (Forst. f.) Wedd.	Urticaceae
aru	*Pisonia longirostris* Teijsm. & Binn.	Nyctaginaceae

sesambop	*Pisonia longirostris* Teijsm. & Binn.	Nyctaginaceae
lasa-lasa	*Pleocnemia macrodonta* (Fée) Holttum	Tectaria group
vebum	*Pleocnemia macrodonta* (Fée) Holttum	Tectaria group
gaga-bumer	*Plesioneuron tuberculatum* (Cesati) Holttum	Thelypteridaceae
kidi-kidi	*Pleuranthodium* sp., ?*trichocalyx* (Valeton) R.M. Smith	Zingiberaceae
man-duroop	*Plocoglottis* cf. *moluccana* Schltr.	Orchidaceae
vebum	*Pneumatopteris sogerensis* (Gepp) Holttum	Thelypteridaceae
sana ngamb	*Pneumatopteris* sp., aff. *keysseriana* (Rosenst.) Holttum	Thelypteridaceae
tatar-ulalat	*Podocarpus* cf. *rumphii* Blume	Podocarpaceae
warang-gab	*Poikilospermum amboinense* Zipp. ex Miq.	Cecropiaceae
sigawag	*Polytocha macrophylla* Benth.	Poaceae
lawalang wiab	*Popowia* sp., aff. *pisocarpa* (Blume) Endl.	Annonaceae
sivar-wiav	*Popowia* sp.	Annonaceae
wato-karok	*Pothos papuanus* Becc. ex Engl.	Araceae
gagab	*Pothos rumphii* Schott	Araceae
pat dagol dagol	*Pronephrium micropinnatum* Holttum	Thelypteridaceae
televa-nganam	*Pseuderanthemum* sp., cf. '*variabile* group' sensu Barker	Acanthaceae
mavanda-ngamb	*Pseudobotrys dorae* Moeser	Icacinaceae
kolaiv-nganam	*Pseuduvaria* sp., aff. ?*versteegii* (Diels) Merr.	Annonaceae
sivar wiav	*Pseuduvaria* sp.	Annonaceae
sivar-yadod	*Pseuduvaria* sp.	Annonaceae
vogo gon dab	*Pseuduvaria* sp.	Annonaceae
kututal	*Psychotria amplithyrsa* Valeton	Rubiaceae
mumbutakut	*Psychotria dipteropoda* Laut. & K. Schum.	Rubiaceae
osag-rep	*Psychotria dipteropoda* Laut. & K. Schum.	Rubiaceae
ngabu ngabu	*Psychotria leptothyrsa* Miq. var. *leptothyrsa*	Rubiaceae
babagalum	*Psychotria mayana* Takeuchi	Rubiaceae
wo-sarep	*Psychotria mayana* Takeuchi	Rubiaceae
watuiam	*Psychotria membranifolia* Bartl. ex DC.	Rubiaceae
ngayom nasag	*Psychotria membranifolia* Bartl. ex DC.	Rubiaceae
ngayom-nasag	*Psychotria cf. membranifolia* Bartl. ex DC.	Rubiaceae
babagalum	*Psychotria phaeochlamys* (Laut. & K. Schum.) Valeton	Rubiaceae
ga-tsurup	*Psychotria phaeochlamys* (Laut. & K. Schum.) Valeton	Rubiaceae
sob-barewa	*Psychotria* sp. nov.	Rubiaceae
wana-barewa	*Psychotria* sp. nov.	Rubiaceae
babagalum	*Psychotria* sp., aff. *micralabastra* (Laut. & K. Schum.) Valeton	Rubiaceae
wasagep	*Psychotria* sp., aff. *micralabastra* (Laut. & K. Schum.) Valeton	Rubiaceae
giligelum-sivar	*Psychotria* (possibly new vining sp.)	Rubiaceae
gaga-bumer	*Pteris warburgii* Christ	Pteridaceae
idang io	*Ptyssiglottis pubisepala* (Lindau) B. Hansen	Acanthaceae
ngumusinam	*Pueraria pulcherrima* (Koorders) Koorders-Schumacher	Fabaceae
mago-ragor	*Pyrrosia princeps* (Mett.) Morton	Polypodiaceae
kasuar dadi	'*Randia*' sp., '*decora* Val., or *sphaerocarpa* K. Schum. facies'	Rubiaceae
ooh-rau-rap	*Rhaphidophora korthalsii* Schott	Araceae
gagap	*Rhaphidophora versteegii* Engler & Krause	Araceae
maberu	*Rhyticaryum longifolium* K. Schum. & Laut.	Icacinaceae

daveh-veh	*Rhyticaryum novoguineense* (Warburg) Sleumer	Icacinaceae
ma-rab	*Riedelia grandiligula* Valeton	Zingiberaceae
ma-rab	*Riedelia macrantha* K. Schum.	Zingiberaceae
ninara-umu	*Rinorea horneri* (Korth.) O.K.	Violaceae
sekera-nasag	*Rinorea horneri* (Korth.) O.K.	Violaceae
vorap	*Rubus moluccanus* L. var. *discolor* (Blume) Kalkman	Rosaceae
pat-sani-sani	*Ruellia* sp. (*Leptosiphonium*)	Acanthaceae
umbol-lap	*Sabia pauciflora* Blume	Sabiaceae
wang-gep	*Saprosma subrepandum* (K. Schum. & Laut.) Valeton	Rubiaceae
atep	*Schismatoglottis* sp.	Araceae
gibaiv	*Schismatoglottis* sp.	Araceae
kibaip	*Schismatoglottis* sp.	Araceae
kasipul	*Schizostachyum lima* (Blanco) Merr.	Poaceae
moimoit	*Scleria polycarpa* Boeck.	Cyperaceae
pupun-lov	*Selaginella* cf. *velutina* Cesati	Selaginellaceae
manda-peb	*Selaginella* sp., aff. ?*hieronymiana* v.A.v.R.	Selaginellaceae
lawa-lawat	*Semecarpus brachystachys* Merr. & Perry	Anacardiaceae
wingam	*Semecarpus forstenii* Blume	Anacardiaceae
lawa-lawat	*Semecarpus magnificus* K. Schum.	Anacardiaceae
wat-ukauel	*Smilax* cf. *australis* R. Br.	Smilacaceae
bo-rap	*Solanum torvum* Swartz	Solanaceae
kasiwar-gili-giliba	*Spathoglottis plicata* Blume ssp. *puberula* N.H.S. Howcroft	Orchidaceae
komekelak	*Sphaerostephanos arfakianus* (Baker) Holttum	Thelypteridaceae
ngaparu-pot	*Sphaerostephanos pilososquamatus* (v.A.v.R.) Holttum	Thelypteridaceae
tuturat	*Stachytarpheta cayennensis* (Rich.) M. Vahl	Verbenaceae
ave-namb	*Steganthera dentata* (Valeton) Kaneh. & Hatus.	Monimiaceae
marap	*Steganthera dentata* (Valeton) Kaneh. & Hatus.	Monimiaceae
bailalum	*Steganthera hirsuta* (Warburg) Perkins	Monimiaceae
aramitap	*Steganthera hospitans* (Becc.) Kaneh. & Hatus.	Monimiaceae
ma-bairap	*Stenochlaena milnei* Underwood	Blechnaceae
kokam-tol	*Sterculia schumanniana* (Laut.) Mildbr.	Sterculiaceae
nanggu-nanggu-nam	*Strobilanthes* s.l., *Hemigraphis primulifolia* (Nees) F. Vill. facies	Acanthaceae
sagag-gosmun	*Strobilanthes* s.l. (*Hemigraphis* sp.)	Acanthaceae
sagag-u-goga-umun	*Strobilanthes* s.l. (*Hemigraphis* sp.)	Acanthaceae
sagag-ugosum	*Strobilanthes* s.l. (*Hemigraphis* sp.)	Acanthaceae
sumure	*Strobilanthes* s.l. (*Hemigraphis* sp.)	Acanthaceae
mansu borobor	*Syzygium aeoranthum* (Diels) Merr. & Perry	Myrtaceae
navyia	*Syzygium* cf. *amplum* Hartley & Perry	Myrtaceae
padada	*Syzygium hylophilum* (Laut. & K. Schum.) Merr. & Perry	Myrtaceae
mansu-borobor	*Syzygium longipes* Merr. & Perry	Myrtaceae
kah-bik	*Syzygium pteropodum* (Laut. & K. Schum.) Merr. & Perry	Myrtaceae
magule	*Syzygium trachyanthum* (Diels) Merr. & Perry	Myrtaceae
da-da-dag	*Syzygium* sp., aff. *goniopterum* (Diels) Merr. & Perry	Myrtaceae
navyia	*Syzygium* sp.	Myrtaceae
uaia	*Tabernaemontana aurantiaca* Gaud.	Apocynaceae
umbol-menyap	*Tabernaemontana aurantiaca* Gaud.	Apocynaceae
samangi manggib	*Tabernaemontana orientalis* R. Br.	Apocynaceae
keiti	*Tapeinochilos recurvatum* K. Schum.	Costaceae

keiti	*Tapeinochilos* sp. nov.	Costaceae
wange-abab	*Tarenna gülcheriana* (K. Schum.) Valeton	Rubiaceae
yag-tauita	*Tarenna gülcheriana* (K. Schum.) Valeton	Rubiaceae
takevam	*Tectaria menyanthides* (Presl) Copeland	Tectaria group
bogang-dap	*Terminalia impediens* Coode	Combretaceae
danga-namb	*Terminalia impediens* Coode	Combretaceae
ananange-woganamb	*Tetracera nordtiana* F.v.M.	Dilleniaceae
bodog	*Tetrastigma lauterbachianum* Gilg	Vitaceae
bon	*Thespesia fissicalyx* Borss.	Malvaceae
ma-kap	*Trichosanthes* sp., '*longiflora-bracteata* group'	Cucurbitaceae
ikikap	*Tropidia disticha* Schltr.	Orchidaceae
idi-muyat	*Versteegia cauliflora* (K. Schum. & Laut.) Valeton	Rubiaceae
waipa	*Versteegia cauliflora* (K. Schum. & Laut.) Valeton	Rubiaceae
wanam-barewa	*Versteegia grandifolia* Valeton	Rubiaceae
ker-ker-kanamb	*Vrydagzynea* cf. *rivularis* Schltr.	Orchidaceae
wungo-bunyam	*Wedelia biflora* (L.) DC.	Asteraceae
maruruma	*Wenzelia dolichophylla* (Laut. & K. Schum.) Tanaka	Rutaceae
ngabu-kuruk	*Zanthoxylum conspersipunctatum* Merr. & Perry	Rutaceae
ambo-dera namb	*Ziziphus djamuensis* Laut.	Rhamnaceae

APPENDIX 3

ETHNOBOTANICAL VALUE OF JOSEPHSTAAL PLANTS

PLANTS WITH FOOD VALUE

Amaranthus dubius Thell.; leaves edible

Artocarpus communis J.R. & G. Forst.; seeds are eaten

Bambusa microcephala (Pilger) Holttum; young shoots are eaten

Buchanania macrocarpa Laut.; the rotting wood is a particularly good source of edible larvae

Callipteris prolifera (Lamk) Bory; young shoots or fronds eaten as a vegetable, fed especially to children to promote their physical development

Callipteris spinulosa (Blume) J. Smith; new leaves are edible

Cucurbita sp.; fruits and leaves are edible

Diplora d'urvillaei (Bory) C. Chr.; leaves are burnt and the ashes used as salt

Ficus dammaropsis Diels var. *obtusa* Corner; fruit is edible

Ficus wassa Roxb.; eaten as a vegetable

Inocarpus '*rubidus*' morphotype fide Verdcourt; seeds are edible

Lepisanthes senegalensis (Poir.) Leenh.; fruit is edible, fed especially to children to improve their growth

Lomagramma cf. *sinuata* C. Chr.; leaves are edible

Melicope sp., cf. *M. burttiana* Stone or *M. grandifolia* B.L. Burtt; the plant is a source of edible leaf caterpillars

Pangium edule Reinw.; seeds are edible

Pimelodendron amboinicum Hassk.; the dead dry wood is a good source of edible larvae

Pneumatopteris sogerensis (Gepp) Holttum; young shoots or fronds eaten as a vegetable

Pneumatopteris sp., aff. *keysseriana* (Rosenst.) Holttum; leaves edible, cooked with meat

Schismatoglottis sp.; young leaves are edible

Stenochlaena milnei Underwood; new leaves are edible

Terminalia impediens Coode; seed is edible

Trichosanthes sp., '*longiflora-bracteata* group'; fruit is edible

MEDICINAL OR PSYCHOACTIVE PLANTS

Alocasia aequiloba N.E. Br.; leaves used to treat pain from salat (stinging nettle) injuries

Alocasia lauterbachiana (Engl.) A. Hay; leaves used to alleviate pain from nettle stings

Areca cf. *macrocalyx* Zipp. ex Blume; chewed as a substitute for buai (betlenut)

Calyptrocalyx albertisianus Becc.; mature fruits chewed as a substitute for buai

Cassia alata L.; used to treat ringworm and skin diseases

Cyperus kyllingia Endl.; leaves are boiled and used for body aches and diarrhea

Euphorbia hirta L.; leaves boiled and the solution is used to treat fever and cold symptoms

Licuala beccariana Furtado; mature nuts are chewed as a buai substitute

Lunasia amara Blanco var. *amara*; young leaves heated over fire and the juice squeezed onto sores

Piper cf. *caninum* Blume; spikes and all other parts chewed with buai

Piper decumanum (Rumph.) L.; roots are chewed with buai

Psychotria membranifolia Bartl. ex DC.; roots mashed and mixed with coconut juice, given to children to treat malaria and stomach disorders

Scleria polycarpa Boeck.; plant is cooked in bamboo and eaten to induce abortion during the early stages of pregnancy, cf. *Mills s.n.* from Josephstaal

Tabernaemontana orientalis R. Br.; roots are boiled and the solution consumed to promote aggression

PLANTS USED IN CONSTRUCTION OR FOR MAKING IMPLEMENTS

Aglaia cuspidata C. DC.; wood is used for making spears

Alangium villosum (Blume) Wangerin ssp. *ferrugineum* (C.T.White) Bloembergen; poles used for house rafters

Brassiophoenix schumannii (Becc.) Essig; planks used as house flooring, also made into implements for sharpening bows and arrows

Calamus humboldtianus Becc.; canes are split and used as ropes for tying and fastening (e.g. house and fence construction)

Casearia macrantha Gilg, or aff.; poles used as digging implements

Cleistanthus sp., aff. ?*papuanus* (Laut.) Jabl.; poles for house building

Dichapetalum sessiliflorum Leenh.; used as ties and bindings in house construction

Donax cannaeformis (Forst. f.) K. Schum.; stems used as rope for house building

Dysoxylum sparsiflorum Mabberley; used for tool handles, wood is very strong

Garcinia maluensis Laut.; wood poles used as a digging stick or planting implement for yams and mami (*Dioscorea esculenta*)

Hibiscus ellipticifolius Borss.; bark is used as wall panels in houses

Intsia bijuga (Colebr.) Kuntze; trunks used for making garamuts, also a strong timber for house posts

Licuala beccariana Furtado; leaves used as roofing for bush shelters

Macaranga fallacina Pax & Hoffm.; used in making rafters for houses

Neuburgia corynocarpa (A. Gray) Leenh.; wood used in house construction

Porterandia sp.; poles are used in making cassowary traps

Pseuduvaria sp.; used as timber poles during house construction

Psychotria membranifolia Bartl. ex DC.; stems used as a planting implement for mami (*Dioscorea esculenta*)

Psychotria sp. nov.; the wood is used for making digging sticks for planting yams and mami (*Dioscorea esculenta*); crop yields are believed to increase when this particular wood is used

Schizostachyum lima (Blanco) Merr.; used for making bowstrings, cf. *R. Pullen 1117*

Versteegia cauliflora (K. Schum. & Laut.) Valeton; wood used as cultivation tool

Versteegia grandifolia Valeton; stem is used as a digging implement for planting, it is a traditional belief that this increases yam yields

PLANTS WITH CEREMONIAL, RITUALISTIC, OR SPIRITUAL APPLICATIONS

Aglaomorpha drynarioides (Hooker) Roos; leaves used in ritual ceremonies

Antrophyum cf. *reticulatum* (Forst.) Kaulf.; leaves used for decorative purposes as a traditional bilas

Dracaena angustifolia Roxb.; young leaves cut and put in bamboo; then used to wash children to prevent crying and chase away spirits

Entada phaseoloides (L.) Merr.; sap collected in bamboo, taro shoots are dipped into the sap and planted, said to increase yield

Euodia hortensis J.R. & G.Forst.; juice extract used to perfume bodies during sing-sings, cf. *NGF 10278*

Ficus odoardi King; sap is rubbed on yam before planting to increase growth

Holochlamys beccarii Engl.; used in magic rituals to increase abundance of game animals

Huperzia cf. *squarrosa* (Forst. f.) Trevisan; plant held skyward towards rain clouds as special incantations are spoken to stop the rain

Microsorum linguiforme (Mett.) Copel.; leaves used as traditional decoration in ceremonies

Neisosperma citrodorum (Laut. & K. Schum.) Fosb. & Sach.; sap from fruit is rubbed on yam before planting to increase yields

Piper mestonii F.M. Bailey; spikes used as decorative bilas in ceremonies

Tabernaemontana aurantiaca Gaud.; fruits are used as Christmas ornaments

Tabernaemontana orientalis R. Br.; flowers used in rituals to improve crop growth

Tetracera nordtiana F.v.M.; water in the vine is used in black magic to inflict illness

Trichosanthes sp.,'*longiflora bracteata* group'; sap from vine is used in hunting rituals

PLANTS OF PARTICULAR VALUE TO WILDLIFE

Aceratium ledermannii Schltr.; mature fruits eaten by bandicoots

Aglaia lepidopetala Harms; mature fruits eaten by possums

Archidendron aruense (Warburg) de Wit; flower nectar sucked by bandicoots; seeds eaten by bandicoots

Arytera sp., aff. *litoralis* Blume, '*litoralis* complex'; fruit eaten by possums

Buchanania macrocarpa Laut.; fruits eaten by cassowaries and other birds

Calyptrocalyx albertisianus Becc.; mature fruits eaten by cassowaries

Casearia macrantha Gilg, or aff.; fruits eaten by possums

Cerbera floribunda K. Schum.; fruits eaten by cassowaries

Cryptocarya laevigata Blume; fruits eaten by cassowaries

Cyathocalyx papuanus Diels, or aff.; ripe fruits eaten by cassowaries

Diospyros papuana Valeton ex Bakh.; fruits swallowed by cassowaries

Dysoxylum brassii Merr. & Perry; ripe fruits eaten by possums

Dysoxylum pettigrewianum F.M. Bailey; ripe fruits eaten by possums

Ficus botryocarpa Miq. var. *subalbidoramea* (Elmer) Corner; mature fruits eaten by bandicoots and bats

Ficus congesta Roxb.; ripe fruits eaten by bandicoots

Ficus conocephalifolia Ridl.; fruits eaten by bandicoots

Ficus pungens Reinw. ex Blume; eaten by birds and bandicoots

Helicia affinis Sleumer; fruits eaten by cassowaries

Neuburgia rumphiana Leenh.; ripe fruits eaten by cassowaries

Orania macropetala Laut. & K. Schum.; ripe fruits eaten by cassowaries

Pangium edule Reinw.; seeds eaten by cassowaries

Pipturus argenteus (Forst. f.) Wedd.; fruits eaten by birds

Porterandia sp.; fruits are swallowed by cassowaries

Psychotria micralabastra (Laut. & K. Schum.) Valeton; fruits eaten by birds

Pyrrosia princeps (Mett.) Morton; used as shelter by possums

Syzygium aeoranthum (Diels) Merr. & Perry; many animals eat the fruit and seeds

Syzygium longipes Merr. & Perry; fruits eaten by cassowaries

Syzygium pteropodum (Laut. & K. Schum.) Merr. & Perry; fruits eaten by cassowaries

PLANTS USED ON DOGS

Aglaia sapindina (F.v.M.) Harms; young leaves are heated over fire, mashed, and the juice squeezed into a hunting dog's nostrils to improve its ability to track game

Alocasia aequiloba N.E. Br.; petiole base and roots fed to hunting dogs to stimulate aggression

Alocasia lancifolia Engl.; petiole base fed to dogs to stimulate aggression in the hunt

Cryptocarya laevigata Blume; fed to dogs to increase their ability to hunt bandicoots

Cyrtosperma cuspidispathum Alderw.; peduncle and spadix cooked in bamboo and fed to hunting dogs to promote aggression

PLANTS WITH OTHER CULTURAL APPLICATIONS

Arytera sp., aff. *litoralis* Blume, '*litoralis* complex'; resin is burned at night as a candle substitute

Calyptrocalyx hollrungii Becc.; leaves used for wrapping food, e.g. fresh meat caught in the bush

Cleistanthus sp., aff. ?*papuanus* (Laut.) Jabl.; said to be a particularly good firewood for cooking

Coix lachryma-jobi L.; fruits used to make necklaces

Cominsea cf. *minor* Valeton; leaves used as wrapping for sago

Curcuma cf. *australasica* Hooker f.; a source of yellow dye

Harpullia ramiflora Radlk.; bark is stripped and used as a fish poison

Helicia affinis Sleumer; ripe fruits provide a dark purple dye (e.g. for bilums)

Heliconia papuana W.J. Kress; leaves used for wrapping food, e.g. fresh meat caught in the bush

Hibiscus ellipticifolius Borss.; bark is peeled in strips as a sleeping mat

Leucosyke cf. *capitellata* (Poir.) Chew; leaves used as toothbrush

Lygodium circinnatum (Burm. f.) Swartz; stems used to make arm bands

Microcos sp. ?nov.; used as a fish poison, cf. *NGF 10231*

Morinda bracteata Roxb.; root bark is used for dye, cf. *NGF 10232*

Ocimum gratissimum L.; used for perfume

Phrynium cf. *macrocephalum* K. Schum.; leaves used as a wrap for garden vegetables and bush meat

Phrynium pedunculatum Warburg, or aff.; leaves used for wrapping sago

Pittosporum sinuatum Blume var. *sinuatum*; young leaves are mashed and rubbed on diving goggles to prevent fogging

Planchonia papuana Knuth; bark is used as fish poison, cf. *NGF 10250*

Psychotria amplithyrsa Valeton; mature fruits mixed with pig food to promote fattening

Psychotria membranifolia Bartl. ex DC.; leaves fed to pigs to promote fattening

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BOOK REVIEW

Peter D. Stiling. 1999. **Ecology: Theories and applications, 3rd ed.** (ISBN 0-13 915653-4, hbk.) Prentice-Hall, Upper Saddle River, New Jersey 07458, U.S.A. 638 pp., b/w and color, and line drawings.

Ecology: theories and applications is a well-written, comprehensive overview of basic key concepts and theories in the fields of ecology and conservation biology. Headings for each of the subsections are statements that summarize the key ideas and provide a helpful outline of the major concepts of the chapter. Tables, photographs, and diagrams throughout the book are well presented and effectively summarize or illustrate important concepts. The book is organized in a fairly tradition format, covering a wide range of topics. It begins with a discussion of the field of ecology in general, then moves through evolutionary ecology, behavioral ecology, population ecology (including a nice presentation of abiotic factors), community ecology, and ecosystem ecology. Stiling also includes a discussion of the relatively young field of conservation biology. Within each section are presentations of modern-day applications relating to the theories that support them. These sections help the student recognize the significant role that the science of ecology has to play in decision-making and policy at local to global scales. The book is a great resource for university students and others interested in the theories forming the foundation for the ecological sciences. —*Charlotte Bryant.*

ERAGROSTIS ANCASHENSIS (POACEAE: CHLORIDOIDEAE), A NEW SPECIES FROM ANCASH, PERU

Paul M. Peterson

Department of Botany
National Museum of Natural History
Smithsonian Institution
Washington, DC 20560-0166, U.S.A.

Nancy Refulio Rodriguez and Oscar Tovar

Museo de Historia Natural
Universidad Nacional Mayor de San Marcos
Lima, 14-0434, PERU

ABSTRACT

Eragrostis ancashensis P.M. Peterson, Refulio & Tovar, sp. nov., is described and illustrated. The new species occurs on steep rocky slopes in three distinct locations in Departamento Ancash: near the southern end of the Cordillera Blanca, approximately 20 km E of Raquia, near Huaylas, and near Bambas, just north of the Cordillera. The new species seems most closely allied with *Eragrostis magna* Hitchc. but differs by its shorter culms (26–84 cm long); shorter and narrower leaf blades [(6–)10–22(–26) cm long × 1–2.5(–3.0) mm wide]; shorter panicles [10–20(–38) cm long]; shorter branches (1.5–11 cm long) that are widely spreading; ovate spikelets (3–6.1 mm long × 2–4.5 mm wide) with a long ciliate (the hairs up to 1.5 mm long) and flattened rachilla; veins of the glumes, lemmas, and paleas usually with minute, whitish, raised glands; broadly ovate lemmas 2–3.2 mm long; and anthers 1.2–2.0 mm long.

RESUMEN

Eragrostis ancashensis P.M. Peterson, Refulio & Tovar, sp. nov., es descrita e ilustrada. Esta nueva especie habita en pendientes de suelos rocosos, en tres localidades distintas del departamento de Ancash: cerca del extremo sur de Cordillera Blanca, aproximadamente a 20 km E de Raquia; cerca a Huaylas y cerca a Bambas, al norte de la Cordillera Blanca. Esta nueva especie está fuertemente relacionada con *Eragrostis magna* Hitchc., pero difiere de ella por sus culmos más cortos (26 84 cm de largo); sus láminas foliares más cortas y menos anchas [(6–)10–22(–26) cm de largo 3 1–2.5(–3.0) mm de ancho]; panículas más cortas [10 20(–38) cm de largo]; ramas de la panícula más cortas (1.5–11 cm de largo) y extendidas; espiguillas ovadas (3–6.1 mm de largo 3 2–4.5 mm de ancho), raquila aplanada y ciliada (pelos hasta 1.5 mm de largo); nervios del las glumas, lemas y páleas usualamente con glandulas diminutas y blanquecinas; lemas anchamente ovadas 2–3.2 mm de largo; y anteras 1.2–2.0 mm de largo.

While making determinations of Peruvian material using the treatments of Tovar (1993), Renvoize (1998), and Laegaard and Peterson (2000), the first and second authors recognized the unique features of three grass collections. These specimens were distinguished by their dark green and plumbeous-spotted spikelets with a ciliate, flattened rachilla. The new species is clearly a member of subfamily Chloridoideae, tribe Eragrostideae,

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subtribe Eragrostidinae (Peterson et al. 1995, 1997). We describe these specimens as a new species of *Eragrostis*, and ascribe the specific epithet to the Departamento Ancash.

Eragrostis ancashensis P.M. Peterson, Refulio & Tovar, sp. nov. (**Fig. 1**). Type: PERÚ. Departamento Ancash. Provincia Recuay: Cordillera Blanca, approximately 20 km E of Raquia on Route 02-014 on road towards Huaraz (10° 8' 55.8" S–77° 19' 48.8" W), 3000 m, 20 Mar 1997, *P.M. Peterson & N. Refulio Rodriguez 13793* (holotype: USM!; isotype: K! MO! NY! RSA! TAES! UC! US! WIS!).

Ab *Eragrostis magna* Hitchc. rhizomatibus nullis, culmis 26–84 cm altis, laminis (6–)10–22(–26) cm longis 1–2.5(–3.0) mm latis, paniculis 10–20(–38) cm longis ramis 1.5–11 cm longis effusis, spiculis 3–6.1 mm longis 2–4.5 mm latis ovatis, rhachilla complanata ciliata trichomatibus usque ad 1.5 mm longis, venis glumarum lemmatum palearum plerumque glandulis albidis elevatis, antheris 1.2–2.0 mm longis recedit.

Caespitose perennials. Culms 26–84 cm tall, erect, terete near base, glabrous below the nodes; nodes mostly basal or 1 rarely 2 above; internodes glabrous. Sheaths 6–16 cm long, longer that the lower internode if present, mostly glabrous or with scattered hairs near the summit, the hairs up to 1.3 mm long; margins mostly smooth usually with a large tuft of hairs near the summit, these hairs up to 3 mm long; collar visible, yellowish. Ligules 0.4–0.7 mm long, a line of hairs, sometimes these hairs extending up to 2.5 mm long, these breaking off at maturity. Blades (6–)10–22(–26) cm long, 1–2.5(–3.0) mm wide, flat above the ligule to tightly involute above, apically acuminate, usually densely pilose-villous near base above and below to sparsely pilose-villous near base and glabrous above, the hairs up to 2.5 mm long. Panicles 10–20(–38) cm long, 5–15 cm wide, open, the loosely flowered branches spreading 20–80 o from the culm axis; inflorescence branches mostly 1.5–11 cm long, naked near base, with spreading secondary branches, one to three per node; pulvini in the axils of primary and secondary branches villous, the hairs up to 5 mm long; pedicels 1.2–6 mm long, delicately spreading, sinuous to flexuous, scaberulous. Spikelets 3–6.1 mm long, 2–4.5 mm wide, florets 3–8, ovate, compressed, dark green with small plumbeous spots; rachilla flattened, usually densely ciliate along the margins, the hairs up to 1.5 mm long; disarticulation with the glumes first then the lemmas falling individually leaving the paleas on the rachilla. Glumes 2–2.8 mm long, lanceolate to ovate, membranous, shorter than the lower lemma, about equal in length, 1-veined, keeled, scaberulous along the keel and usually with minute, whitish, raised glands; apex acute to acuminate, often mucronate, the mucro up to 0.5 mm long. Lemmas 2–3.2 mm long, broadly ovate, membranous, 3-veined, lateral veins somewhat obscure, keeled, scaberulous along the keel and near the apex, the veins usually with minute, whitish, raised glands; apex acute, often darker than below. Paleas 1.8–3.1 mm long, elliptic, bowed-out, membranous, the keels usually with minute, whitish, raised glands; apex truncate to obtuse, sometimes minutely erose. Lodicules 2, 0.2–0.3 mm long, cuneate, fleshy, non-vascularized. Stamens 3, anthers 1.2-2.0 mm long, yellow to purplish at maturity. Ovaries 0.3–0.5 mm long; styles 2, separate, glabrous, stigmas 2, feathery, white to purplish. Caryopses 0.7–0.9 mm long, rectangular-prismatic, deeply grooved on the adaxial (ventral) surface, striate, dark reddish brown.

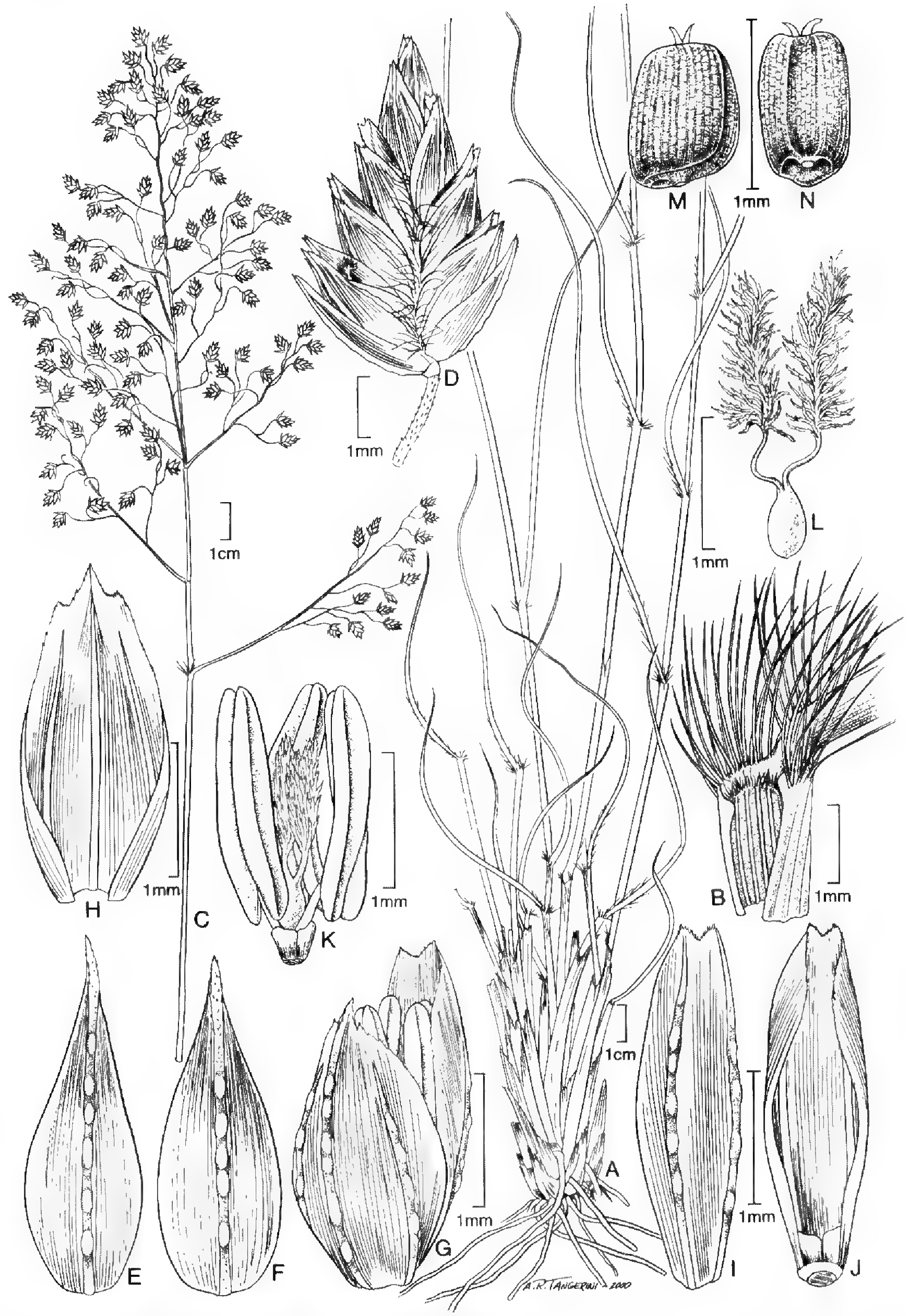

Fig. 1. *Eragrostis ancashensis* (*Peterson & Refulio Rodriguez 13793*). A. Habit. B. Sheath and ligule. C. Inflorescence. D. Spikelet. E. Lower glume, dorsal view. F. Upper glume, dorsal view. G. Floret, as viewed from the dorsal side of lemma. H. Lemma, ventral view. I. Palea dorsal view. J. Palea, ventral view. K. Stamens, pistil, and lodicules. L. Gynoecium, mature. M. Caryopsis, lateral view. N. Caryopsis, ventral view.

Phenology.—Flowering in mid to late March through May, with caryopses in June (*R. Ferreyra 14577*).

Distribution.—*Eragrostis ancashensis* is known only from Departamento Ancash in three distinct locations: near the southern end of the Cordillera Blanca (type locality in Provincia Recuay), near Huaylas (Provincia Huaylas), and near Bambas (Provincia Corongo), just north of the Cordillera. Individuals of *E. ancashensis* can be found growing on steep rocky slopes at mid elevations (2200–3220 m) associated with xerophytic plants such as: *Agave, Commelina, Lupinus, Puya, Vicia, Viguiera,* and other shrubby Asteraceae.

Additional specimens examined: **PERU**. **Departamento Ancash:** Provincia Corongo, 7 km NW of Yupan on road towards Bambas, 3220 m, 26 Mar 1997, *Peterson & Refulio Rodriguez 13915* (US, USM); 7 km NW of Bambas, 2710 m, 26 Mar 1997, *Peterson & Refulio Rodriguez 13919* (US, USM); Provincia Huaylas, between Caráz and Huallanca, 2200-2300 m, 2 Jun 1962, *R. Ferreyra 14577* (USM); between Huaylas and el Callejón, 2400-2500 m, 3 Jun 1962, *R. Ferreyra 14594* (USM).

LEAF ANATOMY

Cross-sectional leaf blade anatomy was determined from hand sections of dry material (*Peterson & Refulio Rodriguez 13915*) on temporary slides. Therefore, an illustration is not presented, since the chlorenchyma tissue and parenchyma bundle sheath cells were mostly collapsed.

The blades are typically kranz-C4, PCK-like [phosphoenolpyruvate carboxykinase or classical PCK type, defined as centrifugal/evenly distributed photosynthetic carbon reduction (PCR) cell chloroplasts (with grana), XyMS+ (presence of cells between the metaxylem vessel elements and laterally adjacent chlorenchymatous tissue, see also Hattersley and Watson 1976), and presence of PCR cell wall suberized lamella, in Hattersley and Watson's (1992) sense] since the chlorenchyma appears loosely arranged and quite regularly is contiguous (not interrupted by a column of colorless cells) between adjacent vascular bundles. The lamina are involute with primary, secondary, and tertiary vascular bundles decreasing in size. The primary vascular bundles are well differentiated into xylem with metaxylem, phloem, and a double bundle sheath (mestome and parenchyma bundle sheath). However, the parenchyma bundle sheath of the primary vascular bundles is interrupted on the abaxial and sometimes the adaxial surface by a girder of fibers. In secondary vascular bundles only the abaxial parenchyma bundle sheath is interrupted by a girder of fibers whereas in tertiary bundles the parenchyma bundle sheath is contiguous. The ribs are flattened with angled sides (rectangular) and the furrows are 1/5 to 1/2 as deep as the thickness of the blade adaxially and usually less than 1/5 as deep abaxially. The medium vascular bundle structure consists of a simple keel with only a single primary vascular bundle. Per blade there are 9–13 primary vascular bundles and 20–28 secondary and tertiary vascular bundles. There are two or three secondary or tertiary vascular bundles placed between each primary vascular bundle. The xylem of the primary vascular bundles contains two wide metaxylem vessels that are about the same size as the parenchyma bundle sheath cells. The mestome, or inner sheath, is always

TABLE 1. Salient features comparing *Eragrostis ancashensis* with *E. magna*.

Characters	***E. ancashensis***	***E. magna***
Rhizomes	absent	present
Culm heights	26–84 cm	to 150 cm
Blades, lengths	(6–)10–22(–26) cm	40–60 cm
Blades, widths	1–2.5(–3.0) mm	3–7 mm
Inflorescence lengths	10–20(–38) cm	30–50 cm
Inflorescence branch lengths	1.5–11 cm, spreading	12–20 cm, ascending
Pedicels aspect	sinuous to flexuous, reflexed	flexuous, ascending
Spikelet shape	ovate	linear-lanceolate
Spikelet lengths	3–6.1 mm	7–10 mm
Spikelet widths	2–4.5 mm	2–2.3 mm
Rachilla vestiture	ciliate, hairs up to 1.5 mm along entire length	ciliate, hairs less than 0.2 mm only at base of lemma
Rachilla shape	strongly flattened	mostly terete
Veins of the glumes, lemmas, and paleas with minute, whitish, raised glands	usually present	absent
Lemma lengths	2–3.2 mm	2–2.5 mm
Lemma shape	broadly ovate	elliptic
Anther lengths	1.2–2.0 mm	1.2–1.5 mm

present in the vascular bundles surrounding the xylem and phloem. Chlorenchyma cells radiate just outside the parenchyma bundle sheath cells and are often contiguous between adjacent bundles forming a loosely radiate arrangement (PCK-like). One to four rows of sclerenchyma fibers form the abaxial and adaxial girders which are wide near the epidermis and narrow toward the vascular bundle. Sclerenchyma fibers form a narrow and very pointed projection along the margin of blade.

DISCUSSION

The new species seems allied to species of *Eragrostis* subgenus *Caesiae* Van den Borre since the majority of these species are PCK-like and perennial (Van den Borre & Watson 1994). We suspect that the closest sister to the new species is *E. magna* (Hitchcock 1927) since it shares many features, e.g., dark green and plumbeous-spotted spikelets with a ciliate rachilla (reduced to a tuft of hairs below each floret in *E. magna*), very few culm nodes (one or two), and rectangular-prismatic caryopses. *Eragrostis ancashensis* differs from *E. magna* by 15 characteristics (see Table 1), most notably: shorter culms (26–84 cm tall); shorter and narrower leaf blades [(6–)10–22(–26) cm long x 1–2.5(–3.0) mm wide]; shorter panicles [10–20(–38) cm long]; shorter branches (1.5–11 cm long) that are widely spreading; ovate spikelets (3–6.1 mm long x 2–4.5 mm wide) with a long ciliate (the hairs up to 1.5 mm long), flattened rachilla; veins of the glumes, lemmas, and paleas usually with minute, whitish, raised glands; broadly ovate lemmas 2–3.2 mm long; and anthers 1.2–2.0 mm long.

Another possible sister to the new species might be *E. macrothyrsa* Hack., mentioned by Hitchcock (1927) as having the same aspect. However, *E. macrothyrsa* differs from *E. ancashensis* by having taller culms (1–1.6 m tall), larger blades (20–45 cm long x 4–15 mm wide), longer panicles (40–60 cm long), shorter glumes (1.2–2 mm long), shorter lemmas (1.5–2 mm long), and shorter anthers (0.6–1 mm long). The distribution of E. *macrothyrsa* is also more southern, occurring in Paraguay (type), Brazil, and Bolivia.

There exists considerable variation among the accessions of *E. ancashensis* that may warrant taxonomic consideration in the future when more collections are available. The specimens from 7 km NW of Bambas *(Peterson & Refulio Rodriguez 13919)* and between Caráz and Huallanca *(Ferreya 14577)* are taller, more robust individuals with less pubescence (hairs shorter and less dense on the blades, sheath and inflorescence pulvini), slightly smaller florets, and shorter hairs present on the rachilla. Both of the collections from Provincia Huaylas *(Ferreya 14577 & 14594)* have less hairs that are shorter on the spikelets.

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WOOD AND BARK ANATOMY OF ACHATOCARPACEAE

Sherwin Carlquist

Santa Barbara Botanic Garden
1212 Mission Canyon Road
Santa Barbara, CA 93105, U.S.A.

ABSTRACT

Qualitative and quantitative data are given for *Achatocarpus nigricans* Triana, *A. praecox* Griseb., and *Phaulothamnus spinescens* A. Gray. The minute vessel pits, lack of successive cambia, and lack of betalains or anthocyanins are distinctive features of the family that justify its removal from Phytolaccaceae. The phyletic nature of these features is unclear; libriform fibers are commonly regarded as specialized. The absence of borders on perforation plates accords with the placement of this family in suborder Phytolaccineae, however. Quantitative features of vessels accord with the concept that *Phaulothamnus* has the wood of a desert shrub, whereas wood of *Achatocarpus* is like that of a shrub from a chaparral-like habitat.

Key Words: Achatocarpaceae, cambial phylogeny, Caryophyllales, ecological wood anatomy, Phytolaccaceae, systematic wood anatomy.

RESUMEN

Se ofrecen datos cualitativos y cuantitativos sobre los leños de *Achatocarpus nigricans* Triana, *A. praecox* Griseb., y *Phaulothamnus spinescens* A. Gray. Punteaduras diminutas de vasos, deficiencia de pigmentos, y deficiencia de cambios sucesivos caracterizan a la familia, y separan Achatocarpaceae de Phytolaccaceae. El estado filético de estas peculiaridades es incierto; las fibras libriformes se interpretan como estado avanzado. Los datos cuantitativos de los vasos indican una ecología desertícola para *Phaulothamnus*, y una ecología de tipo chaparral seco para *Achatocarpus*.

INTRODUCTION

Earlier systems include Achatocarpaceae (e.g., Walter 1909) within Phytolaccaceae sensu lato. The family was segregated by Heimerl (1934) so as to include one species of *Phaulothamnus* and nine of *Achatocarpus*, and has been thus recognized by most subsequent authors (Cronquist & Thorne 1994). The ovary of Achatocarpaceae has two stigmas but is unilocular and matures into a berry. This combination of features does not occur in Phytolaccaceae s.l. if Achatocarpaceae are segregated. More significantly, Achatocarpaceae are not known to produce either betalains or anthocyanins (Clement et al. 1994), whereas all other Phytolaccaceae s.l. contain betalains. All authors place Achatocarpaceae within Caryophyllales, but the position within the order is less clear. Placement of Achatocarpaceae just outside of suborder Phytolaccineae is currently commonly accepted (Manhart & Rettig 1994; Thorne in Cronquist & Thorne 1994; Behnke 1997), whereas Brown and Varadarajan (1985) place Achatocarpaceae outside Phytolaccaceae sensu stricto but inside Phytolaccaceae s.l.

The moderate degree of uncertainty in placement of Achatocarpaceae renders any

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kind of data, including those from wood and bark anatomy, valuable for resolution of the phylogenetic relationships of the family. Data on wood and bark of Achatocarpaceae have been contributed by Metcalfe and Chalk (1950) and Gibson (1994). Molecular data are likely to provide strong evidence also; Caryophyllales are, as yet, relatively sparsely sampled with respect to DNA features.

The stem of species of Achatocarpaceae has a single cambium whereas several genera of Phytolaccaceae have successive cambia. Only a single cambium is known in the phytolaccaceous genera *Lophiocarpus, Microtea, Monococcus,* and *Trichostigma* (these genera would fall into Rivinaceae if Phytolaccaceae s. s. is reduced to *Anisomeria, Ercilla*, and *Phytolacca*). The question of whether successive cambia or a single cambium are plesiomorphic or apomorphic in Phytolaccineae and in Caryophyllales as a whole remains to be resolved.

The concept of Caryophyllales offered by Cronquist and Thorne (1994) or Behnke and Mabry (1994) is used here. Plumbaginaceae and Polygonaceae are considered outgroups when the order is so designated (Rodman 1994). However, the data of Williams et al. (1994) have led a working group (APG 1998) to recognize an expanded Caryophyllales in which Plumbaginaceae, Polygonaceae, Tamaricaceae, Droseraceae, Nepenthaceae and allied families are included. The Cronquist and Thorne (1994) concept of Caryophyllales is then termed "core Caryophyllales." Wood and stem anatomy of Caryophyllales, when all families have been surveyed, may reflect the new classification or may tend to show subgroup patterns.

The present paper is part of a survey of wood anatomy of Caryophyllales that has included Caryophyllaceae (Carlquist 1995), Portulacaceae and Hectorellaceae (Carlquist 1998a), and Basellaceae (Carlquist 1999a). Among the genera or familial segregates of Phytolaccaceae s.l. studied to date are *Petiveria* and *Rivina* (Carlquist 1998b), *Agdestis* (Carlquist 1999b), *Stegnosperma* (Carlquist 1999c), *Barbeuia* (Carlquist 1999d), and rivinoid and phytolaccoid Phytolaccaceae (Carlquist in press). All of the families of Caryophyllales in the broad sense (APG 1998) will ultimately be included.

The two genera of Achatocarpaceae considered here are shrubs to small trees (Heimerl 1934). They are native to areas with dry seasons, most markedly so in the habitats of *Phaulothamnus* in southern Texas and northern Mexico, less extreme in the habitats of *Achatocarpus*, which range from Mexico to Argentina (Walter 1909; Heimerl 1934). The relationship of wood anatomy to the ecology of this family is a focus of the present paper.

MATERIALS AND METHODS

The collections studied are as follows: *Achatocarpus nigricans*, Portoviejo, Manabi, Ecuador (*M. Acosta-Solis 11918*), USw-0020137 (sample 22 mm in diameter); *A. praecox*, Tucumán, Argentina (sample 16 mm in diameter); *Phaulothamnus spinescens*, Sonora, Mexico, *Jones 22596*, POM (sample 5 mm in diameter). After softening with 4% aqueous ethylene diamine, sections were prepared with a sliding microtome and stained with a safranin-fast green combination. Attempts to locate crystals were made with the use of polarizing equipment. Vessel diameter is measured as mean lumen diameter. Means for quantitative features reported are derived from 25 measurements per feature. Terminology for wood features accords with the IAWA Committee on Nomenclature (1964). Vessels per group is a mean based on a solitary vessel = 1, a pair of vessels in contact = 2, etc.

RESULTS

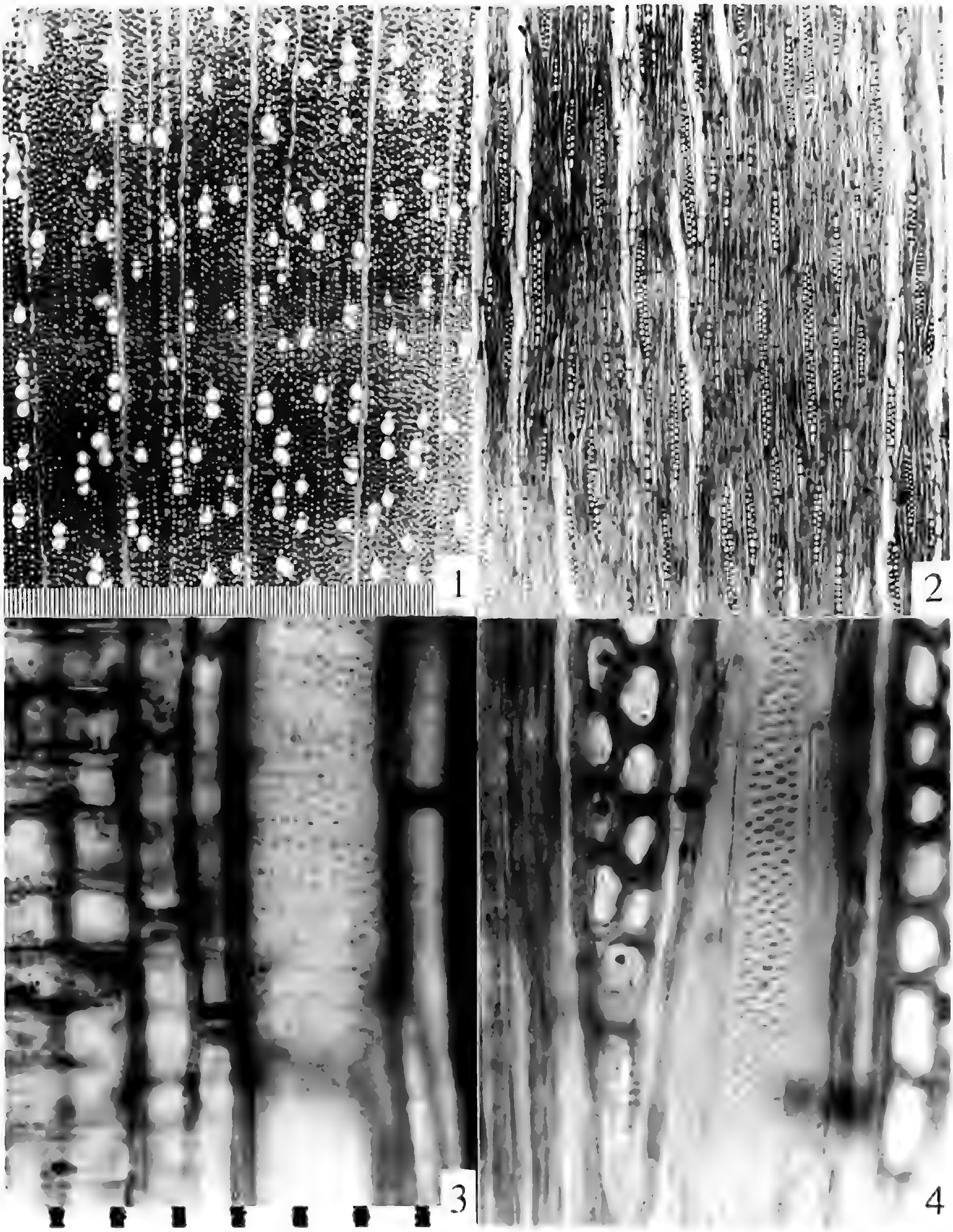
Wood Anatomy

Both qualitative and quantitative features are given for *A. praecox*. Quantitative features are given for the two remaining species, but qualitative features are given for them only when these differ from the conditions in *A. praecox*.

Achatocarpus praecox (Figs. 1–4). Growth rings present but indistinct (Fig. 1). Vessels grouped in radial multiples or solitary; mean number of vessels per group, 1.78. Mean vessel lumen diameter, 30 μm. Mean number of vessels per mm^2, 88. Mean vessel element length, 292 μm. Mean vessel wall thickness, 4.0 μm. Perforation plates nonbordered. Perforation plates simple. Lateral wall pitting opposite on ray-vessel interfaces (Fig. 3), alternate on other vessel faces (Fig. 4). Lateral wall pits of vessels minute, about 1.5 μm in diameter, circular in outline or nearly so, with small elliptical pit apertures. Imperforate tracheary elements are all libriform fibers with very small simple pits (Fig. 4, extreme left). Length of libriform fibers, 677 μm. Mean wall thickness of libriform fibers, 2.5 μm. Axial parenchyma vasicentric scanty, in strands of four cells (Fig. 3, to left and right of vessel). Rays both multiseriate and uniseriate (Fig. 2), the former more abundant. Mean height of multiseriate rays, 365 μm. Mean width of multiseriate rays, 2.63 cells. Mean height of uniseriate rays, 119 μm. Multiseriate rays composed of procumbent cells (Fig. 3, left; Fig. 4) except for tip cells (Fig. 4, lower left), which are square or upright. Uniseriate rays composed of procumbent or upright cells. Ray cell walls lignified, with mostly simple pits. Ray cell walls about 2.2 μm thick. Wood nonstoried. Crystals absent. Starch not observed.

Achatocarpus nigricans. Mean number of vessels per group, 1.85. Mean vessel diameter, 37 μm. Mean number of vessels per mm^2, 17. Mean vessel element length, 273 μm. Mean vessel wall thickness, 2.2 μm. Mean vessel pit diameter, 1.7 μm. Mean libriform fiber length, 670 μm. Mean libriform fiber wall thickness, 1.5 μm. Mean multiseriate ray height, 330 μm. Mean width of multiseriate rays, 3.2 cells. Ray cell wall thickness about 1.1 μm. Many vessels filled with amorphous yellow deposits. Libriform fibers commonly filled with amorphous yellow or dark deposits.

Phaulothamnus spinescens (Figs. 5–7). Vessels predominantly in radial groups or solitary (Fig. 5). Mean number of vessels per group, 2.78. Mean vessel diameter, 21 μm. Mean number of vessels per mm^2, 347. Mean vessel element length, 354 μm. Mean vessel wall thickness, 2.1 μm. Mean vessel pit diameter, 1.8 μm. Mean libriform fiber length, 549 μm. Mean libriform fiber wall thickness, 1.1 μm. Axial parenchyma is in strands of two cells. Uniseriate rays more common than multiseriate rays (Fig. 6). Mean height of multiseriate rays, 302 μm. Mean width of multiseriate rays, 2.0 μm. Mean height of uniseriate rays, 229



Figs. 1–4. *Achatocarpus praecox,* wood sections. Fig. 1. Transection; vessels in center are slighly narrower, indicating inconspicuous growth ring. Fig. 2. Tangential section; rays are biseriate or uniseriate. Fig. 3. Radial section; an axial parenchyma strand touches the left side and another the right side of the vessel. Fig. 4. Tangential section; tip of biseriate ray, left; alternate minute pits on vessel. Figs. 1–2, scale below Fig. 1 (divisions = 10 μm); Figs. 3–4, scale below Fig. 3 (divisions = 10 μm).

µm. Upright ray cells common, but procumbent ray cells also present (Fig. 7). Bordered pits common on tangentially oriented ray cell walls (Fig. 7). Ray cell wall thickness about 1.1 µm. Amorphous deposits present in ray cells and in libriform fibers (Fig. 7).

Bark

The sections of *Phaulothamnus spinescens* (Fig. 8) were unusually good and showed all regions of the bark clearly. The phellem cells (Fig. 8, top) contain dark-staining amorphous deposits. Several layers of phelloderm are present; cells of these layers are all thick walled sclereids (Fig. 8). Outer cortex composed of tangentially widened parenchyma cells with nonlignified cell walls. Inner cortex composed of a continuous cylinder of thick-walled sclereids. Scattered fibers present in older secondary phloem (Fig. 8).

The bark of *A. praecox* is similar to that of *P. spinescens*. In *A. praecox*, however, both an outer and an inner cylinder of thick walled cortical sclereids are present. The more complex bark of *A. praecox* may be related to large diameter of the sample studied here.

DISCUSSION AND CONCLUSIONS

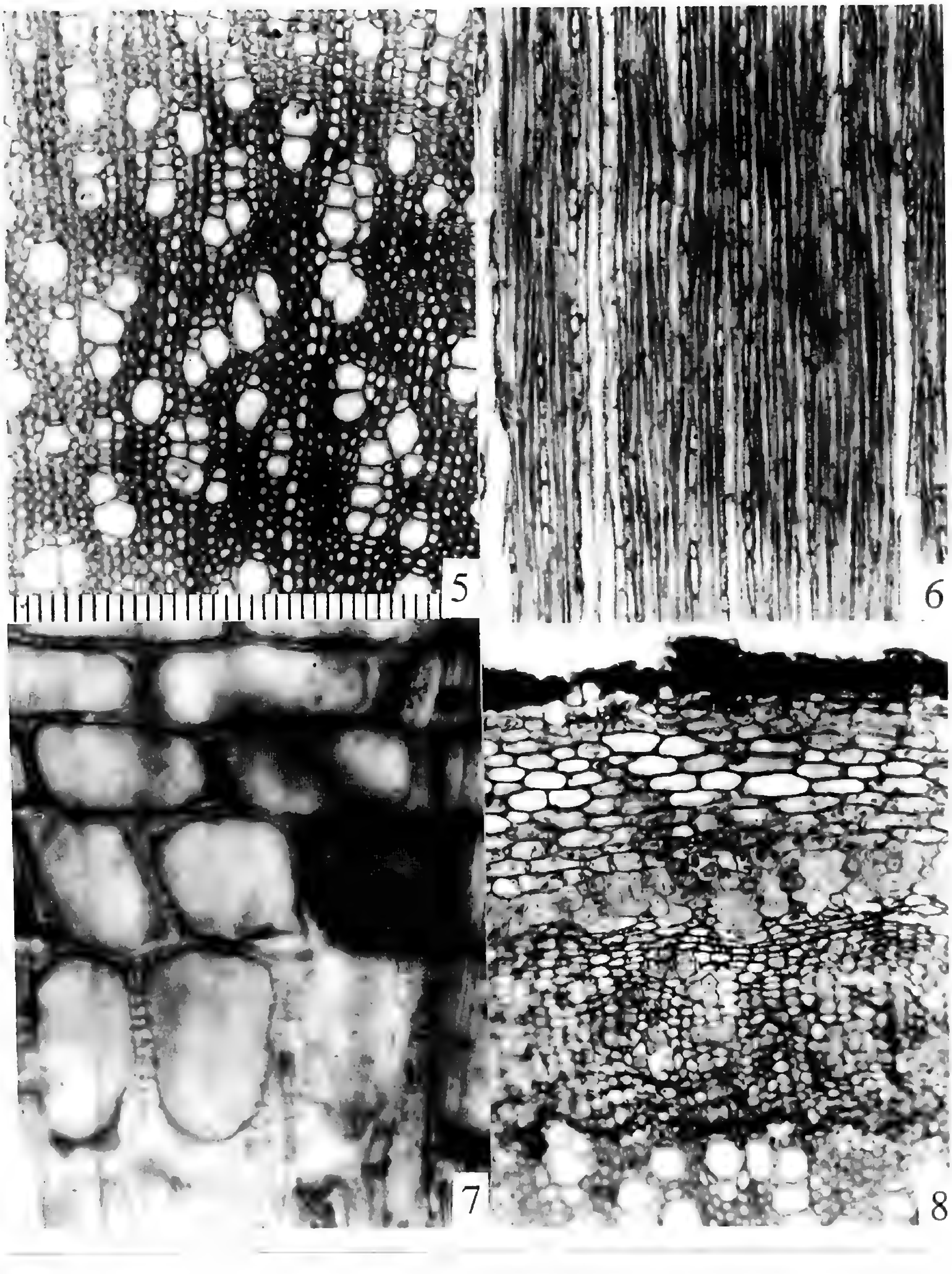
Of all families once included in Phytolaccaceae, the family most universally segregated is Achatocarpaceae. In fact, the molecular results of Manhart and Rettig (1994) and the cladistic and phenetic studies of Rodman (1994) showed that Achatocarpaceae are not, in most analyses, a sister group of Phytolaccaceae, and might even be in a near-basal position in Caryophyllales (as defined by Behnke & Mabry 1994). Achatocarpaceae are not known to contain either betalains or anthocyanins (Clement et al. 1994); this is also true of *Barbeuia*. In two caryophyllalean families, Caryophyllaceae and Molluginaceae, anthocyanins are present but betalains are absent.

The data from wood anatomy suggest that Achatocarpaceae belong to Caryophyllales: absence of borders on perforation plates characterizes Achatocarpaceae and also most families of Caryophyllales investigated thus far (Carlquist 1998b, 1999b, 1999c, in press). Bark data are not available yet for a large enough number of caryophyllalean genera so that they can be presented as evidence for the familial composition of Caryophyllales or the position of Achatocarpaceae within the Caryophyllales.

The libriform fibers of Achatocarpaceae are a specialized feature in dicotyledons according to traditional criteria (Metcalfe & Chalk 1950, p. xlv), whereas tracheids, shown by Metcalfe and Chalk (l. c.) to be more primitive, occur in families often claimed to occupy near-basal positions in the order: Caryophyllaceae (Carlquist 1995), Stegnospermataceae (Carlquist 1999c), and Barbeuiaceae (Carlquist 1999d). All of these families, however, have successive cambia (Caryophyllaceae only in some genera), whereas Achatocarpaceae does not. Whether absence of betalains and absence of successive cambia are plesiomorphic or apomorphic is uncertain.

The presence of very small pits on vessels of Achatocarpaceae is a feature not reported elsewhere in Caryophyllales (Metcalfe & Chalk 1950; Gibson 1994). The minute pits are indicative of the distinctiveness of Achatocarpaceae as a family.

The rays of *Achatocarpus* can be characterized as Heterogeneous Type IIB, transi-



Figs. 5–8. *Phaulothamnus spinescens,* sections of wood (5–7) and bark (8). Fig. 5. Transection; vessels are mostly grouped. Fig. 6. Tangential section; rays inconspicuous, composed mostly of upright cells. Fig. 7. Radial section, procumbent ray cells at top, upright cells at bottom. Fig. 8. Transection, phellem at top, secondary xylem at bottom; outer cortex consists of oval parenchyma cells, inner cortex is comprised of pale gray fibers. Figs. 5, 6, 8, scale below Fig. 5 (divisions = 10 µm); Fig. 7, scale below Fig. 3.

tional to Homogeneous Type I (Kribs 1935; Carlquist 1988). The predominance of upright ray cells in the *Phaulothamnus* specimen studied is related to the small diameter of that specimen and is indicative of a juvenile condition (see Carlquist 1988) and not phylogenetically different from the conditions shown by the comparatively larger *Achatocarpus* specimens, which exhibit a rather more mature pattern.

The moderate to high degree of vessel grouping in the three species is indicative of moderate to marked xeromorphy (Carlquist 1984). This is independently evident in the Mesomorphy Ratio (vessel diameter times vessel element length divided by number of vessels per mm^2), a convenient expression of both conductive safety and conductive efficiency. The values for this ratio are: *A. nigricans*, 59; *A. praecox*, 99; *P. spinescens*, 21. The desert or near-desert habitats of *Phaulothamnus* correlate with the low values for that species. Southern California desert shrubs as a group have a Mesomorphy Ratio of 20.9 (Carlquist & Hoekman 1985). The higher values for *Achatocarpus* are close to the values for southern Californian chaparral shrubs as a group, 66.7, or southern Californian coastal sage shrubs, 80.7 (Carlquist & Hoekman 1985).

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BATOPILASIA (ASTERACEAE: ASTEREAE), A NEW GENUS FROM CHIHUAHUA, MEXICO

Guy L. Nesom

North Carolina Botanical Garden
Coker Hall CB 3280
University of North Carolina
Chapel Hill, NC 27599, U.S.A.

Richard D. Noyes

Plant Genome Mapping Laboratory
Riverbend Research Center, Room 162
University of Georgia
Athens, GA 30602, U.S.A.

ABSTRACT

The Mexican species *Erigeron byei* Sundberg & Nesom is excluded from *Erigeron* and subtribe Conyzinae and treated as the monotypic genus ***Batopilasia*** Nesom & Noyes, gen. nov., and species ***Batopilasia byei*** (Sundberg & Nesom) Nesom & Noyes, comb. nov. *Batopilasia byei* at least superficially resembles the phyletically isolated North American genera *Boltonia* and *Chloracantha* in morphology. DNA studies indicate that *Batopilasia* and *Boltonia* are closely related and suggest that *Boltonia* is closely related to *Chloracantha*. The new genus apparently is restricted to the area of the Barranca del Cobre in southwestern Chihuahua, Mexico. A technical description, illustration, and distribution map are provided.

RESUMEN

La especie mexicana *Erigeron byei* Sundberg & Nesom se excluye de *Erigeron* y de la subtribu Conyzinae y se trata como género monotípico ***Batopilasia*** Nesom & Noyes, gen. nov., y especie ***Batopilasia byei*** (Sundberg & Nesom) Nesom & Noyes, comb. nov. *Batopilasia byei* se parece al menos superficialmente en su morfología a los géneros norteamericanos filéticamente aislados *Boltonia* y *Chloracantha*. Los estudios de DNA indican que *Batopilasia* y *Boltonia* están muy relacionados y sugieren que *Boltonia* está muy relacionada con *Chloracantha*. El nuevo género aparentemente está restringido al área de Barranca del Cobre en el suroeste de Chihuahua, México. Se ofrecen una descripción técnica, una ilustración y un mapa de distribución.

In the original description of *Erigeron byei* (Sundberg & Nesom 1990), it was regarded as most similar to *E. ortegae* Blake (= *Aster spinosus* Benth.) and *E. oxyphyllus* Greene, these three species constituting *Erigeron* sect. *Spinosi* (*E. ortegae*, the type). A number of essential differences have since been recognized between *E. oxyphyllus* and *E. ortegae*, and the latter has been segregated as the monotypic genus *Chloracantha* (Nesom et al. 1991; Sundberg 1991). *Erigeron oxyphyllus* has been treated as a member of the primarily Californian *E. foliosus* Nutt. group (*Erigeron* sect. *Linearifolii*, Nesom 1992 = sect. *Pycnophyllum*; see Nesom & Noyes 1999). Nesom et al. (1991) noted that although "the evolutionary affinities of *E. byei* may yet prove to lie with [*Chloracantha*], outside of *Erigeron*, there is insufficient evidence at present ..." to justify its exclusion, and *E. byei* has been maintained in an isolated position within *Erigeron*. Recent study of molecular variation in the tribe Astereae (Noyes & Rieseberg 1999), however, provides evidence that the origin of *E. byei* lies outside the phylogenetic nexus of *Erigeron* and *Conyza* and their closest relatives.

Relationship to *Erigeron* and Conyzinae

Erigeron byei was originally placed in *Erigeron* because of its perceived resemblance to *E. ortegae* and *E. oxyphyllus*, but after the recognition of the infra-generic relationship of the latter (within *Erigeron* sect. *Pycnophyllum*) and the transfer of the former to *Chloracantha*, *E. byei* has no close similarity to any other species of *Erigeron* and does not fit into any previously circumscribed section (Nesom 1989). The small, few-flowered heads and the subterete, multinerved cypselas, in particular, are unusual in *Erigeron*, although no single morphological character is sufficient to exclude the species from the genus.

Molecular studies by Noyes and Rieseberg (1999) and Noyes (2000) include representative species of *Erigeron* and close relatives (63 *Erigeron*, representing 20 sections; 6 *Conyza*; 2 *Aphanostephus*; 1 each of *Apopyros*, *Neja*, and *Hysterionica*) and delimit a monophyletic group that corresponds to the Conyzinae of Nesom (1994), with three exceptions: (1) the North American genus *Aphanostephus* arose from within the group, apparently in a sister relationship to *Erigeron bellioides* DC. (and presumably its close relatives), a species native to the Carribean Islands—these two groups in a sister relationship with a group of species including *E. quercifolius* Lam.; (2) African species of *Conyza* are placed within subtribe Grangeinae rather than Conyzinae; and (3) *E. byei* is related to species outside of the Conyzinae. As so delimited, the species and genera of Conyzinae encompass considerable morphological diversity, but *E. byei* is the only New World species to be excluded.

Relationship to *Chloracantha* and *Boltonia*

The hypothesis that *Erigeron byei* is closely related to *Chloracantha* was based on their shared rhizomatous habit, cauline leaves much reduced in size and distribution, persistently green-glabrate stems and leaves, erect buds, distinctly similar phyllaries (thin-herbaceous, apically rounded to obtuse, with three, prominent, orange-resinous nerves), and deltate collecting appendages of the disc corolla style branches. *Boltonia* also shares this combination of habital and capitular features.

In the Noyes and Rieseberg (1999) analysis, *Erigeron byei* is positioned as the sister genus to *Boltonia* and this pair of taxa is then most closely related to *Symphyotrichum*, *Oreostemma*, and genera of subtribe Machaerantherinae. *Chloracantha* was not included in their analysis, but phylogenetic proximity between *Boltonia* and *Chloracantha* had earlier been suggested by cpDNA analyses of Astereae—in the context of broader sampling, Morgan (1990) observed that *Chloracantha* is most closely related to the goldenaster group (subtribe Chrysopsidinae), while Suh (1989) observed the same relationship between *Boltonia* and the goldenasters. A close relationship between *Boltonia* and goldenasters, based on cpDNA evidence, is not corroborated by ITS sequence data from nuclear ribosomal DNA (Noyes & Rieseberg 1999), but the suggestion remains that *Boltonia* and *Chloracantha* are closely related. A long-standing hypothesis of close relationship between *Boltonia* and the Asian genus *Kalimeris* was rejected by Gu and Hoch (1997) on morphological grounds and by Noyes and Rieseberg (1999), based on molecular evidence.

Boltonia remains a genus strongly isolated in morphology (see Cronquist 1980 and Anderson 1987 for taxonomic summaries), differing from *Erigeron byei* in having mostly cauline leaves, conical or convex receptacles, phyllaries with a thick, raised, orangish midrib, short-tubed disc corollas, cypselas broadly elliptic to elliptic-obovate, strongly flattened and broadly winged or unwinged, with a nerve at each margin, these often with conspicuous, orangish oil ducts, and pappus absent or short-coronate, also with several small bristles and 2(–4) much longer, thickened, barbellate awns.

Chloracantha differs from *Erigeron byei* primarily in vegetative features—taller stature, thick rhizomes, perennial and lignescent stems with thorns and axillary buds, lack of persistent basal leaves—but also in larger heads and greater number of flowers. The similarities of *Erigeron byei* and *Chloracantha* in their subterete, 4–5-nerved cypselas and pappus of barbellate bristles are probably primitive (plesiomorphic), compared to the highly derived (apomorphic) fruiting features of *Boltonia*.

In summary, although the divergent taxonomic position of *Erigeron byei* was suspected at its original description, based on morphology, its relatively generalized features make it difficult to place the species. In overall morphology, however, *E. byei* is notably similar to the genus *Chloracantha*, and molecular evidence indicates that it is closely related to *Boltonia* and perhaps *Chloracantha*. On the basis of its morphological isolation within *Erigeron* and its unambigous molecular-phylogenetic placement outside of the Conyzinae, we treat *E. byei* as a monotypic genus.

Batopilasia Nesom & Noyes, gen. nov. TYPE: *Batopilasia byei* (Nesom & Sundberg) Nesom & Noyes

A *Chloracanthae* similis vestimento fere glabro, foliis caulinis amplitudine valde redactis, gemmis erectis, phyllariis tenui-herbaceis nervis tribus aurantiacis, flosculis radii laminis albis brevibus circinatis, flosculis disci rami stylares appendicibus deltatis, et acheniis 4–5-nervatis sed differt statura multo minore, habitu cespitoso ab rhizomatibus tenuibus vel ramis caudicis rhizomiformibus, foliis basalibus persistentibus in rosulis coarctatis, capitulis minoribus, et flosculis radii paucioribus. Ab *Erigeronte Conyza* et affinibus late separatus datis molecularibus.

Batopilasia byei Nesom & Noyes, comb. nov. (**Fig. 1**) BASIONYM: *Erigeron byei* Sundberg & Nesom, Phytologia 69:278. 1990.

Perennial, caespitose, glabrous herbs from a system of thin, lignescent, rhizome-like caudex branches. Stems 7–20 cm tall, usually with 1 2 ascending branches near midstem. Basal leaves persistent in rosettes, sessile, narrowly elliptic-oblanceolate, 8–26 mm long, 1–2 mm wide, entire, 1-nerved or faintly 3-nerved, with a mucronulate apex, the cauline leaves few and sharply reduced in size to linear bracts 1–4 mm long. Heads 5–8 mm wide, erect in bud, solitary on nearly naked peduncles 5–10 cm long; phyllaries in 3–4 strongly graduated series, elliptic-oblanceolate with obtuse to acute apices, thin-herba-

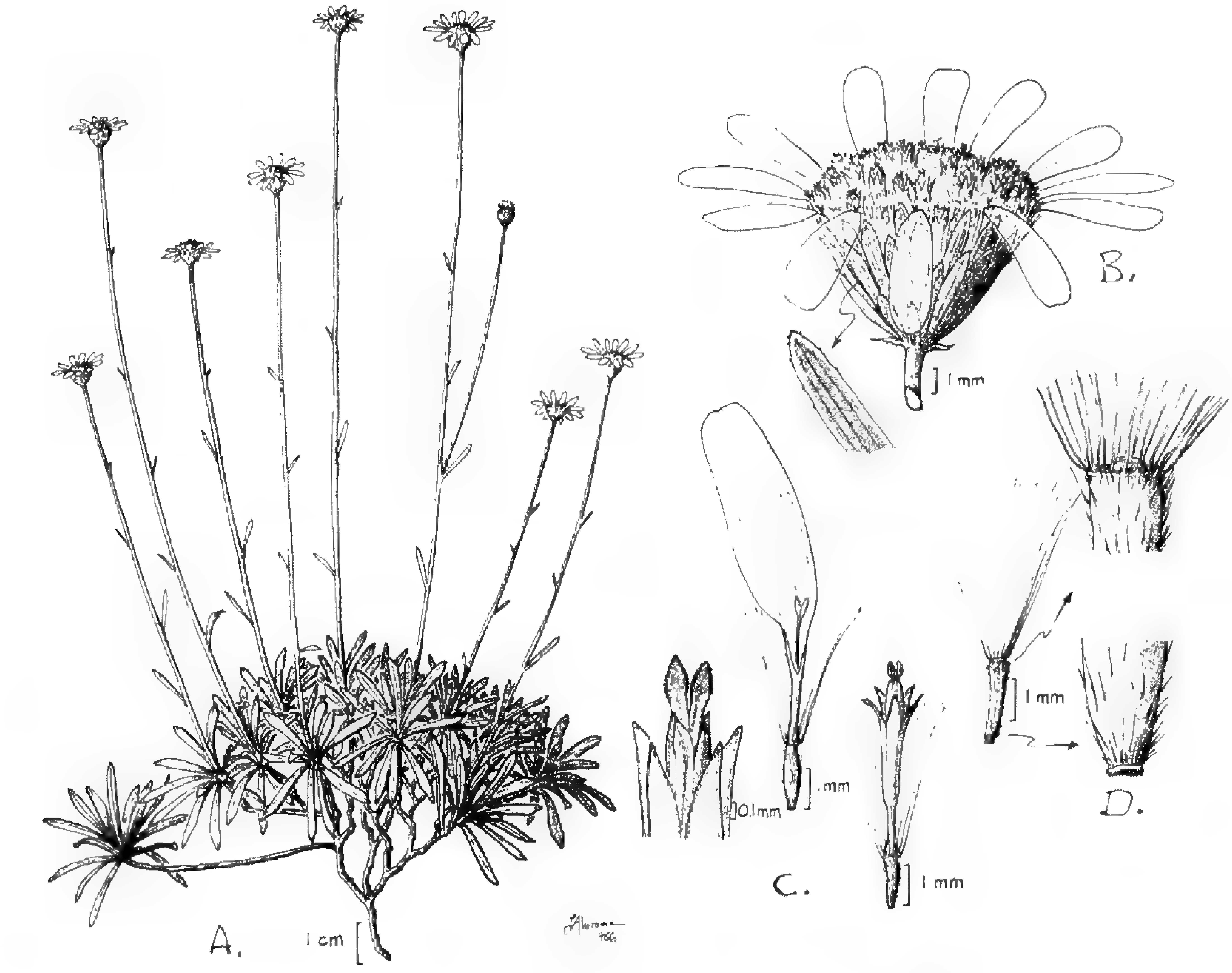

FIG. 1. **Habit and morphological details of *Batopilasia byei*.**

ceous with scarious margins and 1–3, filiform, orange-resinous nerves, sometimes purple tinged at least on the upper half, the inner series 4 5 mm long, 0.5–0.8 mm wide; receptacles low-convex. Ray flowers 9–18, fertile, the corollas white, drying white or purplish, 5–7 mm long, the lamina 1.4–2 mm wide, coiling at the tips. Disc flowers 24–29, fertile, the corollas 3.5–4.2 mm long, not inflated or indurated, lobes triangular-deltate, erect; style branches with deltate collecting appendages 0.1–0.2 mm long. Cypselas sparsely strigose, cylindrical and terete to slightly flattened, 1.8 -2.5 mm long, 0.4–0.5 mm wide, with (2–)4(–5) thin, orange nerves; pappus of 15–27 barbellate bristles 2.9–3.8 mm long and a few outer setae 0.1–0.5 mm long. Chromosome number, 2n = 18 (Sundberg & Nesom 1990).

The genus is named for the region of southwestern Chihuahua to which it apparently is restricted. The known populations of *Batopilasia* (as cited in Sundberg & Nesom 1990) occur in Municipio Batopilas, within a radius of about 25–30 kilometers, south of the town of Creel and in the general area of the Barranca del Cobre (Fig. 2). The plants grow on steep rocky slopes, commonly in rock crevices and ledges in arroyos and canyons, in pine-oak woodlands at 2000–2400 meters elevation, flowering May through July. The epithet commemorates Robert Bye, botanist and ethnobotanist who has had a longstanding and active interest in the flora of Chihuahua.

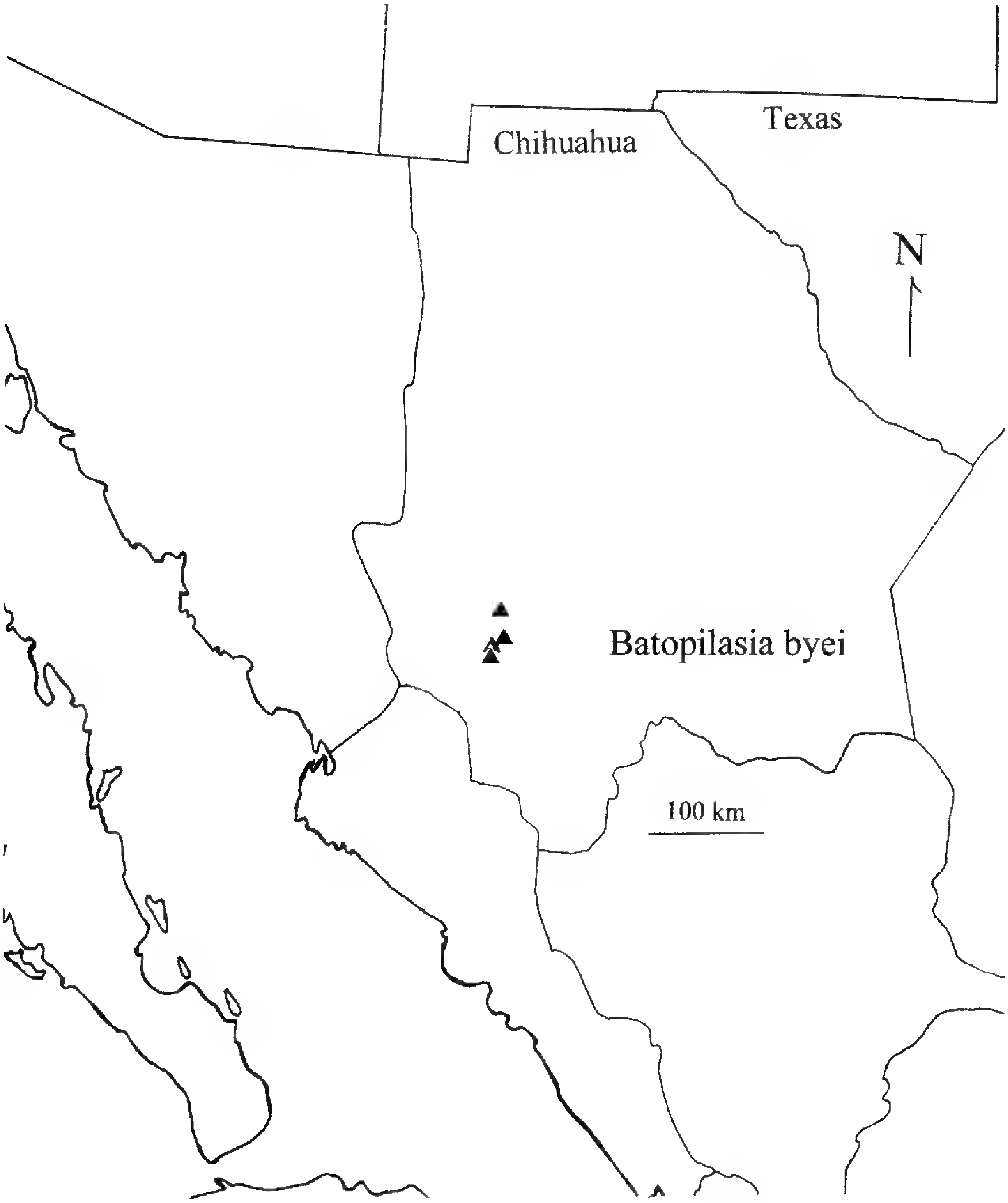

Fig. 2. Geographic distribution of *Batopilasia byei*.

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A NEW COMBINATION IN *ARCHIBACCHARIS* (ASTERACEAE: ASTEREAE)

Guy L. Nesom

North Carolina Botanical Garden
Coker Hall CB 3280
University of North Carolina
Chapel Hill, NC 27599-3280 U.S.A.

ABSTRACT

A new combination in *Archibaccharis* (Asteraceae: Astereae) is made based on an earlier name by F.W. Klatt published in 1884.

RESUMEN

Se hace una nueva combinación en *Archibaccharis* (Asteraceae: Astereae) basada en un nombre anterior de F.W. Klatt publicado en 1884.

Study of a specimen collected in Mexico by F.M. Liebmann shows that a name for an accepted species of *Archibaccharis* was published (as a species of *Baccharis*) by F.W. Klatt nearly 60 years earlier than the name now in use, *A. caloneura* S.F. Blake. The earlier name is brought into current nomenclature by the following combination.

Archibaccharis trichotoma (Klatt) Nesom, comb. nov. *Baccharis trichotoma* Klatt, Leopoldina 20:91. 1884. Type: [Locality not specified on specimen], *Liebmann 55*, "Liebm. Pl. Mus. Nr. 10.994" (holotype: C, scanned image!).

Archibaccharis caloneura S.F. Blake, Proc. Biol. Soc. Washington 55:117. 1942. Type: MEXICO. Oaxaca: Mt. Zempoaltépetl, lower slopes, 19–27 Feb 1937, *W.H. Camp 2701* (holotype: NY, fiche!; isotype: US-photo and fragments!).

Klatt's citation of the type of *Baccharis trichotoma* was "Mexico, leg. Liebmann Nr. 55. Herb. Hort. Bot. Hafn." Judging from the handwriting (by comparison with Burdet 1978), the type specimen apparently was first identified by Schultz-Bipontinus as "*Baccharis elegans* HBK.? var." The identification as "*Baccharis trichotoma* F.W. Klatt" presumably was later and by Klatt himself. The provenance of the collection is not noted on the sheet or label, but other details of the specimen, including the earlier tentative identification by Schultz, match the description and protologue published by Klatt. The nature of the three-parted division alluded to by the epithet is not clear.

Archibaccharis trichotoma is known to occur from central Oaxaca to Chiapas, Mexico, where it grows in pine-oak, pine, evergreen cloud forests, often with oaks, 1750–2900 meters elevation, flowering in October through April (Jackson 1975; Nesom in prep.). Liebmann travelled in Mexico and Cuba during the years 1840–1843 (McVaugh 1987; University of Copenhagen Botanical Museum 1999); he collected in 1842 (May through

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early October) at numerous localities in central regions of Oxaca (McVaugh 1987), presumably where the type specimen of *A. trichotoma* was gathered.

The leaves of *Archibaccharis trichotoma* are ovate-lanceolate with long-acuminate apices, petiolate, thick and glabrous with prominently raised venation, mucronulate on the distal 2/3–1/2 of the margins, the stems are glabrous and evidently dark-colored, and the capitulescence is compact and primarily terminal, raised above the level of the upper leaves. The type specimen bears staminate heads. *Archibaccharis trichotoma* is placed within *Archibaccharis* sect. *Stricta* Nesom (Nesom 1991) with other species of southern Mexico and Central America that have strictly erect stems and coriaceous leaves.

This taxonomic problem was brought to light through study of a specimen "photographed by the Field Museum of Natural History" and distributed as the type of *Baccharis trichotoma* Klatt. The label of the specimen (W 33218, MO-photo!) identifies it as *B. trichotoma* Klatt and indicates only that the collection was made in "Mexico" by Galeotti, with no other specific collection information visible. H.-G. Galeotti collected in Oaxaca, including regions in the central part of the state where *Archibaccharis trichotoma* is known to occur, from April 1839 to early 1840 (McVaugh 1978). The two branches on the W sheet were taken from pistillate plants that are characteristic of the species as known from the type and other collections. Examination of the photo of the Galeotti collection (not the type) led to a search for the type, ultimately resulting in the reduction of the Blake name to synonymy under the Klatt name.

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REVISION OF *LOBELIA* SECT. *TUPA* (CAMPANULACEAE: LOBELIOIDEAE)

Thomas G. Lammers

Department of Biology and Microbiology
University of Wisconsin Oshkosh
Oshkosh, WI 54901, U.S.A.

ABSTRACT

The classification of *Lobelia* L. sect. *Tupa* (G. Don) Benth. was revised following extensive field studies and examination of over 2500 specimens in 43 herbaria. Four species are recognized; all are hexaploids with racemose unilabiate flowers, endemic to central Chile. Two are branched solid stemmed shrubs (rarely small trees) with faintly striate oblong or ellipsoid seeds, found in the dwarf- and xerophytic-shrub and sclerophyllous vegetation zones of the xeric north: *L. polyphylla* Hook. & Arn. with small wine-purple flowers, and *L. excelsa* Bonpl. with larger flowers that change color from yellow and orange in bud to red at anthesis. The other two are large herbaceous or suffruticose unbranched hollow-stemmed perennials with minutely foveolate-reticulate broadly ellipsoid seeds, found in the deciduous forest and evergreen temperate rain forest regions of the mesic south: red-flowered *L. tupa* L. and pink-flowered *L. bridgesii* Hook. & Arn. The species of each pair are at least partly sympatric, and their reproductive isolation (as evidenced by a near total lack of plants with intermediate morphology) may be related to differences in pollination syndrome: entomophily in *L. bridgesii* and *L. polyphylla*, ornithophily in *L. tupa* and *L. excelsa*.

RESUMEN

La clasificación de *Lobelia* L. sect. *Tupa* (G. Don) Benth. se revisó como continuación a estudios de campo extensivos y el examen de más de 2500 especímenes de 43 herbarios. Se reconocen cuatro especies, todas ellas hexaploides con flores unilabiadas racemosas, endémicas de Chile central. Dos son arbustos ramosos de tallos sólidos (raramente pequeños árboles) con semillas oblongas o elipsoides débilmente estriadas, que se encuentran en las zonas de vegetación de arbustos enanos xerofíticos y la zona esclerófila del norte xérico: *L. polyphylla* Hook. & Arn. con flores pequeñas de color púrpura-vino, y *L. excelsa* Bonpl. con flores más grandes que cambian de color desde el amarillo y naranja en el botón, hasta rojo en la antesis. Las otras dos son perennes herbáceas grandes o sufruticosas no ramosas de tallo hueco, con semillas anchamente elipsoides diminutamente foveolado-reticuladas, que se encuentran en las regiones de la pluvisilva caducifolia y la templada perennifolia del sur mésico: *L. tupa* L. de flores rojas y *L. bridgesii* Hook. & Arn. de flores rosas. Las especies de cada par son al menos parcialmente simpátricas, y su aislamiento reproductivo (como se evidencia por la falta casi total de plantas con morfología intermedia) puede estar relacionado con diferencias en el síndrome de polinización: entomofilia en *L. bridgesii* y *L. polyphylla*, y ornitofilia en *L. tupa* y *L. excelsa*.

Lobelia L. is the largest genus of Lobelioideae (Campanulaceae), comprising over 400 species of annual and perennial herbs, shrubs, trees, and giant rosette plants (Lammers 1993a). It is cosmopolitan in distribution, indigenous to six continents and several island groups (e.g., Hawaii, New Zealand, the Antilles). Nearly 38% of the species are African and another 29% North American; Asia and Australasia each have about 10% of the species, South America 8%, and Polynesia 3%, while only two species occur in Europe (Lammers, unpublished data).

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The genus was last monographed by Wimmer (1953, 1968), who divided it into three subgenera: *Lobelia* with two sections; *Mezleria* (C. Presl) E. Wimm., nom. illeg. (cf. Lammers 1999) with two sections; and *Tupa* (G. Don) E. Wimm. with six sections. Further taxonomic structure was indicated by dividing many of the sections into subsections and other subordinate taxa (cf. Lammers 1993a).

Wimmer's classification of *Lobelia* was recently revised by Murata (1995). Though based primarily on seed coat morphology (Murata 1992), this revision was also concordant with other data not available to Wimmer, including chromosome numbers (Lammers 1993a) and chloroplast DNA (cpDNA) restriction-site analyses (Knox et al. 1993). In this classification, Wimmer's three subgenera were maintained (though the illegitimate name of the second one should be replaced by subg. *Isolobus* (A. DC.) Y.S. Lian; Lammers 1999). However, Wimmer's division of the subgenera into sections was greatly altered.

Among the sections of subg. *Tupa* which were remodeled by Murata was sect. *Tupa* (G. Don) Benth. Wimmer (who used the now illegitimate name sect. *Eutupa* E. Wimm.) had construed this section to include 69 diverse species from Asia, Africa, South America, and the West Indies. (Within the section, however, Wimmer did segregate the Chilean species as "§1. Species chilenses" under the invalid subsectional name "Primanae", nom. nud.) In Murata's revision, however, all extra-Chilean species were removed to sect. *Colensoa* (Hook. f.) J. Murata or sect. *Homochilus* A. DC., leaving only a small group of species endemic to central Chile in sect. *Tupa*.

Thus circumscribed, sect. *Tupa* is characterized by its combination of robust iteroparous (polycarpic) habit; large racemose flowers; unilabiate red, pink, or wine-purple non-spurred corolla with monomorphic deflexed lobes coherent at apex; staminal column shorter than the corolla and exserted from its dorsal slit; ventral anthers bearded apically with tufts of stiff white trichomes; smooth seed coat comprising a single layer of cells with long lumina (Type D of Murata 1992, 1995); and hexaploid ($n = 21$) chromosome number. The latter two features appear to be unique within subg. *Tupa* (Murata 1992, 1995; Knox et al. 1993; Lammers 1993a). While hexaploidy is regarded as derived within Lobelioideae (Lammers 1993a), the Type D seed coat is considered plesiomorphic (Murata 1992, 1995).

This more restricted circumscription was supported strongly by the phylogenetic analyses based on cpDNA data (Knox et al. 1993). In the concensus tree, the species of sect. *Tupa* s. str. formed a monophyletic group that was supported by 10 cpDNA restriction-site mutations (bootstrap value 99%, decay value >5). The remaining species of subg. *Tupa* examined, including two (*L. boninensis* Koidz. and *L. nicotianifolia* Roth ex Schult.) that had been included in sect. *Tupa* by Wimmer, formed its sister-group. These plants were all tetraploid ($n = 14$), so far as known (Lammers 1993a).

TAXONOMIC HISTORY

Plants referable to *Lobelia* sect. *Tupa* were first made known to Europeans through the activities of the French missionary Louis Feuillée, who visited Chile between 1707 and 1712. In the published account of his travels (Feuillée 1714), he described and illustrated a highly toxic plant known to the indigenous Mapuche as *tupa.* Feuillée gave the plant the Latin polynomial "Rapuntium spicatum, foliis acutis, vulgò Tupa." In *Species plantarum,* Linnaeus (1753) accepted the species on the sole basis of Feuillée's description and plate, and assigned it to his genus *Lobelia.* In taking up the vernacular name as the *nomen triviale,* he misspelled it "trapa." This error was corrected to *L. tupa* in the next edition (Linnaeus 1762).

In the first half of the nineteenth century, 17 species related to *L. tupa* were described from Chile. More than one-third of these descriptions (e.g., Sims 1810; Lindley 1826, 1830; D. Don 1835) were based on plants cultivated from seed in various European botanic gardens, and were published in illustrated semi-popular venues such as *Curtis's Botanical Magazine.* In the latter half of the century, eight more species were described, primarily by resident botanist Rodulfo Amando Philippi (1808–1904) in the course of his studies of the Chilean flora (e.g., Philippi 1873, 1895). A number of varieties and forms were also described over the years by various workers. Altogether, 35 heterotypic taxa referable to *Lobelia* sect. *Tupa* have been described, all from Chile and nearly all in the nineteenth century.

Differences of opinion on the circumscription and typification of genera created additional combinations in the group. Presl (1836) believed that *Rapuntium* Mill. was the nomenclaturally correct name for most of the species treated under *Lobelia* by Linnaeus, while Kuntze (1891) argued for *Dortmanna* Hill. George Don (1834) segregated robust species of *Lobelia* with unilabiate corollas as the genus *Tupa* G. Don, a move supported by Candolle (1839) but subsequently reversed by Bentham (1876). These differences of opinion (together with changes in rank by various workers over the years) have resulted in an additional 61 homotypic combinations based on the original 35 taxa, giving a total of 96 validly published names referable to *Lobelia* sect. *Tupa.*

In the most recent flora of Chile, Reiche (1905, 1910) synonymized or excluded many of these names, recognizing just six species and six additional heterotypic varieties in sect. *Tupa.* In the most recent monograph of the section (as "§1. Species chilenses"), Wimmer (1953, 1968) recognized 20 taxa: seven species plus thirteen additional heterotypic varieties and forms. This classification was implicitly accepted by Murata (1995) when he remodeled the section, and was also embodied in the most recent catalogue of the Chilean flora (Marticorena & Quezada 1985). However, when I began to prepare a treatment of the Campanulaceae for *Flora de Chile* (cf. Marticorena & Rodríguez 1995), it became apparent that this classification of the section was less than optimal, and that a thorough revision was required.

ETHNOBOTANY

Though *tupa* (sometimes rendered as *trupa*) is the Araucanian name for *L. tupa,* the plant is also widely known in Spanish as *tabaco del diablo* (Santa Cruz 1932; Ibáñez 1955; Mariani 1965; Hoffmann 1997). This common name ("devil's tobacco") relates to early reports that the dried leaves were smoked by the Mapuche for "unholy" purposes, i.e., as a narcotic and alleged hallucinogen. Although its hallucinogenic status has not been demonstrated clinically, the plant was considered by Schultes (1981, 1990) to be "definitely psychoactive." The actual compounds responsible for this activity are not known. The latex does contain pyridine alkaloids, including lobeline and its diketo- and dihydroxy-derivatives, lobelanidine and nor-lobelanidine (Santa Cruz 1932; Hill 1970; Raffauf 1970; Gibbs 1974); however, these substances are not pyschoactive (Schultes & Hoffmann 1980). Lobeline has been used pharmaceutically as a respiratory stimulant, in the treatment of bronchial asthma symptoms, and in overcoming nicotine addiction (Blacow 1972; Lewis & Elvin-Lewis 1977). In Chile, the expressed latex of *L. tupa* has been used by rural folk to relieve the pain of dental caries, and in compresses to treat joint and hoof pain in horses (Murillo 1889; Santa Cruz 1932). The pharmacological bases for such uses are not known.

Hallucinogenic or not, *L. tupa* is definitely toxic. Feuillée (1714) reported that the odor of the flowers alone was enough to induce vomiting. Despite several trials, I was not able to confirm that observation, though the scent is by no means pleasant. In any event, beekeepers consider the plant a nuisance, as its nectar gives honey an acrid, unpleasant flavor (Murillo 1889). Though ostensibly a hummingbird-pollinated plant (see below), I have observed large orange bees stealing nectar from the flowers via the dorsal slit of the corolla, without contacting the anthers or stigma.

Feuillée also reported that small quantities of latex rubbed in the eyes would cause blindness, a statement I can partly confirm. On more than one occasion during field work, I absent-mindedly rubbed my eye after handling material of *L. tupa*. Though latex was no longer perceptible on my hands, in a short time my eye began to sting and water profusely and my vision blurred, while the surrounding skin of the face became swollen and numb. The effects persisted for nearly an hour. Murillo (1889) reported that ingestion of the plant or its latex could result in intestinal distress and bloody diarrhea. Most recently, Matthews (1988) documented the case of a London gardener who was immobilized for 10–15 minutes after accidentally inhaling airborne dried latex of the plant.

On a more pleasant note, the species of *Lobelia* sect. *Tupa* have considerable horticultural potential. When seed was first imported to Europe early in the nineteenth century, the resulting plants generated a great deal of interest among gardeners and plant aficionados (Sims 1825; Lindley 1826, 1830, 1833; G. Don 1834; D. Don 1834, 1835; Lemaire 1843; Loudon 1844). Though most were soon lost from cultivation, *L. tupa* apparently remained in the trade (Voss 1894; Finnis 1966; Matthews 1988; Thomas 1990; Huxley 1992) and may have been the object of some selective breeding; Chittenden (1923) mentions a cultivar from Stokes' nursery named 'Brilliant.' However, seed of the three other species recognized here has been reintroduced to botanic gardens (Lammers 1993b), which may lead to a renewal of interest in these plants as horticultural subjects.

SYSTEMATICS

Much of the data upon which this revision is based was gathered from over 2500 specimens deposited in 43 herbaria (see Acknowledgments for a complete list of institutions). This was supplemented by 10 weeks of intensive field work in Chile during January 1989 and October–November 1990. In company with one to three Chilean colleagues, I travelled over 6500 miles by jeep, covering the entire geographic, elevational, and ecological range of sect. *Tupa,* from Copiapó (27°20'S) in the north to Puerto Montt (41°30'S) in the south. Fifty-six natural populations, representing all species recognized here, were visited and studied. I was also able to examine several naturalized populations of *L. tupa* in the Juan Fernández Islands during an expedition in January-February 1986 (cf. Lammers 1997).

During these studies, particular attention was paid to patterns of morphological variation within populations. Though some of the infraspecific taxa recognized by Wimmer (1953, 1968) are quite striking, if they do not at a minimum form discrete populations, they do not merit taxonomic recognition. Emphasis was also placed on discerning possible geographic, elevational, or ecological correlates of morphological variation. In addition, material was also gathered for cytological investigations. The results of that work were reported separately (Lammers & Hensold 1992).

In the end, it was concluded that only four species and no infraspecific taxa could be distinguished in sect. *Tupa: L. bridgesii* Hook. & Arn. [including *L. blanda* (D. Don) Endl.], *L. excelsa, L. polyphylla* [including *L. ovata* Reiche], and *L. tupa* [including *L. mucronata* Cav.]. The rationale for each of these synonymizations is discussed under the respective species.

These four species can be divided readily into two pairs on the basis of habit, seed morphology, and habitat: (1) a pair of branched solid-stemmed shrubs (rarely small trees) with faintly striate oblong or ellipsoid seeds, in the dwarf- and xerophytic-shrub and sclerophyllous vegetation zones of the xeric northern portion of the range (*L. excelsa* and *L. polyphylla*); and (2) a pair of robust herbaceous or suffruticose unbranched hollow-stemmed perennials with minutely foveate-reticulate broadly ellipsoid seeds, in the deciduous forest and evergreen temperate rain forest regions of the mesic southern portion (*L. bridgesii* and *L. tupa*).

The two pairs are largely allopatric, though populations of *L. excelsa* and *L. tupa* do approach within a few miles of each other in Prov. Colchagua, Curicó, and Talca. The members of each pair are definitely sympatric. In the xeric north, the geographic ranges of *L. excelsa* and *L. polyphylla* overlap by roughly 90%; the former extends a little farther south and not so far north, while the latter generally grows nearer the sea and not so high into the Andean foothills. In the mesic south, *L. bridgesii* has a very restricted distribution that lies entirely within the broader range of *L. tupa.*

Not only are the members of each pair sympatric, they often form mixed populations. Of the 17 populations studied in the mesic south, 76% comprised *L. tupa* only, 18% *L. bridgesii* only, and 6% were mixed. Of the 39 populations studied in the xeric north, 54% comprised *L. excelsa* only, 26% *L. polyphylla* only, and 21% were mixed.

Despite this apparent opportunity for miscegenation, I could not locate a single morphologically intermediate individual during field work, despite intensive searches. Furthermore, I have examined only one herbarium specimen that clearly is intermediate between two accepted species. The holotype of *Tupa kingii* Phil., collected at Valparaíso in 1868, appears to represent *L. excelsa* × *L. polyphylla* (see below).

From these facts, it is apparent that some very efficient isolating mechanism is at work among these species. Differences in chromosome number may be ruled out; all have $n = 21$, interpreted as hexaploid (Lammers & Hensold 1992; Lammers 1993a; but cf. Stace & James 1996 for an alternative interpretation). Phenological differences likewise do not appear to be operative. Though *L. polyphylla* begins to bloom a few weeks earlier than *L. excelsa,* there is still very considerable overlap in their respective phenologies; *L. bridgesii* and *L. tupa* bloom concurrently.

The best hypothesis is that isolation within each pair is a product of pollinator differences, a situation similar to that hypothesized for *L. cardinalis* L. and *L. siphilitica* L. (Thompson & Lammers 1997). Judging from floral morphology, it appears that one member of each pair is adapted to entomophily, the other to ornithophily. The flowers of *L. bridgesii* and *L. polyphylla* appear suitable for effective visits by bees and other insects. I have not observed pollinator visits to *L. polyphylla,* but large orange bees were observed visiting flowers of *L. bridgesii,* contacting the anthers and stigmas with their backs. When the same bees visited *L. tupa,* it was as a nectar thief, removing nectar via the dorsal slit without touching anthers or stigma. With their larger red flowers, *L. excelsa* and *L. tupa* appear to be adapted to pollination by hummingbirds, though I have not observed this. Further biosystematic research clearly is needed to test these hypotheses.

While the four species fall into two pairs on the basis of habit, seed morphology, and habitat, this does not appear to be an accurate reflection of the underlying phylogeny, as inferred from cpDNA restriction-site mutations (Knox et al. 1993). Though the southern pair (*L. bridgesii* and *L. tupa*) is supported as a clade by three shared mutations (bootstrap value 95%, decay index = 3), the northern pair is not. Instead, *L. polyphylla* forms the basal branch of the tree, sister to the remaining three species; *L. excelsa* is then the next branch, sister to the southern pair. The sister-relationship of *L. excelsa* to the southern pair is likewise supported by three mutations (bootstrap value 93%, decay index = 3).

Though no detailed non-molecular analyses have been performed, it does appear that morphological data are concordant with the cpDNA phylogeny. *Lobelia polyphylla,* the basal branch, is the most discordant member of the section, with its much smaller wine-purple flowers. The members of the (*L. excelsa* + southern pair) clade all share larger red (or pink) flowers, while the southern pair is characterized by its unbranched hollow herbaceous or suffruticose stems, usually decurrent leaf margins, and minutely foveate-reticulate broadly ellipsoid seeds. Unique traits within the (*L. excelsa* + southern pair) clade are the pink corolla of *L. bridgesii;* and the tan or pale yellow latex, bibracteolate pedicels, and floral color change (Weiss 1995) of *L. excelsa.* Statements regarding the apomorphy or plesiomorphy of any of these traits are best deferred pending better knowledge of the outgroup.

Lobelia sect. **Tupa** (G. Don) Benth. in Benth. & Hook. f., Gen. Pl. 2:552. 1876. *Tupa* G. Don, Gen. Hist. 3:700. 1834. *Lobelia* [unranked] *Tupa* (G. Don) Heynn., Nom. Bot. Hort. 1:473. 1840. *Lobelia* sect. *Eutupa* E. Wimm., Ann. Naturhist. Mus. Wien 56:365. 1948, nom. illeg. TYPE (under Art. 22.5, first confirmed by Pfeiffer 1874): *L. tupa* L.

Iteroparous shrubs, 0.6–4 m tall (rarely small trees to 6.8 m tall) or robust perennials, 0.5–3 m tall; stems woody, solid, and repeatedly branched, or herbaceous or suffruticose, hollow, and unbranched above the base, pubescent or glabrous; latex white, less often pale yellow or tan. Leaves simple, alternate, exstipulate, pinnately veined, sessile, pubescent or glabrous; margin entire or finely callose-toothed, sometimes forming a sagittate base decurrent on the stem below the point where the midrib meets the node. Flowers perfect, protandrous, resupinate, epigynous, zygomorphic, pedicellate, solitary in the axils of the upper leaves or these reduced in size, creating a terminal 10—65-flowered bracteate anauxotelic (rarely auxotelic) racemose inflorescence; pedicel equalling or shorter than its flower, ebracteolate or with a pair of linear bracteoles at or below the middle. Hypanthium obconic, hemispheric, campanulate, or obovoid, pubescent or glabrous, adnate to the ovary; calyx lobes 5, valvate, triangular or narrowly triangular, pubescent; margin entire or very rarely with a few teeth. Corolla sympetalous, unilabiate, 15–65 mm long, red (sometimes yellow and orange in bud, or very rarely all yellow throughout anthesis), pink, or wine-purple, lacking a nectar spur, glabrous or minutely pubescent; tube suberect, curved, or arcuate, slit dorsally to base; lobes 5, valvate, monomorphic, shorter than the tube, deflexed, coherent at apex. Stamens 5, alternating with the corolla lobes, connate, forming a staminal column shorter than the corolla and free from it; filament tube exserted through dorsal slit in corolla, bearing small flattened triangular trichomes ventrally at base, otherwise glabrous; anthers dehiscing introrsely and longitudinally, the dorsal three longer than the ventral two, occluding the orifice of the tube, the surface of the tube glabrous or the dorsal three with scattered long hairs, the ventral two with tufts of white bristles at apex. Ovary inferior, bilocular; placentae axile, large; ovules numerous, small, anatropous. Fruit a half-inferior capsule, broadly ellipsoid, ovoid, obovoid, oblate, or subspherical, dehiscent by two valves at the rounded or truncate and apiculate apex. Seeds small, light brown or golden brown, oblong or ellipsoid and faintly striate, or broadly ellipsoid and minutely foveolate-reticulate; testa comprising a single layer of cells with long lumina (Type D of Murata 1992, 1995). Chromosome number n = 21. Four species, endemic to central Chile.

KEY TO THE SPECIES

1. Shrubs (rarely small trees); stems woody, repeatedly branched, solid; leaf base not lobed, not decurrent on stem; seeds oblong or narrowly ellipsoid, the surface faintly striate.
    2. Latex white; pedicels ebracteolate or very rarely with a pair of bracteoles 2–5 mm long; hypanthium 4–8 mm in diameter; corolla 15–25 mm long, wine-purple, the tube (7–)10–17 mm long, the lobes 4–12 mm long; filament tube 9–15 mm long; anther tube 4–7 mm long, glabrous or very rarely sparsely pubescent; capsule 6–9 mm in diameter ______ **1. L. polyphylla**
    2. Latex tan or pale yellow; pedicels with a pair of bracteoles 2.5–10 mm long; hypanthium 8–15 mm in diameter; corolla (38–)45–65 mm long, yellow and orange in bud, becoming red at anthesis (very rarely all yellow throughout anthesis), the tube 25–42 mm long, the lobes 12–33 mm long; filament tube 29–47 mm long; anther tube 8–11 mm long, pubescent; capsule 11–18 mm in diameter ______ **2. L. excelsa**

1. Robust perennial herbs; stems herbaceous or suffruticose, unbranched above the base, hollow; leaf base sagittate, the pair of triangular basal lobes decurrent on the stem for 2–30 mm (rarely cuneate or obtuse and non-decurrent); seeds broadly ellipsoid, the surface minutely foveolate-reticulate.
    3. Leaf apex acute or acuminate, sometimes mucronate or cuspidate; lamina, hypanthium, and calyx lobes densely pubescent; corolla 31–49 mm long, red (very rarely yellow), densely pubescent, the tube 19–35 mm long; filament tube 22–33 mm long ________ **3. L. tupa**
    3. Leaf apex long acuminate, aristate or cirrhose; lamina, hypanthium, and calyx lobes glabrous; corolla 25–36 mm long, pink, glabrous, the tube 13–19 mm long; filament tube 14–17 mm long ________ **4. L. bridgesii**

1. Lobelia polyphylla Hook. & Arn., Bot. Beechey Voy. 33. Dec 1830. *Tupa polyphylla* (Hook. & Arn.) G. Don, Gen. Hist. 3:700. 1834. *Rapuntium polyphyllum* (Hook. & Arn.) C. Presl, Prodr. Monogr. Lobel. 29. 1836. *Dortmanna polyphylla* (Hook. & Arn.) Kuntze, Revis. Gen. Pl. 972. 1891. Type: CHILE. Valparaíso, [26 Oct–2 Nov 1825 *or* May 1828, leg. Lay & Collie,] *Beechey s.n.* (holotype: K!). Information in brackets is taken from the official itinerary (Hooker & Arnott 1830).

Lobelia purpurea Lindl., Edwards' Bot. Reg. 16:pl. 1325. Jun 1830; non Breiter, Hort. Breiter. 249. 1817. *Tupa purpurea* G. Don, Gen. Hist. 3:700. 1834. *Rapuntium purpurea* (G. Don) C. Presl, Prodr. Monogr. Lobel. 28. 1836. *Dortmanna purpurea* (G. Don) Kuntze, Revis. Gen. Pl. 972. 1891. Type: CHILE. Valparaíso, Feb 1825, *MacRae s.n.* (lectotype [designated by Wimmer 1953: 616]: CGE; isolectotypes: E! K!).

Rapuntium besserianum C. Presl, Prodr. Monogr. Lobel. 28. 1836. *Tupa besseriana* (C. Presl) A. DC. in DC., Prodr. 7:393. 1839. *Tupa polyphylla* var. *besseriana* (C. Presl) Vatke, Linnaea 38:727. 1874. *Dortmanna besseriana* (C. Presl) Kuntze, Revis. Gen. Pl. 972. 1891. *Lobelia polyphylla* var. *besseriana* (C. Presl) Reiche, Anales Univ. Chile 117:459. 1905. Type: CHILE. Valparaíso, 2.1 km S of Punta de Angeles, on the coastal road from Valparaíso to Laguna Verde, steep rocky slopes of *quebrada* above the road, elev. 120 m, 2 Nov 1990, *Lammers, Baeza & Peñailillo 7741* (neotype here designated: F!; isoneotype: CONC!). As no original material could be located, a recent collection that agrees with the protologue is here selected to serve as the neotype.

Rapuntium subdentatum C. Presl, Prodr. Monogr. Lobel. 28. 1836. *Tupa subdentata* (C. Presl) A. DC. in DC., Prodr. 7:393. 1839. *Dortmanna subdentata* (C. Presl) Kuntze, Revis. Gen. Pl. 972. 1891. *Lobelia polyphylla* f. *subdentata* (C. Presl) E. Wimm., Pflanzenr. IV.276b:615. 1953. Type: CHILE. In cordilleris, *anonymous s.n.* (holotype: PR!).

Rapuntium bracteosum C. Presl, Prodr. Monogr. Lobel. 29. 1836. *Tupa bracteosa* (C. Presl) A. DC. in DC., Prodr. 7:393. 1839. *Tupa polyphylla* var. *bracteosa* (C. Presl) Vatke, Linnaea 38:727. 1874. *Dortmanna bracteosa* (C. Presl) Kuntze, Revis. Gen. Pl. 972. 1891. *Lobelia polyphylla* var. *bracteosa* (C. Presl) Reiche, Anales Univ. Chile 117:459. 1905. *Lobelia polyphylla* f. *bracteosa* (C. Presl) E. Wimm., Ann. Naturhist. Mus. Wien 56:365. 1948. Type: CHILE. Quillota, fruticetis petrosis collium, Oct [1829], *Bertero 1103* (holotype: PR!; isotypes: BM[2]! GH[2]! M! NY! P! TUB! W!)

Rapuntium hyssopifolium C. Presl, Prodr. Monogr. Lobel. 29. 1836. *Tupa hyssopifolia* (C. Presl) A. DC. in DC., Prodr. 7:393. 1839. *Lobelia hyssopifolia* (C. Presl) C. Gay, Fl. Chile 326. 1849. *Dortmanna hyssopifolia* (C. Presl) Kuntze, Revis. Gen. Pl. 972. 1891. *Lobelia polyphylla* f. *hyssopifolia* (C. Presl) E. Wimm., Ann. Naturhist. Mus. Wien 56:365. 1948. Type: "Peruvia? Chile?," *anonymous s.n.* (holotype: PR!).

Tupa polyphylla var. *angustifolia* Hook. & Arn. ex A. DC. in DC., Prodr. 7:393. 1839. *Lobelia polyphylla* var. *angustifolia* (Hook. & Arn. ex A. DC.) Heynh., Nom. Bot. Hort. 1:473. 1840. Type: CHILE. Prope Coquimbo, 1831, *Cuming 888* (lectotype here designated: K!; isolectotype: K!). The other syntype was *Bertero 110* (G-DC [microfiche!]).

Tupa polyphylla var. *latifolia* A. DC. in DC., Prodr. 7:393. 1839. *Lobelia polyphylla* var. *latifolia* (A. DC.) Heynh., Nom. Bot. Hort. 1:473. 1840. Type: CHILE. Prope Valparaíso, 1831, *Cuming 599* (lectotype here designated: K!; isolectotypes: BM! CONC! E! GH! RSA! W!). The other syntype was *Poeppig 290* (G-DC [microfiche!]; isosyntypes: BM! W[3]!).

Tupa atropurpurea Vis., Ill. Piant. Nuov. 2:23. 1844. Type: CHILE. Prov. Valparaíso: 3 km N of Laguna Verde, on the coastal road from Valparaíso, steep rocky slopes overlooking Bahia Laguna Verde, below the road, elev. 150–220 m, 2 Nov 1990, *Lammers, Baeza & Peñailillo 7760* (neotype here designated: F! isoneotypes: CONC! MO!). Described from living plants cultivated at the botanic garden in Padua, Italy. As no original material could be located at PAD (R. Marcucci, in litt., 3 Dec 1997) or elsewhere, a recent collection that agrees with the protologue is designated as the neotype.

Tupa ovata Phil., Anales Univ. Santiago 43:506. 1873; non G. Don, Gen. Hist. 3:700. 1834. *Lobelia ovata* Reiche, Anales Univ. Chile 117:460. 1905. Type: CHILE. Carrizal bajo, Dec 1871, *King s.n.* (holotype: SGO-043561 [three small branches on right side of sheet]!; isotypes: BM! K!). The one large branch on the left side of the sheet is another specimen [Bandurrias, *Geisse s.n.*] which bears the manuscript name "Tupa glabrata Ph."

Tupa polyphylla var. *coquimbana* Vatke, Linnaea 38:727. 1874. *Lobelia polyphylla* var. *coquimbana* (Vatke) Reiche, Anales Univ. Chile 117:459. 1905. Type: CHILE. Prov. Coquimbo [Elqui]: entrada al camino del Mineral La Hiquera, al norte de portezuelo de la Cuesta de Buenos Aires, 13 Oct 1963, *Marticorena & Matthei 172* (neotype here designated: CONC!; isoneotype: OS!). Because the original material presumably was destroyed during World War II (cf. Lammers 1994) and no duplicates could be found, a more recent gathering that conforms to the protologue is here designated as the neotype.

Tupa poeppigiana Phil., Anales Univ. Santiago 90:188. 1895. Type: CHILE. Quillota, *Germain s.n.* (lectotype here designated: SGO-057199!). No specimen was cited in the protologue, merely the locality "Quillota." The sheet designated as lectotype was the only one in Philippi's herbarium that agreed with the protologue and that was annotated with this name in his handwriting.

Tupa axilliflora Phil., Anales Univ. Santiago 90:188. 1895. *Lobelia axilliflora* (Phil.) Reiche, Anales Univ. Chile 117:460. 1895. Type: CHILE. Coquimbo, *Soza s.n.* (lectotype here designated: SGO-057182!). The other syntype cited in the protologue [Catemu, Sep 1860, *Philippi s.n.* (SGO-057183! [photograph: GH!]; isosyntype: W!)] was never annotated by Philippi with this name. Although Muñoz (1960) cited both localities, only the accession number of the latter was listed.

Tupa gayana Phil., Anales Univ. Santiago 90:189. 1895. Type: CHILE. Prov. Coquimbo: ad rivulos Serena, Oct 1836, *Gay 1466* (holotype: SGO! [photograph: GH!]).

Tupa linearifolia Phil., Anales Univ. Santiago 90:189. 1895. *Lobelia polyphylla* f. *linearifolia* (Phil.) E. Wimm., Ann. Naturhist. Mus. Wien 56:365. 1948. Type: CHILE. Coquimbo, 1889/90, *Geisse s.n.* (lectotype here designated: SGO-057195!). No specimen was cited in the protologue, merely the locality "Coquimbo." Philippi's herbarium contains three sheets that matched the protologue reasonably well (Muñoz 1960). The specimen here designated as the lectotype was the only one annotated with this name in Philippi's handwriting.

Tupa serrata Phil., Anales Univ. Santiago 90:189. 1895. Type: CHILE. Valparaíso, *King s.n.* (holotype: SGO-057185! [photograph: GH!]).

Shrubs, 0.6–2 m tall; stems woody, repeatedly branched, solid, pubescent or glabrous; latex white. Lamina 1.8–16 cm long, 0.4–4.8 cm wide, ovate, widely ovate, narrowly oblong, widely elliptic, elliptic, narrowly elliptic, lanceolate, or linear, minutely pubescent or glabrous; margin entire, denticulate, serrulate, or serrate; apex rounded, obtuse, acute, acuminate, or long acuminate, sometimes mucronate, cuspidate, or aristate; base truncate, rounded, obtuse, cuneate, or attenuate. Flowers solitary in the axils of the upper leaves, or aggregated into a 10–30(–45)-flowered raceme; bracts 7–50(–75) mm long, 2.5–28 mm wide, widely elliptic, elliptic, narrowly elliptic, lanceolate, or ovate, glabrous or minutely pubescent; pedicels 7–17 mm long, ebracteolate (very rarely some with a pair of linear bracteoles 2–5 mm long at or below the middle), minutely pubescent. Hypanthium 4–7 mm long, 4–8 mm in diameter, obconic, campanulate, or rarely obovoid, pubescent or subglabrous. Calyx lobes 3–8 mm long, 1–3 mm wide, triangular or narrowly triangular, pubescent; margin entire or very rarely with a few teeth; apex acuminate or long acuminate. Corolla 15–25 mm long, wine-purple, minutely pubescent; tube (7–)10–17 mm long, 1.5–3 mm in diameter at middle, suberect or curved; lobes 4–12 mm long, 0.8–2 mm wide. Filament tube 9–15 mm long, purple; anther tube 4–7 mm long, 1.2–2.5 mm in diameter, grey with pale stripes, glabrous or the dorsal three rarely with scattered long pubescence. Capsule 9–12 mm long, 6–9 mm in diameter, broadly ellipsoid or ovoid. Seeds 0.7–1 mm long, 0.3 0.4 mm in diameter, oblong or ellipsoid, light brown or golden brown, faintly striate (Murata 1995, figs. 52–53). Chromosome number *n* = 21 (Lammers & Hensold 1992; Lammers 1993a).

Icones.—Lindley (1830) [as *L. purpurea*]; D. Don (1834); Hooker (1837); Loudon (1844), pl. 66, fig. 3; Navas (1979), pl. 42D–G.

Distribution, Habitat, and Phenology.—Endemic to xeric north-central Chile between latitude 27°S and 34°S, in the regions of dwarf- and xerophytic-shrub and sclerophyllous vegetation (cf. Walter 1973). Frequent on dry rocky slopes and cliffs, sometimes in sandy soil, from near sea level (often in sight of the ocean) up to 900 m, rarely as high as 1200 m above sea level, often in company with *L. excelsa*. Flowering August through February.

Discussion.—This species is extremely variable in foliar features, especially size and shape of the lamina and the degree of reduction in leaves subtending flowers (i.e., whether the plant forms a discrete bracteate inflorescence or bears solitary flowers in axils of unreduced leaves). This inordinate variability is the source of the species' extensive synonymy. Though the extremes [e.g., plants distinguished by Wimmer (1953) as *L. polyphylla* f. *linearifolia* and *L. ovata*] appear most distinct, it was noted during field study that many populations were quite heterogeneous in foliar morphology. Individuals that differed considerably in leaf length, width, and outline often were found growing side-by-side. Furthermore, leaves that emerged and expanded early in the season often differed significantly from those appearing later. In some cases, two or three of Wimmer's "taxa" could be found on a single individual. For example, in *Marticorena et al. 1367* (CONC), the lower leaves key to var. *besseriana* while the upper leaves key to var. *latifolia*. This suggests that at least some of the observed variation is environmentally induced (related to rainfall or day-length perhaps) rather than under genetic control, or perhaps related to heteroblasty.

In detailed multivariate analyses of this species (Lammers & Glass 1998), no patterns were discernible in the data, which were gathered from 64 herbarium sheets, including nearly all type specimens. Variation in foliar features was absolutely continuous, with no gaps by which meaningful taxa (including *L. ovata*) could be distinguished. No correlations were detected between foliar morphology and any geographic, ecologic, or elevational parameters. Furthermore, the plants examined cytologically (Lammers & Hensold 1992) well represented the diversity of foliar morphology; all showed *n* = 21.

In contrast to foliar structures, the flowers of *L. polyphylla* are remarkably homogeneous. They are distinctive within the section because of their small size and the dark pigmentation. The hue of the corolla is a very intense red-purple which compares favorably to the color of a good Chilean red wine ("vino tinto"). The only variation in floral features which appeared to be geographically correlated was anther pubescence, which showed a clinal pattern of variation: pubescent anthers were commonest towards the north, glabrous anthers towards the south.

This species is unusual among Lobelioideae in showing some variability in the presence or absence of bracteoles. However, the single specimen found that had bibracteolate pedicels (*Marticorena et al. 1379,* CONC) also showed typical ebracteolate pedicels in the same inflorescence. Similarly, inflorescences in sect. *Tupa* ordinarily are anauxotelic (i.e., incapable of renewing vegetative growth; cf. Stein 1987), with growth resuming via branching from axillary buds below the spent inflorescence. However, one collection (*Schlegel 2752,* CONC, SGO) was seen that was clearly auxotelic, with an inflorescence in full anthesis surmounted by ca. 15 cm of new vegetative growth.

Representative specimens. **CHILE. Prov. Copiapó:** 20–25 km W of Totoral, *Taylor et al. 10807* (ASU, MO). **Prov. Huasco:** Las Lozas, *Böcher et al. 545* (C); Huasco, *Kubitzki 290* (VALD); Mina Los Cristales, *Marticorena et al. 1700* (CONC); Huasco, *Montero 7611* (CONC, OS); Quebrada del Pretil, *Ricardi & Marticorena 3966* (CONC); 3–4 km SW of Huasco, *Worth & Morrison 16245* (GH, UC). **Prov. Elqui:** Punta Arrayan, *Dillon et al. 5437* (F); La Higuera, Jan 1886, *Fonck s.n.* (SGO); La Serena, *Frödin 153* (UPS); entre La Serena y Vallenar, *Garaventa 4241* (CONC); entre Tongoy y Guanaqueros, *Gleisner 14* (CONC); El Tofo, *Kubitzki 279* (CONC, VALD); Punta Herradura, *Lammers 7650* (ASC, CONC, F, MU, OSH, UC, US); Punta Teatinos, *Landrum & Landrum 5634* (ASU, GH, NY, RSA, UC); Coquimbo, Oct 1878, *Philippi s.n.* (SGO); La Serena, Sep 1898, *Reiche s.n.* (SGO); Cuesta de las Cordas, *Ricardi & Marticorena 4564/949* (CONC, OS); 20 km S of Incahuasi, *Ricardi & Marticorena 4896/1281* (CONC, OS, Universidad de Talca); La Serena, *Sparre 2793* (S, SGO); N of La Serena, *Taylor et al. 10654* (ASU, F, MO). **Prov. Límarí:** Talinay, *Jiles 439* (CONC); Fray Jorge, *Kubitzki 100* (VALD); 1 km N of Mantos de Hornillo, *Lammers et al. 6372* (CONC, F); 11 km N of Mantos de Hornillo, *Lammers et al. 6386* (CONC, F), *6389* (B, CONC, F, MU), *7665* (CONC, F), *7666* (CONC, F); Fray Jorge, *Muñoz B-152* (SGO); Fray Jorge, *Skottsberg & Skottsberg 887* (GB, NY, S); Fray Jorge, *Werdermann 901* (A, B, BM, E, F, GH, M, MO, NY, UC, US). **Prov. Choapa:** Pichidangui, *Correa 67* (SGO); Puente Negro, *Jiles 4354* (CONC); 0.2 km N of Los Vilos, *Lammers et al. 6331* (B, C, CONC, GB, F, MEXU, MU); 7 km N of Los Vilos, *Lammers et al. 6341* (CONC, F, MU, NY); 8.9 km N of Los Vilos, *Lammers et al. 7536* (CONC, F, TEX); 8.3 km N of Puerto Oscuro, *Lammers et al. 7668* (B, CONC, F, TEX); 23.6 km S of Los Vilos, *Lammers et al. 7677* (CONC, F, MU, OSH, US); Estacion Ingenerio Barriga, *Marticorena et al. 210* (CONC); Agua Amarilla, *Marticorena et al. 332* (B); N of Los Vilos, *McGill 1028* (ASU); Illapel, *Rose & Rose 19241* (NY, US); 33 km SW of Illapel, *Worth & Morrison 16646* (BH). **Prov. Petorca:** 4 km N of Longotoma, *Lammers et al. 6397* (CONC, F, MU, OS, UB); 1 km. S of Papudo, *Lammers et al. 6402* (CONC, F, MU); 1.3 km N of northernmost road to Zapallar, *Lammers et al. 7700* (CONC, F). **Prov. San Felipe de Aconcagua:** Quebrada de Las Palmas, Sep 1965, *Ramirez s.n.* (VALD). **Prov. Valparaíso:** Limache, *Garaventa 299* (CONC); Valparaíso, *Gaudichaud 129* (CONC); Concon, *Gunckel 19081* (CONC); Renaca, *Jaffuel 1752* (CONC); Quintero, *Lammers et al. 6412* (CONC, F), *6413* (CONC, F),

6414 (F), *6415* (F), *7723* (ASC, CONC, F), *7724* (CONC, F), *7725* (BM, CONC, F, UC); 2.6 km S of Punta de Angeles, *Lammers et al. 7753* (CONC, F, NY, OS); Mirasol, *Landrum 3821* (MICH, MO, NY, SGO); Valparaíso, Dec 1851, *Philippi s.n.* (SGO); Placeres, *Stebbins 8542* (UC); Quintero, *Werdermann 30* (BM, CAS, E, F, GH, M, MO, S, U, UC, US). **Prov. San Antonio:** El Tabo, *Gunckel 25483* (CONC); Algarrobo, *Lammers et al. 7800* (B, CONC, F); Quebrada de Cordoba, Jan 1980, *Navarreto s.n.* (VALD). **Región Metropolitana:** Tejas Verdes, *Gunckel 24556* (CONC); Pentaflor, *Montero 1748* (CONC); Cartagena, *Navas 2298* (CONC); Dunas de Las Cruces, 19 Oct 1950, *Pfister & Ricardi s.n.* (CONC, OS).

CULTIVATION. U.S.A. California: University of California Botanical Garden, Berkeley, Jul 1963, *Hutchinson s.n.* (MICH).

2. Lobelia excelsa Bonpl., Descr. Pl. Malmaison 112. 1816. *Rapuntium excelsum* (Bonpl.) C. Presl, Prodr. Monogr. Lobel. 29. 1836. *Dortmanna excelsa* (Bonpl.) Kuntze, Revis. Gen. Pl. 972. 1891. Type: FRANCE. Hort. Malmaison, Jun 1813 (lectotype here designated: Bonpland 1816, pl. 46!). As no original material was located, the plate published with the protologue is here designated as the lectotype.

Lobelia gigantea Sims, Bot. Mag. 32:pl. 1325. 1810; non Cav., Anales Hist. Nat. 2:104. 1800. *Lobelia salicifolia* Sweet, Hort. Suburb. Lond. 37. 1818. *Tupa salicifolia* (Sweet) G. Don, Gen. Hist. 3:700. 1834. Type: CHILE. Valparaíso, 1794, *Menzies s.n.* (lectotype here designated: BM! isolectotype: MO!). The name was based on this collection and on living plants growing in a commercial nursery.

Lobelia arguta Lindl., Edwards' Bot. Reg. 12:pl. 973. 1826. *Tupa arguta* (Lindl.) G. Don, Gen. Hist. 3:700. 1834. *Dortmanna arguta* (Lindl.) Kuntze, Revis. Gen. Pl. 972. 1891. Type: GREAT BRITAIN. Chiswick Garden, Sep 1825 (lectotype here designated: Lindley 1826, pl. 973!). As no original material was located, the plate published with the protologue is here designated as the lectotype.

Lobelia neriifolia Moris, Enum. Sem. Hort. Bot. Taurin. 1833:20. 1833. Type: CHILE. Prov. Cardenal Caro: 1.2 km E of Pichilemu on highway to Nancagua, frequent on arid rocky bluffs above the road, elev. 45 m, 15 Nov 1990, *Lammers, Baeza & Peñailillo 7890* (neotype here designated: OSH!; isoneotypes: CONC! F! MU! TEX! US!). Described on the basis of living plants grown in the botanic garden at Turin, Italy, from seeds sent by Bertero. As no original material or Bertero specimens could be located, a recent collection that conforms to the protologue is here designated as the neotype.

Tupa glaucescens Phil., Anales Univ. Santiago 90:187. 1895. Type: CHILE. San Isidrio, Dec 1882, *Philippi s.n.* (holotype: SGO!).

Shrubs, 2–4 m tall, rarely trees to 6.8 m; stems woody, repeatedly branched, solid, glabrous or minutely pubescent; latex tan or pale yellow. Lamina 2.8–15 cm long, 0.7–3.1 cm wide, oblong, narrowly oblong, elliptic, or narrowly elliptic, rarely lanceolate, glabrous or minutely pubescent; margin serrulate, minutely serrulate, or subentire; apex obtuse, acute, or acuminate, sometimes cuspidate, mucronate, or aristate; base rounded, obtuse, cuneate, or attenuate. Flowers solitary in the axils of the upper leaves; pedicels 12–45 mm long, bibracteolate on the lower third or rarely at the middle, minutely pubescent; bracteoles 2.5–10 mm long, linear, minutely pubescent. Hypanthium 5–10 mm long, 8–15 mm in diameter, hemispheric, broadly hemispheric, broadly campanulate, obconic, or broadly obconic, glabrous or minutely pubescent. Calyx lobes 3.5–9(–20) mm long, 1–4 mm wide, triangular or narrowly triangular, minutely pubescent; apex acuminate or long acuminate. Corolla (38–)45–65 mm long, yellow and orange in bud, becoming red at anthesis (very rarely all yellow), glabrous or sparsely pubescent with minute hairs; tube 25–42 mm long, 2.5–6 mm in diameter at middle, suberect or curved; lobes 12–33 mm long, 1–3 mm wide. Filament tube 29–47 mm long, red; anther tube 8–11 mm long, 2–4 mm in diameter, pale straw-colored, the dorsal three with long white hairs on the surface (especially toward apex). Capsule 10–15 mm long, 11–18 mm in diameter, ovoid, obovoid, oblate, or subspherical. Seeds 1 mm long, 0.4 mm wide, oblong, honey-colored, faintly striate (Murata 1992, figs. 49–50, 70). Chromosome number $n = 21$ (Lammers & Hensold 1992; Lammers 1993a).

Icones.—Sims (1810) [as *L. gigantea*]; Bonpland (1816), pl. 46; Lindley (1826) [as *L. arguta*]; Muñoz (1966), pl. 128 [as *L. tupa*]; Navas (1979), pl. 42A–C [as *L. salicifolia*]; Hoffmann (1997), pg. 218 no. 1 [as *L. tupa*].

Distribution, Habitat, and Phenology.—Endemic to xeric north-central Chile between latitude 29°S and 35°S, in the regions of dwarf- and xerophytic-shrub and sclerophyllous vegetation (cf. Walter 1973). Frequent on dry rocky slopes and cliffs, sometimes in sandy soil, from near sea level (though seldom in sight of the ocean) up to 1200 m above sea level, often in company with *L. polyphylla*. Flowering September through February.

The report of this species from Bolivia (Wimmer 1953) is apparently due to an inadvertant switching of labels. *Rusby 623* (US) allegedly represents the only known specimen of *L. excelsa* from Bolivia, while *Rusby 634* (US) is supposedly the only specimen from Chile of another lobelioid, *Centropogon cornutus* (L.) Druce, which is indigenous to Bolivia (cf. Stein 1987). However, duplicates of *Rusby 634* at GH and NY are specimens of *L. excelsa* from Valparaíso. Clearly, labels were accidentally switched at some point, resulting in the erroneous reports.

Discussion.—In contrast to *L. polyphylla,* the other woody member of the section, *L. excelsa* is relatively homogeneous in its vegetative morphology. One feature that does vary more in this species than in *L. polyphylla* is habit. Although *L. excelsa* is ordinarily a shrub, one individual was encountered in Prov. Limarí in 1989 (*Lammers et al. 6382,* B, C, CONC, F, MU) that was definitely a tree. The plant was fully 6.8 m tall and did not begin to branch until 2.5 m above the ground. Its twin boles were 11.5 cm and 9.5 cm in diameter just above the base and were of sufficient strength that the tree could be climbed to collect flowering branches without damage.

Lobelia excelsa is unique within the section in its tan or pale yellow (vs. white) latex, regularly bibracteolate pedicels, and for the color change of its flowers, which go from yellow and orange in bud to brilliant red at full anthesis. The taxonomic distribution and biological significance of such color changes were detailed by Weiss (1995).

Plants bearing pure sulfur yellow flowers with no trace of orange or red (and thus no color change) are known, but only from cultivation. The label of a specimen cultivated in Switzerland [*anonymous s.n.,* 29 Jul 1858 (NY)] states "flor sulphurei." More recently, Eric Knox (pers. comm.) reported that plants grown at the University of Michigan's Matthei Botanical Garden from seed of *Lammers et al. 6393* consistently bore yellow flowers over a period of three years. I know for a fact that the plants from which the seed was obtained bore normally pigmented flowers. It would be of interest to learn if plants with yellow flowers ever occur in natural populations, and if so, under what conditions.

Representative specimens. **CHILE. Prov. Elqui:** Coquimbo, 14 Jan 1971, *Blaise s.n.* (SGO); Cuesta de Buenos Aires, *Kubitzki 278* (VALD); Cuesta de Buenos Aires, *Lammers et al. 7604* (ASC, CONC, F, OS, UC); Yerba Loca, *Simon 327* (RSA, UC); La Serena, *Sparre 2780* (S, SGO); 42 km N of La Serena, *Worth & Morrison 16328* (BH). **Prov. Límarí:** Monte Redondo, *Jiles 372* (CONC); Quebrada La Higuera, *Jiles 1131* (CONC); Cabreria, *Jiles 1150* (CONC); Fray Jorge, Sep 1958, *Kummerow s.n.* (CONC); 1 km N of Mantos de Hornillo, *Lammers et al. 6375* (CONC, F, MU, NY); 11 km N of Mantos de Hornillo, *Lammers et al. 7664* (BM, CONC, F). **Prov. Choapa:** 1 km S of Los Vilos, *DeVore 1574* (OSH); 0.2 km N of Los Vilos, *Lammers et al. 6330* (C, CONC, F, MEXU, MU, NY); 10 km N of Los Vilos, *Lammers et al. 6348* (CONC, F, MU, NY); 11 km E of Panamerican Hwy on road to Canela Baja, *Lammers et al. 6353* (CONC, F, GB, MU, NY); 5 km S of Canela Baja, *Lammers et al. 6357* (B, CONC, F, GB, MU); 8 km NE of Illapel, *Lammers et al. 6362* (CONC, F, MU); 7 km SE of Illapel, *Lammers et al. 6364* (CONC, F, NY); 24 km SW of Illapel, *Lammers et al. 6367* (B, CONC, F, MU); 6 km S of Puente Amolanas, *Lammers et al. 6370* (CONC, F, MU, NY); 14.5 km S of Río Choapa bridge, *Lammers et al. 7676* (CONC, F, NY); entre Illapel & Los Vilos, *Marticorena & Matthei 427* (CONC); Illapel, *Montero 2399* (CONC); Los Vilos, *Montero 8772* (CONC), *Montero 10777* (CONC); Illapel to Huentelauquen, *West 3940* (GH, MO, UC). **Prov. Petorca:** 3 km S of Zapallar, *Gardner & Page 5085* (E); Pichicuy, *Lammers et al. 6393* (B, CONC, F, MU); 2 km E of Papudo, *Lammers et al. 6399* (B, CONC, F, MU); 1 km S of Papudo, *Lammers et al. 6401* (B, CONC, F, MU); 21 km N of Nogales, *Lammers et al. 6408* (CONC, F, MU, NY); 14 km N of Nogales, *Lammers et al. 6411* (CONC, F, MU, NY); 1.3 km N of northernmost road to Zapallar, *Lammers et al. 7701* (ASC, CONC, F); Pichicuy, *Marticorena et al. 177* (CONC); Papudo, *Montero 8023* (CONC); Cerro Iman, *Villagran & Meza 750* (SGO), *932* (SGO). **Prov. San Felipe de Aconcagua:** Quebrada de Cabildo, 29 Jan 1950, *Pfister s.n.* (CONC, OS); Quebrada de Las Palmas, Sep 1965, *Ramirez s.n.* (VALD). **Prov. Quillota:** 12 km from Tiltil towards Olmue, *Gardner & Knees 5446* (E); Olmue, *Böcher et al. 587* (C); 2 km S of San Pedro, *Lammers et al. 6418* (CONC, F, MU, NY, UB); Parque Nacional La Campana, *Lammers et al. 6440* (B, CONC, F, MU), *6448* (CONC, F, MU), *6450* (CONC, F, MU), *6452* (CONC, F). **Prov. Valparaíso:** Valparaíso, *Gaudichaud 129* (P); Las Zonas, *Harshberger 1074* (NY, PENN); Quebrada de la Tortuga, 24 Feb 1941, *Junge s.n.* (CONC, OS); 9 km N of Concon, *Lammers et al. 6417* (CONC); 2.6 km S of Punta de Angeles, *Lammers et al. 7754* (CONC, F, UC); 3 km N of Laguna Verde, *Lammers et al. 7759* (CONC, F); Algarrobo, *Landrum 3341* (ASU); Mirasol, *Landrum 3822* (MICH, NY, SGO); Quebradas de Viña, *Lourteig 2510* (K, S); El Salto, *Meyer 9336* (MO, UC); Valparaíso, Dec 1862, *Philippi s.n.* (SGO); Via del Mar, *Ricardi 5449* (CONC); Valparaíso, *Rusby 634* (K, MICH, NY, PH); Valaparaíso, *Rusby 634* (GH, NY); Agua Potable, *Schlegel 381* (CONC); Cerro Valparaíso, *Schlegel 967* (CONC); Quebrada Verde, *Schlegel 89* (CONC); El Salto, *Skottsberg & Skottsberg 947* (GB, S); El Salto, *Solbrig et al. 3600* (GH, NY); 3.9 km N of Concon, *Spooner & Contreras 4304* (CONC, F, MO, WIS). **Prov. San Antonio:** Quebrada Cordoba, *Gentry 68043* (NY); 3 km E of Algarrobo, *Lammers et al. 7795* (B, BM, CONC, F); N of San Sebastian, 2 Feb 1971, *Oehrens s.n.* (VALD); El Tabo, Feb 1968, *Santos s.n.* (VALD). **Región Metropolitana:** Quebrada Dormida, *Garaventa 1323* (CONC); Cerro La Cruz, 30 Sep 1932, *Olathe s.n.* (CONC); Dunas de las Cruces, 19 Oct 1950, *Pfister & Ricardi s.n.* (CONC, OS); Quebrada La Plata, *Schlegel 1680* (CONC). **Prov. Cardenal Caro:** Pichilemu, *Montero 9286* (CONC); 9 km S of Pichilemu, *Lammers et al. 7903* (CONC, F, MO, NY); Estuario Nilahue, *Lammers et al. 7917* (CONC, F, NY); 4.2 km N of Bucalemu, *Lammers et al. 7933* (CONC, F); Pichilemu, *Sanz de Cortazar 573* (SGO). **Prov. Colchagua:** Ciruelos, *Aravena 47* (SGO); Matanzas, Mar 1878, *Fernández s.n.* (SGO); Nancagua, 11 Jan 1951, *Ricardi s.n.* (CONC, OS). **Prov. Curicó:** Lipimavida, *Aravena 34L* (SGO); Lipimavida, *Spooner & Contreras 4332* (CONC, F, WIS); Punta Totorilla, 6 Feb 1969, *Villagran & Tapia s.n.* (SGO); 1 km antes de Iloca, *Weldt 107* (CONC). **Prov. Talca:** Quivolgo, *Matthei & Bustos 34* (B); Constitución, Feb 1895, *Philippi s.n.* (SGO).

CULTIVATION. SWITZERLAND: Hort. Bot. Basil., 29 Jul 1858, *anonymous s.n.* (NY).

3. Lobelia tupa L., Sp. Pl. 929. 1753, 'trapa.' *Tupa feuillei* G. Don, Gen. Hist. 3:700. 1834. *Rapuntium tupa* (L.) C. Presl, Prodr. Monogr. Lobel. 28. 1836. *Dortmanna tupa* (L.) Kuntze, Revis. Gen. Pl. 972.

1891. *Lobelia feuillei* (G. Don) Voss in Siebert & Voss, Vilm. Blumengärtn. (ed. 3) 1:577. 1894, nom. illeg. Type: CHILE. Mountains, 37°S (lectotype [designated by Matthews 1988:161]: Feuillée 1714, pl. 29!).

Lobelia mucronata Cav., Icon. 6:11. 1801. *Tupa cavanillesiana* G. Don, Gen. Hist. 3:700. 1834, nom. illeg. *Rapuntium mucronatum* (Cav.) C. Presl, Prodr. Monogr. Lobel. 29. 1836. *Tupa mucronata* (Cav.) A. DC. in DC., Prodr. 7:392. 1839. *Tupa feuillei* var. *mucronata* (Cav.) Vatke, Linnaea 38:727. 1874. *Dortmanna mucronata* (Cav.) Kuntze, Revis. Gen. Pl. 972. 1891. *Lobelia tupa* var. *mucronata* (Cav.) Reiche, Anales Univ. Chile 117:458. 1905. Type: CHILE. Fundo Cuchacucha, *Nee s.n.* (holotype: MA! [photographs: F! GH! MICH! W!; fragments: F! CONC! W!]).

Lobelia serrata Meyen, Reise 1:300. 1834. Type: CHILE. Prov. Curicó: Hacienda Monte Grande, alt. ca. 600 m, Dec 1924, *Werdermann 572* (neotype here designated: BM!; isoneotypes: E! F! GH! M! MO! NY! UC!). No original material could be located, so a more recent collection from the same general area, which agrees with the protologue, is here designated as the neotype.

Tupa berteroi A. DC. in DC., Prodr. 7:392. 1839, 'berterii.' *Tupa feuillei* var. *berteroi* (A. DC.) Vatke, Linnaea 38:727. 1874, 'berterii.' *Dortmanna berteroi* (A. DC.) Kuntze, Revis. Gen. Pl. 972. 1891. *Lobelia tupa* var. *berteroi* (A. DC.) Reiche, Anales Univ. Chile 117:458. 1905, 'berterii.' *Lobelia mucronata* var. *berteroi* (A. DC.) E. Wimm., Pflanzenr. IV.276b: 614. 1953, 'berterii.' Type: CHILE. Rancagua, in sylvaticis umbrosis, torrentes et rivulos, Apr 1828, *Bertero 389* (holotype: G-DC [microfiche!]; isotypes: P! SGO!). Orthography corrected following the recommendations of Stuessy and Marticorena (1990).

Tupa mucronata var. *hookeri* A. DC. in DC., Prodr. 7:392. 1839. *Lobelia mucronata* f. *hookeri* (A. DC.) E. Wimm., Pflanzenr. IV.276b: 614. 1953. Type: GREAT BRITAIN. Scotland, Glasgow Botanic Garden, Aug 1832 (holotype: Hooker 1833, pl. 3207!).

Tupa montana Phil., Anales Univ. Santiago 43:506. 1873; non C. Wright ex Griseb., Cat. Pl. Cub. 159. 1866. *Dortmanna philippiana* Kuntze, Revis. Gen. Pl. 972. 1891. *Lobelia tupa* var. *montana* Reiche, Anales Univ. Chile 117:459. 1905. Type: CHILE. Hac[ienda]. del Principal, 1870, *Philippi s.n.* (holotype: SGO-057202!; isotype: SGO-043568! [photograph: GH!]).

Tupa feuillei var. *macrophylla* Vatke, Linnaea 38:726. 1874. Type: GREAT BRITAIN. Lowe's Nursery (lectotype here designated: Lindley 1833, pl. 1612!). Vatke also cited *Philippi 340, Ochsenius s.n.*, and a specimen cultivated at Berlin in 1832, all deposited at B. None of these specimens could be located and presumably perished during World War II (cf. Lammers 1994). I have seen duplicates of the Philippi specimen at K, P, and W, but they do not conform to the description given in the protologue, while the plate does.

Dortmanna bicalcarata Kuntze, Revis. Gen. Pl. 3(2): 186. 1898. *Lobelia bicalcarata* (Kuntze) A. Zahlbr. ex K. Schum., Just's Bot. Jahresber. 26(1): 373. 1900. *Lobelia tupa* var. *bicalcarata* (Kuntze) E. Wimm., Ann. Naturhist. Mus. Wien 56:365. 1948. Type: CHILE. Chiguayante, 19 Feb 1892, *Kuntze s.n.* (holotype [mounted on two sheets]: NY!; isotypes: B† [photographs: F! GH! MICH! NY! SGO!], W! [photographs: A! F! MICH!]).

Lobelia mucronata f. *ovalifolia* E. Wimm., Pflanzenr. IV.276b: 614. 1953. Type: GERMANY. H[ort.] Bonn, 1848, *anonymous s.n.* (holotype: B!).

Lobelia tupa var. *pavonii* E. Wimm., Pflanzenr. IV.276c: 881. 1968. Type: CHILE. *Ruiz & Pavon s.n.* (holotype: BM!).

Robust perennials, 0.5–3 m tall; stems several from the base, normally unbranched, hollow, herbaceous or suffruticose, densely short or long pubescent; latex white. Lamina 4.5–25.5 cm long, 1.2–7.8 cm wide, ovate, oblong, elliptic, narrowly elliptic, or rarely lanceolate; upper surface densely short pubescent; lower surface very densely short pubescent; margin serrulate or minutely serrulate; apex acute or acuminate, sometimes mucronate or cuspidate; base sagittate, the pair of basal lobes decurrent on the stem for 2–30 mm (rarely cuneate or obtuse and non-decurrent). Inflorescence a 10–65-flowered raceme, densely short pubescent; bracts 7–45(–85) mm long, 2–15(–20) mm wide, ovate, lanceolate, or rarely linear, the apex acuminate, the base sagittate, the pair of basal lobes decurrent on the stem for 2–33 mm (or very rarely free from the stem), rarely obtuse and non-decurrent; pedicels 8–30 mm long, ebracteolate. Hypanthium 5–10 mm long, 8–14 mm in diameter, hemispheric, depressed hemispheric, obconic, or broadly campanulate, densely short pubescent. Calyx lobes 2–8 mm long, 1–3 mm wide, triangular or narrowly triangular, short pubescent; apex acuminate, long acuminate, or rarely acute. Corolla 31–49 mm long, red (very rarely yellow), sparsely or densely short pubescent; tube 19–35 mm long, 2–4 mm in diameter at middle, arcuate; lobes 10–22 mm long, 1–2.5 mm wide. Filament tube 22–33 mm long, red; anther tube 6–9 mm long, 2–3 mm in diameter, grey, the dorsal three pubescent with long white hairs or rarely glabrous. Capsule 0.9 cm long, 1.2 cm in diameter, ovoid. Seeds 0.7 mm long, 0.3 mm wide, broadly ellipsoid, honey-brown, minutely foveolate-reticulate (Murata 1995, figs. 54–55). Chromosome number $n = 21$ (Vilmorin & Simonet 1927; Spooner et al. 1987; Lammers & Hensold 1992; Lammers 1993a); the voucher (*Sanz 573*, SGO) for Sanz de Cortazar's (1948) report of $n = 16$ in *L. tupa* is actually a specimen of *L. excelsa*, and the count is considered erroneous in any event (Lammers & Hensold 1992; Lammers 1993a).

Icones.—Feuillée (1714), pl. 29 [as "Rapuntium spicatum ..."]; Cavanilles (1801), pl. 516 [as *L. mucronata*]; Sims (1825); Sweet (1827–29); Hooker (1833) [as *L. mucronata*]; Lindley (1833); Loudon (1844), pl. 66, fig. 1; Santa Cruz (1932), p. 99; Wimmer (1953), fig. 96; Finnis (1966), fig. 48; Schultes (1976), p. 153, (1981), p. 122; Matthews (1988); Thomas (1990), pl. II, no. 5; Hoffmann (1997), pg. 218, no. 2 [as *L. bridgesii*].

Distribution, Habitat, and Phenology.—Endemic to mesic south-central Chile between latitude 32°S and 42°S, in the regions of deciduous forest and evergreen temperate rain forest (cf. Walter 1973). Also naturalized on Masatierra (Isla Robinson Crusoe) in the Juan Fernández Islands sometime prior to 1824 (Matthei et al. 1993). Common on roadsides, fields, streambanks, grassy slopes, and forest margins, at elevations from near sea level up to 400 m (rarely up to 940 m). Flowering late October to early April.

Discussion.—*Lobelia tupa* varies considerably in the nature of its leaf and bract bases, variation which Wimmer (1953) used to recognize several taxa. Typically, the leaf margins continue as a pair a broad triangular auricles for some distance below the point of attachment of the midrib at the node, forming a sagittate base that is adnate to the stem. Wimmer (1953, 1968) treated plants with relatively short auricles, particularly among the bracts, as var. *tupa* or (if the leaves were lanceolate) var. *pavonii*. Those with very long auricles were var. *montana* or (if the auricles of the bracts were free from the inflorescence rachis) var. *bicalcarata*. Otherwise similar plants with obtuse or cuneate non-decurrent leaf bases were segregated as *L. mucronata*. Plants that were intermediate between *L. mucronata* and *L. tupa*, i.e., those with very shortly decurrent auricles, were treated as *L. mucronata* var. *berteroi*. The intermediacy of this variety is highlighted by the fact that Vatke (1874) and Reiche (1905, 1910) previously had assigned it to *L. tupa*.

Careful study of natural populations showed that the length of the basal auricles varied considerably within populations and even within individual plants. This was apparent even in herbarium material. In *Gay 1468* (SGO), the auricles were only 3 mm long in the basal-most leaves, but 15 mm long within the inflorescence. As such, the varieties of *L. tupa* recognized by Wimmer (1953, 1968) do not merit recognition.

The case of *L. mucronata* is more complex. Though not emphasized by Wimmer, it differs from *L. tupa* not only in it non-decurrent leaves, but also in its very sparse inflorescence (cf. Hooker 1833). Here, only 10–15 flowers form before the apical meristem aborts; the flowers appear to be largely in bloom all at once and to take on a nodding rather than spreading or ascending posture. However, all other features of the plants, including the flowers and the seeds, are identical to *L. tupa*. Furthermore, all specimens referable to *L. mucronata* have been collected within the geographic and elevational range of *L. tupa*.

I was unable to locate plants in nature that matched this description, and have seen only a few specimens besides the types cited above. While it is possible that *L. mucronata* is an extremely rare or possibly extinct species, perhaps adapted to some unusual edaphic niche, other hypotheses must be considered. The handful of specimens examined may simply represent plants of *L. tupa* whose apical meristems were damaged at a critical point of development by some insect or pathogen, resulting in aberrant growth. They may represent an occasional genetic variant, perhaps a simple Mendelian recessive, of that species. Alternatively, these plants may be relicts close to the evolutionary divergence of *L. excelsa* and *L. tupa,* or recent hybrids of these two species. Although they are not sympatric today, their ranges do approach one another (see above) and may have overlapped in the past. The most recent gathering of plants referable to *L. mucronata* (*Montero 736,* CONC) was collected in 1928 in Prov. Colchagua, in the zone of closest approach between these two species.

Until such time as sufficient new data permit support or rejection of some of these hypotheses, I am loathe to recognize *L. mucronata* as a distinct species. Because it occurs within the geographic range of *L. tupa* and because its flowers and seeds are indistinguishable from those of that species, it is here relegated to synonymy.

Populations of *L. tupa* also show clinal variation in pubescence. The hairs on leaves and stems generally become longer and softer from north to south, while the dorsal surface of the anther tube becomes increasingly pubescent from south to north. The corolla of *L. tupa* typically is red, though it does not change color (Weiss 1995) as in *L. excelsa*. I have seen just one specimen (*Reiche s.n.*, Jan 1902, SGO) in which the corolla is yellow ("flores flavescente"; cf. Reiche 1905, 1910).

Representative specimens. **JUAN FERNÁNDEZ ISLANDS. Isla Masatierra:** in fruticetis apricis collium, *Bertero 12473* (CONC); Quebrada Pangal, *Marticorena et al. 9172* (CONC, M, OS); Valley Anson, *Meyer 9580* (MO, RSA, UC); San Juan Bautista to Pangal, *Pacheco & Valdebenito 6291* (B, CONC); Valle Colonial, *Sparre 7* (CONC, S); colony, *Skottsberg & Skottsberg 183* (GB, S, UPS); between Pangal and La Centinela, *Stuessy & Crawford 6306* (CONC, OS); between hosteria and San Juan Bautista, *Stuessy & Crawford 6310* (CONC); path to Quebrada Pangal, *Stuessy et al. 6200* (CONC, OS).

CHILE. Prov. Cachapoal: Rancagua, *Frödin 494* (UPS); Termas de Cauquenes, 3 Nov 1952, *Pfister s.n.* (CONC). **Prov. Colchagua:** Las Penas, *Barrientos 1605* (CONC); Cerro Echaurrina, *Montero 736*

(CONC). **Prov. Curicó:** Lipimavida, *Spooner & Contreras 4332* (CONC, F, WIS). **Prov. Talca:** Constitución, Feb 1895, *Philippi s.n.* (SGO); Talca, 13 Oct 1897, *Philippi s.n.* (SGO); Constitución, Nov 1891, *Reiche s.n.* (SGO). **Prov. Linares:** Río Achibuena, *Gereau & Taylor 5171* (ASU, F); Termas de Catillo, *Montero 6276* (CONC). **Prov. Ñuble:** a Quirihue despues de Trehuaco, *Schlegal 756* (CONC). **Prov. Concepción:** Parque Hualpen, *Carrasco 333* (CONC); Concepción, *DeVore 1278* (OSH, JC); Concepción, *Elliot 144* (BM, NY); Punta Hualpén, *Hutchinson 248* (F, GH, UC); 1 km E of Coronel, *Lammers et al. 6316* (C, CONC, F, MEXU, MU, NY); 20 km S of San Pedro, *Lammers et al. 6323* (B, CONC, F, MU); Playa El Soldado, *Lammers et al. 6329* (C, CONC, F, GB, MEXU, MU, NY); 10 km W of Florida, *Lammers et al. 6460* (B, CONC, F, MU); Concepción, *Landrum 8388* (F); San Vicente, *Pennell 12867* (GH, NY, PH, SGO); Talcahuano, Dec 1861, *Philippi s.n.* (SGO); Talcahuano, *Skottsberg & Skottsberg 1377* (GB, S); San Pedro, *Stuessy et al. 6681* (OS). **Prov. Arauco:** Contulmo, *Gunckel 40765* (CONC); 3 km E of Contulmo, *Lammers & Baeza 6510* (CONC, F, MU); Laraquete, 20 Dec 1949, *Ricardi s.n.* (CONC, OS); 4.7 km N of bridge over Lébu, *Spooner 4483* (F, WIS). **Prov. Malleco:** Purén, *Lammers & Baeza 6508* (CONC, F, MU); 9 km W of Purén, *Lammers & Baeza 6509* (F, MU); Nahuelbuto, *Rahn & Ødum 4735* (C); Contulmo, Jan 1902, *Reiche s.n.* (SGO); entre Purén y Contulmo, *Sparre & Smith 156* (CONC, OS). **Prov. Cautín:** Puerto Saavedra, *Aravena 30* (CONC); Trovolhue, *Montero 7904* (CONC); Carahue, *Sparre 3381* (SGO). **Prov. Valdivia:** Niebla, *Bricker 227* (ASU); Valdivia, *Bridges 661* (BM, E, RSA); 20 mi. NE of Valdivia, *Eyerdam 10687* (F, NY, SGO, UC, WTU); Niebla, *Garaventa 5533* (CONC); Huiecolla, *Gardner & Knees 4158* (E, K); Valdivia, *Gunckel 21* (CONC); 1 km W of hwy on road to Corral, *Lammers & Baeza 6463* (CONC, F, MU); 38 km E of Corral, *Lammers & Baeza 6464* (F, MU); 31 km E of Corral, *Lammers & Baeza 6466* (F, MU); 7 km N of Chaihuin Bajo, *Lammers & Baeza 6478* (CONC, F, MU); 10 km E of Mehuin, *Lammers & Baeza 6496* (F, MU); Mehuin, *Lammers & Baeza 6503* (B, F, MU); 6 km S of San Jose de la Mariquina, *Lammers & Baeza 6506* (F, MU); Corral, *Rudolph 6097* (VALD); Angachilla, Dec 1960, *Santos & Retamal s.n.* (ISC); Niebla, *Schmitz 91* (VALD). **Prov. Osorno:** Alencapi, *Rudolph 6091* (VALD); Tres Esteros, *Rudolph 6092* (VALD), *6094* (VALD), *6095* (VALD); La Barra del Río Bueno, *Sparre 4558* (S, SGO). **Prov. Chiloé:** Ancud, *Pennell 12493* (F, GH, NY, PH), 25 Dec 1951, *Pfister & Ricardi s.n.* (CONC).

CULTIVATION. U.S.A. California: Berkeley, *Bracelin 1450* (GB). **GERMANY:** Hamburg, 1834, *anonymous s.n.* (S).

4. Lobelia bridgesii Hook. & Arn., J. Bot. (Hooker) 1:278. 1834. *Rapuntium bridgesii* (Hook. & Arn.) C. Presl, Prodr. Monogr. Lobel. 28. 1836. *Tupa bridgesii* (Hook. & Arn.) A. DC. in DC., Prodr. 7:394. 1839. *Dortmanna bridgesii* (Hook. & Arn.) Kuntze, Revis. Gen. Pl. 972. 1891. TYPE: CHILE. Valdivia, near El Castello de Amargos, *Bridges 663* (HOLOTYPE: K!; SOTYPES: BM! E! K[2]! NY! RSA! W! [photographs: A! F! MICH!]).

Tupa blanda D. Don in Sweet, Brit. Fl. Gard. (ser. 2) 4:pl. 308. 1835. *Rapuntium blandum* (D. Don) C. Presl, Prodr. Monogr. Lobel. 27. 1836. *Lobelia blanda* (D. Don) Endl., Cat. Hort. Acad. Vindobon. 1:437. 1842. *Dortmanna blanda* (D. Don) Kuntze, Revis. Gen. Pl. 972. 1891. TYPE: GREAT BRITAIN. Kent, Sundridge Park, raised from Chilean seeds by Mr. Malleson (LECTOTYPE here designated: D. Don 1835, pl. 308!). As no original material was located, the plate published with the protologue is here designated as the lectotype.

Rapuntium lucaeanum C. Presl, Prodr. Monogr. Lobel. 27. 1836. *Lobelia lucaeana* (C. Presl) A. DC. in DC., Prodr. 7:383. 1839. *Dortmanna lucaeana* (C. Presl) Kuntze, Revis. Gen. Pl. 972. 1891. TYPE: GERMANY. Cultum in horto botanico berolinensi, semina ex America meridionali orta diguntur, Sep 1835, *anonymous s.n.* (HOLOTYPE: PR!).

Robust perennials, 0.5–2.5 m tall; stems several from the base, normally unbranched, hollow, herbaceous or suffruticose, glabrous; latex white. Lamina 9–24 cm long, 1.8–4.5 cm wide, lanceolate, glabrous; margin minutely serrulate; apex long acuminate, aristate or cirrhose; base sagittate, the pair of basal lobes decurrent on the stem for 12–32 mm.

Inflorescence a 15–55-flowered raceme; bracts lanceolate, 15–60 mm long, the base sagittate, the pair of basal lobes decurrent on the stem for 6–22 mm; pedicels 14–30 mm long, ebracteolate, glabrous or sparsely pubescent with stiff spreading hairs. Hypanthium 4–8 mm long, 6–10 mm in diameter, hemispheric or obconic, glabrous. Calyx lobes 5–10 mm long, 2–4 mm wide, narrowly triangular, glabrous; apex narrowly acuminate, aristate. Corolla 25–36 mm long, pink, glabrous; tube 13–19 mm long, 2.5–4.5 mm in diameter at middle, suberect; lobes 12–16 mm long, 1.5–2.5 mm wide. Filament tube 14–17 mm long; anther tube 6–7 mm long, 2–3 mm in diameter, gray, the dorsal three sometimes with scattered long spreading hairs, and/or all five pubescent with short appressed hairs. Capsule 16–17 mm long, 13–14 mm in diameter, ovoid to subglobose. Seeds 0.5 mm long, 0.4 mm in diameter, broadly ellipsoid, golden tan, minutely foveolate-reticulate. Chromosome number $n = 21$ (Lammers & Hensold 1992; Lammers 1993a).

Icones.—D. Don (1835) [as *T. blanda*]; Hooker (1839); Lemaire (1843) [as *T. blanda*]; Loudon (1844), pl. 66, fig. 2; Lammers (1993b).

Distribution, Habitat, and Phenology. Endemic to the immediate vicinity of Bahia San Juan in Prov. Valdivia (latitude 39°49′S), in the evergreen temperate rain forest region (cf. Walter 1973) of south-central Chile, at elevations from near sea level up to 200 m. Not infrequent there, on grassy slopes, roadsides, and forest margins, sometimes in company with *L. tupa*. It is most easily found along the road that runs from the main highway south of Valdivia to the little coastal village of Corral. Also collected once (from introduced plants?) in Prov. Cautín and in Prov. Osorno or Llanquihue. Flowering mid-December through early March.

Discussion.—Wimmer (1953) distinguished *L. blanda* (including *L. lucaeana*) from *L. bridgesii* on the basis of subtle differences in the size and shape of the leaves. Study of natural populations convinced me that this variation was of no taxonomic significance. This species is unique in the section (and perhaps in the subgenus) for its pink corolla (cf. Lammers 1993b).

Representative specimens. **CHILE. Prov. Cautín:** Conguillio, *Delgado s.n.* (VALD). **Prov. Valdivia:** Corral, *Brooke 6985* (BM); 24 km SE of Corral, *Gardner & Newton 17* (E); Corral, *Gay 1469* (SGO); Amargos, *Gunkel 29* (BM, F); Corral, *Gunckel & Junge 618* (BH, CONC); La Aguada, *Gunckel 5018* (NY); Castillo San Luis a San Martin, *Klempar s.n.* (VALD); San Carlos, 1987, *Krause s.n.* (CONC, SGO); 31 km E of Corral, *Lammers & Baeza 6465* (B, CONC, F, MU); 4 km E of Corral, *Lammers & Baeza 6470* (CONC, F, GB, MEXU, MU); 2.5 km S of Corral, *Lammers & Baeza 6485* (CONC, F, MU, NY); 36 km E of Corral, *Lammers et al. 7856* (CONC, F, UC); Amargos, *Montero 1341* (CONC); Corral, Mar 1878, *Philippi s.n.* (SGO); Amargos, *Sparre & Smith 397* (CONC, OS, Universidad de Talca); Corral, *Werdermann 1938a* (B, M, S); hills above Corral, *West 4880* (GH, MO, UC). **Prov. Osorno** or **Llanquihue**: Monte Sobre, Lago Llanquihue, 1939, *Santa Cruz s.n.* (BH).

CULTIVATION. GERMANY: Münich bot. gard., 9 Apr 1863, *Kummer s.n.* (M), 30 Aug 1867, *Kummer s.n.* (M), 5 Jul 1869, *Kummer s.n.* (M).

PUTATIVE HYBRID

Lobelia excelsa Bonpl. × **L. polyphylla** Hook. & Arn. *Tupa kingii* Phil., Anales Univ. Santiago 90:189. 1895, 'kingi.' Type: CHILE. Valparaíso, Poppe's [Poeppig's] Hill, Dec 1868, *King s.n.* (holotype: SGO-057170! [photograph: GH!]).

Presumably a shrub; stems woody, glabrous. Lamina 4.8–11.2 cm long, 1.3–2.4 cm wide, oblong, glabrous; margin minutely serrulate, particularly toward apex; apex acute; base cuneate. Flowers aggregated into a 18-flowered inflorescence; bracts 28–38 mm long, 4–9 mm wide, oblong, minutely pubescent; pedicels 15–18 mm long, ebracteolate, minutely pubescent. Hypanthium 5–6 mm long, 8–10 mm in diameter, hemispheric or broadly campanulate, minutely pubescent. Calyx lobes 5 mm long, 1 mm wide, narrowly triangular, minutely pubescent; apex acuminate. Corolla 40 mm long, apparently dark reddish-purple, minutely pubescent; tube 23 mm long, 2.5 mm in diameter at middle, curved; lobes 17 mm long, 1 mm wide. Filament tube 21 mm long, dark reddish-purple; anther tube 6 mm long, 2 mm in diameter, pale straw-colored, the dorsal three with scattered long white hairs on the surface toward apex. Fruit and seeds not seen. Chromosome number unknown.

Discussion.—Though *Tupa kingii* was treated as a synonym of *L. polyphylla* by Reiche (1905, 1910) and Wimmer (1953), the type appears to represent a hybrid between that species and *L. excelsa*. It resembles *L. excelsa* generally, particularly in the size and shape of the leaves, but differs in its well-demarcated inflorescence (vs. flowers solitary and axillary) of darker flowers on ebracteolate pedicels, features characteristic of *L. polyphylla*. Various quantitative features of the flowers are intermediate in size: pedicels 15–18 mm long (vs. 7–17 mm in *L. polyphylla* and 12–45 mm in *L. excelsa*); hypanthium 8–10 mm in diameter (vs. 4–8 mm in *L. polyphylla* and 8–15 mm in *L. excelsa*); corolla 40 mm long (vs. 15–25 mm in *L. polyphylla* and 38–65 mm in *L. excelsa*), with tube 23 mm long (vs. 7–17 mm in *L. polyphylla* and 25–42 mm in *L. excelsa*) and lobes 17 mm long (vs. 4–12 mm in *L. polyphylla* and 12–33 mm in *L. excelsa*); and filament tube 21 mm long (vs. 9–15 mm in *L. polyphylla* and 29–47 mm in *L. excelsa*), with anther tube 6 mm long (vs. 4–7 mm in *L. polyphylla* and 8–11 mm in *L. excelsa*). As noted above, this specimen is the sole evidence I have seen of hybridization between these two sympatric species.

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A NEW SPECIES OF *TREPADONIA* (ASTERACEAE: VERNONIEAE) FROM PERU

Harold Robinson
Department of Botany
National Museum of Natural History
Smithsonian Institution
Washington, DC 20560-0166, U.S.A.

Hamilton Beltrán
Museo de Historia Natural
Universidad Nacional Mayor de San Marcos
Av. Arenales 1256, Apartado 14-0434
Lima, PERU

ABSTRACT

Trepadonia oppositifolia (Asteraceae:Vernonieae) is described from Peru and a key is presented for the two species of the genus.

RESUMEN

Se describe *Trepadonia oppositifolia* (Asteraceae:Vernonieae) de Perú y se presenta una clave para las dos especies del género.

Trepadonia was established as a genus separate from the broad concept of *Vernonia* (Jones 1980) by Robinson (1994) based on the one Peruvian species, *Vernonia mexiae* (Robinson 1981). The genus is based on the totally scandent habit and the 90°-angle branching of the primary branches of the inflorescence. The species also has distinctive racemose branchlets in the inflorescence. A second species, *Trepadonia oppositifolia* is described herein, also from Peru, differing by having opposite leaves, cymiform inflorescence branchlets, and more florets in the heads. The new species occurs in southern Peru, and if distributions of cohabitants such as the bamboo *Guadua* are indicative, the new species may be found eventually in nearby western Brazil.

Trepadonia oppositifolia H.Rob. & H.Beltrán, sp. nov. (**Fig. 1**). Type: PERU: Dpto. Cuzco: Provincia La Convencion, Echarati, Cashiriari-3 Well Site, 5 km S of Camisea River; 11°52'57.1 S, 72°39'6.1 W, 700 m, upland forest mixed with "paca" *Guadua sarcocarpa*, vine, petals pale purple, clearing, 2 Sep 1998; *P. Nuñez, H. Beltran, W. Nauray R. de la Colina, J. Tenteyo et al. 23967* (holotype: US; isotype USM, CUZ).

A *T. mexiae* in foliis oppositis ramulis inflorescentiae cymiformis et floribus 18–23 in capitulo differt.

Scandent, to 8–9 m high; branches striate, glabrous. Leaves opposite; petioles mostly 1.0–1.5 cm long, base dilated and reddish; lamina ovate, 11–13 cm long, 5–7 cm wide, base rounded, margins entire to slightly undulate, apex acuminate, adaxial surface bright green, glabrous, abaxial surface paler green, puberulous with minute hairs, venation pinnate, ca. 9–10 pairs of widely spreading secondary veins. Inflorescence rather thyrsoid-paniculate, with primary and secondary branching mostly spreading at 90°-angles, branchlets cymose. Heads separate, mostly sessile, homogamous; involucre campanulate, 3–4 mm high, 4–5 mm wide; involucral bracts ca. 28, gradate in 3–4 series; outer bracts ovate, 2 mm long, 1 mm wide, puberulous outside, brown at apex, inner bracts

Fig. 1. ***Trepadonia oppositifolia*** **H. Rob. & H. Beltrán. Live plant.**

oblong-lanceolate, 4 mm long, 1 mm wide, glabrous. Florets 18–23; corollas purple, glabrous, ca. 5 mm long, tube 2 mm long, throat ca. 1 mm long, 1 mm wide, lobes erect, lanceolate, ca. 2 mm long. Cypselas 2 mm long, 0.5 mm wide, 10-costate, with many short appressed setulae; pappus bristles white, ca. 38, 4 mm long, scabrid, squamae of outer series ca. 0.9–1.2 mm long, scabrid. Pollen ca. 37 mm in diameter in fluid, tricolporate, non-lophate.

Paratype: PERU. Dpto. Cuzco: Provincia La Convencion, Echarati, Cashiriara-3 Well Site, 5 km south of Camisea River; 11°52'57.1 S, 72°39'6.1 W, 700 m, 2 Sep 1998, *P. Nuñez, H. Beltran, W. Nauray, R. de la Colina, J. Tenteyo 23842* (CUZ, US).

KEY TO THE SPECIES OF *TREPADONIA*

1a. Leaves alternate, blade oblong-ovate; branchlets of inflorecence racemiform; heads with 8–10 florets ______ **T. mexiae**
1b. Leaves opposite, blades ovate; branchlets of inflorescence cymiform; heads with 18–23 florets ______ **T. oppositifolia**

Leaves of the Vernonieae are usually alternate. Opposite and verticillate leaves are comparatively rare in the tribe, being most common in the Neotropical subtribe Piptocarphinae and the African genus *Bothriocline* Oliv. ex Benth. In the subtribe Vernoniinae, to which *Trepadonia* belongs, opposite or verticillate leaves have previously been known only in one Jamaican species of *Lepidaploa* and one Colombian variety of another species of *Lepidaploa* (Robinson 1999). The character is almost always variable within the genera in which it occurs. Only in the Andean genus *Joseanthus* H. Rob., of the Piptocarphinae, with five species, are all the species opposite-leaved.

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BOOK REVIEW

Wilhelmina Feemster Jashemski. 1999. **A Pompeian Herbal: Ancient and Modern Medicinal Plants.** (ISBN 0-292-74060-3, pbk.). Univ. of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. $17.95, pbk., $35.00, hbk. 123 pp., 15 color and 7 b&w photos, 36 b&w line drawings.

While excavating ruins at Pompeii, author Wilhelmina Jashemski noticed several workmen collecting a variety of plants for medicinal purposes. "As the days passed and my workmen continued to collect plants, I began to wonder if the plants they were collecting for medicine were the same ones the ancient Romans had used for cures." That question germinated into *A Pompeian Herbal*, a collection of 36 plants common to Pompeii juxtaposing contemporary medicinal uses with ancient ones. Not only does this book elucidate the continuity of life and environment in the Pompeian area, but it also serves as an example of exhaustive and thorough research. My initial skepticism of reading an herbal- not written by a botanist, was soon replaced with a sense of relief that we, as readers and researchers, are lucky enough for it be written by an archaeologist. For only an archaeologist, perhaps, would pose the question and have the fortunate circumstances to be doing archaeological excavations while simultaneously collecting ethnobotanical information from local Pompeians.

In the introduction the author explains her fieldwork and methodology and gives appropriate background information on Pompeii, local medicinal plants, and the ancient literature of Pliny the Elder, Dioscorides, Theophrastus and others. Gleaning data from a variety of sources is what makes the book both comprehensive and unique. Information on the contemporary uses of medicinal plants came from locals and workmen of the site- the people, often times bringing plants to the author and describing preparations and what ailments the plants treat (*fegato*, or liver problems—treated with *Verbanum sinuatum* L. are common). For the ancient uses of the plants Jashemski consults ancient literature, discussing both mythological and medicinal citations. This information is strongly supported by the scant, yet important, archaeological evidence. Excavations on sites that were covered with the resulting pyroclastic flow of Mt. Vesuvius provided invaluable archaeo-botanic evidence normally unavailable in the climate of Pompeii. The lava provides enough heat to carbonize plant remains such as seeds, roots, fruits, and stems, however it's unfavorable to preservation of pollen, limiting identification to family names but not of genus and species. Archaeological evidence also revealed the planting patterns of ancient Pompeians- that as the workers revealed, were the same patterns they followed in their own gardens today. Most sites that have been excavated at Pompeii over the years have neglected the paleoethnobotanic dimension making this book all the more valuable as it provides insight into ancient Pompeian life that before now was obsolete.

Following the introduction comes the core of the book, the herbal. The design of the herbal is one of this book's major strong points. For each plant the author provides the scientific, English, and Italian names and a physical description of the plant and its habitat. Drawing on information from local villagers the author describes how the plant is prepared as a medicinal and what ailments it is used to treat. From there the author cites the ancient literature giving reference to the plant as a medicinal and its mythological connotations. Information on each plant is presented vis-à-vis a full-page black and white plant portrait giving the herbal an elegance any classicist is sure to appreciate. Completing the herbal is a bibliography of ancient literature and notes on citations, a bibliography of secondary sources, a list of illustrations, and general and Greek indices.

The potentially wide readership should stand testament to the book's worth. Being under 100 pages and less than $20 makes it a bargain for the lay reader interested in alternative medicine, folklore, and Pompeii as well as the classicist, botanist, and archaeologist. The book is not designed for college courses, but should prove to be an invaluable reference for those researching Old World paleoethnobotany.—*Kevin D. Janni.*

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RHYNCHOSPORA ZACUALTIPANENSIS AND *ELEOCHARIS MOOREI*, TWO NEW CYPERACEAE FROM MEXICO

Mark T. Strong

Department of Botany, MRC/166
Smithsonian Institution
10th and Constitution Avenue
Washington, DC 20560-0166 U.S.A.
strong.mark@nmnh.si.edu

M.S. González-Elizondo

Herbario CIIDIR, CIIDIR - IPN
Apdo. Postal 738
Durango, Dgo., 34000
MEXICO
sgonzalez@omanet.com.mx

ABSTRACT

Rhynchospora zacualtipanensis M. Strong and *Eleocharis moorei* M. Strong & S. González, from eastern Mexico, are described and illustrated. Their relationships to closely allied and morphologically similar species are discussed.

RESUMEN

Se describen e ilustran *Rhynchospora zacualtipanensis* M. Strong y *Eleocharis moorei* M. Strong & S. González, del oriente de México, y se discuten sus relaciones con especies cercanas y morfológicamente similares.

Rhynchospora Vahl nom. cons. is a genus of approximately 250 species worldwide. It is most diverse in the Western Hemisphere, particularly warm-temperate North America and the neotropics. Espejo Serna and López Ferrari (1997), recognized 51 taxa (including infraspecific taxa) from Mexico.

Rhynchospora, a very vegetatively diverse group, contains plants that range from small diminutive annuals less than 10 cm tall to large rhizomatous perennials up to 3 m tall. The leaves are primarily basal, 2-several cauline, linear to filiform, dorsiventrally compressed, and often have scabrous margins. The inflorescence ranges from a single solitary spikelet or capitate head of spikelets at the summit of the culm to large decompound panicles of many spikelets, often composed of a terminal and a series of 1-several lateral, remote or contiguous, simple to compound, corymbiform or cymose partial panicles from the upper sheathing bracts. The floral morphology is generally uniform and can be characterized as follows: spikelets have spirally arranged scales, with (1–)2-many basal scales empty (sterile), the fertile scales are borne above these and each subtends a perfect flower, or often the terminal 1–2 scales are staminate only with an abortive pistil; each flower has (1–)2–3 stamens; the style is 2-branched or entire; and achenes are biconvex or lenticular and are often transversely rugose or rugulose, each bearing at its apex the persistent triangular, triangular-lanceolate or discoid base of the style.

Rhynchospora zacualtipanensis M. Strong, sp. nov. **(Fig. 1)**. Type: MÉXICO. Hidalgo State: Zacualtipán District, ca. 3 mi [4.8 km] from Zacualtipán on road to Tianguistengo, 2100 m, pine woods and sphagnum bogs, in sphagnum, 4 Jul 1947, *Moore 3327* (holotype: BH; isotypes: MICH, UC, US 3386987). Possible isotypes at G and M [These herbarium acronyms were also recorded in

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Fig. 1. *Rhynchospora zacualtipanensis* M. Strong (drawn from the type). A. Habit. B. Sections of leaf blades, proximal end (left) to apex (right). C. Section of leaf at sheath orifice showing junction of sheath and blade. D. Detail of terminal inflorescence panicle. E. Mature spikelet with achene. F. Spikelet scale. G. Achene.

H.E. Moore's collection notebook as prospective herbaria for the distribution of duplicates. However, recent searches made by curators at these institutions were unsuccessful].

Planta perennis caespitosa glabra rhizomate brevi crasso. Culmi erecti vel ascendentes, 20–60 cm alti, 0.5–1.7(–2) mm lati, obtuse trigoni vel subteretes. Folia basilaria et inferne caulinaria; vaginae eligulatae; laminae 10–30 cm longae, 0.5–2 mm latae vel 3 mm latae ubi planae, v-formae vel subcomplicatae vel subinvolutae vel lunulatae apicem versus subtrigonae. Inflorescentia paniculata, paucispiculata, panicula terminalis major, superiores 2 approximatae, laterales 1–2, pedunculatae, pedunculi ad 6 cm longi. Spiculae 3.5–4.2 mm longae, 1.2–1.5(–1.6) mm latae, anguste ovoideae vel ovoideo lanceoloideae, 3–4-floriferae, 2 nucigerae; squamae 5–7, ovatae vel ovato-ellipticae, mucronatae vel breviter aristatae, divergentes ubi maturae, squamae fertiles (2.5–)2.6–3.1 mm longae, 2–2.7(–3) mm latae, squamae steriles breviores. Stamina tres, antheris 1.5–3 mm longis. Stylus profunde bifidus. Achaenia 1.8-2.1 mm longa (sine styli basi), 1.2–1.4 mm lata, obovata biconvexa spadicea, leviter transverse rugulosa; styli basis anguste triangularis, 0.8–1 mm longa, 0.3–0.7 mm lata; setae 6, antrorse barbatae, basi saepe setosae, achaenium leviter breviores ad superantes.

Caespitose perennial; rhizome short, thickened and knotty. Culms erect or ascending, 20–60 cm tall, 0.5–1.7(–2) mm wide, obtusely trigonous to subterete, finely ribbed, often channelled along one side distally, green, glabrous. Leaves basal and lower cauline; sheaths eligulate, coarsely veined abaxially, green to pale brown, often reddish brown proximally, glabrous, the inner band membranous, finely veined, reddish brown, with concave orifice at apex; blades somewhat stiff, 10–30 cm long, 0.5–2 mm wide (to 3 mm wide when flattened) widely to narrowly v-shaped or crescentiform in cross section, sometimes subinvolute or tightly folded, often subtrigonous towards apex, finely ribbed abaxially, smooth adaxially, at least medially, green, glabrous, the margins antrorsely scabrous or sometimes essentially smooth proximally. Inflorescence composed of a terminal and 1–2, small, lateral cymose-fasciculate partial panicles, the lateral panicles on slender peduncles to 6 cm long, the lowest panicle remote from the two upper subcontiguous ones; peduncles flattened, finely ribbed, antrorsely scabrous on margins, glabrous; bracts of the panicle branches setaceous, those subtending the peduncles, particularly the lower, leaf-like; spikelet pedicels subtrigonous or plano-convex in cross section, the margins often antrorsely scabrous; spikelets narrowly ovoid to ovoid lanceoloid, 3.5–4.2 mm long, 1.2–1.5(–1.6) mm wide, with 5–7 scales, 3(–4)-flowered, maturing 2 achenes, the scales spreading with maturing achenes; scales ovate to ovate-elliptic, indistinctly finely veined, glabrous, margins entire, the midcosta prominent, pale brown to brown, prolonged beyond the acute to acuminate apex as a mucro or short awn; fertile scales (2.5–)2.6–3.1 mm long, 2–2.7(–3) mm wide; sterile scales 2–3 at base of spikelet, smaller than fertile ones, 2–2.2(–2.5) mm long, 0.8–1.2 mm wide. Flowers bisexual; stamens 3, the anthers 1.5–3 mm long, basifixed, thecae parallel, longitudinally dehiscent, apiculate at apex; style 2-branched from below middle, ca. 2/3 length of style, the branches glabrous, minutely scaly; achenes biconvex, obovate or obpyriform, achene body 1.8–2.1 mm long (excluding style base), 1.2–1.4 mm wide, light brown to yellowish brown, finely transversely rugulose; style base narrowly triangular, 0.8–1 mm long, 0.3–0.7 mm wide, pale brown, often truncated at apex; bristles 6, antrorsely barbed, reddish brown, often setose at very base, slightly shorter than to equaling or exceeding the length of the achene body with several sometimes equaling the tip of the style base.

Habitat and distribution.—*Rhynchospora zacualtipanensis* is known only from the type collection made in the southern extent of the Sierra Madre Oriental mountain range at approximately 20° 43' 00"N, 98° 39' 00"W, ca. 4.8 km north of the town of Zacualtipán. It occurs in pine woods and sphagnum bogs at about 2100 m.

Rhynchospora zacualtipanensis is a species of *R.* subgenus *Rhynchospora*. It keys to *R.* section *Stenophyllae* Kükenthal in Kükenthal's (1950) monumental worldwide treatment of the subfamily Rhynchosporideae. Section *Stenophyllae* included Gale's (1944) *Rhynchospora* section *Rhynchospora* series *Glaucae* (C.B. Clarke) Gale (in part), and series *Rariflorae* Gale (in part). *Rhynchospora zacualtipanensis* seems to be best placed in *R.* section *Glaucae* C. B. Clarke as circumscribed by Guaglianone (1979). The obovate or obpyriform, yellow-brown achene, with a longitudinally striate surface interrupted by transverse corrugations (finely transversely rugulose) is characteristic of species in that section. However, the narrow (0.5–2 mm), stiff, thickened, often v-shaped or crescentiform leaf blades of *R. zacualtipanensis* are uncharacteristic of the wider (1–5 mm), flattened leaf blades typical of species in *R.* section *Glaucae*. *R. zacualtipanensis* can be distinguished at once by this feature from closely related species such as *R. brownii* ssp. *americana* Guaglianone, *R. pungens* Liebmann, and *R. rugosa* (Vahl) Gale. Generally, *R. zacualtipanensis* has longer bristles and a longer style base than *R. brownii* and *R. pungens*. The bristles of *R. zacualtipanensis* typically equal or exceed the length of the achene body with several sometimes equaling the tip of the style base, while in the latter two species, there are generally several that are shorter than the achene body and rarely do any equal the tip of the style base. The style base of *R. zacualtipanensis* ranges from 0.8–1 mm in length while those of *R. brownii* ssp. *americana*, *R. pungens*, and *R. rugosa* range from 0.5–0.8 mm in length. In a treatment of Mesoamerican *Rhynchospora* by Thomas (1992), *R. zacualtipanensis* falls out at couplet 79[b] (*R. rugosa*) in the part of the key that treats species of *R.* section *Glaucae*. *R. zacualtipanensis* can be distinguished from the wide-ranging *R. rugosa* by the morphology of the leaf blades (as previously discussed) and further distinguished by its shorter spikelets (3.5–4.2 mm vs. 3.5–5 mm long) and smooth margins of the style base (often antrorsely scabrous proximally in *R. rugosa*).

Eleocharis R. Brown is a widely distributed genus of ca. 200 species with 43 species recorded by Espejo Serna & López Ferrari (1997) from Mexico. The taxonomy of the genus is difficult, in part because there are very few morphological characters represented, e.g., the inflorescence is reduced to a single spikelet and lacks foliar involucral bracts; and leaves are all basal and reduced to tubular sheaths (González & Peterson 1997).

Eleocharis moorei M. Strong and S. González, sp. nov. (**Fig. 2**). TYPE: MÉXICO. HIDALGO STATE: District Zacualtipán, ca. 3 mi [4.8 km] from Zacualtipán on road to Tianguistengo, 2100 m, pine woods and sphagnum bogs, in sphagnum, 4 Jul 1947, *H.E. Moore, Jr. 3332* (HOLOTYPE: BH; ISOTYPES: MICH, UC, US 2594748). Possible isotypes at B, G, and M [These herbarium acronyms were also recorded in H.E. Moore's collection notebook as prospective herbaria for the dis-

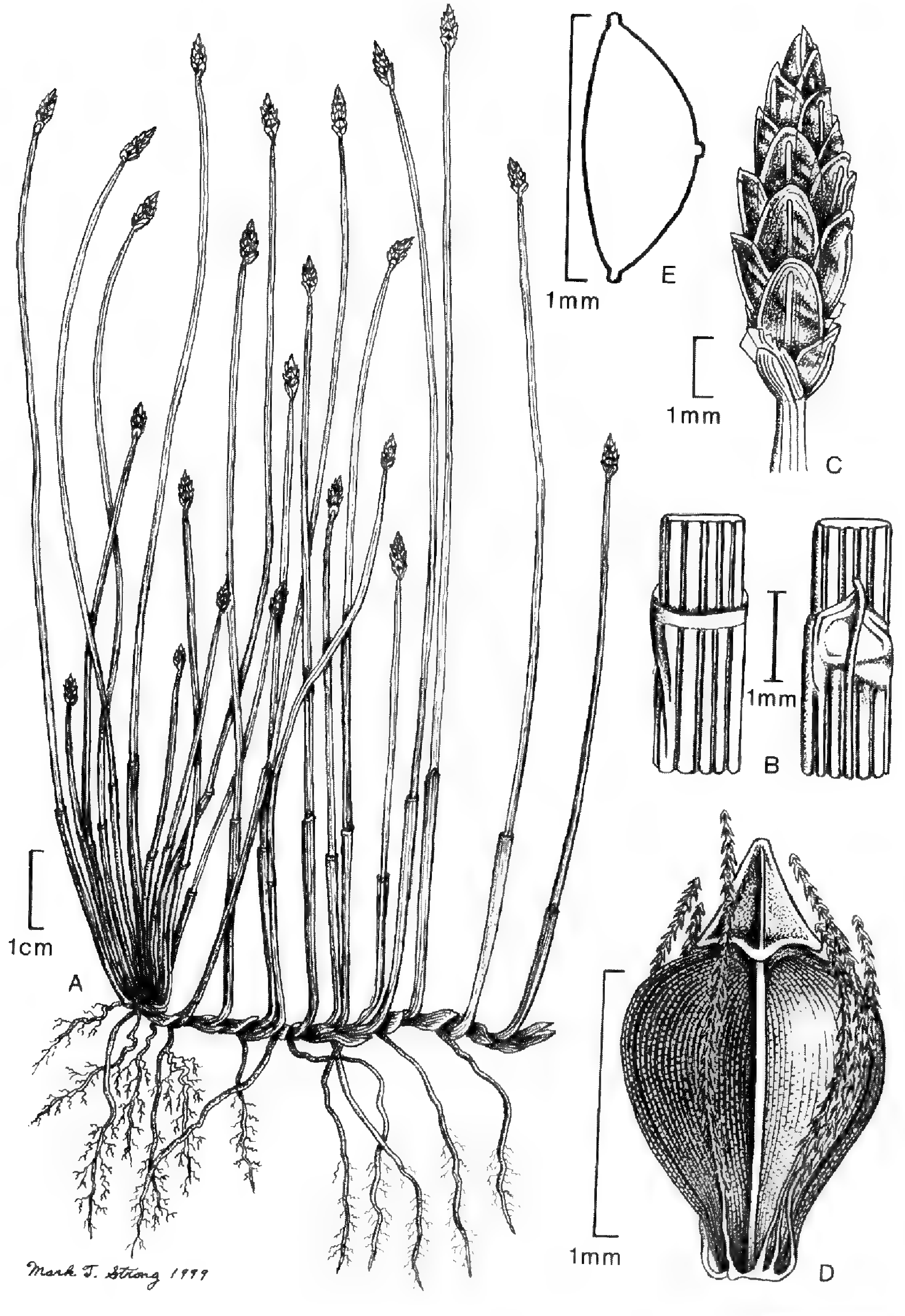

FIG. 2. *Eleocharis moorei* M. Strong & S. González (drawn from the type). A. Habit. B. Sections of culm showing dorsal summit of leaf sheath with acute, mucronate apex (right) and ventral summit of leaf sheath with slightly concave membranous orifice (left). C. Inflorescence (single spikelet). D. Achene. E. Cross section outline of achene at its widest point.

tribution of duplicates. However, recent searches made by curators at these institutions were unsuccessful].

Planta perennis. Rhizoma ca. (1.5–)2.5–3.5 mm crassum, repens vel oblique ascendens cum squamis atropurpureis instructum. Culmi erecti, 4–20 cm alti, (0.2–)0.4–1 mm latae; apice vaginis subtruncatis vel subobliquis vel subacutis. Spiculae 3.5–9 mm longae, 2.5–3 mm latae, ovatae vel lanceolatae, plerumque acutae, 9–35-floriferae; squamae floriferae polystichae, 2–2.6 mm longae, carinatae, ovatae vel oblongae, obtusae, maturitate divergentibus ad apicem. Stamina tres, antheris (0.6–)1.1 mm longis. Stylus trifidus. Achaenia 1.4–1.6 mm longa (cum styli basi), 0.75–1 mm lata, late obovata vel obpyriformia, obtuse trigona vel biconvexa ad superficiem abaxialem cristata, angulis costatis, lutea vel rubro-brunnea, conspicue reticulata; styli basis pyramidalis vel deltata, leviter complanata, basaliter crassa trilobata leviter decurrens; setae 4–7, retrorsum barbatae, achaenium aequantes vel superantes.

Perennial from an elongated, creeping or slightly ascending rootstock ca. (1.5–)2.5–3.5 mm thick, covered by conspicuous, elongate, sheath-like, dark purple, fibrous scales. Culms caespitose, or sometimes solitary along the rhizome, erect, 4–20 cm tall, (0.2–)0.4–1 mm wide, angular to terete, soft, flattened when dried, finely sulcate, pale green; sheaths membranous, purple, or stramineous and purple-striolated at the base, green to translucent distally, subtruncate to slightly oblique or acute at apex dorsally, emucronate or with a 0.1–0.2 mm long mucro, the orifice margin not or slightly darkened; upper sheaths with the ventral orifice concave; lower sheaths with the ventral orifice truncate to somewhat convex. Spikelets ovoid to ovoid-lanceoloid, 3.5–9 mm long, 2.5–3 mm wide, usually acute to subacuminate at apex; rachilla 0.3–0.4 mm wide, 9–35-flowered; scales polystichous, 2–2.6 mm long, 0.5–0.8 mm wide in lateral view, divergent distally, membranaceous, subtranslucent, ovate to oblong, obtuse at apex, carinate, with a narrow pale green to stramineous midvein, the sides dark purple to black distally, the margins and apex very narrowly hyaline, (at most 0.1–0.2 mm wide); 1–2 basal scales shorter, 1–2.3 mm long, 1–1.8 mm wide, ovate, obtuse, ecarinate, with a broad midvein of the same color and appearance as the culm, the sides purple, black, or hyaline, and the margins and apex hyaline, 0.3–0.5 mm wide; flowers bisexual; stamens 3, the anthers (0.6–)1.1 mm long, the connective shortly prolongated at apex; style 3-branched. Achene 1.4–1.6 mm long (including the style-base), 0.75–1 mm wide, very obtusely triangular or biconvex with a costula on the abaxial face, the angles costulate, widely obovate to obpyriform, yellow to reddish-brown, finely and shallowly cellular-reticulate, often conspicuously so, the cells rectangular or nearly square, longitudinally arranged; style base pyramidal to deltoid, dorsally subflattened, 0.4–0.5 mm long and as wide at base, sometimes slightly wider than the apex of the achene, trilobate at the base, the lobes slightly decurrent on the angles of the achene, whitish to brown, sometimes with a narrow ridge at junction with the body of the achene; bristles 4–7, reddish brown or yellowish, retrorsely barbed 1/2 to 2/3 their length, equaling to exceeding the achene.

Paratype. MEXICO. Veracruz State: carretera al sur de Huayacocotla, 17 km del borde con Hidalgo, 2100 m, Bosque de encino, suelo arcilloso, hierba 5 cm, perenne, regular, 13 Jul 1977, *J. Fay and J.I. Calzada 883* (F, US 2879357) [distributed as *Eleocharis acicularis* (L.) R. Br.].

Habitat and distribution.—*Eleocharis moorei* is known from only two localities that are in close proximity to each other in the southern extent of the Sierra Madre Oriental mountain range in the states of Hidalgo and Veracruz. These lie at approximately 20° 33' 00"N, 98° 29' 00"W to 20° 43' 00"N, 98° 39' 00"W, the Hidalgo locality near Zacualtipán being approximately 25–30 km northwest of the Veracruz locality near Huayacocotla. *E. moorei* occurs in sphagnum bogs in pine woods, and in oak forest, at about 2100 m.

The name of the new species honors its collector, Harold Emery Moore, Jr. (1917–1980), world renowned Arecaceae specialist, professor, and director of the L.H. Bailey Hortorium at Cornell University, Ithaca, New York from 1960–1980.

Eleocharis moorei belongs to *E.* series *Eleocharis* (*E.* series *Palustriformes* of Svenson 1929, 1932, 1939, 1957), subseries *Truncatae* Svenson, in the subgenus *Eleocharis*. However, its achene with costulate angles and trilobate style base distinguishes it from all other species in the group. Achenes of *E. tricostata* Torrey are prominently costulate, but in cross section they are trigonous, while those of *E. moorei* are very obtusely triangular or biconvex with a costula on the abaxial face. The achenes of *E. tricostata* also differ in bearing a much shorter and narrower style base that is neither trilobate nor decurrent, and they lack bristles. Furthermore, the sheaths and scales of *E. tricostata* differ as well in being lighter-colored, and the spikelets are generally longer and obtuse to subrounded at apex while those of *E. moorei* are acute to subacuminate. *E. moorei* differs from *E. compressa* Sullivan in having scale tips not whitened and attenuate; larger achenes with a different tubercle; and more abundant bristles, which are longer and coarser. From *E. montevidensis* Kunth it differs in the elongate, sheath-like, dark purple and fibrous scales covering the rhizome; the soft, flattened culms; the membranous sheaths; the spikelets usually acute; the larger, biconvex or very obtusely triangular achene with costulate angles; and the big tubercle which is trilobate at the base. From the variable *E. tenuis* (Willdenow) Schultes, *E. moorei* differs in the coarser, flattened culms; the lowest spikelet scale being shorter than the middle scales; the larger, biconvex to obtusely trigonous achenes with much less pronounced reticulation; and the larger and coarser bristles.

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DISTINCTION BETWEEN *VITIS BLANCOI* AND *V. CINEREA* VAR. *TOMENTOSA* (VITACEAE)

Barry L. Comeaux
1634 Hwy 356
Sunset, LA 70584, U.S.A.

Jiang Lu
Center for Viticultural Sciences
Florida Agricultural and Mechanical University
Tallahassee, FL 32307, U.S.A.

ABSTRACT

Vitis blancoi Munson as treated by Munson included two, unrelated taxa with separate distributions. Plants from southern Mexico are treated as *V. blancoi* Munson emend. Comeaux, and are assigned to series *Occidentales* Munson. The northern group of plants from northern Mexico and extreme southern Texas belong to series *Cinerascentes* Planchon, and are here designated as *V. cinerea* (Engelm. in Gray) Engelm. ex Millardet var. *tomentosa* (Planchon) Comeaux. Revised descriptions and specimen citations are provided.

RESUMEN

Vitis blancoi Munson tal como fue tratada por Munson incluye dos taxa no relacionados con distribuciones diferentes. Las plantas del sur de México son tratadas como *V. blancoi* Munson emend. Comeaux, y se asignan a la serie *Occidentales* Munson. El grupo norteño, de plantas del norte de México y extremo sur de Texas, pertenece a la serie *Cinerascentes* Planchon, y se designa aquí como *V. cinerea* (Engelm. in Gray) Engelm. ex Millardet var. *tomentosa* (Planchon) Comeaux. Se ofrecen descripciones y citas revisadas de especímenes.

Thomas Volney Munson Munson (1843–1913) was the recognized authority of his day on the indigenous species of North American *Vitis* and respect for his knowledge has continued into recent times (Renfro 1983). Munson studied the North American species of *Vitis* for nearly fifty years and through these efforts he produced a comprehensive treatment of the genus contained in his classic work, *Foundations of American Viticulture* (Munson 1909).

Despite Munson's immense knowledge of the genus his interpretation of *V. blancoi* (Munson 1909)included two unrelated taxa with separate distributions. The plants from northern Mexico and extreme southern Texas belong to series *Cinerascentes* Planchon and the more southerly distributed individuals belong to series *Occidentales* Munson.

The objectives of this study were: (1) to provide a chronological historical account of the taxa involved; (2) to emend Munson's description of *V. blancoi*; (3) to thoroughly describe and provide justification for accepting as distinct *V. cinerea* var. *tomentosa* (Planchon) Comeaux, a currently unrecognized taxon from northern Mexico and extreme southern Texas; (4) and to document the distributions of these taxa.

NOMENCLATURAL REVIEW

Munson (1890a; 1890b) first reported obtaining specimens of *V. blancoi* in 1887 from

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Luciana Blanco of Guadalajara, Mexico, for whom he named the species. Blanco discovered it growing along streams in the nearby Sierra Madre Mountains in the southern state of Jalisco and repeatedly sent Munson specimens of the plants.

Munson (1909) provided an elaborate description of *V. blancoi*; along with a photograph of a specimen labeled as from Guadalajara. Significantly, Munson stated that in 1895 he received additional specimens from C.M. Stuart collected near Montemorelos, in the state of Nuevo Leon in northern Mexico. *Vitis blancoi* was placed in series *Cinerascentes* Planchon by Munson, since he felt it was closely related to *V. caribaea* DC (*V. tiliifolia* Humb.& Bonpl. ex Roem. & Schult.), also assigned to that series.

Subsequent treatments of *V. blancoi* have varied regarding its status as a species and classification within the rank of series. Bailey (1895–97) interpreted *V. blancoi* as synonymous under *V. tiliifolia*, but he later (Bailey 1934) recognized it as distinct and related to series *Labruscoideae* Planchon, which included *V. labusca* L. and other large-fruited (15–25 mm dia.) species. Standley (1920–26) also considered *V. blancoi* as a synonym of *V. tiliifolia*, while Galet (1988) treated *V. blancoi* as distinct and placed it along with *V. tiliifolia* in series *Caribaea* Galet.

Bailey (1934) made a substantial contribution towards clarifying the correct status of *V. blancoi*. He pointed out that Planchon's (1887) description of *V. berlandieri*, was based on two forms. Plants with glabrous leaves as in *Berlandier 2412* (holotype PH!) from New Mexico or Texas were treated as the typical form, *V. berlandieri* var. *berlandieri*, and plants with tomentose leaves as in *Berlandier 3116* (WIS!) from the state of Nuevo León were referred to var. *tomentosa* Planchon. The latter trinomial has not been treated in any subsequent publications. Significantly, Bailey suggested that the tomentose form might be *V. blancoi*, and, also mentioned that in the Munson distribution of specimens in 1888 another name was used, but he did not provide to his readers the earlier name.

MATERIALS AND METHODS

Field work by the senior author was carried out in 1986 and 1994 in Texas and in 1986, 1987 and 1990–92 in Mexico with collections made in the following states: Coahuila, Colima, Guerrero, Jalisco, México, Michoácan, Nuevo León, Oaxaca, Puebla, San Luis Potosi and Tamaulipas. Herbarium studies were conducted from 1980–92 during visits to the following: BRIT, JAL, JALU, MEXU, MO, TAMU, UF and UT.

RESULTS AND DISCUSSION

Recent studies revealed that the northern and southern plants treated by Munson as *V. blancoi* are, in fact, two unrelated taxa with separate distributions. The southern plants are separated morphologically from the northern taxon (Table 1) by their relatively large stipules (2–5 mm long), which are often obscured by arachnoid trichomes. Also, individuals in the states of Colima (*Comeaux 4207, 5074, 5075* and *5076* BRIT), Jalisco (*Comeaux 5078* BRIT) and Puebla (*Bruff 1511* MEXU) have leaves with rufescent pubescence, while all collections observed of the northern taxon have only white pubescence. Large stipules indicate that this species is not related to *V. tiliifolia* and other members of series

TABLE 1. Comparison of certain characters between *V. blancoi* Munson and *V. cinerea* var. *tomentosa* (Planchon) Comeaux.

Characters	***V. blancoi***	***V. cinerea* var. *tomentosa***
1. *Leaves pubescent*		
adaxial surface	pr[1], gt[2], gs[3]	gt, gs
abaxial surface	ft[4], ts[5], pb[6], pr	ts, pb
2. *Pubescence color*	white to rusty	white
3. *Stipule length*	2–5 mm	1–3 mm
4. *Pistil length*	1.5 mm	1.0 mm
5. *Fruit size* *(diameter in mm)*	*1 seeded* average 7.4 range 6.0–10.0 sample size 42	1-seeded average 6.7 range 5.5–8.0 sample size 37
	2-seeded average 9.4 range 7.0–12.0 sample size 41	2-seeded average 7.8 range 6.0–9.0 sample size 19
	3-seeded average 10.1 range 9.0–12.0 sample size 23	3-seeded average 9.1 range 8.5–10.0 sample size 4
	4-seeded average 10.9 range 9.0–13.0 sample size 13	
	5-seeded average 12.0 range — sample size 1	

[1] pr = puberulent
[2] gt = glabrescent
[3] gs = glabrous
[4] ft = felted
[5] ts = tomentose
[6] pb = pubescent

Cinerascentes, which have short stipules (approximately 1–3 mm long). The fruit size (6–13 mm dia.) shows that it is not a relative of *V. labrusca* and other large-fruited (15–25 mm dia.) species of series *Labruscoideae*. Instead, the above characters and others, such as relatively early flowering time, stems round in cross section, and medium size fruit ripening in midseason, suggest that the southern taxon referred to as *V. blancoi* has closest affinities with the western series *Occidentales* Munson.

The northern Mexican vines considered by Munson as *V. blancoi* are, as suggested by Bailey (1934), the same as *Berlandier 3116*, which was designated by Planchon as *V. berlandieri* var. *tomentosa* Planchon. In Munson's (1909) description of *V. blancoi* most of the attributed characters apply to both northern and southern plants, however, features such as small stipules and tiny flowers (see pistil length) are found only in the northern grapes (Table 1), and are characteristic of series *Cinerascentes*. The northern taxon differs from other members of series *Cinerascentes* by a syndrome of characters including: tomentose abaxial leaf surfaces, a general absence of short, straight trichomes on leaves and stems, entire leaf margins, U- or lyre-shaped basal sinuses, and relatively short fruit clusters (5.6–14.7 cm) It is the overall combination of characters that delimits this taxon, and the absence of one or two characters in an individual does not exclude it from the group.

TAXONOMIC TREATMENT

Vitis blancoi, as first published by Munson (1890a; 1890b), included plants from southern Mexico having large stipules (2–5 mm long) and relatively large fruit (6–13 mm dia.). This taxon initially named *V. leucobrya* by Munson, as evidenced by a specimen (*Munson s.n.* UF!) distributed in 1888, was later renamed *V. blancoi* as seen on a specimen from 1889 (*Munson s.n.* MO!). The binomial *V. leucobrya*, is not valid since it was never published; therefore *V. blancoi* is the correct name.

Munson's (1909) description of *V. blancoi* also included plants from northern Mexico and southern Texas having small stipules (1–3 mm long) and relatively small fruit (5.5–10.0 mm dia.). Planchon (1887) named this taxon *V. berlandieri* var. *tomentosa*. In view of the recent treatment (Moore 1992) of *V. berlandieri* as *V. cinerea* var. *helleri* (Bailey)Moore, and its intergradation with the northern group of plants treated by Munson as *V. blancoi* in the Del Rio, TX, area, this taxon should be treated as *V. cinerea* (Engelm. in Gray) Engelm. *ex* Millardet var. *tomentosa* (Planchon) Comeaux.

KEY TO SELECTED TAXA

1\. Stipules 2–5 mm long; pistils 1.5 mm long; southern Mexico ____________ **V. blancoi**
1\. Stipules 1–3 mm long; pistils 1.0 mm long; northern Mexico and United States ____________ **2**
    2\. Leaves tomentose on abaxial surfaces, entire to minutely toothed, basal sinuses U- or lyre-shaped; leaves and stems without short (0.2 mm long), straight, pointed trichomes; inflorescences (including peduncles) 5.6–14.7 cm long; stems nearly terete in cross section ____________ **V. cinerea** var. **tomentosa**
    2\. Leaves pubescent to glabrous on abaxial surfaces, toothed, basal sinuses V-shaped; stems with or without short, straight, pointed trichomes; inflorescences (including peduncles) 5.5–20 cm long; stems angular in cross section ____________ **3**
        3\. Leaves glabrous to glabrate on abaxial surfaces; berries glaucous ____________ **V. cinerea** var. **helleri**
        3\. Leaves pubescent on abaxial surfaces; berries glaucescent ____________ **V. cinerea** var. **cinerea**

Vitis blancoi Munson emend. Comeaux, Amer. Forests 3:374–375. 1890; USDA Pom. Bull. 3:13–14. 1890. TYPE: MEXICO. JALISCO: From the Sierra Madre Mountains 30 mi from Guadalajara, collected by Luciana Blanco, 1887, *Munson s.n.* (NEOTYPE, here designated: MO!).

Vines to 15 m, stems on current season growth typically tomentose (glabrous in certain individuals from high elevations) faintly striated; branchlets terete; internodes 2.3–10 cm long; nodes not encircled with red pigmentation; pith interrupted at nodes by a diaphgram 2–3 mm thick; lenticels absent; growing tips normally tomentose varying to pubescent, with white, tan or rufescent arachnoid trichomes, not enveloped by young leaves. Leaves cordiform to long-cordiform or nearly deltoid, usually 3-lobed, with lateral lobes acute to acuminate, infrequently divergent, apex acute to long-acuminate, base cordate to nearly truncate with the basal sinus varying from U-shaped, to V-shaped and also lyre-shaped, lateral sinuses acute; margins serrate to nearly entire, with teeth to 3 mm long (typically 2 mm long), occasionally ciliate, with veins frequently extending beyond the teeth, midrib with 5–8, usually 6 pairs of prominent veins; lamina glabrous to puberulent on adaxial surfaces, felted, tomentose to pubescent (puberulent on high elevation specimens from Morelos) on abaxial surfaces, with the pubescence consisting of mostly arachnoid trichomes, sometimes including simple, straight, pointed trichomes that are ordinarily confined to primary veins, 4.2–16.5 cm wide, 7.4–20.5 cm long; petioles tomentose to puberulent, 2.6–10.5 cm long; stipules clear to brown, especially at the base, sometimes obscured by dense pubescence, 0.5–1 mm wide, 2–5 mm long, caducous. Tendrils and inflorescences absent every third node, tendrils bifurcate or trifurcate, to 18 cm long. Inflorescences 2.2–9.5 cm long, peduncles 1.9–4.8 cm long, shoulder 2.3–3.5 cm long, sometimes absent or replaced by a tendril. Flowers of the functionally pistillate plants with pistils 1.5 mm long. Fruit a berry, black, glaucous, 7–13 mm in diameter, with a pleasant flavor when fully ripe. Seeds brown, pyriform, 3.0–6.0 mm long.

Distribution.—Widely distributed in the southern deciduous forests and the pine/evergreen oak forests (De Miranda 1989) of southern Mexico south of the twenty-second parallel, in the states of Colima, Guerrero, Jalisco, México, Michoacán, Morelos, Oaxaca, Puebla and San Luis Potosi. Typically found along streams and similar sites at high elevations (1,050–2,450 m).

Above description based on the following specimens: **MEXICO. Colima:** 2.6 km S of Jalisco state line via Hwy 55, 1,300 m, 29 Jun 1986, *Comeaux 4207* (BRIT); 23.7 km N jct. Hwy 55 to Manzanillo via toll Hwy 55 to Guadalajara, 1,150 m, 27 Jul 1991, *Comeaux 5074, 5075, 5076* (BRIT). **Guerrero:** 17.1 km W jct. Hwy 95 at Chilpancingo, 1,550 m, 18 Jul 1992, *Comeaux 5189* (BRIT); 18.9 km W jct. Hwy 95 at Chilpancingo, 1,500 m, 18 Jul 1992, *Comeaux 5190, 5191* (BRIT); 16 km S of Taxco via Hwy 23, 1,200 m, 18 Jul 1992, *Comeaux 5193* (BRIT); Mpio. Chilpancingo de los Bravos, a 28 km al W de Chilpancingo, 27 Mar 1982, *Martinez 226* (MEXU); Mpio. Cutzamala de Pinzon, 1 km al E de Ventarron, 17 Mar 1973, 600 m, *Medrano 5593* (UT); W of Chilpancingo, 21 Oct 1944, *Sharp 441413* (MEXU). **Jalisco:** Nevado de Colima, below La Joya, 2287 m, 20 Nov 1968, *Boutin* and *Brandt 2378* (MEXU); Mpio. of Autlan de Navarro, 2,160 m, 17 Aug 1980, *Breedlove 45741* (MEXU); 1 km N of Colima state line via old Hwy 44, 1,200 m, 27 Jul 1991, *Comeaux 5078* (BRIT); Charandas, Mazamitla, 2,400 m, 14 May 1972, *Luna 3176* (MEXU); Cerro Viego, vereda al de la Bola del Viego, Mpio. Jocotepec, 2,450 m, 24 Apr 1986, *Machua 550* (JAL); Cerro Viejo, cauce enfrente de Huejotitan, Mpio. Jocotepec, 2,050 m, 2 May 1986, *Machua 1000* (JAL); 6 km N de Huapala, Mpio. de Jilotlan, 1,390 m, 5 Apr 1988, *Mendoza 3708* (MEXU); 3 km al so de las Coloradas, Mpio. de Jilotlan, 1,720 m, 5 Apr 1988, *Mendoza 3730* (MEXU); Near Tecalitlan, 2,100 m, 2 Aug 1985, *Rodriquez* and *Rosa 167* (MEXU). **México:** Valle de Bravo, 25 May 1971, *Boege 1806* (MEXU); 9.8 km N of Guerrero state line via Hwy 55, 1,550 m, 18 Jul 1992, *Comeaux 5194* (BRIT); 10.7 km N of Guerrero state line via Hwy 55, 18 Jul 1992, *Comeaux 5195* (BRIT); N of Ixtapan on toll rd. 4.2 km S of jct. rd. to Villa Guerra, 2,000 m, 18 Jul 1992, *Comeaux 5196* (BRIT); N of Ixtapan on toll rd.

3.8 km S of jct. rd. to Villa Guerra, 2,100 m, 18 Jul 1992, *Comeaux 5197* and *5198* (BRIT); N of Ixtapan on toll rd. 1.6 km S jct. rd. to Villa Guerra, 2,300 m, 18 Jul 1992, *Comeaux 5199* (BRIT); N of Ixtapan on toll rd. 0.8 km S jct. rd. to Villa Guerra, 2,300 m, 18 Jul 1992, *Comeaux 5200* (BRIT); N of Ixtapan on toll rd. 1.0 km N jct. rd. to Villa Guerra, 2,300 m, 18 Jul 1992, *Comeaux 5201* (BRIT); Nepantla, 2,000 m, 17 May 1953, *Matuda 28368* (MEXU); Amatepec y cercanias, 2,000 m, 11–12 Apr 1954, *Matuda 30668* (MEXU). **Michoacán:** Rincon, 4 Apr 1909, *Arsene 3009* (MEXU); La Cascada, Testarazo, cerca de Tacambaro, 2,100 m, 28 May 1981, *Arguelles 1595* (MEXU); Cucuchucnu, Mpio. de Tzintzuntzan, 2,200 m, 23 Apr 1979, *Caballero 966* (MEXU); Mpio. de Quiroga, 24 Mar 1986, *Campos 911* (MEXU); 5 km E of Zitácuaro via Hwy 15, 2,000 m, 24 Jul 1991, *Comeaux 5046* (BRIT); 4.2 km E of Zitácuaro via Hwy 15, 2,000 m, 24 Jul 1991, *Comeaux 5047* (BRIT); 3.8 km E of Zitácuaro via Hwy 15, 2,000 m, 24 Jul 1991, *Comeaux 5048* (BRIT); 3.5 km E of Zitácuaro via Hwy 15, 2,000 m, 24 Jul 1991, *Comeaux 5049, 5050* (BRIT); 5.3 km W of Zitácuaro via Hwy 15, 2,000 m, 24 Jul 1991, *Comeaux 5051* (BRIT); 5.6 km W of Zitácuaro via Hwy 15, 1,950 m, 24 Jul 1991, *Comeaux 5052, 5053, 5054* (BRIT); 7.7 km W of Zitácuaro via Hwy 15, 1950 m, 24 Jul 1991, *Comeaux 5055* (BRIT); 25.8 km W of Zitácuaro via Hwy 15, 1,850 m, 24 Jul 1991, *Comeaux 5056* and *5057* (BRIT); 42 km W of Zitácuaro via Hwy 15, 2,000 m, 24 Jul 1991, *Comeaux 5058* (BRIT); 10.7 km W of Hidalgo via Hwy 15, 2,150 m, 25 Jul 1991, *Comeaux 5059, 5060* (BRIT); 10.8 km W of Hidalgo via Hwy 15, 2,150 m, 25 Jul 1991, *Comeaux 5061* (BRIT); 11.0 km W of Hidalgo via Hwy 15, 2,150 m, 25 Jul 1991, *Comeaux 5062* (BRIT); 25.9 km W of Hidalgo via Hwy 15, 2,300 m, 25 Jul 1991, *Comeaux 5063* (BRIT); 60.2 km W of Hidalgo via Hwy 15, 2,450 m, 25 Jul 1991, *Comeaux 5064* and *5065* (BRIT); 61.1 km W of Hidalgo via Hwy 15, 2,450 m, 25 Jul 1992, *Comeaux 5066* and *5067* (BRIT); 20.6 km E jct. Hwy 15 and 126/43 near Morelia, 2,400 m, 25 Jul 1991, *Comeaux 5068* (BRIT); 31.7 km E jct. Hwy 15 and 126/43 near Morelia, 2,300 m, 25 Jul 1991, *Comeaux 5069* (BRIT); 31.0 km E jct. Hwy 15 and 126/43, 2,300 m, 25 Jul 1991, *Comeaux 5070* (BRIT); 13.1 km E jct. Hwy 15 and 126/43, 2,000 m, 25 Jul 1991, *Comeaux 5071* (BRIT); 7.2 km E jct. Hwy 15 and 120, W of Morelia, 2,200 m, 26 Jul 1991, *Comeaux 5072* (BRIT); 32.8 km E of Zamora via Hwy 15, 2,000 m, 26 Jul 1991, *Comeaux 5073* (BRIT); Ladera Norte del Cerro El Cacique, zona 9, Mpio. Zitácuaro, 2,410 m, 11 Oct 1980, *Contreras 1214* (MEXU); Rincon, 2 Apr 1932, *Hinton 482* (MEXU); 2 km S de Villa Escalante, 27 May 1979, *Soto Nunez 1428* (MEXU); 16 km al E de Uruapan, 29 May 1979, *Soto Nunez 1445* (MEXU); 12 km E de Coalcoman, 28 Mar 1980, 1,675 m, *Soto Nunez 2157* (MEXU); En Turundeo, 6 km al NW de Tuxpan, carr. México-Morelia, 1,845 m, 3 Apr 1981, *Soto Nunez 2930* (MEXU); San Jose Purua, Mpio. de Jungapeo, 10 Mar 1984, *Soto Nunez 6231* (MEXU); Mpio. de Villa Madera, 2,240 m, 29 Apr 1979, *Zavala 206* (MEXU). **Morelos:** 1.1 km N jct. Hwy 95 and 115 near Tepoztlán, 2,200 m, 22 Jul 1991, *Comeaux 5033* and *5034* (BRIT); Base of mountain with temple at Tepoztlán, 1,500 m, 23 Jul 1991, *Comeaux 5035, 5036, 5037, 5038, 5039, 5044*, and *5045* (BRIT); 12.8 km S of Tepoztlán via Hwy 115, 1,450 m, 23 Jul 1991, *Comeaux 5040* (BRIT); NE of Tepoztlán ca. 3 km on dirt road, 23 Jul 1991, *Comeaux 5041* (BRIT); 1.3 km E of square at Tepoztlán, 1,450 m, 23 Jul 1991, *Comeaux 5042* and *5043* (BRIT); Cuernavaca, Nov 1941, *Mirand 1906* (MEXU); Mountainside above Cuernavaca, 3 Feb 1899, *Pringle s.n.* (MEXU); Sierra de Tepoxtlan, 2,287 m, 15 Mar?, *Pringle s.n.* (MEXU); Tepetixtla km 71 carr. México-Cauutla, Mpio. de Cauutla, 19 Mar 1978, *Sanchez 2142* (MEXU); Pedregal de Santa Maria, 1 Apr 1970, *Vazquez 2415* (MEXU); Barranca Santa Clara, N.O. de Acatlipa, 2 Apr 1971, *Vazquez 3100* (MEXU). **Oaxaca:** 19.5 km N of jct. Hwy 190 and 175 at Oaxaca, 1,700 m, 16 Jul 1992, *Comeaux 5180* (BRIT); 10 km NE Oaxaca, camino a Yxtlan, 4 Feb 1966, *Delgadillo 213* (MEXU); Dto. de Ixtlan, Sierra de Juarez, Ruta 175 a 1 km al N de Ixtlan de Juarez, 1,800 m, 18 Apr 1962, *Lorence 4067* (MEXU); 10 km S de Cuquila, carr. Tlaxiaco-Putla, Dto. de Tlaxiaco, 1,800 m, 8 Jun 1985, *Mendoza 1479* (MEXU); 4 km al W de. Vado, camino a San Sebastian de las Gratas, Dto. Sola de Vega, 6 Apr 1984, *Torres 4927* (MEXU). **Puebla:** Zacatlan, Feb 1943, *Bruff 1511* (MEXU); 1.4 km N of Puente Cantarranas II via Hwy 190 S of Atlixco, 1,850 m, 15 Jul 1992, *Comeaux 5171* (BRIT); At Puente Cantarranas II S of Atlixco, 1,850 m, 15 Jul 1992, *Comeaux 5172, 5173, 5174, 5175, 5176, 5177, 5178, 5179* (BRIT). **San Luis Potosi:** In Rio Verde, 50 m S of Hwy 70 along dirt rd. 0.2 km E of main blvd., 1,050 m, 28 Jun 1986, *Comeaux 4205* (BRIT); in Rio Verde, 2.9 km E jct. Hwy 69 and 70, 1,050 m, 19 Jul 1992, *Comeaux 5207* (BRIT).

Vitis cinerea (Engelm. in Gray) Engelm. ex Millardet var. **tomentosa** (Planchon) Comeaux, comb. nov. Basionym: *V. berlandieri* var. *tomentosa* Planchon, Compt. Rend. Hebd. Séances Acad. Sci. 91:425. 1880. Type: MEXICO. Nuevo León: Cerro de la Silla, Jun, 1834, *Berlandier 3116* (lectotype: WIS!; isolectotype: MO!).

Vines to 15 m, stems on current season growth tomentose to pubescent, rarely with bristle-like trichomes, branchlets nearly terete to faintly angular; internodes 3 10 cm long; nodes faintly banded to without red pigmentation; pith interrupted at the nodes by a diaphragm 2–3 mm thick; lenticels absent; growing tips tomentose, with white, arachnoid trichomes, not enveloped by young leaves. Leaves cordiform to long-cordiform, generally without lobes or less frequently 3-lobed, with lateral lobes acute, apex acute to acuminate, base cordate to nearly truncate with the basal sinus varying from mostly U-shaped, to lyre-shaped and also V-shaped, lateral sinues acute; margins mostly entire, occasionally with teeth to 3 mm long, with or without cilia; midrib with 4–7, usually 5 pairs of prominent veins; lamina glabrous to puberulant on adaxial surfaces, tomentose to pubescent on abaxial surfaces, with the pubescence consisting of mostly arachnoid trichomes, sometimes including simple, straight, pointed trichomes, 5.5–11.2 cm wide, 6.2–12.8 cm long; petioles tomentose to puberulent, 1.4–4.1 cm long; stipules brown, 0.5–1 mm wide, 1–3 mm long, caducous. Tendrils and inflorescences absent every third node, tendrils bifurcate or trifurcate, to 10 cm long. Inflorescences 4.0–11.0 cm long, peduncles 1.0–4.2 cm long, shoulder 1.0–5.0 cm long, sometimes absent or replaced by a tendril. Flowers of the functionally pistillate plants with pistils 1 mm long. Fruit a berry, black, glaucous, 5.5–10 mm in diameter, with a pleasant flavor when fully ripe. Seeds brown, pyriform, 3.5–5.5 mm long.

Commonly found along streams and other moist sites in the semiarid scrub and grasslands (De Miranda 1989) east of the Sierra Madre Oriental along the Rio Grande from the Del Rio, TX, area south to the Tropic of Cancer (120–1050 m. elev.) Individuals from the Del Rio area have characters intermediate between *V. cinerea* var. *helleri*, primarily from the Edwards Plateau region of Texas, and the more southerly distributed var. *tomentosa*. These intermediates establish the existence of clinal variation between the above varieties of *V. cinerea*.

Above description based on the following specimens: **MEXICO. Coahuila:** S edge of Morelos via Hwy 57, 16 Jun 1986, *Comeaux 4032* and *4033* (BRIT); 10.1 km N of Morelos via Hwy 57, 16 Jun 1986, *Comeaux 4034* (BRIT); 36.8 km N of Morelos via Hwy 57, 16 Jun 1986, *Comeaux 4035, 4036, 4037* and *4038* (BRIT); S of Acuna at 3.0 km S jct. Hwy 2 and 29, 17 Jun 1986, *Comeaux 4039* (BRIT); S of Acuna at 3.5 km S jct. Hwy 2 and 29, 17 Jun 1986, *Comeaux 4040* and *4041* (BRIT); S of Acuna at 23.0 km S jct. Hwy 2 and 29, 17 Jun 1986, *Comeaux 4042, 4043* and *4044* (BRIT); 27.2 km S jct. Hwy 2 and 29 in S. Juan de Sabina, 17 Jun 1986, *Comeaux 4045* (BRIT); 2.7 km N of Muzquiz via Hwy 53, 17 Jun 1986, *Comeaux 4046, 4047* and *4051* (BRIT); 10.7 km N of Muzquiz via Hwy 53 at river, 17 Jun 1986, *Comeaux 4048, 4049* and *4050* (BRIT). **Nuevo León:** 6.6 km E of Sabinas Hildago via Hwy 34, 16 Jun 1986, *Comeaux 4026, 4027* and *4028* (BRIT); 1.8 km W of Sabinas Hidalgo via Hwy 34, 16 Jun 1986, *Comeaux 4029* (BRIT); 21.1 km W of Sabinas Hidalgo via Hwy 29, 16 Jun 1986, *Comeaux 4030* (BRIT); 22.1 km W of Sabinas Hidalgo via Hwy 29, 16 Jun 1986, *Comeaux 4031* (BRIT); Monterey, 25.0 km N jct. Hwy 85 and rd. to Santiago, 18 Jun 1986, *Comeaux 4052* and *4053* (BRIT); S of Monterey at 2.2 km N jct. Hwy 85 and rd. to Santiago, 18 Jun 1986, *Comeaux 4054* and *4055* (BRIT); at river 19.2 km N of Montemorelos via Hwy 85, 18 Jun 1986, *Comeaux 4056* (BRIT); 1.1 km N of Montemorelos via Hwy 85, 18 Jun 1986, *Comeaux 4057, 4058* and *4059* (BRIT); 3.2 km S of Montemorelos via Hwy 85, 18 Jun 1986, *Comeaux 4060* (BRIT); 37.3 km S of Montemorelos via Hwy 85, 18 Jun 1986, *Comeaux 4061* (BRIT); 3.5 km N of Linares via Hwy 85, 18 Jun 1986, *Comeaux 4062* (BRIT); 27.5 km N of Montemorelos via Hwy 35, 29 Sep 1987, *Comeaux 4946* (BRIT); 20.5 km N of Montemorelos via Hwy 35, 29 Sep 1987, *Comeaux 4947* (BRIT); 19.4 km N of Montemorelos via Hwy 35, 29 Sep 1987, *Comeaux 4948* (BRIT); 24.2 km N of Linares via Hwy 85, 29 Sep 1987, *Comeaux 4949* (BRIT); 5.0 km W of Iturbide via Hwy 58, 5 Oct 1990, *Comeaux 4975* (BRIT); 2.4 km E of Iturbide via Hwy 58, 5 Oct 1990, *Comeaux 4976* (BRIT); 5.4 km E of Iturbide via Hwy 58, 5 Oct 1990, *Comeaux 4977* (BRIT); 9.4 km E of Iturbide via Hwy 58, 5 Oct 1990, *Comeaux 4978* (BRIT); 12.6 km E of Iturbide via Hwy 58, 5 Oct. 1990, *Comeaux 4979* (BRIT); 7.8 km W of jct. rd. to Horsetail Falls and Hwy 85, 950 m, 22 May 1991, *Comeaux 5001* (BRIT); 8.8 km W of jct. rd. to Horsetail Falls and Hwy 85, 1050 m, 22 May 1991, *Comeaux 5002* and *5003* (BRIT); 5.6 km E of jct. of rd. to Casacade de Chipitin and rd. to Horsetail Falls from Hwy 85, 850 m, 22 May 1991, *Comeaux 5004* (BRIT); 9.4 km N of bridge at General Teran via Hwy 35, 275 m, 11 Jul 1992, *Comeaux 5154* (BRIT); 1.0 km S of bridge at General Teran via Hwy 85, 275 m, 11 Jul 1992, *Comeaux 5155* (BRIT); 13.0 km N of bridge at Linnares via Hwy 85, 275 m, 11 Jul 1992, *Comeaux 5156* (BRIT); 4.8 km NW of General Teran, Hacienda San Pedro, 21 Apr. 1962, *Ruiz 63* (TAMU). **Tamaulipas:** 31.4 km N of Rio Corona near Hwy 85, 19 Jun 1986, *Comeaux 4063* and *4064* (BRIT); 18.1 km N of Rio Corona via Hwy 85, 19 Jun 1986, *Comeaux 4065* (BRIT); At Rio Corona jct. Hwy 85, 19 Jun 1986, *Comeaux 4066* (BRIT); 21.9 km N of Tropic of Cancer via Hwy 85, 19 Jun 1986, *Comeaux 4067* (BRIT); 5.6 km N of Rio Purificacion via Hwy 85, 29 Sep 1986, *Comeaux 4950* (BRIT); 0.3 km S of Rio Purificacion via Hwy 85, 29 Jun 1990, *Comeaux 4951* (BRIT); 10.9 km N of Tropic of Cancer via Hwy 180, 120 m, 5 May 1991, *Comeaux 4980* and *4981* (BRIT).

U.S.A. TEXAS. Maverick Co.: 1.6 km S of Quemado via Hwy 277, 275 m, 21 May 1986, *Comeaux 3861* and *3863* (BRIT). **Val Verde Co.:** Del Rio, near Val Verde Winery, 300 m, 21 May 1986, *Comeaux 3864, 3865, 3866, 3867, 3868, 3869* and *3870* (BRIT); San Felipe Country Club, Del Rio, 8 May 1943, *Cory 41717* (UT).

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BOOK REVIEW

Brent Berlin. 1992. **Ethnobiological Classification: Principles of Categorizationof Plants and Animals in Traditional Societies.** (ISBN 0-691-09469-1, hbk.). Princeton University Press, 41 William Street, Princeton, New Jersey 08540, U.S.A. $29.00. Illustrated with b&w line drawings.

As more and more anthropology and biology departments begin to collaborate and ethnobiology becomes a bona fide program, it's hard to imagine *Ethnobiological Classification* not being an essential text. It is because of this book, and the debates it sparked, that folk biological taxonomies have become such a hot topic for a better part of the nineties and worthy of so much further investigation in the coming millennium. It is fitting that one of the nation's leading ethnobiology programs, the University of Georgia, Athens, is run by the author and his wife, Elois.

Divided into two major parts, "Plan" and "Process," Berlin discusses the foundations of ethnobiological classification inferred from an analysis of descriptions of individual systems and the underlying processes involved in the functioning and evolution of ethnobiological systems in general. Essentially this book is a revision and summary of the many articles Berlin co-authored with Dennis Breedlove and Peter Raven in the late sixties and the articles he continued to publish on his own throughout the 70s, 80s and 90s. These articles lead many more budding ethnobiologists to chime in on the issue. Eugene Hunn, Cecil Brown, Terence Hays, to name a few, either agreed, disagreed, or agreed to disagree with Berlin. This debate contributed a great deal to the overall knowledge of ethnobiological classification and theory. It is only when such topics become thoroughly researched and continually challenged that the essence of the subject is revealed and worthy of inclusion in a college program.

Part one is divided into four chapters, discussing the "Making of a Comparative Ethnobiology," "The Primacy of Generic Taxa in Ethnobiological Classification," "The Nature of Specific Taxa," and "Natural and Not So Natural Higher Order Categories." Berlin tackles the essentials of the folk classification debate, intellectualists and utilitarian approaches, the changing data presentation as a reflection of a changing theory, perceptual salience, general nomenclatural properties of specific taxa, and folk taxonomic ranking to name a few. Part two comes in 3 chapters: "Patterned Variation in Ethnobiological Knowledge," "The Nonarbitrariness of Ethnobiological Nomenclature," and "The Substance and Evolution of Ethnobiological Categories." This is where the book becomes more than just a book on ethnobiological classification, but a book that asks further questions and challenges those anthropologists who see reality as a "set of culturally constructed, often unique and idiosyncratic images, little constrained by the parameters of an outside world." Berlin looks for variation in the patterns of ethnobiological knowledge and the biological ranges of Folk Taxa, discusses experiments on sound symbolism, and the typological speculations on the evolution of ethnobiological categories. The book ends with a proper bibliography, author index, indices of scientific and ethnobiological names, and a general subject index.

From a student's perspective the best thing I can say about the book is that it pushed me into the library and taught me an essential lesson in research, that often the most important part of an article is its bibliography. Not only did I get the necessary background on ethnobiological classification theories, I also looked further and began to understand the questions Berlin was tackling and started asking my own. But, his thorough citations of the articles that challenged and/or corroborated with his ideas made research both enjoyable, but perhaps more importantly, comprehensive. I wasn't left with one guy's theory on ethnobiological classification, I got the full debate.—*Kevin D. Janni.*

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BOLBITIS THOMMANKUTHIANA (LOMARIOPSIDACEAE), A NEW SPECIES OF FERN FROM INDIA

Santhosh Nampy

Department of Botany
St. Joseph's College
Kozhikode, Kerala 673 008, INDIA

ABSTRACT

Bolbitis thommankuthiana, a new species of fern from Kerala, India, is described.

Key words: Lomariopsidaceae, *Bolbitis thommankuthiana*, India, Ferns, Pteridophyta.

RESUMEN

Se describe *Bolbitis thommankuthiana*, una nueva especie de helecho de Kerala, India.

INTRODUCTION

In his monograph of the genus *Bolbitis* Schott, Hennipman (1977) recognized 44 species and 13 hybrids. Since that time, 17 new taxa have been described, including two from Kerala (Manickam & Irudayaraj 1992; Nayar & Geevarghese 1993). During recent floristic explorations in the Western Ghats of Kerala, I encountered an interesting population of plants growing on exposed wet boulders and rocks in streams at an elevation of 400 m. Since this material does not agree with descriptions of any of the known species of *Bolbitis*, it is described here as new.

Bolbitis thommankuthiana Nampy, sp. nov. (**Figs. 1, 2**). Type: INDIA. Kerala. Idukki Dt.: Thommankuthu, alt. 400 m, 26 Dec 1996, *Nampy S 426* (holotype: CALI; isotype: K).

Bolbitis thommankuthiana, *B. semicordata* affinis, sed ab ea statu minore, squamis rhizomatis clathratis distincte bicoloribus, rhachidi late alata, alis ad rhizoma extendentibus, sporis fuscioribus exina dense plicata, bulbillis foliaribus nullis facile distinguenda.

Plants 10–13 cm tall. Rhizome 1.5–2 mm thick, short-creeping, sclerenchyma strands 2–4, without circumvascular sheath. Rhizome scales ovate-lanceolate, pseudo-peltate, gradually tapering to a glandular apex, bicolorous, central cells blackish, margin pale, glandular. Fronds clustered, dimorphic, pinnate, scaly along the stipe and occasionally the costa. Sterile fronds 6–13 cm long, 2.2–3 cm broad, pinnae 4–6 pairs; terminal pinna conform with the lateral pinnae. Stipe 2–3.5 cm with wings ca. 1mm wide. Pinnae sub-opposite to alternate, 1–2.3 × 0.5–0.7 cm, 2.5 cm apart, acroscopic side broadly cuneate, basiscopic side narrowly cuneate, herbaceous, apex blunt to acute, margin shallowly lobed with short setae; lacking foliar bulbils; veins anastomosing to form a row of costal areoles, extra costal free veins present. Fertile fronds to 10.5 cm long, pinnae acrostichoid, 4–7 mm long. Sporangium 261 × 226 µm. Annulus 13 or 14 celled. Spores monolete, bilateral, 41 × 31 µm, dark with densely folded exine.

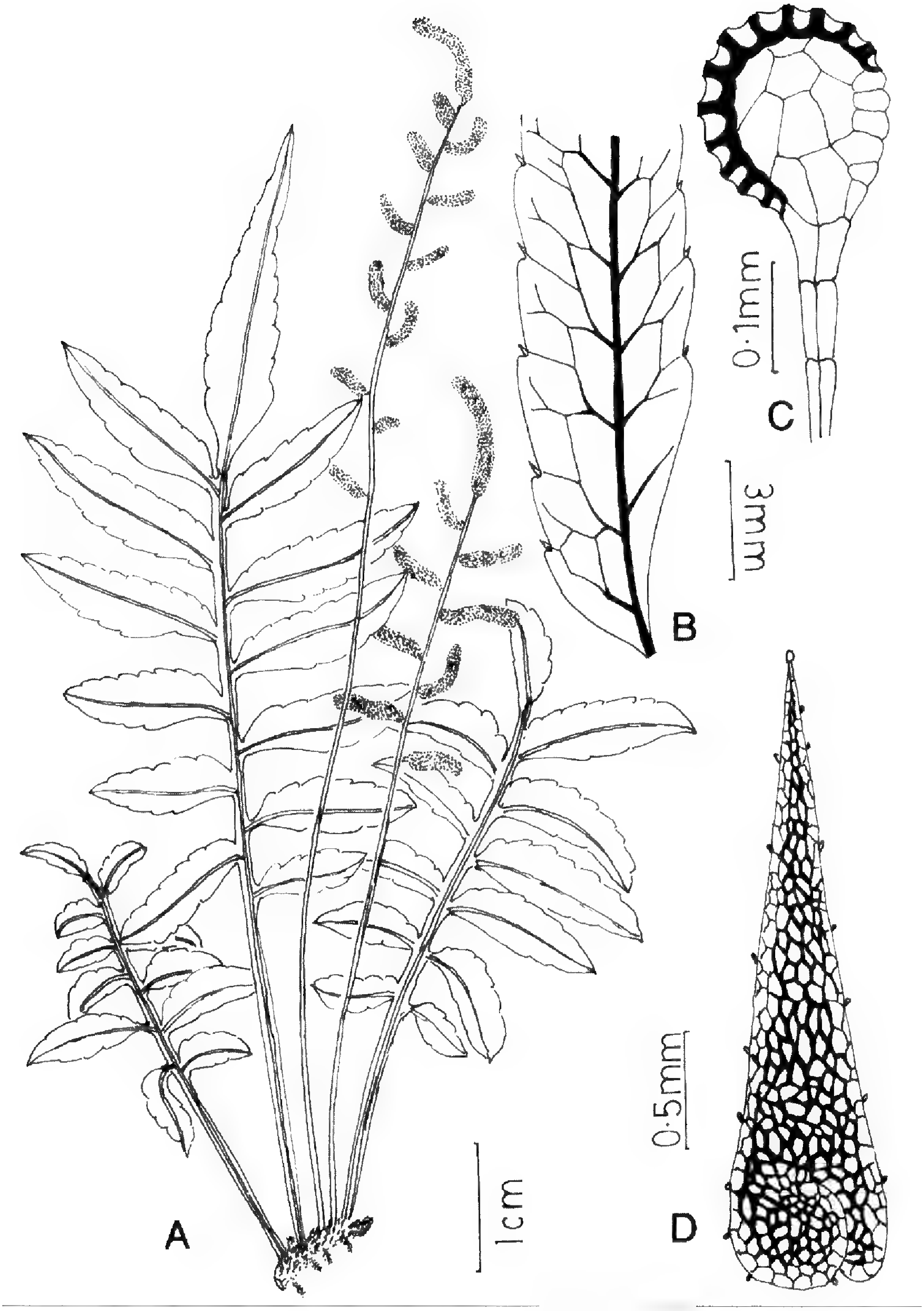

Fig. 1. *Bolbitis thommankuthiana* Nampy. A. Habit; B. Venation; C. Sporangium; D. Rhizome Scale.

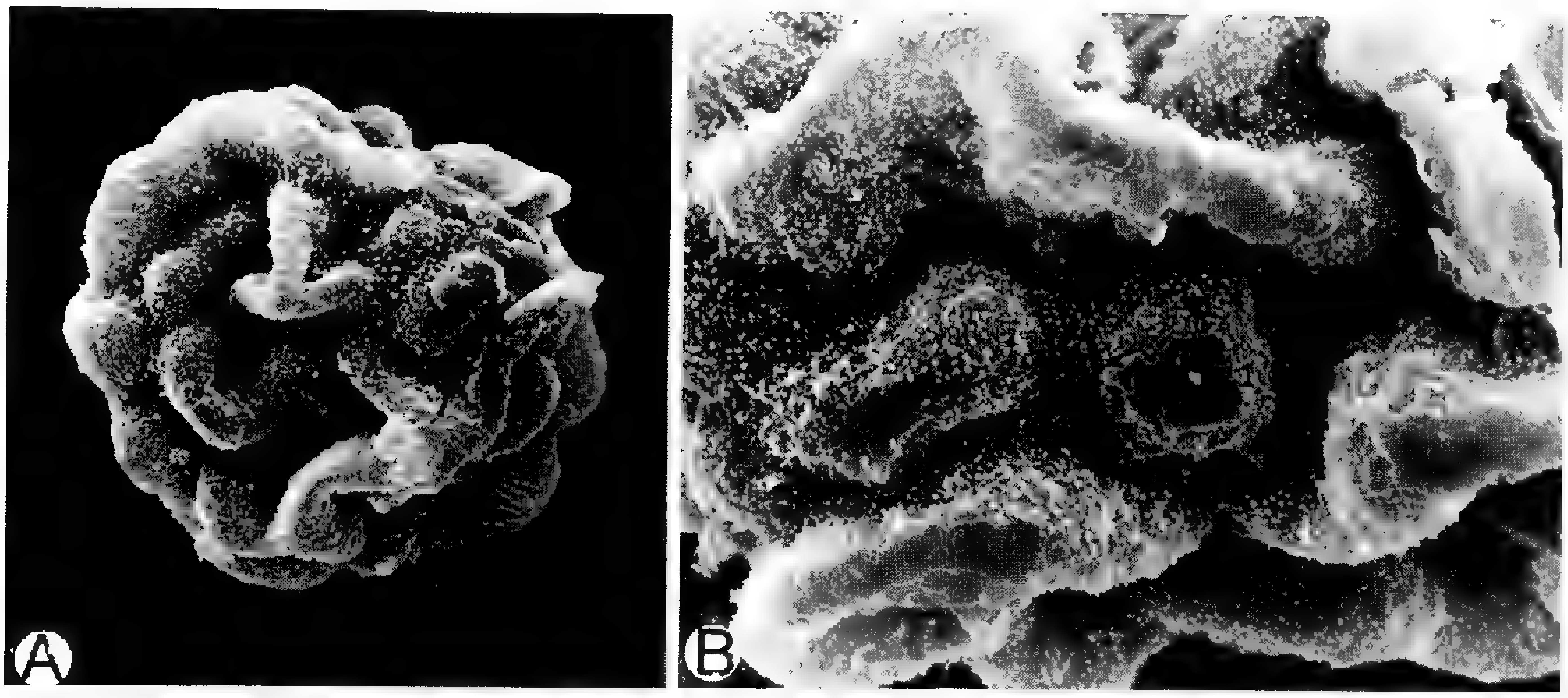

Fig. 2. SEM photograph of the spore of *Bolbitis thommankuthiana* Nampy. A. Spore x 2000; B. Detail of perispore x 5000.

Etymology.—The species is named after the type locality Thommankuthu, a water fall at an elevation of 400 m in wet evergreen forests of Kerala.

Distribution and habitat.—Known only from three localities in the Western Ghats of Kerala, usually found growing on boulders and rocks in streams.

Additional specimens examined: **INDIA. KERALA. Idukki Dt**.: Thommankuthu, 1 Jan 1995, *Nampy S 75* (CALI). **Kozhikode Dt**.: Vellarimala, 11 Aug 1995, *Nampy S 74* (CALI). **Pathanamthitta Dt**.: Kulathupuzha, 29 Nov 1974, *Shyamala CU 9366* (CALI).

Notes.—*Bolbitis thommankuthiana* is closely allied to *B. semicordata* but can readily be distinguished by its smaller size, broadly winged rachis, the wings extending to the rhizome and complete absence of foliar bulbils. In *B. semicordata* the plants are 15–70 cm tall, wings usually below 0.5 mm, which are not extending to the rhizome and with foliar bulbils. I have examined the type of B. semicordata (K) as well as other material of this species and found that these two species are not connected by any intermediates.

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BOOK REVIEW

H. Resit Akçakaya, Mark A. Burgman, and Lev R. Ginzburg. 1999 **Applied Population Ecology.** (ISBN 0-87893-028-0, pbk. and CD-ROM), Sinauer Associates, Inc. 23 Plumtree Road, Sunderland, MA 01375, U.S.A. (*publish@sinauer.com*). $41.95. 280 pages/64 illustrations, text with CD-ROM).

This book is designed to be used as a text for undergraduates studying biology, wildlife or natural resource management, or environmental science. It functions with the RAMAS® EcoLab 2.0 software, which is provided with the book on a CD-ROM. Its "aim is to teach quantitative methods that are necessary to develop a basic understanding and intuition about ecological processes, without intimidating or discouraging students who do not have extensive mathematical backgrounds." The aim has certainly been achieved.

The book is divided into 8 chapters, including: 1) Population Growth, 2) Variation, 3) Population Regulation, 4) Age Structure, 5) Stage Structure, 6) Metapopulations and Spatial Structure, 7) Population Viability Analysis, and 8) Decision-Making and Natural Resource Management. Each chapter includes the introduction of several major concepts, discussions of each, followed by exercises and further reading. The information is very clearly presented and richly illustrated with tables and figures. The exercises, using the RAMAS Ecolab, provide students with the opportunity for data manipulation and analysis, and will be useful when they need to set up their own models based on data they have collected.

This textbook, concomitant with its CD-ROM, provides a powerful package that will make any population biology course relevant to everyday situations a practicing biologist must face. It provides not only tools to facilitate mastery of the course material, but that will also serve as a framework upon which students can formulate their own hypoethical models and test them using actual population data. I was particularly impressed with the chapter on metapopulations, which are precisely the most common phenomenon botanists face when designing and sighting Integrated Conservation and Development sites. While the text does not address the novel molecular approaches to conservation of infraspecific genetic diversity, the text's success thus far ensures that it will have another edition, where we fully expect to find that additional element. Other than that one oversight, I find the book to be complete, clearly presented and certainly a bargain given the long-term utility of the software provided on the CD ROM. I unhesitatingly recommend it to all who must teach a population biology course.—*John J. Pipoly III, Botanical Research Institute of Texas.*

A NEW COMBINATION FOR *SARCOSTEMMA CYNANCHOIDES* VAR. *HARTWEGII* (ASCLEPIADACEAE)

Alexander Krings[1]

Zilker Botanical Garden
2220 Barton Springs Rd.
Austin, TX 78746, U.S.A.

In order to validate names for a checklist of the vines of the Chihuahuan desert, a new combination for a taxon traditionally placed in *Sarcostemma* R. Br. (Correll & Johnston 1979; Kartesz 1994) is proposed. Recent cladistic analyses by Liede (1996) failed to support the monophyly of *Sarcostemma* sensu Holm (1950), instead showing support for the monophyly of genera as circumscribed by Schlechter (1914). Based on her analyses, Liede (1996) suggested, among other circumscriptions, that *Sarcostemma* be restricted to the non-campanulate Old World taxa and that *Funastrum* E. Fourn. should apply to the non-campanulate New World taxa. The taxon in question, *Sarcostemma cynanchoides* Decne. var. *hartwegii* (Vail) Shinners, was originally described as *Sarcostemma lineare* Decne. in 1840. However, the existence of an earlier homonym, *Sarcostemma lineare* Spreng., 1822, (based on a Venezuelan collection), required the use of another name for the Mexican taxon. Although once employed through widespread misapplication, Holm (1950) notes that the name *Sarcostemma heterophyllum* Torr. is unavailable for the subspecific taxon of *Sarcostemma cynanchoides* as the type (*Wright 1679*, New Mexico, USA) is *Sarcostemma crispum* Benth. Holm (1950) decided to employ the epithet "hartwegii" rather than create a new name. Thus, the name *Philibertella hartwegii* Vail—validly published in 1897, based on the same collection as the 1840 Decaisne name (*Hartweg 217*, León, Mexico)—is the appropriate basionym of the most recently used names, *Sarcostemma cynanchoides* var. *hartwegii* (Vail) Shinners and *Sarcostemma cynanchoides* ssp. *hartwegii* (Vail) R.W. Holm, as well as the proposed, new combination:

Funastrum cynanchoides (Decne.) Schltr. var. **hartwegii** (Vail) Krings, comb. nov. *Philibertella hartwegii* Vail, Bull. Torrey Bot. Club 24:308. 1897. TYPE: MEXICO. LEÓN: *Hartweg 217*, 1839 (NY). *Funastrum hartwegii* (Vail) Scnltr., Repert. Spec. Nov. Regni Veg. 13:285. 1914. *Sarcostemma cynanchoides* Decne. var. *hartwegii* (Vail) Shinners, Sida 1:361. 1964. *Sarcostemma cynanchoides* Decne. ssp. *hartwegii* (Vail) R.W. Holm, Ann. Missouri Bot. Gard. 37:530. 1950. *Sarcostemma lineare* Decne. in Benth., Pl. Hartw. 25. 1840 (non Spreng. 1822).

Distribution.—Funastrum cynanchoides var. *hartwegii* occurs between 30–1500 m in dry, sandy, or gravelly soil in Trans-Pecos Texas, New Mexico, Arizona, and Utah, as well as the Mexican states of Baja California Norte, Baja Califonia Sur, Chihuahua, Coahuila, Durango, Guanajuato, Jalisco, Querétaro, Sinaloa, Sonora, and Zacatecas.

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[1] Current address: Herbarium, Department of Botany, North Carolina State University, Campus Box 7612, Raleigh, NC 27695-7612, U.S.A.

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RHYNCHOSPORA LEPTOCARPA (CYPERACEAE), AN OVERLOOKED SPECIES OF THE SOUTHEASTERN UNITED STATES

Bruce A. Sorrie

3076 Niagra-Carthage Road
Whispering Pines, NC 28327, U.S.A.

ABSTRACT

Based on morphological analysis, *Rhynchospora leptocarpa*, long synonymized under *R. capitellata*, is reinstated as a distinct species. Although clearly related to the latter, *R. leptocarpa* differs in a number of mensural and qualitative characters. Furthermore, its distribution is confined to the southern coastal plain and it inhabits a narrow range of plant communities, very unlike those of *R. capitellata*. Based on the relative ease of finding *R. leptocarpa* in suitable habitat, it is believed not to be rare, but merely overlooked.

RESUMEN

En base a análisis morfológicos *Rhynchospora leptocarpa*, que fue sinonimizada a *R. capitellata*, se vuelve a considerar como una especie diferente. Aunque claramente relacionada con esta última, *R. leptocarpa* difiere en cierto número de caracteres cuantitativos y cualitativos. Además, su distribución está confinada al sur de la llanura costera y vive en un número restringido de comunidades vegetales, muy diferentes de las de *R. capitellata*. Debido a lo fácil que es encontrar *R. leptocarpa* en los hábitats adecuados, se cree que no es rara, sino que simplemente ha sido ignorada.

INTRODUCTION

Rhynchospora leptocarpa (Chapm. ex Britt.) Small was first recognized as a distinct entity by A.W. Chapman, longtime resident of the Florida panhandle and author of Flora of the Southern United States (Chapman 1860, 1883, 1897). Curiously, Chapman did not publish the name, although he had prepared a manuscript (fide Britton 1892). In the three editions of his Flora, Chapman does not mention this entity. In 1892 Britton published it as *R. glomerata* (L.) Vahl var. *leptocarpa* Chapm. and ascribed to it a range of South Carolina, Florida, and Alabama. Later, Blake (1918) unraveled the *R. glomerata* tangle by splitting off the generally more northern *R. capitellata* (Michx.) Vahl from the more southern *R. glomerata*. Blake treated the entity as *R. capitellata* var. *leptocarpa* (Chapm. ex Britt.) Blake and provided a brief Latin diagnosis. Blake gave its range as Virginia to Florida and Mississippi. In the second edition of his Flora, Small (1933) raised it to full species status (without explanataion or discussion) and provided the only complete English description available. Small gave its range as South Carolina to Florida and Mississippi. In her monograph of the section *Eurhynchospora*, Gale (1944) reduced it not to varietal status, but to complete synonymy under *R. capitellata*. Although she treated two other botanical forms of *R. capitellata*, Gale omitted any discussion of taxon *leptocarpa*, possibly due to the paucity of known specimens at that time.

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Subsequent authors, most notably Clewell (1985), Godfrey and Wooten (1979), Jones and Coile (1988), Kartesz (1994), Radford et al. (1968), and Wunderlin (1998), do not recognize *R. leptocarpa* at any level. None of the state Natural Heritage Programs within the range of *R. leptocarpa* recognizes it or lists it as rare, except for North Carolina. The only references to *Rhynchospora leptocarpa* in the past half century are those of Anderson (1995) and Sorrie et al. (1997). Anderson collected specimens in the Florida panhandle and treated *leptocarpa* at the species level, but suggested that the *R. capitellata* complex needed further study. Robert Kral (pers. comm.) also has suggested that *R. leptocarpa* may warrant renewed status.

My attention was first brought to the problem by Julia Larke, who collected plants in 1992 on Fort Bragg Military Reservation, North Carolina, as part of a rare species survey. Although these plants keyed cleanly in Godfrey and Wooten (1979) and Gale (1944), her plants did not closely resemble plants I knew from New England as *R. capitellata*. Field and herbarium studies over the past seven years have convinced me that the two are distinct species.

MATERIALS AND METHODS

Specimens of *Rhynchospora leptocarpa* were collected in the field during the course of botanical survey work in Alabama, Florida, Mississippi, and North Carolina. These have been supplemented by specimens examined at the following herbaria: DUKE, FLAS, FSU, GA, GH, IBE, NCSC, NCU, SWSL, US, USA, VDB. From across the range of each species, five achenes from each of 10 plants were measured. Measurements were made of the following achene characters: length of achene body, tubercle length, and length of perianth bristles relative to tubercle (e.g., the length that the bristles exceed the tip of the tubercle). Measurements were also made of the width of spikelet clusters (n = 50). Counts were made of the number of spikelet clusters per culm and the number of glomerules per inflorescence node (n = 50).

Notes on habitat were made at over 40 sites in the field, supplemented by herbarium label data. Range maps were prepared from available literature, atlases, herbarium specimens, and field work.

Herbarium acronyms follow Holmgren et al. (1990), except "bas" (personal herbarium of Bruce A. Sorrie).

RESULTS AND DISCUSSION

Distinguishing characters

Mensural data are presented in Table 1. These data suggest that *Rhynchospora leptocarpa* differs from *R. capitellata* in at least four important ways.

1) Number of spikelet clusters per culm.—*Rhynchospora leptocarpa* possesses 5–8 clusters per culm, occasionally 4; *R. capitellata* possesses 3–5, rarely 6.

2) Glomerule width.—Each spikelet cluster is composed of 1–3 head-like glomerules, which are much broader in *R. capitellata*. In addition, glomerules of *R. leptocarpa*

Table 1. Comparison of selected characters of *Rhynchospora leptocarpa* and *R. capitellata*, based on 50 counts or measurements. Measurements in millimeters.

Character	***R. leptocarpa***	***R. capitellata***
number of spikelet clusters per culm	4–8 ($\bar{X}$=6.2)	3–5 ($\bar{X}$=4.1)
glomerule width	4–8 ($\bar{X}$=6.8)	6–13 ($\bar{X}$=9.1)
achene body length	1.6–1.8 ($\bar{X}$=1.7)	1.4–1.8 ($\bar{X}$=1.6)
tubercle length	0.8–1.1 ($\bar{X}$=1.0)	0.9–1.4 (–1.6) ($\bar{X}$=1.1)
ratio of achene body/ tubercle length	1.75	1.45
longest bristle relative to tip of tubercle	bristle exceeds tip by 0.3–1.0 mm ($\bar{X}$=0.8 mm longer)	bristle varies from shorter than tip (0.4 mm) to longer (0.3 mm) ($\bar{X}$=0.05 mm shorter)

assume a turbinate shape, rather than the broadly ovoid to hemispherical shape of *R. capitellata*.

3) Achene body and tubercle length. —Although the combined length of body and tubercle is similar in the two species, the proportions differ. Body length of *R. leptocarpa* averages longer than *capitellata*, but tubercle length averages shorter.

4) Bristle length.—A striking feature of *R. leptocarpa* is that the bristles always exceed the tubercle (in rare instances, one of the six bristles may be equal or slightly shorter). Moreover, the longest bristle usually exceeds the tubercle by at least 0.5 mm. In *R. capitellata*, bristles normally are slightly shorter than the tubercle, but the longest bristle may exceed it by 0.2 or even 0.3 mm.

There are qualitative characters which also serve to distinguish the two species. The first three are strikingly different and will facilitate field identification.

1)—Plants of *R. leptocarpa* form dense tussocks, from which radiate many lazy culms (prostrate to ascending). This habit of the culms appears to be a constant feature, independent of flooding or fire events (pers. obs.). By contrast, *R. capitellata*, although more-or-less cespitose, does not form dense tussocks and the relatively few culms are erect to strongly ascending. Anderson (1995) reports 30–40 culms for *R. leptocarpa* in Florida, and I have occasionally noted similar numbers in North Carolina, but my sense is that 15–30 is the norm. Herbarium specimens almost invariably consist of a lesser number of culms, because whole plants are rarely collected.

2)—Foliage and culms of *R. leptocarpa* are light green, often glaucescent; those of *R. capitellata* are medium to dark green. These differences are retained in dried specimens and seem to be independent of light levels. For example, *R. leptocarpa* growing in clearings created by logging or military activity show the same pale coloration as those growing in shade. Similarly, *R. capitellata* retains the same dark coloration in dense alder thickets as when growing in open sites (pers. obs.).

3)—Spikelet clusters of *R. leptocarpa* are pale brown; those of *R. capitellata* are dark brown.

4)—Number of glomerules per spikelet cluster. In *R. leptocarpa*, glomerules occur singly or in pairs at intervals along the culm; in *R. capitellata*, glomerules are paired or tripled–there clearly are 2–3 "heads", arising from separate or branched stalks. Combined with greater glomerule width, the overall effect is to give *R. capitellata* a very much broader look to the clusters.

5)—Mature achene color is pale brown with a pale central bulge (umbo) in *R. leptocarpa*; dark brown with a more contrasting pale bulge in *R. capitellata*.

6)—The base of the achene narrows into a shorter stipe in *R. leptocarpa* than in *R. capitellata*, as depicted by Blake (1918).

Habitat

The widespread *Rhynchospora capitellata* occupies a broad range of moist to wet, mostly open habitats, from moist meadows to wet marshes, creek banks, pond and lake shores, beaver ponds, peat bogs, and roadside ditches. By contrast, *R. leptocarpa* is very limited in its habitat preference, occurring almost exclusively in sphagnous streamhead communities within longleaf pine ecosystems. These communities receive water from seepage which discharges from adjacent uplands and form the head ends and upper portions of drainage creeks. In the Carolinas, they are termed "streamhead pocosins," due to the density of shrubs in them. Farther south and on the Gulf Coastal Plain, they are called "baygalls," due to the presence of "bay" species: sweet bay, *Magnolia virginiana* L.; red bay, *Persea palustris* (Raf.) Sarg.; loblolly bay, *Gordonia lasianthus* (L.) Ellis. When embedded in a mesic ravine, as occurs frequently on the Gulf Coastal Plain, the baygall community is called a "steephead." All of these habitats are typically forested, but the narrowness of such streamheads normally allows for filtered sunlight to penetrate from the sides. There, *R. leptocarpa* occurs in the semi-shade of trees and tall shrubs, and especially in small openings created by blowdowns, fire, animal trails, and human disturbance. Downstream, where flooding becomes too frequent or of long duration, *R. leptocarpa* is absent. Table 2 lists common associates at streamhead sites.

In addition, *Rhynchospora leptocarpa* occasionally inhabits sphagnous margins of beaver ponds and human impoundments, especially where tributaries enter. One specimen from southern Mobile County, Alabama, was collected from a "pitcher plant bog," presumably from the edge where such bogs typically grade into streamheads. Anderson (1995) reports *R. leptocarpa* from the upper edge of a tidal marsh in panhandle Florida; it is the only record from a near-maritime habitat.

Range

Rhynchospora capitellata is a wide-ranging species of the northeastern United States and southeastern Canada. Figure 1 portrays this range, with emphasis on the southern margins. *Rhynchospora capitellata* is common southward through the montane and plateau regions of the Carolinas, north Georgia, Tennessee, northeastern Alabama, southern

Table 2. Common associates of *Rhynchospora leptocarpa* in streamhead habitats. Species are listed alphabetically within each group, not according to frequency.

TREES

Acer rubrum L.
Chamaecyparis thyoides (L.) B.S.P.
Ilex opaca Aiton
Liriodendron tulipifera L.
Magnolia virginiana L.
Nyssa biflora Walter
Persea palustris (Raf.) Sarg.
Pinus elliottii Engelm. var. *elliottii*
Pinus serotina Michx.

SHRUBS AND VINES

Clethra alnifolia L.
Cliftonia monophylla (Lam.) Britton ex Sarg.
Cyrilla racemiflora L.
Ilex coriacea (Pursh) Chapman
Illicium floridanum Ellis
Leucothoe racemosa (L.) Gray
Lyonia lucida (Lam.) K. Koch
Myrica heterophylla Raf.
Rhododendron viscosum (L.) Torrey
Smilax laurifolia L.
Toxicodendron vernix (L.) Kuntze
Vaccinium formosum H.C. Andrews
Viburnum nudum L.

HERBS

Arundinaria tecta (Walter) Muhl.
Carex collinsii Nutt.
Eriocaulon decangulare L.
Mayaca fluviatilis Aubl.
Osmunda cinnamomea L.
Panicum lucidum Ashe
Peltandra sagittifolia (Michx.) Morong
Pinguicula primuliflora Wood & Godfrey
Platanthera clavellata (Michx.) Luer
Rhynchospora chalarocephala Fern. & Gale
Rhynchospora gracilenta Gray
Rhynchospora stenophylla Chapman
Sphagnum sp.
Viola primulifolia L.
Woodwardia areolata (L.) T. Moore

Missouri, and Arkansas. However, it abruptly becomes rare southward and is absent from the rest of the southern Atlantic and East Gulf Coastal Plains.

In southern Arkansas, *R. capitellata* appears to be fairly common (Smith 1988), but I question whether all spcimens are correctly identified, since three specimens have recently been annotated to *R. glomerata*: Bradley Co., *Demaree 24539* (NCU); Hempstead Co., *Demaree 54102* (NCU); Pulaski Co., *Merrill 183* (GH).

In Louisiana, Thomas and Allen (1993) map *R. capitellata* in five parishes, but two cited specimens are actually *R. glomerata*: Natchitoches Parish, *Thomas 72521* (NLU); Rapides Parish, *Thomas 40834* (NLU). In addition, specimens from Grant, Morehouse, Ouachita, Rapides, Sabine, and Vernon parishes (FSU, NCU, NLU) prove not to be *R. capitellata*. A Union Parish specimen is equivocal—the achene size is closer to *R. glomerata*, but shape is closer to *R. capitellata*: *Lewis 3308* (NLU). I have not seen specimens from Red River and Winn parishes that were cited by Thomas and Allen.

Two east Texas specimens are correctly identified as *Rhynchospora capitellata*: Henderson Co., *Correll 26688* (GH); Smith Co., *Moore, Jr. 888* (GH). Both were collected in hillside seepage bogs. A Leon County collection, also from a bog, proves to be *R. glomerata* var. *angusta* Gale, an overlooked taxon of the West Gulf Coastal Plain: *Barkley 13505* (GH, US).

Rhynchospora leptocarpa is a strict inhabitant of the southern Atlantic and East Gulf Coastal Plains (Fig. 1). It occurs from the vicinity of New Orleans, Louisiana, eastward to Tallahassee, Florida and adjacent Georgia, then reappears in the Sandhills region of the

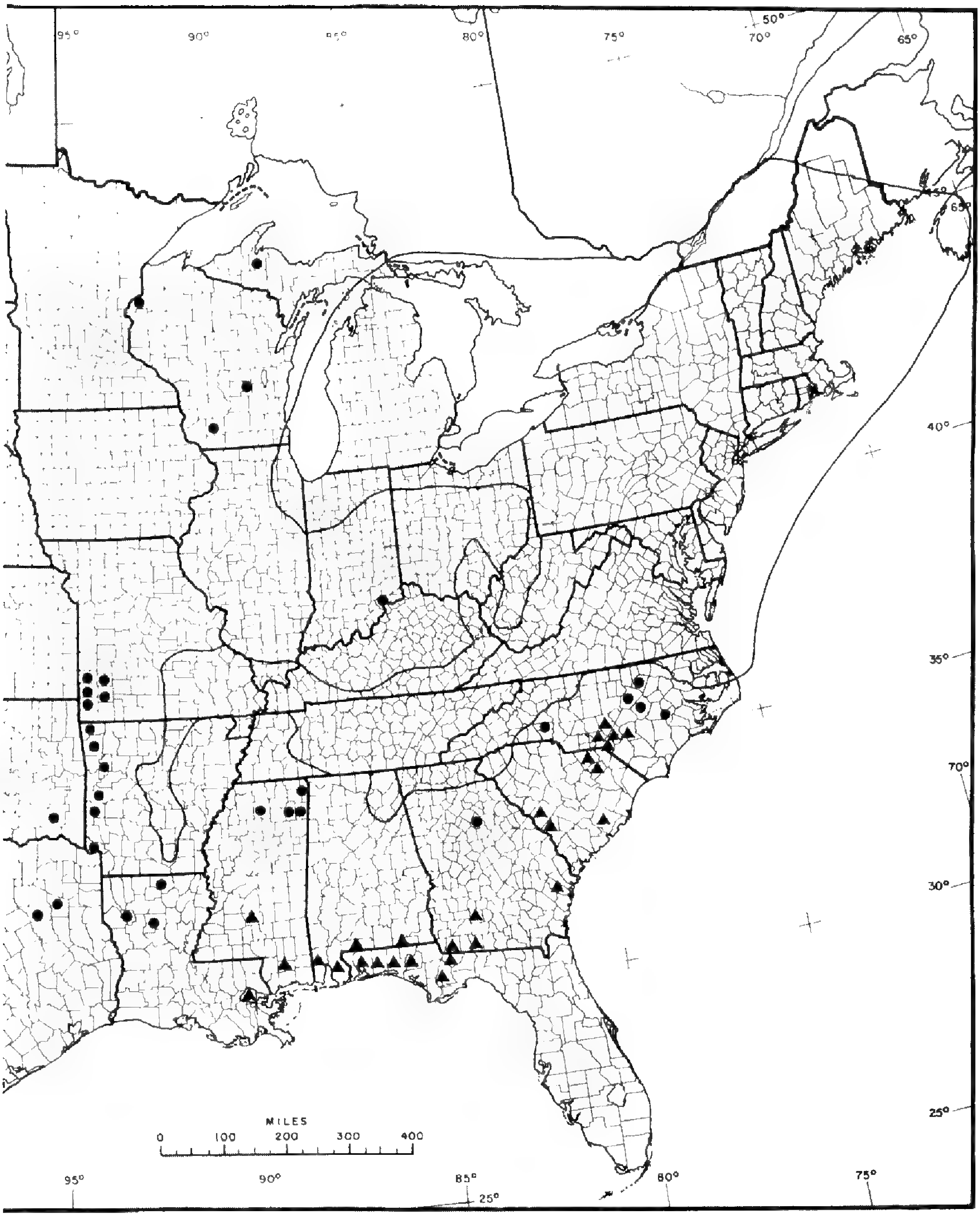

FIG. 1: Ranges of *Rhynchospora leptocarpa* and *R. capitellata* in the eastern United States and Canada. Triangles = *R. leptocarpa*. Dots = extralimital records of *R. capitellata*. Area bounded by solid line = general distribution of *R. capitellata*.

Carolinas. Current knowledge suggests that *R. leptocarpa* rarely occurs on the outer portion of the Atlantic Coastal Plain. This distribution pattern—a Gulf Coastal Plain component and a disjunct Carolina Sandhills component—occurs in a number of other species (Sorrie et al. 1997). Among the latter is *Rhynchospora macra* (C.B. Clarke) Small, which inhabits open seepage slopes adjacent to streamheads and baygalls.

Rhynchospora leptocarpa and *R. capitellata* are not currently known to be sympatric, but further field work may bridge the narrow gap that separates them. Speciation may have occurred during the Pleistocene, when glaciation cycles forced the ancestral entity (presumably a species of cool temperate climates) deep onto the coastal plain. Once there, this entity survived in open wet habitats analogous to those farther north, and also by adapting to localized cool-water environments in shady streamheads. Retreat of glaciers allowed the ancestral entity to return northward, while the newly adapted entity of southern streamheads remained. Several glacial cycles may have been involved to complete speciation. Alternatively, the ancestral entity may have occupied a southern range; during glacial cycles peripheral populations became adapted to a broad suite of cool-water habitats as they migrated northward.

Representative specimens. The following are representative specimens from throughout the range of *Rhynchospora leptocarpa* and include all historical collections. **ALABAMA: Baldwin Co.:** frequent in wet wooded stream with *Peltandra sagittifolia*, upper Majors Creek drainage, 26 Jun 1993, *L.C. Anderson 14393* (FSU). **Geneva Co.:** W of route 87, 6.7 mi. S of Samson, sphagnous headwaters of tributary of Pea River, 3 Aug 1996, *B.A. Sorrie 8960* (bas, NCU). **Mobile Co.:** pine woods near the coast, Jul 1879, *C. Mohr s.n.* (US); Theodore, pitcher plant bog on Range Line Road, 22 Nov 1980, *M. Powers s.n.* (USA). **FLORIDA: Gadsden Co.:** Quincy, *A.W. Chapman s.n.* (GH). **Liberty Co.:** hammock on road 12 near Bristol, 22 Jul 1940, *West and Arnold s.n.* (FLAS). **Santa Rosa Co.:** 5 mi. N of Milton, local in dense sweet bay-*Cliftonia* hammock, 24 Jul 1965, *S. McDaniel 6607* (IBE); Eglin Air Force Base, bay swamp near head of steephead ravine, Weaver Creek, 22 Sep 1989, *Orzell and Bridges 12567* (NCU). **Walton Co.:** springy woodland, bay head between Mossy Head and Deerland, 1956, *R.K. Godfrey 55250* (GA, GH); swamp near De Funiak Springs, 6 Jul 1897, *A.H. Curtiss 5926* (FLAS, FSU, GA, GH, NCU, US). **Washington Co.:** acid seep forest ravine above sandy limesink depression pond, 12 Sep 1989, *S. Orzell and E. Bridges 11883* (NCU). **GEORGIA: Decatur Co.:** wet woods near Whigham, 10 Aug 1901, *R.M. Harper 1185* (US). **Liberty Co.:** Fort Stewart, bayhead E of FS 9, locally common in full shade, stems lax, 9 Jul 1992, *R. Carter 10114 with P. Bower* (VDB). **Thomas Co.:** low wet woods along small stream, near Thomasville, 14 Aug 1936, *D.S. Correll 6484A* (DUKE). **Worth Co.:** densely shaded sphagnum pocket in swamp, Sylvester, *H.K. Svenson 6928* (GH). **LOUISIANA: Orleans Parish:** New Orleans, *Ingalls s.n.* (NY) [cited by Gale 1944]. **MISSISSIPPI: Simpson Co.:** Saratoga, 3 Aug 1903, *S.M. Tracy 8616* (GH, US). **Stone Co.:** University of Mississippi Forest Lands, S of Wire Road and E of route 15, mossy headwaters of Little Railroad Creek, 21 Aug 1997, *B.A. Sorrie 9445* (GH, NCU). **NORTH CAROLINA: Hoke Co.:** Fort Bragg, McPherson Impact Area buffer zone, sphagnous mucky soil of streamhead pocosin, 25 Oct 1991, *B.A. Sorrie 6060* (bas, GH); Fort Bragg, in troop trail through branch of Nicholson Creek, growing prostrate through sphagnum, 28 Sep 1992, *B.A. Sorrie 7002* (bas, NCU). **Moore Co.:** Sandhills Game Land, E of SR 1104, in sphagnum of old roadbed through tributary of Deep Creek, 4 Sep 1997, *B.A. Sorrie 9482* (NCU, SWSL). **Richmond Co.:** Sandhills Game Land, W of SR 1003, tributary of Naked Creek, large tussocks where fire burned into pocosin, 9 Sep 1997, *B.A. Sorrie 9490* (bas, FSU, GA, GH, NCU, VDB). **Scotland Co.:** Camp MacKall (U.S. Army), boggy depression bordering floodplain of Drowning Creek, 5 Aug 1992, *J.O. Larke s.n.* (VDB); Sandhills Game Land, headwaters of Little Muddy Creek, frequent in streamhead pocosins with abundant cane, burned January 1994, 17 Aug 1994, *B.A. Sorrie 8131* (bas, GA, GH, NCU, VDB). **SOUTH CAROLINA: Aiken Co.:** Aiken, 1866, *H.W. Ravenel s.n.* (GH). **Barnwell Co.:** pond side, Savannah River Nuclear Operations Area, *W.T. Batson and W.R. Kelly s.n.* (NCU). **Chesterfield Co.:** swift stream in Carolina Sandhills Refuge, 4.2 mi. S of jct. of SC 109 on SC 145, 26 Jul 1994, *R. Kral 83865* (VDB). **Darlington Co.:** Hartsville, flats across from paper mill, 5 Jul 1909, *W.C. Coker s.n.* (NCU).

Rarity

Despite the relative paucity of historical specimens, I believe that *Rhynchospora leptocarpa* is not rare but merely overlooked. In addition to the above collections, I have encountered it at 40 sites from North Carolina to Mississippi. *Rhynchospora leptocarpa* is not difficult to find in proper habitat. It inhabits a narrow niche, but one which is widely distributed over much of the coastal plain. However, these streamheads are usually very shrubby and tangled with *Smilax laurifolia*, thus uninviting to botanists. The period when it is most easily detected—July to mid September—is one of formidable heat and humidity. Add insects, venomous snakes, poisonous plants (*Toxicodendron vernix* (L.) Kuntze), and resemblance to several other *Rhynchospora* (especially *R. chalarocephala*), and there is small wonder that *R. leptocarpa* remained little known. For many of the same reasons, *Lindera subcoriacea* remained unknown until recently (Wofford 1983), but subsequently has been documented from over fifty sites in eight states. The two species co-occur at several sites in the Carolina Sandhills. Even with continued fire suppression and conversion of longleaf ecosystems, searches in appropriate habitat are likely to yield many more populations of *Rhynchospora leptocarpa*.

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BOOK REVIEW

Richard B. Primack. 2000. **A Primer of Conservation Biology, Second Edition.** (ISBN 0-87893-732-3, pbk.). Sinauer Associates, Inc. 23 Plumtree Road, Sunderland, MA 01375-0407, U.S.A. (*publish@sinauer.com*) $ 31.95 pbk. 319 Pp. 95 illustrations.

This book has as its stated intention, "to provide a brief but thorough introduction to the major concepts and problems of the field," and it certainly fulfills its mission. The book is divided into 5 chapters, including: 1) Conservation and Biological Diversity, 2) Threats to Biological Diversity, 3) Conservation at the Population and Species Levels, 4) Conservation at the Community Level, and 5) Conservation and Sustainable Development. Within each chapter, concepts are introduced in sections in bold print, and include numbered tables and figures. Ancillary, explanatory material is presented in numbered Boxes in the first chapter only. More of such boxes to further explain concepts in the other chapters would be welcome.

The level of complexity of the text reinforces its purpose as a basic, introductory undergraduate textbook for an upper level course. I would recommend that students have basic biology and ecology as prerequisites so that time can be spent on supplementary articles or perhaps a short term paper. The summary points listed at the end of each chapter and suggested readings integrate the individual concepts presented within each chapter into its respective overall theme very well.

The book does an excellent job of incorporating elements of anthropology and economics into the basic biological framework that supports research and implementation of modern approaches to solving problems in conservation biology. In addition, the appendix with "Selected Environmental Organizations and Sources of Information," extensive bibliography, and index make it easy find concepts throughout the book.

A suggestion for improvement would be to update the two Boxes of Chapter one, where "Naming and Classifying species" and "Origin of New Species" are presented, respectively. The first box intends to explain the hierarchy used in taxonomy but unfortunately implies that organisms are grouped by their overall similarity instead of by their hypothesized evolutionary relationships. I would recommend explaining the hierarchy in terms of genealogy, so that it would not conflict with what students will learn about phylogenetics in any subsequent systematics course they will take. It may also be valuable to introduce the concepts of sympatric, allopatric and parapatric (stasipatric) speciation, perhaps somewhere in the chapter on conservation at the population and species levels. With even a limited discussion of these topics, eluded to but not elaborated upon in Box 1.2 of Chapter One, other concepts such as the Founder and Bottleneck Effects may be better understood and the profound effects of habitat fragmentation better appreciated. In future editions, the tremendous contribution that molecular studies, including DNA fingerprinting techniques, and intraspecific genetic variation work, have given to modern conservation studies, should be added.

Despite these few comments, I know of no finer text to introduce the subject of Conservation Biology to undergraduates, at a global level and with such a synthetic approach. The text, with its durable back and high-quality pages, its figures conveniently placed, its references copious, succinct yet thorough summaries and suggested readings, all make this text easy to read and optimally student-friendly. I highly recommend it for everyone planning to teach such a course.—*John J. Pipoly III, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102 4060, U.S.A.*

OCCURRENCE, DISTRIBUTION, AND ECOLOGY OF *ALOCASIA*, *CALADIUM*, *COLOCASIA*, AND *XANTHOSOMA* (ARACEAE) IN THE SOUTHEASTERN UNITED STATES

Brett E. Serviss

Department of Biological Sciences
Mississippi State University
Mississippi State, MS 39762, U.S.A.
bes3@ra.msstate.edu

Sidney T. McDaniel

Department of Biological Sciences
Mississippi State University
Mississippi State, MS 39762, U.S.A

Charles T. Bryson

USDA, ARS
Southern Weed Science Research Unit
P.O. Box 350
Stoneville, MS 38776, U.S.A.
cbryson@ag.gov

ABSTRACT

Eight species in four genera of *Aroideae* (Araceae) are introduced, cultivated, and variously established in the southeastern United States. Keys, illustrations, descriptions, distribution and ranges, habitat preference, flowering and fruiting periods, and variation in both vegetative and sexual reproductive characteristics are provided for the genera, species, and varieties. Additional information on the cultivation of all species and the weedy attributes of *Colocasia* and *Xanthosoma* are discussed.

RESUMEN

Ocho especies de cuatro géneros de *Aroideae* (Araceae) están introducidas, cultivadas, y establecidas en el sureste de los Estados Unidos. Se ofrecen claves, ilustraciones, descripciones, distribución y áreas, hábitat preferente, periodos de floración y fructificación, y variación en las características vegetativas y reproductoras para los géneros, especies, y variedades. Se discute información adicional sobre el cultivo de todas las especies y las características como malas hierbas de *Colocasia* y *Xanthosoma*.

INTRODUCTION

The Araceae (including Lemnaceae; Mayo et al. 1995) or arum family is represented worldwide by 105 genera and about 3,200 species (Croat 1998; Mayo et al. 1997). At present 16 genera (excluding *Acorus* that it is now placed in the Acoraceae) and approximately 31 species occur in the continental United States and Alaska. Of these 31 species, only about

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one-half are native; the remaining exotics are established to various degrees as components of our flora. *Alocasia*, *Colocasia*, and *Xanthosoma* are among those non-native naturalized (or potentially so) genera and are represented by seven species in the United States. The origination of these genera from various tropical regions and the characteristics of the naturalized species discussed herein, imply an inherent plasticity for adaptation to different climatic conditions and habitat types. In the southeastern United States, differences in seasonal temperature range, habitat type, and floristic species composition all combine to provide some environmental deviation from the conditions in which these species evolved. Five of the eight species are experiencing some degree of range expansion since introduction, and three varieties of *Colocasia esculenta* (*Colocasia esculenta* var. *antiquorum*, *Colocasia esculenta* var. *aquatilis*, and *Colocasia esculenta* var. *nymphaeifolia*) and *Xanthosoma sagittifolium* are rapidly becoming invasive. Intraspecific morphological variability within *Colocasia*, and an overall similarity in appearance between the several varieties of *Colocasia esculenta* and certain species of *Alocasia* and *Xanthosoma* allow for continual uncertainty in field identification of this group. Ambiguity in terms of species identification and potential for invasiveness of these introduced Araceae necessitate a better understanding of their morphological and ecological variability and character in the United States.

Currently, *Alocasia macrorrhizos* and *Xanthosoma sagittifolium* are restricted in their naturalized ranges to central and southern Florida and southern Texas, while *Colocasia*, in addition to occurring throughout Florida and most of eastern Texas, also occurs in scattered locations throughout the Gulf coastal region. *Colocasia esculenta* var. *aquatilis*, *Colocasia esculenta* var. *nymphaeifolia*, and *Colocasia esculenta* var. *antiquorum* are established as far north as east central Texas, northern Louisiana, and throughout the lower one-half of Alabama, Georgia, and Mississippi. These three varieties of *C. esculenta* are invasive weeds of semi-aquatic and aquatic conditions throughout the Gulf coastal region. *Xanthosoma sagittifolium*, while not established as a serious weed, is becoming more prevalent in peninsular Florida and southern Texas.

Colocasia was introduced into the United States as a food crop for its edible tubers and for ornament, while *Xanthosoma* and *Alocasia* were introduced for their value as ornamentals with minimal consideration as a food source (Neal 1991; Vaughan & Geissler 1997). Several varieties of *Colocasia* are grown commercially for tuber production, as the tubers are a source of food and propagules for ornamental use. We would like to clarify and delineate among the intergeneric, intraspecific, and ecological differences between the species and varieties of *Alocasia*, *Caladium*, *Colocasia*, and *Xanthosoma* in the United States.

TAXONOMY

Alocasia, *Caladium*, *Colocasia* and *Xanthosoma* are currently classified in subfamily *Aroideae* (Mayo et al. 1997). These four genera are not monophyletic as once thought when formerly placed in the old subfamily *Colocasioideae*, thus paleotropical *Alocasia* and *Colocasia* remain in tribe *Colocasieae* and subtribe *Colocasiinae*, while the neotropical genera of *Caladium* and *Xanthosoma* are separated into tribe *Caladieae* and subtribe *Caladiinae* (French et al. 1995; Mayo et al. 1997). Subfamily *Aroideae* (based primarily on Croat 1988, 1998; Grayum 1994; Mayo 1997) are perennial, predominately terrestrial, rarely hemiepiphytic or epilithic herbs, which produce white or yellow to orange latex sap. Plants caulescent to acaulescent, hypogeal, stems sometimes aerial, erect to decumbent, often rhizomatous and tuberous; leaves petiolate, ovate, ovate-lanceolate, ovate-elliptic, or triangular-ovate, variously peltate or not, basally sagittate, hastate, or cordate; petioles elongate and fleshy, with the terminal petiole housing the newest unemergent leaf; venation usually reticulate, sometimes parallel-pinnate. New leaves arise singly from the apical portion of the stem and emerge from a cavity within the terminal petiole. Laticifers present, simple, articulated, or anastomosing; trichosclereids absent. Plants monoecious (occasionally polygamomonoecious), androgynous; perianth parts absent; at anthesis the spadix is usually open, with or without a terminal appendix and a region between the staminate and pistillate flowers comprised of synandrodes (sterile staminate flowers); stamens are connate and arranged in synandria; fruit a 1-numerously seeded berry, endosperm copious or not; predominately insect pollinated by various taxa of beetles, flies, and bees. Our species of *Aroideae* perenniate from subterranean tubers and or rhizomes. Production of these perenniating structures allows for efficient and prolific vegetative reproduction.

Many *Aroideae* form asexual colonies of genetically identical individuals. This is the typical method of reproduction for representative genera in the US and one of the primary factors allowing for naturalization. Seed production also occurs if environmental conditions are conducive, but this is rare in tne US. Throughout the plant, but concentrated in the tubers, are deposits of poisonous capsules of pointed calcium oxylate crystals. Plants are poisonous unless cooked or prepared in such a way as to remove or neutralize the crystals. These can cause numbing and irritation of the skin and mucus membranes and problems with digestion if foliage and tubers are eaten raw or incompletely cooked (Vaughan & Geissler 1997).

KEY TO *ALOCASIA*, *CALADIUM*, *COLOCASIA*, AND *XANTHOSOMA* IN THE SOUTHEASTERN UNITED STATES

1. Leaves predominately green and tinged with purple coloration to completely purple, or green with white, pink, or red coloration (leaves rarely uniformly green in *Caladium*).
   2. Leaf margins not crenate to only slightly so; lamina variously mottled with white, pink, or red coloration, or some combination thereof ________ **Caladium**
   2. Leaf margins variously crenate or not, leaves uniformly purple or a combination of purple and green.
      3. Newly formed leaves blue-violet, lamina becoming green as they enlarge and age, midvein, primary lateral veins, and petioles violet or becoming yellow ________ **Xanthosoma**
      3. Newly formed and older leaves green, petioles green and often glaucous
         4. Veins of upper leaf surface conspicuously raised above the blade and leaf margins strongly crenate; leaves not or only slightly peltate ________ **Alocasia**

4. Veins of upper leaf surface flush with blade to slightly raised above it, the entire upper surface of the leaf appearing flat or leaf margins weakly crenate; leaves obviously peltate ______ **Colocasia**

1. Leaves essentially green, sometimes glaucous or glaucescent on the lower surface
    5. Plant arising from well-developed, subterranean tubers.
        6. Basal 2 lobes of leaves apically acute; leaves not peltate ______ **Xanthosoma**
        6. Basal 2 lobes of leaves apically rounded; leaves peltate or not.
            7. Veins of upper leaf surface conspicuously raised above the blade and leaf margins strongly crenate; leaves not peltate to peltate ______ **Alocasia**
            7. Veins of upper leaf surface flush with blade to slightly raised above it, the entire upper surface of the leaf appearing flat and leaf margins weakly crenate; leaves peltate ______ **Colocasia**
    5. Plants lacking well-developed tubers, or if tubers present then much reduced
        8. Plants producing long slender rhizomes above and or below the ground; stems arising from a slightly tuberous caudex.
            9. Basal 2 lobes of leaves rounded; rhizomes usually emerging and running for most of their length above or below ground ______ **Colocasia**
            9. Basal 2 lobes of leaves acute; rhizomes usually completely running below ground ______ **Xanthosoma**
        8. Plants not rhizomatous and caudex not tuberous ______ **Peltandra**

NOTE: *Peltandra* is included in this key because of morphological similarities and possible confusion with the other genera.

SPECIES ORIGIN, OCCURRENCE, RANGE, AND DESCRIPTION

ALOCASIA

Alocasia (Schott) G. Don in Sweet, Hort. Brit., ed. 3. 631. 1839. nom. cons; Krause in Engler, Pflanzenr. 4. 23E. 71:71. 1920. TYPE SPECIES (conserved): *Alocasia cucullata* (Lour.) G. Don, *Arum cucullatum* Lour.

Colocasia sect. *Alocasia* Schott in Schott & Endlicher, Melet. Bot. 18. 1832. *Ensolenanthe* Schott in Bonplandia 9. 368. 1861.
Xenophya Schott in Ann. Mus. Bot. Lugduno-Batavum 1:124. 1863.
Schizocasia Schott ex Engler in Bot. Jahrb. 1:185. 1880–1881.
Panzhuyuia Z.Y. Zhu in J. Sichuan Chinese Medicinal School 4(5):49. 1985.

Perennial caulescent or acaulescent herbs usually from a creeping tuberous-rhizome caudex, with or without elongate rhizomes, reproducing asexually by secondary tubers, tuber offshoots, and or rhizomes. Above ground stems erect to decumbent; leaves ovate to triangular-ovate, basally sagittate or rarely slightly peltate; spadix pedunculate, arising axillary and subtended by 1 or 2 acute to acuminate bracts, staminate and pistillate flowers separated by a section of synandrodes (sterile staminate flowers), appendix present; spathe present, longer than spadix, constricted basally to form a tube which encloses the spadix until anthesis; the basal portion remaining tightly closed; staminate flowers comprised of truncate synandria of 3 8 stamens; pistillate flowers 1–4 carpellate, 1–4-locular, stigma weakly 3-lobed, ovules 1-numerous, placentation basal; fruit a 1-numerous seeded berry sometimes with portions of the stigma persistent; ovules 6–10, orthotropous, hemiorthotropous, hemianatropous, or anatropous, funicles short; seed subglobose to ellipsoid, testa smooth or scabrous, endosperm copious.

About 70 species native to Indomalaysia and throughout southern Asia. Three species occur in the US. *Alocasia macrorrhizos* and *Alocasia odora* are both established.

Etymology.—colocasia an arum, and *alocho*, a prefix meaning bedfellow or spouse; depicting the morphological similarity between *Alocasia* and *Colocasia.*

KEY TO SPECIES OF *ALOCASIA*

1. Leaves and foliage green (foliage rarely purple in *A. macrorrhizos*, if so, then leaves not peltate).
    2. Mature leaves not peltate; leaves on juvenile plants sometimes slightly peltate ____ **1. A. macrorrhizos**
    2. Mature leaves obviously peltate ____ **2. A. odora**
1. Leaves and foliage purple, petioles sometimes green; leaves peltate ____ **3. A. plumbea**

1. Alocasia macrorrhizos (L.) G. Don var. **macrorrhizos** in Sweet, Hort. Brit., ed. 3. 631. 1839. Hook. f., Fl. Br. Ind. 6:526. 1893. Petch, Ann. Roy. Bot. Gard. Peradeniya 7:53. 1919. Krause in Engler, Pflanzenr. 4. 23E. 17:84. 1920. (**Fig. 1**). *Arum macrorrhizon* L., Sp. Pl. 965. 1753. *Caladium macrorhizon* R. Br., Prod. 336. 1810. *Alocasia macrorrhiza* (L.) Schott in Schott & Endl., Melet. Bot. 18. 1832. *Alocasia macrorrhizon* (L.) G. Don in Sweet, Hort. Brit., ed. 3. 631. 1839. *Colocasia macrorrhiza* Kunth, Enum. Pl. 3:39. 1841.

Arum peregrinum L., Sp. Pl. 966. 1753.
Arum mucronatum Lam., Encyc. 3:12. 1786.
Arum indicum Lour., Fl. Cocninch. 536. 1790. *Colocasia indica* (Lour.) Kunth, Enum. Pl. 3:39. 1840. *Alocasia indica* (Lour.) Spach, Hist. Nat. Veg. Phan. 12:47. 1846.
Arum cordifolium Bory, Voy. Iles. Afrique 1:376. 1804.
Caladium giganteum Blume, Cat. Gew. Buitenz. 103. 1823.
Arum punctatum Desf., Cat. Hort. Par., ed. 3. 385. 1829.
Caladium glycyrrhizum Fraser in Hook. Bot. Misc. 1:259. 1830.
Calla badian Blanco, Fl. Filip. 658. 1837.
Calla maxima Blanco, Fl. Filip. 658. 1837.
Arum grandifolium Blanco, op. Cit., ed. 2. 1845.
Alocasia alba Schott in Oestr. Bot. Wochenbl. 2:59. 1852.
Caladium indica Hort. ex C. Koch, Berl. Allg. Gartenz. 136. 1857.

Caulescent herbs up to 5 m in height from a tuberous caudex; stems to 1.5 m tall and 20 cm in diameter, becoming thickened and caudex-like, erect or often falling over with age and resting on the ground, basally covered with dry, chartaceous, persistent cataphylls, adventitious roots sometimes present, rhizomes present or absent, when present variable in length, elongate, white to whitish-green; leaves 35–160 cm long and 30–90 cm wide (often smaller in dimensions if on young, damaged, or spring emergent plants) ovate to ovate-triangular, apically subacute to short acuminate, basally sagittate, young leaves sometimes peltate, margins strongly undulate, primary lateral veins 4–8 per side, midvein and lateral veins prominently raised above the lamina; petioles 70–130 cm in length, lamina and petioles green; inflorescence of 1-numerous spadices, peduncles 20–50 cm long, spathe 11–35 cm long, 3.5–6.2 cm wide, chartaceous, apically withering with age, greenish-white to green or glaucous, becoming peach or light orange with age,

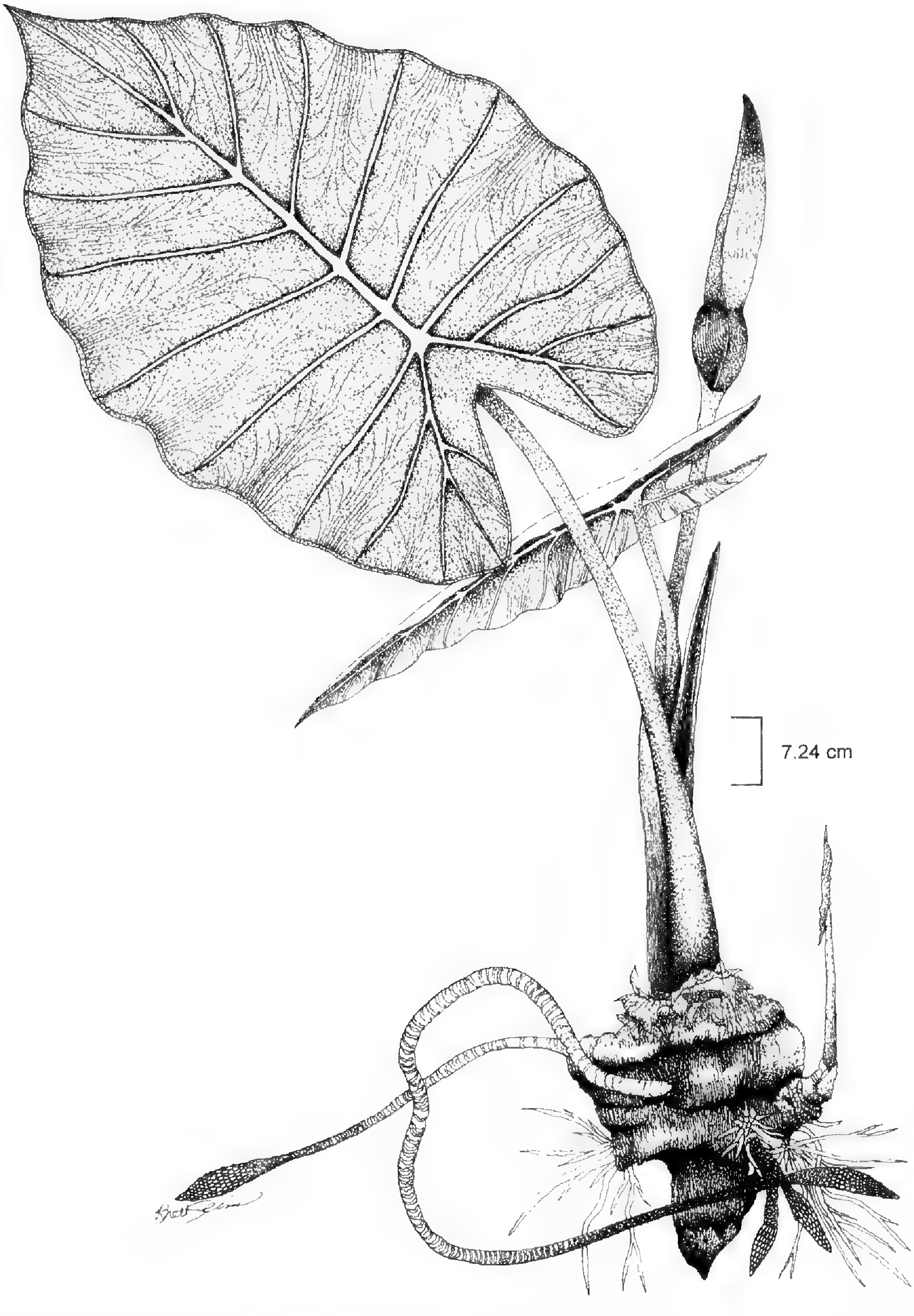

Fig. 1. *Alocasia macrorrhizos* (L.) G. Don var. *macrorrhizos*. Young plant, general habit.

spadix 11–35 cm in length, yellowish to cream, appendix 7–21 cm long, fertile staminate region 2–7 cm, sterile staminate region 0.3–2 cm long, fertile pistillate region 1.2–5 cm long, pistillate flowers emit the odor of ether prior to fertilization; berries ovoid, orange to scarlet, 8–10 mm long and 5–8 mm in diameter, usually containing 5–6 ovules.

Some species of *Alocasia*, most importantly *A. macrorrhizos* and *A. odora*, are important food crops in tropical regions, particularly Asia, the south Pacific, and to a lesser extent, Africa (Bailey 1997; Neal 1991). The actual crop and source of nutrition is the large, edible, subterranean tubers. The tubers provide high levels of dietary starch (approx. 25% by weight), ascorbic acid, low amounts of vitamin A, B complex vitamins, and small amounts of protein (Bailey 1997; Neal 1991; Vaughan & Geissler 1997). Through use as crops and ornamentals *A. macrorrhizos* and other species of *Alocasia* have been distributed and established throughout the subtropics and tropics.

Alocasia macrorrhizos was introduced into the United States from tropical Asia and occurs sporadically in central and southern Florida and southern Texas. While widely cultivated in the southern US, it is only truly established in central and southern peninsular Florida, where climatic conditions permit essentially year-round growth and little to no enforced dormancy. Its ability to reproduce vegetatively has aided naturalization. Its rate of expansion is reduced in the absence of disturbance and where soils are without adequate moisture and drainage. Once established, *Alocasia macrorrhizos* appears to tolerate a wide range of condition variability (drought, periodic flooding, variable light intensity, and occasional hard freezes) and interspecific interference. The rate of range expansion by *A. macrorrhizos* may at least in part be impeded because it usually colonizes vegetatively by secondary or daughter tuber formation. This method of establishment is not normally as conducive to invasion as is rhizome production in *Colocasia* and *Xanthosoma*. The apparent inability of *A. macrorrhizos* to produce much fruit (in the United States) for dispersal and potential long-range colonization also probably contributes to its limited expansion.

In the United States flower and fruit production typically occur from late summer into winter, though flowering can occur at any time of year. One to several inflorescences are produced per plant at any one time. *Alocasia macrorrhizos* is self compatible but probably requires out-crossing between different genotypes for full fertility (obviously environmental conditions are also important here). In the US most colonies arise from a single genotype, which may explain the apparent lack of fecundity in our plants. The lack of appropriate insect pollinators is yet another consideration. When fruit is produced the number of berries are usually few (10–15 per spadix).

Alocasia macrorrhizos prefers moderate to well-drained but continuously moist, moderately to highly acid soil. It also seems to require at least moderate disturbance for establishment. It can be found along wet woodland edges, thickets, roadsides, old fields, open areas of waste ground, vacant lots, or persisting and spreading at home sites. Once established it spreads vegetatively, by secondary tubers which produce many small plantlets or to a limited extent along tuberous rhizomes. These plantlets originate and grow for an extended period of time remaining attached to the main plant and may or may not eventually separate. *Alocasia macrorrhizos* is semi cold tolerant and can withstand limited exposure to freezing temperatures, regenerating foliage afterwards. A form with purple foliage very similar in color to *Alocasia plumbea* is sometimes cultivated and occasionally reverts back to the wild-type green coloration.

Common names.—pai, taro, cunjevoi, giant taro, ape giant, elephant-ear

2. Alocasia odora (Lodd.) Spach, Hist. Nat. Veg. Phan. 12:46. 1846; (Roxb.) K. Koch, 1. c. 1854. *Arum odorum* Roxb., Hort. Beng. 65. 1814; Roxb., Fl. Ind. 3:499.1832; Lodd., Bot. Cab. 5: t. 416. 1820; Wight, Ic. Pl. Ind. Or. 3(6): t. 797. 1844. *Caladium odoratum* Lodd., Bot Cab. t. 416. 1820. *Caladium odorum* (Lodd.) Lindl., Bot. Reg. 8: t. 641. 1822. *Colocasia odora* Hort. ex Brongn. in Nouv. Ann. Mus Par. 3. 145. 1834.

Alocasia commutata Schott in Oestr. Bot. Wochembl. 409. 1854.
Caladium odoratissimum Hort. ex C. Koch, Berl. Allg. Gartenz. 20. 1857.

Extremely similar to *Alocasia macrorrhizos* but differing by having peltate leaves and foliage often glaucescent. Also similar to *Xanthosoma sagittifolium* but basal leaf lobes are apically rounded, whereas those of *X. sagittifolium* are apically acute. *Alocasia odora* is native to southeast Asia and the Philippines and is cultivated for food and ornament throughout the tropics and for ornament in the extreme southern US. *Alocasia odora* is spontaneous in southern Florida and much of the material reported or determined as *A. macrorrhizos* is in fact *A. odora*. *Alocasia odora* is likely only a subspecies or variety of *A. macrorrhizos*. Ecology is similar to that of *A. macrorrhizos*.

Common names.—taro, elephant-ear, ape giant.

3. Alocasia plumbea Van Houtte in Fl. Des. Serres, Sér. 2. 6. 93: t. 2206. 1875.

Alocasia indica Schott in Oestr. Bot. Wochenbl. 410. 1854.
Alocasia metallica Schott in Oestr. Bot. Wochenbl. 410. 1854.

Caulescent herbs 1–3 m in height from a tuberous caudex; stem to 1 m tall, basally covered with dry, chartaceous, persistent cataphylls, rhizomes present or absent, when present variable in length, elongate, white to white-green, often tinged with pink or purple coloration; leaves 20–100 cm long and 15–65 cm wide, ovate-triangular, apically subacute to short acuminate, basally sagittate, often peltate, margins undulate, primary lateral veins 4–8 per side, midvein and lateral veins prominently raised above the lamina, petioles 40–110 cm in length, lamina adaxially dark green-purple, abaxially variable-purple, purple-green, red-brown, or yellow-green; inflorescence of 1-numerous spadices, peduncles 25–50 cm long, spathe 10–20 cm long, 3–7.5 cm wide, chartaceous, apically withering with age, purple-pink to pink, becoming peach or yellow with age and often violet-striate, spadix 10.5–19 cm in length, yellowish to cream, appendix 6.5–13 cm long, fertile staminate region 1.5–2.5 cm, sterile staminate region 0.3–0.7 cm long, fertile pistillate region 1.5–2.5 cm long, pistillate flowers emit a slight odor of ether prior to fertilization; ovary containing 3–5 ovules; fruit not observed.

Similar in form and habit to *A. macrorrhizos* but differing in its smaller and less robust stature, purple to purple-green foliage (petioles often pink or pinkish-white with purple or red spots when on young plants, or plants growing under shade conditions), and pink to lavender spathe. It is not currently naturalized in the US but is often cultivated in extreme southern Florida, Louisiana, and Texas, and readily persists subsequent to cultivation.

Common names.—purple taro, purple ape.

CALADIUM

Caladium Vent., Mag. Enc. 4(16):463. 1800–1801; Vent., Descr. Pl. Nouv. Jard. Cels 30. t. 30. 1801; Vent., Arch. Bot. (Leipzig) 2(3):347. 1801; Vent., J. Bot. (Schrader) 4(6):316. 1801. Engler, Pflanzenr. 4. 23E. 71:23. 1920. LECTOTYPE SPECIES: *Caladium bicolor* (Ait.) Vent., *Arum bicolor* Aiton.

Cyrtospadix C. Koch, Ind. Sem. Hort. Berol. 1858.
Arosma Rafin., Fl. Tellur. 3:66. 1886.
Aphyllarum S. Moore in Trans. Linn. Soc. London, Bot. Ser. 2, 4:501. 1895.

Perennial acaulescent herbs from a creeping tuberous rhizome, reproducing asexually by daughter tubers. Above ground stems erect; leaves ovate to triangular-ovate, basally sagittate, peltate; spadix pedunculate, arising axillary and subtended by 1 or 2 acuminate bracts, staminate and pistillate flowers separated by a section of synandrodes (sterile staminate flowers), appendix absent; spathe present, longer than spadix, constricted basally to form a tube which encloses the spadix until anthesis; the basal portion remaining tightly closed; staminate flowers comprised of angular synandria of 3–5 stamens; pistillate flowers 1–4 carpellate, 1–2 or incompletely 3-locular, stigma discoid, ovules 1-numerous, placentation subbasal, pseudoaxile, or parietal; fruit a 1-numerous seeded berry; ovules 1–20, anatropous, funicles short; seed ovoid to ellipsoid, testa variously costate, endosperm copious.

About 12 species all originating in the neotropics. Several species cultivated in the US, currently none established, though *C. bicolor* is widely cultivated.

Etymology.—Latin: *keladi*, of Malaysian origin, vernacular name for several Colocasioid and Caladioid genera.

Caladium bicolor (W. Ait.) Vent., Mag. Enc. 4(16):464. 1801; Vent., Descr. Pl. Nouv. Jard. Cels 30. t. 30. 1801; Vent., Arch. Bot. (Leipzig) 2(3):348. 1801; Vent., J. Bot. (Schrader) 4(6):319. 1801. Engler, Pflanzenr. 4. 23E. 71:31. 1920. (**Fig. 2**). *Arum bicolor* W. Ait., Hort. Kew. 3:316. 1789.

Caladium surinamense Miq., Delect. Sem. Hort. Amst. 3. 1853.
Caladium regale Lem., Illustr. Hort. 9. t. 316. 1862.
Caladium x hortulanum Birdsey, Cult. Aroids 42. 1951.

Acaulescent herbs from 0.2–1 m in height from a tuberous rhizome, tuberous caudex well-developed, plant without elongate stoloniferous rhizomes; leaves 5–35 cm long and 5–21 cm wide, ovate to ovate-triangular or ovate-elliptic, apically rounded to acute, basally sagittate, peltate, margins subundulate, angular, or entire; primary lateral veins

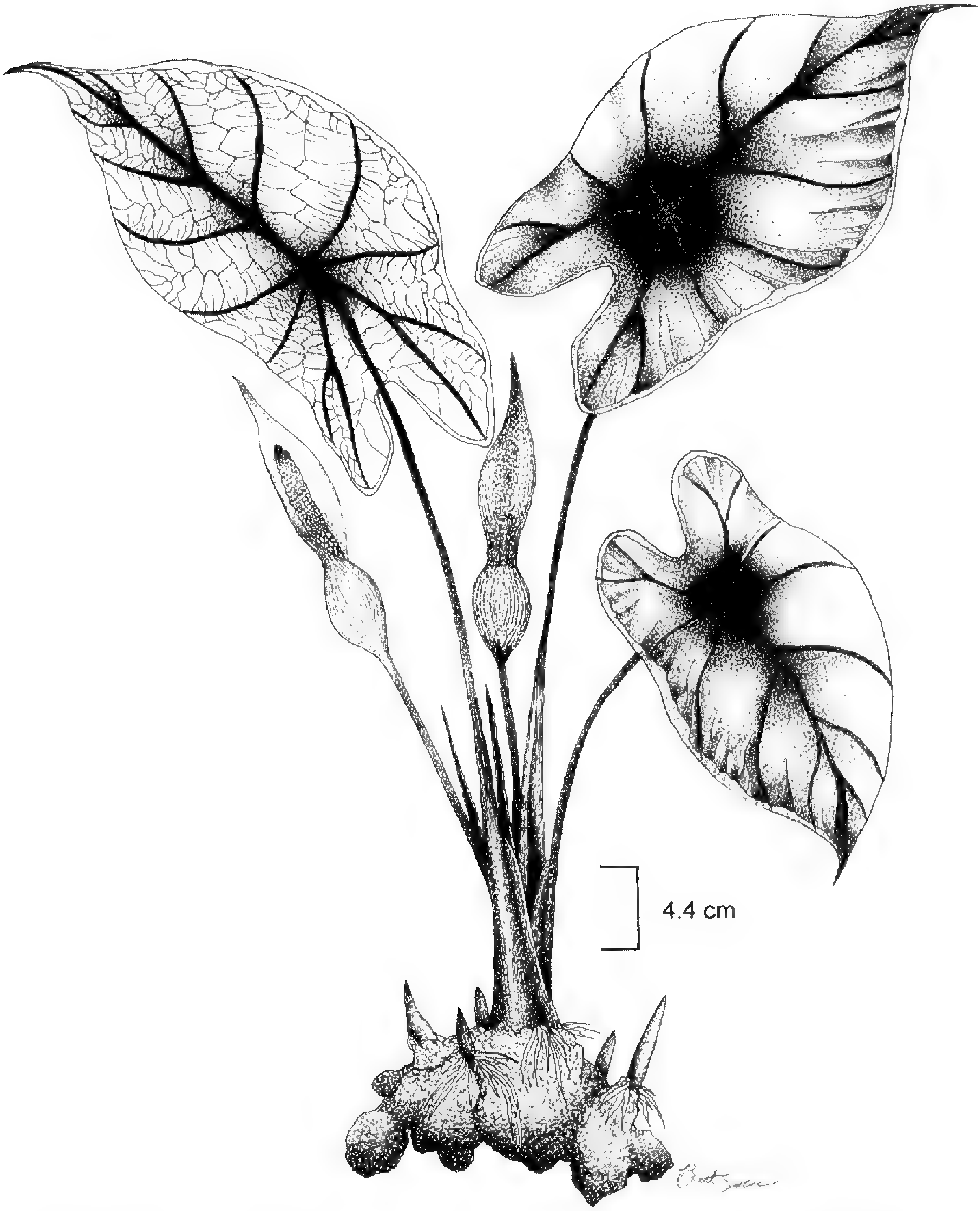

Fig. 2. ***Caladium bicolor*** **(W. Ait.) Vent. General habit.**

3–8 per side, lamina ranging in color from entirely green to green and variously mottled with white, pink, or red or some combination thereof, sometimes lamina predominately white or red, midvein and lateral veins raised above the blade on abaxial side, petiole 10–50 cm in length, green to red, purple, or black, often green and splotched with purple, sometimes pink basally; inflorescence of 1-numerous spadices, peduncles 28–40 cm long, spathe 7–25 cm long, chartaceous, broadly acute, green externally, white to white-green on the inner surface; spadix 9.5–14 cm long, white to yellowish, appendix absent or much reduced, region of fertile staminate flowers 3.5–5.5 cm long, region of sterile staminate flowers 1–2 cm long, region of fertile pistillate flowers 3.5–5 cm long, pistillate flowers essentially without odor, ovaries with 1-numerous ovules; berries white.

A highly variable species comprised of numerous varieties separated primarily on the basis of foliage coloration. Commonly cultivated in the southeastern US for ornament but not currently documented as naturalized. *Caladium bicolor* is a prolific seed producer and is spontaneous in new growth forests and moist disturbed areas throughout the tropics. It should be expected along moist disturbed sites, woodland edges, hammocks, and fields in southern Florida.

Common names.—caladium, elephant's-ear, angel-wings, mother-in-law plant.

COLOCASIA

Colocasia Schott in Schott and Engl., Melet. Bot. 18. 1832, nom. cons; Krause in Engler, Pflanzenr. 4. 23E. 71:62. 1920. Type species (conserved): *Colocasia antiquorum* Schott, *Arum colocasia* L., *Colocasia esculenta* (L.) Schott.

Leucocasia Schott in Oestr. Bot. Wochenbl. 7:34. 1857.

Perennial caulescent to acaulescent herbs from a creeping tuberous-rhizome; tubers and rhizomes usually present; asexual reproduction by means of secondary or daughter tubers, and or rhizomes. Above ground stems erect; leaves ovate to triangular-ovate, basally cordate, cordate-sagittate, or sagittate, typically peltate, often glaucous to glaucescent abaxially; spadix pedunculate, arising axillary and subtended by 1 or 2 acute to acuminate bracts, staminate and pistillate flowers separated by a section of synandrodes (sterile staminate flowers), appendix present; spathe present, 2–6 times longer than spadix, constricted basally to form a tube which encloses the spadix until anthesis; the basal portion remaining tightly closed; staminate flowers comprised of truncate synandria of 3–6 stamens; pistillate flowers 1-locular, stigma discoid-capitate or weakly lobed, ovules numerous, placentation parietal; fruit a 1-numerous seeded berry with a persistent stigma; ovules numerous, hemiorthotropous, funicles long; seed ovoid to ellipsoid, testa costate, endosperm copious.

Seven or eight species primarily of tropical Asia, some in Africa. Two species established in the US but only certain varieties of *Colocasia esculenta* widely naturalized.

Etymology.—Greek: *kolokasia*, term used for the root of *Nelumbo nucifera* Gaertn. (water lotus) (Nelumbonaceae), thus applied to *Colocasia* because of its edible tubers.

KEY TO SPECIES OF *COLOCASIA*

1. Leaves and foliage predominately to entirely green, often somewhat glaucous on the lower surface, petioles and lamina sometimes with a reddish or purplish tinge; plants well-established in southeastern United States.
   2. Rhizomes up to 25 dm long; tubers usually poorly developed or nearly absent; widely naturalized (some material of *C. esculenta* var. *antiquorum* will key here).

3. Rhizomes originating at apex or middle of tuber body ______ **1. C. esculenta var. aquatilis**

3. Rhizomes originating only at very base of tubers _____ **8. C. esculenta var. nymphaeifolia**

2. Rhizomes often reduced in length or absent; tubers normally large and well-developed.

4. Tubers large, few; terminal appendage of spadix short or nearly absent; rhizomes usually short or absent ______________________ **3. C. esculenta var. esculenta**

4. Tubers small, few to numerous, often with short or long rhizomes, occasionally rhizomes up to 25 dm long; terminal appendage of spadix elongated.

5. Plants of aquatic areas; relatively wide-spread ______ **2. C. esculenta var. antiquorum**

5. Plants of upland areas with well-drained soils, often occurring and persisting along field edges where cultivated but rarely occurring outside these areas ______________________________________ **6. C. esculenta var. globulifera**

1. Leaves with purplish or blackish coloration, or white-glaucous on the under surface; plants not truly naturalized in the United States.

6. Leaves white-glaucous on the lower surface and lacking purple coloration, veins usually whitish; spathe white to cream ________________________________ **9. C. gigantea**

6. Leaves not white-glaucous on lower surface, may be glaucous-green, blue or purple, and at least with some purple coloration on veins and or blade, veins never with white coloration; spathe yellow-green to orange, or pink.

7. Leaves green on upper surface (sometimes tinged with purple), petioles and lower surface veins purple or purple-black, leaf margins usually purple.

8. Lamina dark green, almost appearing tinged with purple; leaves with purple veins on the lower surface, with or without purple margins; plants large, often 1.5–2.0 m tall _____________________________ **5. C. esculenta var. fontanesii**

8. Lamina bright green; leaves usually with veins purple, sometimes green on the lower surface, margins purple; plants small, usually 1 m or less tall ____ **4. C. esculenta var. euchlora**

7. All or at least part of the upper surface of leaves dark purple to purple-black

9. Leaves completely purple at maturity, almost black, glaucous-purple on the lower surface, primary veins dark purple to purple-black _____ **5. C. esculenta var. fontanesii**

9. Leaves green with spots or broad bands of purple between the veins on the upper surface, glaucous-green on the lower surface, primary veins green ____ **7. C. esculenta var. illustris**

Another variety of *Colocasia esculenta* —*C. esculenta* var. *acris* (R. Br.) A.F. Hill, Bot. Mus. Leafl. 7:7. 1939. *Caladium acre* R. Br., Prodr. Fl. Nov. Holl. 336. 1810. *Colocasia acris* Schott in Schott & Endl., Melet. Bot. 18. 1832. *Colocasia antiquorum* Schott var. *acris* Schott, Syn. Aroid. 42. 1856; Prodr. Syst. Aroid. 140. 1860; Engl. in A. DC. Monogr. Phan. 2:492. 1879; Engler & Krause in Engl., Pflanzenr. 4. 23E. 71:68. 1920—differs from the above varieties by the absence of an appendix.

Colocasia esculenta (L.) Schott in Schott & Endl., Melet. Bot. 18. 1832; Kunth, Enum. 3:57. 1841. *Arum esculentum* L., Sp. Pl. 1753. *Caladium esculentum* (L.) Vent., Mag. Enc. 4:471. 1801; Vent., Descr. Pl. Nouv. Hort. Cels t. 30. 1801; Vent. J. Bot. (Schrader) 4:319. 1801. *Colocasia antiquorum* (L.) Schott in Schott & Endl., Melet. Bot. 18. 1832; Kunth, Enum. 3:37. 1841; Hook. f. in Bot. Mag. t. 7364. 1894; Engler & Krause in Pflanzenr., 4. 23E. 65. 1920.

This species is divided into numerous varieties and over 300 forms or land races primarily on the basis of vegetative differences (Engler & Krause 1920; Hill 1939; Neal 1991). The primary criteria for varietal separation are: size, shape, color, and number of tubers produced, texture and chemical composition of tubers, degree of rhizome formation, and foliage morphology and coloration. Flower and fruit characters are also used. Varieties are used as ornamentals or as food crops for the edible, high carbohydrate tuberous rhizomes; some varieties are also invasive weeds. Spadix morphology and color can vary depending on variety. Flesh of tubers ranges in color from white, yellow, lilac-purple, or pink to reddish. Varieties of *Colocasia esculenta* are separated into two groups based on differential affinities for available soil or substrate moisture. Aquatic or wetland varieties prefer aquatic or semi-aquatic conditions of continual soil saturation, while upland forms prefer well-drained but continually moist soils. Both groups will survive under either set of conditions. Vegetative propagation occurs by division of the caudex, new secondary or daughter tubers, rhizome fragments, and buli (top one-third of tuber and 12–20 cm of stem; Neal 1991). Propagation by seed is also effective.

In 1939, A.F. Hill published: *The nomenclature of the taro and its varieties*, showing *Colocasia esculenta* (L.) Schott, 1832 to be an earlier name than *Colocasia antiquorum* Schott, 1832. The species was originally described by Linnaeus as *Arum esculentum*, Sp. Pl. 965. 1753. Our varieties of *Colocasia esculenta* along with synonymy and specific varietal attributes are discussed below.

Varieties *aquatilis*, *antiquorum*, and *nymphaeifolia* differ only slightly in their morphology. Variety *antiquorum* is most easily separated, differing by having petioles often nearly green in color, usually greater tuber development, and less developed rhizomes, whereas both *aquatilis* and *nymphaeifolia* have petioles usually with pronounced reddish or purple coloration, often little to nearly no tuber development, and long, well-developed rhizomes. Varieties *aquatilis* and *nymphaeifolia* essentially differ from each other only in area of origination of rhizomes from the tuber or caudex (see key to species of *Colocasia*). These three varieties intergrade appreciably in form and ecology and probably encompass only a single, hignly variable taxon.

1. **Colocasia esculenta** (L.) Schott. var. **aquatilis** Hassk., Pl. Jav. Rar. 150. 1848. (**Fig. 3**). *Caladium aquatile* Rumph., Herb. Amboin. 5:313. t. 110. f. 1. 174/. *Colocasia antiquorum* Schott var. *aquatilis* Hassk. in Engl., Pflanzenr. 4. 23E. 71:68. 1920.

Colocasia antiquorum Schott var. *stolonifera* (Haines) H.B., Nathani, Flou. Pl. India, Nepal and Bhutan. 454. 1990.

Colocasia esculenta (L.) Schott var. *stolonifera* (Haines) H.B., Nathani, Flou. Pl. India, Nepal and Bhutan. 454. 1990.

Essentially acaulescent herbs to 1.5 m in height from a slightly tuberous caudex, tuberous caudex usually poorly developed to nearly absent, well-developed rhizomes present to 2.5 m in length, elongate, brittle, and covered with tan scale-like cataphylls, distal portion greenish-white and usually lacking the cataphyll covering; leaves 7–40 cm long and 5–30.5 cm wide, ovate, ovate-triangular, or ovate-elliptic, apically rounded to acute, basally cordate, cordate-sagittate, or sagittate, peltate, margins weakly undulate to entire; primarily lateral veins 3–8 per side, ranging in color from green to yellow, or purple, midvein and lateral veins even or minutely raised above the blade on adaxial side of leaf, blade

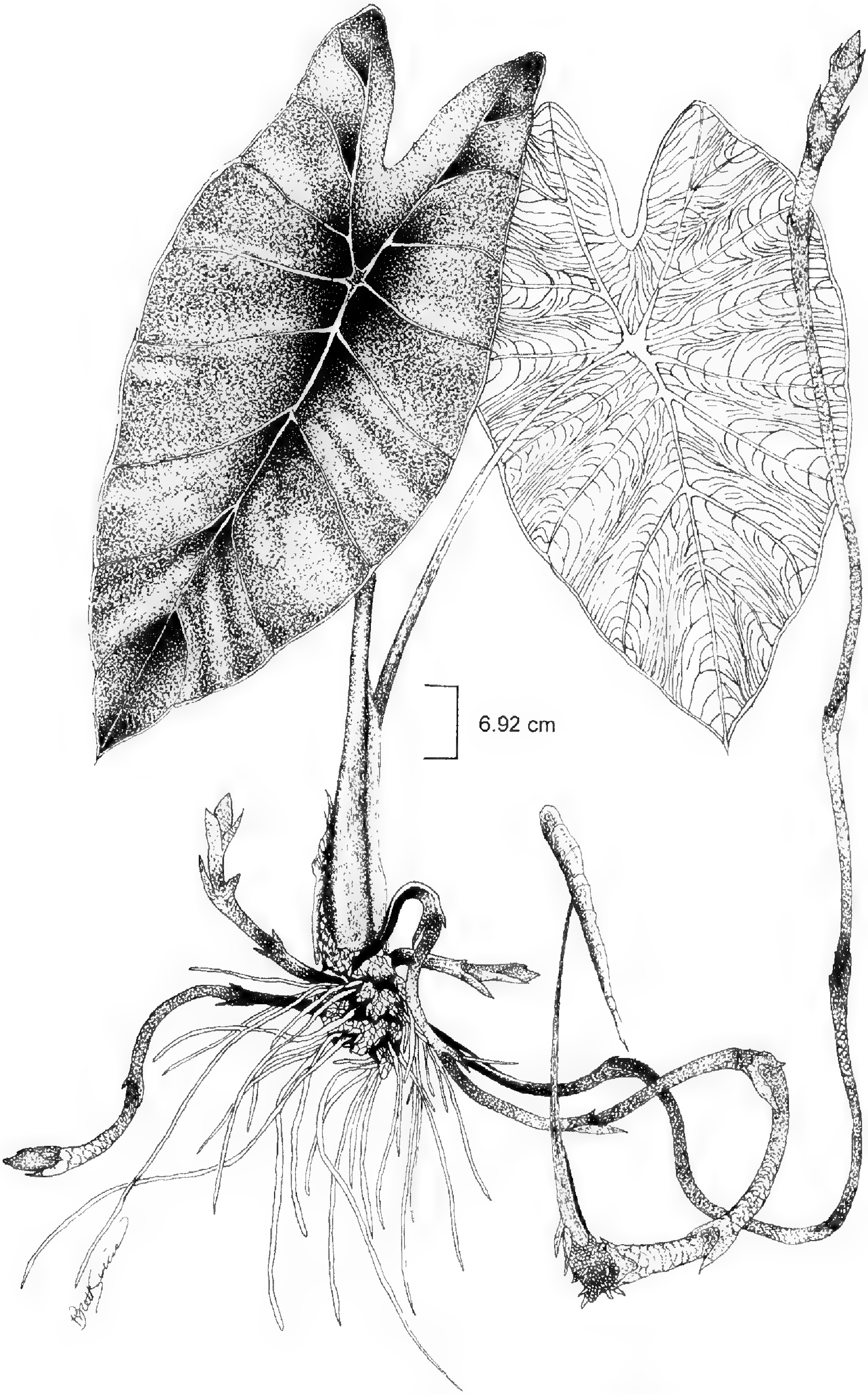

Fig. 3. *Colocasia esculenta* (L.) Schott var. *aquatilis* Hassk. General habit.

glaucous to glaucescent abaxially, petiole 40–180 cm in length, green to red or purple, often green and splotched with purple, sometimes pink basally; inflorescence of 1-numerous spadices, peduncles 15–50 cm long, spathe 10–40 cm long, chartaceous, broadly acuminate, yellow-green, yellow, yellow-orange, or orange; spadix 6–14 cm long, yellow-cream and often tinged with orange or pink, appendix 0.5–3 cm long, region of fertile staminate flowers 2–4 cm long, region of sterile staminate flowers 1.5–5 cm long, region of fertile pistillate flowers 1–2.5 cm long, pistillate flowers essentially without odor; berries red, ellipsoid to oblong and 3–7 mm in diameter.

Originally from southeast Asia, this variety along with varieties *antiquorum* and *nymphaeifolia* have become pantropical weeds of aquatic habitats, particularly rice fields, fresh water marshes, lake and waterway margins, and drainage sloughs. It is truly aquatic and cannot tolerate prolonged conditions of drought without the onset of dormancy. Extended drought over several months usually induces plant fatality. It was introduced into the United States as an ornamental and is completely naturalized as a member of our flora. *Colocasia esculenta* var. *aquatilis* has become an invasive weed in the southeastern U S. It ranges from eastern Texas, to Louisiana, Mississippi, and Alabama, throughout Florida and north to Georgia. Variety *aquatilis* is the most established of the varieties of *Colocasia esculenta* in the United States. Though potentially invasive under any conditions with adequate moisture, the habitat preferences of variety *aquatilis* in the southeast US are continually wet or flooded roadside ditches; freshwater marshes; open areas of floodplains; fresh water beaches, and shallow water along the edges of ponds, lakes, streams, and slow moving waterways. Any environment with shallow standing water or continually wet soil is a potential habitat. Variety *aquatilis* requires little to no disturbance for establishment. It has the potential to aggressively invade and quickly establish vegetative colonies regardless of the floristic component or degree of disturbance. Small colonies and isolated juvenile plants seem to indicate that spread is because of vegetative propagule (rhizome fragments) fragmentation, translocation, and subsequent plant regeneration. This scenario is further supported because of the lack of fruit production in the US by *Colocasia esculenta*.

Although roughly similar in form to *Alocasia macrorrhizos* and *Xanthosoma sagittifolium*, variety *aquatilis* is smaller and generally has more vigorous rhizome production. These stoloniferous rhizomes are capable of producing several plants along their length (up to one per node). Typically only one or two plantlets are produced at the rhizome terminus. Each plant can produce 2–10 or more rhizomes at any one time. Rhizomes are brittle and sever with minimal disturbance. Separation of rhizomes stimulates additional rhizome production. Rhizomes severed before leaves or roots have emerged from the nodes can root and produce new plants on moist soil or in standing water. Extensive colonies of variety *aquatilis* occur throughout Florida, but are otherwise currently restricted to a zone approximately 100 miles inland from the Gulf of Mexico. Some isolated and localized populations occur slightly farther inland and northward. Tuber development is usually reduced or almost absent, the subterranean portion usually only consisting of many fleshy fibrous roots and rhizomes. Large specimens sometimes have more pronounced tuber development at the crown region. Plants with larger more developed tubers (see *Colocasia esculenta* var. *antiquorum*) are not uncommon. Once rhizomes begin to elongate, they often emerge from the soil and become stoloniferous, rooting along the nodes and producing new plantlets. At various lengths, the rhizomes sometimes repenetrate the given substrate. New colonies are nearly exclusively founded by translocation and subsequent establishment of nodal rhizome fragments or small plantlets.

Variety *aquatilis* only occasionally produces flowers in the United States. Flowering usually occurs in mid to late summer (late June through September or October), during which time conditions are dry throughout much of the southeastern US. If the site occupied becomes moderately dry, flowers are often produced. Usually 1–3 inflorescences are produced. Plants will sometimes also flower in wet conditions. Fruit is not normally produced in the continental US and dispersal and colony establishment by seed is rare or absent.

Colocasia esculenta var. *aquatilis* is propagated readily by plantlet division from rhizomes. Plantlets can be removed immediately after emergence from the rhizome so long as the node from which the plantlet originated is left attached, even leafy stem sections with a functioning apical meristem will usually root in water or wet soil. It can be grown with or without soil as long as standing water is provided, but establishment and growth is enhanced with some type of rooting medium. Plants thrive on excess nitrogen and phosphorous. Mature plants transplant readily.

A variegated form of variety *aquatilis* with irregular lutescent areas of yellow to white on leaves and petioles, occurs infrequently within wild-type populations.

Common names.—aquatic elephant-ear, elephant's-ear, wild taro.

2. Colocasia esculenta (L.) Schott var. **antiquorum** (Schott) Hubb. & Rehd. in Bot. Mus. Leafl. 1:1.5. 1932. *Colocasia antiquorum* Schott in Schott & Endl., Melet. Bot. 18. 1832; Schott, Syn. Aroid. 41. 1856; Schott, Prodr. Syst. Aroid. 138. 1860; Kunth, Enum Pl. 3:37. 1841; Engl. in A. DC., Monogr. Phan. 2:491. 1879; Hook. f. in Bot. Mag. 120. t. 7364. 1894; Engl. & Krause in Engl., Pflanzenr. 4. 23E. 71:65. 1920.

Arum aegyptium Rumph., Herb. Amboin. 5:313. t. 109. 1747.
Arum colocasia L., Sp. Pl. 965. 1753.
Arum peltatum Lam., Encyc. 3:13. 1786.
Arum lividum Salisb., Prodr. Stirp. Chap. Allerton 260. 1796.
Colocasia peregrina Rafin., Fl. Tellur. 3:65. 1836.
Colocasia vulgaris Rafin., Fl. Tellur. 3:65. 1836.
Caladium colocasia W.F. Wight in Contr. U.S. Natl. Herb. 9:208. 1905.

Nearly identical in morphology and habit to varieties *aquatilis* and *nymphaeifolia*, variety *antiquorum* differs primarily on the basis of its nearly green petioles, larger tubers (especially those at the crown) and usually shorter, less developed rhizomes, though these can approach the length and development of rhizome formation in varieties *aquatilis* and *nymphaeifolia*.

Introduced for its edible tubers and as an ornamental from southeast Asia, *Colocasia esculenta* var. *antiquorum* is naturalized in the southeastern US but is less widespread than variety *aquatilis*. Variety *antiquorum* prefers margins of ponds and lakes, but will also rapidly colonize and invade lawns, flower beds, and other disturbed sites so long as adequate soil moisture is present. Establishment and complete invasion of various lawns and gardens was observed in Baton Rouge, Louisiana, in 1998 by both varieties *antiquorum* and *nymphaeifolia*. Plants prefer moist to saturated soil or shallow water and usually do not occur in water over 30 cm deep.

The primary mode of reproduction is vegetative and occurs from secondary tubers, or plantlets produced from rhizomes. Variety *antiquorum* requires similar conditions for growth, colonization and expansion, and flowering as variety *aquatilis*. Flower morphology is similar to variety *aquatilis*, and as in variety *aquatilis*, fruit is not normally produced in the continental US. It seems to withstand somewhat drier conditions than variety *aquatilis*. It occurs from east-central Texas, east to the Atlantic coast, and from Georgia southward throughout Florida.

Common names.—Egyptian taro, culgas, qolqas, black taro, eddoe, eddo, kalo, elephant-ear.

3. Colocasia esculenta (L.) Schott var. **esculenta** Schott, Syn. Aroid. 42. 1856. *Arum esculentum* L., Sp. Pl. 965. 1753. *Caladium esculentum* (L.) Vent., Descr. Pl. Nouv. Jard. Cels 30. t. 1800; Vent., Mag. Enc. 4:471. 1801; Vent., J. Bot. (Schrader) 4:319. 1801. *Colocasia antiquorum* Schott var. *esculenta* Schott, Syn. Aroid. 42. 1856; Schott, Prodr. Syst. Aroid. 140. 1860; Engl. in A. DC., Monogr. Phan. 2:492. 1879; Engl. & Krause in Engl., Pflanzenr. 4. 23E. 71:67. 1920.

Arum maximum Bauhin in Verh. Batav. Gen. 4. 1790.
Colocasia esculenta (L.) Schott var. *typica* Engl., Vers. Entwicklungsgesch. Extratrop. Florengeb. 8. 1879.

Variety *esculenta* is the most common ornamental form grown in the US and is characterized by its large tubers (up to 22 cm long and 18 cm in diameter), leaves, and size (to 2 m or more tall). Usually only a few tubers are produced per plant at any one time. *Colocasia esculenta* is the most important species of Araceae in terms of food production worldwide (Bailey 1997; Vaughan & Geissler 1997; Neal 1991). The tubers have a high starch content (approx. 25%), some protein, and 13 mg/100 g vitamin C. Small secondary tubers, also known as cormels, are equally consumed (Vaughan & Geissler 1997). Secondary tubers develop directly from the primary caudex or at the nodes or terminus of rhizomes. The foliage is also eaten and normally contains 7 mg/100 g carotene, and 52 mg/100 g vitamin C; all parts of the plant are used as food in certain regions of Africa and Asia. Removal of calcium oxylate from the tubers is accomplished through boiling (Vaughan & Geissler 1997; Neal 1991). Chemical composition of the tubers produced by *Colocasia* is similar to those of *Alocasia* and *Xanthosoma* (Vaughan & Geissler 1997). *Colocasia* is grown as a food source in the United States and Mexico, throughout the neotropics, Africa, and Asia. It is a staple food crop in many areas of Africa where it is known as cocoyam (Vaughan & Geissler 1997; Neal 1991). The amount of tuber production varies with varietal type, soil texture, environmental conditions, and health of the plant (Young 1946).

Common names.—taro, elephant-ear, elephant-plant.

4. Colocasia esculenta (L.) Schott var. **euchlora** (C. Koch and Sello) A.F. Hill, Bot. Mus. Leafl. 7:7. 1939. *Colocasia euchlora* C. Koch and Sello in Ind. Sem. Hort. Bot. Berol. App. 4. 1854. *Colocasia antiquorum* Schott var. *euchlora* Schott, Syn. Aroid. 42. 1856; Schott, Prodr. Syst. Aroid. 140. 1860; Engl. in A. DC. Monogr. Phan. 2:491. 1879; Engl. & Krause in Engl. Pflanzenr. 4. 23E. 71:67. 1920.

Plant to 92 cm tall, leaves with lamina bright green, margins usually purple, petioles and veins red to purple. Rhizomes similar to those of varieties *aquatilis* or *nymphaeifolia* but red or purple in color and usually shorter. Similar to variety *fontanesii* in coloration but smaller. Vegetative reproduction by rhizomes and secondary tubers. Grown in extreme southern US but no current record of establishment outside cultivation.

Common name.—purple-stemmed taro.

5. Colocasia esculenta (L.) Schott var. **fontanesii** (Schott) A.F. Hill, Bot. Mus. Leafl. 7:7. 1939. *Colocasia fontanesii* Schott in Oestr. Bot Wochenbl. 4. 409. 1854. *Colocasia antiquorum* Schott var. *fontanesii* Schott, Syn. Aroid. 42. 1856; Schott, Prodr. Syst. Aroid. 140. 1860; Engl. in A. DC., Monogr. Phan. 2:491. 1879; Hook. f. in Bot. Mag. 126. t. 7732. 1900; Engl. & Krause in Engl. Pflanzenr. 4. 23E. 71:67. 1920.

Arum colocasioides Desf., Cat. Hort. Par. ed. 3. 7. 385. 1829.
Caladium violaceum Hort. ex Engl. in DC. Monogr. Phan. 2:492. 1879; Desf., Cat. Hort. Par. ed. 3. 7. 1829.
Caladium colocasioides Hort. Par. ex Brongn. in Nouv. Ann. Mus. Par. 3. 156. 1834; Kunth, Enum. Pl. 3:43. 1841.
Colocasia violacea Hort. ex Hook. f. in Bot. Mag. 126. t. 7732. 1900.

Nearly identical in form to variety *euchlora*, but larger—to 2.14 m tall, and more robust with the petioles and veins of leaf usually black or dark purple; lamina dark green, often tinged with purple coloration. Rhizomes similar to varieties *aquatilis* and *nymphaeifolia*, but purple to purple-black and thicker. A form with completely purple to purple-black foliage is also cultivated in the US. Lamina, petioles, peduncles, and spathe all purple, undersurface of leaf glaucous-purple, roots often with pink or purple coloration. Leaves on plants grown under shade conditions and newly emergent leaves are blue-green with purple coloration along veins and petioles. Newly emergent leaves on juvenile plants sometimes green. This form actually appears to be an intervarietal cross between varieties *fontanesii* and *illustris*—being phenotypically intermediate between the two. Both forms are vegetatively aggressive similar to varieties *aquatilis* and *nymphaeifolia*. Cultivated in extreme southern US and observed spreading vegetatively at these sites but no record of establishment outside cultivation. It is another potentially weedy variety.

Common Names.—black-stemmed taro, black taro, purple taro, black magic taro.

6. Colocasia esculenta (L.) Schott var. **globulifera** (Engl. & Krause) Young in U.S. Dept. Agric. Dept. Bull. 8:1247. 1924. *Colocasia antiquorum* Schott var. *globulifera* Engl. & Krause in Engl. Pflanzenr. 4. 23E. 71:68. 1920.

This upland variety is grown commercially in the US for its small edible tubers. Individual plants normally produce 20 or more 2–10 cm long secondary tubers terminating short rhizomes or originating from the primary caudex. Plants to 95 cm tall. Variety *globulifera* is not well-established in the US but does occur and persist near areas where it is in production.

Common name.—dasheen.

7. Colocasia esculenta (L.) Schott var **illustris** (Bull.) A.F. Hill, Bot. Mus. Leafl. 7:7. 1939. *Alocasia illustris* Bull., Cat. 4. 1873; Bull. in Flor. Mag. t. 107. 1874. *Colocasia antiquorum* Schott var. *illustris* Engl. in A. DC. Monogr. Phan. 2:492. 1879; Engl. & Krause in Engl. Pflanzenr. 4. 23E. 71:67. 1920.

Plants to 1m tall and resembling varieties *aquatilis* and *nymphaeifolia* in form but less aggressive and usually with shorter, more tuberous rhizomes. Newly formed rhizomes are more slender than those of varieties *aquatilis* or *nymphaeifolia*. Leaves with lamina green and spotted to completely purple between primary veins, primary veins green, lamina glaucous abaxially, petioles green with red or red-brown coloration or completely red. Variety *illustris* is cultivated in the extreme southern US. It is not currently naturalized but spreads locally where cultivated and could potentially be invasive under favorable conditions.

Common names.—Imperial taro, black caladium.

8. Colocasia esculenta (L.) Schott var. **nymphaeifolia** (Vent.) A.F. Hill, Bot. Mus. Leafl. 7:7. 1939. **(Fig. 4).** *Caladium nymphaeifolium* Vent., Descr. Pl. Nouv. Jard. Cels sub t. 30. 1800; Willd., Sp. Pl. 4. 488. 1805. *Arum nymphaeifolium* Roxb., Hort. Beng. 65. 1814; Roxb., Fl. Ind. 3:495. 1814. *Colocasia nymphaeifolia* Kunth, Enum. Pl. 3:87. 1840. *Colocasia antiquorum* Schott var. *nymphaeifolia* Schott, Syn. Aroid. 42. 1856; Schott, Prodr. Syst. Aroid. 140. 1860; Engl. in A. DC., Monogr. Phan. 2:492. 1879; Engl. & Krause in Engl., Pflanzenr. 4. 23E. 71:67. 1920.

Practically identical in form and habit to variety *aquatilis* (see varietal discussion following *Colocasia esculenta*) but differs by producing rhizomes exclusively from the base of tubers. Similar range and ecology as var. *aquatilis* but seemingly less common.

Common names.—aquatic elephant-ear, taro.

9. Colocasia gigantea (Blume) Hook. f., Fl. Britt. Ind. 6:524. 1893.

Caulescent, erect, terrestrial or epilithic herbs to 2 m or more in height from a tuberous caudex. Leaves 20–120 cm long and 15–90 cm wide, ovate, apically rounded to acute, basally cordate, cordate-sagittate, or sagittate, peltate, apices short-acuminate, margins undulate; primarily lateral veins 4–8 per side, lamina green, petiole 20–150 cm in length, light green, white-pruinose; inflorescence of 1-numerous spadices, peduncles 20–55 cm long, spathe 25–50 cm long, chartaceous, short-acuminate, white; spadix 8–23 cm long, yellowish, appendix 3 6 mm long, region of fertile staminate flowers 2–9.5 cm long, region of sterile staminate flowers 2–4.5 cm long, region of fertile pistillate flowers 4–8 cm long; berries oblong to 1 cm in diameter.

Colocasia gigantea is similar to *Colocasia esculenta* and *Alocasia macrorrhizos*, and is included here to alleviate any confusion in identification of plants encountered. This species is rarely cultivated and not currently established outside cultivation in this country. Native to Java.

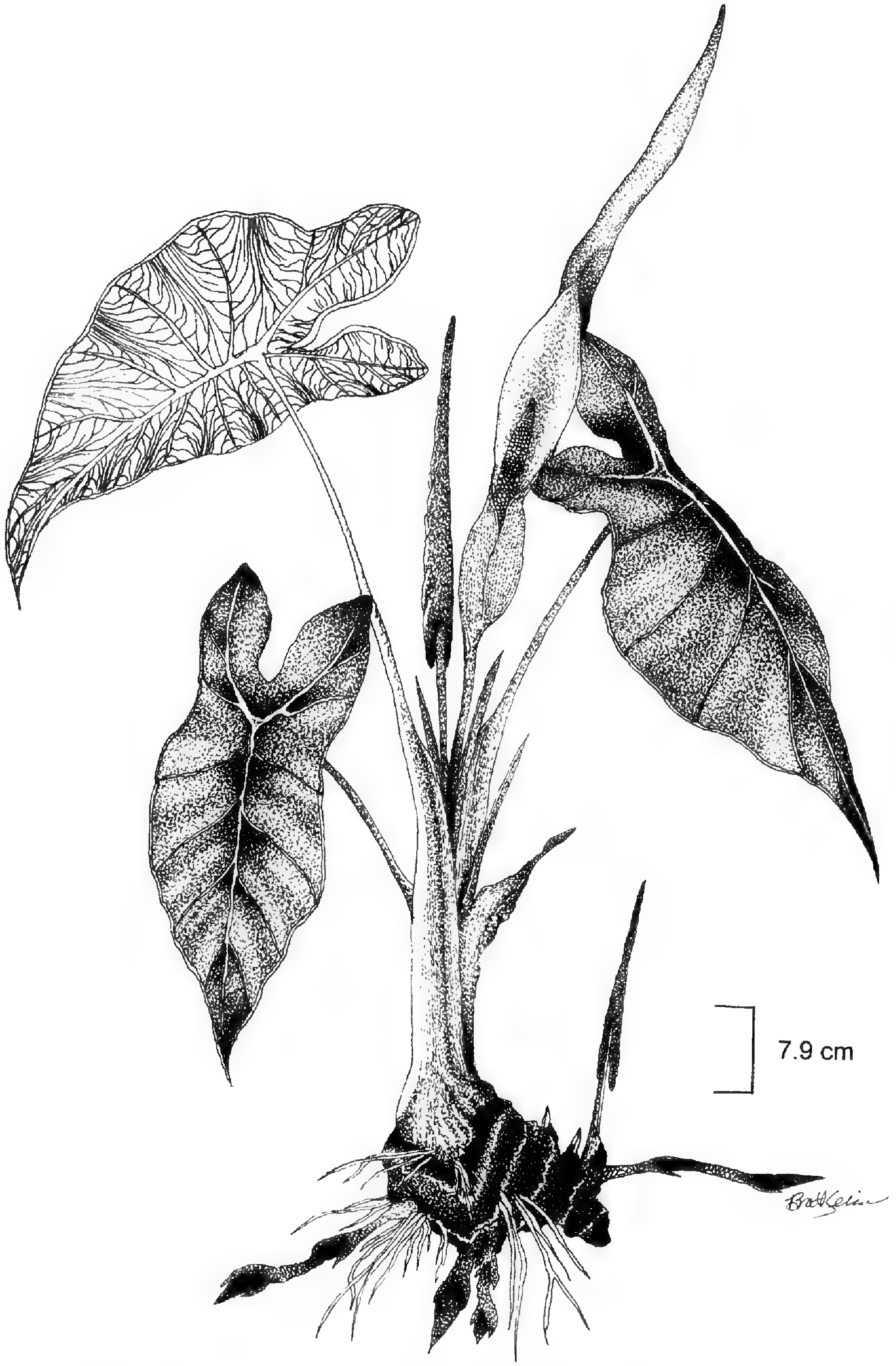

Fig. 4. *Colocasia esculenta* (L.) Schott var. *nymphaeifolia* (Vent.) A.F. Hill. General habit.

Common names.—giant taro, elephant-ear.

XANTHOSOMA

Xanthosoma Schott in Schott & Endl., Melet. Bot. 19. 1832; Engler Pflanzenr. 4. 23E. 71:41. 1920. Lectotype species: *Xanthosoma sagittifolium* (L.) Schott, *Arum sagittifolium* L.

Acontias Schott, Melet. Bot. 19. 1832.
Phyllotaenium André in Illust. Flortic. 19:3. t. 88. 1872

Perennial caulescent to acaulescent herbs, with or without a tuberous caudex. Tubers and or rhizomes typically present, asexual reproduction by means of secondary or daughter tubers and or rhizomes. Above ground stems erect to decumbent; leaves ovate, triangular-ovate to ovate-elliptic, long petioled, basally hastate, three to several lobed or pedatisect, leaves and stems glaucous or not; spadix pedunculate, arising axillary and subtended by 1 or 2 acute to acuminate bracts, staminate and pistillate flowers separated by a section of synandrodes (sterile staminate flowers), sterile appendix reduced or absent; spathe present, 1–3 times longer than spadix, constricted basally to form a tube which encloses the spadix prior to anthesis, the basal portion remaining tightly closed; staminate flowers comprised of synandria of 4–6 stamens; pistillate flowers 1-carpellate, 2–4-locular, stigma discoid, ovules numerous, placentation pseudoaxile or parietal; fruit a cylindrical, furrowed berry; ovules usually 12–20, but can be numerous, anatropous or hemianatropous, funicles long; seed ovoid, testa costate, endosperm copious.

About 58 species originating in the neotropics. Currently only *X. sagittifolium* is naturalized in the United States.

Etymology.—Greek: *xantho*, the color yellow and *soma*, a body; yellow body—probably in reference to the yellow color of various stem tissues.

KEY TO SPECIES OF *XANTHOSOMA*

1. Leaves entirely green to green-blue, young leaves green to green-blue; petioles green to glaucous ____ **1. X. sagittifolium**
1. Leaves green but margins and veins usually purple, young leaves blue-purple to primrose; petioles often purple but can be yellow-green ____ **2. X. violaceum**

1. Xanthosoma sagittifolium (L.) Schott in Schott & Endl., Melet. Bot. 19. 1832; Engler, Pflanzenr. 4. 23E. 71:45. f. 9A. 1920. (**Fig. 5**). *Arum sagittifolium* L., Sp. Pl. 966. 1753. *Arum sagittaefolium* L., 1.c., ed. 2, 1369. 1763. *Caladium sagittifolium* (L.) Vent., Mag. Enc. 4(16):471. 1801; Vent., Arch. Bot. (Leipzig) 2(3):351. 1801; Vent., J. Bot. (Schrader) 4(6):319. 1801. *Caladium sagittaefolium* (L.) Willd., Sp. Pl. 4:489. 1805; Spreng. Syst. Veg. 3:771. 1826. *Xanthosoma sagittaefolium* (L.) Schott in Schott & Endl., Melet. Bot. 19. 1832.

Arum acaule Plum., Pl. Amer. t. 35. 1756.
Arum triangularis Plum., Pl. Amer. t. 35. 1756.
Arum xanthorrhizon Jacq., Pl. Hort. Schoenbr. 2:32. 1797. *Caladium zanthorrhizom* (Jacq.) Willd., Sp. Pl. 4:490. 1805. *Xanthosoma xanthorrhizon* (Jacq.) C. Koch, Bonplandia 4:4. 1856.
Caladium edule G.F.W. Mey, Fl. Esseq. 272. 1818. *Xanthosoma edule* (G.F.W. Mey) Schott in Schott & Engl., Melet. Bot. 19. 1832.

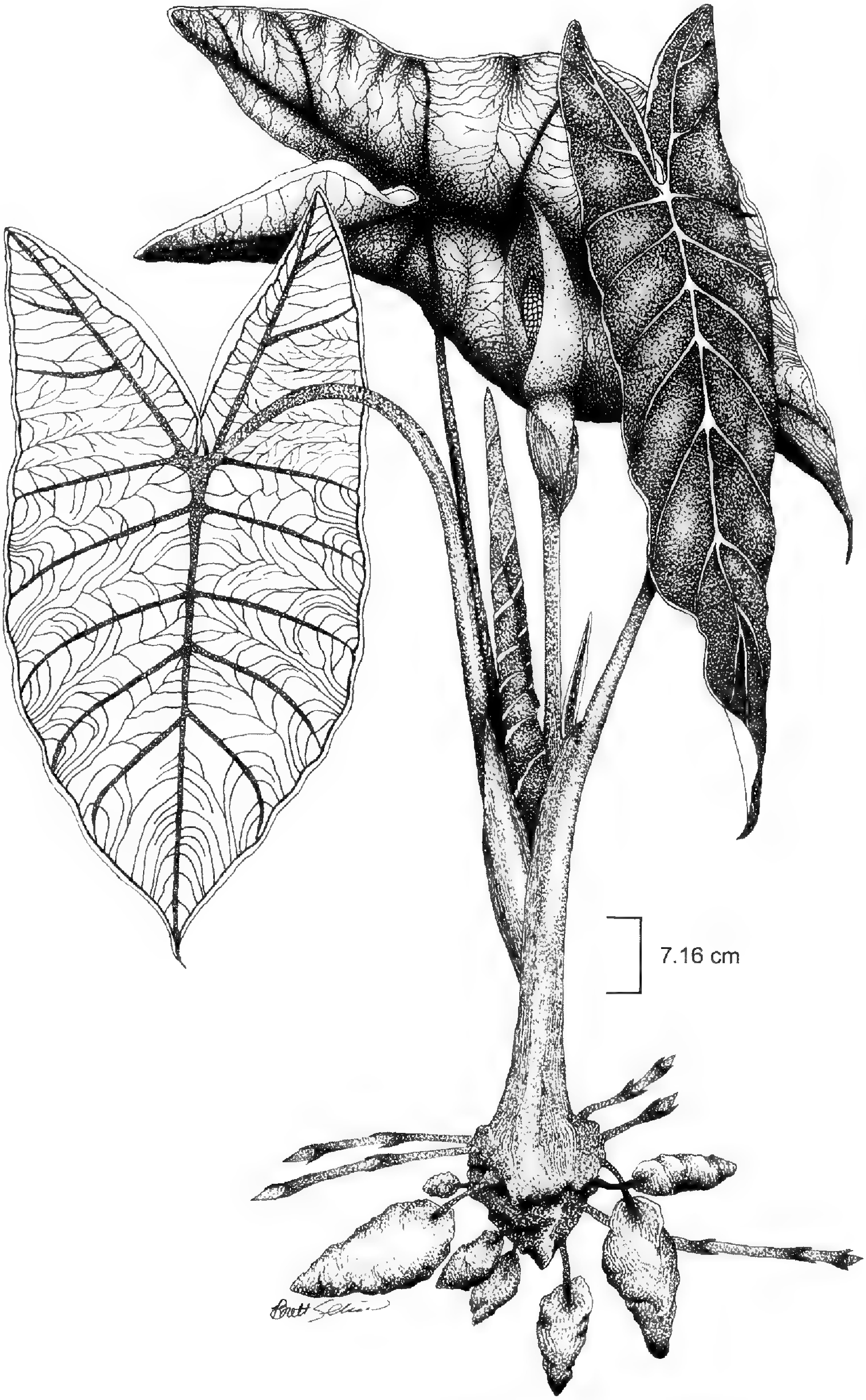

Fig. 5. *Xanthosoma sagittifolium* (L.) Schott. General habit.

Xanthosoma atrovirens C. Koch and Bouché, Ind. Sem. Hort. Berol. 3. 1854.
Xanthosoma utile C. Koch & Bouché, Ind. Sem. Hort. Berol. 2. 1854.
Xanthosoma zanthorrhizon C. Koch, Bonplandia 4:4. 1856.
Xanthosoma wendlandii Schott in Oestr. Bot. Zeitschr. 15:3. 1865.
Caladium utile Hort. ex Engl. in A. DC. Monogr. Phan. 2:469. 1879.

Caulescent herbs to 3.5 m in height from a tuberous caudex, tubers and tuberous caudex poorly developed or absent in juvenile plants; well-developed rhizomes present to 1 m or more in length, elongate, slender, without scaly covering of cataphylls, often tuberous at various places along the length, white and often tinged with light green; leaves 20–120 cm long and 15–90 cm wide, ovate to triangular-ovate, apically acute to acuminate, basally hastate-each lobe distally acute, margins weakly but broadly undulate or entire, abaxial surface usually glaucous; primary lateral veins 3–9 per side, whitish or light green, lighter than the surrounding blade, midvein and lateral veins sunken below the blade on adaxial side of leaf; petioles green to glaucous; inflorescence of 1-numerous spadices, peduncles 20–30 cm long, glaucous or glaucescent; spathe 18–22 cm long and 4 cm wide, chartaceous, pale green to glaucescent, turning cream to peach with age; spadix 6–13 cm long, green to cream or yellowish, appendix 3–4 cm long, fertile staminate region 5–7 cm long, sterile staminate region 3–4 cm long, fertile pistillate region 3.5–5 cm long, pistillate flowers with slight odor of ether; berries ovoid, yellow, 7–10 mm long and 4–8 mm in diameter.

Native to the neotropics and cultivated in Central and South America and the West Indies since pre-Columbian times (Vaughan & Geissler 1997). It was introduced into the United States as an ornamental for its large size, leaves, attractive flowers, and fruit (Bailey 1997; Vaughan & Geissler 1997). *Xanthosoma sagittifolium* is naturalized throughout central and southern Florida and in southern Texas. It is highly rhizomatous and can become an invasive weed in areas of disturbance and adequate moisture. This species has the potential to increase as a weed under favorable conditions.

Plants generally produce large, somewhat elongate, oblong, subterranean tubers along the length or at the end of slender rhizomes or from the base of the crown. Juvenile plants have little or no tuber development; instead they possess a network of fleshy fibrous roots interspersed with elongate slender rhizomes. Large colonies are formed through vegetative propagation by rhizomes. Small to medium sized colonies of immature plants at the rhizome stage are often observed. Such plants likely arise through vegetative fragmentation and subsequent relocation of the rhizome fragments. Dispersal and establishment from seed is also possible but less likely. Although fruit production is not often observed, plants are self compatible, with a single individual or colony producing fruit and viable seed. It can be difficult to determine whether new populations originated from seedlings or from vegetative plant propagules. Vegetative expansion seems a more plausible explanation. This species is probably not distinct from the similar *X. atrovirens* C. Koch and Bouché.

Xanthosoma sagittifolium prefers moderate to high soil disturbance and soil water content. It is generally found in any disturbed area where water collects; along roadside ditches, pond and lake margins, drainage areas, freshwater wetlands, marshy woods, seasonably wet sites, woodland edges, old fields, vacant city lots, roadsides, and home sites. Although *X. sagittifolium* prefers soil conditions that are moderately hydrated to highly saturated, it will grow on mesic slopes and other habitats with well-drained soils, as long as adequate moisture is present. It was observed in both wet and mesic sites in Ocala and Bellview, Florida, in 1996 and 1997. *Xanthosoma sagittifolium* has minimal cold tolerance. It withstands occasional freezing temperatures, but cannot sustain prolonged freezing. Juvenile, unestablished plants are most susceptible to freezing because older plants can regenerate from tubers. The tubers are used as a food source throughout the American tropics and to a lesser extent in the South Pacific and Africa (Bailey 1997; Vaughan & Geissler 1997; Neal 1991). The tubers are similar in chemical composition to those of *Colocasia* or *Alocasia,* but the starch is more difficult to digest (Vaughan & Geissler 1997). In West Africa, the tubers are preferred over those of *Colocasia* for the production of the food substance known as fufu (Vaughan & Geissler 1997).

Xanthosoma sagittifolium is easily cultivated. Vegetative propagation is accomplished through tuber division, rhizome tip development and fragmentation, plantlet removal, and crown division. Small plantlets can be removed from the parent plant at the 2–3 leaf stage so long as the entire stem is intact. Unlike *Colocasia*, rhizomes of *Xanthosoma* are primarily subterranean. Even mature individuals transplant readily.

Common names.—arrowleaf-elephant-ear, elephant-ear, yautia, malanga, tannia, tanier, tanyah, tajer, ocumo, cocoyam.

2. Xanthosoma violaceum Schott, Ind. Sem. Hort. Berol. 370. 1853; Schott in Oest. Bot. Wochenbl. 417. 1854.

Arum nigrum Vell., Fl. Flumin. 9. t. 107. 1829. *Xanthosoma nigrum* (Vell.) Mansf., Verz. Pfl. Deut. Reich. 1940.
Arum variolatum Schott, Prod. Syst. Aroid. 81. 1860.
Xanthosoma ianthium C. Koch & Bouché, Ind. Sem Hort. Berol. 2. 1854.

Caulescent herbs 30–150 cm in height, from a tuberous caudex, stems purple or yellow-green, tubers and tuberous caudex poorly developed or absent in juvenile plants; well-developed rhizomes present to 1 m or more in length, elongate, slender, without scaly covering of cataphylls, often tuberous at various places along the length, white and often tinged with light green or pink coloration; leaves 30–100 cm long and 15–75 cm wide, ovate to triangular-ovate or ovate-oblong, apically acute to acuminate, basally sagittate to hastate—each lobe distally obtuse to acute and unequal, margins weakly but broadly undulate or entire, abaxial surface usually glaucous; primary lateral veins 4–9 per side, purple or rarely a pale yellow-green, midvein and lateral veins sunken below the blade on adaxial side of leaf, petioles usually purple, sometimes yellow-green, older leaves dark green, young leaves blue-purple or yellow-green with purple or yellowish primary or secondary veins; inflorescence of 1-numerous spadices, peduncles 30–50 cm long, glaucous or glaucescent; spatne 7–10 cm long and 3.5 4 cm wide, chartaceous, constricted portion purple to violet, green to yellow-green and violet-striate; spadix 15–25 cm long, initially purple but with age becoming grey or yellowish, appendix absent, fertile staminate region 10–15 cm long, sterile staminate region 3–5 cm long, fertile pistillate region 3–5 cm long, pistillate flowers with slight odor of ether; berries ovoid, yellow, 7–10 mm long and 4–8 mm in diameter.

Cultivated in southern Florida but not strongly naturalized. Plants have been observed spreading vegetatively at sites of cultivation, and eventual establishment outside these conditions is probable. *Xanthosoma violaceum* is cultivated throughout the tropics for its edible tubers similar to *X. sagittifolium*. The exact area of origin (possibly the West Indies) for *X. violaceum* is uncertain, but it originated in the neotropics. Ecology similar to that of *X. sagittifolium*.

Common names.—blue tannia, blue taro, blue ape, tanier, tajer.

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GEOGRAPHIC DISTRIBUTION PATTERNS OF THE GENUS *ARIOCARPUS* (CACTACEAE) IN TAMAULIPAS, MEXICO

José Guadalupe Martínez-Avalos

Instituto de Ecología y Alimentos
Universidad Autónoma de Tamaulipas
13 Blvd. López Mateos 928
Cd. Victoria, Tamaulipas, MÉXICO 87040

Humberto Suzán-Azpiri

Escuela de Biología
Universidad Autónoma de Querétaro
Cerro de las Campanas s/n Querétaro
Querétaro, MÉXICO 76010

ABSTRACT

The geographic distribution of the genus *Ariocarpus* in the State of Tamaulipas, Mexico was determined based on literature, herbarium vouchers, botanical gardens and several field trips in 1991 and 1992. Three species and two subspecies were detected: *Ariocarpus agavoides, A. kotschoubeyanus, A. retusus* subsp. *retusus and A retusus* subsp. *trigonus. Ariocarpus agavoides* is extremely restricted geographically, occupying an area less than 2 km^2; the main factor responsible for its distribution is soil type, which has clay texture, low organic matter content and a slightly alkaline pH. *Ariocarpus retusus* subsp. *trigonus* has the largest distribution (all the arid and semiarid portions of the state) probably because of its tolerance to different ecological factors, such as vegetation, soil types, and its ability to survive even if nurse plants were removed.

Key words: *Ariocarpus*, Geographic distribution.

RESUMEN

Se determinó la distribución geográfica del género *Ariocarpus* en el estado de Tamaulipas, México con base en revisiones bibliográficas, consultas de herbarios, jardines botánicos, así como en recorridos de campo realizados en 1991 y 1992. Se encontraron tres especies y dos subespecies: *Ariocarpus agavoides, A. kotschoubeyanus, A. retusus* subsp. *retusus y A. retusus* subsp. *trigonus. Ariocarpus agavoides* se encuentra extremadamente restringida geográficamente, ocupando un área no mayor a 2 km^2; el factor responsable de su distribución es el tipo de suelo, el cual se caracteriza por su textura arcillosa, bajo contenido de materia orgánica, así como un pH ligeramente alcalino. *Ariocarpus retusus* subsp. *trigonus* presenta el mayor rango de distribución (ocupando las regiones áridas y semiáridas del estado) debido a su tolerancia a diferentes factores ecológicos tales como vegetación, tipo de suelo, y a su sobrevivencia cuando las plantas nodrizas son removidas.

INTRODUCTION

The genus *Ariocarpus* described by Scheidweiler in 1838 (Mitich & Bruhn 1977), is widely distributed in the Chihuahuan Desert (Anderson 1960). This desert is located in the Mexican highlands that includes portions of the states of Texas (U.S.A.) and Coahuila, Nuevo León, San Luis Potosí, Hidalgo, Querétaro, Zacatecas, and Tamaulipas in México (Shreve 1951; Jaeger 1957; Rzedowski 1978; Bravo 1978). In Tamaulipas this region is known as the Tamaulipan Arid Zone (Bravo & Sánchez-Mejorada 1992) including the municipalities (*municipios*) of Tula, Palmillas, Miquihuana, Bustamante and Jaumave (Fig. 1).

The genus *Ariocarpus* includes seven species: *Ariocarpus agavoides* (Castañeda) E.F. Anderson, *A. bravoanus* H. Hernández & E.F. Anderson, *A. kotschoubeyanus* (Lemaire) K.

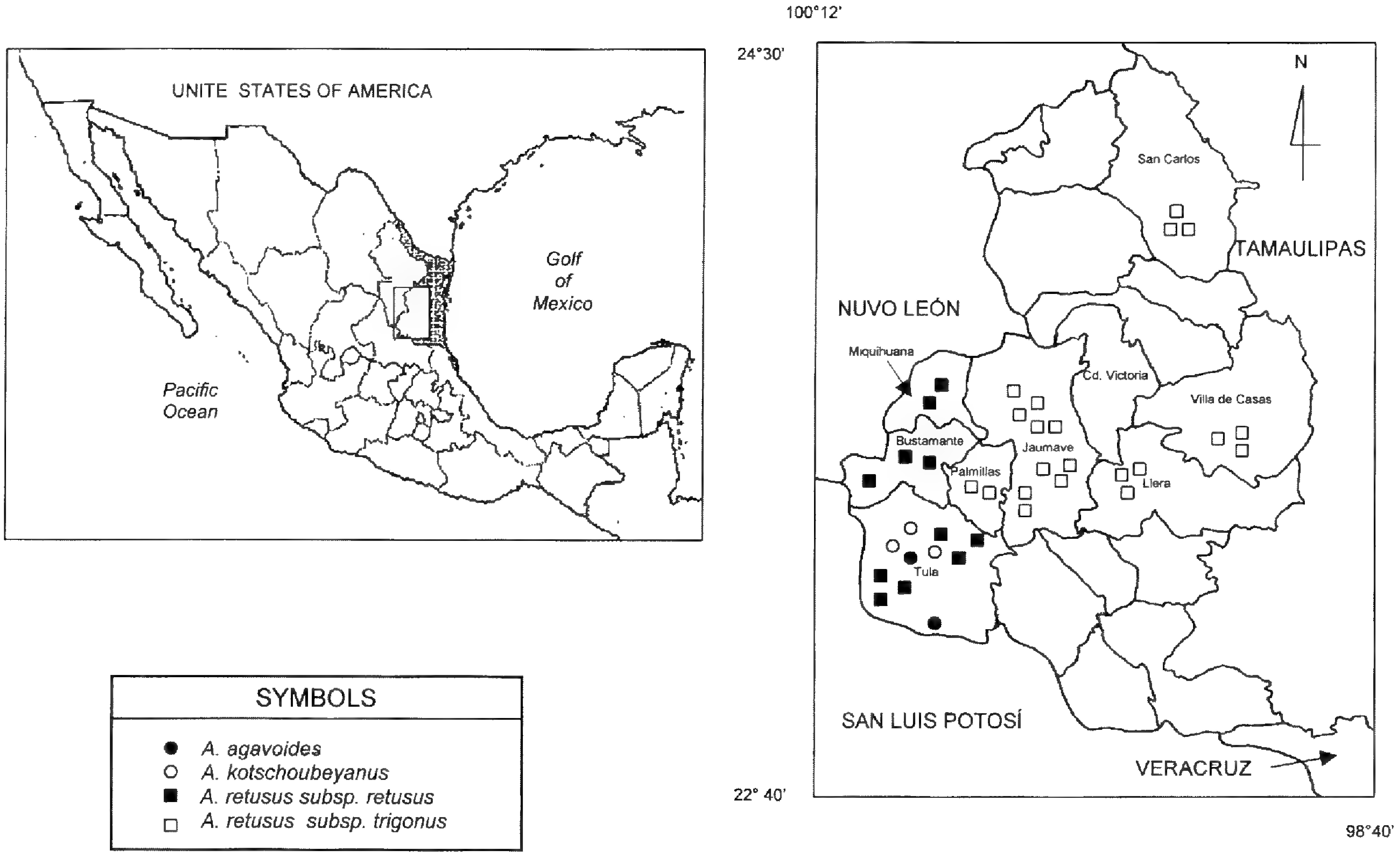

Fig. 1. Map of the state of Tamaulipas, with the distribution of *Ariocarpus* species.

Shumann, *A. fissuratus* (Engelmann) K. Schumann, *A. retusus* Scheidweiler, *Ariocarpus trigonus* Weber, and *A. scaphirostris* Boedeker (Hunt 1992; Hernández & Godínez 1994). Nevertheless in a recent revision of the genus Anderson and Fitz Maurice (1998) added two new subspecies, *A. bravoanus* H. Hernández & E.F. Anderson subsp. *hintonii* E.F. Anderson & Fitz Maurice, and *A. retusus* K. Schumann subsp. *trigonus* (Weber) Scheidweiler based on morphological traits, and hybridizing populations. All taxa are considered threatened or endangered (Anonymous 1991; CITES 1992; UICN 1985; Vovides 1988). The biggest threat to the survival of *Ariocarpus* species is habitat fragmentation due to the removal of natural vegetation in large areas, overgrazing, highway construction, development of urban areas and over-collection of wild populations by commercial and amateur collectors for sale as ornamental plants (Sánchez-Mejorada 1982, 1987; Hernández & Godínez 1994).

The literature published on the genus includes the works by Anderson (1958, 1960, 1961, 1962, 1963, 1964); Bravo (1978), Bravo and Sánchez-Mejorada (1992) and Sánchez-Mejorada (1987).

Only one species of the genus have been studied with an ecological perspective (*Ariocarpus trigonus)* by Suzán et al. (1989) and Martínez et al. (1993).

In Tamaulipas little is known about the distribution and viability of these species because no floristic inventories and demographic studies necessaries for the definition of the real status of each species exists to date (Vázquez-Yanes 1979). The main objective of the present study is to document the geographic distribution of the genus *Ariocarpus* in the state of Tamaulipas, México.

METHODS AND MATERIALS

The state of Tamaulipas is located at the northeastern portion of México, bordered by U.S.A. to the north, the States of San Luis Potosí and Veracruz to the south, Gulf of Mexico to the east, and State of Nuevo León to the west. Three major climatic regions according to the Köppen classification modified by García (1964) exist in the state: 1) the central-north region with semi-arid, semi-hot climates, with little annual rainfall (BS1 hw); 2) the southeast region with hot sub-humid or humid climates with summer rainfall (Awo); 3) the south-west region located in the Sierra Madre Oriental with climates ranging from semi-hot sub-humid climates (A) C (W1) (W) to semi-hot humid climates (A) C (m) (w), in an altitude gradient on the eastern slope, and the semi-hot subhumid (A)C(m)(w) to dry semi-hot Bsohw, in an altitude gradient on the western slope (Secretaría de Programación y Presupuesto (SPP) 1985).

The vegetation is dominated by the thorn-forest (north central region), the xerophytic shrubland (south-west region), and tropical deciduous forests (southeast region). In the highlands of the Sierra Madre Oriental, Pine-Oak and Cloud forests are the dominant vegetation types (Table 1) (Marroquín et al. 1964; Rzedowski 1978).

Data were gathered from voucher specimens at the following herbaria: DS, GH, IBUG, K, MEXU, MO, NY, POM-RSA, UAT, US (Holmgren et al. 1981).

TABLE 1. Climatic characteristics of the different municipalities in Tamaulipas where *Ariocarpus* species were detected. Data from Secretaría de Programación y Presupuesto (1985).

Species	Municipality	Vegetation	Soils	Climate	Altitude **(m)**	Temperature **(°c)**	Precipitation **(mm)**
A. agavoides	Tula	Ms	Xk	BSohw	900–1250	21	436
A. kotschoubeyanus	Tula	Ms	Xk	BSohw	1120–1200	21	436
A. retusus subsp. *retusus*	Tula	Mr, Xk	I	Bsohw, BSlhw	1100–1300	21	434
	Bustamente	Mr, Ch	I, Xk	Cx, BSlkx	1700–1900	17	464
	Miquihuana	Mr, Ch	I, Xk	Bsohx, BSlkx	1600–1900	17	464
A. retusus subsp. *trigonus*	Jaumave	Mr, MeT	Bk, I, Xk	BSlhw, Bsohw	600–900	23	469
	Palmillas	MeT	Bk, I	(A)C(wo)	1100–1300	19	606
	V. de Casas (San Francisco)	Sbc	Bk	BSl(h)hw, Awo	200–304	24	749
	San Carlos	MeT, M	Bk, Zg	(A)C(wo)	150–190	24	809
	Llera	Sbc	Zg	Awo	350 -450	25	789

Ms= submontane shrubland; MeT – tamaulipan shrubland; Mr = century plants shrubland; Ch = chaparral; Sbc = tropical dry forest; M = mesquite forest; Xk = calcic xerosols; Bk = calcic cambisol; I = Litosoil; Zg = Solonchak gleyic; Bsohw = semidry semi-warm; BS1hw = temperate semidry; (A)C(wo) = semi-warm sub-humid with winter rains; BS1(h)hw = semidry warm; Awo = warm sub-humid with winter rains.

Living specimens of *Ariocarpus* were studied in the botanical gardens: Jardín Botánico de la Universidad Nacional Autónoma de México (UNAM); Colección de Cactáceas del Instituto de Ecología y Alimentos (UAT); Jardín Botánico del Instituto Tecnológico de Ciudad Victoria, Tamaulipas (ITCV). Field work was carried out through the state, in order to visit reported sites of *Ariocarpus* occurrence.

RESULTS

In Tamaulipas only three species and two subspecies of the genus were found: *Ariocarpus agavoides, A. kotschoubeyanus, A. retusus* subsp. *reutusus* and *A. retusus* subsp. *trigonus*. Distribution of the species is expressed in Fig. 1. The geographic distribution and characteristics of each species are:

1. **Ariocarpus agavoides** (Castañeda) E.F. Anderson

Common name.—"Magueyito"

Geographic distribution.—San Luis Potosí and Tamaulipas. This species is endemic to the valley of Tula, municipality of Tula, Tamaulipas. The first population reported was located in the north slopes of the city of Tula. However, a new locality was discovered within the valley recently. *Ariocarpus agavoides* inhabit small hills with medium slopes and easily erodable rocky soils (xerosols), in altitudes from 900 m to 1200 m. The associated vegetation in the population located north of Tula were dominated by *Prosopis glandulosa, Koeberlinia spinosa* and *Acacia farnesiana,* whereas for the new locality the dominant species were *Hechtia glomerata, Agave lecheguilla* and *Agave striata.*

Field observations indicated strong dependence to nurse plants, low recruitment and pollination dependent on bees. The type locality is extremely perturbed by a waste disposal and overgrazing. Signs of plant extraction were detected several times.

Cited specimens: **MEXICO. Tamaulipas:** Tula, 1200 m, *Castañeda s.n.* (DS); Tula, 1200 m, *Cowper 1957* (POM); Tula, 1200 m, *Anderson 1616,* (GH, K, MO, NY, POM).

Specimens examined: **MEXICO. Tamaulipas:** Tula, 1200 m, *Bravo s.n.* (MEXU); Tula, 1170 m, *Hernández et al. 2054* (MEXU); Tula, 1240 m, *Scheinvar & Sánchez-Mejorada 750* (MEXU); Tula, 1200 m, *Sánchez-Mejorada 750* (Jardín UNAM); Tula 1200 m, *Hernández* (Jardín ITCV); Tula, 1200 m, *Martínez-Avalos & Jiménez 0441* (UAT); Tula, 914 m, *Martínez-Avalos 0446* (UAT).

2. **Ariocarpus kotschoubeyanus** (Lemaire) K. Schumann

Common names.—"Pezuña de venado," "Pata de venado"

Geographic distribution.—Tamaulipas, Nuevo León, Zacatecas, San Luis Potosí and Querétaro. This species is reported for Tamaulipas in two sites in Tula, located northeast of Tula City (1200 m). The species grows in rocky soils, with poor organic material (xerosols), and inhabit medium slopes in a desert shrubland (Rzedowski 1978) dominated by *Agave lecheguilla, A. striata, Hechtia glomerata* and *Dasylirion longissimum.*

We detected a well-preserved locality (location concealed for conservation purposes), with populations represented in different size classes. Sites close to Tula City exhibited heavy habitat disturbance by overgrazing and over-collection of plants.

Cited specimens (Anderson 1960, 1963): **MEXICO. Tamaulipas:** Tula 1200 m, *Albert 1959* (POM. US); Tula, *Anderson 1617* (POM, US)

Examined specimens: **MEXICO. Tamaulipas:** Tula, 1190 m, *Anderson 1738* (MO); Tula, *Arreola 736* (IBUG); Tula, *Scheinvar* et al. *4070* (MEXU); Tula, 1200 m, *Martínez-Avalos 091* (UAT); Tula, 1127 m, *Martínez-Avalos 0437* (UAT).

3. **Ariocarpus retusus** K. Schumann subsp. **retusus** (Scheidweiler) E.F. Anderson & Fitz Maurice

Common names.—"Chaute," "Chautle"

Geographic distribution.—Tamaulipas, Coahuila, Nuevo León, San Luis Potosí y Zacatecas. In Tamaulipas it is common in the municipalities of Miquihuana, Bustamante, Tula and Palmillas. This species grows over hills and rocky slopes with clustered populations at altitudes from 700 to 2100 m, in a desert shrubland (Rzedowski 1978), dominated by *Agave lecheguilla, A. striata, Dasylirion longissimum, D. texanum* and *Yucca carnerosana.*

Populations of *A. retusus* subsp. retusus inhabit also perturbed areas dominated by *Dodonea viscosa*, in small canyons. Hybridizing specimens with *A. resusus* subsp. trigonus were found in eastern slopes of "El Cielo Biosphere Reserve." Populations were also detected in pinyon pine forests dominated by *Pinus nelsonii* and *Pinus cembroides* in Miquihuana.

Cited specimens (Anderson 1964): **MEXICO. Tamaulipas:** Miquihuana, 1900 m, *Cowper 1889, 1958* (POM, US); Tula, 1200 m, *Anderson 1964* (POM, US).

Specimens examined: **MEXICO. Tamaulipas:** Bustamante, 1700 m, *Hernández et al. 2029* (MEXU); Bustamante, 1590 m, *Hernández et al. 2033* (MEXU); Bustamante, 2000 m, *Jiménez 0018* (UAT); Miquihuana, 1524 m, *Martínez-Avalos 054* (UAT); Miquihuana, 1487 m, *Martínez-Avalos 0151* (UAT); Tula, 1250 m, *Martínez-Avalos 0664* (UAT).

4. **Ariocarpus retusus** K. Schumann subsp. **trigonus** (Weber) E.F. Anderson & Fitz Maurice

Common name.—"Chaute," "Chautle"

Geographic distribution.—Tamaulipas and Nuevo León. This species is distributed in the municipalities of Jaumave, Palmillas, San Carlos, Villa de Casas and Llera de Canales. The populations inhabit areas from 250 m to 1400 m, in different soil types. The centre of the distribution is the Jaumave Valley (Martínez-Avalos et al. 1993).

Field observations indicate an ability to survive in exposed and eroded soils, A survey in the Jaumave Valley indicated 11 sub-populations with approximately 35,000 individuals. The plants exhibited a non-exclusive cactus-nurse plant relationship. The must important nurses were *Prosopis laevigata* and *Cercidium praecox.* Plants beneath healthy nurses exhibited better conditions than those with damaged nurses (and with smaller canopies). *A. trigonus* plants are able to thermo-regulate in open sun but individuals beneath the shade of nurses exhibited better thermo-regulation (Suzán unpublished data).

Cited specimens (Anderson 1964): **MEXICO. Tamaulipas:** Jaumave Valley, 760 m, *Anderson 1580* (POM, US, NY, MO, GH, K); Jaumave Valley, 760 m, *Meyer & Rogers 3115* (MO,US); E of San Vicente, Jaumave Valley, 760 m, *Anderson 1089* (POM, US, NY, MO, GH); W of Cd. Victoria, 700 m, *Anderson 1153, 1708* (POM, US).

Specimens examined: **MEXICO. Tamaulipas:** W of San Antonio, 676 m, *Arreola 275* (IBUG); NE of Tula, *Sánchez-Mejorada 2070* (MEXU); Jaumave 750 m, *Hernández et al. 2038* (MEXU); Jaumave, 750 m, *Hernández 2047* (MEXU); Valle de Jaumave, 610 m, Martínez-Avalos 068 (UAT); Villa de Casas, 304 m, Martínez-Avalos 0383 (UAT); San Carlos, 189 m, Martínez-Avalos 541 (UAT); San Carlos, 400 m, Martínez-Avalos 0745 (UAT).

DISCUSSION

It's difficult to determine the ecological requirements that affects the geographic distribution of the genus *Ariocarpus* with the analysis of herbarium specimens, and even with field studies in the Chihuahuan Desert in México (Anderson 1958, 1961). In Tamaulipas this genus is restricted to the Chihuahuan Desert region, the Tamaulipan arid zone (Tamaulipas biotic province) and some specific tropical neighboring areas with similar climatic parameters (i.e. LLera Valley) (Fig. 1). The area in Tamaulipas where *Ariocarpus* grows is similar habitats in the neighboring states of Nuevo León and San Luis Potosí.

The genus is distributed in altitudinal gradients from 200 to 2100 m (Table 1). Of the three species in the state, *A. retusus* subsp. *trigonus* shows the widest range in distribution, inhabiting different types of vegetation, soils and climate in the southwestern, central and southern parts of the state. *Ariocarpus agavoides* has the most restricted distribution in an area smaller than 2 km^2, being the species most highly disturbed due to direct and indirect factors such as habitat destruction for garbage incineration, marked hydric soil erosion, overgrazing, and excessive over-collection of individuals (Hernández 1992; Sánchez-Mejorada 1987). *Ariocarpus kotschoubeyanus* is a difficult species to find in the field due to its size and form; therefore, the true size of wild populations is relatively unknown. *Ariocarpus retusus* subsp. *retusus* inhabits the southwestern arid zones of the state and is well-adapted to the Chihuahuan Desert region.

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BOOK REVIEW

KEVIN ADAMS and MARTY CASSTEVENS. 1996. **Wildflowers of the Southern Appalachians: How to Photograph and Identify Them.** (ISBN 0 89587-143-2, pbk.). John F. Blair Publisher, 1406 Plaza Drive, Winston-salem, NC 27103 (910-768-1374; 910-768-9194 fax). $26.95. 257 pp. Color photos.

You can find field guides that are less expensive, more compact, and include more species, but this book has several features that make it well worth the money. First, it is the most comprehensive guide to herbaceous wildflowers of this specific geographic region. The southern Appalachians—sometimes called the botanical jewel of the eastern United States, with over 2500 species of flowering plants—includes sections of Virginia, West Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Alabama, and Georgia. However, since many of the 180 species in this book have wide geographic distributions, the book has application far beyond these states.

A second important feature of the book is the high quality of the photographs, along with hints on how to photograph wildflowers. The photos are striking because they have exceptional focus contrast to separate the flowers from their backgrounds, a feat the authors usually accomplished with a 75-300 mm zoom lens with an attached close-up lens. The 28-page chapter on "Photographing Wildflowers" has 23 photos of flowers (copies taken from the main section of the book) that demonstrate the excellent results that can be obtained with the equipment and techniques described. This chapter would be much improved if it also included photographs of the equipment items themselves (or the authors using the equipment), since many amateur photographers may not be familiar with such items as a Bogen super clamp, Bogen accessory side arm, ball head, focusing rail, or wind barrier. The ten-page chapter on "Format" includes an additional seven pages of "Photo Tips" and "Wildflower Photography Categories," which correspond to the useful photo tips adjacent to each flower photo.

A third important feature is the emphasis on conservation. The authors strive to educate the public about wildflowers, in the belief that "education is the best environmental policy." The book promotes environmental stewardship in the introductory chapter, and in the chapters on "The Natural Setting," "Botanical Exploration of the Southern Appalachians," and "Environmental Concerns."

The authors encourage people to photograph rare flowers, rather than pick them. Their photographic tips include ways to minimize disturbance to flowers and their habitats, and warn that sometimes flowers should not even be photographed if intrusion into the habitat is too damaging.—*Jerry Carpenter, Northern Kentucky University.*

PLATEILEMA (ASTERACEAE: HELENIEAE) A NEW GENERIC REPORT FOR THE UNITED STATES

Billie L. Turner

Department of Integrative Biology
University of Texas
Austin, TX 78713, U.S.A.

The monotypic genus *Plateilema* was first proposed by Cockerell (1904) in his treatment of the genus *Hymenoxys* for North America, basing this upon *Actinella palmeri* A. Gray, the sole member of section *Plateilema.* The latter was maintained as a genus by subsequent workers (eg. Rydberg 1914), and I intend to accept its generic status in my forthcoming treatment of the Helenieae for Mexico (Turner 1999, in prep.).

The single species concerned, *Plateilema palmeri* (A. Gray) Cockerell, acaulescent perennial herb superficially resembling *Gaillardia comosa* A. Gray, has been largely ignored by most phyletic workers (eg. Bierner and Jansen 1998), presumably because it is represented in herbaria by relatively few collections, mostly type material, the latter obtained from near Saltillo, Coahuila, Mexico. Indeed, prior to the present report, in addition to the type, the species was known by only a few skimpy collections from the Ocampo region of central Coahuila.

The present article calls attention to two collections of the species from the United States, 200 kilometers or more from the previously known collections (Fig. 1), as follows:

TEXAS. Brewster Co.: "Infrequent at Schuler mail box 44 mi S of Alpine; Terlingua Road; altitude 3,600 ft," 10 Apr 1929, *Henry T. Fletcher 219* (SRSC); "infrequent annual along Chalk Draw; Schuler Ranch; limestone soil; altitude 3,700 ft," 10 Apr 1929, *Henry T. Fletcher 884* (SRSC).

Henry T. Fletcher (1884–1955) was a remarkable man in the Brewster County region, serving his community in many ways: Vice President of the State National bank in Alpine, Rotary Club Governor, owner and manager of the Fletcher Cattle Company, to name but a few of his enterprises (Casey 1976). He was also an excellent collector and keen observer of range land plants, as attested to by his rarely cited but excellent publication for the times, Vegetation of the Green Valley Region (Fletcher 1928), a 40 km^2 of rolling plains with bordering mountains some 40–50 kms south of Alpine. Indeed, in a brief survey of the collections on file at SRSC, I calculate that he assembled and placed on deposit at that institution five thousand or more plant specimens. And his are not fragmentary collections as often collected by non botanists, rather they are neatly pressed, solidly mounted and in the best possible flowering and fruiting condition. In short, Fletcher collections served as the founding core of the SRSC herbarium, this subsequently built upon by the late Barton H. Warnock (Turner 1998).

Both of the above specimens were said to have been collected on the same date, but possess very different collection numbers (*219* and *884*), suggesting that the collec-

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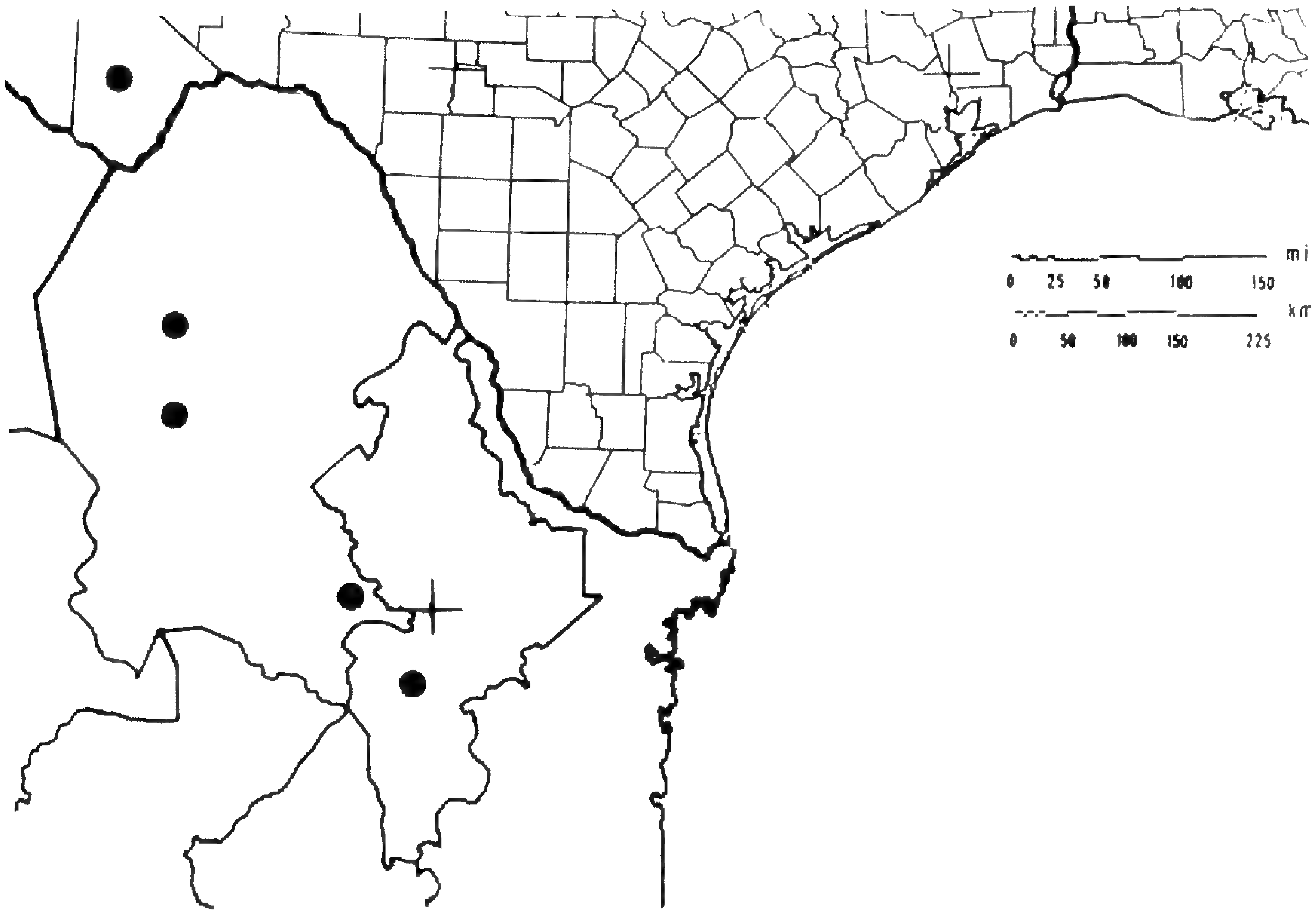

Fig. 1. Known distribution of *Plateilema palmeri*.

tor arbitrarily assigned his collection numbers and/or dates, or else he collected over 600 different specimens on the same date, an unlikely feat considering the time (April is usually a very dry month in the region concerned and even heavy early rains are unlikely to bring out a profusion of collectable species of this magnitude.)

No collection book or records survive to sort out the peculiar numbers assigned Fletcher's specimens, but most likely he assembled his plants over several months and then assigned his plants numbers irrespective of their order of collection; similar anomalies as that found with the numbers alluded to in the above are also encountered with other assemblages of this collector.

Since the above two sheets were only recently sorted out of a pile of unidentified specimens at SRSC, little opportunity has been available to search the area concerned to see if the species might still exist. My hunch is that they are still represented by small populations along Chalk Draw, a poorly collected area of the Big Bend region of Texas. Unfortunately, most ranchers in the trans-Pecos at the present time are reluctant to allow botanists on their ranchlands, fearful that an endangered taxon might be observed and as a result their use of their rangelands placed in some sort of jeopardy.

Finally, it should be noted that two recent collections of *Plateilema palmeri* have been made in the state of Nuevo Leon, Mpio. Galeana, Mexico, by the Hinton family (*Hinton* et al. *27195*.TEX) some 100 kilometers south of the type locality. What was once thought to be a very localized species is now known to be quite widespread, albeit relatively rare, to judge from the collections at hand.

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BOOK REVIEW

SUSYN ANDREWS, ALAN LESLIE, and CRIMAN ALEXANDER. (eds). 1999. **Taxonomy of Cultivated Plants**. (ISBN 1 900347 89, hbk.). Royal Botanic Gardens, Kew. £ 27, 553 Pp.

This volume contains the results of the 1998 "Third International Symposium on the Taxonomy of Cultivated Plants," sponsored jointly by the Royal Botanic Garden Edinburgh, the Royal Botanic Gardens, Kew, and the Royal Horticultural Society under the auspices of the International Society for Horticultural Science. The Symposium was organized by HORTAX (Horticultural Taxonomy Group) and held at the Pollock Halls of the University of Edinburgh from 20-26 July 1998.

The book is organized into introductory material, papers and shorter papers, but I found short papers or abstracts in each section. In the papers division, 43 works are distributed among ten conceptual sections, including: 1) Plant and germplasm collections, 2) Nomenclature in the ornamental seed trade, 3) Intellectual property rights and plants, 4) registration of plant names, 5) principles of cultivated plant classification, 6) the cultivar definition and recognition, 7) databases for collections, nomenclature and taxonomy, 8) modern techniques in breeding and taxonomy, 9) case studies in the taxonomy of cultivated plants, and plant introductions. The next division covers short papers that were delivered as posters during the conference, and includes 50 abstracts divided among the following concepts: 1) investigations using molecular techniques, 2) databases and registers, 3) systematics, 4) classification and nomenclature, 5) conservation and collections, and finally, 6) publications.

This volume truly sums up the latest in horticultural taxonomy from a plethora of points of view, and gives the reader a precis of current concerns and vacuums in our understanding of cultivated plant systematics. It is impossible here to thoroughly review each subject presented, but such subjects as living collections' importance, germplasm collection, *ex* and *in-situ* conservation, role of herbaria, etc. are written to address the concerns of the practicing horticulturalist in the commercial world as much as the academic. The chapter on "the cultivar-definition and recognition'" was particularly noteworthy and significantly enhanced my understanding of the challenges horticultural taxonomy faces. I am thoroughly convinced that the papers on fingerprinting of cultigens, concomitant with others that presented phylogentic hypotheses for indigens and their cultigens, will be extremely valuable as lessons for us all, to help us tackle what has largely been a neglected area. Several of the molecular papers highlighted the fact that many cultigens may have their origin traced to but a few individuals, rather than representing an adequate sample of the infraspecific genetic diversity present in wild populations of the species. These papers can surely guide those who are attempting endangered species rescues, or introducing wild species into cultivation and have obvious conservation consequences.

I believe this book can open the traditionally trained systematist's eyes to the many problems facing horticultural taxonomy and should foster a greater appreciation for it. While the papers are brief summaries, their extensive references permit further study of each area, making the book an extremely useful tool. The book's physical features are like that of the other fine Kew publications, and the volume of information presented makes the book well worth the price. I unhesitatingly recommend it to anyone working in botanical gardens or universities, those who train future systematists, plant conservationists or horticulturalists.—*John J. Pipoly III; Head of Research, Botanical Research Institute of Texas, 509 Pecan St., Ft. Worth, TX 76126-3019, USA.*

WHICH NON-NATIVE PLANTS ARE INCLUDED IN FLORISTIC ACCOUNTS?

Guy L. Nesom

North Carolina Botanical Garden
Coker Hall, CB 3280
University of North Carolina
Chapel Hill, NC 27599-3280, U.S.A.

ABSTRACT

It is suggested that four terms provide an adequate general description of the major categories of non-native plants in our flora: cultivated, persisting, waif, and naturalized. Comparative definitions are given for seven related terms that describe the non-native origin and floristic integration of vascular plant species in North America: adventive, alien, escaped, established, exotic, introduced, and non-native.

RESUMEN

Se sugiere que cuatro términos dan una descripción general adecuada de las grandes categorías de las plantas no nativas de nuestra flora: cultivada, persistente, abandonada, y naturalizada. Se dan definiciones comparativas de siete términos relacionados que describen el origen no nativo y la integración florística de plantas vasculares en Norteamérica: adventicia, extraña, escapada, establecida, exótica, introducida, no-nativa.

Plants are usually included in floristic accounts of the North American flora on the basis of their status either as native or as non-native but integrated into the flora to some degree. For non-native plants, an assessment of their integration is based primarily on reproductive status and dispersive success. The more summary floristic accounts commonly do not provide information necessary for a clear assessment of the degree of floristic integration of non-native plants.

A selection of general statements of intent for major floristic studies (from numerous examined) indicates that a broad range of non-native taxa is treated. Naturalized plants are invariably treated, but the definition of "naturalized" is not consistent, and plants recognized as "waifs" and as merely "persistent" may or may not be included.

Radford et al. (1968) for the Carolinas: "species of vascular plant known to grow without cultivation."

Correll and Johnston (1970) for Texas: "all native and naturalized flowering plants and ferns."

Voss (1972) for Michigan: "all species ... known to grow (or to have grown) outside of cultivation in Michigan, whether originally native or not." See Voss (Preface, 1996) for related comments.

Great Plains Flora Association (1986) for the Great Plains: "all vascular plants known

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to occur spontaneously"—"the native members of the flora and those introductions that appear to be permanently established outside of intentional cultivation."

Welsh et al. (1993) for Utah: "All indigenous plant species known to occur in Utah are included in the flora. Introduced plants are also covered, but not so intensively as are the native ones." "This flora attempts to present coverage of all established species, all common adventive taxa, and many of the commonly grown cultivated species."

Gleason and Cronquist (1993) for northeastern United States and adjacent Canada: plants "growing wild" (including—from the text—"often escaped from cultivation," "adventive" and "rarely adventive," "occasionally introduced," and "sparingly established").

Hickman (1993) for California: "plants growing wild in California." "All aliens that have become an integral part of the Californian flora are included. The general policy was not to include (or to note only in passing) waifs or non-reproducing but long-persisting individuals or clones." For non-native species the area of origin is specifically named (e.g., "native to Europe") and a brief description of its habitat, geographic range, and relative abundance is provided, without the use of any further terminology.

Cooperrider (1995) for Ohio: "the native members of these families, the alien plants of these families that have become established or that appear occasionally in the state's flora, and to a lesser extent the families' major cultivated plants."

Flora of North America Editorial Committee (1996) for North America north of Mexico: to be included in full are "all native plants" and "introduced taxa that are naturalized or found frequently outside cultivation;" to be mentioned in the discussion are "naturalized plants now known only as historic records" and "non-native, economically important or extensively cultivated plants that tend not to escape cultivation (e.g., alfalfa)."

Diggs et al. (1999) for north central Texas: "all known native and naturalized vascular plant species .... A few long-persistent (e.g., *Ficus carica*—the common fig), but apparently non-reproductive taxa have been included because of the likelihood of them being encountered."

Kartesz (1999) for North America north of Mexico: "all known native, naturalized or waif occurrences of vascular plant taxa within the region." Also included, but not explicitly, are non-native taxa recognized as "persisting" (as described below).

Despite the demonstration in the recent Jepson Manual (Hickman 1993) that the floristic integration of non-native plants can be precisely described without specialized terminology, a minimal set of descriptive terms is useful if consistently applied. The four terms below provide an adequate general description of the major categories of non-native plants in our flora.

1. Cultivated

Plants of native and non-native species, across various categories of duration and habit, that are deliberately planted, actively maintained, and grown for ornament, interest, consumption, or other use. These are rarely included in floristic studies (but see Welsh et al.

1993). Native species are sometimes encountered only as cultivated plantings, and these should be distinguished from naturally occurring plants. Another distinction can be drawn by recognizing a *cultigen* (a cultivated plant of unknown or obscure origin) as different from a *cultivar* (a cultivated plant of known origin).

2. Persisting

Perennial plants (woody, suffrutescent, and herbaceous) cultivated for ornament or interest and remaining in place at old home sites, roadsides, etc., without human assistance after the site has returned to a more natural state, sometimes after evidence of associated human presence is decayed or completely gone. Such plants are not reproducing or at least not spreading beyond the original planting. The difference between "cultivated" and "persisting" is primarily a temporal one, referring to the duration of existence, and persisting plants usually are not included in floristic accounts with the same status of native and naturalized species. Because, however, in a sense they grow outside of cultivation, they may appear in unannotated summaries or they may be explicitly described in floristic studies as "persisting."

3. Waif

Plants of non-native species growing outside of cultivation but not maintaining a viable population for more than one or a few seasons. A number of waifs in the North American flora are known only as single historic records; other essentially non-reproductive plants as waifs apparently may be recurrent. Some species reported with new distribution records may become known more precisely as waifs as the site of their reported occurrence is reinvestigated. More than a single season is required to observe the reproductive status of such a plant or population, and some of those initially suspected of being waifs may become naturalized. Waifs may originate from various kinds of natural and human-mediated long-distance dispersal. They may originate from seeds washed out from garden plantings and commonly are found at sites where seeds are mixed with other exotic materials (e.g., ballast dumps, wool mills). Tomato seeds, which pass unharmed through digestive tracts and sewage treatment, are spread in sludge-based fertilizer and may spawn waif plants in repeated cycles. The usage here for "waif" is a good match for its ancient European etymology as "ownerless property, stray, or homeless."

4. Naturalized

Plants of non-native species accidentally or deliberately introduced into the flora, now reproducing and maintaining viable populations from year to year (more than just one or a few seasons), and dispersing without deliberate human assistance beyond the population or populations of original establishment. The degree of naturalization may vary from widespread and abundant occurrence to local establishment (from recent introduction or sluggish reproduction and dispersal). Perhaps the most difficult in interpretation are cultivated plants spreading slightly beyond their original planting—these might be best characterized as waifs, if their reproductive ability is slight (e.g., *Impatiens* spp.), or they may be "incipiently naturalized" if reproduction and spread appear to be vigorous, even though restricted in area. Species native to North America may become naturalized in areas of the continent other than where recorded as native in the past or present. Some species apparently have a mixture of native and non-native North American populations (e.g., *Achillea millefolium*, *Galium aparine*, and *Prunella vulgaris*).

Associated Terms

In addition to the four terms suggested above to cover the major categories of integration of species and other taxa in the North American flora, various other related terms have commonly been used in floristic works to characterize the origin and integration of such plants. The usage of these terms varies considerably, and without other references that provide comparative definitions in a floristic context, it is hoped that those provided here will contribute toward more consistent application. "Native species,""alien species," and "introduction" are formally defined in the recent Executive Order (U.S. Executive Order 13112). Because of the difficulty in ordering this set of terms in the context of floristic criteria, they are listed here alphabetically.

Adventive—non-native, becoming naturalized either from deliberate plantings or accidental introduction.

Alien—non-native, commonly considered to have originated from a different continent, but not necessarily exclusive of an origin from an ecologically different region of the same continent.

Escaped—non-native, becoming naturalized from deliberate plantings, usually only in a local area or represented by relatively few individuals over the range of naturalization.

Established—non-native, similar to "adventive" and "introduced" but with the implication of being more securely naturalized.

Exotic—non-native, essentially similar to the term "alien," but with stronger implication of an extra-continental origin. In the recently issued "Synonymized Checklist" for the North American flora (Kartesz 1999), exotic species in the continental flora are considered to originate from other continents or from Mexico or Central America.

Introduced—non-native, released accidentally or deliberately into the flora and growing without cultivation, at least for one generation. Similar to "adventive" but with slightly stronger implication of having originated through plants used for horticultural or practical purposes.

Non-native—originating from outside the geographic region of concern, either from a different continent or from an ecologically different area of the same continent. Among a group of terms often used interchangeably (adventive, alien, exotic, introduced, non-native), "non-native" is the most general, at least in the definitions suggested here.

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N.W. Simmonds and J. Smartt (chapter 9 by S. Millam and W. Spoor). 1999. **Principles of Crop Improvement.** (ISBN 0-632-04191-9, hbk.). Blackwell Science Ltd, 350 Main Street, Malden, MA 02148-5018, U.S.A. (800-759-6102; 781-388-8255 fax; www.blackwell-science.com). $104.95, hbk. 412 pp. Illustrated.

From the cover: "The second edition of this highly regarded text provides a broad introduction to the principles of plant breeding. It presents a synoptic view of crop history, linking original studies of crop origin and early evolution with recent and possible future trends in breeding. The text has been revised and expanded to include recent developments relevant to crop improvement. There is a new chapter on biotechnology and new information on the use and conservation of genetic resources. Throughout the book examples are drawn from a wide range of crops and locations, and flow diagrams are used to supplement and expand information given in the text. This book is aimed primarily at senior undergraduate and graduate students of agriculture, horticulture and applied biology." Contents: **1)** The evolution of crops; **2)** Basic features of plant breeding; **3)** Objectives of plant breeding; **4)** Genetic aspects: Populations and selection; **5)** Breeding plans; **6)** Trials and Multiplication; **7)** Disease resistance; **8)** Special techniques; **9)** Biotechnology and crop improvement; **10)** New crop and genetic conservation; **11)** The social context; Bibliography, Index of plant names, and General index.

Edward A. Weiss (Foreword by Sir Charles Pereira, FRS). 2000. **Oilseed Crops, Second Edition.** (ISBN 0-632-05259-7, hbk.). Blackwell Science Ltd, 350 Main Street, Malden, MA 02148-5018, U.S.A. (800-759-6102; 781-388-8255 fax; www.blackwell-science.com). $156.95, hbk. 364 pp. Illustrated.

From the cover: "Oilseeds are a very important component of semi-tropical and tropical agriculture, providing easily available and highly nutritious human and animal food. Many also have industrial uses and are relatively easy to incorporate into locally manufactured products. This book gathers together scientific, economic and field practice information on the most widespread oilseed crops. After a discussion on world production and trade in oilseeds there are separate chapters on castor, groundnut, safflower, sesame, soya and sunflower, crambe, niger and jojoba. A final chapter looks in detail at oilseed processing operations and the great variety of products and uses for oilseeds. This new edition has been completely rewritten to include the latest agricultural research, the influence of biotechnology on crops and processing, and advances in farm machinery and equipment." "The book is a valuable reference for all involved directly or indirectly with oilseed production, research and processing."

CINNA AND *LIMNODEA* (POACEAE): NOT CONGENERIC

David M. Brandenburg
The Dawes Arboretum
Newark, OH 43056 U.S.A.

John W. Thieret
Department of Biological Sciences
Northern Kentucky University
Highland Heights, KY 41099 U.S.A.

A decade after Clayton and Renvoize (1986) suggested that *Limnodea* L.H. Dewey is "a prairie version of *Cinna*," Tucker (1996) reduced this long-recognized grass taxon to synonymy under *Cinna* L. As the only justification for the change he noted that *Limnodea arkansana* (Nuttall) Dewey "has been treated as constituting a monotypic genus ... but there seem to be no compelling differences other than length of lemma awn, a minor distinction." We regard this nomenclatural aberration as being unsupportable. A similar reduction of *Limnodea* to synonymy occurred in 1841 when Trinius in Steudel (Steudel 1841) transferred it to *Limnas*, a Siberian genus of two species from which *Limnodea* differs in several features (Bentham 1881). (On the basis of the lemma awn of *Limnodea* alone, the genus could just as well be allied with *Stipa*.)

Our purpose in this note is to point out that, in addition to features of the awn, there are indeed other compelling differences between *Limnodea* and *Cinna* and that considering these two taxa to be congeneric is untenable. Unfortunately the new combination has already been adopted in two recent floras (Wunderlin 1998; Yatskievych 1999).

Nuttall (1835–1836) recognized that a grass he had in hand constituted a distinct genus, which he called *Greenia* Nutt. Unfortunately, this was a preoccupied name, as were two other generic names later applied to the genus, *Sclerachne* Torrey in Trinius (Trinius 1841) and *Thurberia* Bentham (Bentham 1881). Finally, Dewey (1894) published the generic name *Limnodea*, which has hitherto remained unchallenged. Whatever the generic name, for over a century and a half *Limnodea* has been recognized as distinct by agrostologists and other botanists (except Tucker and the two authors of floras cited above) who have dealt with it; we list some of these here (e.g., Allen 1980; Beal 1896; Beetle 1977; Bentham 1881; Bentham & Hooker 1883; Bews 1929; Campbell 1985; Clayton & Renvoize 1986; Correll & Johnston 1970; Dewey 1894; Diggs et al. 1999; Dore 1956; Featherly 1946; Gould 1968, 1975, 1979; Gould & Box 1965; Gould & Shaw 1983; Great Plains Flora Association 1977, 1986; Hackel 1887, 1890; Hatch et al. 1999; Hitchcock 1920, 1935, 1937, 1951; Johnston 1990; Kartesz 1994; Kartesz & Meacham 1999; Lamson-Scribner 1900a, 1900b; Lonard 1993; Powell 1994; Shinners 1972; Silveus 1933; E.B. Smith 1994; J.P. Smith 1981; Stebbins & Crampton 1961; Terrell 1971; Vasey 1883, 1885; Watson & Dallwitz 1992). The genus *Limnodea* is also recognized in the Missouri Botanical Garden's New World Grass Checklist (<www.mobot.org/mobot/tropicos/Poa/Limnodea.html> Accessed 1999 September 30) and in the Texas A&M University Grass Images (<http://www.csdl.tamu.edu/FLORA/image/k4606700.htm>Accessed 1999 September 30).

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TABLE 1. Comparison of various characters of *Cinna* and *Limnodea*.

Character	*Cinna*	*Limnodea*
Flowering/ fruiting time	Late estival/autumnal	Late hibernal/vernal
Duration	Perennial	Short-lived annual
Spikelet compression	Laterally compressed	Subterete
Texture of glumes	Membranous	Chartaceous*
Abaxial surface of glumes	Sharply keeled	Rounded (or broadly keeled in distal portion)
Margin of glumes	Flat, hyaline	Inrolled, not hyaline
Vestiture of glumes	Sparingly to moderately scabrous	Sparingly to densely scabrous *or* pilose especially on veins (var. *pilosa* (Trin.) Scribn.)
Texture of lemma	Membranous	Chartaceous
Abaxial surface of lemma	Sharply keeled	Rounded
Awn	Much shorter than spikelet, straight, not twisted, not hygroscopic, *or* lacking	Much longer than spikelet, geniculate, twisted proximally, hygroscopic
Palea	Well developed, prominent, relatively long compared to lemma	Poorly developed, relatively short compared to lemma
Veins of palea	1 or if 2, these closely approximate, in either case extending to or nearly to tip of palea	2-veined only at base
Number of stamens	1 or 2	3
Endosperm	Semi-liquid ("soft -fleshy") (Terrell 1971; Dore 1956)	Liquid (Brown 1955; Terrell 1971; Dore 1956)
Chromosome number	$2n = 28$ (Bowden 1960; Davidse & Pohl 1978; Pohl & Davidse 1971)	$2n = 14$ (Watson & Dallwitz 1992 onward)
Articulation	Spikelets not readily disarticulating	Spikelets readily disarticulating
Habitat	Woods	Prairies and disturbed areas

*The describer of *Limnodea*, Nuttall (1835–1836), wrote of the glumes as being "coriaceus" and, in English translation, as "indurated." His adjectives formed the basis for Torrey's new name, *Sclerachne*.

Cinna was recently revised by Brandenburg et al. (1991). Differences between its four species and *Limnodea* are summarized in Table 1.

True it is, of course, that *Limnodea* and *Cinna* share certain features. Among these are 1-flowered spikelets, articulation below the glumes, extended rachilla, and awned spikelets (sometimes awnless in *Cinna*). Each of these features is found in other genera of Agrostideae sensu Hitchcock (1951). The combination of the four may be unique to *Cinna* and *Limnodea*—it is among U.S. grasses—and may indicate a possible relationship between the two genera. Bentham and Hooker (1883) suggested a resemblance between *Limnodea* and *Polypogon*; Nuttall (1835–1836) considered *Limnodea* to be "allied to *Oryzopsis*." However, resemblance and possible relationship are not necessarily the same. Combining the two genera because of a feature of the awn is, we suggest, most emphatically negated by the many other features separating them.

Distinguishing among the spikelets of the species of *Cinna* takes some experience, but distinguishing between spikelets of *Cinna* and those of *Limnodea* takes hardly more than a glance. As an experiment we removed the awns of several spikelets of *Limnodea* and then mixed them with a number of *Cinna* spikelets representing all four species of that genus. Next we invited several colleagues to examine the mixture under a dissection scope to determine which spikelets "did not belong." No one had any trouble pointing out the *Limnodea* spikelets—even without their conspicuous awns—as the "different" ones.

The genera *Cinna* and *Limnodea* are easily separable by the following synoptic key.

1. Spikelets laterally compressed; glumes membranous, sharply keeled; lemmas awnless or with a straight awn much shorter than the spikelet; palea well developed, relatively long compared to lemma, the veins 1 or 2, extending to or nearly to palea tip, when veins 2, the veins closely approximate; stamens 1 or 2; late estival/autumnal perennials __________ **Cinna**
1. Spikelets subterete; glumes chartaceous, rounded on back; lemmas with a geniculate, twisted, hygroscopic awn much longer than the spikelet; palea poorly developed, relatively short compared to lemma, 2-veined only at base; stamens 3; short-lived, late hibernal/vernal annual __________ **Limnodea**

CONCLUSION

The inclusion of *Limnodea* in *Cinna* introduces a markedly discordant element into the latter small and well-circumscribed genus. The four currently recognized species of *Cinna* are quite similar to each other and all differ consistently from the monotypic *Limnodea* in several significant features, especially in the strikingly different spikelet morphology. These genera are not congeneric.

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THEMEDA QUADRIVALVIS (POACEAE: ANDROPOGONEAE) IN KANSAS: AN EXOTIC PLANT INTRODUCED FROM BIRDSEED

E. Gene Towne
Division of Biology
Kansas State University
Manhattan, KS 66506-4901, U.S.A.
egtowne@ksu.edu

Iralee Barnard
Herbarium, Division of Biology
Kansas State University
Manhattan, KS 66506-4901, U.S.A.
iralee@ksu.edu

In November 1998, a peculiar grass growing in a residential yard in Wamego (Pottawatomie County), Kansas was submitted to the Herbarium at Kansas State University (KSC) for identification. The grass was identified as *Themeda quadrivalvis* (L.) Kuntze, a plant native to southeastern Asia. In the United States, this grass has been collected in Louisiana (Brown 1945) and Florida (Wunderlin 1998), presumably as an escapee from cultivation. A search of herbaria records revealed that *Themeda* also has been collected in California (RSA).

Themeda quadrivalvis can be recognized by the following description: Annual, 20–50 cm tall; blades papillose-ciliate on the lower margins; ligule membranous, lacerate, < 1 mm long; inflorescence a lax flabellate cluster of racemes, each subtended by a strongly keeled spathe; spikelet clusters with a fertile sessile spikelet surrounded by four infertile sessile spikelets and two infertile pedicellate spikelets, all partially enclosed by a spatheole; fertile spikelet terete, bearded, 4.7–7.2 mm long with a 3–4 cm long geniculate awn, disarticulating obliquely to form a pointed callus; infertile spikelets 4–5 mm long; flowering Sep–Oct. The specimens may be assigned to variety *helferi* based on the presence of tuberculate hairs on the involucral spikelets and the plant stature (Bor 1960). The inflorescence of *Themeda* is a complex arrangement of spikelet clusters that is described in greater detail by Baird and Thieret (1985).

In a follow-up examination of the collection site, eight additional *Themeda* plants were found growing under a bird feeder and in an unmowed area near the porch. The yard was semi-shaded, and the lawn was predominately crabgrass (*Digitaria sanguinalis*) and bluegrass (*Poa pratensis*). Microscopic examination of birdseed from the feeder found numerous *Themeda* spikelets among the thistle (*Guizotia abyssinica*: Asteraceae) seeds, indicating that it was the source of the introduction.

To determine if *Themeda* seeds were prevalent in birdseed, nine sacks of commercial thistle seed with different lot numbers were purchased and inspected thoroughly (30.1 kg of seed). All of the sacks contained *Themeda* and other contaminant seeds, which were removed and compiled. Three hundred of the *Themeda* seeds and numerous other unidentified seeds were planted in vermiculite in a 22° C greenhouse and monitored for five months. In the spring, an additional 900 *Themeda* seeds were broadcast sown in a lawn dominated by crabgrass. The area was not fertilized or mowed during the growing season but did receive occasional supplemental water.

Themeda seeds removed from the birdseed were apparently inert. However, some *Vigna radiata* var. *radiata* (Fabaceae) and *Arthraxon hispidus* (Poaceae) seeds germinated in the greenhouse. Three unidentified dicotyledons also germinated but died before reaching maturity. Both *Vigna radiata* and *Arthraxon hispidus* are weedy annuals from southeastern Asia that have been introduced into the United States (Kartesz 1999).

One year after the initial collection, examination of the yard where *Themeda* was discovered did not find any recurrence of the grass. A floristic survey of numerous residential yards where thistle seed was fed to birds also did not detect any exotic plants. *Themeda* may be unable to persist in Kansas, but in Louisiana it has flourished for more than 40 years in disturbed sites near cultivated fields (Reese & Landry 1985).

India and Ethiopia are major producers of thistle for birdseed (Sharma 1982; Vincent & Cusick 1998), and *Themeda* seeds, as well as numerous other weedy species, are present in the harvested material. Although imported seeds are treated to prevent germination, the process is fallible. Contamination or inconsistent sterilization procedures apparently were responsible for introduction of *Themeda* into Kansas. The incidence of viable seeds in thistle may be small, but birdseed represents a potential source for adventive plants.

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PHILIP PREGILL and NANCY VOLKMAN. 1999. **Landscapes in History: Design and Planning in the Eastern and Western Traditions, Second Edition.** (ISBN 0-471-29328-8, hbk.). John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012. $89.95. 844 pp. Numerous b&w photos.

From the Cover: "This revised edition of *Landscapes in History* features for the first time new information—rarely available elsewhere in the literature—on landscape architecture in India, China, Southeast Asia, and Japan. It also expands the discussion of the modern period, including current North American planning and design practices.

This unique, highly regarded book traces the development of landscape architecture and environmental design from prehistory to modern times—in Europe, the Middle East, Asia, and North America. It covers the many cultural, political, technological, and philosophical issues influencing land use throughout history, focusing not only on design topics but also on the environmental impact of human activity. Landscape architects, urban planners, and students of these disciplines will find here:

The most comprehensive, in-depth, and up-to-date overview of the subject
Hundreds of stunning photographs and design illustrations
A scholarly yet accessible treatment, drawing on the latest research in archaeology, geography, and other disciplines
The authors' own firsthand observations and travel experiences
Insight into the evolution of landscape architecture as a discipline
Useful chapter summaries and bibliographies"

C. WAYNE SMITH and J. TOM COTHREN (eds.). 1999. **Cotton: Origin, History, Technology, and Production.** (ISBN 0-471-18045-9, hbk.). John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10158-0012. $250.00. 850 pp. Numerous b&w photos.

From the preface: The genus *Gossypium* contains 49 species distributed throughout most tropical and subtropical regions of the world. The genus contains an amazing amount of diversity, ranging from herbaceous perennials to small trees. Seed coverings, or fibers, range from almost nonexistent to short, stiff, dense brown hairs that aid in wide dispersal to long, fine white fibers that characterize highly improved cultivars. This monograph is truly about a miracle plant. It provides fibers for an array of textile products including the clothes we wear, oil for human consumption, feed for livestock, and base chemicals for a plethora of industrial products." *Contents:* **1)** Origin and history; **2)** The cotton plant; **3)** Production and production hazards; and **4)** Processing and products.

NODULATING LEGUMES FROM THE TAHOE BASIN, CALIFORNIA

Mohammad Athar
Dept. of Environmental Horticulture
University of California-Davis
Davis, CA 95616, U.S.A.
atariq@cdfa.ca.gov

James Harding
Dept. of Environmental Horticulture
University of California-Davis
Davis, CA 95616, U.S.A.
jaharding@ucdavis.edu

ABSTRACT

A survey was conducted to determine the nodulating ability of 44 legume species from the Tahoe Basin. All were found to nodulate under natural soil conditions. Nodulation is reported for the first time in nine species in five genera of Papilionoideae. These species are distributed in tribes Galegeae, Genisteae, Thermopsideae, Trifolieae and Vicieae. Nodule color, shape and frequency are also described. The results support using the morphology of nodular structures to classify legumes. The soils of the Tahoe Basin are generally nutrient poor. However, legumes survive and grow well there. Healthy plants with lush green foliage growing in nutrient-limited environments, suggest that they were nurtured by nitrogen-fixing nodules. Exploitation of legume *Rhizobium* symbiosis may help to improve nutrient poor soils and may provide refuge and quality browse for wildlife in the Tahoe Basin.

RESUMEN

Los condicionantes geológicos y bioclimáticos han permitido la existencia en el área de Tahoe de un entorno único. Nuestra investigación se centró en la determinación de la capacidad de nodulación de algunas especies de leguminosas en el área del lago Tahoe donde predominan los suelos pobres en nutrientes. Todas las especies estudiadas resultaron nodulantes en condiciones edáficas naturales. En nueve de ellas, pertenecientes a cinco géneros de Papilionoideae e incluidas en las tribus Galegeae, Genisteae, Thermopsideae, Trifolieae y Vicieae, se describe por primera vez el proceso de nodulación indicándose la coloración, forma y frecuencia de las formaciones nodulares. Los resultados apoyan la estrecha relación existente entre los diferentes grupos taxonómicos y la morfología estructural de los nódulos. El desarrollo de poblaciones sanas con follaje exuberante colonizando estaciones con suelos pobres en nutrientes puede ser utilizado como bioindicador del proceso nodular de fijación del nitrógeno. La utilización de la simbiosis leguminosa-*Rhizobium* quizás ayude a mejorar la pobreza en nutrientes de los suelos del área de Tahoe así como, en general, a proveer de mejores hábitats para el incremento y la supervivencia de la vida silvestre en la cuenca del lago Tahoe.

INTRODUCTION

The California flora is rich in Fabaceae members or legumes; there are 69 genera and 491 species found in California (Hickman 1993). Most legumes are indigenous while others are naturalized, often widely so (Witham 1994). Bacteria associated with legumes fix atmospheric nitrogen and are helpful in improving and maintaining soil fertility both in agriculture and natural ecosystems. This novel legume-*Rhizobium* association provides an ideal system for the study of plant-microbe interactions. Athar (1996a) studied nodu-

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lation in 66 Papilionoid species from Sacramento Valley, California and found that the majority of the species were abundantly nodulated under natural soil conditions. However, a majority of the legumes found in California have not been examined for their nodulating ability under natural conditions. A survey was conducted to determine the nodulating ability of some legume species from the Tahoe Basin of California's Sierra Nevada Range (39° N, 120° W). Plants were collected from accessible areas within the Basin, ranging from Desolation Wilderness in the west to the Carson Ridge in the east, Alpine Meadows in the north, and Hope Valley and Carson and Luther passes in the south.

Geologic and climatic forces have combined to form Tahoe's unique and varied environment (Blackwell 1997; Graf 1999). Tahoe's floral diversity can be attributed in part to its central location between plant communities of the Sierra Nevada western foothills, the western Great Basin desert, and the northern and southern Sierra Nevada. The variety of plant species can further be explained by the area's rapidly changing and varied habitats, which have contributed to the large number of Tahoe plants with limited geographic ranges (Graf 1999; Strong 1999). Although vegetation in the basin is mixed due to variations in temperature, precipitation and soil, coniferous forests dominate (Blackwell 1997; Strong 1999).

MATERIALS AND METHODS

Legume species growing under natural conditions were surveyed for their nodulating ability. Periodic field trips were made from late spring to early fall in various parts of Tahoe Basin. Observations were made as described previously (Athar 1996a). Legumes examined included indigenous and introduced herbs, shrubs and vines. At least five plants of each species were examined to minimize error. Legumes were identified by specimens of mature plants. Nodules were distinguished from other kinds of morphological modifications or pathogenic root malformation, and nodulation data were recorded. In some cases, nodule smears and nodule slices were prepared and examined under the microscope (Somasegaran & Hoben1994).

RESULTS AND DISCUSSION

Nodulation status was examined in 44 Papilionoid species growing under natural conditions in the Tahoe Basin. All the species observed were nodulated to various extents (Table 1). These results were compared with the available reports on nodulation (Aguilar et al. 1994; Allen & Allen 1981; Athar 1996a,b, 1997a,b; Athar & Mahmood 1990; Corby 1988; de Faria et al. 1994; Nasim et al. 1998; Roggy & Prevost 1999). Nodulation is reported for the first time in nine species within five genera of Papilionoideae. These species are distributed in tribes Galegeae, Genisteae, Thermopsideae, Trifolieae and Vicieae. Joe Kirkbride, USDA, Beltsville, Maryland has been scanning the literature to create a database that records the presence or absence of root nodules. The database currently contains about 3,000 taxa reported with nodules and about 400 taxa reported without nodules. The results of the present investigation were also sent to him for comparison. Kirkbride

TABLE 1. Nodulation characteristics of some legume species from the Tahoe Basin, California.

Nodulating Species[1]	**Previous Report[2]**	**Frequency[3]**	**Color**	**Shape**
Galegeae				
Astragalus bolanderi A. Gray	B	++	Brown	Elongated
Astragalus gambelianus E. Sheld.	A	++	Brown	Elongated
Astragalus tener A. Gray	A	+	Reddish brown	Elongated
Astragalus whitneyii A. Gray	B	++	Brown	Elongated
Genisteae				
*_Lupinus affinis_ J. Agardh	A	++	Pink	Globose
*_Lupinus albifrons_ Benth.	A	+	Brown	Globose
*_Lupinus albus_ L.	A	+	Brown	Globose
*_Lupinus angustiflorus_ Eastw.	B	++	Pink	Globose
Lupinus arbustus Douglas ex Lindl.	B	++	Pink	Globose
Lupinus argenteus Pursh	A	+	Brown	Globose
*_Lupinus arizonicus_ (S. Watson) S. Watson	A	+	Reddish brown	Globose
Lupinus brewri A. Gray	B	+++	Pink	Globose
Lupinus fulcratus Greene	B	+++	Pink	Globose
Lupinus grayi (S. Watson) S. Watson	A	++	Pink	Globose
Lupinus lepidus Douglas ex Lindl.	A	++	Pink	Globose
*_Lupinus microcarpus_ Sims	A	+	Reddish brown	Globose
Lupinus polyphyllus Lindl.	A	+	Brown	Globose
*_Lupinus succulentus_ Douglas ex K. Koch	A	+	Brown	Globose
Loteae				
*_Lotus corniculatus_ L.	A	+++	Pink	Elongated
Lotus nevadensis (S. Watson) Greene	A	+	Pink	Elongated
*_Lotus unifoliatus_ Benth.	A	++	Pink	Elongated
Millettieae				
*_Wisteria chinensis_ DC.	A	+	Brown	Globose
Thermopsideae				
*_Thermopsis montana_ Nutt.	B	++	Brown	Semi-globose
Trifolieae				
*_Medicago lupulina_ L.	A	+++	Pink	Elongated
*_Medicago polymorpha_ L.	A	++	Pink	Elongated
*_Medicago sativa_ L.	A	+++	Pink	Elongated
*_Melilotus alba_ Medik.	A	+++	Pink	Elongated
*_Melilotus indicus_ (L.) All.	A	+++	Pink	Elongated
Trifolium barbigerum Torr.	A	+++	Pink	Elongated
*_Trifolium campestre_ Schreb.	A	++	Pink	Elongated
*_Trifolium dubium_ Sibth.	A	+	Pink	Elongated
*_Trifolium hirtum_ All.	A	++	Pink	Elongated
Trifolium kingii S. Watson	A	+++	Pink	Elongated
Trifolium longipes Nutt.	B	++	Pink	Elongated
*_Trifolium repens_ L.	A	+++	Pink	Elongated
*_Trifolium pratense_ L.	A	+++	Pink	Elongated

TABLE 1. continued

Nodulating Species[1]	Previous Report[2]	Frequency[3]	Color	Shape
**Trifolium subterraneum* L.	A	+++	Pink	Elongated
Trifolium variegatum Nutt.	A	++	Pink	Elongated
Vicieae				
Lathyrus nevadensis S. Watson	B	++	Pink	Elongated
**Lathyrus odoratus* L.	A	+++	Pink	Elongated
**Vicia faba* L.	A	++	Pink	Elongated
Vicia hirsuta (L.) Gray	A	+++	Pink	Elongated
**Vicia sativa* L.	A	++	Pink	Elongated
**Vicia villosa* Roth	A	++	Pink	Elongated

[1] Species are arranged alphabetically within genera. The nomenclature and tribal classification are as described by Polhill and Raven (1981). Author citations are quoted following instructions of Brummitt and Powell (1992). Introduced species are marked with an asterisk (*).

[2] Nodulating status

A = Nodulation previously observed

B = Nodulation reported for the first time

[3] Nodule frequency

+ = Indicates sparse nodulation (1 to 5 nodules per plant)

++ = Indicates moderate nodulation (6 to 10 nodules per plant)

+++ = Indicates abundant nodulation (more than 10 nodules per plant)

compared the results with his global listing and has confirmed the new reports. The nodules observed in other species corroborate earlier studies (Allen & Allen 1981; Athar 1996a, b; Athar & Shabbir 1997; Corby 1988).

Nodules in most of these species were generally distributed on the main, as well as lateral roots, and were found in the 10 cm layer of the soil. Nodules of some legumes, particularly *Lupinus* spp., sometimes grew on the surface of the soil and were covered by a layer of damp litter. Similar observations were made by Athar (1996a) for some legumes from the Sacramento Valley. The size, number and color of the nodules varied for various species, as well as with the growth stage of the plants. Nodules varied from semi-globose to globose with streaked or smooth surfaces, to elongated and branched forms (Table 1). They occurred singly or as lobed structures. Nodule morphology strongly coincided with the descriptions of earlier workers (Allen & Allen 1981; Athar 1996a; Corby 1988; Pueppke & Broughton 1999; Roggy & Prevost 1999; Somasegaran & Hoben 1994). Nodules were mostly pink or brown with reddish interiors. Nodule morphologies in legume species described by Corby (1988), showed that they were uniform at the tribal level and linked to their position in the evolution of the family. It is becoming clear that nodulation is a robust taxonomic character, both at the presence/absence level and at the structural/physiological level (Sprent 1999). The pioneer work of Corby (1988), linking the morphology of nodular structures to the taxonomy of the legumes, is still relevant, provided that it is coupled to anatomical analyses taking into account the modes of establishment of the symbiosis between the two partners (Pueppke & Broughton 1999; Roggy & Prevost 1999; Sprent 1999).

Attempts to isolate rhizobia or to test nitrogenase activity were not made for these nodulated legumes. However, healthy plants with lush green foliage growing in a nutrient-limited environment imply that they were nurtured by nitrogen-fixing nodules (Hartwig 1998; Somasegaran & Hoben 1994). This is supported by the generally accepted view that nodulated legumes have an internal regulatory system to allow them to adjust nitrogen fixation to environmental conditions (Hartwig 1998; Sprent 1999).

Lupinus (Lupines) were the most prevalent nodulated legumes in Tahoe Basin with 14 species followed by *Trifolium* (clovers), *Vicia* (vetch) and *Astragalus* (locoweeds) with 10, 4 and 4 species each respectively (Table 1). The soils of the Tahoe Basin generally are nutrient poor, especially near the surface where drainage greatly exceeds the rate of chemical erosion from individual soil particles. All the legumes grew well in the nutrient poor environment of the Tahoe Basin. Physiological processes that plants undergo to survive in the Basin help in understanding Tahoe's vegetation ecology. Nutrient limitation plays an important role in plant distribution. Plants cope with nutrient deficiency through mutualisms with mycorrhizal fungi or through associations with bacteria capable of nitrogen fixation. Nitrogen fixation is a crucial component of many plant communities in the Sierra Nevada Range, where nitrogen is ways in short supply. Exploitation of the legume-*Rhizobium* symbiosis in nutrient poor environment of the Tahoe Basin may help improve natural ecosystem, and provide refuge and quality browse for wildlife.

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Special gratitude is expressed to Joseph H. Kirkbride, USDA Beltsville, Maryland for his cooperation in checking the legume nomenclature and taxonomy, and comparing the results against his global database of legume nodulation. Thanks are due to Steve Shoenig, California Department of Food and Agriculture, Sacramento, California for helpful discussion and suggestions; Ellen Dean and Grady Webster and the staff at the J.M. Tucker Herbarium, Davis, California for providing access to their herbarium facilities.

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NOTEWORTHY PLANTS FROM NORTH FLORIDA. VII

Loran C. Anderson

Department Of Biological Science
Florida State University
Tallahassee, FL 32306-4370 U.S.A.

ABSTRACT

The following appear to be first reports for the state of Florida: *Ajuga reptans*, *Aster laevis* var. *concinnus*, *Cyperus retrofractus*, *Linum macrocarpum*, and *Rhynchospora thornei*. Several additions to the flora of north Florida are also documented, and some species that were thought to be restricted in Florida to the western panhandle are noted for extreme northeastern Florida.

RESUMEN

Los siguientes taxa parecen ser las primeras citas para el estado de Florida: *Ajuga reptans*, *Aster laevis* var. *concinnus*, *Cyperus retrofractus*, *Linum macrocarpum*, y *Rhynchospora thornei*. Se documentan también varias adiciones a la flora del norte de Florida, y algunas especies que se pensaba que estaban restringidas en Florida a la franja occidental se han encontrado en el extremo nordeste de Florida.

In previous installments of this series (Anderson 1984, 1986, 1988, 1989, 1991, 1995), "north Florida" was defined as the Florida panhandle west of the Suwannee River. Recent botanical surveys, particularly in Clay, Nassau, and Putnam counties of northeastern Florida, have prompted me to expand the area of coverage to include that portion of the state from Putnam County northward. Particularly interesting sites were found at Black Creek Ravines Conservation Area just E of Middleburg in Clay County and Ralph E. Simmons Memorial State Forest just E of Boulogne in Nassau County. Exotics that appear to be adventive or naturalized are included. Nomenclature generally follows Wunderlin (1998). Herbarium specimens are at FSU unless noted otherwise. These findings will update species distributions as mapped by Wunderlin et al. (1999).

TAXA NEW TO THE AREA

Ajuga reptans L.—Leon Co.: extensively naturalized in Tallahassee lawns, 7 May 1999, *Anderson 18620*; new to Florida.

Aster laevis L. var. **concinnus** (Willd.) House.—Okaloosa Co.: N side of Karick Lake, 11 Oct 1996, *Anderson 17191*; Santa Rosa Co.: shrubby thicket around lake at Camp Paquette, 6 mi NNE of Munson, 27 Oct 1995, *Anderson 16036*, margin of Krull Lake, W of Sweetwater Creek, 11 Oct 1996, *Anderson 17157*; new to Florida.

Duplicates identified by Almut G. Jones (pers. comm.), but I think they may represent a new taxon. These Florida samples have disk corollas 3.7–4.8 mm long, whereas disk corollas from four samples of *A. laevis* (from neighboring states) ranged from 5.2–6.0 mm. The Florida disk flowers have long lobes (1.3–1.6 mm long) and short throats, whereas the *A. laevis* samples I measured had short corolla lobes and long throats. A large lobe/throat ratio is characteristic of *A. lateriflorus* (L.) Britton, but that species is cespitose or with short, stout rhizomes and a branching paniculate inflorescence, whereas the Florida plants have long, slender rhizomes and more racemiform inforescences.

Chenopodium murale L.—Leon Co.: cracks in sidewalk along Sixth Avenue in Tallahassee, 6 Mar 1999, *Anderson 18268*; new to Florida panhandle.

Conobea multifida (Michx.) Benth.—Leon Co.: railroad crossing at Capitol Circle NW in Tallahassee, 2 Oct 1992, *Godfrey 84404*, same locality, 6 Oct 1999, *Anderson 19056*; new to north Florida and second county of record for Florida. Many authors (e.g., Gleason & Cronquist 1991) list this taxon as *Leucospora multifida* (Michx.) Nutt.

Cyperus retrofractus (L.) Torr. in A. Gray.—Jackson Co.: Florida Caverns State Park with *Desmodium ochroleucum* M. A. Curtis and *D. rotundifolium* DC., 10 Oct 1998, *Anderson 18188*; new to Florida. Clewell (1985) listed *C. retrofractus* for the Florida panhandle, but the plants to which he was referring are now considered *C. plukenetii* Fernald; see Carter and Jarvis (1986) for clarification.

Linum macrocarpum Rogers.—Bay Co.: pine flatwoods near Long Beach, 7 Jul 1963, *Godfrey 62966*; Franklin Co.: Apalachicola National Forest, E of Rte 65, 5 Jul 99, *Anderson 18810*; new to Florida. The Bay County specimen was annotated as *L. floridanum* (Planch.) Trel. by Rogers, but later Bruce Sorrie noted its capsules were 3.4–4.6 mm long and identified it as *L. macrocarpum*. The Franklin County specimen was immature, with capsules 3.3–3.5 mm long and shrunken seeds 2.5–2.6 mm long. This species was previously known only from the 1897 type collection (in swamps, Spring Hill) in Mobile Co., Alabama (Rogers 1963). *Anderson 16859* adds a second locality (east of Bayou LaBatre) in Mobile County, AL.

Lipocarpha aristulata (Cov.) G. Tucker.—Putnam Co.: wet depression beside railroad, 1 mi N of Palatka, 18 Sep 1997, *Anderson 18119*, same locality, 22 Oct 1998, *Anderson 18500*; new to north Florida. Kral (pers. comm.) prefers *Hemicarpha aristulata* (Cov.) Smyth.

Mecardonia procumbens (Mill.) Small.—Putnam Co.: frequent in border of lawn, S of rte 100, W edge of Palatka, 16 May 1997, *Anderson 17444*, same locality, 19 Sep 1997, *Anderson 18152*; new to north Florida.

Rhynchospora thornei Kral.—Jackson Co.: marshy area bordering lake 1 mi E of Marianna, 27 Sep 1957, *Kral & Godfrey 5996*, edge of small pond 2 mi NW of Grand Ridge, 10 Oct 1997, *Anderson 18203*; Putnam Co.: wet roadside depression 1 mi N of Palatka, 18 Sep 1997, *Anderson 18133*; new to Florida. The species was previously known only from the type locality in Baker County, Georgia (Kral 1977). The Kral and Godfrey specimen (originally labeled "*Rhynchospora divergens* Chapm.?") was annotated as *R. thornei* by Kral in 1992.

Taraxacum laevigatum (Willd.) DC.—Putnam Co.: lawn weed at St. Johns River Community College in Palatka, 15 Jan 1999, *Anderson 18550*; new to north Florida and second county of record for Florida.

Thunbergia alata Bojer ex Sims.—Leon Co.: escaped from cultivation and naturalized in Tallahassee, 22 Jun 1998, *Anderson 18388*; new to north Florida.

Thymophylla tenuiloba (DC.) Small.—Leon Co.: escaped from cultivation and naturalized in Tallahassee, 7 Jul 1999, *Anderson 18817*; new to north Florida.

Xanthosoma sagittifolium (L.) Schott.—Leon Co.: naturalized (vegetative) in swampy woodland by Ochlockonee Rd, NW of Tallahassee, 1 Nov 1996, *Anderson 17247*, same locality (flowering), 20 Sep 1999, *Anderson 19053*; new to north Florida.

ADDITIONAL RANGE EXTENSIONS

Abutilon theophrasti Medik.—Leon Co.: edge of flood-control pond on Call Street in Tallahassee, 7 Jul 1999, *Anderson 18816*; new county of record and second collection for north Florida.

Aureolaria virginica (L.) Pennell.—Clay Co.: steephead ravine at Black Creek Ravines Conservation Area, 10 Jun 1999, *Anderson 18691*; new to northeast Florida and first collection in Florida east of Ochlockonee River.

Boltonia asteroides (L.) L'Her.—Nassau Co.: bordering St. Marys River at Hwy 17 bridge, 9 air mi NW of Yulee, 5 Oct 1985, *Anderson 8911*; new to northeast Florida.

Callisia repens (Jacq.) L.—Leon Co.: escaped from cultivation and naturalized along roadside ditch in Tallahassee, 20 Oct 1998, *Anderson 18491*; second county of record for north Florida.

Carex crebriflora Wiegand.—Clay Co.: deep shade of swampy floodplain of Black Creek, Black Creek Ravines Conservation Area, 10 Jun 1999, *Anderson 18674*; new to northeast Florida.

Carex styloflexa Buckley.—Clay Co.: deep shade of floodplain of Black Creek near junction of the two forks, Black Creek Ravines Conservation Area, 10 Jun 1999, *Anderson 18687*; new to northeast Florida.

Chasmanthium latifolium (Michx.) Yates.—Nassau Co.: shaded banks of St. Marys River at Simmons State Forest, 25 Jun 1999, *Anderson 18788*, 8 Jul 1999, same locality, *Anderson 18842*; new to northeast Florida (first collection in Florida east of Ochlockonee River).

Croton willdenowii G.L. Webster.—Bay Co.: abundant in white sand of depression just E of Enfinger Rd, S of rte 20 (ca. 2 mi W of Econfina Creek), 27 Oct 1999, *Lisa & Ed Keppner*; second county of record for the state of Florida. This species was previously known as *Crotonopsis elliptica* Willd. Pennell (1918) stated that, in the south part of its range, it occurred "mostly inland, on granitic rocks." Here it occurs in loose white sand, and the other known occurrence in Florida is on citronelle sandstone outcrops at the summit of Rock Hill in Washington County.

Cyperus pseudovegetus Steud.—Nassau Co.: seepage slope, Simmons State Forest, 25 Jun 1999, *Anderson 18764*; second county of record in Florida east of Leon County.

Desmodium rotundifolium DC.—Jackson Co.: Florida Caverns State Park with *D. ochroleucum* and *Cyperus retrofractus*, 10 Oct 1997, *Anderson 18185*; third county of record for Florida.

Fimbristylis decipiens Kral.—Leon Co.: lawn and open weedy slopes above pond E of Mary Ellen Drive in Tallahassee, 8 Oct 1992, *Anderson 14062*, same locality, 25 Oct 1997, *Anderson 18241*. Listed by Clewell (1985) for Florida panhandle, but no specimens seen; these collections confirm its presence.

Hypericum gymnanthum Englem & A. Gray.—Nassau Co.: seepage slope, Simmons State Forest, 25 Jun 1999, *Anderson 18777*; new to northeast Florida and first collection in Florida east of Ochlockonee River.

Kyllinga squamulata Thonn. ex Vahl.—Leon Co.: locally common at Tallahassee Southeast Farm, S of Tram Rd, 25 Sep 1995, *Horne 773*, same locality, 26 Sep 1995, *Anderson 15899*; new to Florida panhandle.

Leersia lenticularis Michx.—Nassau Co.: along stream in Plummer Swamp, 4 air mi WSW of Yulee, 24 Jul 1999, *Anderson 18926*; new to northeast Florida and first collection in Florida east of the Ochlockonee River.

Lithospermum incisum Lehm.—Putnam Co.: dry sand of open oak woodland in Palatka, 27 Mar 1998, *Anderson 18926*; second county of record for northeast Florida.

Murdannia keisak (Hassk.) Handel-Mazz.—Leon Co.: under Meridian Rd bridge W of Lake Iamonia, 18 Oct 1993, *Anderson 14590*, 27 Oct 1999, *Anderson 19082*, shaded streamlet at Elinor Klapp-Phipps Park, N edge of Tallahassee, 23 Sep 1996, *Anderson 17068*; second county of record for Florida panhandle for this recently introduced, aggressive weed. At the Lake Iamonia site, it appears to be displacing *Polygonum meisnerianum* Cham. & Schlecht., which is an endangered species in Florida (Coile 1998).

Oxycaryum cubense (Poeppig & Kunth) Lye.—Bay Co.: frequent along edge of drainage ditch, W of Rte 389 at Girl Scout Camp, 5 Jun 1999, *Keppner 1120*. Reported (as *Scirpus cubensis* Poeppig & Kunth) by Clewell (1985), but no vouchers from the Florida panhandle were found in major Florida herbaria (Wunderlin et al. 1999). This collection documents its presence; the species has also been found recently in Alabama and Georgia (Bryson et al. 1996).

Paederia foetida L.—Duval Co.: alley behind Clemson Rd near University Blvd in Jacksonville, 13 Nov 1998, *Podris* s.n.; Franklin Co.: St. George Island, 13 Apr 1995, *Jubinsky* s.n.; Leon Co.: woodland along Crestdale Ln, NE of Tallahassee, 30 Sep 1997, *Jubinsky* s.n.; new counties of record for this Class I weed (FLEPPC 1999.)

Paspalum conjugatum Berg.—Clay Co.: mesic woodland bordering St. Johns River, Bayard Point State Preserve, 17 Aug 1999, *Anderson 18955*; new to northeast Florida.

Plantago major L.—Nassau Co.: beside rte 2 at St. Marys River bridge, W of Callahan, 24 Jul 1999, *Anderson 18931*; second county of record for northeast Florida.

Plantago rugelii Decne.—Jackson Co.: Pine Shelter service road, Florida Caverns State Park, 10 Oct 1997, *Anderson 18190*; second county of record. Additional sites in Leon Co.: *Anderson 18078, 18389*; first reported for this county (and the state) by Anderson (1986).

Platycladus orientalis (L.) Franco.—Marion Co.: naturalized, several trees of differing ages in pine-oak woodland S of Ferry Rd, E of rte 19 in Ocala National Forest, 23 Oct 1998, *Anderson 18507*; second record for state of Florida (not collected since 1905, see Wunderlin 1998).

Polygonum lapathifolium L.—Nassau Co.: edge of cultivated field, ca. 4 air mi NE of Boulogne, 8 Jul 1999, *Anderson 18852*; new to northeast Florida.

Pycnanthemum flexuosum (Walt.) B.S.P.—Nassau Co.: semishade of seepage slope, Simmons State Forest, 25 Jun 1999, *Anderson 18764*, same general area in full sun, 18 Aug 1999, *Anderson 19009*; new to northeast Florida and first collection in Florida east of Suwannee River.

Rhynchospora macrostachya Torr.—Nassau Co.: shallow pond on seepage slope, Simmons State Forest, 25 Jun 1999, *Anderson 18762*. Reported for the state in 1933 by Small (but not by Godfrey and Wooten 1979 or Wunderlin 1998), but this is apparently the first specimen documenting its presence (G. Moore, pers. comm.). Another horned beaksedge from two sites at Simmons State Forest (*Anderson 19007, 19014*) is puzzling in having achenes with short bristles typical for *R. corniculata* (Lam.) A. Gray but with stout rhizomes as in *R. careyana* Fernald.

Schisandra glabra (Brickell) Rehder.—Leon Co.: mesic woodland along Trillium Court in Tallahassee, 1 May 1999, *Anderson 18617*; new county of record for this endangered species (Coile 1998).

Scirpus koilolepis (Steud.) Gleason. -Nassau Co.: campground at Cary State Forest, just NE of Bryceville, 1 May 2000, *L.C. Anderson 19196*; first report for Florida east of the Apalachicola River.

Spermacoce glabra Michx.—Madison Co.: steep limestone slopes of Withlacoochee River at Blue Spring, 16 Jul 1999, *Anderson 18876*; first collection in Florida east of Ochlockonee River.

Spermacoce verticillata L.—Putnam Co.: roadside 1 mi N of Palatka, 18 Sep 1997, *Anderson 18122*, same general area, 5 Dec 1997, *Anderson 18263*; third county of record for northeast Florida.

Vaccinium tenellum Aiton.—Clay Co.: overgrown seepage slope, Bayard Conservation Area, SE of Green Cove Springs, 10 Dec 1998, *Slaughter 10717*, sandhill seepage at Black Creek Ravines Conservation Area, 10 Jun 1999, *Anderson 18665*; St. Johns Co.: powerline corridor, Moses Creek Conservation Area, 2 mi WNW of Crescent Beach, 9 Apr 1998, *Ware s.n.* These collections confirm its occurrence in Florida. Vander Kloet (1988) noted a single 1943 collection from Clay Co. and implied the species may no longer be found in Florida; the same situation was noted in 1996 (Luteyn et al.). Surprisingly, Wunderlin et al. (1999) listed the species for over 20 counties in north Florida. The discrepancy between this wide distribution and all previous reports may arise from confusion of this species with other elements of the genus.

ACKNOWLEDGMENTS

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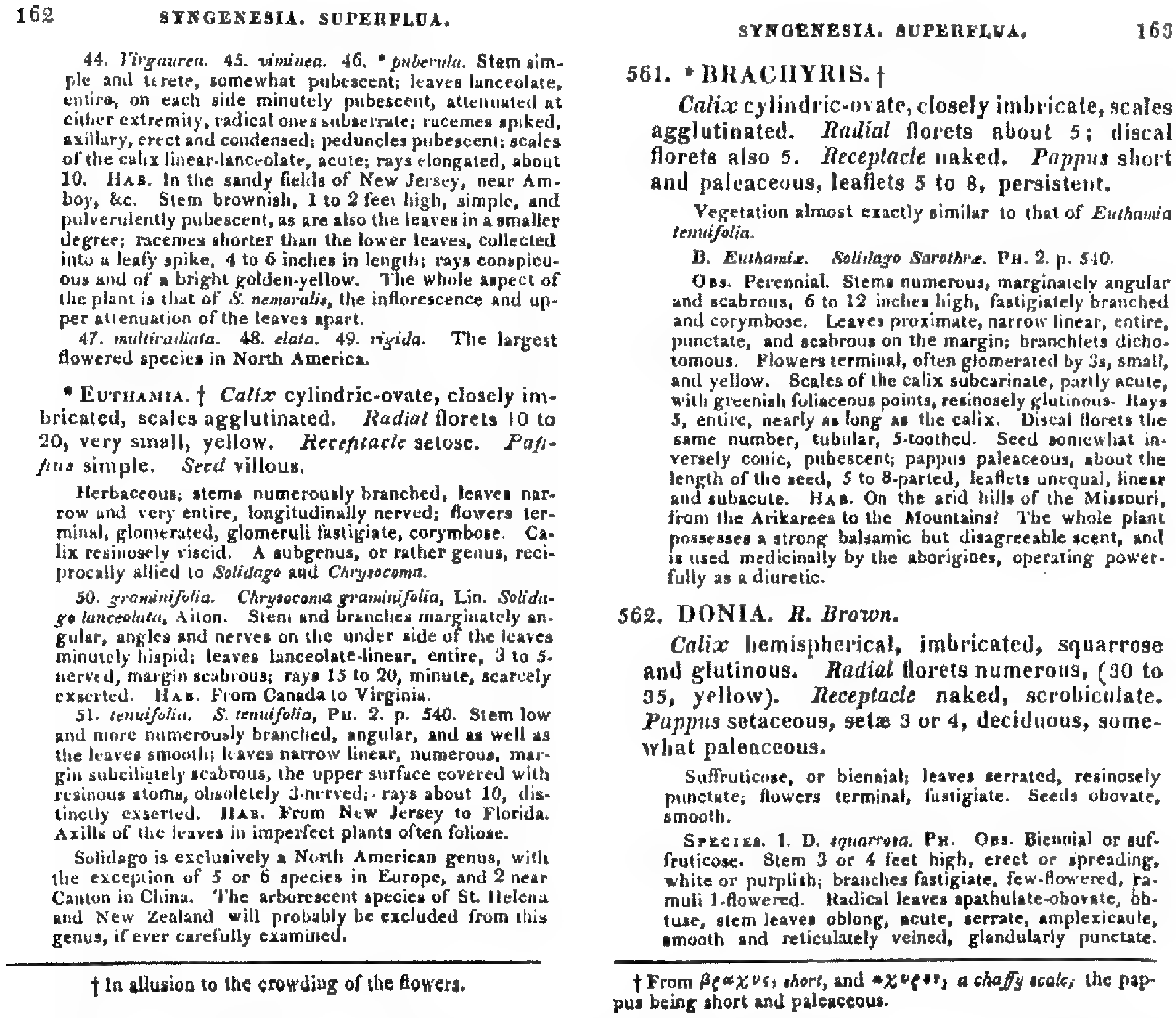
WHO NAMED *EUTHAMIA* (COMPOSITAE: ASTEREAE) AND WHEN?

John L. Strother

University Herbarium
1001 Valley Life Sciences Building #2465
University of California
Berkeley, CA 94720-2465, U.S.A.

Nesom (1999) and Gandhi (1999) reviewed author attributions and dates for the generic name *Euthamia* and for binomials in *Euthamia*. They expressed slightly different interpretations; here is a third interpretation:

The first known use of *Euthamia* as a botanical name was by Nuttall (1818). Nuttall wrote of his *Euthamia*, "A subgenus, or rather genus, reciprocally allied to *Solidago* and *Chrysocoma*" (Fig. 1). Only a taxon of generic rank can be said to be "reciprocally allied" to



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44. *Virgaurea*. 45. *viminea*. 46. * *puberula*. Stem simple and terete, somewhat pubescent; leaves lanceolate, entire, on each side minutely pubescent, attenuated at either extremity, radical ones subserrate; racemes spiked, axillary, erect and condensed; peduncles pubescent; scales of the calix linear-lanceolate, acute; rays elongated, about 10. Hab. In the sandy fields of New Jersey, near Amboy, &c. Stem brownish, 1 to 2 feet high, simple, and pulverulently pubescent, as are also the leaves in a smaller degree; racemes shorter than the lower leaves, collected into a leafy spike, 4 to 6 inches in length; rays conspicuous and of a bright golden-yellow. The whole aspect of the plant is that of *S. nemoralis*, the inflorescence and upper attenuation of the leaves apart.

47. *multiradiata*. 48. *elata*. 49. *rigida*. The largest flowered species in North America.

* Euthamia.† *Calix* cylindric-ovate, closely imbricated, scales agglutinated. *Radial* florets 10 to 20, very small, yellow. *Receptacle* setose. *Pappus* simple. *Seed* villous.

Herbaceous; stems numerously branched, leaves narrow and very entire, longitudinally nerved; flowers terminal, glomerated, glomeruli fastigiate, corymbose. Calix resinosely viscid. A subgenus, or rather genus, reciprocally allied to *Solidago* and *Chrysocoma*.

50. *graminifolia*. *Chrysocoma graminifolia*, Lin. *Solidago lanceolata*, Aiton. Stem and branches marginately angular, angles and nerves on the under side of the leaves minutely hispid; leaves lanceolate-linear, entire, 3 to 5-nerved, margin scabrous; rays 15 to 20, minute, scarcely exserted. Hab. From Canada to Virginia.

51. *tenuifolia*. *S. tenuifolia*, Ph. 2. p. 540. Stem low and more numerously branched, angular, and as well as the leaves smooth; leaves narrow linear, numerous, margin subciliately scabrous, the upper surface covered with resinous atoms, obsoletely 3-nerved; rays about 10, distinctly exserted. Hab. From New Jersey to Florida. Axills of the leaves in imperfect plants often foliose.

Solidago is exclusively a North American genus, with the exception of 5 or 6 species in Europe, and 2 near Canton in China. The arborescent species of St. Helena and New Zealand will probably be excluded from this genus, if ever carefully examined.

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† In allusion to the crowding of the flowers.

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561. * BRACHYRIS.†

Calix cylindric-ovate, closely imbricate, scales agglutinated. *Radial* florets about 5; discal florets also 5. *Receptacle* naked. *Pappus* short and paleaceous, leaflets 5 to 8, persistent.

Vegetation almost exactly similar to that of *Euthamia tenuifolia*.

B. *Euthamiæ*. *Solidago Sarothræ*. Ph. 2. p. 540.

Obs. Perennial. Stems numerous, marginately angular and scabrous, 6 to 12 inches high, fastigiately branched and corymbose. Leaves proximate, narrow linear, entire, punctate, and scabrous on the margin; branchlets dichotomous. Flowers terminal, often glomerated by 3s, small, and yellow. Scales of the calix subcarinate, partly acute, with greenish foliaceous points, resinosely glutinous. Rays 5, entire, nearly as long as the calix. Discal florets the same number, tubular, 5-toothed. Seed somewhat inversely conic, pubescent; pappus paleaceous, about the length of the seed, 5 to 8-parted, leaflets unequal, linear and subacute. Hab. On the arid hills of the Missouri, from the Arikarees to the Mountains? The whole plant possesses a strong balsamic but disagreeable scent, and is used medicinally by the aborigines, operating powerfully as a diuretic.

562. DONIA. *R. Brown*.

Calix hemispherical, imbricated, squarrose and glutinous. *Radial* florets numerous, (30 to 35, yellow). *Receptacle* naked, scrobiculate. *Pappus* setaceous, setæ 3 or 4, deciduous, somewhat paleaceous.

Suffruticose, or biennial; leaves serrated, resinosely punctate; flowers terminal, fastigiate. Seeds obovate, smooth.

Species. 1. D. *squarrosa*. Ph. Obs. Biennial or suffruticose. Stem 3 or 4 feet high, erect or spreading, white or purplish; branches fastigiate, few-flowered, ramuli 1-flowered. Radical leaves spathulate-obovate, obtuse, stem leaves oblong, acute, serrate, amplexicaule, smooth and reticulately veined, glandularly punctate.

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† From βραχυς, *short*, and αχυρον, *a chaffy scale*; the pappus being short and paleaceous.

Fig. 1. Pages 162 and 163 from volume 2 of Nuttall's *The Genera of North American Plants*.

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two other genera and a taxon cannot be both a subdivision of *Solidago* and, at the same time, "reciprocally allied to *Solidago* and *Chrysocoma*." Nuttall (Fig. 1) associated the epithets *graminifolia* and *tenuifolia* with the generic name *Euthamia* and, in his protologue of *Brachyris* (Fig. 1), Nuttall used the binomial *Euthamia tenuifolia*.

Elliott (1823), Cassini (1825), and de Candolle (1836) treated Nuttall's *Euthamia* as a generic name published in 1818 and Elliott and de Candolle treated Nuttall's *E. graminifolia* and *E. tenuifolia* as published in 1818.

Regardless of typographic lapses or errors or inconsistencies of numbering and/or positioning in production of Nuttall's *Gen. N. Amer. pl.* (see Gandhi 1999; Nesom 1999; and papers cited by them), citations for Nuttall's *Euthamia* names should be:

Euthamia Nutt., Gen. N. Amer. pl. 2:162. 1818.

Euthamia graminifolia (L.) Nutt., Gen. N. Amer. pl. 2:162. 1818. BASIONYM: *Chrysocoma graminifolia* L., Sp. pl. 841. 1753.

Euthamia tenuifolia (Pursh) Nutt., Gen. N. Amer. pl. 2:162. 1818. BASIONYM: *Solidago tenuifolia* Pursh, Fl. Amer. sept. 540. 1813 [1814].

ACKNOWLEDGMENTS

I thank K.N. Gandhi, G.L. Nesom, P.C. Silva, and A.R. Smith for discussions on *Euthamia*.

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JOSEPH ANDORFER EWAN
OCTOBER 24, 1909 – DECEMBER 5, 1999
A MEMOIR

Anne S. Bradburn

Tulane University Herbarium
Dept. of Ecology and Evolutionary Biology
Tulane University
New Orleans, LA 70118-5698, U.S.A.

The lights were back on, projection equipment was being put away, when a man with a neat white goatee, twinkling eyes, and the most active eyebrows one can imagine said "That's such a good show, you need to know all the plant names. I can help you!" After dinner the following week, Professor Ewan, who would become my mentor and friend, did just that; adding names to flowers in the slide show used in a seven-year, finally-successful effort to have two small Mississippi barrier islands added to the National Wilderness System. By the time the campaign was over, I had taken all the botany courses offered at Tulane, wound up with a master's degree, and found a new career.

For over thirty years, Professor Ewan touched the lives and minds of Tulane students. None of the hundreds of students who enrolled in biology 431 (Plant Systematics in the catalogue but really a course in "Plant Appreciation") could ever walk across the campus in the same way. Their eyes had been opened to a world of wonder. Music, art, and his beloved history were woven into plant biology. You never missed a Ewan lecture, nor forgot one!

For one whose focus would be the history of science, Joseph Ewan left a remarkably thin personal paper trail. The facts of his life are scant and not easy to find. Born in Philadelphia, educated in Los Angeles, he received an A.B. degree in botany from the University of California, Berkeley in 1934. In 1935, he married Ada Nesta Dunn, a fellow student who shared many of his interests and his life for the next 64 years. They had three daughters: Kathleen, Dorothy, and Marjorie and five grandchildren. He was an instructor at the University of Colorado (1937–1944), botanist with the Foreign Economic Administration (1944–1945), Assistant Curator, Smithsonian Institution (1945 1946) and Associate Botanist, Bureau of Plant Industry, U.S. department of Agriculture (1946–47). In 1947, he came to Tulane as an Assistant Professor, moved steadily up the academic ladder, and in 1972 was named the Ida Richardson Professor of Botany, a chair he held until 1977 when he was appointed Emeritus Professor. For nearly forty years, Tulane students, faculty, and staff members were exposed to his mind, his vast knowledge, and his enigmatic wit.

Along the way, Ewan was a Guggenheim Fellow (1954), a National Science Foundation Fellow (1959–61), a Smithsonian Regents' Fellow (1984), and held visiting professorships at the Universities of Hawaii and Oregon, and at the Ohio State University.

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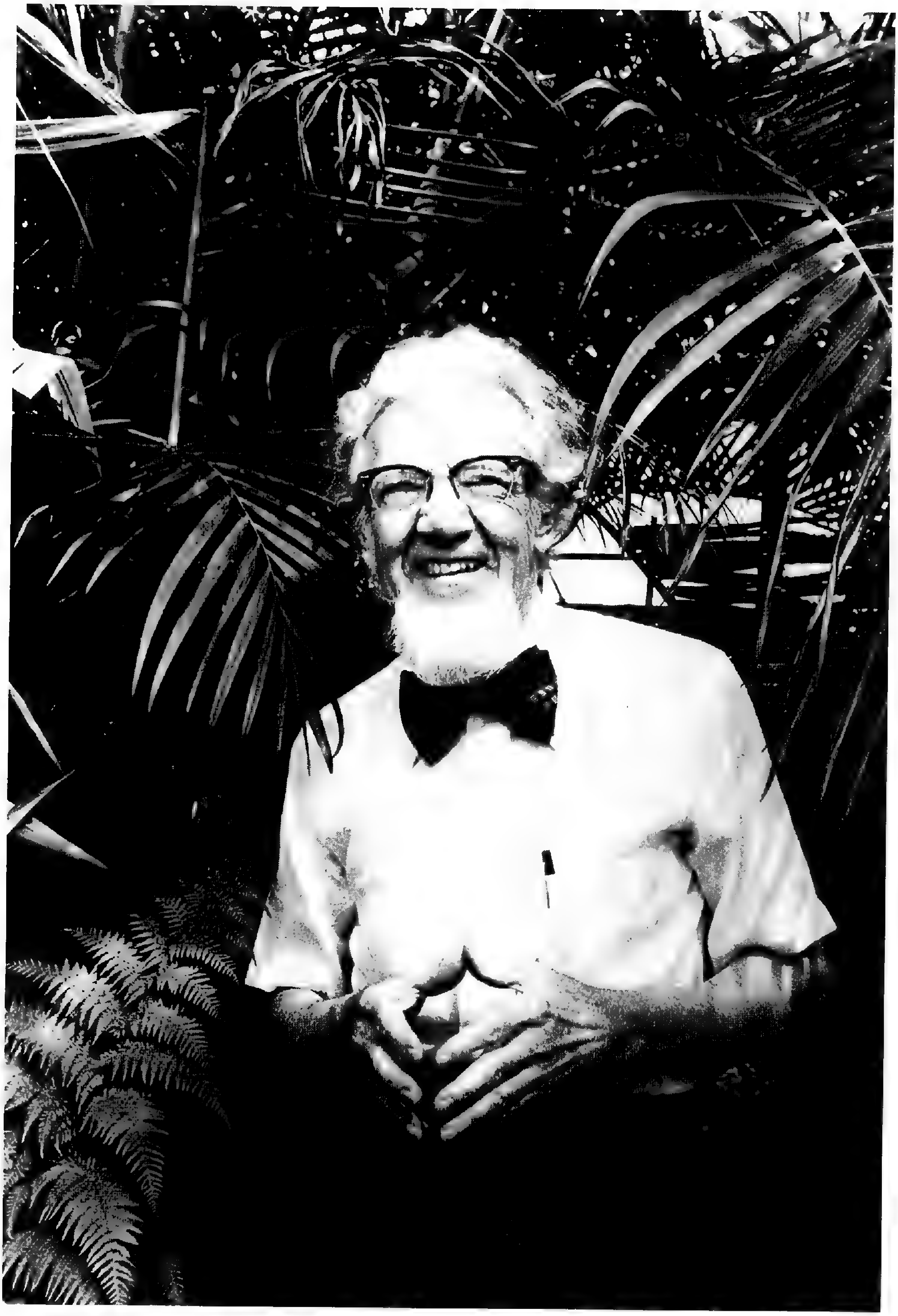
He received the Founders Medal from the Society for the History of Natural History, London in 1977, the Elosie Payne Luquer Medal from the Garden Club of America in 1978, and with his wife Nesta Dunn Ewan, the Henry Shaw Medal from the Missouri Botanical Garden in 1994. Ewan was an elected Fellow of the Linnean Society of London. The Botanical Society of America awarded him a Certificate of Merit in 1989. The College of William and Mary and Tulane University awarded him honorary doctorates.

"A bite of immortality" is the Ewanian concept of publication. His own first "bite", at age 19, was *A Report on the California Black Rail in Los Angeles County* published in *Condor*. His early botanical interests focused on ferns, and he was President of the American Fern Society in 1951. Taxonomic studies on Delphinium and other Gentianaceae followed but his interest had always been captivated by biogeography, bibliography, and history of biology and by the time I became his student in the early 1970's, history had completely replaced taxonomy in his research. Questions to Ewan were most frequently answered by questions and one left his office burdened with books. He believed books were to be used, and was always generous with his personal library. As a new graduate student, I remember being awe struck when he handed down from above his rickety desk, a beautiful vellum copy of Bauhin's *Prodromus* with the disclaimer that it was only the second edition from 1671. Back in my cubicle, I was afraid to open it!

Other samples from his "bites" include such tempting titles as: "From Calcutta and New Orleans, or tales from Barton's greenhouse", "Roots of the California Botanical Society", "Who Conquered the World? or four centuries of exploration in an indehiscent capsule", and "The Botany of Cook's Voyages; or around the world on six shillings a day."

Then there are his many contributions to The Dictionary of Scientific Biography where ones finds, among others, sketches of George Engelmen, Albert Spear Hitchcock, Elmer Drew Merrill, Frederick Pursh, and the irascible Constantine Samuel Rafinesque. His introductions to the Classica Botanica Americana series are classics themselves. As a book reviewer, Ewan was in constant demand. His writings into his venue were always tantalizing. As in "A good beginning is the true story of nine pigs driven 71 miles by a peon carrying a pine torch" which certainly tempts one to dip into Archie Carr's "*High Jungles and Low*." Or "How can you know the gardens of the deep south without this book close to the hammock?" and the fact that its author is "not frightened by information" makes one want to dash out to acquire Charlotte Seidenberg's *The New Orleans Garden*."

Perhaps more meaty "bites" are his books. *Rocky Mountain Naturalists* (1950), its follow-up, *Biographical Dictionary of Rocky Mountain Naturalists* (1981), and *John Banister and His Natural History of Virginia* (1970) the later two co-authored by his wife, Nesta Dunn Ewan. In 1969 Ewan edited *A Short History of Botany in the United States* and contributed the Calendar of Events and chapters on Early History and Plant Geography. Here he graphically illustrated the "Role of the Bartrams in natural History" for Ewan believed William Bartram's contributions central to the development of botany in the United States. His *William Bartram and His Botanical and Zoological Drawings* was published by the American Philosophical Society in 1968 and the Ewans' monumental biography of Philadel-



Joseph Andorfer Ewan
October 24, 1909 – December 5, 1999

phia botanist Benjamin Smith Barton will be published posthumously by the Missouri Botanical Garden.

In 1986, the Ewans moved from Tulane. The Missouri Botanical Garden had bought his prodigious library and given them a new home. There they were housed in the old museum building and for the first time the Ewans had spacious working conditions with large double desks for each of them and his 4,500 books carefully catalogued and shelved within easy reach. In announcing the move, Peter Raven, Director of the Garden, said "The Joseph Ewan collection is an extremely valuable acquisition for the Garden. The historical significance of the collection, its relevance to the work we do, and the respect Joseph Ewan commands in the scientific community make this announcement one of the most exciting I've made while at the Garden."

We a Tulane are left with his name on the door, lots of happy memories, and his herbarium now over 110,000 specimens. Just last week we received a request from Switzerland for Tulane's holdings of *Macrocarpaea*, a genus monographed by Ewan in 1948. As I compose on the Pentium, in my mind's ear, I can still hear the clicking of his manual typewriter which sounded in the same room for so many years.

The 1989 *Ewania: The Writings of Joe and Nesta Ewan* lists 358 "bites of immortality." The following ten years produced many other "bites." Surely a veritable feast for generations of botanists, natural historians, and biogeographers in the generations to come.

BOOK REVIEWS

JOE LIGGIO and ANN O. LIGGIO (David H. Riskind, Scientific Advisor). 1999. **Wild Orchids of Texas.** (ISBN 0-292-74712-8, hbk). Univ. of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. $29.95, hbk. i–xii, 1–228 pp., color photos, distribution maps.

The *Wild Orchids of Texas* is an outstanding treatment of the fifty-two species of orchids known to occur in Texas and the authors deserve high praise for such an accomplishment. It begins with a chapter giving an overview of the state's orchids emphasizing their diversity and conservation. Subsequent chapters give exceptionally clear and interesting discussions of such topics as pollination, saprophytic species, and orchid-fungal partnerships. These are followed by a detailed discussion of orchids by the main habitat in which they occur, including bogs and savannahs, open sunny habitats, forests and woodlands, and mountains and canyons.

The main part of the book, taking up about three-quarters of the text, is a wonderfully complete trip through all of Texas' orchids by genus and species. For example, the treatment of the genus *Calopogon* (grass pink orchids) begins with a discussion of the genus, giving such information as the number of species (five) and the range (eastern North America from Newfoundland to Cuba and westward to Minnesota and Texas). The derivation of the genus name is said to be derived from two classical Greek words meaning "beautiful beard," in reference to the lip tufted with colorful hairs. An insightful discussion on pollination in *Calopogon* shows how the pollinating bees are victims of these deceptive orchids which give no reward (such as nectar) in return for the insects' services. Both of the Texas species of *Calopogon* are then discussed with such information as common name, range, a detailed description of the species characteristics, taxonomic and nomenclatural history, habitat and other ecological data including blooming time, and a county distribution map showing precise locations in Texas. Such thorough accounts are given for each of the state's genera and species. While my basic reaction is that only praise is due this work, I could make a few of the most minor criticisms. For example, a few recently reported distributional records were missed.

The authors have clearly given extensive thought to making the book as useful as possible to a varied audience. For example, for amateurs wanting to identify an orchid with which they are not familiar, there is a list of orchids by flower color. However, for both professional and interested lay readers, the most exceptional and enjoyable part of the book is the quality of the remarkable color photography. Joe Liggio is a gifted photographer and the approximately 90 photos are a testament not only to his artistic and technical skills but also to his intimate knowledge of orchids. Some of the species photographed rarely and irregularly bloom and often do so only in extremely inaccessible places. The complete coverage of the state's species is thus clearly the result of hard work covering many years. The beauty of the photographs is complimented by the pleasing layout and the obvious thought given to design. There are, for example, numerous appealing details such as interesting quotes in the spacious margins and special text boxes pointing out particularly fascinating bits of information (e.g., "Ice Age Legacy" describes a rare yellow Lay's slipper discovered in the Texas Panhandle, apparently a relict of a colder and wetter climate regime during the last ice age).

The scientific accuracy and attention to detail evident in this volume also make it valuable to professional botanists. The Liggios and their scientific advisor, David Riskind, have used the most up-to-date information on scientific nomenclature, have visited herbaria to obtain information for the detailed distribution maps, and have carefully documented their sources in an extensive Literature Cited section. As a taxonomist currently working on a treatment of the orchids of East Texas (as part of the *Illustrated Flora of East Texas* project), I found the book an extremely valuable and helpful resource. For example, the genus *Spiranthes* (ladies'-tresses orchids) is known for its difficulty in terms of species identification. There is a very clear and informative section discussing the differences between *S. cernua*, *S. magnicamporum*, and *S. odorata*, three notoriously difficult species. Finally, the authors' intimate knowledge of the plants in the field is evident throughout the book and is a welcome relief in a scientific climate where work in the laboratory is too often valued more than knowledge of organisms in the wild.

In summary, among state and regional treatments of orchids or other plant families, this is the most detailed, aesthetically pleasing, and just plain enjoyable book I've seen. From the beautiful dust jacket to the superb photography and details about orchid biology, it was clearly a labor of love for the authors. This is a book that anyone interested in Texas plants definitely should not miss.—*George M. Diggs, Jr., Dept. of Biology, Austin College, Sherman, TX 75090, and Botanical Research Institute of Texas, Fort Worth, TX 76102.*

John H. Wiersema and Blanca León. 1999. **World Economic Plants: A Standard Reference.** (ISBN 0-8493-2199-0, hbk.). CRC Press LLC, 2000 Corporate Blvd. NW, Boca Raton, FL 33431, U.S.A. (1-800-272-7737; 1-800-374-3401 fax). $125.00, hbk. 749 pp.

While discussing some of my research on the Kallawaya herbalists of Andean South America with one of the researchers here at BRIT, it was recommended I consult *World Economic Plants* to help validate some of my work. Covering almost 10,000 vascular plants of economic importance, this reference volume is sure to be on the shelves of any botanist or anthropologist concerned with economic plants. Data were compiled for the Germplasm Resources Information Network (GRIN), which is the USDA/ARS's genetic resource management database. While much of this database is open to the public via internet access, this volume makes a strong argument that pulling a book off the shelf, as decadent as that may sound, could still be a faster way to get an answer.

Wiersema and León divide the book into two major parts, both of which are organized alphabetically. Part one is the catalog of economic plants offering the scientific name, synonymy, common names, economic impacts, and geographical distribution for a given plant. Part two offers an index of common names that includes the list of common names from part one with corresponding scientific names. All of the above information was validated by 150 specialists, something few reference volumes can boast about. Following a brief introduction that describes the methods of compiling data comes a discussion of content where the authors discuss the rationale for part one and its design. While serving as an excellent reference to confirm plant names, scientific and common, this book first and foremost is concerned with the economic salience of vascular plants world wide. Under the heading of economic importance, the authors give reference to the plant's role as a food or food additive, animal food, bee plant, invertebrate food and poison, material, fuel, social use, medicine, environmental use, gene source, weed, and harmful organism host. For plants that are subject to the regulation of the Convention on International Trade in Endangered Species (CITES) the authors have made the appropriate reference. Completing the mission of the book, the authors cite the geographical distribution of each plant, following the standard *World Geographical Scheme for Recording Plant Distributions* (Hollis & Brummitt 1991), that divides the terrestrial world into nine areas: Africa, Antartica, Asia-Temperate, Asia-Tropical, Australasia, Europe, Northern America, Pacific, and Southern America. However, the actual breakdown does not quite gel with the divisions. For instance, for North America the authors include Canada, U.S.A, and most of Mexico. While South America includes Mesoamerica, the West Indies and South America.

My current research is concerned with the plant origins of the Kallawaya pharmacopoeia, specifically exotic botanicals or non native plants. Using my own data as well as "Pharmacopeia of Qollahuaya Andeans" by Joseph W. Bastien (1983), Journal of Ethnopharmacology, 8:97–111, I looked for information on a number of plants, using both their common and scientific names. I looked in the common name index for ***altamisa***, for which the authors give the scientific name *Tanacetum parthnium*, but Bastien gives the scientific name *Ambrosia peruviana*. I looked for *A. peruviana* in the catalog of economic plants and while many species of the *Ambrosia* genera are listed, there is no citation for *A. peruviana*. When I looked for ***berro*** in the common name index for its scientific name, both *World Economic Plants* and Bastien cite the name *Nastrium officinale*. But, when I looked in the catalog of economic plants for *N. officinale* the authors cite its only economic importance as a food(vegetable) while Bastien cites a medicinal use (a Mate for Hepatitis and Kidney infections) the authors leave out. I decided to supplement my investigation with "Introduced Plants in the Indigenous Pharmacopoeia of Northern South America" by Brad Bennett and Ghillean Prance (2000) Economic Botany, 54(1):90–102, my rationale being a more recent article might limit confusion. I consulted the catalog of economic plants for *Plantago major*, a plant that Bennett and Prance cite as used to treat 12 body systems with 15 pharmacological properties. *World Economic Plants* lists its only economic importance as a Weed with possible seed contamination. Coincidentally, while investigating *P. major*, I noticed that one of the common names listed was ***llanten***. Bastien lists ***llanten*** as *Plantago tomentosa*, which until now, I had had a great deal of trouble locating at all. Using another plant from Bennett and Prance, *Rosmarinus officinalis*, I consulted the catalog of economic plants again. The authors cite it as a medicinal and its geographic distribution, not a South American plant, corroborates with Bennett and Prance.

In summary, while this book is not definitive, it still exists as the only one of its kind. And as the forward states, "this handy reference will address the ongoing needs of a broad spectrum of users including agricultural commodity traders, farmers searching for potential crops or seeking to eradicate harmful weeds; health or veterinary workers concerned with poisonous plants; scientific information specialists; and scientists in a variety of disciplines that involve economic plants."—*Kevin D. Janni.*

ERNEST SMALL and PAUL M. CATLING. 1999. **Canadian Medicinal Crops.** (ISBN 0-660-17534-7, pbk). National Research Council of Canada. Monograph Orders, NRC Research Press, M-55, National Research Council Canada, Ottawa, Ontario K1A 0R6, CANADA. (613 990-2254; 613-952-7656 fax) <http://www.nrc.ca/cisti/journals/mgraphs.html>. $29.95. 240 pp., 25 color plates, b&w line drawings, distribution maps.

Responding to the demands of the agricultural community for more information on native medicinal plants, the National Research Council of Canada has produced a reference book that sets the standard for other countries to follow. Canada is no stranger to the medicinal plant industry. They gross $100 million annually from the cultivation of Ginseng, as well as producing other crops, like echinacea, Pacific Yew, and goldenseal. With the current surge of interest in herbal alternatives to costly prescription drugs, medicinal plants are in vogue to a currently sluggish agricultural industry. *Canadian Medicinal Crops* is targeted to the agricultural community, offering not only an encyclopedic reference to 25 potential medicinal crops, but also a section devoted to the business of medicinal plants.

Opening with an appropriate introduction for the uninitiated, the authors discuss medicinal plants from ancient times to present, medicinal chemicals, herbals vs. pharmaceuticals, nutraceuticals, and economic opportunities. This sets the stage for the core of the book and the 25 plants of economic potential and their detailed species accounts. For each plant the authors provide the scientific, English and French names, morphology, classification and geology, ecology, medicinal uses, toxicity, chemistry, non-medicinal uses, agricultural and commercial aspects, and a section on myths, legends, tales, folklore, and interesting facts. For each plant there is also a page-sized color illustration of the plant, a geographical distribution map and a list of selected references and World

Wide Web links. I found the references to web links a nice bonus, the authors cite web sites in the text, so—for example—while reading about the toxicity of *Arnica Montana*, the authors provide the web address to a 1995 Health Canada document on herbs used as non-medicinal ingredients in nonprescription drugs. The web links listed after the selected references section are more plant specific. For example, in the chapter on echinacea the authors cite http://res.agr.ca/lond/pmrc/study/newcrops/echinacea.html, plus nine other sites. The addition of web links makes information readily accessible, and along with the text itself, comprehensive.

Following the information on plants comes chapters devoted to the business of growing medicinal plants, the regulatory and legal framework in Canada for producing and marketing medicinal plants, various hazards, and a general overview of medicinal plant research in Canada. This section is quite interesting- the authors discuss principal determinants of the commercial importance of medicinal plants, marketplace timing, a list of native aromatic, insecticidal, and nutraceutical crops, and a list of non-native medicinal crops that could be grown in Canada. While this section does pay some lip service to conservation and sustainability, it would be nice to see in future editions a full-blown chapter on the subject, with references and web links. There is also a section on medicinal cautions that discusses health fraud and gives recommendations to legislators, regulators, product manufacturers, physicians, and consumers, and discusses herbal remedies in Canadian and American laws. The last 30 pages consist of a list of information resources, such as contacts to Canadian experts, organizations, and publications, an appendix offering a regional review of medicinal plant research in Canada, a list of general references, a list of web sites on medicinal herbs, and finally, a glossary of pharmacological and medical terms relevant to medicinal plants.

I was slightly disappointed that there was no general index and that the authors did not fully address conservation and sustainability but, otherwise *Canadian Medicinal Crops* is a model text for other countries to follow. The sections discussing the business side of the medicinal crop industry were particularly interesting and I'm sure, invaluable to anyone interested in starting a medicinal crop. Even though this book has a target audience (the agricultural community), I wouldn't expect readership to be exclusive. This book would also serve well as part of a medical botany class or as a general reference to anyone interested in Canadian medicinal crops.—*Kevin D. Janni.*

JOHN T. KARTESZ and CHRISTOPHER A. MEACHAM. 1999. **Synthesis of the North American Flora, Version 1.0.** (ISBN 1-889065-05-6). North Carolina Botanical Garden and the University of North Carolina at Chapel Hill, CB #3375, Totten Center, Chapel Hill, NC 27599-3375, U.S.A.

Minimum hardware configuration: Pentium 90 MHz-class processor, 32 megabytes RAM, 25 megabytes free hard disk space, SVGA display (800 X 600 pixel resolution) with 16 colors, Microsoft Windows 3.1, NT, 95, 98, or 2000 operating system, CD-ROM drive for installation, a mouse, and, of course, a keyboard.

This CD-ROM includes an updated version of Kartesz's *A Synonymized Checklist of the Vascular Flora of the United States, Canada, and Greenland*, but it is so much more. Besides being able to switch between thesaurus and checklist format at the click of a mouse, you also have the option of omitting authors from the listing, omitting synonyms completely, or new with the Synthesis, displaying common names. And this is only the tip of the iceberg.

There are many other practical functions packed into this program. They are so numerous and applicable in so many different ways that it's actually a little confusing at first. I'll start with the more straightforward functions. The Synthesis allows you to highlight any taxon from a family, genus, or species list and displays its distribution on a map of the circumscribed area. It also color codes regions (the U.S. is divided into its states, and Canada into its provinces) as to status of the taxon in terms of noxious, rare, extinct, eradicated, extirpated, or simply present. Another touch is discovered when you hover the cursor over a region and a flag pops up telling you the location of a voucher or in some cases a citation for the species from that region.

Another basic function of the synthesis is the biological attributes window. In its simplest use it displays the biological attributes of the currently selected taxon. Some of the attributes covered are general plant habit (forb, grass, shrub, tree etc.), major plant group (monocot, dicot, fern, gymnosperm etc.), duration (annual, perennial or biennial), nativity (native or exotic), habitat (alpine, aquatic, submerged, floating, wetland etc.), and the list goes on.

These functions alone are worth the investment in the CD. But it is only the beginning of the functions of the program. The rest revolves around three possible queries and four operations you can perform on the queries in numerous Boolean permutations. From here I found it somewhat convoluted if not in design at least in the explanation. The four operations (union, intersection, restricted, and "not") can be performed on any single, pair, or trio of queries (geographic, attributes, or taxonomic). As an example you could select two geographic regions like Texas and North Dakota and perform the union operation on the selection. The program would then highlight all of the species that occur in these two states combined. Further you could add an attribute query such as all annual dicots found in both states. Finally you could add the third query with something like Asteraceae and all annul dicots in the Asteraceae in both states would be highlighted. Besides the taxa in the list being highlighted a table with the number of taxa at each rank is displayed in the lower right hand corner. The intersection operation displays the taxa with the particular attributes or in a particular taxon, if selected, that are common to the chosen geographic regions. The restricted operation displays taxa that are restricted to the selected region or regions. Finally, the "not" operation is the functional opposite of the restricted function and displays all of the species of the circumscribed area not found in the selected region. For example, there are about 28,000 species in the Synthesis (North America north of Mexico) and about 6,000 species in Texas. If the "not" operation were performed on Texas as the selected region the program would display 22,000 species. This may be the least usable of the functions found in the program.

Besides this dizzying array of query/operations combinations there are also several different colors of fonts used in the displayed query lists that carry different kinds of information. This added information takes sometime to sink in and may or may not be useful to some.

All in all, once you spend some time with the program, it is quite usable. It will probably become the standard for its medium just as the Kartesz books have become a standard for the printed medium.—*Robert J. George.*

W.S. Judd, C.S. Campbell, E.A. Kellogg, and P.F. Stevens. 1999. **Plant Systematics: A Phylogenetic Approach**. (ISBN 0-87893-404-9, hbk.). Sinauer Associates, Inc. 23 Plumtree Road, Sunderland, MA 01375, U.S.A. (*publish@sinauer.com*; http://www.sinauer.com/). $67.95, hbk. xvi + 464 pp., with CD-ROM.

I shared the general enthusiasm of many colleagues in the summer of 1999 upon learning of the availability of a new textbook for plant systematics by Judd and colleagues, whose collective depth, breadth, and expertise in taxonomy is considerable. Promotional literature distributed by the publishers indicates the text has been adopted by a considerable number of institutions in the United States. However, this review is mixed because of contradicting interests in the text as a researcher and a teacher of introductory plant systematics.

As a detailed and modern source information for graduate students and thoroughly trained plant systematists, the text is highly recommended. Stated simply, *Plant Systematics* is the only modern and relatively complete source of information summarizing the numerous recent changes in plant classification at the family level based on phylogenetic analysis. The text has an abundance of classic and more recent citations concerning the taxonomy of particular groups. For these reasons alone the text can be consulted profitably by all practicing taxonomists. The coverage of general topics by and large reflects what graduate students in taxonomy should master. The volume probably should be consulted by all instructors of plant taxonomy, given emerging changes in our knowledge of evolutionary relationships.

Apart from the Forward, Preface, and Acknowledgments, the book is divided into eight chapters, two appendices, separate taxonomic and subject indices, and a CD-ROM.

Chapter One, entitled "The Science of Plant Systematics", immediately introduces the phylogenetic context that pervades the entire text. Although the term synapomorphy is introduced later, a simplified cladogram showing the shared derived characters uniting the major lineages of plants appears on the second page. Phylogeny is the unifying principal throughout the text, as any modern treatment should be.

In the second chapter, "Methods and Principles of Biological Systematics", the principles of phylogenetic systematics are developed in some detail. Unfortunately, the treatment is much too dense for most students at the introductory level. The excessive detail evident in chapter two permeates the text throughout, and from a pedagogical perspective, it is the largest shortcoming of the book. As one who used the text for a semester long, upper division plant taxonomy course at a medium-sized public university shortly after its introduction, I suggest with some confidence that the level of detail overwhelms most beginning students.

As such, and with greater perusal, one wonders for whom the text is targeted. For example, a number of unrooted networks in chapter two illustrate how character state variation can be ordered, which seems unnecessary at an introductory level. Likewise, a concise summary of long-branch attraction appears as an offset box on page 20, which apparently is deemed more important to beginning students than including simple illustrations showing the differences between monophyly, paraphyly, and polyphyly (although monophyletic and paraphyletic groups are shown in fig 2.23 in the context of phylogenetic and evolutionary classifications). The common use of cladograms early in the text is admirable, as for example in the first chapter, where common names are used as terminals of cladograms (raspberries, blackberries, cherries) to illustrate common ancestry and sister taxa. Soon thereafter (figs. 2.9, 2.12, 2.13), however, cladograms begin to incorporate terminal taxa such as Piperales, Winteraceae, Saururuaceae, Chloranthaceae, Calycanthaceae, and other names that mean nothing to the majority of students who likely would be covering this material during the second or third week of an introductory taxonomy class. Since thorough comprehension of diagrams generally requires some understanding of word(s) contained therein, examples of cladograms containing more accessible names might have been preferable from the perspective of beginning students. One topic in which *insufficient* detail is provided in chapter two is the inadequate coverage of phenetic and evolutionary classifications. If students are to understand the importance of phylogenetic systematics in an historical context — given the phylogenetic unity of the text, how could the authors wish otherwise? — then they must have a greater appreciation of the methods of classification that preceded it.

In contrast, the third chapter, entitled "Classification and System in Flowering Plants: The Historical Background", seems to approximate more closely the level of coverage towards which an introductory text probably should strive. The author of this chapter, P. Stevens, centers the discussion around numerous historically prominent taxonomists. Sometimes, however, the text presupposes a knowledge that beginning students clearly will lack, such as a reference to Bentham and Hooker (p. 36), which would be understood only by those possessing considerable depth in their knowledge of taxonomic history. Once again, one wonders for whom the text is written.

The fourth chapter, "Taxonomic Evidence: Structural and Biochemical Characters", also exemplifies the excess of detail that characterizes much of the text. The figures accompanying the narrative are good, but I question the necessity of eight types of marginal teeth in leaves (fig. 4.13), eleven variations of cell types in xylem (fig. 4.31), five TEM micrographs of sieve-element plastids (fig. 4.32), nine different stomatal types (fig. 4.35), twelve "common petiole vascular patterns" (fig. 4.36), and entire sections regarding "Anatomy" and "Embryology". Taxonomic specialists need to know much of this information, but not introductory students. Besides, the above material belongs more appropriately in a text covering traditional plant anatomy. One area where detail was appreciated by this reviewer was in the illustrations of important secondary plant compounds, which are not included in some texts.

The floral formulas (Box 4a: 57) also seem excessively complex as presented in the text. Although these need not be of universal consistency, I think those of Smith (1977), which use a letter (e.g., K for calyx, C for corolla, etc.) to anchor the numbers associated with each floral whorl, are easier for students to understand and apply.

The detailed discussion of inflorescence types and the fundamental dichotomy between determinate and indeterminate inflorescences is another situation where excessive detail drowns out the basic knowledge beginning students require. The terms panicle, raceme, spike, cyme, umbel, corymb, head, and a few more specialized ones (e.g., spikelet, perigynium) are generally adequate to key out specimens in regional floras. Although the basic dichotomy of inflorescence types is necessary for specialists, some terms assigned to determinate inflorescences such as "panicle-like cyme" and "raceme-like cyme" are cumbersome. A better approach might have been to introduce the basic terms denoting floral arrangement, followed by a relatively brief commentary on the distinction between indeterminate and determinate inflorescences. Speaking again from experience in the classroom, the determinate/indeterminate distinction seemed to interfere with the student's ability to understand the more basic terms associated with inflorescence structure.

Chapter four includes other topics that should have been omitted or relegated to separate chapters. Sections covering pollination syndromes, coevolution between plant and pollinator, deception in orchid pollination, self-incompatibility, agamospermy, chromosomes, and palynology all seem either unnecessary or out of place. Here the text seems to drift off course and begins to resemble a text on reproductive biology.

Chapter Five, entitled "Molecular Systematics", is also written at a level of detail considerably beyond an introductory text. For example, figs 5.1 and. 5.5 are bewildering in their complexity to anyone but an evolutionary biologist or taxonomic specialist. The clarity and simplicity of figs 5.2, 5.3, and 5.7 are more appropriate for an introductory text. In view of the molecular focus of much recent research in plant taxonomy, and given the need for more advanced students to have an introduction to the topic, the chapter is a useful component of the book. Graduate students and established taxonomists trained before the advent of phylogenetic analysis and the use of molecular data may find much of the modern cladistic and molecular terminology more comprehensible after reviewing this chapter. To them I recommend the text without reservation.

The sixth chapter is the first one not directly related to detailed familial descriptions. Entitled "The Evolution of Plant Systematic Diversity", the text returns to the theme of phylogeny, history, and evolution. Microevolutionary processes are covered, including the nature of variation in plant species. Hybridization is also discussed in some detail, as are polyploidy and species concepts. Regarding the latter, the authors correctly highlight varying perspectives of the phylogenetic species concept, although it eludes me why the genealogical concept of species is mentioned at all.

Starting with Chapter 7, "Phylogenetic Relationships of Major Groups of Tracheophytes, Excluding Angiosperms", the authors begin their detailed coverage of family treatments, following to a considerable extent the classification of the Angiosperm Phylogeny Group (1998). Along with

Chapter eight, which covers angiosperm families, 145 families are treated in detail. These families are summarized on the back inside endplate, and boldfaced in table 8.1. The more inclusive groups, whose cladistic relationships are summarized on the inside front plates, include the "Free-sporing tracheophytes" (Lycopodiophytes, Psilophytes, Equisetophytes, Leptosporangiate ferns), the "Seed Plants" (cycads, *Ginkgo*, Conifers), and the Angiosperms ("Non-monocot paleoherbs", "Magnoliid complex"; "Monocots" s.s., "Basal tricolpates", Cayophyllanae and a few smaller lineages; "Eurosids I and II", Cornales and Ericales; and "Euasterids I and II"). As indicated above, the book is an excellent vehicle for professional taxonomists to acquaint themselves with newer concepts of higher taxa.

The quality of illustrations of taxa, which are generally recycled from other sources and therefore inconsistent regarding level of detail, ranges from fair (e.g., fig. 8.99) to good (e.g., fig. 7.15). The book is inconsistent in providing descriptions for some (e.g., Malvales) but not all (e.g., Apiales) Orders. Keys are typically provided to the major families of a given order. In some cases (e.g., Brassicales), fairly detailed cladograms are also provided. Although the average student cannot grasp this amount of detail, it is a positive development to see a text using cladograms and promoting phylogenetic thinking throughout. Families whose monophyly is considered equivocal are indicated with quotation marks, which students seemed to grasp quickly. Putative synapomorphies are boldfaced, although to reiterate the theme, family descriptions are excessively detailed for an introductory text.

The majority of leptosporangiate fern families are subsumed under Polypodiaceae, which seems a necessary approach for an introductory text. The coverage of Gnetales lacked any citations of Friedman (1990, 1994) regarding the evolution of double fertilization, which came as a surprise. Judd et al. has a recurring bias towards coverage in the Northern Hemisphere. For example, despite an erroneous referral in the Taxonomic Index to page 152 for Araucariaceae, this family is not treated. However, its coverage would have provided an opportunity to mention the excitement, careful research, and conservation measures involved with the recent discovery of the Wollemi Pine in Australia. The bias returns later in Table 1 in Appendix 2, where important journals from the Southern Hemisphere are overlooked, such as *Australian Systematic Botany, Austrobaileya, Bothalia, Darwiniana, New Zealand Journal of Botany*, and *South African Journal of Botany*, to mention some.

Appendix 1 covers the basics of botanical nomenclature, and in contrast to much of the book, seems to be written at a level appropriate for newcomers to the field. However, table 1, which contains nearly 300 Latin names of specific epithets, is of questionable value. In contrast, a normal glossary is absent. Since beginning students rely on glossaries constantly, its absence is a prominent shortcoming.

Appendix 2, likewise written at an appropriate level for beginners, reviews aspects of making collections, conservation laws, plant identification and keys, an overview of the taxonomic literature (particularly journals), and a brief mention of herbaria and botanical gardens.

The CD-ROM contains some 650 color photographs of plant taxa, which can be selected from an alphabetical list (by genus) of species, by families, or by orders. Like Cantino (1999), I question the value of photographs in the teaching of systematics. Most students seem relatively uninterested in the use of CD-ROMS in the lab, probably because they know the material therein will not be covered on exams. None the less, many photos are of high quality, the taxonomic coverage is broad, and some will no doubt appreciate that some taxa are illustrated by more than one photo (e.g., *Albizzia julibrissin, Argemone albiflora, Cocos nucifera, Liriodendron tulipifera*). My computer seemed unable to call up an image for *Plantago major*. Included in the CD-ROM are comparisons of more traditional familial classifications of Cronquist and Thorne.

The largest caveat to those who adopt the book for the classroom is to remain hawkishly alert to the details of family level changes in the book, irrespective of whether we agree them all. Family circumscriptions sometimes depart considerably from the manner in which they have been taught up to the present time. To cite one of the more spectacular examples, Scrophulariaceae sensu Judd et al. is considerably different from its previous circumscriptions sensu lato. Many genera previously placed in the family have been transferred into Plantaginaceae, such as *Veronica*, *Penstemon*, *Mimulus*, *Digitalis*, and *Antirrhinum*. The expanded Plantaginaceae, however, also now includes Callitrichaceae and Hippuridaceae. Other genera such as *Pedicularis*, *Castilleja*, and *Agalinus* have been transferred to Orobanchaceae.

These and other taxonomic changes will challenge our "knowledge" of families and force us to consider how we teach this information. My approach has been to explain the historical concept of the family, followed by the newer concept presented by the text. This provides a wonderful opportunity to champion taxonomy as a dynamic science, as the text admirably does, and stress that newer data support the need for the changes. The first time such a major familial level change arises I stress to the students that most other biologists will "know" these families in their previous incarnations, and that nearly all floras will treat them as such. I also caution that students may be challenged by their elders regarding their knowledge of newer familial boundaries. One can easily imagine a bright younger student raising the ire of an older biologist by insisting that *Penstemon* belongs in Plantaginaceae rather than Scrophulariaceae. It is also fairly easy to envision the older biologist wondering what the nearest tax supported university is teaching, and perhaps voicing disparaging remarks about the competence of the instructor. Revised taxonomies also provide an opportunity to discuss the pronounced discontent that can arise in the face of nomenclatural changes, and why students should be able to explain in non-technical terms why such changes are periodically necessary.

Apart from discussing the empirical basis for specific taxonomic changes, the abundance of taxonomic changes in the text can also offer an opportunity to discuss some basics of field diplomacy, such as when and when not to challenge others on the "correct" disposition of specific taxa. For example, it would be lacking in common sense to pontificate about the "correct" disposition of *Penstemon* to a private landowner whose land you would like to collect on, and who possessed some understanding of Scrophulariaceae s.l. As an anecdotal aside, some landowners have a sophisticated knowledge of local plants. Two colleagues and I once were dumbfounded when an amiable rancher in southeastern Colorado, who, when informed we were looking for a sunflower type plant technically called *Haplopappus*, nonchalantly and correctly asked whether we were looking for *Haplopappus fremontii*!

In general, the text highlights some of the pedagogical challenges currently faced by instructors. For example, is it better to teach families that have been merged in their newer, more inclusive sense (e.g., Amaranthaceae), or as distinct families in their more traditional sense (e.g., Amaranthaceae plus Chenopodiaceae)? To my mind it seems preferable to present both perspectives, since beginning students need to know these family names when keying out material in local Floras, and those who pursue taxonomy beyond the introductory level eventually will have to become acquainted with the older concepts.

It is uncomfortable to say so given favorable impressions of the book as a researcher, but the biggest pedagogical challenge for a introductory taxonomy class may be whether to use the volume at all. Despite being one who is against the lowering of curriculum standards, the book is too information rich for many beginning students. Written student evaluations largely echoed this sentiment, even though much of the material was covered in lecture as well. When students are overwhelmed they either turn away from a text or turn elsewhere for information. The most poignant evidence of turning elsewhere was reflected by a few students who, unprompted from the instructor, began bringing textbooks by Smith (1977) and Walters and Keil (1996) to lab. In short, from a teaching standpoint, the value of the book as an introductory text is questionable if many beginning students are unable to benefit from its contents.

I hope that the authors will see the need for a distilled version of the book targeted for introductory students and quickly produce a volume of perhaps 275 pages under a different title. The precedent already exists for Sinauer Associates, Inc., to publish more detailed (Hartl and Clark 1989) and less detailed (Hartl 1988) texts covering basically the same content by the same author(s).

In conclusion, the book is indispensable for graduate students and as a source of updated information for well-trained systematists. But the authors need to remember that the great majority of students in introductory classes in plant taxonomy are those majoring in wildlife biology, forestry, agronomy, horticulture, biology, and botany as well, but that only a small percentage have any inclination to pursue taxonomy professionally. In my view the text does not succeed as a phylogenetically oriented introduction to plant systematics *for undergraduates*, where the need is greatest.

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—Neil Snow, Department of Biological Sciences, University of Northern Colorado, Greeley, CO 80639, USA.

BOOKS RECEIVED

ROGERS MCVAUGH. 2000. **Botanical Results of the Sessé & Mociño Expedition (1787-1803): VII. A Guide to Relevant Scientific Names of Plants.** (ISBN 0-913196-68-1, hbk.). Hunt Institute for Botanical Documentation, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213-3890. $55.00. 626 pp.

From the preface: The purpose of this paper is not taxonomic, in the sense that it is not monographic, but primarily a task of reporting. Most of the identifications reported herein are those made by other workers who have studied the publications of Sessé & Mociño, or their specimens, or the illustrations made by their artists. I have not attempted to give modern equivalents for names except in a few groups of which I have special knowledge. Likewise I usually have not attempted to comment upon the competence of those who have made identifications, but merely to report the fact of identification. Naturally many names that were applied in the herbarium of Sessé & Mociño, in 1936 and soon thereafter, have become obsolete for taxonomic or other reasons. Many new species and genera that were based on specimens or *icones* during the first half of the 19th century have since been re-evaluated." *Contents:* Preface, Introduction to the Guide, How to use the Guide, The use of "ex" attributed to authors, Authors contemporary with Sessé & Mociño, Latin and other quotations, Relevant names defined, Unpublished names, Documentation from *Icones*, Authorship of names based on the Sessé & Mociño paintings, Unpublished names applied by de Candolle, Documentation from non-pictorial sources, Appendix: Mociño's list, Selected references, Annotated list of names, and Index to scientific names. Two new combinations are published in the volume: ***Dahlia cordifolia*** (Sessé & Moc.) McVaugh, comb. nov. (p. 148) and ***Bernardia dodecandra*** (Sessé & Cav.) McVaugh, comb. nov. (p. 222).

HUNT INSTITUTE FOR BOTANICAL DOCUMENTATION. 1998. **Sessé & Mociño Biological Illustrations.** (ISBN 0-913196-60-6, CD-ROM). Carnegie Mellon CD Press, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213-3890. $40.00. Shipping/Handling: $4 Domestic; $6 Outside U.S.

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UNIVERSIDAD AUTÓNOMA DE NUEVO LEÓN
IV CONGRESO LATINOAMERICANO DE ESTUDIANTES DE CIENCIAS FORESTALESALECIF
"Compartiendo Oportunidades y Retos para el Manejo Sustentable de los Ecosistemas Forestales"
Linares, México del 9 al 14 de octubre del 2000

Para: Estudiantes de Ciencias Forestales de América Latina

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La presente tiene como objetivo invitarlos oficialmente al IV Congreso de la Asociación Latinoamericana de Estudiantes de Ciencias Forestales (ALECIF) que se llevará a cabo en la Facultad de Ciencias Forestales de la Universidad Autónoma de Nuevo León, con sede en Linares, N.L., México, del 9 al 14 de octubre del 2000.

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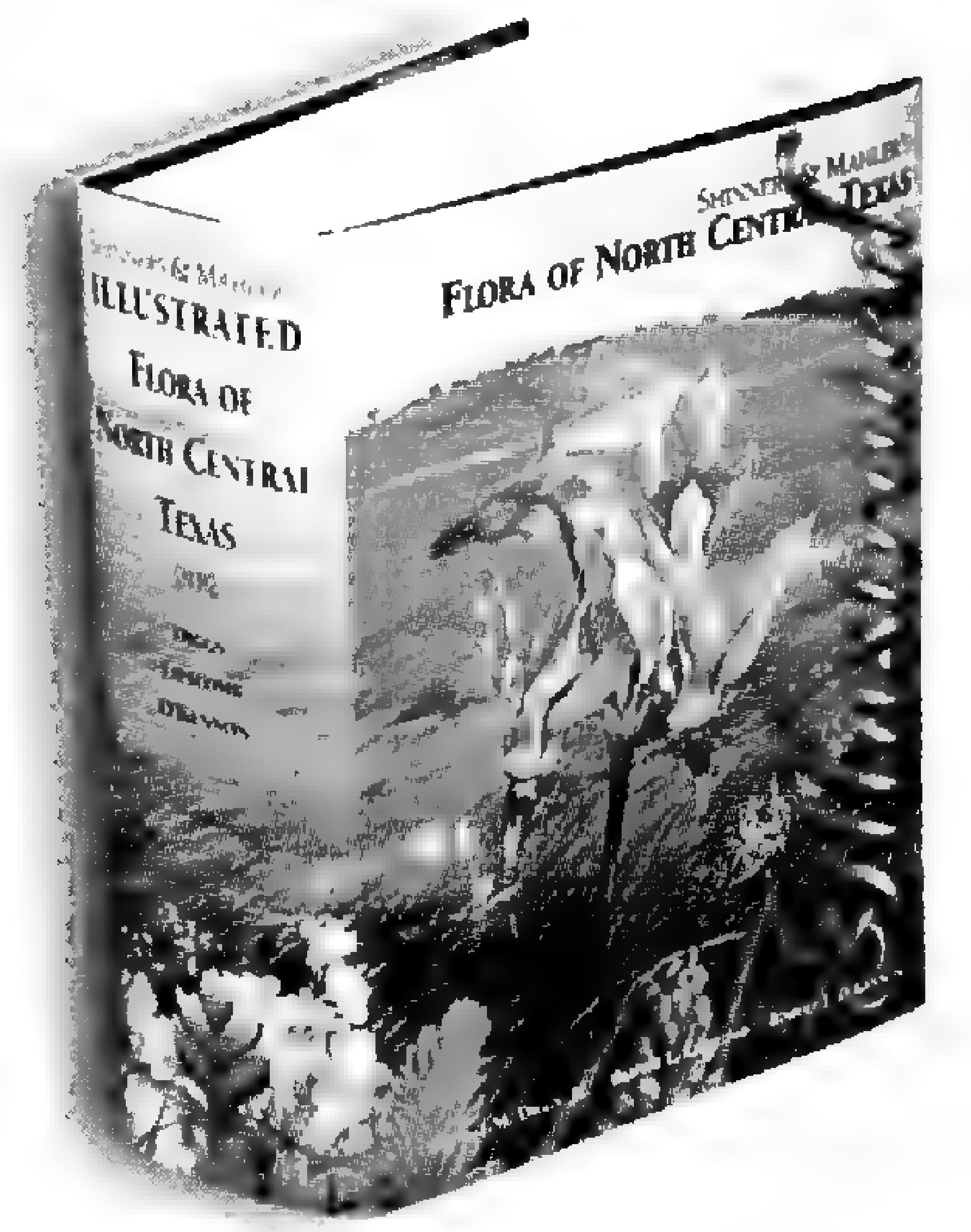

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ENNSYLVANIA NEW JERSEY MASSACHUSETTS *Asteraceae* ID

WYOMING ARIZONA HAWAII NEVADA UTAH WASHINGTON SOUTH DAKOTA NO

DAKOTA *Cactaceae* RHODE ISLAND COLORADO DELAWARE MISSOURI W

IRGINIA MINNESOTA CANADA ONTARIO ALBERTA BRITISH COLUMBIA SASKATCHEWAN YU

ERRITORY NORTHWEST TERRITORIES NOVA SCOTIA MANITOBA NEWFOUNDLAND MANATOBA QU

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NEW SOUTH WALES QUEENSLAND VICTORIA WESTERN AUSTRALIA NORTHERN TERRITORY SO

Fabaceae AUSTRALIA TASMANIA NEW ZEALAND MALAYSIA SUMATRA TU

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IBYA JORDON KENYA CONGO SUDAN ZIMBABWE MOZAMBIQUE ZAMBIA SAUDI A

ERACRUZ MEXICO NUEVO LEON CHIHUAHUA MONTEREY MICHOACAN OA

HIDALGO GUADALAJARA *Liliaceae* COAHUILA YUCATAN SIN

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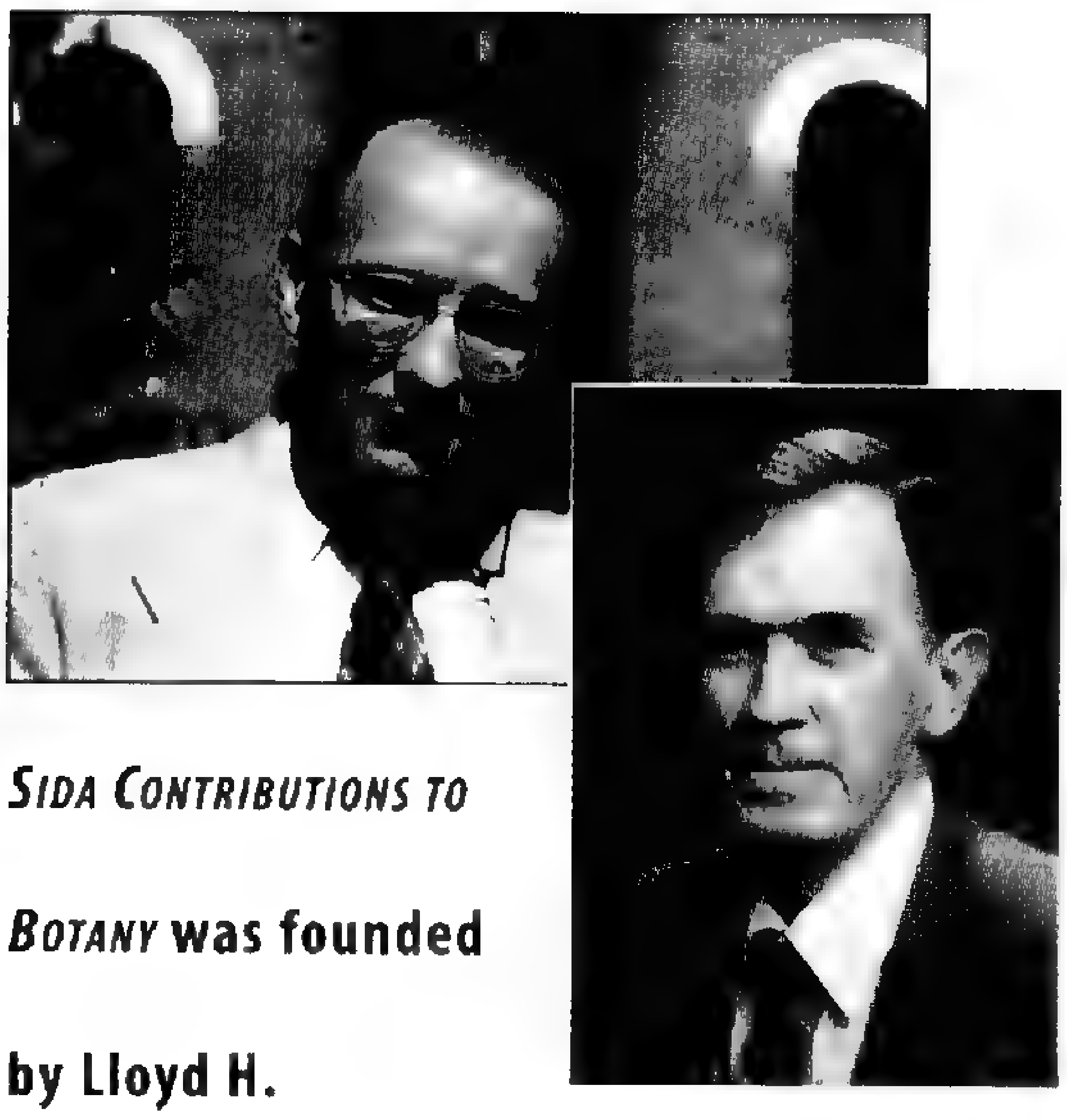

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Barney L. Lipscomb, Editor
Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, USA
817 332-4441 / 817 332-4112 FAX
Electronic mail: sida@brit.org
Home page at the URL: http://www.brit.org/sida/

John W. Thieret, Associate Editor
Dept. of Biological Sciences
Northern Kentucky University
Highland Heights, KY 41099 USA

Félix Llamas, Contributing Spanish Editor
Dpto. de Botánica, Facultad de Biologia
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E-2471 León, SPAIN

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A NEW VARIETY AND FOUR NEW COMBINATIONS IN *PITTOCAULON* AND *TELANTHOPHORA* (ASTERACEAE: SENECIONEAE) FROM MEXICO

Bonnie L. Clark

8201 Hauser Drive
Lenexa, KS 66212-2542, U.S.A.

ABSTRACT

A new variety, *Pittocaulon hintonii var. cerrograndensis* (Asteraceae: Senecioneae) is described, and four new combinations are proposed: *Pittocaulon velatum* var. *tzimolensis, Telanthophora cobanensis* var. *molinae, Telanthophora grandifolia* var. *serraquitchensis,* and *Telanthophora sublaciniatus.*

KEY WORDS: *Senecio, Telanthophora, Pittocaulon,* Mexico, Central America

RESUMEN

Se describe una variedad nueva, *Pittocaulon hintonii* var. *cerrograndensis,* y se propon cuatro combinaciónes nuevas, *Pittocaulon velatum* var. *tzimolensis. Telanthophora cobanensis* var. *molinae, Telanthophora grandifolia* var. *serraquitchensis, y Telanthophora sublaciniatus.*

Recent studies in certain Mexican and Central American segregates of *Senecio,* s.l. (Clark 1996) have led to the recognition a new variety and the need for four new nomenclatural combinations. These are recorded here to make the names available for curatorial purposes. More complete explanations will be presented when the revisionary studies are published.

Pittocaulon hintonii H. Rob. & Brettell var. **cerrograndensis** B.L. Clark, var. nov. TYPE: MEXICO: JALISCO: Sierra de Manantlán, on very steep E-facing slopes of Cerro Grande on road from Lagunillas to Campo Cuatro & Juluapan, on limestone cliffs above camp 4, dry, deciduous woodland, together with the gigantic creeping stems of *Philodendron warczewiczii, Selenicereus* spp., and *Pedilanthus* in full sun, lat. 19° 23–25' N and long. 103° 51' 30"–52' 30" W, elev. 1480 m, 15 Mar 1987, *H.H. Iltis et al. 29713* (HOLOTYPE: WIS!; ISOTYPES: IBUG, KSC!, TEX, ZEA).

A var. *hintonii* cujusque capituli flosculis radiatis 14 (nec 7–9) perspicue diversa.

Pittocaulon hintonii var. *cerrograndensis* differs notably from var. *hintonii* in having capitula with 14 ray florets instead of 7–9. It is apparently restricted to the Sierra de Manantlán, a region known for a number of endemics (Vázquez et al. 1995). The nomenclaturally typical var. *hintonii* occurs farther to the north, in the region of Sierra Naranjillo, Michoacán.

Pittocaulon velatum (Greenm.) H. Rob. & Brettell var. **tzimolensis** (T.M. Barkley) B.L. Clark, comb. nov. *Senecio praecox* (Cav.) DC. var. *tzimolensis* T.M. Barkley, Phytologia 69:142. 1990. TYPE: MEXICO: CHIAPAS: Tzimol, tropical deciduous forest 15 km S of Comitán on road to Tzimol and Tuxtal Gutierrez, elev. 1200 m, 20 Mar 1981, *D.E. Breedlove 50266* (HOLOTYPE: CAS!).

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Telanthophora cobanensis (J.M. Coult.) H. Rob. & Brettell var. **molinae** (H. Rob. & Brettell) B.L. Clark, comb. et stat. nov. *Telanthophora molinae* H. Rob. & Brettell, Phytologia 27:428. 1974. Type: GUATEMALA: Department of San Marcos: near Alta Fraternidad, between San Rafael Pie de la Cuesta and Palo Gordo, W facing slope of the Sierra Madre Mountains, wet mountain forest, elev. 1800–2400 m, 10–18 Dec 1963, *L.O. Wiliams, A. Molina & T.P. Williams 26271* (holotype: US!; isotypes: F!, GH!, MO!, NY!)

Telanthophora grandifolia (Less.) H. Rob. & Brettell var. **serraquitchensis** (Greenm.) B.L. Clark, comb. et stat. nov. *Senecio serraquitchensis* Greenm., Field Mus. Nat. Hist., Bot. Ser. 2(6):286. 1907. *Telanthophora serraquitchensis* (Greenm.) H. Rob. & Brettell, Phytologia 27:428. 1974. Type: GUATEMALA: Department of Alta Verapaz: Serraquitche, elev. 760 m, Apr 1889, *J. Donnell Smith 1598* (holotype: GH!; isotype: CHI!).

Telanthophora sublaciniatus (Greenm.) B.L. Clark, comb. et stat. nov. *Senecio cobanensis* J.M. Coult. var. *sublaciniatus* Greenm., Ceiba 1(2):120. 1950. Type: GUATEMALA: Department of Sacatepequez: hills of finca Carmona southeast of Antigua, in damp forest, elev. 1590–1800 m, 27 Jan 1939, *P.C. Standley 63680* (holotype: MO!; isotype: F!).

ACKNOWLEDGMENTS

This study derives from a doctoral dissertation prepared at Kansas State University, Manhattan, Kansas, under the direction of T.M. Barkley. Rupert Barneby of the New York Botanical Garden kindly rendered the Latin diagnosis.

REFERENCES

Clark, B.L. 1996. A study of variation in *Senecio* Sect. *Terminales* Greenm. (Compositae; Senecioneae). Ph.D. dissertation, Kansas State University, Manhattan, Kansas.

Vázquez G., J.A., R. Cuevas G., T.S. Cochrane, H.H. Iltis, F.J. Santana M., and L. Guzmán H. 1995. Flora de Manantlán. Sida, Bot. Misc. 13, Botanical Research Institute of Texas, Fort Worth.

ADDITIONS TO THE FLORA OF CRATER MT., PAPUA NEW GUINEA

W. Takeuchi

Botanical Research Institute of Texas (BRIT)
c/o Lae National Herbarium and Papua New Guinea Forest Research Institute
P.O. Box 314, Lae, Morobe Province 411, PAPUA NEW GUINEA

ABSTRACT

The floristic checklist for the Crater Mt. Wildlife Management Area (CMWMA) is updated. *Canarium acutifolium* var. *pioriverensis* (Burseraceae) is newly described.

Key Words: Botanical survey, *Canarium*, Papuasia

ABSTRACT (JAPANESE)

クレイター山 野生生物 管理地区の植物チェックリストを最新のものに改める。
Canarium acutifolium var. pioriverensis **(ブルセラ科) は新たに記述されている.**

INTRODUCTION

As one of Papuasia's largest wilderness environments, the Crater Mt. Wildlife Management Area (CMWMA) was recently a focal venue for an intensive program of floristic exploration and documentation. In the following account, an earlier botanical summary of the CMWMA (cf. Takeuchi 1999) is updated with several additions and corrections.

BURSERACEAE

Canarium acutifolium (DC.) Merr. var. **pioriverensis** Takeuchi, var. nov. Type: PAPUA NEW GUINEA. Chimbu Province: Crater Mt. Wildlife Management Area, Pio River, alluvial forest, 06°47'S, 145°02'E, 500 m, 25 Mar 1997 (stam. fl.), *W. Takeuchi 11,886A* (holotype: LAE; isotypes: A, BRIT, L).

Differt a *C. acutifolio* (DC.) Merr. var. *aemulans* folioliis longioribus usque ad 43 cm longis, stipulibus majoribus usque ad 25 × 6 mm, fructibus ellipsoideis 24–27 × 12–14 mm.

Canopy tree, 25–30 m tall, deciduous, plank-buttressed to ca. 1 m height, outer bark furrowed, pallescent, slash ferruginous to ochraceous, clear-resiniferous, wood white, very dense. *Branchlets* longitudinally corrugate, ca. 1.5 cm diam., minutely furfuraceous, pithy, not hollowed with age; vascular strands peripheral, appressed to the pith. *Leaves* spiral, phyllotaxy 2/4, 6–8 jugate, 1.0–1.4 m long, the flush emerging simultaneously with flowering; leaflets membranaceous, (ovate), elliptic-oblong, or oblong, decrescent on the rachis, (11–)20–31(–43) × (6.5–)9.0–14.0 cm, apex rounded or (obtusely acuminate), base truncate to (cuneate), margins entire; venation camptodromous, bifacially prominulous, secondaries 10–15(–16), at the leaflet center diverging 55–70° from costulae, gradually arcuate or turning abruptly at the margin, crossing nerves scalariform, reticulum dense; laminar surfaces adaxially dark dull green, abaxially medium green, on both sides pusticulate, all parts with an indument of appressed furfuraceous hairs; petiolule terete

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or compressed, pulviniform at both ends, 9–25 × 1.5–2.5 mm; rachis cylindrical, shallowly sulcate, purple-green; petiole 250–390 × 7–10 mm, dilate at the branchlet, articulative or not, broadly concave on the upper side, rounded beneath; stipules persistent, inserted at the base of the petiole, acuminate, 14–16(–25) × 3–4(–6) mm, flat, paired, evenly tapered to the apex. *Staminate inflorescence* axillary (lateral), thyrsoid, pyramidal, 51–60 cm long, rachide branches to 15 cm long, all axes glossy green or reddish-green and with an indument of pale scalelike hairs; rachis bracts narrowly acuminate, the larger ones 7–10 mm long, higher order bracts ovate, 1–2 mm long, undulate; peduncle 170–240 × 4–5 mm. *Staminate flowers* ellipsoid-oblongoid in bud, perianth 3-merous; calyx tubiform, ca. 5 × 3 mm, 1/2–2/3 connate, lobes ovate, densely sericeous on inner surfaces, glabrate or puberulent outside; corolla distinct, imbricate, petals lanceolate-oblong, 6–7 mm long, adaxially glabrous, externally with lax sericeous hairs; stamens 6, uniseriate, equal, united at the base into a glabrous column ca. 1 mm high, filaments plane, 0.5–0.75 mm long, anthers basifixed, sagittate, mucronulate, oblongish, ca. 2.5 × 0.5 mm, erect, pilosulous; disk dome-shaped or globular, rugose, glabrous, ca. 1 mm high and not exceeding the column, 6-lobulate, recessed at the summit; pistillode absent. *Pistillate inflorescence* unknown. *Infructescence* axillary (lateral), occasionally from defoliate nodes, ebracteate, puberulous, ca. 20 cm long, branching only at the top, peduncle 170 × 4 mm. *Drupe* ellipsoid or (subovoid), 24–27 × 12–14 mm, obtusely 6-angled in cross-section, apex acute or bluntly rostrate, locules 3, 2 of the cells sterile and rudimentary, exocarp with scattered subappressed hairs; calyx persisting, spreading, not accrescent, lobes deltate or rounded, 3.0 × 3.5 mm, adaxially densely sericeous, externally glabrate.

Distribution and habitat.—Known thus far only from lowland forest in the CMWMA.

Etymology.—The varietal name commemorates the type locality.

PARATYPE: PAPUA NEW GUINEA. CHIMBU PROVINCE: Crater Mt. Wildlife Management Area, Pio River, foothill forest, 06°47' S, 145°02' E, 500 m, Jan 1998 (fr.), *W. Takeuchi 11,886B* (LAE).

Malesian *Canarium* has been treated by Leenhouts (1955a, 1955b, 1956, 1959; cf. also Steenis 1972). There are 20 species reported from New Guinea (ibid).

The new taxon belongs to section *Pimela* (Lour.) DC. and is related to the complex consisting of *C. acutifolium* (DC.) Merr. and its allies. Because of the 6-staminate flowers, the novelty is comparable to *C. acutifolium* var. *aemulans* but is more robust, with leaflets to 43 × 14 cm and with larger stipules to 25 × 6 mm. Although var. *acutifolium* has similar panicles, the fruits of var. *pioriverensis* are 24–27 mm long (up to 15.0–17.5 mm for the other varieties of *A. acutifolium*). The deciduous phenology of var. *pioriverensis* is also distinctive. According to village respondents the new tree is characteristically leafless immediately prior to flowering. Their report is substantiated by the fact that other individuals of the same variety were seen in leafless condition near the type collection and later exhibited synchronous flowering and leaf flush. The correspondence between leaf and flower emergence is clearly reflected on the type, which has denigricant membranaceous leaves unlike the coriaceous blades usually seen on herbarium sheets of congeners.

The new variety will key to the species using the modified sequence in Steenis (1972) and can be incorporated into the varietal conspectus by replacing lead 2b (Leenhouts 1956: 292) with the following continuation.

2. Nerves 12–15 pairs
Leaves 2–4-jugate, leaflets 7–18 × 3.5–8.5 cm, abruptly acuminate; stipules subulate,
to 17 × 1.5 mm; fruits subglobose, to 17.5 × 15 mm ________ var. **aemulans**
Leaves 6–8-jugate, leaflets (11–)20–31(–43) × (6.5–)9.0–14.0 cm, apex obtuse or (gradually subacuminate), never abruptly developed; stipules acuminate, flat, broader, to
25 × 6 mm; fruits ellipsoid, 24–27 × 12–14 mm ________ var. **pioriverensis**

OTHER COLLECTIONS

ADIANTACEAE

Coniogramme macrophylla (Bl.) Hieron.; coll. *12,197*. Initially reported as 'sp. nov. aff. *macrophylla*' (Takeuchi 1999: 953), the CMWMA plants have once-pinnate fronds with pinnae to 36 × 5 cm. Comparisons against extra-Papuasian material indicate that the survey collections are merely a vigorous growth form. The lax venation noted previously (ibid) is actually within the range of variation for the species.

MIMOSACEAE

Archidendron hispidum (Mohlenbr.) Verdc.; coll. *11,210*. (**Fig. 1**). *Archidendron hispidum* was formerly recorded only from Northern and Milne Bay Provinces (Nielsen et al. 1984: 95; Nielsen 1992: 133). The Crater Mt. provenance places the species further west, and on the southern side of the Central Divide. The plant is apparently rare throughout its range.

There are two species in the series *Ptenopae* Nielsen to which *A. hispidum* is assigned (ibid). Although the congener *A. ptenopum* Verdc. has terminal inflorescences, it is now apparent that *A. hispidum* is strictly cauliflorous. The Crater Mt. specimen confirms that series *Ptenopae* is characterized by an inflorescence of pedunculate umbels. However, unlike *A. ptenopum*, the gynoecium in *A. hispidum* consists of a single ovary, so the pluricarpellate condition is not salient to the series.

An accessory description is provided for the previously unknown flowers of *A. hispidum*:

Inflorescence a panicle of umbels or (corymbs), cauligerous, pendulous, diffuse, to 15 3 12 cm, all axes filiform, nitid green, ± densely hirtellous; floral bractlets chartaceous, oblongish or widest above the middle, ca. 1.0 3 0.3 mm, falling early, aglandular, hairy; pedicels 5–11 mm long; rachide branches usually alternate, 20–50 3 0.2–0.4 mm, bracteate at the base, the rachis bracts scarious or not, acuminate, 0.7–2.0 mm long, persistent, adaxially glabrate, externally hirtellous; peduncle 5–52 3 0.4–0.5 mm. *Flowers* (measurements from spirit material) seen in bud only, up to 11 per cluster, bisexual, perianth pentamerous, subfleshy, green, hirtellous; calyx obconic, 1.0–1.5 mm long, margin subtruncate, erulose, or denticulate; corolla gamopetalous but connate only near the base, the lobes lanceolate or ovate, ca. 2.5 3 1.0–1.5 mm; androecium polyandrous (ca. 40–50), stamens glabrous, entirely white, column obsolete, ca. 0.5 mm long, filaments delicate, contorted,

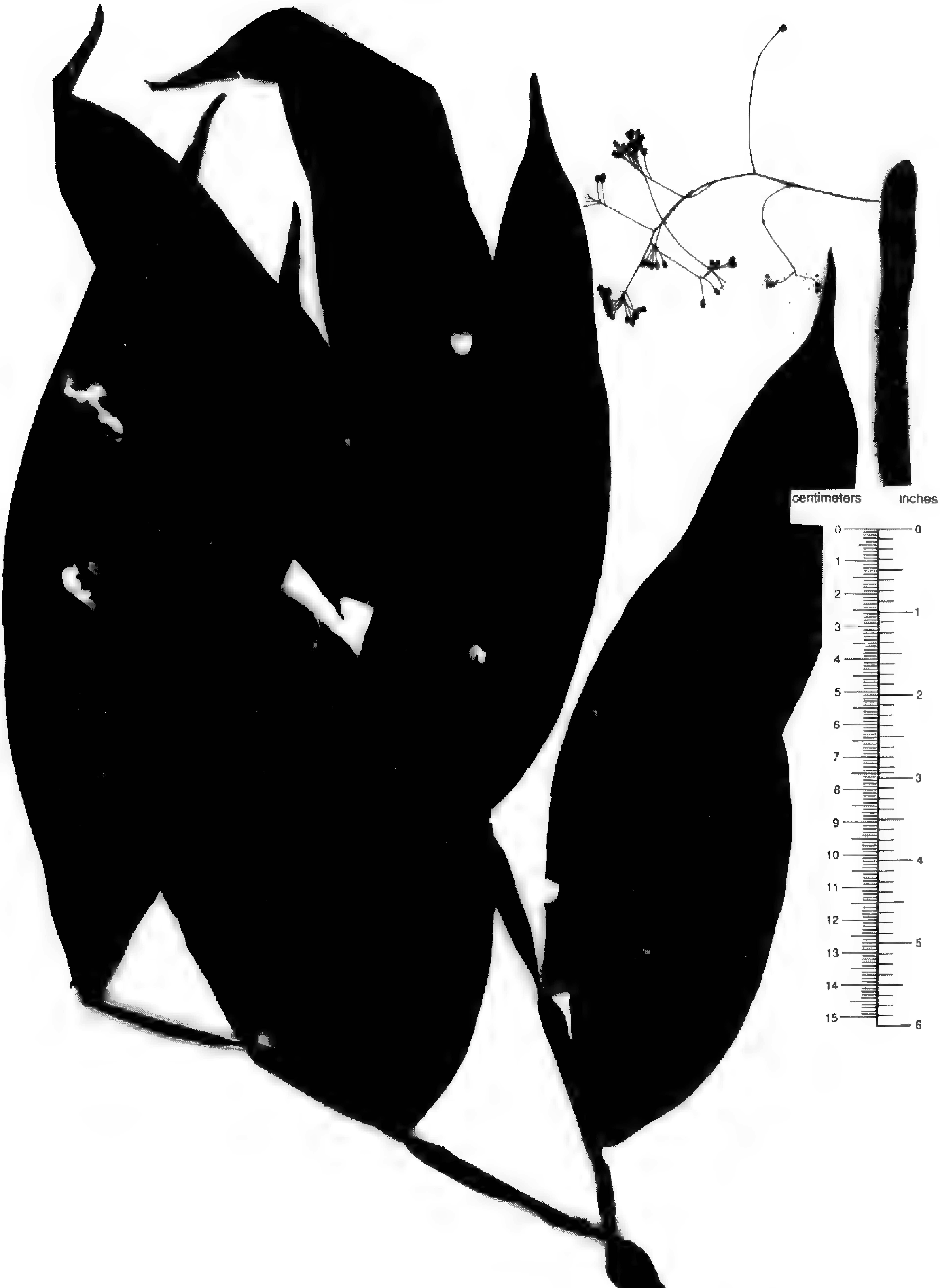

FIG. 1. *Archidendron hispidum* (Mohlenbr.) Verdc. Flowering habit. Scanned from *Takeuchi 11,210*.

anthers minute, globular, 2-locellate; gynoecium glabrous, sessile, ovary solitary, columnar, slightly reduced near the top, style cylindrical, equal to the ovary, stigma dilate, obconic to disciform.

MYRTACEAE

Syzygium hylochare (Diels) Merr. & Perry; coll. *11,847*. (**Fig. 2**). The survey voucher was previously cited as '*Syzygium* aff. *roseum* Merr. & Perry, possible sp. nov.' but has been rekeyed to the given binomial. Although the Crater Mt. specimen has leaves with very prominent, evenly-spaced, and more numerous lateral veins, it is otherwise referable to the new result. The stipitate base (4–5 mm long) on dried flowers and the comment of the stipes being very noticeable on immature fruits (Hartley & Perry 1973: 168) are deciding. These latter features are well-expressed on the survey number. *Syzygium hylochare* is also apparently characterized by the appearance of large pustules on the lamina and inflorescence after drying, in the manner of *S. malaccense* (L.) Merr. & Perry sens. lat. This identification aid can be advantageously appended to the couplet sequence for the species.

Syzygium hylochare is much closer to *S. roseum* Merr. & Perry than is apparent from the artificial key in Hartley and Perry (ibid). Specimens belonging to either facies should be compared against the congener, especially for collections from the southern districts.

PIPERACEAE

Piper arfakianum C. DC.; coll. *12,453*. The survey collection differs from the typical facies *inter alia* by the much sparser indument and the pendulous spikes with unusually filiform peduncles. The delicate peduncles are only 0.1–0.2 mm diam. (0.5–1.0 mm in other provenances) and the rachis is similarly narrowed to 0.5–0.6 mm diam. (normally 1.0–2.2 mm diam.). On the fully mature spike the individual fruits are elongate-ellipsoid rather than the more typical squat-obovoid shape, and laxly disposed so the rachis is occasionally visible between the berries. At 12 × 6.5 cm, the laminae are at the maximum end of the size range for the species. Although the Crater Mt. voucher was listed as '*Piper* sp. ?nov.' in the CMWMA checklist (Takeuchi 1999: 977) the collections at hand suggest that the survey number can be accommodated within the variable concept for *P. arfakianum* established in specimen annotations by Chew (cf. also Jebb 1987). While the character states for the Crater Mt. population appear distinct from the species sens. str., future collections should speculatively be able to unite the herbarium variation into a single continuum. If this does not eventuate, then the Crater Mt. plants will be deserving of future recognition as a separate subspecies or variety.

Piper is well-represented in the Crater Mt. Wildlife Management Area, with 17 species now documented for the locality.

ADDITIONS AND EMENDATIONS TO THE CRATER MT. PLANT CHECKLIST

The following taxa are listed as additions and emendations to the earlier compilation in Takeuchi (1999). Voucher source for occurrence record: LAE = staff collections from the Lae National Herbarium series; UPNG = institutional series from the University of Papua

FIG. 2. *Syzygium hylochare* (Diels) Merr. & Perry. Flowering habit. Scanned from *Takeuchi 11,847*.

New Guinea Herbarium; WT = W. Takeuchi. Other collectors indicated by name. Determinations by WT unless otherwise noted.

FERNS AND FERN ALLIES

ADIANTACEAE

Coniogramme macrophylla (Bl.) Hieron.; *WT 12,197*

DICOTS

ASCLEPIADACEAE (all dets. by P.I. Forster)

Hoya aff. *microphylla* Schltr.; *WT 12,449*
Hoya sussuela (Roxb.) Merr.; *WT 12,669*
Hoya sp.; *WT 12,752*
Marsdenia sp., probably nov.; *WT 12,469*

BURSERACEAE

Canarium acutifolium (DC.) Merr. var. *pioriverensis* Takeuchi; *WT 11,886A* (type), *11,886B*

ERICACEAE

Vaccinium acrobracteatum K. Schum.; *WT 12,451*, originally cited as 'Gaultherieae indet.'

EUPHORBIACEAE

Euphorbia plumerioides Teijsm. ex Hassk.; *WT 12,689*, the voucher previously cited (*WT 12,702*) is actually for *Codiaeum variegatum* (L.) Bl.

MELASTOMATACEAE

Medinilla forbesii Bak.; *J. Croft et al. LAE 61,178*, det. J. Regalado

MIMOSACEAE

Archidendron hispidum (Mohlenbr.) Verdc.; *WT 11,210*

MONIMIACEAE

Steganthera sp. nov. ined.; *WT 12,742* (type)

MYRTACEAE

Syzygium hylochare (Diels) Merr. & Perry; *WT 11,847*
Syzygium sp. nov. ined.; *WT 11,719* (type)

PIPERACEAE

Piper arfakianum C. DC.; *WT 12,453*

RUBIACEAE

Myrmecodia tuberosa Jack, entity '*muelleri*'; *UPNG 3,481*, cited in Huxley & Jebb (1993: 285).
Myrmecodia tuberosa Jack, entity '*versteegii*'; *UPNG 3,479*, (ibid: 287)

SAPINDACEAE

Rhysotoechia sp. nov. ined.; *WT 12,694* (type)

MONOCOTS

PANDANACEAE (all dets. by K.-L. Huynh)

Freycinetia acuta Huynh, sp. nov. in press; *WT 12,875* (type)
Freycinetia biroi Warb.; *WT 12,738*
Freycinetia craterensis Huynh, sp. nov. in press; *WT 11,955* (type)
Freycinetia lagenicarpa Warb.; *WT 11,761*
Freycinetia obtusiacuminata Huynh, sp. nov. in press; *WT 12,107* (type)

DISCUSSION

The flora of the Crater Mt. Wildlife Management Area (CMWMA) has been addressed, at least in part, by a succession of papers based on the 1997–1998 plant surveys. These surveys were originally intended as part of a comprehensive assessment through a continuous elevational sequence, on a schedule eventually to culminate in the preparation of a plant identification guide. Because of the truncation of our itinerary in duration and scope, the major objectives are now out of reach. However the existing documentary base provides considerable opportunities for future investigators. As noted earlier, the lowland environment at Crater Mt. is still relatively unsurveyed and almost certainly presents rich prospective opportunities for discovery (Takeuchi 1999). Even though some work has already occurred in the low elevation zone, previous efforts have been brief and spatially restricted. The existing herbarium documentation is also highly skewed, with past collectors tending to focus on easy-to-obtain taxa such as understory herbs and shrubs. A conscious attempt to secure fertile gatherings of canopy/subcanopy phanerophytes and high epiphytes should prove rewarding. The previously reported discoveries of new plants from the ecotone contact with the Pio alluvial plain, are suggestive of the possibilities.

The Crater Mt. tract is positioned on the leading edge of the Australian craton, forming part of a southern geoprovince which is floristically depauperate in comparison to the speciose northern orogen of New Guinea (*inter alios* Pigram & Davies 1987; Welzen 1997). The contrasting species content on north-south orientations has been attributed to the orogenic etiology of northern New Guinea environments, and to increased speciation induced by the orogeny (Balgooy et al. 1996; Welzen 1997). At least part of the difference however, is an artifact of the uneven state of plant exploration in PNG, of which a salient element is the lesser number of collections from the southern districts. Since mountain-building processes appear to drive floristic endemism in New Guinea, the highest species density from its austral geoprovince should be expected on the latter's northernmost margin, where the plate has been forced upwards by tectonic collision with the island arc terranes. The novelties from Crater Mt. can be rationalized on this basis. Further exploration of the south descending side of the Dividing Ranges can be expected to produce similar results.

The CMWMA represents a previously unexplored expanse of wilderness forest. Recent discoveries from this tract are indicative of the necessity of surveying such areas as part of an overall program for developing veridical phytogeographic estimates of the New Guinea flora. The existing CMWMA checklist consists of a diverse mixture of allochthonous and autochthonous taxa, including many distributional records. While there are bases for anticipating that future findings will follow patterns suggested by geological correlation, new refinements are likely to arise from exhaustive work on the Papuan side. Additional surveys toward the lowland alluvial zone could eventually connect to the elevational anomalies discerned at Lakekamu (cf. Takeuchi & Kulang 1998; Takeuchi in press). At the latter site for example, *Palmeria gracilis* Perkins was found in lowland communities corresponding to Australian provenances, though the species is ordinarily strictly montane in Papuasia. A complete elevational series may be demonstrable at Crater Mt., where *P. gracilis* is already documented from its more characteristic montane stations.

Several generalizations can be offered from our ongoing inventory work in wilderness areas, many of them previously little-explored or unexplored. 1) Substantial numbers of undiscovered species are sequestered in lowland habitats, even in accessible places, having been unrecorded because of the poor documentation from low elevations (Takeuchi 2000). 2) Although montane areas are better documented than lowland ones, additional discoveries are more likely to result from working the south-descending ranges, on the margin of the Austro-craton, rather than the Mamose-descending side. To be sure, virtually any sort of serious effort will result in substantive discovery. Even at this late date in Papuasian botany, every major expedition comes back with new collections. 3) It is an imperative on inventories, for survey botanists to collect uncritically by taking everything encountered, in multiple numbers rather than being selective (Pipoly pers. comm.). Many of the most consequential findings from current investigations were of taxa whose significance was only revealed in the herbarium. This is especially true of novelties from speciose genera. If investigators are too choosy in what they gather, these sort of records will be missed. 4) In traditional PNG cultures, there is a characteristic emphasis on vegetative markers for plant identification, which not unexpectedly results in highly erratic nomenclatural systems. The significance and discriminatory value of vernacular names are considerably overrated. At Crater Mt., this is exemplified by the Pawaian 'way-e-be,' which was described as monotypic by village guides, but actually encompasses *Gymnacranthera*, *Horsfieldia*, and *Myristica*; in fact virtually the entire Myristicaceae. Numerous examples of comparable imprecision were documented during the CMWMA inventory. Especially when compilations are based on limited sampling, the local names will appear to be specific merely because of discontinuities in the polling. While it is often standard practice for investigators to report local names in revisionary work, these reports have little to acquit themselves unless they are cast in the context of a comprehensive census accompanied by comparative evaluation of the vouchers. Our experience is that such inquiry will reveal numerous examples of nomenclatural circumscription grossly incompatible with formal science. The quirkiness of local naming systems has also been shown in the ethnobotanical polling from the recent Josephstaal surveys (Takeuchi 2000).

The Integrated Conservation and Development (ICAD) strategy at Crater Mt. conjoins community-based conservation initiatives with low-impact socioeconomic development. Nearly all conservation programs in Papua New Guinea are now founded on this principle. As one of the largest of the ICAD experiments, the CMWMA also ranks among the floristically richest sites presently subsumed under this operational paradigm. Whether or not the ICAD philosophy can achieve programmatic success in places such as the CMWMA is still open to question (cf. Saulei & Ellis 1998). What the Crater surveys demonstrate is that the long-term viability of ICAD at Crater Mt. could have dramatic implications for a remarkable and precinctive flora. The nature of future scientific contributions to be forthcoming from this area is in many respects an imponderable, but the results achieved thus far clearly point to a considerable promise for further floristic discovery.

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BOOK REVIEW

JOACHIM WOLSCHKE-BULMAHN and JACK BECKER. 1998. **American Garden Literature in the Dumbarton Oaks Collection (1785–1900): From The Newengland Farmer to Italian Gardens: An Annotated Bibliography.** (ISBN 0-88402-253-6, pbk.). Dumbarton Oaks Research Library and Collection, Washington, D.C. U.S.A. $35.00 pbk. ix + 243 pp., b/w illustrations.

This annotated bibliography summarizes 410 books on horticulture, botany, gardening, garden design, cemeteries, parks, rural architecture, and landscape architecture in America. The titles were published in the United States between 1785 and 1900 and are housed in the collections of the Garden Library of Dumbarton Oaks. Traditionally, the library's dominant holdings have been in the areas of English, French, and Italian garden literature, in keeping with the interests of garden historians. In recent years, as increasing numbers of scholars have addressed the American landscape, Dumbarton Oaks expanded its holdings in 19th-century American literature.

Although, as noted by the authors, the traditional form of bibliography no longer has the same importance as it did in the past, because more and more libraries place their complete holdings online, and printed bibliographies are still valuable for scholars because they often provide important additional information in introductory essays, annotations, illustrations, indices, and other supplementary material. It is precisely in this aspect that the value of the present bibliography lies.

The book is organized in five sections: **I.** Introduction; **II.** Annotated list of titles; **III.** Chronological list of titles; **IV.** Index; and **V.** Bibliography. The introductory essay presents a history of the literature of American gardening, horticultural, and landscape, cemetery and park design. The annotations are succinct but adequate comments on each title's contents. The index is extensive and provides one of the greatest values of the volume. One wishes for more and better illustrations (none are in color); however, publishing constraints may have placed unwanted limitations on the bibliographers.

The bibliography of *American Garden Literature in the Dumbarton Oaks Collection (1785-1900)* will be a useful addition to the library of a scholar of the genre.—*Joan H. Swaim.*

SIDA 19(2): 248. 2000

THE INTRIGUING CASE OF *CYPRIPEDIUM CROSSII*, ITS PRIORITY OVER *CYPRIPEDIUM CALLOSUM* AND ITS TRANSFER TO THE GENUS *PAPHIOPEDILUM*

Guido J. Braem

Schlechter Institute and
California Academy of Sciences
Naunheimer Str. 17
D-35633 Lahnau, GERMANY

Karlheinz Senghas

Botanischer Garten der Universität Heidelberg
Im Neuenheimer Feld 340
D-6900 Heidelberg, GERMANY

ABSTRACT

Cypripedium crossii Morren was first mentioned in La Belgique Horticole for 1865 and described in the same journal for 1883. Its priority over *Cypripedium callosum* Rchb.f. 1886 is discussed and established. The taxon and two of its known varieties are transferred to the genus *Paphiopedilum* Pfitzer.

KEY WORDS: *Orchidaceae, Cypripedioideae, Cypripediaceae, Cypripedium, Paphiopedilum, callosum, crossii, barbatum, sublaeve, potentianum*, Taxonomy, Systematics, Orchid Hybrid Registration, International Code of Botanical Nomenclature, Saint Louis Code.

RESUMEN

Cypripedium crossii Morren se mencionó por primera vez en La Belgique Horticole en 1865 y se describió en la misma revista en 1883. Se discute y establece su prioridad sobre *Cypripedium callosum* Rchb.f. 1886. Este taxon y dos de sus variedades conocidas se transfieren al género *Paphiopedilum* Pfitzer.

INTRODUCTION

During the preparatory work for the third volume of Braem, Baker & Baker, *The genus Paphiopedilum – Natural History and Cultivation*, the literature *regarding Paphiopedilum callosum* (Rchb.f.) Stein was reviewed. The taxon referred to as *Cypripedium crossii* Morren has been interpreted as a synonym of *Paphiopedilum barbatum* by Braem (1988) and considered to be a *nomen nudum* within the synonymy of *Paphiopedilum callosum* by Cribb (1987, 1998). A review of the original literature has conclusively revealed that both interpretations are erroneous.

DISCUSSION

Cypripedium crossii was first mentioned by Morren (1865) in a short article in volume 15 of La Belgique Horticole, 21 years before the publication of *Cypripedium callosum* (Rchb.f. 1886). In his 1865 article, Morren simply states that the *Cypripedium* originates from Peru and that it carries the name of its discoverer, Mr. Cross. No description or any further information is made available. However, plate 17, which is part of the article, shows a plant labeled as *Cypripedium crossii.* This illustration leaves no room to doubt that the taxon published by Morren as *Cypripedium crossii* is identical with the plant described as *Cypripedium callosum* by the younger Reichenbach in 1886. The Morren "note" has been interpreted as insufficient to be regarded as a valid and effective publication of *Cypripedium crossii* as an autonomous taxon, an interpretation generally based on article 42.3 of the International Code of Botanical Nomenclature (ICBN) generally referred to as the "Code." Article 42.3 (taken from the Saint Louis Code [Greuter et al. 2000], which is the effective version) reads,

> *"Prior to 1 January 1908 an illustration with analysis, or for non-vascular plants, a single figure showing details aiding identification, is acceptable, for the purpose of this article, in place of a written description or diagnosis."*

And article 42.4 clarifies what is to be understood as an analysis,

> *"For the purpose of Art. 42, an analysis is a figure or group of figures,* ***commonly*** *separate from the main illustration of the plant (though usually on the same page or plate), showing details aiding identification, with or without a separate caption."*

The Morren note was accompanied by a color plate of *Cypripedium crossii* (Fig. 1). There can be no doubt about the identity of the plant published as *Cypripedium crossii* by Morren in 1865 is identical with the taxon we have hitherto referred to as *Paphiopedilum callosum* (Rchb.f.) Stein. The plate contains details that allow for the identification; two flowers are shown. The color plate clearly depicts the different aspects of the plant and flower such as shape and tesselation of leaves, shape and color of all parts of the corolla, from the front as well as from the back, detailed shape of staminodal shield, the ovary, and the floral bract. In other words all aspects relative to the identification of a slipper orchid. Thus the plate satisfies the requirements of Art. 42.4, especially as that article clearly states (see above) that the "figure" or "group of figures" do(es) not necessarily have to be "separate from the main illustration of the plant." If this were not so, the inclusion of the word "commonly" in article 42.4 would make no sense.

It is ludicrous to disqualify the publication of *Cypripedium crossii* by Morren in the scientific journal La Belgique Horticole knowing that the valid code accepts publication in trade catalogues or non-scientific newspapers before 1 January 1953, and in seed-exchange lists before 1 January 1973 (see Code, Article 30.3). As every botanist knows, a publication in a seed list generally means simple mention of the botanical (Latin) name. Thus, *Cypripedium crossii* is for all purposes to be regarded as validly and effectively published in 1865.

In 1883, in volume 33 of the same journal *(*La Belgique Horticole*),* Morren wrote an extensive article entitled "*Cypripedium barbatum,* Lindl. and its major varieties, *crossi* [sic.], *warnerianum,* etc." This article was illustrated with a colored plate (Fig 2).

The plate reveals that the plant Morren described is identical with the plant he had depicted in 1865, thus the plant we have hitherto generally addressed as *Paphiopedilum callosum* (Rchb.f.) Stein. Morren writes, "*Cypripedium crossi* [sic.] has a very wide, somewhat trilobed dorsal sepal which is white, veined with green and crimson. It is transversally divided in the middle by a crimson stripe. The petals are half-green and half-white with green veins and rose extremities. The lip is dark rose-brown."

Thus, in 1883, Morren published a description of *Cypripedium crossii*, although he considered this plant to be a variety of *Paphiopedilum barbatum* Lindley.

CONCLUSIONS

In view of the facts delineated above, there is no reason to deny *Cypripedium crossii* Morren full taxonomic validity. Whereas the validity of Morren's publication of 1865 could possibly be a matter of discussion (but see below), the taxon was distinctly described in Morren's 1883 article, and clearly identified as an autonomous taxon identical to the species hitherto generally referred to *as Paphiopedilum callosum* (Rchb.f.) Stein. Both Morren publications predate the publication of *Cypripedium callosum* by the younger Reichenbach and therefore, *Cypripedium crossii* Morren is to be given priority in accordance with the rules of nomenclature. The taxon is to be transferred to the genus *Paphiopedilum*. The authors are well aware of the fact that conservative growers and hybridizers will argue that the name *"Paphiopedilum callosum"* should be retained because a multitude of hybrids has been registered indicating *"Paphiopedilum callosum"* to be part of their ancestry. This argument must be rejected. The registration of orchid hybrids (and any other hybrids for that matter) is no concern to botanical taxonomy. Furthermore, the registration authority for orchid hybrids (Royal Horticultural Society, London) is by no means a taxonomic ruling body. Furthermore, if the horticultural argument were to be followed, the name *"Cypripedium"* would have to be re-instated for the genus *Paphiopedilum* (and other genera), etc. Last, but not least, the identity of (at least) some of the hybrids must be questioned. If we would reject a valid name because its use is considered to be inconvenient to horticulture, it would, indeed be best to ignore all rules of botanical taxonomy.

TAXONOMY

Paphiopedilum crossii (Morren) Braem & Senghas, comb. et stat. nov. BASIONYM: *Cypripedium crossii* Morren in Belgique Horticole 15:226, t. 17, 1865; Belgique Horticole 33:96–98 [97–98], t. 7, 1883.

Cypripedium callosum Rchb.f., Gard. Chron. ser. 2, 26:326. 1886. *Cordula callosa* (Rchb.f.) Rolfe, Orchid Rev. 20:2. 1912.

Cypripedium schmidtianum Kraenzl., Bot. Tidsskr. 24:13. 1901. *Paphiopedilum callosum* var. *schmidtianum* (Kraenzl.) Pfitzer in Engler, Pflanzenr. IV. 50. Orchidaceae-Pleonandrae: 93. 1903.

Paphiopedilum callosum var. *angustipetalum* Guillaumin, Bull. Soc. Bot. France ser. 4, 24:551. 1924.

The decision to transfer the following two varieties was a difficult one as their botanical validity is by no means established. The differentiation between the type variety (thus the autonym *Paphiopedilum crossii* var. *crossii)* and *Paphiopedilum crossii* var. *sublaeve*

FIG. 1. *Paphiopedilum crossii* (Morren) Braem & Senghas, from Morren in Belgique Horticole, 1865.

Fig. 2. *Paphiopedilum crossii* (Morren) Braem & Senghas, from Morren in Belgique Horticole, 1883.

consists merely in var. *sublaeve* having somewhat smaller flowers with a smaller dorsal (cf. Cribb 1987, 1998). Reichenbach fil. (1888), in his original publication of var. *sublaeve,* simply notes that the plant came out of a batch of *"Cypripedium callosum,"* and that "it might be supposed to be a natural hybrid." Cribb also states (loc. cit.) that the petals of var. *sublaeve* "usually bear warts only on the upper margin." This, however, also applies to the plant he depicts as *Paphiopedilum callosum* var. *callosum* on page 333 of his book (Cribb 1998).

It is amazing that the validity and effectiveness of the Reichenbach fil. publication, rendered in a British horticultural newspaper and in English, without any description or illustration, has never been questioned, whereas the publication of *Cypripedium crossii* by Morren, admittedly in a Belgian scientific journal, and admittedly in French, should be denied acceptance although Morren's plant can be positively identified by the explicit illustration that is part of the publication.

Variety (?) *potentianum* differs merely by the lack of the marginal warts on the upper margin and its narrower dorsal sepal (see Cribb 1998).

It may very well be argued that these are phenotypes that are well within the normal range of a natural species.

Paphiopedilum crossii var. **sublaeve** (Rchb.f.) Braem & Senghas, comb. et stat. nov. Basionym: *Cypripedium callosum* var. *sublaeve* Rchb.f., Gard. Chron. Ser. 3, 3:331. 1888. *Paphiopedilum callosum* subsp. *sublaeve* (Rchb.f.) Fowlie, Orchid Digest 36:145. 1972; 38:187. 1974. *Paphiopedilum sublaeve* (Rchb.f.) Fowlie, Orchid Digest 43:224. 1979. *Paphiopedilum callosum* var. *sublaeve* (Rchb.f.) Cribb, Genus *Paphiopedilum* 188. 1987.

Paphiopedilum thailandense Fowlie, Orchid Digest 43:220. 1979, nomen nudum.

? *Cypripedium callosum* var. *warnerianum* T. Moore in Warner, Select Orchid. Pl. 3, t. 11, 1878.

Paphiopedilum crossii var. **potentianum** (Gruß & Röth) Braem & Senghas, comb. et stat. nov. Basionym: *Paphiopedilum potentianum* Gruß & Röth., Caesiana 5:39. 1995. *Paphiopedilum callosum* var. *potentianum* (Gruß & Röth) Cribb, Genus *Paphiopedilum,* 2nd ed. 337. 1998.

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BOOK REVIEW

HAROLD W. KELLER and KARL L. BRAUN. 1999. **Myxomycetes of Ohio: Their Systematics, Biology, and Use in Teaching.** (ISBN 0-86727-133-7, pbk.). Ohio Biological Survey Bulletin New Series volume 13 Number 2 (ISSN 0078-3994). Ohio Biological Survey, 1315 Kinnear Road, Columbus, OH 43212-1192, U.S.A. (615-292-9645, 614-688-4322 fax; http://www-obs.biosci.ohio-state.edu). $35.00 pbk. (Wire-O Binding or Perfect Binding) xvi + 182 pp., 16 color plates.

"Half animal-half plant!" A fungus **and** a protozoan? A naked mass of colorful, slimy, "snot-like" protoplasm, sometimes several inches or more across, creeping in mass or in a vein-like network over rotten logs and leaves in the woods - or in the lab on a bowl of oatmeal. Under the microscope beautifully ornamented globe-shaped balls, the wind-borne spores that in dew break open to release minute, swarming, sperm-like creatures that swim with rapidly moving flagellar paddles, these zoospores changing into white blood cell-like amoebas that glide and feed by engulfing bacteria and other minute morsels, these reproducing themselves into an army of amoebas that eventually reunite and fuse into masses of streaming, multinucleated protoplasm, which, like the beautiful butterfly that emerges from the drab cocoon, may change overnight into dozens of minute, marvelously structured and colorful spore producing bodies that we can see easily with a 10 X hand lens and which contain the tiny balls that we saw first under the microscope.

What are Myxomycetes? Mycology has been the traditional home for this mysterious group of "animal like plants." How do mycologists study this living stuff where there is no such thing as an individual organism that we can separate and count or experiment with such as an ant, a single great ape, or a single bean plant? Does it really matter where in their hierarchical categories the biosystematists place these creatures? Wherever Myxomycetes are classified, they are wonderfully fascinating life.

One of the most important kinds of biosystematic research is that which results in practical, useful products that can be used at a local level by teachers, students, and other scientists to learn about and identify the specific organisms in their immediate surroundings. This is especially true for microorganisms, which are much less popular than macroorganisms and have had very few useable publications written about them at a local level.

Keller and Braun's book is the kind of product that gives practical, useful, thorough, colorful information about the biology, morphology, and taxonomy of Myxomycetes. It also includes valuable information about techniques for studying these fantastic microorganisms. I recommend this book especially because it not only presents the well-organized scientific data about Myxomycete species, but also because of its personal touch about the authors, their teachers, their students, and other scientists who have contributed to knowledge of Ohio Myxomycetes. But this book is valuable in a much wider area than the state of Ohio. Nearly 35 % of the world's 600 species and 57 genera of Myxomycetes are included, and the contributions of the scientists mentioned has had influence worldwide.

Every state needs an agency like the Ohio Biological Survey that supports field research on groups of local biota and publication of useful, interesting, practical information about the specific things that live in our own backyards. Where in the United States of America is there a county that has all of its species biodiversity catalogued? In what locality does anyone know all of the living things, especially the microorganisms, that one might find in a handful of soil from nearby parks, prairies, woodlands, schoolyards, or even flower pots? Keller and Braun have produced an excellent book that is a necessary step toward achieving the goal of an "all-taxa inventory" of at least a small part of the world.—*Joe F. Hennen, Resident Research Associate, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A.*

USE OF VARIETY AND SUBSPECIES AND NEW VARIETAL COMBINATIONS FOR *STYRAX PLATANIFOLIUS* (STYRACACEAE)

B.L. Turner

Section of Integrative Biology
University of Texas
Austin, TX 78713, U.S.A.

Guy L. Nesom

North Carolina Botanical Garden
University of North Carolina
Chapel Hill, NC 27599-3280, U.S.A.

ABSTRACT

The term "variety" has historical precedence over "subspecies" and is either prescribed or recommended by the ICBN as the rank to be first used in the description of infraspecific taxa. The rank "subspecies" is then used to cluster related varieties. Accordingly, to replace earlier combinations at subspecific rank, the following new combinations in *Styrax platanifolius* are proposed: var. **mollis** (P.W. Fritsch) B.L. Turner, comb. et stat. nov.; var. **texanus** (Cory) B.L. Turner, comb. et stat. nov.; and var. **youngiae** (Cory) B.L. Turner, comb. et stat. nov. No subspecies are recognized here in *S. platanifolius*.

RESUMEN

El término "variedad" precede históricamente al de "subespecie" y es ordenado o recomendado por el ICBN como el primer rango a ser usado en la descripción de taxa infraespecíficos. El rango "subespecie" se usa después para agrupar variedades relacionadas. De acuerdo con ésto, se proponen las siguientes nuevas combinaciones para reemplazar combinaciones previas en el rango subespecífico en *Styrax platanifolius*: var. **mollis** (P.W. Fritsch) B.L. Turner, comb. et stat. nov.; var. **texanus** (Cory) B.L. Turner, comb. et stat. nov.; y var. **youngiae** (Cory) B.L. Turner, comb. et stat. nov. No se reconocen subespecies aquí en *S. platanifolius*.

Fritsch (1997) has provided a much needed revision of *Styrax* for Mesoamerica, Mexico and western Texas, recognizing 19 species. One of these, *S. platanifolius* Engelm. ex Torr., was treated as having five subspecies, bringing to 24 the number of formal taxa of *Styrax* recognized for the region concerned. Fritsch recognized infraspecific taxa as "subspecies" rather than "varieties," noting (p. 711) that his usage was "in accordance with the concepts of Hultén (1967) and Thorne (1978)," who "use the subspecies category for infraspecific taxa that are geographically as well as morphologically distinct."

Of course, most current botanists who employ "variety" also use it in reference to infraspecific taxa that are geographically and morphologically distinct, and we do not accept what is essentially the equating of these two categories of infraspecific classification. The use of variety in plant taxonomy for the first infraspecific rank dates back to Linnaeus and has historical precedence over the term subspecies. More significantly,

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this usage of variety is set forth by the current International Code of Botanical Nomenclature (Greuter et al. 2000) in the same format and language as other conventions that are clearly prescriptive.

Article 4.1. "The secondary ranks of taxa in descending sequence are tribe (tribus) between family and genus, section (sectio) and series (series) between genus and species, and variety (varietas) and form (forma) below species."

Use of the "sub" prefix provides added ranks.

Article 4.2. "If a greater number of ranks of taxa is desired, the terms for these are made by adding the prefix sub- to the terms denoting the principal or secondary ranks. A plant may thus be assigned to taxa of the following ranks (in descending sequence): regnum, subregnum, divisio or phylum, subdivisio or subphylum, classis, subclassis, ordo, subordo, familia, subfamilia, tribus, subtribus, genus, subgenus, sectio, subsectio, series, subseries, species, subspecies, varietas, subvarietas, forma, subforma."

Philosophical and interpretive differences regarding use of infra-taxon categories are magnified by this tension in the ICBN: **variety and/or forma are the ranks to be used first in describing infraspecific taxa (Article 4.1), but subspecies is the term first in hierarchical rank below species (Article 4.2).** Use of *species* and *variety*, however, is analogous to that for general use of *kingdom* and *division*, *class* and *order*, *family* and *tribe*, and *genus* and *section*. In each of these pairs the first used sub-rank (the second term) is code-prescribed as such (4.1), with the orthographically subsidiary and immediately hierarchical ranks *subkingdom*, *subclass*, *subfamily*, and *subgenus* generally used for an additional rank (4.2), as is *subspecies*.

Varieties may be clustered by use of the subspecies category

Varieties are recognized within a species when it is desirable to refer by name to morpho-geographically differentiated entities comprising that species. In our concept and experience, varieties usually are closely similar allopatric entities that intergrade over a relatively short distance in regions of contact (as opposed to gradual, broadly regional intergradation), if they intergrade at all. In addition to morphology and geography, other factors may be used in evaluation of taxonomic status of such entities—genetic divergence, likelihood of natural hybridization, and fertility of hybrids (Stuessy 1990).

In a species where several varieties are recognized, two or more varieties may be grouped within a subspecies. In this sense, use of the subspecies rank may point to larger patterns of variation and/or coherence within the species. This use of infraspecific categories finds support in the ICBN, which implies that the term subspecies is used for clustering varieties.

Recommendation 26A.2. "A subspecies not including the type of the correct name of the species should, where there is no obstacle under the rules, be given a name with the same final epithet and type as a name of one of its subordinate varieties."

Use of the subspecies rank in clustering varieties is not pervasive, but it is currently found across various families and genera in the North American flora (e.g., *Agastache*, *Arenaria*, *Arnica*, *Artemisia*, *Cerastium*, *Chamaecrista*, *Chrysothamnus*, *Ericameria*, *Erigeron*, *Eriogonum*, *Heterotheca*, *Ipomopsis*, *Lathyrus*, *Lupinus*, *Machaeranthera*, *Monarda*, *Prunus*, *Ptelea*, *Ruellia*, *Salix*, *Salvia*, *Scutellaria*, *Sidalcea*, *Silene*, *Solidago*, *Streptanthus*, *Symphyotrichum*, and *Tetramolopium*).

Other perspectives on the use of infraspecific categories

The issue of "variety vs. subspecies" in infraspecific classification has been discussed repeatedly. Cronquist (1988) and Stuessy (1990) gave detailed overviews of the issue and Hamilton and Reichard (1992) provided a review of current practice in the use of infraspecific categories. Our commentary does not break new ground, but it emphasizes primary considerations and it is a reminder that usage of these categories remains inconsistent and commonly without explicit rationale.

Views similar to ours have been well-expressed by Kapadia (1963) and Holmgren (1994). In a contrasting view, Raven (1974) proposed to simplify infraspecific terminology by using only the term subspecies, nomenclaturally equating the term variety, this proposal accompanied by detailed suggestions for its formalization in the ICBN. Another form of this latter solution is to use subspecies as the first category for infraspecific taxa—then to use varieties (at lower rank) for subsequent subdivisions of subspecies (see Stuessy 1990, Fig. 12.1). For Thorne (1978, p. 190), "Genetic variants without well-defined geographic ranges are treated as varieties … ." Such proposals, however, to formally displace "variety" as the first infraspecific category have not been accepted, presumably because many botanists find utility in maintaining two classificatory units at infraspecific rank and because the basis for use of "variety" is historical and currently codified.

The rank of variety has been used to describe taxa over a range of evolutionary and morphological differentation. Some taxa are more strongly differentiated than others. Traditional views of boundaries between taxa at specific and infraspecific rank also differ among genera and families. Replacing variety with subspecies would not change this.

The International Code of Zoological Nomenclature (International Commission on Zoological Nomenclature 1999) does not provide for the term "variety" for classificatory purposes. The latter term, as used by most botanical taxonomists and as prescribed by the ICBN, is essentially equivalent to the subspecies rank of zoologists. This is acceptable. The botanical code is for plant workers, the zoological code for animal workers and the two codes need not become one. Actually, it is informative to see the term "variety" in a title or abstract: one knows that the organisms concerned are most likely plants.

It might be argued that the term "variety" has been misapplied by various workers, especially horticulturists and plant breeders, to designate mere forms. But most professional plant taxonomists use the term "forma" for such population variants, while the International Code of Nomenclature for Cultivated Plants (Trehane et al. 1995) refers to such an individual plant or genetic strain as a "cultivar" (cultivated variety). The horticultural taxonomists coordinate their taxonomy with the ICBN, providing an adjunct system, not one that contradicts (Brickell & Trehane 1997). In short, horticultural usage is not a tenable rationale for generally adopting the rank of subspecies to the exclusion of variety.

In contrast to these more pragmatic arguments for using variety as first choice of infraspecific rank, guidance of the ICBN is more ambiguous. Is the nomenclatural convention codified in Article 4.1 a prescription, or is it merely a suggestion or recommendation? In either case, what is its relationship to Article 4.2? And what bearing, if any, does Article 5.1 have on this interpretation?

Article 5.1. "The relative order of the ranks specified in Art. 3 and 4 must not be altered (see Art. 33.7 and 33.8)."

Articles 4 and 5 are not included among those whose conditions must be met for valid publication, according to Article 32. But, then, how should they be interpreted? What bearing, if any, does Article 2.1 have on this interpretation?

Article 2.1. "Every individual plant is treated as belonging to an indefinite number of taxa of consecutively subordinate rank, among which the rank of species (species) is basic."

Infraspecific taxa in *Styrax platanifolius*

Evidence from morphology and isozyme analysis indicates that only a single species should be recognized among the populations of *Styrax* in west Texas and adjacent Mexico—*S. platanifolius*, a morphologically and geographically distinct taxon, apparently most closely related to the California endemic *S. redivivus* (Torr.) Wheeler (Fritsch 1997). While variation in pubescence quantity in other New World *Styrax* species is essentially random, Fritsch (1997, p. 741) found that "trichome morphology or abundance within *S. platanifolius* is distinctly regional and facilitates the delimitation of nearly or completely allopatric taxa. Therefore, I have recognized five subspecies within *S. platanifolius* based on minor but distinctive differences. Trichome characters are those most reliable for the delimitation of these subspecies; characters of secondary importance include leaf form, calyx gland density, and surface features of the stem," characters considered by Fritsch "not taxonomically reliable" or "taxonomically inconsequential" within many other species of the genus.

Three of the *Styrax platanifolius* subspecies (*platanifolius*, *stellatus*, *texanus*) form a relatively compact geographic cluster on the Edwards Plateau of Texas; the other two (*youngiae* and *mollis*) are longitudinally aligned in sierran localities from trans-Pecos Texas into northeastern Mexico. Fritsch did not mention any aspect of intergradation among these taxa—while it apparently is true that the distinctions are fairly discrete, the populations are rare, composed of very few individuals, and each population can be seen as completely isolated within the rugged terrain. Fritsch's comment (p. 743) that "subspecies *stellatus* resembles subspecies *mollis* more closely than does subspecies *youngiae*" might suggest that [subsp.] *stellatus* and *mollis* could be considered together as a larger infraspecific unit, but the geographic disjunction between these two would render this a peculiar concept.

In sum, the morphological and evolutionary status of infraspecific taxa of *Styrax platanifolius* (sensu Fritsch 1997) corresponds to what we conceive of here as varieties. Varietal rank is generally used as the first infraspecific taxonomic category throughout the Texas flora, especially in the developing "Atlas of the Flora of Texas" (Turner in prep.). In this context, the following varietal combinations in *S. platanifolius* (a, d, e) are proposed in order to provide for their use in matters systematic.

a. Styrax platanifolius var. **mollis** (P.W. Fritsch) B.L. Turner, comb. et stat. nov. BASIONYM: *Styrax platanifolius* subsp. *mollis* P.W. Fritsch, Ann. Missouri Bot. Gard. 84:742. 1997.

b. Styrax platanifolius Engelm. ex Torrey var. **platanifolius**. Automatically established with the publication of Cory's var. *stellatus*, as listed below.

Styrax platanifolius subsp. *platanifolius*. Automatically established by Fritch's subspecies, as listed below.

c. Styrax platanifolius var. **stellatus** Cory, Madroño 7:111. 1943.

Styrax platanifolius subsp. *stellatus* (Cory) P.W. Fritsch, Ann. Missouri Bot. Gard. 84:743. 1997.

d. Styrax platanifolius var. **texanus** (Cory) B.L. Turner, comb. et stat. nov. BASIONYM: *Styrax texanus* Cory, Madroño 7:112. 1943.

Styrax platanifolius subsp. *texanus* (Cory) P.W. Fritsch, Ann. Missouri Bot. Gard. 84:744. 1997.

e. Styrax platanifolius var. **youngiae** (Cory) B.L. Turner, comb. et stat. nov. BASONYM: *Styrax youngiae* Cory, Madroño 7:113. 1943.

Styrax platanifolius subsp. *youngiae* (Cory) P.W. Fritsch, Ann. Missouri Bot. Gard. 84:744. 1997.

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NEW SUBTRIBES FOR NORTH AMERICAN ASTEREAE (ASTERACEAE)

Guy L. Nesom

North Carolina Botanical Garden
Coker Hall CB 3280, University of North Carolina
Chapel Hill, NC 27599, U.S.A.

ABSTRACT

Recent molecular evidence indicates that most genera of North American Astereae comprise a monophyletic assemblage. Within this North American clade are three distinctive generic groups previously hypothesized to be most closely related to subtribes of the Southern Hemisphere—the *Monoptilon* group, the *Pentachaeta* group, and the *Townsendia* group. Additionally, morphological and molecular evidence indicates that the genera *Boltonia*, *Chloracantha*, and *Batopilasia* are closely related among themselves and constitute a coherent group. These four North American groups are recognized here with formal names at subtribal rank: **Chaetopappinae** subtr. nov. (*Chaetopappa*, *Monoptilon*), **Pentachaetinae** subtr. nov. (*Pentachaeta*, *Rigiopappus*, *Tracyina*), **Astranthiinae** subtr. nov. (*Astranthium*, *Dichaetophora*, *Geissolepis*, *Townsendia*), and **Boltoniinae** (*Batopilasia*, *Boltonia*, *Chloracantha*). Homochrominae is placed synonymy under subtribe Bellieae.

RESUMEN

Recientes evidencias moleculares muestran que la mayoría de los géneros norteamericanos de Astereae comprenden un conjunto monofilético. Dentro de este clado norteamericano hay tres grupos genéricos sobre los que se hipotetizó previamente que fuesen los más relacionados con las subtribus de hemisferio sur—el grupo *Monoptilon*, el grupo *Pentachaeta*, y el grupo *Townsendia*. Adicionalmente, la evidencia morfológica y molecular indican que los géneros *Boltonia*, *Chloracantha*, y *Batopilasia* están muy relacionados entre ellos y constituyen un grupo coherente. Estos cuatro grupos norteamericano se reconocen aquí con nombres formales en el rango: **Chaetopappinae** subtr. nov. (*Chaetopappa*, *Monoptilon*), **Pentachaetinae** subtr. nov. (*Pentachaeta*, *Rigiopappus*, *Tracyina*), **Astranthiinae** subtr. nov. (*Astranthium*, *Dichaetophora*, *Geissolepis*, *Townsendia*), y **Boltoniinae** (*Batopilasia*, *Boltonia*, *Chloracantha*). Se lectotipifica Homochrominae, colocándola en la sinominia de la subtribu Bellieae.

A primarily morphological overview of the tribe Astereae (Nesom 1994a) recognized 14 subtribes, four of which were hypothesized to be primarily North American (Machaerantherinae, Chrysopsidinae, Solidagininae, and Symphyotrichinae). Three distinctive North American generic groups were hypothesized to be most closely related to subtribes of the Southern Hemisphere—the *Monoptilon* group (subtribe Feliciinae = Bellieae, primarily Africa and western North America), the *Pentachaeta* group (subtribe Bellieae), and the *Townsendia* group (subtribe Brachyscominae, primarily Australia and North America). The genus *Boltonia* was hypothesized to be related to genera of subtribe Asterinae, primarily an Eurasian group (Nesom 1994a, 1994b).

Noyes and Rieseberg (1999) used nucleotide sequence data from nuclear ribosomal DNA representing a broad range of Astereaean genera to test various hypotheses of

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relationship and classification in the tribe. Their results showed that all genera examined of North American Astereae comprise a single, strongly supported clade—thus morphological parallelism rather than homology underlies hypotheses suggesting that dispersal from the Southern Hemisphere and Asia accounts for the origin of the *Monoptilon*, *Pentachaeta*, and *Townsendia* groups and *Boltonia*.

Notwithstanding these unexpected patterns of relationship, the infra-tribal generic groups under consideration have consistently been recognized as coherent (see caveats below regarding *Aphanostephus*, *Geissolepis*, and *Boltonia*). The morphological distinctiveness of these groups is equal to others already recognized at subtribal rank, and with recognition of their origin from within the broad North American clade, they are provided here with formal names at the same rank.

Chaetopappinae Nesom, subtr. nov. TYPE GENUS: *Chaetopappa* DC.

Herbae annuae vel perennes vitae brevis radice palari. Capitula plerumque solitaria; phyllaria marginibus late hyalinis. Corollae radii albae vel caeruleae, valde circinnatae. Pappus setarum, squamarum vel palearum, setarum ac squamarum, vel carens. Numerus basicus chromosomatum, x = 8.

Small, annual or short-lived perennial herbs, taprooted, decumbent (*Monoptilon*, some *Chaetopappa*) to erect. Leaves entire, oblong to oblanceolate-spatulate, alternate. Heads mostly solitary; phyllaries flat to convex, with broad, sharply delimited, hyaline margins. Ray corollas blue to white, strongly coiling. Disc flowers sometimes with sterile ovaries; style branches with obtuse or truncate to triangular collecting appendages. Cypselae eglandular or glandular, terete and multinerved (most *Chaetopappa*) or obovate, flattened, and 2-nerved (*Monoptilon*, some *Chaetopappa*); pappus of persistent bristles, or scales, or pales, or of bristles and scales, commonly in multiples of 5 (in *Chaetopappa*), or absent. Base chromosome number, x = 8. Genera included: *Chaetopappa* DC., *Monoptilon* Torr. & A. Gray ex Gray. Distribution primarily in arid habitats in the southwestern and south-central USA and northern Mexico.

This is essentially the "*Monoptilon* group," earlier placed in subtribe Feliciinae = Bellieae (Nesom 1994a) and as "Incertae sedis" (Nesom 2000). The two genera of Chaetopappinae form a monophyletic group sister to *Euthamia* Nutt. ex Cass. in the Noyes and Rieseberg analysis. In the analysis of Lane et al. (1996), the phyletic origin of *Chaetopappa* lies immediately between *Astranthium* and *Townsendia*, although it does not do so in the original analysis from which the DNA data were drawn (Morgan 1990).

The southern European genus *Bellium* L. was earlier included in the *Monoptilon* group (Nesom 1994a), but with the strong indication that *Monoptilon* and *Chaetopappa* are North American in origin, it is probable that the closest relationships of *Bellium* are with the other Old World genera. Similarities between *Bellium* and *Amellus* L. were noted by Nesom (1994a).

Pentachaetinae Nesom, subtr. nov. TYPE GENUS: *Pentachaeta* Nutt.

Herbae annuae radice palari. Folia filiformia vel linearia vel anguste oblanceolata. Capitula solitaria longipedunculata; phyllaria marginibus hyalinis. Corollae radii flavae vel rubescentes, minus plerumque albae, valde circinnatae. Appendices collectentes lineari-lanceolatae ramorum styli florum disci. Cypselae teretes vel leniter complanatae, anguste oblongae vel oblanceolatae in ambitu; pappus setarum vel squamarum. Numerus basicus chromosomatum, x = 9.

Annual herbs, taprooted. Leaves alternate, entire, filiform or linear to narrowly oblanceolate. Heads solitary and long-pedunculate; phyllaries with hyaline margins. Ray corollas yellow to reddish, less commonly white, strongly coiling (lamina absent in some *Pentachaeta*). Disc flowers: style branches with linear-lanceolate collecting appendages. Cypselae terete to slightly compressed, narrowly oblong to oblanceolate in outline, beaked in *Tracyina*, eglandular; pappus 1-seriate (1–2 seriate in *Tracyina*), of persistent bristles frequently in multiples of 5s, sometimes flared at the base and partially connate, or sometimes completely lacking, or of long scales (*Rigiopappus*). Base chromosome number, x = 9. Genera included: *Pentachaeta* Nutt., *Rigiopappus* A. Gray, *Tracyina* S. F. Blake. Distribution primarily in grassland habitats of California, USA, with several taxa of *Pentachaeta* reaching Baja California, Mexico; *Rigiopappus* also occurs into Oregon, Washington, Idaho, and Nevada.

This is the "*Pentachaeta* group," earlier placed in subtribe Feliciinae = Bellieae (Nesom 1994a) and as "Incertae sedis" (Nesom 2000). The close resemblance and relationship among these three genera have been noted by Blake (1937), Ornduff and Bohm (1975), and Robinson and Brettell (1973); they were placed as a coherent unit within the "*Chaetopappa* group" by Bremer (1994). The Pentachaetinae form a monophyletic group sister to *Ericameria* Nutt. in the Noyes and Rieseberg analysis.

Astranthiinae Nesom, subtr. nov. Type genus: *Astranthium* Nutt.

Herbae annuae biennes vel perennes plerumque radice palari. Capitula solitaria, plerumque longipedunculata; phyllaria marginibus late hyalinis; receptacula convexa vel conica. Corollae radii plerumque albae vel caeruleae, midfascia abaxiali lavandula, non reflexae aut circinnatae. Corollae discii tubo brevi. Cypselae oblanceolatae vel obovatae, complanatae, 2(–3)-nervatae, laeves vel papillatae, plerumque pubescentes trichomatibus glochidiatis; pappus setarum vel corona demissa setarum et squamarum. Numerus basicus chromosomatum, x = 9 et x = 3, 4, 5.

Annual, biennial, or perennial herbs, taprooted, often with a branching caudex, rarely fibrous-rooted, mostly strigose with short, white hairs. Leaves alternate, spatulate to linear, entire or few-toothed. Heads solitary, mostly long-pedunculate, rarely sessile; phyllaries with broad, hyaline margins; receptacles convex to conical. Ray corollas white to bluish or pinkish above (rarely yellow in *Townsendia*), usually with a lavender to blue or pink abaxial midstripe, not reflexing or coiling. Disc corollas short-tubed; style branches with triangular-lanceolate collecting appendages. Cypselae oblanceolate to obovate, flattened, 2(–3)-ribbed, the surfaces smooth or papillate, glabrate or usually pubescent with duplex hairs with glochidiate, bifurcate, or entire apices (achenes winged and fringed-ciliate in *Dichaetophora*); pappus 1-seriate, of barbellate bristles or a low crown of setae/bristles and scales (2-awned in *Dichaetophora*). Base chromosome number, x = 9 (or x = 3, 4, and 5 in *Astranthium*; x = 3 in *Dichaetophora*). Genera included: *Astranthium* Nutt., *Dichaetophora* A. Gray, *Geissolepis* B.L. Rob., *Townsendia* Hook. Distribution mostly in western North America north of Mexico (*Townsendia*), Mexico and south-central USA (*Astranthium*), Texas and adjacent Mexico (*Dichaetophora*), and east-central Mexico (*Geissolepis*).

This is the "*Townsendia* group," earlier placed in subtribe Brachyscominae (Nesom 1994a) and as "Incertae sedis" (Nesom 2000). *Aphanostephus* DC. also was earlier included in the *Townsendia* group (by Nesom and various others), but molecular data from several sources (Morgan 1990; Lane et al. 1996; Noyes and Rieseberg 1999; Noyes 2000) consistently indicate that *Aphanostephus* arose from within the Conyzinae. *Astranthium*, *Dichaetophora*, and *Townsendia* comprise a monophyletic group essentially sister to the Conyzinae and Chrysopsidinae in the Noyes and Rieseberg analysis. *Geissolepis* is phyletically interposed between the *Townsendia* group and these two related subtribes, but a set of morphological features places it closer to the *Townsendia* group than the Conyzinae or Chrysopsidinae, and the genus can reasonably be included in the Astranthiinae. Alternately, it presumably would be treated as a monophyletic subtribe.

Geissolepis is similar to the Astranthiinae "core" genera in its solitary heads, white, straight ray corollas, conical receptacles, and glochidiate cypselar vestiture. It is distinct within the subtribe in its combination of a prostrate habit with creeping, fibrous-rooted, lignescent stolons, succulent leaves, resin canals on the phyllaries, cypselae, and disc corollas, paleate receptacles, ray corollas without an abaxial midstripe, gradually ampliate disc corollas, subterete cypselae with 8 resinous ribs, and pappus of short scales with uncinate-ciliate margins. The chromosome number has been reported as 2n = 16 (Ralston et al. 1989) and 2n = 18 (Lane and Li 1993).

Boltoniinae Nesom, subtr. nov. Type genus: *Boltonia* L'Hérit.

Herbae vel subfrutices perennes rhizomatosae caulibus ac foliis persistente viridi-glabratis. Folia admodum omnino caulina. Capitula solitaria vel laxe aggregata; phyllaria herbacea, ad apicem rotundata vel obtusa nervis ternis aurantiaci-resinosis. Corollae radii albae vel leniter caerulescentes, circinnatae. Appendices collectentes deltatae ramorum styli florum disci. Numerus basicus chromosomatum, x = 9.

Perennial, herbs or subshrubs (*Chloracantha*), rhizomatous, with persistently green-glabrate stems and leaves, thorny in *Chloracantha*. Leaves essentially all cauline, entire or few-toothed. Heads solitary or very loosely corymboid to paniculate; phyllaries primarily herbaceous, apically rounded to obtuse, with three orange-resinous nerves. Ray corollas white to slightly bluish, coiling. Disc corollas orange-veined; style branches with deltate collecting appendages. Cypselae terete and multinerved or flattened, 2-nerved, and winged (*Boltonia*). Base chromosome number, x = 9. Genera included: *Batopilasia* Nesom & Noyes, *Boltonia* L'Hérit., *Chloracantha* Nesom, Suh, Morgan, Sundberg, & Simpson. Distribution in northwestern Mexico (*Batopilasia*), eastern USA (*Boltonia*), and Mexico and the southwestern USA to Louisiana (*Chloracantha*).

Batopilasia, *Boltonia*, and *Chloracantha* apparently are closely related among themselves (summary of ideas and evidence in Nesom & Noyes 2000). *Batopilasia* and *Boltonia* are sister genera in the Noyes and Rieseberg analysis, the pair in a sister relationship to the Symphyotrichinae and Machaerantherinae. *Chloracantha* was not included in this molecular analysis but is morphologically similar to *Batopilasia*, as observed in the original description of the species (Sundberg & Nesom 1990).

Boltonia is set apart from the other two genera by its conical or convex receptacles, short-tubed disc corollas, and flattened, 2-nerved, orange-veined, often winged cypselae with an abbreviated pappus. These specializations prompted the observation that "*Boltonia* is morphologically isolated in the New World" (Nesom 1994b, p. 163), but molecular evidence has found its close relatives. It is related neither to Old World Asterinae (Nesom 1994b) nor to genera of the *Townsendia* group (Bremer 1994).

With the formal recognition of the four subtribes above, six North American genera of Astereae remain without a clear hypothesis of subtribal affinity. These are among the "'primitive' Asters" (Nesom 2000), placed by Nesom (1994a, 1994b) mostly in subtribes Asterinae or Symphyotrichinae: *Doellingeria* Nees, *Eucephalus* Nutt., *Ionactis* Greene, *Oclemena* Greene, *Oreostemma* Greene, and *Tonestus* A. Nelson.

Note on Homochrominae.—My interpretation (Nesom 1994a) of subtribe Homochrominae of Bentham & Hooker as invalid was incorrect. This name was validly published—it was provided with a description and it can be assumed to have been based on a legitimate genus name (*Homochroma* DC.) included by Bentham and Hooker among those genera they placed in the subtribe. Homochrominae presumably formed the nomenclaturally "sister" taxon to the illegitimate Heterochrominae Bentham & Hooker (this name not based on an included genus), but a reasonable lectotypification for Homochrominae already has been effected by Solbrig (1963), who specified the type.

Homochrominae Bentham & Hooker, Gen. Pl. 2:174. 1873. Lectotype: (Solbrig 1963): *Homochroma* DC. (= *Zyrphelis* Cass.).

With this typification, Homochrominae becomes a synonym of Bellieae DC. ex Godr. (in Gren. & Godr., Fl. France 2:83, 104. 1850; type, *Bellium* L.) along with Feliciinae Nesom (Phytologia 76:205. 1994; type, *Felicia* Cass.).

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STYLOGYNE AGUARUNANA (MYRSINACEAE) A NEW SPECIES FROM AMAZONAS, PERU

John J. Pipoly III

Fairchild Tropical Garden Research Center
11935 Old Cutler Road, Miami, FL., 33156-4299, U.S.A.
jpipoly@fairchildgarden.org; clusia@latinmail.com

Jon M. Ricketson

Missouri Botanical Garden
P.O. Box 299, St. Louis MO 63166-0299, U.S.A.
jon.ricketson@mobot.org

ABSTRACT

Preparation of our treatment of the family Myrsinaceae for the florula of the "Río Cenepa" region resulted in the discovery of a heretofore undescribed species in the genus *Stylogyne*. *Stylogyne aguarunana* Pipoly & Ricketson is described, illustrated, mapped and its phylogenetic relations are discussed.

RESUMEN

Estudios para preparar un tratamiento taxonómico de la Myrsinaceae para la flórula de la región "Río Cenepa" resultaron en el descubrimiento de una nueva especie perteneciente al género *Stylogyne*. *Stylogyne aguarunana* Pipoly & Ricketson se describe, se ilustre, se mapea y se discute su parentezco.

INTRODUCTION

The neotropical genus *Stylogyne* A. DC. comprises approximately 60–70 species, a number of which remain undescribed, owing to lack of adequate material. Understanding the systematic biology of this genus has long been problematic because of its sexual liability. Androdioecious, bisexual, polygamo-dioecious and dioecious species of *Stylogyne* have been documented (Pipoly 1989, 1991), as well as the consequent morphological variation due to sex expression. Since no comprehensive study of the genus *Stylogyne* has occurred since C. Mez's treatment in Engler's Das Pflanzenreich (1902), the genus is in need of additional study. Our current studies continue in the genus *Stylogyne* (Pipoly & Ricketson 1999; Ricketson & Pipoly 1997), as well as the entire family for our treatment of the Myrsinaceae for *Flora Neotropica*.

During preparation of a manuscript for the Florula of the Río Cenepa Drainage Basin Project of the Missouri Botanical Garden, a new species was found and is described herewith.

Stylogyne aguarunana Pipoly & Ricketson, sp. nov. **(Fig. 1)**. Type. **PERU**. Amazonas: Prov. Bagua; Distrito Imaza, NW Region of Río Marañón; Comunidad Yamayakat, 04° 55' S, 078° 19' W, 320 m, 5 Aug 1994 (pist. fl.), *N. Jaramillo, A. Peña, R. Apanu & S. Katip 296* (HOLOTYPE: MO; ISOTYPES: CPUN n.v., F, FTG).

Quoad inflorescentiam racemosam bractea floricina numerosa *S. brancteolatam* valde arcte affinis sed ab ea habito arbreo (non fruteo), ramulis crassis (non tenuis), laminis subsessilibus (non longipetiolatis), 32–39 (nec 9.5–18) cm longisque praeclare distat.

Tree or small tree 4–8 m tall, to 5.7 cm in diam. *Branchlets* ca. 10 mm in diam., terete, the bark yellowish-brown, longitudinally ridged, glabrous, hollow, densely lenticellate. *Leaves* pseudoverticillate; *blades* chartaceous, oblong to oblanceolate, 32–39 cm long, 5.5–13.4 cm wide, apically acute to obtuse, basally tapering gradually to petiole base, the midrib channel prominently raised above, decurrent on the petiole/stem junction, the midrib prominently raised below, the secondary veins numerous, brochidodromous, prominulous above and below, smooth above, densely and conspicuously red punctate below, the hydropotes scattered, bright orange below, the margin flat, entire; leaf base and petiole, when distinguishable, deeply canaliculate, obsolete to 10 mm long, the petiole margin often abruptly tapered at petiole apex to almost appear auriculate, deeply canaliculate and marginate, glabrous. *Staminate inflorescence and flowers* unknown. *Pistillate inflorescence* lateral, a condensed raceme, 3–10 mm long; floral bract girdling peduncle, chartaceous, elliptic, 2.7–3 mm long, 1.3–1.5 mm wide, apically acute, densely and prominently orange punctate and punctate-lineate, the margin irregular, somewhat erose apically otherwise entire; pedicel cylindrical, 2.5–3 mm long. *Pistillate flower* 5-merous, white; calyx carnose, membranaceous, 2.5–2.7 mm long, the tube ca. 0.2 mm long, the lobes nearly free, ovate, 2.3–2.5 mm long, 1.5–1.7 mm wide, apically obtuse, with one or two orange punctations medially, glabrous, the margin hyaline, entire; corolla membranaceous, 3.8–4.2 mm long, the tube 2–2.2 mm long, the lobes connate basally, ovate to lanceolate, 1.8–2.2 mm long, 1–1.2 mm wide near the base, apically acute, conspicuously orange punctate and punctate-lineate, glabrous, the margins entire, hyaline; stamens 3.7–4.3 mm long, the filaments 2.8–3.2 mm long, filamentous, free, epunctate, glabrous, the anthers free, narrowly ovate to lanceolate, 1.2–1.3 mm long, 0.5–0.6 mm wide at the base, apically emarginate, basally cordate, longitudinally dehiscent by slits, the connective conspicuously punctate; pistil obturbinate, 3–3.3 mm long, 1.3–1.5 mm in diam, glabrous, the ovary 1.5–1.7 mm long, the style 1.3–1.5 mm long, the stigma punctiform, the placenta cotyliform, with 4 open chambers above, the ovules 4, exposed. *Fruit* globose, 5–6.2 mm long, 5–6.2 mm diam., apically truncate, red at maturity, densely and prominently pellucid lineate-punctate, the exocarp thin.

Distribution.—*Stylogyne aguarunana* is known only from Imaza District, Bagua Province, Amazonas, Peru, in the Río Marañón Drainage Basin around the Comunidad Yamayakat (Fig. 2), from 300–480 m.

Ecology and conservation status.—*Stylogyne aguarunana* is know from only four collections and is thus considered rare. It occurs in primary transitional forests at the junction of the lowland with the premontane forests on sandstone-derived soils.

Etymology.—We dedicate this species to the Aguaruna people who inhabit the area.

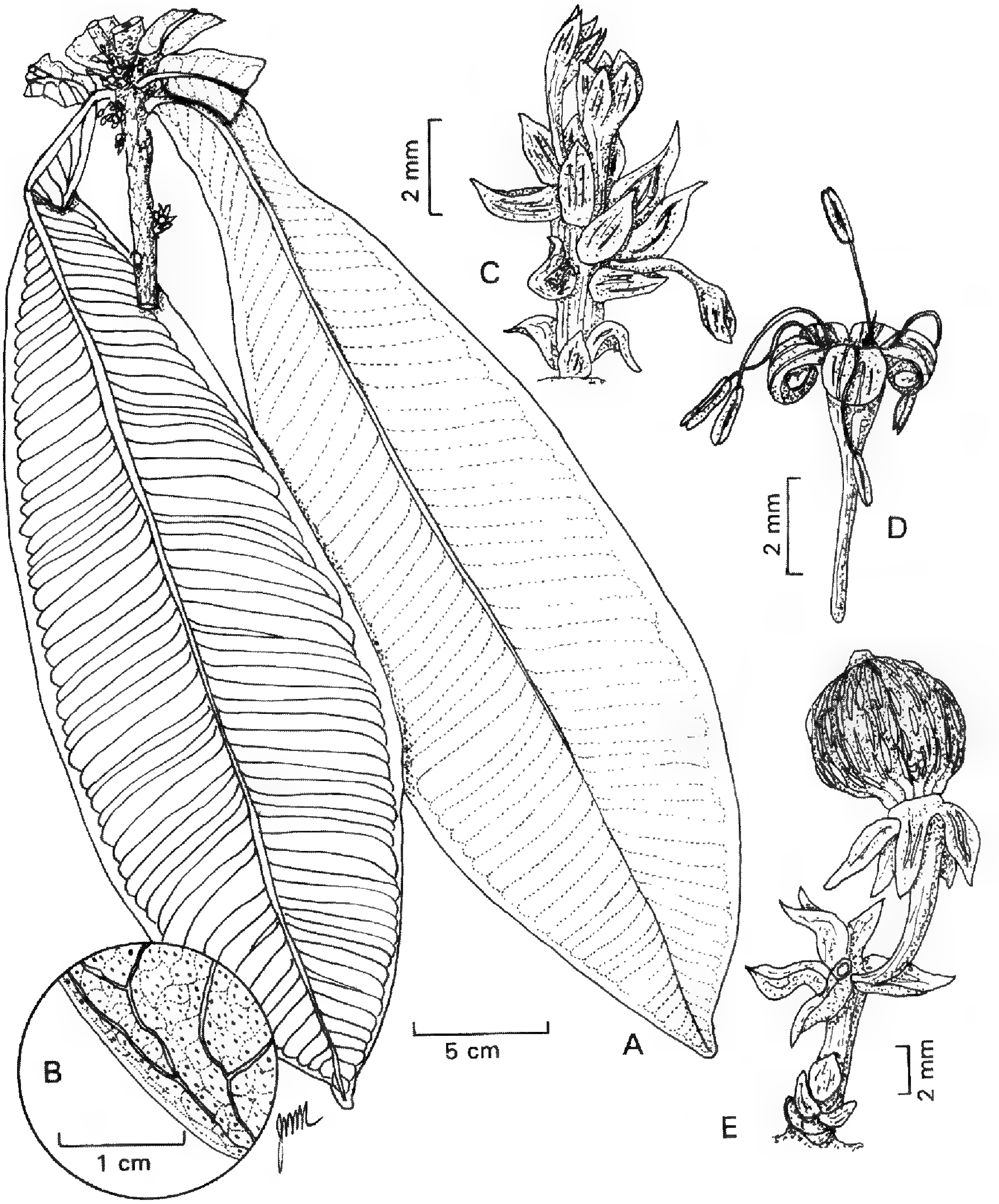

Fig. 1. ***Stylogyne aguarunana*** **Pipoly & Ricketson. A. Flowering branch. B. Detail of abaxial leaf surface. C. Detail of pistillate inflorescence. D. Detail of pistillate flower. E. Fruit and fruiting inflorescence. A–D drawn from holotype,** ***N. Jaramillo et al. 296*** **(MO). E drawn from** ***C. Diaz et al. 7895*** **(MO).**

Paratypes. **PERU. Amazonas**: Prov. Bagua, Distrito Imaza, Comunidad Aguaruna Yamayakat, camino hacia Temashnum, bordes de la quebrada, 300–480 m, 17 Ago 1996 (fr), *C. Díaz et al. 7895* (CPUN n.v., FTG, MO); Prov. Bagua, Distrito Imaza, Comunidad Aguaruna de Putuim, arriba Río Shimutaz, 04° 55' S, 078° 19' W, 480 m, 20 Jun 1996 (young bud), *E. Rodríguez et al. 1167* (CPUN n.v., FTG, MO); Prov. Bagua, Distrito Imaza, Yamayakat, 05° 03' 20"S, 078° 20' 23"W, 380 m, 6 Nov 1996 (ster.), *R. Vasquez et al. 21594* (CPUN n.v., MO).

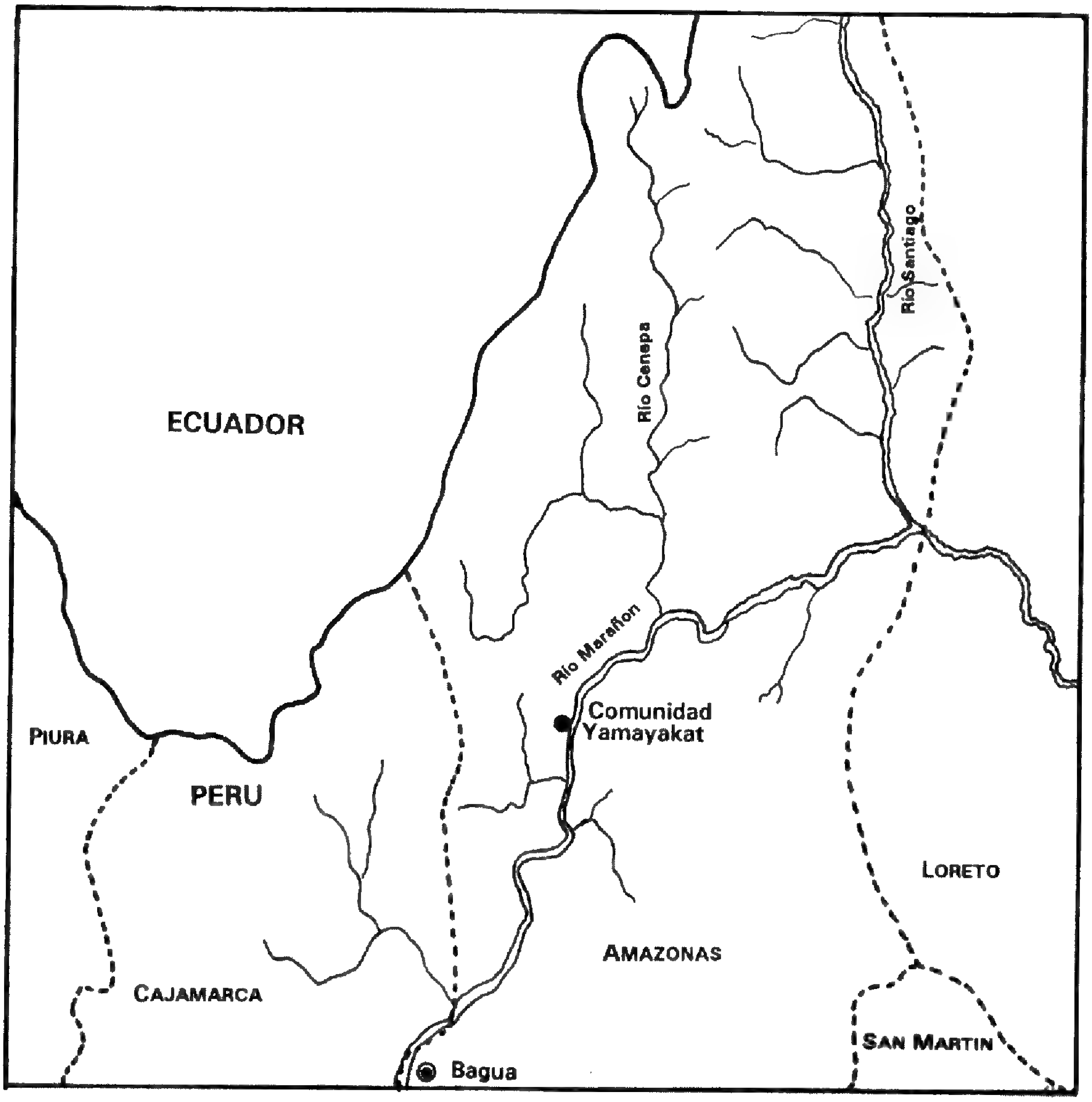

Fig. 2. Distribution of *Stylogyne aguarunana* Pipoly & Ricketson (•), in the area around the Comunidad Yamayakat, near the Río Marañón, in the Department of Amazonas, Peru.

The long leaf blades, that are nearly sessile and pseudoverticillate, clearly distinguish *Stylogyne aguarunana* from all other members of the genus. The multibracteate inflorescence rachis is similar to those of *Stylogyne bracteolata*, but can be easily distinguished from that species by its smaller or obsolete petioles, and 5-merous flowers. *Stylogyne aguarunana* belongs to a group of taxa with 5-merous flowers and anthers and antherodes on long spindly filaments, generally 3 or more times longer than the anthers.

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BOOK REVIEW

Karsten H.K. Wodrich. 1997. **Growing South African Indigenous Orchids.** (ISBN 90-5410-650-6, hbk.). Rotterdam (in USA: A.A. Balkema Publishers, Old Post Road, Brookfield, VT 05036-9704, U.S.A (Fax 802-276-3837, e-mail info@ashgate.com, http://www.balkema.nl) $85.00 hbk., 253 pp., 94 color and 109 b&w photos and drawings.

This beautifully illustrated volume is a self-contained monograph on how to grow South African orchids, from summarizing the habitats in which the orchids are found to providing plans for setting up a tissue culture lab at home. Although, the focus is on species native South Africa, much of the general discussion can be applied to the culture of any orchids. Early in the book, the discussion moves from general aspects of growing orchids to the various habitats and climates in South Africa. Next is a general discussion of design of culture space around one's home, orchid physiology and nutrient requirements, and orchid pests and diseases. The next chapter looks at the three major growth forms of orchids and the horticultural requirements common to each. Within the treatment of the respective growth habits, each genus and species is broken out for specific instruction on natural occurrence and horticultural needs. Most species are illustrated with a color photograph of its inflorescence or individual flower. There are sections on orchid breeding and propagation using culture media both with and without fungal symbionts. Step-by-step photos and recipes guide the novice through sterile culture methods using only kitchen equipment and a pH meter. An appendix even includes designs for building one's own sterile seeding box and a laminar-flow hood. The author does not forget conservation issues and includes copies of conservation legislation. The book is so complete and well-designed that I found only one negative point: the inks contain a volatile compound that has the odor of overly ripe guavas. This book is a must-buy for orchid enthusiasts everywhere and would make a worthwhile addition to any horticulturist's library.—*Roger W. Sanders, Associate Collections Manager, Botanical Research Institute of Texas.*

DISCOVERY OF *ARDISIA* SUBGENUS *ACRARDISIA* (MYRSINACEAE) IN MESOAMERICA: ANOTHER BOREOTROPICAL ELEMENT?

John J. Pipoly III

Fairchild Tropical Garden
11935 Old Cutler Road, Coral Gables (Miami) FL 33156-4299, U.S.A.
jpipoly@fairchildgarden.org; clusia@latinmail.com

Jon M. Ricketson

Missouri Botanical Garden
P.O. Box 299, St. Louis MO 63166-0299, U.S.A.
jon.ricketson@mobot.org

ABSTRACT

Ardisia rarescens, native to the border area of SE Chiapas, Mexico and SW Guatemala, was studied in preparation for a treatment of Myrsinaceae for the *Flora Mesoamericana* project. Its dextrorsely imbricate petals, extremely short free apical portions of the filaments, anthers whose wide longitudinal slit from each theca meet apically to form a subcontinuous opening at anthesis, short and broadly conical flower buds, and relatively numerous ovules on the rather thick placenta, precluded its placement in any known neotropical subgenus of *Ardisia*. Curiously, the aforementioned features comprise the diagnostic character states unique to the Indo-Malesian *Ardisia* subgenera *Acrardisia* and *Stylardisia*. Because subgenus *Stylardisia* is defined by its protogynous flowers (the style piercing the bud apex long before the bud opens), *Ardisia rarescens* can be excluded from that group and therefore placed in subgenus *Acrardisia* Mez. We suggest that *Ardisia rarescens* is a member of *Ardisia* subgenus *Acrardisia* and that this represents another species whose distribution may be attributable to the logical extension of the Boreotropics Hypothesis, previously explained in our work on the discovery of the genus *Hymenandra* in Mesoamerica. *Ardisia rarescens* is described, newly illustrated, its distributions, phylogenetic relationships, ecology and conservation status, are discussed.

RESUMEN

Ardisia rarescens fue estudiada para el tratamiento taxonómico de la familia Myrsinaceae para la Flora Mesoamericana. Sus pétalos dextrorsamente imbricados, porciones apicales libres de los filamentos que son muy cortas, anteras con dehiscencia comprendida por hendiduras longitudinales anchas y contínuas en el ápice, botones corto- y anchamente cónicos en perfíl, y óvulos relativamente numerosos y insertados en una placenta gruesa, se combinaron para indicar que no fue posíble ubicar ésta especie dentro de un subgénero previamente conocido en el neotrópico. Sin embargo, los caracteres susodichos comprenden los que se define el género *Ardisia* subgéneros *Acrardisia*, y *Stylardisia*, ambos provenientes de la región Indo-Malesia. Debido al hecho de que se define el subgénero *Stylardisia* por sus flores protóginas, y que *Ardisia rarescens* no tiene esa cualidad, ubicamos la especie dentro del subgénero *Acrardisia*. Surgerimos que *Ardisia rarescens* es otro elemento, tanto como el género *Hymenandra* previamente reportado, cuya distribución se atribuya a la extensión lógica de la Hipótesis Boreotropical. Se describe, se ilustra y se discute su distribución, parentezco, ecología y estatus en cuanto a la conservación se refiere.

SIDA 19(2): 275 – 283. 2000

INTRODUCTION

The pantropical genus *Ardisia* Sw. is by far the largest in the family Myrsinaceae, containing perhaps as many as 500 species (Chen & Pipoly 1996). Its circumscription has been problematic owing to a lack of comprehensive treatment since that of Mez (1902) in Engler's Pflanzenreich, almost a century ago. While reviewing the status of *Ardisia rarescens* Standl., we observed the combination of: dextrorsely imbricate petals, extremely short free apical portions of the filaments; anthers whose longitudinal slits from each theca meet apically to form a subcontinuous opening at anthesis; short, broadly conical buds, and relatively numerous ovules on the rather thick (thicker than long) placenta, all characteristics of *Ardisia* subgenus *Acrardisia* Mez. With subgenus *Acrardisia*'s distribution from Sri Lanka eastward through Malaysia and Indonesia to the Philippines and New Guinea, it is strikingly similar to that of *Hymenandra* (A. DC.) A. DC. ex Spach, a group that we suspect is of boreotropical origin (Pipoly and Ricketson 1999). A distribution such as this, most closely fits those groups cited as partial evidence to support what Wendt (1993) discovered in his study of lowland Mexican wet forests, and what Lavin and Luckow (1993) attributed to the Boreotropics Hypothesis, proposed by Wolfe (1975) and Tiffney (1985a, b) to explain the distribution of the "boreotropical flora." The hypothesis proposes that the biotas of North America and Europe, including tropical North America, were once more widespread in the northern hemisphere and transgressed the North Atlantic by direct land connections or over limited water gaps until the late Eocene or early Oligocene (Lavin & Luckow 1993). A logical extension to Wolfe's and Tiffney's concept, presented by Wendt (1993) and Lavin and Luckow (1993) is that the boreotropical flora not only existed in the Eocene, but also left a significant number of direct descendant lines in present lowland tropical floras of northern Latin America. Therefore, we would expect that many of the early Tertiary fossil taxa from both North America and Europe were most closely related to extant species from tropical southeast Asia, and to some extent, Central America and the Greater Antilles (Lavin & Luckow 1993). It is the latter notion that is congruent with the Amphipacific distributional pattern like that found in our new concept of *Ardisia* subg. *Acrardisia*. This extension to the boreotropics hypothesis was cited by Wendt (1988, 1989, 1993), in discussing the relationships of *Chiangiodendron* (Flacourtiaceae), and by Zona (1990) in discussing the biogeography of *Sabal* (Arecaceae). A similar distribution for the genus *Alstonia* (Apocynaceae) was cited by Gentry (1983), but he did not invoke the hypothesis *per se*. Conran (1995), in his study of the Liliiflorae, found that three taxa defining the Southeast Asian/northern Australasian clade (Stemonaceae, Hanguanaceae and Uvulariaceae) were widespread northern taxa that have spread southwards.

The geographic distribution of subgenus *Acrardisia* is entirely consistent with the area cladogram presented by Lavin and Luckow (1993, Fig. 1), where Central and South American elements are ultimately derived from among diverse North American lineages, these lineages having a sister group relationship to paleotropical groups. While Wolfe's

(1975) hypothesis could be correct even if no modern descendants of the boreotropical flora were found in the Neotropics owing to extinction, the three criteria proposed by Lavin and Luckow (1993) to test the hypothesis were: 1) a center of diversity in North America (including "tropical North America" as they define it), 2) an early Tertiary fossil record in North America, and 3) a pantropical distribution.

For the first test criterion, "North America" includes both tropical and temperate elements, the tropical ones south of the Tropic of Cancer. In the case of subgenus *Acrardisia* it is clear that only one species is presently known, but until we have tested hypotheses of phylogenetic relationship among other related *Ardisia* species, in particular the group described by Lundell as *Ibarrea*, and containing the rather common species *Ardisia paschalis* Donn. Sm., we cannot be sure. Subgenus *Acrardisia* itself may be paraphyletic, because the only characteristics separating it from the extremely closely related subgenus *Stylardisia* Mez are that it does not have a stigma that perforates the flower bud and is receptive before the flower opens (thus protogynous), and that its ovules are pluri- rather than uniseriate. A group even partially defined by the lack of a structure can be problematic because it is not clear if protogynous flowers have occurred more than once within the genus *Ardisia* as a whole.

Unfortunately, no data is available for use in the second test criterion owing to lack of fossils known for the group. As for the last criterion, a pantropical distribution, the closest related group, *Ardisia* subgenus *Stylardisia*, is concentrated in Borneo, but occurs from northern India and Bangladesh through Indochina, eastward through Malesia as far as Sulawesi, with no neotropical members known at this time. However, the entire genus *Ardisia* is truly pantropical, as is the tribe Ardisieae. Until a phylogenetic analysis is complete for the tribe, a rigorous test cannot be performed. Despite the absence of a cladogram, the pattern of distribution among the genera of the tribe Ardisieae fit the general pattern one would expect if the distribution was boreotropical.

In summary, we hypothesize that *Ardisia* subgenus *Acrardisia* appears to fit the overall pattern consistent with a boreotropical distribution. We must emphasize that until a phylogenetic analysis among the subgenera of the genus *Ardisia*, and more importantly, among the genera of Myrsinaceae is complete, there is no reliable way to unequivocally determine if the group is boreotropical or Gondwanan. However, at this point in our work, we find it useful to point out the strong correlation and call attention to the value of examining generic limits on a worldwide basis when preparing treatments for a large flora such as *Flora Mesoamericana*.

Ardisia rarescens is known only from 27 herbarium specimens, and apparently is restricted to the eastern slope of the Sierra Madre de Chiapas, from central-southernmost Chiapas, Mexico, along the slope and into northern San Marcos and Quetzaltenango Departments, Guatemala. This region, including the famous Volcán Tacaná, houses many endemics and a myriad of taxa with boreotropical affinities, particularly in the pine-oak and *Liquidambar* forests in the region.

NOTES ON DESCRIPTION AND TERMINOLOGY

Quantitative and qualitative data in the description for floral parts and bracts were taken from organs rehydrated from herbarium specimens by boiling in water. Measurements from these range from 10% to 15% greater than those measurements taken directly from dried material. Data regarding stem diameters, inflorescence rachises, pedicels, leaf and fruit shape and size were taken from dried herbarium specimens.

Morphological terms in this treatment follow Lindley (1848) and Pipoly (1987, 1992) for the inflorescence, rachis pedicels and floral parts. Description of leaf morphology follows Hickey (1984), trichome description follows Theobald et al. (1984) and basic cell and tissue terminology follow Metcalfe (1984).

TAXONOMIC TREATMENT

Ardisia Swartz subgenus **Acrardisia** Mez, Pflanzenr. IV. 236(Heft 9):116. 1902.

Subshrubs to small trees. Branchlets glandular-papillate, glandular-hirtellous, ferrugineous tomentose or rarely, glabrous. Leaf blades mostly entire or obscurely crenulate, but never regularly serrate. Inflorescence terminal, subtended by a foliaceous bract, the branches corymbose to umbellate or rarely racemose in fruit. Flowers 5-merous; buds short and broadly conical; sepals and petals dextrorsely imbricate; stamens with extremely short apical portions of the filaments, anthers dehiscent by wide, apically confluent longitudinal slits; pistils not protogynous, the ovules numerous, pluriseriate.

Distribution.—Approximately 35 species, throughout Indo-Malesia, with one disjunct at the border of Mexico and Guatemala.

Ecology.—Premontane to montane humid to wet forest, often on calcareous or sandstone-derived soils, 500–2400 m elevation.

Ardisia rarescens Standl. **(Fig. 1)**, Publ. Field Columbian Mus., Bot. Ser. 4:248. 1929. *Amatlania rarescens* (Standl.) Lundell, Wrightia 7:40. 1982. Type. MEXICO. Chiapas: Cerro del Boquerón, without elevation, Sep 1913 (fl) *C.A. Purpus 7032* (holotype: F, F neg. no. 68247; isotypes: BM, GH, MO, NY, US).

Shrub to small trees 3–12 m tall. *Branchlets* slender, terete, 2–5 mm in diam, densely glandular-papillate, glabrescent. *Leaves* loosely pseudoverticillate; *blades* chartaceous, elliptic to slightly oblanceolate, 3.5–16.2 cm long, 1.1–5.3 cm wide, apically acuminate, the acumen 0.5–1.4 mm long, basally acute to cuneate, decurrent on the petiole, midrib impressed above, prominently raised below, the secondary veins 15–27 pairs, slightly raised above and below, prominently black punctate and conspicuously punctate-lineate, glabrescent above and below, the margins entire, revolute; petioles slender, canaliculate, 3.5–10.2 mm long, glabrescent above and below. *Inflorescence* terminal, erect, bipinnately or tripinnately paniculate, 6–22.5 cm long, 5.5–20 cm wide, pyramidal, usually longer than the leaves, densely, erect glandular-papillate, the branches terminally congested into 7–12-flowered corymbs; peduncles 0.3–2.2 cm long; inflorescence bract unknown; inflorescence branch bracts foliaceous, chartaceous, ovate to oblong, 2.3–3.7 cm long,

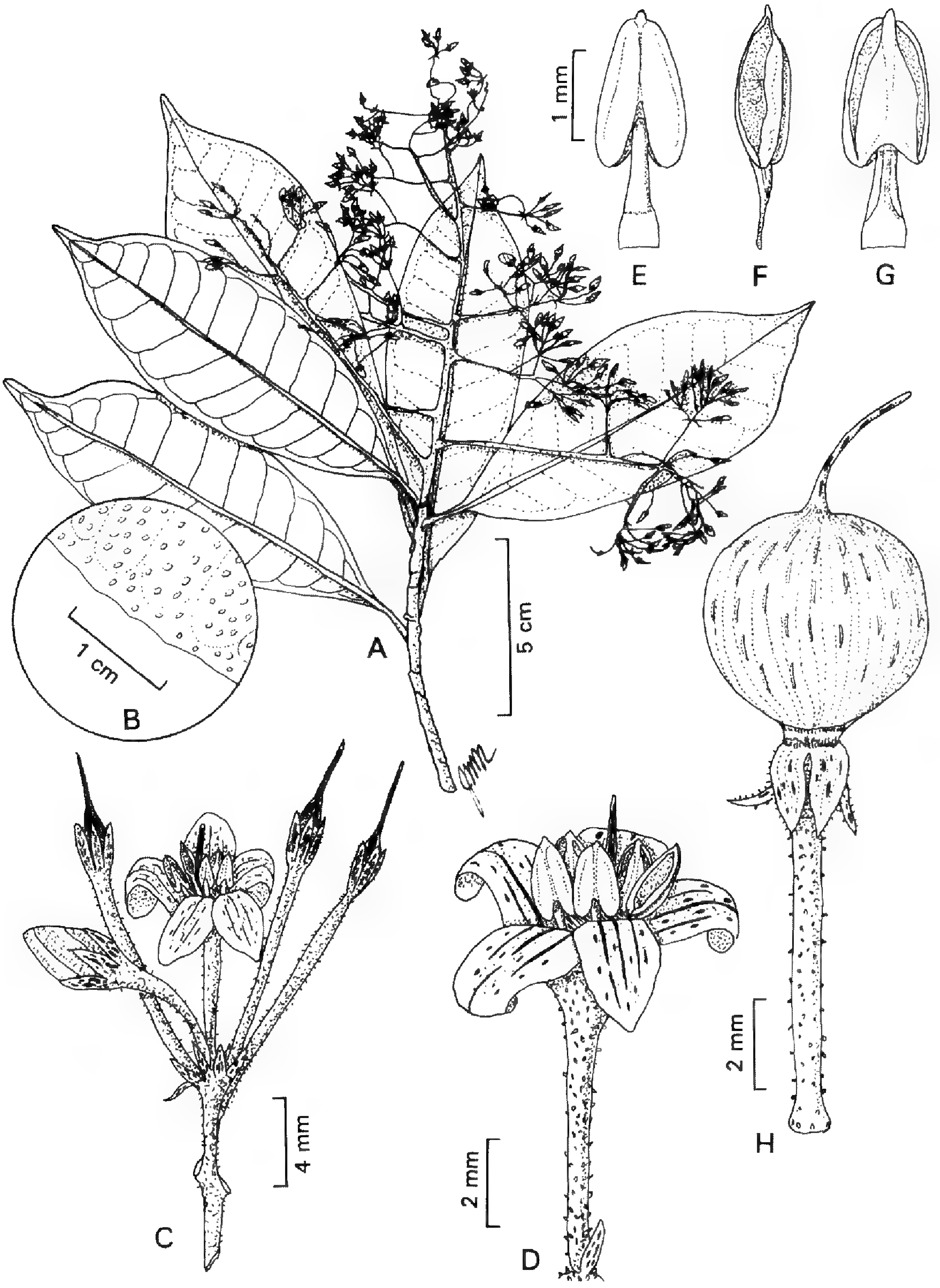

Fig. 1. *Ardisia rarescens* Standl. A. Flowering branch. B. Detail of abaxial leaf surface. C. Detail of inflorescence. D. Detail of flower. E. Detail of stamen, showing adaxial surface. F. Detail of stamen, showing lateral margin. G. Detail of stamen, showing abaxial surface. H. Fruit. A–B drawn from isotype, *C. Purpus 7032* (BM). C–G drawn from isotype, *C. Purpus 7032* (GH). H drawn from *L. Williams et al. 26002* (F).

1.3–1.9 cm wide, apically acute, early caducous; secondary branches similar to the peduncles, but 0.9–2.2 cm long; floral bracts persistent, membranaceous, ovate to oblong, 0.7–1.8 mm long, 0.3–0.7 mm wide, apically acute, the midrib inconspicuous, the secondary veins obscure, densely and prominently punctate and punctate-lineate, glabrous above, sparsely erect glandular papillate below, the margins entire, hyaline, sparsely glandular-ciliate; pedicels slender, terete, 6.7–10.3 mm long, inconspicuously punctate and punctate-lineate, densely, erect glandular papillate. *Flowers* 5-merous, membranaceous, pink to reddish-violet; calyx 1.6–1.8 mm long, the tube 0.3–0.5 mm long, the lobes ovate to lanceolate, 1.1–1.5 mm long, 0.6–0.8 mm wide near the base, asymmetric, apically acute to rounded, prominently punctate and punctate-lineate, glabrous within, tomentum of scattered, erect glandular papillae, the margins entire, minutely erose, hyaline, sparsely glandular-ciliolate; corolla 5–5.3 mm long, the tube 0.9–1.1 mm long, the lobes connate basally, ovate to lanceolate, 3.9–4.4 mm long, 2.5–2.8 mm wide near the base, apically acute to rounded, prominently punctate and punctate-lineate, glabrous throughout, the margins entire; stamens 3.1–3.3 mm long; the filaments 1.9–2.1 mm long, apically free, 0.3–1.7 mm long, connate basally into an elobate tube, 0.4–0.6 mm long, free from the corolla tube, epunctate, glabrous, the anthers free, ovate, 1.4–1.7 mm long, 0.8–0.9 mm wide near the base, apically apiculate, basally sagittate, dehiscent by wide, apically continuous longitudinal slits, the connective epunctate; pistil obturbinate, 4–4.2 mm long, glabrous; ovary 0.9–1.1 mm long, the style 2.9–3.3 mm long, slender, erect, inconspicuously punctate; stigma punctiform; ovules 11–15, pluriseriate. *Fruit* globose, 5–6.4 mm in diam., conspicuously and prominently punctate, the style base persistent.

Distribution.—*Ardisia rarescens* is restricted to the extreme SE corner of Chiapas in the Sierra Madre Mountains, and in the adjacent area in the Departments of San Marcos and Quetzaltenango in Guatemala, growing at 1,300–2,400 m elevation.

Ecology and conservation status.—*Ardisia rarescens* occurs in montane rain forest and cloud forests. Because of its restricted distribution, it should be considered threatened.

Etymology.—The specific epithet comes from the combination "rare" meaning far apart, sparsely and "-escens" to indicate a process of becoming without full attainment reached, referring to the sparse tomentum.

Common Name.—"Cereza morada" (*J. Steyermark 33656*).

Specimens examined. **MEXICO. CHIAPAS:** Mpio. Motozintla de Mendoza, 45–50 km NE of Huixtla along road to Motozintla, 1,900 m, 17 Nov 1971 (fr), *D. Breedlove & A. Smith 22592* (LL, MO); 28 Dec 1972 (fr), *D. Breedlove & R. Thorn 31017* (LL, MO); Municipio of Motozintla de Mendoza, SW side of Cerro Mozotal, 11 km NW of the junction of the road to Motozintla along the road to El Porvenir and Siltepec, 2,100 m, 21 Nov 1976 (fr), *D. Breedlove 41608* (MO); 23 Nov 1981 (fr), *D. Breedlove & B. Bartholomew 55740* (LL, NY); Municipio of Motozintla de Mendoza, between El Rosario and Ojo de Aqua along road to Niquivil, 1,770 m, 10 Jun 1988 (fl), *D. Breedlove 69114* (CAS); Above El Rosario, 8 mi S of Motozintla, 1,800 m, 10 Jul 1977 (fl), *T. Croat 40740* (LL, MO); Mt. Ovando, without elev., 24 Dic 1936 (fr), *E. Matuda 0680* (US); Mt. Pasitar, without elev., 3–4 Aug 1937 (fl), *E. Matuda 1641* (LL); 4 Aug 1937 (fl), *E. Matuda S-206* (A, K, LL, MO, NY, US); Mt. Ovando, 2,100 m, 14–18 Nov 1939 (fl), *E. Matuda 3942* (A, NY); Mt. Ovando, Escuintla, without elev., 1–16 Jul 1940 (fl), *E. Matuda 4180* (A, GH, LL, MO, NY); Saxchanal, Sierra Madre, 2,700 m, 1 Jul 1941 (fl), *E. Matuda 4306* (A, F, LL, MO, NY); Carlas, near

Motozintla, 2,176 m, Apr 1945 (fl), *E. Matuda 5511* (LL 2-sheets, TEX); San Juan Panama, Escuintla, 1,834 m, 23 Jul 1948 (fl), *E. Matuda 18148* (F); Along the dirt road to Siltepec, past Ejido Benito Juarez, ca. 12 km from the turnoff from Mexican highway 190, S of Motozintla, 15° 20' N, 92° 15' W, 2,100 m, 9 May 1987 (fl), *J. Miller & J. Myers 2778* (BRIT, F, MEXU, MO); Tapachula, Finca Chinincé, 1,500 m, 17 Aug 1961 (fl, fr), *H. Schwabe s.n.* (B 2-sheets); Municipio of Motozintla de Mendoza, track from Ejido Boquerón to Cerro Boquerón, 15°?15' N, 92° 17' W, 2,400 m, 9 Feb 1990 (fr), *P. Stafford et al. 347* (BM, MO); Municipio of Motozintla, Buenos Aires, 1,900 m, 31 Jul 1986 (fl), *E. Ventura y E. López 3985* (MO). **GUATEMALA. Quezaltenango:** Volcán Zunil, 6,100 ft [1,859 m], 5 Aug 1934 (fl), *A. Skutch 948* (F, NY); Lower S-facing slopes of Volcán Santa María, between Santa María de Jesús and Calahuaché, along great barranco between Finca Pirineos and San Juan Patzulín, 1,300–1,500 m, 6 Jan 1940 (fr), *J. Steyermark 33656* (F, LL). **San Marcos:** 6 mi SW of town of Tajumulco, NW slope of Volcán Tajumulco, along Río Malacate, 2,300–2,800 m, 26 Feb 1940 (ster.), *J. Steyermark 36666* (F); Above Finca El Porvenir, between "Todos Santos Chiquitos" and "Loma de la Paloma:, S-facing slopes of Volcán Tajumulco, 1,400–1,700 m, 8 Mar 1940 (ster.), *J. Steyermark 37283* (F, LL); 1,300–1,500 m, 16 Mar 1940 (ster.), *J. Steyermark 37981* (F, LL); Near Aldea Fraternidad, between San Rafael Pie de la Cuesta and Palo Gordo, W-facing slope of the Sierra Madre Mountains, 1,800–2,400 m, 10–18 Dec 1963 (fr), *L. Williams et al. 26002* (F); (fl, fr), *26004* (F 2-sheets); (fr), *26101* (NY); Outer slopes of Tajumulco Volcano, Sierra Madre Mountains about 8–10 km W of San Marcos, ca. 2,300 m, 31 Dec 1964–1 Jan 1965 (fr), *L. Williams et al. 26799A* (US).

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BOOK REVIEW

Virginia Scott Jenkins. 2000. **Bananas. An American History.** (ISBN 1-56098-966-1, pbk.). Smithsonian Institute Press, 470 L'Enfant Plaza Suite 7100, Washington, DC 20560-0950, U.S.A. $16.95 pbk., 232 pp., 36 b&w photos.

From the author of 1994's *The Lawn: A History of an American Obsession* comes a book about American culture, politics, and trade as related to all things, the banana. From its days of an exotic fruit for the riches (late 1800's), to its days of being cheap food for the poor, to its modern day ubiquity and subsequent absorption into American culture and everyday life, the banana has been a dynamic part of the last century of American history.

From the introduction, " ...the twentieth century was to see a phenomenal growth in the banana-importing industry with the rise of giant multinational corporations. Bananas became the cheapest fruit in the grocery store throughout the year and taken for granted by consumers. The banana lost its exotic image and disappeared from the formal dinner table as it became the most widely eaten fruit in the United States." Not to indicate that this book is about the rise of the banana and its fall to mediocrity, however, this book is entertaining reading about the history of a staple fruit in the American diet.

In eight chapters, Jenkins covers everything you ever wanted to know about bananas. The first chapter covers the introduction of the banana to America in the nineteenth century. The second chapter traces the development of the major American banana-importing companies. Chapter 3 discusses the growth of modern transportation systems that helped put the banana in more homes nationwide. Chapter 4 is about the marketing and selling of bananas. Chapter five looks at public health and sanitation issues in relation to the popularization of the banana. Chapter 6, "Eating Bananas," discusses everything from the nineteenth century consumption of bananas on special occasions to the twentieth century banana split. The seventh chapter is devoted to two American cities, Fulton, Kentucky, and South Fulton, Tennessee, the banana capitals of the world- thanks, of course, to a connection in Central America. The final chapter looks at how bananas have become rooted in American life despite the fact that they have never been a selection of the fruit of the month club. Closing the book is an appendix of songs about bananas, notes, and an index.

Highlights of the book include accounts of the history of import trading of bananas with Central American countries and integration of this exotic fruit as a staple of an American diet. Bananas came from Jamaica, Honduras, various parts of Latin America and the Hawaiian islands and due to its versatility and nutritional value became a part of the American diet. Corporations that paid for advertisements and teaching items discussing the nutritional importance of the banana, its germ free packaging, and importantly its taste, no doubt had a small part to play in the popularization of the fruit. Marketed to children (read: future buyers) and the elderly, bananas became a necessity, and mostly, a part of breakfasts and desserts.

This book is intended for lay readers and it would be safe to presume that's where you will find the bulk of the readership. While it is extensively researched, it doesn't carry with it the sociocultural insight and interpretation of Sidney Mintz's *Tasting Food, Tasting Freedom: Excursions into Eating, Culture and the Past* or his works on sugar and the Caribbean. It could work in classes of American history, political science, and anthropology due to it being both short and inexpensive, but only in conjunction with other more scientific books. In summary, it is enjoyable reading and anyone interested in American culture, international trade and politics and, of course, bananas will be interested.—*Kevin D. Janni, Botanical Research Institute of Texas, kjanni@brit.org.*

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SENECIO QUAYLEI (ASTERACEAE: SENECIONEAE), A NEW SPECIES FROM NORTH CENTRAL TEXAS, U.S.A

Theodore M. Barkley

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, TX 76102-4060, U.S.A.
barkley@brit.org

ABSTRACT

Senecio quaylei, a new species from Texas, U.S.A., is described.

RESUMEN

Se describe *Senecio quaylei*, una especie nueva de Texas, U.S.A.

Jeffrey Quayle, an astute amateur naturalist in north central Texas, recently submitted an unusual *Senecio* to BRIT for determination. It was presumed that the plant was simply a recent or otherwise unrecorded introduction, but a survey of the literature and several herbaria, plus the opinions of several colleagues, suggested no possible matches, so it is offered here as a new species, *Senecio quaylei*.

The only known occurrence of the plant is a conspicuous colony of about 15 individuals, growing waist high in a weedy roadside ditch, along with *Cirsium, Geranium, Sonchus, Verbena,* and much dead vegetation from the previous year. The new species vaguely resembles *Senecio ampullaceus* Hook., a Texas endemic of disturbed open sites in the central part of the state, however, *S. quaylei* is glabrous and notably coarse, to 12 dm tall, while *S. ampullaceus* is conspicuously hairy but unevenly glabrate in age and typically only 3–7 dm tall. In addition, the new species has large, broad, and clasping cauline leaves. These characteristics combine to give the new species a distinctive gross aspect. Four of the plants were collected to make the specimens needed for documentation, and they were divided into eleven herbarium sheets.

Structurally, the stems are hefty, with the proximal third some 10–15 mm in diameter, but they are hollow and thin-walled. There is a conspicuous purplish-red layer in the sub-epidermal region of freshly cut proximal stems; the red color fades as the specimen dries. The leaves have unevenly scattered light-brownish spots that are caused by a species of *Coleosporium*, a heteroecious rust, *fide* Dr. Joe Hennen, a mycologist at BRIT and an authority on rust fungi.

The biology of *S. quaylei* is unknown and only suggested from inference. It appears to be an annual, with a short, narrow taproot and a tuft of abundant, thin, fibrous roots that are weakly branching. The most mature ovaries in the specimens collected are wrinkled and unfilled, indicating that they are sterile. The pollen is of uneven size and

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shape, suggesting that it is of reduced or doubtful viability. The chromosome number is undetermined.

The resemblance of *Senecio quaylei* to *Senecio ampullaceus* and other typical senecios (Barkley 1999) in both structure and aspect clearly places the new species in *Senecio* s. str.; rigorous quantitative analyses are yet to be done. It is possible that additional data from cytology, pollen morphology, and comparative biochemisty, may suggest that the new species is allied to *Packera*, but that notion seems remote. *Senecio quaylei* is of poor fit in the keys to Senecio in the treatment in the North American Flora (Barkley 1978), for there the possession of leaves that are progressively reduced upwards carries it to the *Senecio integerrimus* assemblage, a group with unbranched fleshy-fibrous roots and of very different gross aspect. If the initial couplet of the key is ignored, it falls into the Annui group, along with *Senecio ampullaceus.*

Recognition of *Senecio quaylei* generates speculation on its significance in the flora. The possibility that it is merely an exotic waif cannot be discounted, but neither can it be said that it is not a rare member of the regional flora. This notion is compatible with the review by Ertter (2000) on the occurrences and recognition of distinctive species of limited occurrence in North America.

Senecio quaylei T.M. Barkley, sp. nov. (**Figs. 1, 2**). Type: U.S.A. TEXAS. Parker Co.: waste ground adjacent to Lake Mineral Wells State Trailway (an abandoned railroad right-of-way), at Holder Chapel Road intersection, ca. 2 mi N of Hwy 180, E of Mineral Wells, 32° 45' N, 98° 02'W, 29 Apr 2000, *T.M. Barkley 4882, M. Barkley, R.J. O'Kennon, & W. Garrett* (holotype: BRIT; isotypes: BRIT, MO, NY, TEX, UC).

A *Senecioni ampullaceo* similis sed differt altitudine ampliore (7–12 dm vs. 3–7 dm) et foliis caulinis glabris amplectentibus ovati-lanceolatis folia basalia amplitudine fere aequans.

Annual, 8–12 dm tall, glabrous throughout or with a few inconspicuous hairs on the peduncles and phyllaries. *Stems* single, striate, the proximal third 10–15 mm in diameter, narrower distally, hollow, with a conspicuous reddish subepidermal layer when freshly cut; arising from a short, thin taproot surrounded by abundant, thin and sparingly branched fibrous roots. *Basal and proximal cauline leaves* with blades ovate, mostly 12–24 cm long and 8–12 cm wide, margins wavy, with a few scattered minute denticles, midvein prominent and lateral veins less conspicuous in dried specimens, tapering or gently contracted to a distinct petiole, ca. 2/3 the length of the blade. *Middle cauline leaves* with blades nearly as large as the basal leaves, ovate to broadly lanceolate, sessile and clasping. *Distal cauline leaves* lanceolate to linear-lanceolate, 6–14 cm long, sessile, the distal most further reduced and bractlike. *Capitulescences* terminal or arising from the axils of the upper leaves; fundamentally corymbiform cymes of 20–40 capitula, or a close cluster of corymbiform cymules. *Involucres* cylindrical or turbinate to weakly campanulate, each subtended by a weakly defined calyculus of 2–7 linear bracteoles, 1–3 mm long, margins hairy. *Phyllaries* mostly 13, ± 8 mm long, green with hyaline margins, abaxial surfaces with short hairs distally, the apex with a minute tuft of hyaline hairs. *Corollas* yellow. *Ray florets* mostly 8, pistillate; corollas ca. 11 mm long, tubes 4 mm and

Fig. 1. *Senecio quaylei*. A. habit, B. capitulum, C. disk floret, D. ray floret, E. achene (immature). Drawn from type material by Linny Heagy.

Fig. 2. *Senecio quaylei*. Habitat from type locality. Photograph by Bob O'Kennon.

laminae ca. 7 mm long, 2.5 mm wide. *Disk florets* 20–40, bisexual; corollas 7(–10) mm long, tube and limb (including lobes) of about equal length, corolla lobes triangular, ± 0.5 mm long. *Cypselae* not seen, oldest ovaries wrinkled, empty, 1–3 mm long, pubescent throughout. *Pappus* of abundant white, minutely barbellate bristles in a single series, 6–7 mm long. *Chromosome number* unknown.

Etymology.—The specific epithet *quaylei* commemorates Jeffrey Quayle, the discoverer of the new species.

Distribution.—Endemic to Texas. There are no known collections other than the type collection.

KEY TO SPECIES OF *SENECIO* S. STR. IN NORTH CENTRAL TEXAS

This key covers the range of the recently published Illustrated Flora of North Central Texas (Diggs et al. 1999)

1. Capitula discoid; ray florets rarely present and then with laminae of corollas less than 1 mm long; phyllaries and calyculate bracts with prominent triangular black tips; leaves shallowly pinnate. Introduced weeds. ______ **1. S. vulgaris**
1. Capitula radiate; laminae of ray corollas 7–15 mm long; phyllaries and calyculate bracts green or gray-green tipped; leaves shallowly toothed to subentire. Native or apparently so.
    2. Herbage woolly-pubescent, or at most unevenly glabrate in age; middle cauline leaves lanceolate and rarely more than 10 cm long, shallowly clasping; stems 3–7(+) dm tall. ______ **S. ampullaceus**
    2. Herbage glabrous or nearly so, middle cauline leaves ovate or broadly lanceolate, 10–20 cm long, prominently clasping; stems mostly 8–12 dm tall. ______ **S. quaylei**

ACKNOWLEDGMENTS

It is a pleasure to acknowledge the assistance of Joe Hennen, Barney Lipscomb, Guy Nesom, Robert O'Kennon, John Pruski, Peter Raven, John Strother, Debra Trock, and others who offered advice on the nature of this plant. Guy Nesom kindly translated the Latin diagnosis and Linny Heagy prepared the illustration.

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BOOK REVIEW

JUDITH SUMNER. 2000. **The Natural History of Medicinal Plants.** (ISBN 0-88192-483-0, hbk.). Timber Press. Inc., The Haseltine Building, 133 S.W. Second Avenue. Suite 450. Portland, OR 97204-3527, U.S.A. (503-227-2878, 503-227-3070 fax; www.timberpress.com). $24.95 hbk. 235 pp. Line drawings, 30 color plates.

Despite the modest title, *The Natural History of Medicinal Plants,* is much more than just a historical account of the uses of plant medicine. The author, Judith Sumner of the Arnold Arboretum, covers that and in doing so reviews everything from medicinal chemistry to zoopharmacognosy. Though not necessarily designed as such, this book is an excellent overview of the contemporary issues concerning medicinal plants. Complete with a foreword by the ubiquitous Mark Plotkin and being just over 200 pages, this book snould attract a wide readership and deservingly so. The writing within bares all the wisdom of a historian, botanist, and enthusiast of a subject whose time has come. Indeed, westerners are experiencing a renaissance of interest in medicinal plants and their potential to treat modern diseases. And new drugs aren't the only concern; conservation of global biodiversity is an increasingly salient issue for academic and lay readers. While I refer to the title as being modest, the author's goal to, "...connect the human concerns of botanical medicines and ethnobotany with the role of medicinal plants and their secondary compounds in nature" is anything but and she admirably succeeds.

The book is laid out in ten chapters: **1)** A Brief History of Medicinal Botany, **2)** Acquiring Knowledge, **3)** Medicinal Plants in Nature, **4)** Toxins and Cures: A Cabinet of Plant Chemicals, **5)** Defensive Strategies and Plant Chemistry, **6)** Significant Discoveries, **7)** Zoopharmacognosy and Botanical Toxins, **8)** Chemical Prospecting and New Plant Medicines, **9)** Protecting Medicinal Biodiversity and Knowledge, **10)** Herbal Histories, Considerations, and Caveats. A brief- 1/2a page- glossary, three pages of further reading and an index follow these chapters. Throughout the book Sumner covers plant medicines in prehistory, medicinal chemistry, herbarium collections, healing gardens, dispersal and naturalization of medicinal plants, alkaloids, curare plants, coca, chimpanzees and self-medication, cancer drugs from plants, and tropical conservation- just to name a few.

Strong points are in chapters four through six in which the author covers plant compounds, chemical evolution, and significant discoveries in the field. Chapters eight and nine are of interest to the budding ethnobotanists among us, as Sumner discusses new plant drugs, future prospects, ownership of medicinal plants and traditional knowledge, and conservation. But, Sumner does more than just cover big-ticket issues of ethnobotany; this is a history book after all. Chapter's one, three, and ten are exceptionally written historical discussions of plant medicines, their discovery and uses. It is perhaps the author's skillful writing that makes this book so valuable. While written for a lay audience, this book is sure to hold the attention and interest of any scholar. The breadth of academia covered in this relatively small book is remarkable and for twenty-five dollars, a bargain.

Simply put, *anyone* interested in medicinal plants, ethnobotany, history, anthropology and conservation should have this book on their shelves. The book is not only accessible to a large academic audience, but also lay readers of a wide variety of interests. The potential readership alone is enough to say that it is only a matter of time before this book becomes a classic. *The Natural History of Medicinal Plants* is well suited for college level classes covering Medical Anthropology, Ethnobotany, and Medical Botany, as an introduction to a field with a myriad of contemporary concerns.—*Kevin D. Janni, Botanical Research Institute of Texas, kjanni@brit.org.*

SOLIDAGO VILLOSICARPA (ASTERACEAE: ASTEREAE), A RARE NEW SOUTHEASTERN COASTAL PLAIN ENDEMIC

R.J. LeBlond

North Carolina Natural Heritage Program
Coastal Plain Office
P.O. Box 787
Richlands, NC 28574, U.S.A.

ABSTRACT

Solidago villosicarpa, sp. nov., is described from the outer coastal plain of southeastern North Carolina, where collections have been made from four counties. Although it apparently is extant in only two of these four counties, its habitat and evident adaptation to disturbance suggest that the new species may be more frequent along the Carolina coast than is currently known. *Solidago villosicarpa* is placed as a member of sect. and subsect. *Solidago* and is distinctive in its combination of pubescent stems, glabrous to glabrate leaves, thyrsoid inflorescence, large heads with bright lemon-yellow rays, densely villous achenes, and late flowering.

RESUMEN

Se decribe*Solidago villosicarpa*, sp. nov., de la llanura costera externa del sudeste de Carolina del Norte, donde se han hecho colecciones en cuatro condados. Aunque aparentemente existe en sólo dos de estos cuatro condados, su hábitat y evidente adaptación a las perturbaciones sugieren que la nueva especie puede ser más frecuente a lo largo de la costa de Carolina de lo que se conoce actualmente. *Solidago villosicarpa* se coloca como un miembro de la sect. y subsect. *Solidago* y es distintiva su combinación de tallos pubescentes, hojas glabras o glabrescentes, inflorescencia tirsoide, capítulos grandes con lígulas amarillo limón, aquenios densamente villosos y floración tardia.

INTRODUCTION

Early collections of a distinctive goldenrod species were made from "live-oak scrub" on a barrier island in Brunswick County, North Carolina, in 1949 and 1950. Specimens from the 1950 collection were annotated as *S. sciaphila* Steele (Fox et al. 1952), a plant otherwise known only from sandstone and calcareous habitats in the Upper Mississippi River region (Minnesota, Wisconsin, Iowa, and Illinois). A subsequent collection of the North Carolina entity was made in 1963 from a sandy roadside in neighboring New Hanover County, N.C., and annotated as *S. erecta* Pursh (NCU). Three more populations were found 1991–1998 in Onslow County, N.C., during a natural area inventory of Camp Lejeune Marine Corps Base by the North Carolina Natural Heritage Program (NCNHP), and a population was found in Pender County in 1998 during another NCNHP inventory. Only the Onslow and Pender county populations are known to be extant.

The original collections of the North Carolina entity from 1949 and 1950 have a curious history. According to Fox et al. (1952) the 1950 collection (*Godfrey 50963 & Boyce*) was identified as *Solidago sciaphila* "by Dr. Arthur Cronquist and it was rechecked by him

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after several duplicate specimens were sent to him. Godfrey also checked specimens of the collection against material of the species at the Gray Herbarium, and he concurs with Dr. Cronquist in his determination. We are at a complete loss to account for the occurrence of this goldenrod so far from the hitherto known range of its distribution." The 1949 collection (*Godfrey 50132*) is not mentioned in the 1952 Rhodora article. A specimen from this collection was found in the folder for undetermined *Solidago* specimens at the N.C. State University herbarium (NCSC) during the current investigation. The label of this specimen (herbarium #19998) has a typed and penciled portion. The typed portion reads "*Solidago* ... In live oak scrub on the sand dunes, Long Beach." The penciled portion reads "sp. aff. *S. sciaphila* Steele, less closely aff. *S. glutinosa* sens. lat. May need a name. A.C. 3-22-50." "A.C." undoubtedly is Arthur Cronquist. These circumstances suggest that the 1949 collection had been forgotten by the time the 1950 collection was determined. Adding to the mystery, the three specimens from the 1950 collection at NCSC (herbarium #'s 26549, 26550, 34039) were annotated as *S. sciaphila* by H.E. Ahles, not Cronquist. Yet there is no mention of *S. sciaphila* occurring in the Carolinas in Radford et al. (1968) (Ahles was responsible for the treatment of Asteraceae), nor apparently in any other flora, treatment, or checklist since that time. No specimens from the 1949 and 1950 collections are known from other herbaria, including the New York Botanical Garden (Kallunki 1998), where Cronquist worked.

This distinctive, rare, and narrowly endemic North Carolina plant does indeed "need a name," and is here described as a new species.

Solidago villosicarpa LeBlond, sp. nov. (**Figs. 1–6**). Type: UNITED STATES. North Carolina. Onslow Co.: in pine-oak hickory forest with open hardwood understory, Camp Lejeune Marine Corps Base near Salliers Bay, about 0.6 mi W of Tactical Landing Zone Albatross, 13 Oct 2000, *R.J. LeBlond 5435 and B.A. Sorrie* (holotype: US; isotypes: BRIT, FLAS, FSU, GA, GH, MO, NCU, NY, USCH).

A congeneribus diversa caulibus pubescentibus, foliis glabris vel glabratis, inflorescentia thyrsoidea, capitulis grandibus corollis radii vivide citreis, acheniis dense villosis, et florescentia serotina.

Roots wiry, elongate; caudex stout. Stems usually solitary, occasionally loosely cespitose by short rhizomes, 4.5–15 dm long, 2.5–6 mm wide 2 cm above caudex, ribbed and grooved throughout, the ribs rounded to angled, some decurrent from leaf bases; pubescent with short stiff spreading or appressed trichomes 0.1–0.3 mm long, many uncinate; stem color medium brown to dark brownish purple below, and light brown, stramineous, or purple above. Basal leaf rosette present; basal and lower cauline leaves the largest, petiolate, toothed; larger blades 7–14 cm long (not including petiole) by 4–7 cm wide, elliptic, broadly elliptic, or elliptic-obovate, apices obtuse, subacute, or broadly acute; bases cuneate-attenuate, often somewhat abruptly narrowed; petioles 2–7 cm long; petiole base non-auriculate but sheathing the stem for 1/4–1/2 of its circumference; blade margins toothed, the sinuses 1–2.5 mm long from base of cavity to tip of tooth mucro, the mucros mostly 0.2–0.4 mm long, blunt; teeth margins ciliate-scabrous with recurved-ascending trichomes about 0.1–0.2 mm long; primary veins tending to

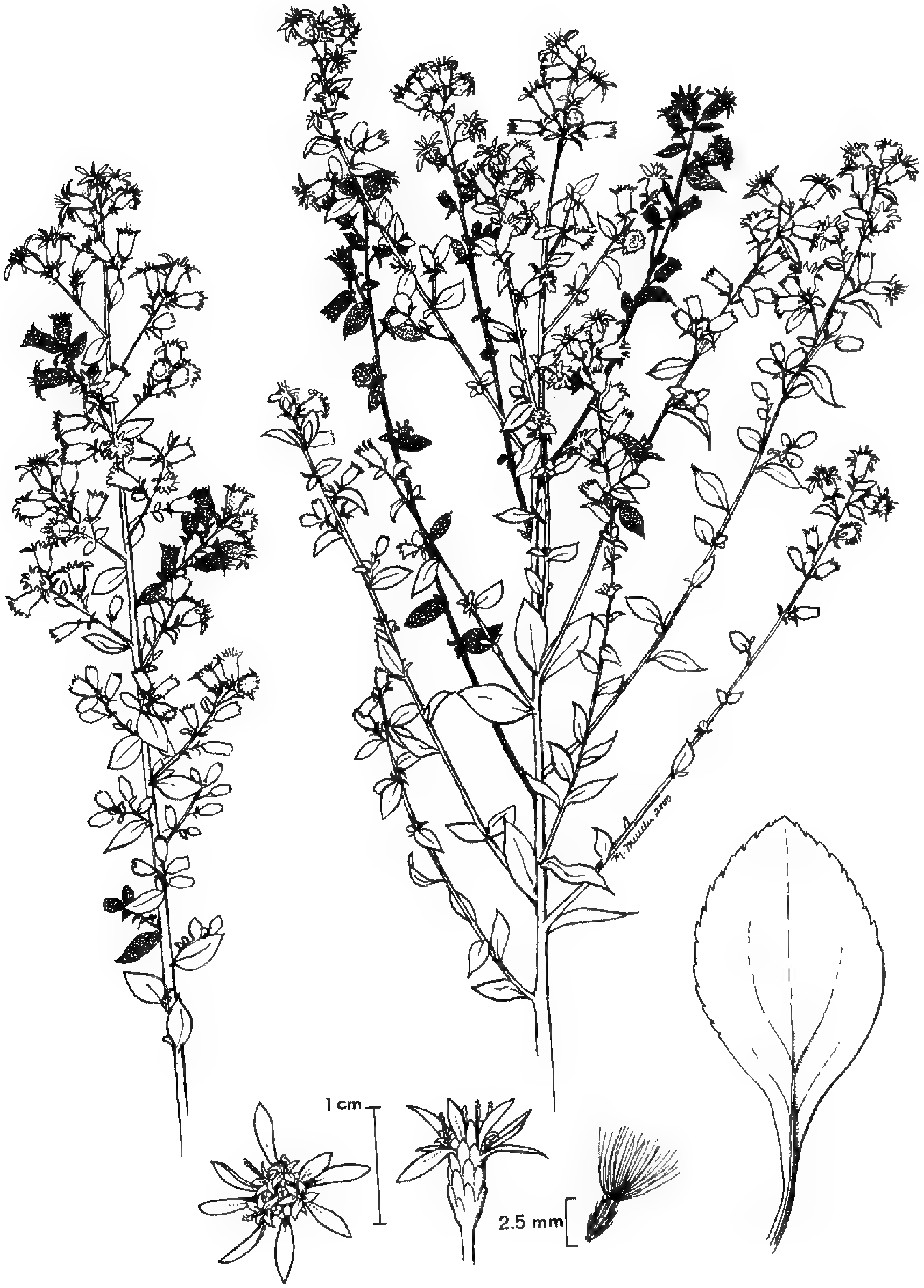
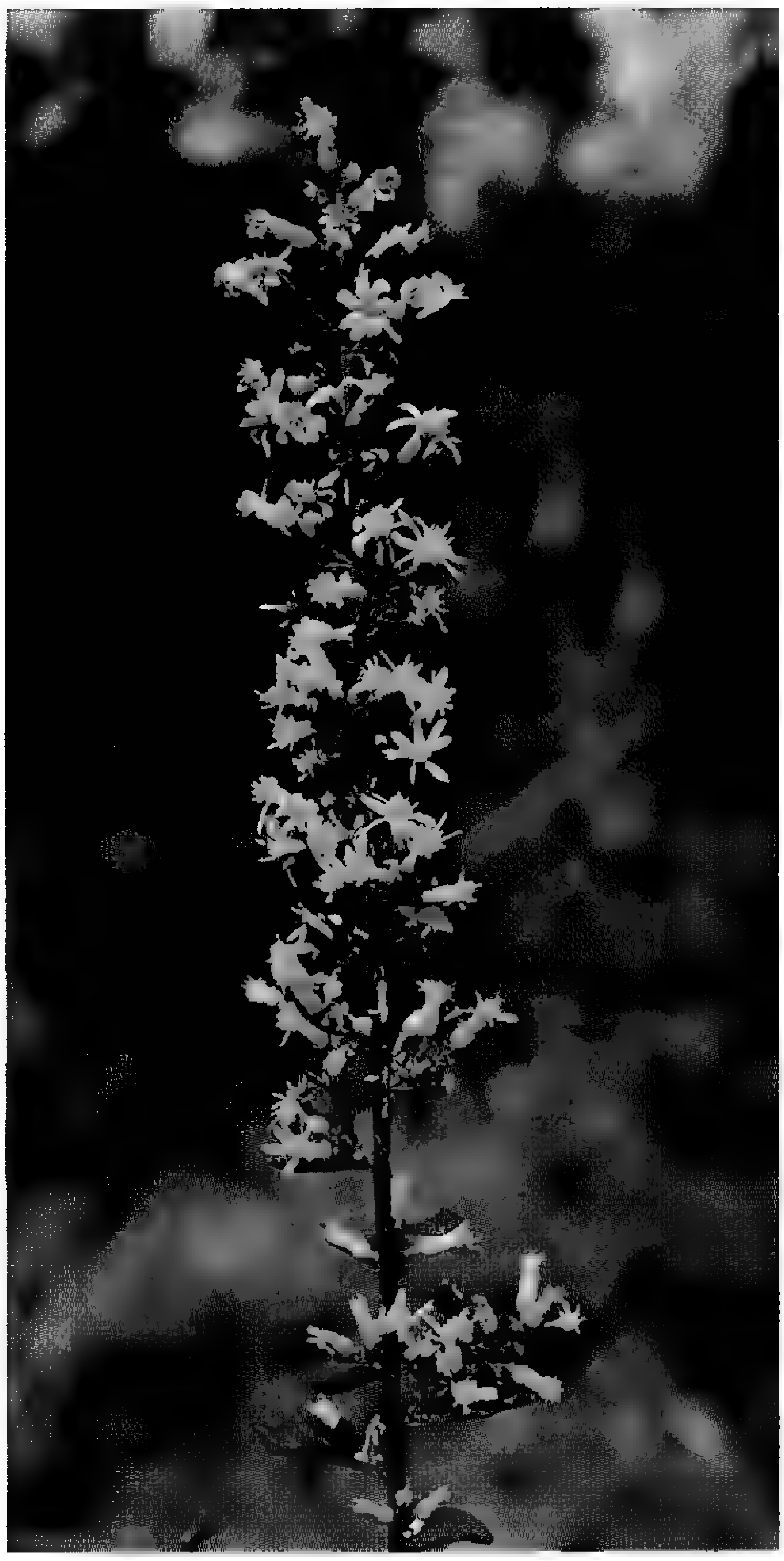


Fig. 1. *Solidago villosicarpa* LeBlond. A. Simple thyrsoid inflorescence. B. Paniculately branched thyrsoid inflorescence. C. Flower head at anthesis (top view). D. Flower head at anthesis (side view). E. Pappus and achene. F. Lower stem leaf. Drawn from type collection by Margret Mueller.

Fig. 2. *Solidago villosicarpa* LeBlond. Habitat showing example of paniculately branched thyrse.



Figs. 3–6. *Solidago villosicarpa* LeBlond. Fig. 3 (top left) simple elongate thyrse inflorescence form. Fig. 4 (top right) example of the paniculately branched thyrse. Fig. 5 (bottom left) close-up of the inflorescence. Fig. 6 (bottom right) a well-developed basal rosette.

be raised on both surfaces, the mid-nerve flattish and squarred at the edges, pale stramineous; ultimate nerves distinctly reticulate on both surfaces; adaxial surface glabrous to sparsely pubescent with short stiff trichomes mostly along the mid-nerve and larger veins; glabrous to glabrate abaxially; texture thin, papery, brittle when dried; color drab green to olive-green, the lower surface barely if at all lighter than the upper. Middle and upper cauline leaves gradually reduced upwards, sessile, becoming entire; cauline leaves 15–50 below inflorescence. Inflorescence a simple or paniculately branched thyrse; when simple (elongate terminal thyrse), the terminal axis bracteate, straight, narrow, and cylindric, 7–22 cm long by 3–6 cm wide; when paniculiform, producing straight, elongate, thyrsoid axillary branches up to 20 cm long; bracteal leaves at the base of the branches similar to the cauline leaves, gradually reduced in size upwards. Short secondary branches and peduncles moderately densely to densely invested with stiff, spreading and ascending, straight and recurved trichomes 0.1–0.4 mm long, which appear resinous and segmented; peduncles 0.5–9 mm long. Heads at anthesis 1.4–1.7 cm wide measured from ray tip to ray tip. Involucre 5–8 mm long by 3–5 mm wide at anthesis, the summit 6–8 mm wide at maturity. Phyllaries strongly imbricate, the outer shorter, ovate, somewhat cucullate, the inner broadly linear; outer phyllaries 1.0–2.0 mm wide, appressed; inner phyllaries 0.8–1.5 mm wide, with rounded to subacute apices becoming somewhat squarrose in age; all phyllaries with a narrow but distinct pale reddish-brown midrib; surface glabrous, glandular centrally and near the apex, greenish near the apex, cream-colored centrally and laterally, the margins hyaline, often lacerate, long-ciliate or ciliate-fimbriate (at least near the apex) with cilia 0.1–0.3 mm long. Ray florets 4–8 per head, limb *in vivo* 5–7.5 mm long, 1–2 mm wide, bright lemon-yellow. Disk florets 10–18 per head, the corolla lobes 1.5–2.2 mm long, the entire disk corolla 4.9–6.8 mm long; stigmatic lobes 0.9–1.1 mm long, anthers 2.1–2.2 mm long. Pappus (4.2–)4.7–6.1 mm long, occasionally some bristles clavate. Achenes villous with ascending hairs 0.3–0.5(–0.7) mm long, the achene body 2.6–2.9 mm long when mature.

Additional specimens examined: **NORTH CAROLINA. Brunswick Co.:** in live oak scrub on the sand dunes, Long Beach, 22 Oct 1949, *R.K. Godfrey 50132* (NCSC); in live-oak scrub thickets on sand dunes, Long Beach, 28 Oct 1950, *R.K. Godfrey 50963 and S.G. Boyce* (NCSC). **New Hanover Co.:** sandy roadside, Pembroke Jones Park, Wrightsville Sound, 29 Nov 1963, *A. McCrary 1813* (NCU). **Onslow Co.:** in pine-oak forest with open understory, Camp Lejeune Marine Corps Base near mouth of Frenchs Creek, 22 Oct 1991, *R.J. LeBlond 2622* (pers. herb.); same locality, 18 Oct 1992, *R.J. LeBlond 3127* (NCU); in pine forest with open understory, Camp Lejeune Marine Corps Base near Salliers Bay, 08 Oct 1995, *R.J. LeBlond 4440* (pers. herb.); same locality, 11 Oct 1998, *R.J. LeBlond 5074, A.S. Weakley, and K. Patterson* (RJL pers. herb.); same locality, 18 Oct 1998, *R.J. LeBlond 5082* (DUKE, NCSC, NCU); Camp Lejeune Marine Corps Base, SW of Mock-up Road, 0.9 mi SE of NC 172, 05 Nov 1998, *R.J. LeBlond 5124 and E. Davis* (NCU). **Pender Co.:** in pine-hardwood forest 0.65 mi WNW of Clarks Landing on Long Creek, 30 Sep 1998, *R.J. LeBlond 5051 and B.A. Sorrie* (NCU).

DISCUSSION

The most striking feature of *Solidago villosicarpa* is the width of the floral heads at anthesis, which measure 1.4–1.7 cm wide from ray tip to ray tip, and with ray limbs *in vivo* 5–7.5

mm long. The size combined with the bright lemon-yellow color of the ray limbs make this one of the showier goldenrods. The density of the achene pilosity completely obscures the body surface with hairs 0.3–0.5(–0.7) mm long. The combination of thyrsoid inflorescence, persistent and glabrous to glabrate basal leaves, upwardly reduced cauline leaves, and pubescent achenes place the new species in *Solidago* sect. *Solidago* subsect. *Solidago* in Nesom's 1993 overview of infrageneric goldenrod taxonomy. North American members of subsect. *Solidago* are *S. calcicola* (Fernald) Fernald, *S. glomerata* Michx., *S. multiradiata* Ait. (including =*S. cutleri* Fernald), *S. nana* A. Gray, *S. plumosa* Small, *S. sciaphila*, *S. simplex* Kunth, *S. spathulata* DC., and *S. spithamaea* M.A. Curtis. *Solidago villosicarpa* differs from other members of the subsection by a combination of stem pubescence, floral head width at anthesis, involucre length (5–8 mm), pappus length (4.2–6.1 mm), length of disk corolla and lobes (4.9–6.8 mm), and nature of achene pubescence (villous, the hairs 0.3–0.7 mm long). Also, it flowers late September to early November, one to two months later than the others. It superficially resembles *S. bicolor* L., *S. hispida* Muhl., and *S. squarrosa* Muhl., members of sect. *Solidago* subsect. *Albigula* in Nesom's treatment. It is readily distinguished from all three by its pubescent achenes, from *S. bicolor* and *S. hispida* by its glabrous (-glabrate) leaves, and from *S. squarrosa* by its appressed outer phyllaries.

The following key distinguishes southeastern U.S. *Solidago* taxa with thyrsoid inflorescences, basally disposed leaves conspicuously larger than middle and upper cauline leaves, and pubescent stems.

1. Inner phyllaries very narrow, <0.5-0.75 mm wide at mid-length, tapering to slender tip
    2. Stems and leaves finely pubescent with minute, stiffly spreading viscidulous hairs; ray florets mostly 9-16 ______ **S. puberula**
    2. Stems irregularly or decurrently short-hairy (-glabrous) below the inflorescence; leaves glabrous; ray florets mostly 6-9 ______ **S. roanensis**
1. Inner phyllaries broader, 0.75-1.5 mm wide at mid-length, the margins usually parallel and the tips blunt to broadly acute
    3. Leaves glabrous (-sparsely pubescent adaxially); involucre 5-8 mm long; ray florets 4-8; pappus (4.2-)4.7-6.1 mm long; achenes villous ______ **S. villosicarpa**
    3. Leaves pubescent on both surfaces; involucre 3-6 mm long; ray florets 7-14; pappus 2.5-4 mm long; achenes strigose-puberulent or glabrous
        4. Achenes strigose-puberulent; disk flowers 14-27; larger leaves 3.5-12 cm long; plants flowering in spring ______ **S. verna**
        4. Achenes glabrous (sometimes sparsely hairy when immature); disk flowers 7-16; larger leaves 8-20 cm long; plants flowering late summer-fall
            5. Ray limbs white (rarely yellow), often turning yellowish in drying; phyllaries whitish to stramineous, usually with a well-defined green tip ______ **S. bicolor**
            5. Ray limbs deep yellow to orange-yellow; phyllaries yellowish, the tip weakly or not at all greenish ______ **S. hispida** var. **hispida**

Although similar to *Solidago sciaphila* in overall habit, *S. villosicarpa* is distinguished by several characters, particularly within the inflorescence (Table 1). The stem of *S. villosicarpa* is pubescent throughout, while that of *S. sciaphila* is normally glabrous below the

TABLE 1. A comparison of floral characters used to distinguish *Solidago villosicarpa* from *S. sciaphila*.

Character	*Solidago villosicarpa*	*Solidago sciaphila*
Involucre length	5–8 mm	3–6 mm
Phyllary cilia length	0.1–0.3 mm	<0.05–0.1(–0.2) mm
Ray flower limb length	5–7.5 mm	2–4 mm
Disk corolla length (limb and lobes)	4.9–6.8 mm	3.2–4.9 mm
Disk corolla lobe length	1.5–2.2 mm	0.8–1.4 mm
Pappus length	(4.2–)4.7–6.1 mm	2.3–3.8 mm
Density of achene pubescence, length of hairs	villous, 0.3–0.5(–0.7) mm	sparsely to moderately hairy, 0.1–0.3 mm

inflorescence (Fernald 1950; Gleason 1952; Gleason & Cronquist 1991), though *S. sciaphila* occasionally can have sparsely to moderately pubescent stems (frequently so just below the inflorescence). The basal and lower leaves of *S. villosicarpa* tend to be sparsely pubescent to glabrous adaxially and glabrous abaxially, while those of *S. sciaphila* tend to be either glabrous on both surfaces or, less frequently, sparsely pubescent on both surfaces.

With so few collections and known populations, the ecology of *Solidago villosicarpa* is only partially understood. The 1949 and 1950 Brunswick County collections are from "live-oak scrub" or "live-oak scrub thickets" on the Long Beach coastal barrier island. This likely is either Maritime Evergreen Forest or Maritime Shrub (Schafale and Weakley 1990). Maritime Evergreen Forest typically has a canopy dominated by *Quercus virginiana*, usually with *Pinus taeda* and *Q. hemisphaerica*. Characteristic understory species include *Juniperus virginiana* var. *silicicola*, *Ilex vomitoria*, *Persea borbonia*, *P. palustris*, and *Osmanthus americana*. Wind-borne sand and salt spray often produce dense thickets along the ocean-facing side of such forests. In areas closer to the ocean or more exposed, the Maritime Shrub community forms. It is characterized by a dense growth of such shrubs as *Cerothamnus cerifera* (=*Myrica cerifera* var. *cerifera*), *Ilex vomitoria*, *Baccharis halimifolia*, and stunted *Juniperus virginiana* var. *silicicola* and *Quercus virginiana*.

The three *Solidago villosicarpa* sites in Camp Lejeune Marine Corps Base in Onslow County have been altered by past logging. Canopies at all three sites are dominated by pine (*Pinus taeda*), with hickory (*Carya glabra* var. *megacarpa* or *C. alba*) and/or oak (*Quercus falcata*, *Q. nigra*, and *Q. stellata* the most common). Frequent understory species are *Q. margarettiae*, *Liquidambar styraciflua*, and *Ilex opaca*. This composition suggests the Dry or Dry-Mesic Oak-Hickory Forest natural community of Schafale and Weakley (1990), perhaps transitional to Coastal Fringe Evergreen Forest (*ibid.*) at the site near Salliers Bay, where *Q. virginiana* is a subcanopy component. Two of the sites occur on excessively drained Wando fine sand entisol, and the third site occurs on well-drained Marvyn and Norfolk loamy fine sand ultisol.

The site in Pender County near Clarks Landing occurs on slopes above a drain; it also has been disturbed by past logging. Tree species include *Pinus taeda*, *Acer rubrum* var. *trilobum*, *Gordonia lasianthus*, *Quercus nigra*, and seedling *Pinus palustris*. Understory and shrub species include *Ilex opaca, Lyonia lucida,* and *Vaccinium arboreum.* This mix suggests a former longleaf pine community grading downslope to a pocosin streamhead, and likely influenced by proximity to tidal freshwater swamp 300 feet downstream (*S. villosicarpa* itself appears to be an indication of that influence).The upland soil at this site is classified as well-drained Baymeade fine sand ultisol.

Two of the four currently known sites—in Camp Lejeune near Salliers Bay and near Mock-up Road—are within one mile of the ocean, and each was impacted by the hurricanes of 1996 and 1998, with considerable canopy blow-down. Increased seedling establishment and reproductive maturation was observed in 1998, suggesting a positive response to the hurricane impacts. At the Salliers Bay site, 300–400 flowering individuals and 1000+ vegetative rosettes were estimated in 1998, compared with 50 flowering and 100 vegetative rosettes under a closed canopy in 1995. The Mock-up Road site, first discovered in 1998, had 500+ flowering/fruiting individuals. The other two sites are considerably inland, with the Frenchs Creek site in Camp Lejeune seven air miles from the coast and the Clarks Landing site in Pender County 16 air miles from the coast. Each site, however, is located on low uplands or upland slopes adjacent to fresh or slightly brackish tidal creeks or floodplains. Due to their more inland locations, these sites were much less impacted by the 1996 and 1998 hurricanes. Comparative population data are available only for the Frenchs Creek site: 25 flowering with 75 vegetative rosettes in 1998, and 40 flowering with 150–200 vegetative rosettes in 1992. Another observed habit of *Solidago villosicarpa* that may be associated with hurricane impacts is the tendency of plants in canopy openings to produce more robust inflorescences with paniculate thyrsoid branches, while plants in shaded areas tend to produce a simple elongate terminal thyrse.

These variable conditions and evident adaptation to disturbance suggest that *Solidago villosicarpa*, while likely restricted in range, may be more frequent along the Carolina coast than is currently known.

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STRUCTURE OF POPULATIONS OF OTATE (*OTATEA ACUMINATA* SUBSP. *AZTECORUM*: POACEAE) IN HARVESTED STANDS

Jose Martin Vazquez Lopez[1], Bruce F. Benz[1,2],
Miguel Olvera Vargas[1], Sergio Graf Montero[3]

[1]*Universidad de Guadalajara, Centro Universitario de la Costa Sur*
Departamento de Ecología y Recursos Naturales
Apdo. Postal No. 108, Autlan de Navarro
Jalisco, C.P. 48900 MEXICO

[2]*Department of Biology, Texas Wesleyan University*
1201 Wesleyan, Fort Worth, TX 76105, U.S.A.

[3]*Direccion de la Reserva de la Biosfera Sierra de Manantlan*
Secretaría del Medio Ambiente Recursos Naturales y Pesca
Autlan, Jalisco, 48900 MEXICO

ABSTRACT

We describe the structure of eight natural stands of otate (*Otatea acuminata* (Munro) Cald. & Sod. subsp. *aztecorum* Guzmán, Anaya & Santana) that are subject to traditional extraction. These populations are compared based on density, diameter and height using growth stage categories, site characteristics and history of management. The point quarter method was used to sample populations to obtain estimates of stem densities. Analysis of variance was conducted on stem categories and density to compare stands; all comparisons showed significant differences between stands. Results suggest that the population structure of otate is being modified by harvest intensity, which appears to be a function of accessibility of the stands by basket makers and their history of use. Results are described in relation to harvesting otate for craft production.

Key Words: Structure, otate, stem category, harvesting, artisan

RESUMEN

Se describe la estructura de ocho rodales naturales de otate (*Otatea acuminata* (Munro) Cald. & Sod. subsp. *aztecorum* Guzmán, Anaya y Santana) que están sujetos a extracción tradicional. Se comparan estas poblaciones de acuerdo a categorías de tallos, características del sitio e historial de manejo. Se utilizó el método punto cuadrante para estimar la densidad de tallos. Se hizo un análisis de varianza de la densidad y categorías de tallos para comparar los rodales entre sí; todas las comparaciones mostraron diferencias significativas en una o varias de las características evaluadas. Los resultados indican que la estructura de las poblaciones de otate está siendo modificada por la intensidad del aprovechamiento, el cual está determinado principalmente por la cercanía y accesibilidad de los rodales a los artesanos. Los resultados se discuten en relación al aprovechamiento para fines artesanales.

Palabras Clave: Estructura, otate, categoría de tallo, aprovechamiento, artesano

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INTRODUCTION

Numerous genera and species of the Bambusoideae play an important role in forests because they occupy a wide diversity of habitats and exhibit extremes of morphological diversity (Soderstrom & Calderon 1974). The genera of bamboos in Mexico include: *Otatea, Olmeca, Guadua, Chusquea* and *Olyra* (Judziewicz et al. 1999). The antiquity of Bambusoideae species' use in Mexico is not known with certainty though we suspect its most ancient inhabitants used them. The bamboo otate (*Otatea* spp.) has been used in Mexico since prehispanic times for a wide variety of purposes including house construction, walking sticks, stakes, and for basket making, among others (Torres 1985; Anaya 1989; Benz et al. 1994; Bye 1995). Despite its long history of use and considerable study of its distribution and taxonomy, it is clear that information about the species' ecology and management is sorely lacking.

Otatea is a genus indigenous to Mexico and Central America, occurring in Pacific watersheds from Sonora to Chiapas and Central America, besides the Mexican states of Veracruz, Puebla, Queretaro and Mexico (Guzmán et al. 1984). There is a disjunct population in northeastern Colombia where it is called caña brava (Judziewicz et al. 1999). There are two species in the genus, *O. fimbriata* and *O. acuminata*, the last one with two subspecies, *O. acuminata* subsp. *acuminata* and *O. acuminata* subsp. *aztecorum*. These species are used for basket making, walk sticks, broom sticks, corral construction, canes, furniture, crop supports, and house rafters (Guzmán et al. 1984; Judziewicz et al. 1999).

This research was carried out in the ejido of Platanarillo, in the Municipality of Minatitlan in the Mexican state of Colima where otate (*Otatea acuminata* (Munro) Calderon & Soderstrom subsp. *aztecorum* Guzmán, Anaya & Santana) is an important natural resource. This subspecies occurs in the Mexican states of Sonora, Chihuahua, Sinaloa, Durango, Nayarit, Jalisco, Queretaro, Mexico, Guerrero y Puebla (Guzmán et al. 1984).

Otate forms dense thickets of erect, two to eight meter tall individual shoots whose apex often overarches surrounding vegetation. This species occurs mainly in gorges and on pronounced slopes, on thin and stony basic or acidic soils usually derived from calcareous rocks (Guzmán et al. 1984). Otate spreads asexually by rhizomatous growth. Young individuals are totally covered with culm leaves. Stems (culms) emerge annually in the humid season and reach their maximum height within three to four months. In Platanarillo, otate is used in house and corral construction but its principal utility and value is tied to its suitability for making handicrafts, principally baskets. There has been resurgence in local interest to promote large-scale extraction because of its market potential as a source of stakes for cultivation of tomatoes, chayotes and other vegetable crops.

Craft production in the ejido Platanarillo is of great socioeconomic importance because 32 families, or about 40 percent of the residents, engage in basket manufacture as a principal means of generating household income. Otate harvesting for this purpose has been carried out over the years under a traditional management scheme, that consists of the selective cutting of young stems. This traditional form of management is of considerable interest because these practices could have negative impacts on the resource because extraction frequently occurs repeatedly in the same areas and stands. The objective of this work is to describe how the structure of otate populations has been affected by traditional extraction.

STUDY AREA

The Ejido of Platanarillo is located between geographic coordinates 19°21' and 19°29' N latitude and 103°56' and 104°00' W longitude in the state of Colima. This ejido encompasses 3,028 hectares at an altitude ranging from 900 to 1800 meters above sea level. Nearly one-half of the ejido´s land area is located on the southwest flanks of Cerro Grande, a calcareous formation of sedimentary origin with 10 to 45 degree slopes. The remainder of the ejido is located on the north slope of the Sierra Perote, a volcanic formation with 25 to 45 degree slopes. Both form part of the northern-most extent of the Sierra Madre del Sur. Soils on the slopes of Cerro Grande are litosols and andosols, and on the Sierra Perote, regosols and cambisols (INEGI-SPP 1981).

Lithosols are generally shallow, rocky and infertile soils located in areas with pronounced slope. These soils are not particularly apt for agricultural purposes. Cambisols are superficial soils rich in organic material with weakly developed horizons found on moderate slopes. Nevertheless, cambisols are more appropriate for agriculture than lithosols. Andosols form from volcanic ash. They are very light textured and have a high capacity for retaining water and nutrients. This type of soil scarcely occurs in the study area, generally in areas with high slopes. Regosols are similar to cambisols in being rich in organic matter and having weakly developed horizons found on moderate slopes. They differ by regosols having almost no horizon development. Regosols support agricultural activities.

The climate in the area surrounding the ejido is mild, mid-latitude humid subtropical with dry winters and hot summers according to the modified Koeppen classification. Average annual precipitation is 1,350 mm. It presents a marked seasonality with a dry season from October to May and a wet season from June to September (Martínez et al. 1991). The predominant vegetation types in the ejido are the tropical deciduous forest, tropical sub-deciduous forest, and deciduous oak forest (Vazquez et al. 1995). Otate populations are an important component of the tropical deciduous forest that occupies the greatest extension in the ejido. These populations of otate occur mainly in communal land in the ejido, but also in areas with assigned rights, where basket makers must get permission for extracting the resource.

SAMPLING METHOD

Sites dominated by otate stands were delimited with aerial photos and a satellite image SPOT1 HRV2; band 321, scale 1:50,000 taken on March 30th of 1987 and ground truthing in the ejido. Otate populations occur over 340 ha in the ejido. An inventory of the otate populations was conducted during the months of May, June and November of 1993 to document the presence and evaluate the quality of stands.

A total of 25 individuals with an age ranging from 18 to 70 years helped in the inventory and were interviewed about the levels of extraction and harvesting intensity. Seven populations were selected on the calcareous soils of the flanks of Cerro Grande, and one was selected on the volcanic soils of Sierra Perote. These varied according with the harvesting intensity. Site characteristics were recorded for each stand in order to describe basic aspects of the sites where otate grows. These populations cover about 100 ha, almost a third of the total area with otate in the ejido. All of these populations have existed in the area during the last 30 years at least and remain today in spite of harvesting.

Estimation of stand density was calculated as the number of stems per hectare based on the point-quarter method of Cottam and Curtis (1956). Eight stands subject to different extraction levels were sampled systematically. Fifteen to twenty points were sampled in each stand. Points were placed on linear transects distributed systematically every 10 meters across each stand. The distance between points was established according to observed spatial pattern of the stand. Estimates of density were calculated using the equation proposed by Cottam and Curtis (1956): $D=dm^{-2}$ where: D is equal to density and dm is equal to the mean distance of stems from the center point in each quarter. Analysis of variance with multiple post-hoc comparisons using Duncan's method was used to compare population densities.

Culm diameter at breast height (dbh) was measured using a caliper. Height was measured using marked stakes. As stems reached their maximum height, they were classified into four growth-stage categories: new, young, adult and dead. New refers to stems that emerged during the last rainy season and were easily recognized by having complete spiculate culm leaves; young refers to those stems that had emerged two to three years ago, losing some culm leaves in the intervening time; adult stems refer to those with few or no culm leaves. Dead stems were easily recognized since they had neither foliage nor culm leaves and had brittle stems. Average age of shoot death was unknown. The average density of stumps (cut stems) was considered an indicator of the level of extraction and the average density of new stems was considered an indicator of regeneration.

Vigor was characterized in the following manner: good refers to green stems that are notably healthy, complete foliage; regular, yellowish stems and incomplete foliage with some damage; bad, refers to gray and cracked stems with irregular internodes with few, notably damaged leaves.

RESULTS

Population vigor varied from good to regular for new and young stems. Adult stems generally had regular vigor. Site characteristics were similar for stands located on the slopes of Cerro Grande while the single population on Sierra Perote was notably more favorable (Table 1, stand 8).

Stand eight exhibited the greatest regeneration and the highest density of stumps of sites with evidence of extraction. Stand six showed no evidence of extraction and the

TABLE 1. Site characteristics of eight otate stands in the ejido of Platanarillo.

Stand	Accessibility[1]	Area (ha)	Aspect	Slope in degrees	Rockiness[2]
1	Easy	10	Southwest	10–40	Medium
2	Easy	11	West	15–40	Medium
3	Moderate	19	West	15–45	High
4	Moderate	9	West	15–40	High
5	Difficult	8	Southwest	20–45	High
6	Difficult	4	West	20–35	High
7	Difficult	29	Southwest	20–45	High
8	Moderate	10	Northeast	25–45	Low

[1] Accessibility refers to distance, ease of transport and land tenure (communal or assigned rights). Easy access (within 20 minutes walk from the community, path with moderate incline and not rocky, communal land), Moderate access (between 30 and 60 minutes walk from the community, path rocky with moderate incline, assigned land rights limited to certain individuals), difficult access (greater than 60 minutes walk from the community, path rocky with steep incline, communal land)

[2] Rockiness refers to abundance and proximity of rocks (sediment > 1m in diameter) (Olvera et al. 1996). Low (absent to one rock every 20 meters), Medium (a rock every three to 10 meters), High (rocks predominate, soil barely visible).

lowest level of regeneration. Sites three and four exhibited intermediate levels of extraction and of regeneration (Table 2). Stands five and eight had the largest diameter of young, mature, and dead stems. Stands one, four and five had relatively large-diameter stems. Stands six and seven had small-diameter stems (Table 3). The tallest stems occurred in stands one and five; the shortest stems in stands two, three and seven (Table 4). Stand seven also had mostly small, short stems while stand eight had the tallest stems (Table 3 and 4).

In summary, stands number six and eight presented significant differences from the rest with respect to density, degree of extraction, and stem diameter. Stand eight exhibited the highest level of extraction, the greatest density of regeneration, and the largest—diameter and height—stems compared to the rest of the stands. In contrast, stand six exhibited no evidence of extraction, had the largest density of dead stems, showed the lowest density of regeneration, and had some of the smallest diameter stems (Tables 2–4).

According to our interviews with local basket makers, stands one and four were intensively extracted in the past. Stems are extracted from stands one and four by the greatest number of basket makers, with greatest regularity, each collecting between 40–60 stems per fortnight during September through November. Stands two, three and eight are subject to an intermediate level of extraction, at most ca. 40–60 stems per month. Stands five, six, and seven currently have the lowest levels of harvesting, the equivalent or less of 10 stems per month.

TABLE 2. Density (mean and standard deviation) of stems ha^{-1} in eight stands of Otate in the ejido of Platanarillo, Municipio of Minatitlan, Colima, Mexico. Stands with the same letters are not significantly different at $p<0.05$.

	Stands							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
New	2309±2556 bcd	2582±1391 bcd	3140±1193 cd	2671±2646 bcd	2618±3283 bcd	1206±1266 abc	966±999 ab	3131±1845 cd
Young	1412±1302 abc	2411±2463 abcd	3556±2599 bcde	2911±2922 abcde	4810±2603 cde	4871±3210 cde	3557±3789 bcde	3365±1416 bcde
Adult	4025±6057 abcde	2089±2141 abc	4550±6686 abcde	3081±3306 abcd	6480±3623 abcde	8227±6393 cde	5472±6352 abcde	6993±8984 bcde
Dead	1304±1065 abc	4402±6397 abcde	5270±4653 abcde	3106±3463 abcd	7614±9690 bcde	9556±9355 cde	8000±9999 cde	4144±2443 abcd
Stumps	2424±3238 abcde	1551±2177 abc	2898±3981 abcde	4257±4789 acde	968±1894 abc	*	414±688 abcd	4685±3987 cde

*No stumps

TABLE 3. Diameter at breast height of stems (in cm, mean and standard deviation) in eight stands of otate in the ejido of Platanarillo, Municipio of Minatitlan, Colima, Mexico. Stands with the same letters are not significantly different at $p<0.05$.

	Stands							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
New	2.5±0.56 bcd	2.4±0.61 bc	2.±0.67 bc	2.9±0.64 de	2.7±0.69 cde	2.4±0.64 bc	2.0±0.70 a	2.8±0.76 de
Young	2.6±0.60 def	2.3±0.59 bcd	2.3±0.62 bcd	2.4±0.63 bcdef	2.6±0.79 def	2.0±0.79 a	1.8±0.77 a	3.0±0.84 g
Adult	2.2±0.39 cd	2.0±0.42 bcd	2.0±0.54 bcd	2.1±0.48 cd	2.3±0.63 cd	1.8±0.64 bc	1.4±0.60 a	2.8±0.78 e
Dead	2.3±0.47 de	1.9±0.43 abc	1.8±0.43 abc	2.1±0.62 cde	2.0±0.61 bcd	1.7±0.42 abc	1.5±0.57 ab	2.6±0.76 f

TABLE 4. Height (in meters, mean and standard deviation) of otate stems in eight stands in the ejido of Platanarillo, Municipio of Minatitlan, Colima, Mexico. Stands with the same letters are not significantly different at $p<0.05$.

	Stands							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
New	4.09±1.14 bcd	4.23b±1.2 cd	3.90±1.14 abc	4.92±1.03 def	5.50±1.64 ef	5.08±1.66 ef	3.55±1.45 ab	4.52±1.55 cde
Young	3.71±0.97 cd	2.97±0.91 bc	3.02±0.89 bc	3.31±0.79 bc	4.13±1.09 e	3.35±1.19 bcd	2.42±1.03 a	3.25±0.84 bc
Adult	2.92±0.79 cd	2.46±0.71 bc	2.45±0.82 bc	2.82±0.65 cd	3.47±0.95 e	2.67±0.90 bcd	2.01±0.84 a	2.88±0.67 cd
Dead	2.85±0.76 c	2.28±0.73 b	2.33±0.79 b	2.73±0.70 c	3.23±1.08 d	2.75±0.64 c	1.88±0.78 a	2.64±0.63 c

DISCUSSION

Harvesting in the ejido is based on selection of young stems because these make better, more flexible, baskets. Over the years, this kind of management has produced a stand structure with an abundance of adult stems and appears to promote regeneration.

Field observations indicated that stands one and four have the greatest proliferation of woody species (*Acacia* spp. and *Lysiloma* spp.) and these stands have some of the lowest densities of young, adult, and dead stems. According to local informants these two sites were once occupied by dense stands of otate that were intensely exploited in the past, suggesting that prolonged and intense extraction impeded regeneration of adult stems in these otate populations and permitted the invasion and establishment of trees and shrubs. This intense harvesting of sites one and four during the past was due mainly to their proximity to the communities inhabited by a large number of basket makers.

On the other hand, stand eight appeared to respond to high levels of extraction by producing a high density of new large-diameter stems. This could be due either to high levels of extraction reducing competition or its location on rock-free acidic soils with high fertility. Stand six had the lowest level of regeneration—it had the highest density of mature and dead stems—perhaps because the population has not been subject to thinning by basket makers extracting stems for basketry manufacture. These results lead us to hypothesize that the basket makers of Platanarillo have exceeded sustainable levels in some stands (one and four) while maintaining appropriate levels of extraction in others (two, three, five, seven and eight) appropriate to ecological conditions and the population's ability to regenerate.

Numerous hypotheses have been offered to explain massive flowering of bamboos. This phenomenon (gregarious monocarpy) might be determined by physiological changes caused by growing conditions, attempts to satiate seed predators, the intensity of extraction or by perturbation like wildfire or similar factors (Janzen 1976; Keeley & Bond 1999). The flowering periodicity of these otate populations is known from local folklore (Santana & Lemus 1992). According to local people, the last massive flowering event occurred 30 to 35 years ago. Seven informants between 40 and 55 years old report having seen the flowering process once before, and two informants, 75 and 80 years old, have seen it flower twice before.

In 1993 we observed a few culms flowering in some otate populations of the ejido, but not all individuals in a stand appeared to flower simultaneously. Widely separated individual culms flowered while nearby culms did not. Within one year's time from the appearance of one flowering individual, all individuals will have flowered. Now, in the year 2000, most of the populations have flowered completely. Nevertheless, the flowering process has been sequential and prolonged, not simultaneous; some populations still have not flowered. By the time the last population in the ejido flowers, the first population to flower will have new shoots that can be extracted for basket manufacture. The flowering process in the ejido requires a period of about seven years to be completed. If our observations about the flowering process are accurate, we suspect that extraction for basket manufacture has little or no impact on flowering process.

CONCLUSIONS

Continuous harvesting of young stems from stands three, five, six, seven, and eight appears to be possible from the information we have obtained thus far. These stands had either a high density of regeneration (stand three) or had high densities of young and adult stems (stands five, six, and eight). Stand seven had the lowest level of regeneration, so, the extraction of new stems here must be the lowest. There is an obvious need to reduce extraction in stands one, two, and four, all of which have been intensively exploited in the past and exhibit densities of young and adult stems that suggests high regeneration rates.

It appears contradictory that population six located at the greatest distance from the largest number of basket makers possesses the poorest quality for basket manufacture, while population eight located closest to a significant number of basket makers exhibits the greatest intensity of extraction, hast the greatest amount of regeneration and possesses stems with greatest useful dimensions. We offer the working hypothesis that human extraction of otate stems in Platanarillo has actually fostered growth of more stems with better qualities.

Otate is a very important resource for the ejido, especially for the poor people (most of the ejido´s inhabitants) because of its utilitarian and economic value. Commercial extraction poses management challenges because the intensity of extraction could be considerably greater than potential regeneration, while labor investment and the immediate economic benefits are significantly higher than actual costs.

Suggestions For Management

A controlled management program must be implemented in order to regulate harvesting practices. Basket makers agree that regulation of extraction is necessary and propose some actions of control, like protection against fire, excluding livestock, and commercial harvesting of adult stems. Establishment of permanent research plots is also necessary in order to continuing monitoring and evaluating the populations' responses to different harvesting treatments. These measures could lead to improved management by establishing cutting level as well as a systematic registration of the phenology of the species. This will be very important since the process of flowering is nearly complete in all populations of the ejido. The monitoring process should involve local people and trained investigators.

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BLOOMING "BEHAVIOR" IN FIVE SPECIES OF *BOERHAVIA* (NYCTAGINACEAE)

Richard Spellenberg

Department of Biology, MSC 3AF
New Mexico State University
Las Cruces, NM 88003-8001, U.S.A.

ABSTRACT

Observations are reported on anthesis, stamen and style movement, and insect visitation in five taxa of *Boerhavia*, one a pantropical perennial (*B. coccinea* Mill.), and five that are North American annuals (*B. intermedia* M.E. Jones, *B. spicata* Choisy, *B. torreyana* S.Wats., and *B. wrightii* A. Gray). Observations were made in natural situations in Las Cruces, New Mexico. Individual flowers are open for only a portion of one day. Insect visitors were Hymenoptera, Diptera, and Coleoptera. All species received insect visitation; the larger-flowered species had more visitors. Autogamy is believed to be the usual method of reproduction, either through insect pollination or self-pollination of the flower as stamens contact the stigma as the flowers close. There is no evidence of wind pollination even in crowded populations. Chromosome numbers are fairly high, especially for annuals. New chromosome number reports are made for *B. coccinea* ($n = 26$), *B. diffusa* L. ($n = 27$), *B. intermedia* ($n = 26$, ca. 27), *B. linearifolia* ($n =$ ca. 26), *B. mathisiana* F.B. Jones ($n =$ ca. 26), *B. spicata* ($n = 26$), and *B. wrightii* ($n = 27$). It is suggested that high chromosome number, prevalent autogamy, but occasional outcrossing or hybridization, produce a population structure of locally uniform populations that differ slightly to greatly from other populations, a pattern that can lead to difficulty in classification.

RESUMEN

Se informa de las observaciones del movimiento de los estambres y el estilo durante la antesis, así como de la visita de insectos en cinco taxa de *Boerhavia*, uno pantropical perenne (*B. coccinea* Mill.), y cinco anuales norteamericanos (*B. intermedia* M.E. Jones, *B. spicata* Choisy, *B. torreyana* S. Wats., and *B. wrightii* A. Gray). Las observaciones se hicieron en situaciones naturales en Las Cruces, New Mexico. Las flores individuales se abren sólo una parte de un día. Los insectos visitantes fueron Hymenoptera, Diptera, y Coleoptera. Todas las especies recibieron visitas de insectos; las especies de flores grandes tuvieron más visitantes. Se cree que la autogamia es el método normal de reproducción, tanto por entomogamia como por autopolinización de la flor mediante contacto de los estambres con el estigma cuando la flor se cierra. No hay evidencia de anemogamia ni siquiera en poblaciones densas. Los números cromosómicos son bastante altos, especialmente en las anuales. Se citan nuevos números cromosomáticos para *B. coccinea* ($n = 26$), *B. diffusa* L. ($n = 27$), *B. intermedia* ($n = 26$, ca. 27), *B. linearifolia* ($n =$ ca. 26), *B. mathisiana* F.B. Jones ($n =$ ca. 26), *B. spicata* ($n = 26$), y *B. wrightii* ($n = 27$). Se sugiere que el alto número cromosomático, la autogamia predominante, con reproducción cruzada ocasional o hibridación, producen una estruchura poblacional de poblaciones localmente uniformes que difieren de ligeramente a mucho de otras poblaciones, un patrón que puede llevar a dificultades en la clasificación.

INTRODUCTION

Nyctaginaceae comprise a small family of approximately 30 genera and 390 species (Mabberly 1997) consisting mostly of American genera, several of which are noted for

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their taxonomic problems. Among those genera is *Boerhavia* (ca. 20 species) which, in addition to being highly developed in North America, contains some rather difficult groups, for example, a pan-tropical complex of perennial forms (*B. diffusa* L., *B. coccinea* Mill., etc.) and at least two North American groups of annuals (*B. spicata* Choisy complex; *B. erecta* L. complex). As discussed by Ornduff (1969), insights into reproductive aspects may help to understand variation seen within and between populations and this, then, may be useful in taxonomic interpretations.

In the case of *Boerhavia*, populations in the field often appear homogenous within, but differ to a greater or lesser extent with neighboring populations. This population structure is conspicuous in the perennial *B. coccinea* where there are numerous races of maroon-flowered populations that differ in general robustness of plants, in nature and distribution of pubescence, or in number of fruits in the terminal clusters of the inflorescence. In addition, a few populations in this species vary markedly with respect to flower color and other characteristics. For example, an isolated consistently white-flowered population with bright green, lightly pubescent foliage occurs on a rock outcrop on the plains of southern New Mexico. Elsewhere in the region a yellow-flowered race with dull green more heavily pubescent foliage has been discovered adjacent to maroon-flowered less densely pubescent plants (white: New Mexico, Doña Ana Co., ca. 3 mi S of Cambray on Providence Cone, 25 Aug 1985, *Spellenberg and Zucker 8244* [NMC, NY]; yellow: New Mexico, Doña Ana Co., Doña Ana Mts., S slopes Summerford Mountain, 14 Sep 1969, *Spellenberg 2141* [NMC]). Within the annual species there are also a number of examples. *Boerhavia alata* S. Wats. (in the *B. erecta* L. complex) grows on the rocky coast in and near Guaymas in southern Sonora, Mexico. Without conspicuous habitat differences it contacts and intergrades very locally with *B. intermedia* M. E. Jones, common on the hillsides in the immediate vicinity (Mexico, Sonora, Guaymas, 26 Aug 1973, *Spellenberg and Willson 3627, 3629* [*B. alata*], *3630, 3631* [intermediates], *3628, 3632* [*B. intermedia*] [all at NMC, variously distributed to CIIDIR, MEXU, IBUG, RSA, NY, UC, etc.]) (herbaria acronyms from Holmgren et al. 1990).

Perhaps because of the curiosity of nocturnal flowering in a number of species of Nyctaginaceae and/or the presence of chasmogamic and cleistogamic flowers on different plants within populations of a species or, commonly, on the same plant, a number of authors have reported on floral reproductive features and insect visitation in several genera. Several papers report that Nyctaginaceae have flowers that attract insects but often self-pollinate by anthers contacting the stigma as the flower closes (*Boerhavia*, Chaturvedi 1989; *Mirabilis*, section *Mirabilis*, Hernández 1990) and/or through cleistogamy in plants that are also chasmogamous (*Acleisanthes*, *Ammocodon*, *Selinocarpus*, Spellenberg and Delson 1977; *Cyphomeris*, Mahrt and Spellenberg 1995; *Mirabilis*, section *Oxybaphus*, Cruden 1973). Self-incompatibility is known also in *Abronia* (Tillet 1967; Williamson & Bazeer 1997) and *Mirabilis*, section *Quamoclidion*, (Baker 1964; Pilz 1978).

Identification of specimens of *Boerhavia* is often equivocal; species are variable and often are differentiated by minute and subjective characteristics of the fruit. Differences in taxonomic treatments in floras during the past 50 years attests to the difficulty of satisfactorily circumscribing species in some groups of *Boerhavia*. Often in such groups of plants (in general and not just in *Boerhavia*) a combination of biological characteristics contribute to the source of the difficulties faced by the taxonomist. Here I make a comparison of pollination and floral action of five New World taxa, one perennial and four annuals, and relate these observations in a general sense to the variation seen in the genus.

METHODS

Taxa observed were *Boerhavia coccinea*, *B. intermedia*, *B. spicata*, a small-flowered form called *B. torreyana* (S. Wats.) Standl. (considered a synonym of *B. spicata*), and *B. wrightii* A. Gray. All were observed in Las Cruces, New Mexico, and are vouchered under my collection numbers in the New Mexico State University herbarium (NMC). Among these, *B. coccinea* (*7867*), the only perennial in this study, is a pan-tropical species similar to *B. diffusa*, the former often considered a synonym of the latter (compare, for example, Whitehouse [1996], both species recognized, and Wunderlin [1998] or Diggs et al. [1999], one species recognized). *Boerhavia spicata* Choisy (*7866*) is an annual which, in its inclusive sense, includes several synonyms referring to phases more or less different from one another (e.g., *B. torreyana - 7868*) but linked by various intermediate forms (Reed 1969). *Boerhavia intermedia* (*7869*), an annual of arid and semi-arid regions in southern North America, is sometimes considered as a variant of the widespread, weedy, *B. erecta* L. [*B. erecta* var. *intermedia* (M. E. Jones) Kearney & Peebles]. *Boerhavia wrightii* (*7870*) is part of a small complex of species from North and South America that are fairly distinct from one another.

Boerhavia plants respond to summer rains, flowering primarily in August and September in southern New Mexico. In 1984 summer rains in the region were "good," resulting in ample late season growth for both perennials and annuals. Observations on pollination mechanisms were made daily during an eight day period (31 Aug – 7 Sep). The positions of stamens and stigma during the period of anthesis were observed with a 10× hand lens. *Boerhavia coccinea* and *B. spicata* were studied in a small weedy area on the NMSU campus where the species were intermixed. The three other annuals were studied ca. 5 km E of the NMSU campus in Chihuahuan Desert vegetation dominated by *Larrea*, where they were also intermixed but plants were much more sparsely distributed.

Periods of observation.—Plants were observed daily, with observation of each taxon lasting for 10 minutes. The observation periods were rotated from one species to the next, with a few minutes allowed in between for relocation. The first period each morning began with a different species. Observations were made at each location (on or off campus) on alternate days.

Insect visitation.—Records were kept of insect visitors, the duration of visits, insofar as possible where the insect next visited, and general identity. Records were kept for visits to individual flower clusters (terminal spikes in *B. spicata, B. torreyana,* and *B. wrightii,* individual subumbellate clusters in *B. coccinea* and *B. intermedia*) and visits to entire plants under observation. The latter data were not corrected for number of visitors relative to the number of total terminal inflorescences. In addition to observations, insects were also collected either with a net or by aspiration, were killed, and later identified to taxon as precisely as possible. Number of insect visits per taxon were analyzed using JMP 3.0 (SAS Institute, Cary, North Carolina) to determine if insect visitation differed among species. An α level of 0.1 was considered significant.

Wind pollination.—To estimate the role of wind pollination, four glycerin-coated microscope slides were oriented horizontally on tops of stakes that were located within 10 cm of inflorescences of a single plant of each species. Slides, each having a surface area of 12.5 cm^2 were approximately aligned with cardinal directions. Slides were placed in populations one day during the entire period from immediately prior to perianth opening to closure.

Exclusion of pollinators.—Cross pollination was prevented by loosely wrapping an inflorescence in several layers of fine nylon stocking mesh immediately prior to anthesis. This effectively prevents passage of the large and spinulose *Boerhavia* pollen (pollen described in Nowicke 1970). The netting remained on the plant until seed maturation, typically 9–10 days. The netting prevented loss if fruits were shed prior to removal of the net. At the same time, other inflorescences were marked, exposed to open pollination, then bagged in a similar manner the following morning, after the flowers closed. Fruits were then collected from both treatments and opened to determine whether each contained a seed.

Pollen / ovule ratios.—Since *Boerhavia* species produce one ovule per fruit, pollen / ovule ratios were calculated simply by counting the pollen grains produced by a flower. Anthers from a single flower were crushed in cotton blue and lactophenol on a microscope slide and the pollen grains were counted using a compound microscope at 100× magnification. Ten flowers for each species were examined.

Hybridization.—As a generalization, breeding barriers may be weak within autogamous species beyond the barrier provided by the breeding system itself (e.g., Lewis 1963; Stebbins 1957), which might account for some of the variation patterns with the *B. spicata* or *B. erecta* complexes. Woodson and Kidd (1961) suggested that hybridization occurs within mixed populations of *B. diffusa* (perennial) and *B. erecta* (annual), the putative hybrids representing *B. coccinea* in the sense of Standley (1918). To attempt to gain some perspective on the potential for hybridization, an interspecific cross was made in early September, 1984. In the mixed population on the New Mexico State University campus, *B. coccinea* was used as the pollen-receiving plant, *B. spicata* was the pollen donor. Eleven flowers within a single umbellate cluster were emasculated very early in the onset of anther dehiscence with fine forceps under a dissecting microscope. Stigmas were thoroughly inspected with the dissecting microscope and the few pollen grains already on the stigmas were removed by "sweeping" them off with a moistened dissecting needle.

The stigmas were then saturated with many grains of the donor pollen by bringing an inflorescence of *B. spicata* to *B. coccinea* and brushing the dehisced anthers against the recipient stigmas. The flower cluster was bagged in double layers of nylon mesh and mature fruits were collected in 10 days.

RESULTS AND DISCUSSION

Floral "behavior."—In each of the species of *Boerhavia* an individual flower is open for only a portion of a day (Fig. 1). Anthesis begins near dawn, usually for all or most of the flowers in a single flower cluster. In *B. spicata* and *B. coccinea* anthesis began 1-2 hours before it began in the other three (the perhaps warmer and more mesic campus environment may have influenced timing and duration of anthesis). In all, anthesis begins with the opening of the corolla-like perianth, stamens and styles uncoil and, in the larger-flowered species, the final stigma position is slightly beyond the anthers. In the smaller-flowered species stigma and anthers are not as well separated initially (Fig. 1). As the morning progresses, the filaments and style curl and the anthers haphazardly contact the stigma. Self-pollination may occur at this time. Perianth closure begins in late morning and progresses rapidly, so that by mid-afternoon the perianth is crumpled, the stamens and style usually contained within. Only rarely do flowers weakly open a second day. These observations fully support those of Chaturvedi (1989), who reported that the widespread perennial, *B. diffusa*, is autogamous (as known from plants studied in the botanic garden, Allahabad University, India).

Insect visitation.—Insect visitors varied in kind, frequency and duration (Table 1), with various bees and flies frequent visitors. This is concordant with Bittrich and Kühn's (1993) review that *Boerhavia* flowers fit the profile of bee and fly pollination. In a previous observation, however, ants covered with pollen grains were noted entering flowers of *B. coccinea*. On such occasions, ants may also serve as pollen vectors (observation and comment on specimen, Mexico, Colima, 10 km SW of Tecoman, El Real, *Spellenberg 2955*, NMC). The total number of insect visits varied considerably for the five taxa of *Boerhavia* studied (Table 2). Small sample size and considerable variation must be considered when viewing data in these tables. Raw data of total insect visit per species per day, summarized in Table 2, is not normally distributed (Shapiro-Wilk W Test, prob $< W < 0.0001$). The Wilcoxon / Kruskal-Wallis Ranked Sums Test indicated significant differences in the data ($\chi^2 = 9.196$, $df = 4$, $p = 0.0564$). The Tukey-Kramer comparison of all pairs indicated that *Boerhavia spicata* differed most from all other species, significantly from from *B. wrightii*, *B. intermedia* and *B. torreyana*.

Based on these preliminary observations, no conspicuously strong floral fidelity was observed by visiting insects. An insect initiating visits on one species might fly to several inflorescences on the same plant, then move to another plant of the same or different species, then return to the original plant, and so forth. Therefore, insect movement would allow both for autogamy, xenogamy, and hybridization.

Wind pollination.—Very little *Boerhavia* pollen was trapped on the glycerin-coated

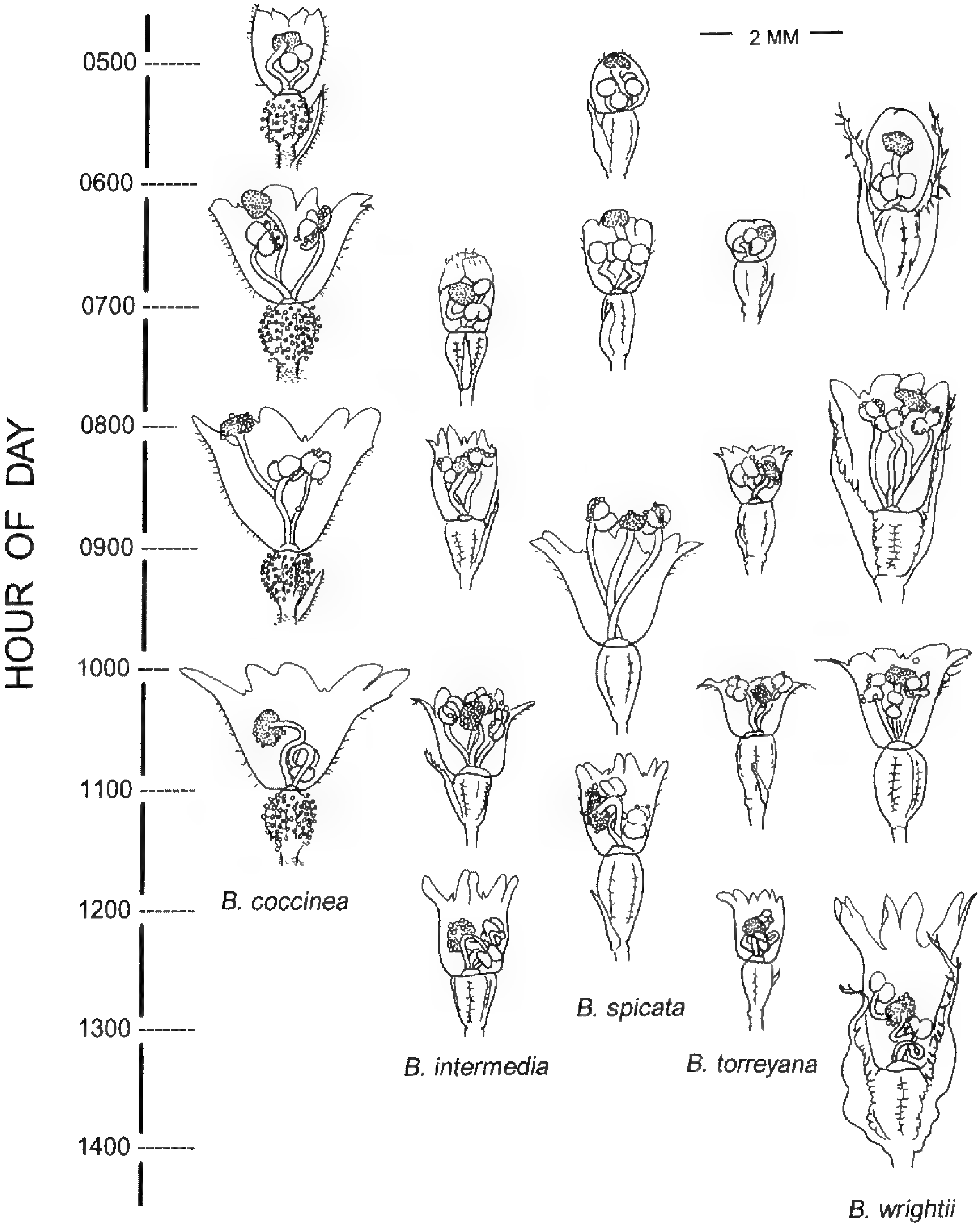

Fig. 1. "Picture graph" of stages of anthesis in five species of *Boerhavia*. Each species is diagramed in one column, anthesis beginning at the top. Hour of day is given on axis at left. All flowers are drawn to the same scale.

slides. Grass and *Salsola* pollen was frequent. For each species the following number of grains were trapped upon the slides and from this data the number of grains per centimeter squared per hour was calculated (number of grains: grains/hr/cm^2): *B. coccinea* (5: 0.025), *B. intermedia* (7: 0.035), *B. spicata* (17: 0.09), *B. torreyana* (0: 0), *B. wrightii* (8: 0.053). One slide from *B. wrightii* was removed from scoring because it had a large clump of

TABLE 1. Total number of insect visitors observed in multiple observation periods for individual plants of each of five species of *Boerhavia*. N is equal to the number of ten minute observation periods. The average number of seconds per visit in given in parentheses. Small Hymenoptera visitors consisted of Bethylidae, Andrenidae (*Perdita*), Halictidae (*Dialictus, Lasioglossum, Halictus*).

	B. coccinea *N = 18*	**B. intermedia** *N = 11*	**B. spicata** *N = 23*	**B. torreyana** *N = 15*	**B. wrightii** *N = 20*
	Total number of visits for all observation periods (average duration of visit in seconds)				
Insect visitor					
HYMENOPTERA					
LARGE					
Scoliidae (*Scolia*)	14(5)		4(7)		
MEDIUM					
Anthophoridae (Mellisodes)	8(5)	5(2)	6(4)	4(0.75)	6(4)
Chrysididae (*Holopyga rudis* Kimsey)	5(1)	8(0.5)		1(3)	5(0.25)
Ichneumonidae	1(3)		4(2)		
Sphecidae (*Ammophila*)			1(60)		
SMALL (see table caption)	25(10)		21(5)	2(1)	1(5)
DIPTERA					
MEDIUM					
Calliphoridae	2(7)		1(2)		
Syrphidae (*Pseudodoros clavatus* [Fab.])			2(6)		
Tachinidae		1(1)		1(0.25)	1(5)
SMALL					
Syrphidae (Toxomerus, Paragus)	6(9)	3(2)	56(7)	2(15)	5(17)
Muscidae	2(10)				
COLEOPTERA					
Nitulidae or Byturidae		8(10)			

pollen, presumably from the landing of a pollen-laden insect. From this data it seems unlikely that wind pollination is significant in *Boerhavia*. Pollen sexine is spinulose, and pollen size is rather large, consistent with that reported for these and other species by Nowicke (1970), and characteristic of insect pollinated plants.

Pollination.—Pollen load on stigmas (as determined by direct observation of pollen grains on stigmas with a 10× hand lens) progressively increased during anthesis, the

TABLE 2. Estimated number of insect visits to individual flower clusters per hour in five species of *Boerhavia*. Estimations are based upon 10 minute observation periods spread throughout the period of anthesis. Number of periods involved in estimations and number of flower clusters indicated in parentheses.

Hour of day	**07–0800**	**08–0900**	**09–1000**	**10–1100**	**11–1200**	**12–1300**	**13–1400**	**Total**
B. coccinea (15 ten minute periods; 125 flower clusters)								
	0.0	0.3	1.0	0.3	1.3	1.1	0.0	3.7
B. intermedia (14 ten minute periods; 111 flower clusters)								
	0.0	0.0	0.0	0.6	0.0	0.1	1.0	1.7
B. spicata (21 ten minute periods; 174 flower clusters)								
	0.0	0.0	2.3	0.6	4.0	2.2	0.0	9.1
B. torreyana (14 ten minute periods; 86 flower clusters)								
	0.0	0.0	0.0	0.4	0.0	0.2	0.0	0.6
B. wrightii (17 ten minute periods; 124 flower clusters)								
	0.0	0.0	0.0	1.4	1.6	0.7	1.4	5.1

majority of stigmas having more than 6 grains adhered by early afternoon (Table 3). For samples of *B. torreyana* (Table 3), the species with the smallest flowers, data indicate the same trend, though somewhat erratic. This species also received the fewest insect visits during anthesis (Table 2). Four of the five species, *B. spicata* the exception, still had a low to moderate percentage of stigmas without pollen at the time of perianth closure (Table 3).

Even though some stigmas were unpollinated at time of flower closure, percentage of filled fruits in each species was high for both open pollinated and pollinator-excluded inflorescences. Curling of stamens and the style places pollen on the stigma, with the assumption that autogamy results. In each case in the following pairs of data, the number of filled seeds precedes the number of unfilled seeds for plants protected from pollinators and for plants openly pollinated: in plants protected from pollinators – *B. coccinea* 20/0; *B. intermedia* 5/0; *B. spicata* 8/0; *B. torreyana* 19/0; *B. wrightii* 5/0; in plants openly pollinated—*B. coccinea* 21/3; *B. intermedia* destroyed; *B. spicata* 23/0; *B. torreyana* 24/1; *B. wrightii* 13/0.

Pollen/ovule ratios.—Pollen/ovule ratios for the five *Boerhavia* species examined ranged between 28:1 and 102:1. These figures lie between those proposed by Cruden (1977) for obligate and facultative autogamy (Table 4). For each taxon more than 95% of the pollen grains stained well in cotton blue and lactophenol, suggesting a high level of fertility.

Hybridization.—Eleven mature fruits were collected from the single head of *Boerhavia coccinea* that had received pollen from *B. spicata*. All appeared normal. One was opened and the seed was normally filled. The other 10 were planted in native soil in pots outdoors near the end of September, 1984. Even after 16 years, none have

TABLE 3. Percentage of stigmas with number of pollen grains in *Boerhavia* at different hours of the day. Number of stigmas is the total scored for the entire period. Different stigmas were counted during each period.

Species, hour of day, number of stigmas scored	**Number of grains on stigma**			
	0	**1-3**	**6-10**	**>10**
	Percent of stigmas with above number of pollen grains			
B. coccinea (160 stigmas)				
0600–0900	86	10	4	–
0900–1100	69	16	13	2
1100–1300	17	12	32	39
1300–1500		Perianth closed		
B. intermedia (150 stigmas)				
0600-0900	100	—	—	—
0900–1100	83	10	4	3
1100–1300	56	19	13	12
1300–1500	14	12	12	62
B. spicata (210 stigmas)				
0600–0900	64	12	17	7
0900–1100	8	17	37	38
1100–1300	1	6	14	79
1300–1500	—	10	10	80
B. torreyana (150 stigmas)				
0600-0900	100	—	—	—
0900–1100	66	23	11	—
1100–1300	32	30	18	20
1300–1500	32	34	21	13
B. wrightii (150 stigmas)				
0600–0900	100	—	—	—
0900–1100	46	4	50	—
1100–1300	33	7	20	40
1300–1500	22	20	14	44

germinated. The cross may have been too distant (perennial crossed to very different annual). In general, seeds in *Boerhavia* are difficult to germinate in high frequency (personal observation) and dormancy may never have been broken in otherwise "normal" seeds.

GENERAL DISCUSSION

The flowers of the five different types of *Boerhavia* each opened for a few hours in the morning, and then closed permanently. Movement of stamens and style apparently assure self-pollination. These observations conform with those of Chaturvedi (1989) for *Boerhavia*. A similar mechanism was noted by Cruden (1973) and Hernández (1990) for some *Mirabilis*, Mahrt and Spellenberg (1995) for *Cyphomeris*, and Spellenberg and Delson (1977) for *Ammocodon*. Allowing for the exception in the specialized Asclepiadaceae

TABLE 4. Pollen/ovule ratios in five species of *Boerhavia* as related to predicted breeding systems as proposed by Cruden (1977, Table 1).

Breeding system (Cruden) or species of *Boerhavia*	**Mean ± standard deviation, pollen/ovule ratio**	
Cleistogamy	28	±3
B. torreyana	51	±16
B. wrightii	77	±18
B. intermedia	80	±19
B. spicata	86	±20
B. coccinea	102	±39
Facultative autogamy	162	±22
Facultative xenogamy	797	±87
Xenogamy	5859	±937

(Wyatt et al. 2000), pollen/ovule ratios suggest high levels of autogamy (Cruden 1977). In an independent study to determine various sugar concentrations in nectar (unpublished, ratios provided on herbarium vouchers at NMC), I extracted nectar from all species; flowers of *B. coccinea* and *B. spicata* individually produce much more nectar than flowers of the other three; these two species had the most insect visitors, *B. spicata* significantly so. Bittrich and Kühn (1993) review that *Boerhavia* flowers produce nectar in the narrow tube, are melittophilous, and are suited for head pollination by small bees, all observations supported by this study. Insect visitation between plants within a species would allow for occasional outcrossing as noted for autogamous plants by Lewis (1963). This would also allow for the potential of hybridization, which is supported by seed produced (but not germinated) in a very small trial of artificial interspecific pollination. Hybridization may take place occasionally in the field, as suggested by Woodson and Kidd (1961). This is especially likely in closely related, little-differentiated populations, as might be the case between *B. alata* and *B. intermedia* in the Guaymas region in Sonora. Chromosome numbers known in *Boerhavia* are fairly high ($n = 13, 20, 26, 27, 58$, see Appendix I), especially for annuals, which for those known $n = 26$ or 27. A high n number would be an important contributor to a high recombination index, promoting a higher number of new gene combinations through segregation and recombination in a limited number of generations (Stebbins 1951) than would a low n number. Hybridization followed by recombination and repetitive inbreeding would be expected to produce a rather fine-grained patchwork of populations homogeneous within and more or less different between. This kind of population structure, reviewed by Lewis (1963) and Stebbins (1957) in discussions of the relationship between autogamy and problems of classification, applies in *Boerhavia*. As noted by Lewis, autogamy *per se* creates no taxonomic problem, and a number of species of *Boerhavia* seem fairly trouble free. When combined with outcrossing, many local phenotypically differentiated populations may be temporarily stabilized by autogamy. This may apply in other *Boerhavia* groups, such as *B. coccinea* and *B. spicata* (both *sensu lato*), and such complexes may be treated in the same manner as those where complex patterns of variation result from outcrossing and/or hybridization without notable inbreeding (Lewis 1963). In such situations, the taxonomist exercises considerable personal judgment, attempting to communicate in a classification a useful taxonomy that corresponds to broad limits on gene flow and/or fidelity to certain ecological situations.

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APPENDIX

Known chromosome numbers in *Boerhavia*. My original counts are indicated by voucher citations, unless otherwise indicated, collection number is mine; voucher specimens are at NMC, with many widely distributed. Other counts were compiled from the literature, the citation provided; for counts reported in the literature, somatic numbers were converted to expected gametic numbers for ease of comparison within the following listing. Within a species, all are organized alphabetically by country. Original counts were obtained from buds fixed in cold modified Carnoy's solution (4:3:1 - chloroform: ethanol:glacial acetic acid), and stained and squashed in hydrochloric acid-carmine (Snow 1963).

Boerhavia coccinea Mill. (perennial). *n* = 26. Arizona, Maricopa Co., 12 mi. N of Phoenix. *2527*; New Mexico, Doña Ana Co., Doña Ana Mts. N of Las Cruces, *1943*; Bolivia (Fernández Casas & Fernández Piqueras, 1981); Mexico, Vera Cruz, Paso de Ovejas, *Pilz & Strother_683*; *n* = ca. 26. New Mexico, Doña Ana Co., Las Cruces, *7867*.

Boerhavia diffusa L. (perennial). *n* = 13. India, (Srivistava & Misra 1966); Tanzania (Gill & Abubakar 1975); *n* = 26. Hawaii (Carr 1978); *n* = 27. Hawaii, Oahu, SW part of island, roadside weed along highway H-93, s end of Waianu Range, *6396*; Haleiwa at Waialu Bay, *6406*; n = 58, India (Thombre 1959).

Boerhavia intermedia M. E. Jones (annual). *n* = 26. New Mexico, Doña Ana Co., Las Cruces, *2080*; Texas, Presidio Co., 24.9 mi. E of Redford, *3431*; *n* = ca. 27. New Mexico, Doña Ana Co., Las Cruces, *7869*.

Boerhavia linearifolia A. Gray (perennial). *n* = ca. 26. New Mexico, Chaves Co., 9.2 mi. NW of Roswell, *3431*.

Boerhavia mathisiana F. B. Jones (perennial). *n* = ca. 26. Texas, San Patricio Co., ca. 2 mi. NW of Mathias, *Turner 80-80M*.

Boerhavia repanda Willd. (perennial). *n* = 20. India (Gajapathy 1962); *n* = 21. India (Tandon and Rao 1963).

Boerhavia spicata Choisy (annual). *n* = 26. New Mexico, Doña Ana Co., Las Cruces, *2080*; *n* = ca. 26. Mexico, Puebla, 1 mi. W of Acatlan, *Pilz & Strother 671*; *n* = 27. New Mexico, Doña Ana Co., Las Cruces, *7866*; *8291* [latter *B. torreyana* (S. Wats.) Standl. phase].

Boerhavia wrightii A. Gray (annual). *n* = 27. New Mexico, Doña Ana Co., Las Cruces, *7870*.

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TAXONOMIC ADDENDUM

This paper was written and submitted so that some of its conclusions could be referenced in an upcoming Flora of North America treatment of *Boerhavia*. The taxonomy followed was that of Reed (1969). As the paper was in galley and virtually "out the door" for publication, the taxonomy of the *Boerhavia spicata* group in the United States yielded to study. This requires name changes from those given in the paper, changes that may be referenced by way of voucher numbers given in the body of the paper. Name changes occur only for those collections originally called *B. spicata* and *B. torreyana*.

Boerhavia coulteri (Hook. f.) S. Wats., *7868*, fourth column of Fig. 1; *8291*, chromosome number, $n = 26$. It has been introduced in the Las Cruces area.
Boerhavia spicata Choisy, *Pilz & Strother 671*, chromosome number, $n =$ ca. 26 (no change in name).
Boerhavia torreyana (S. Wats.) Standl., *7866*, middle column of Fig. 1, *2080*, *7866*, chromosome number, $n = 26$.

In tables 1, 2, 3 and 4 *Boerhavia spicata* now becomes *B. torreyana*, and *B. torreyana* now becomes *B. coulteri*.

BOOK REVIEW

Delena Tull. 1999. **Edible and Useful Plants of Texas and the Southwest.** (ISBN 0-292-78164-4, pbk.). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. (512-471-4032, 512-320-0668 fax; orders: 800-252-3206 or 800-687-6046 fax; www.utexas.edu/utpress/). $24.95 pbk., xxiv + 518 pp. Line drawings, 57 color photos.

Edible and Useful Plants of Texas and the Southwest is just as its subtitle says: a practical guide. In its second edition (first in paperback) this book, by Delena Tull, offers information on plant characteristics, habitat, and range in Texas, to be used with a supplemental and more detailed flora of Texas. Despite the preface in which the author goes on about the joys of her new home, Alaska, the book is undoubtedly written by a lover of Texas biota. Subsequently, other lovers of the Texas outdoors and its biological diversity will find it valuable and enjoyable.

The book breaks down in seven major parts followed by a glossary, bibliography, and index. **Part One,** titled "Edible and Useful Wild Plants" discusses native plants and tips on grazing from wild plants. What follows is a list of over 30 plant families who have species that are edible and/or useful. This is roughly a third of the book and offers encyclopedic reference to native Texas plants and their uses. **Part Two,** "Teas and Spices" covers 40 plants used as such. **Part Three,** "Edible and Poisonous Berries and Other Fleshy Fruits" is incredibly valuable for the camper or naturalists who wants to distinguish a poisonous fruit from an edible one. **Part Four,** "Poisonous and Harmful Plants" discusses similar issues and covers first aid methods for toxic plant ingestion, dispels some myths about poisonous plants, livestock poisoning, plant toxins, and then lists toxic wild plants by family. **Part Five,** "Colorful Dyes with Texas Plants" is definitely a strong point of this book. First discussing vegetable dyes historically and dyes today, and going on to discuss fibers for dyeing, factors that influence dye colors, dyeing techniques and dye recipes. **Part Six,** "Fibers from Texas Plants" covers plants for basketmaking, textile fibers, and papermaking. Part Seven, "Rubber, Wax, Oil, and Soap: Industrial Resources from Texas Plants" closes the book.

This would be a great book for any Texas university-level economic botany class. This is a great book to take out in the field to identify useful and edible plants and taking them back to a lab to do a number of projects, whether, papermaking, basket weaving, or dyeing textiles. This book, along with Simpson and Ogorzaly's *Economic Botany*, Murphey's *Indian Uses of Native Plants*, and perhaps a selected ethnography of local group, would be suitable for an Economic Botany class that could be cross listed for both anthropology and botany credit. With 50 plus color plates and twice as many black and white illustrations this edition is field ready and easily accessible.

While the possibilities of using this book in the academic level are exciting, it should find wide readership among naturalists and/or Texas lovers. As a field guide for identification and an encyclopedic reference of edible and economic uses of Texas plants, this book is must have for anyone waiting in anticipation for the spring and summer camping and hiking seasons.—*Kevin D. Janni, Botanical Research Institute of Texas, kjanni@brit.org.*

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CYPERUS SANGUINOLENTUS (CYPERACEAE) NEW TO THE SOUTHEASTERN UNITED STATES, AND ITS RELATION TO THE SUPPOSED ENDEMIC *CYPERUS LOUISIANENSIS*

Richard Carter

Herbarium, Biology Department
Valdosta State University
Valdosta, GA 31698-0015, U.S.A.

Charles T. Bryson

Southern Weed Science Research Unit
USDA, ARS, Jamie Whitten Delta States Research Center
P.O. Box 350
Stoneville, MS 38776, U.S.A.

ABSTRACT

Field studies show *Cyperus louisianensis* is locally common and weedy in eastern Louisiana and southern Mississippi and extend its range into Alabama and Georgia. Morphometric and herbarium studies show *C. sanguinolentus* and *C. louisianensis* are taxonomically indistinguishable, and *C. louisianensis* is treated as a synonym of *C. sanguinolentus*. The widespread weed, *C. sanguinolentus*, formerly thought to be restricted to the Eastern Hemisphere, is reported new to North America, and data on its frequency, distribution, and ecology in the southeastern United States are presented.

RESUMEN

Los estudios de campo muestran que *Cyperus louisianensis* es localmente común y una mala hierba en el este de Louisiana y el sur de Mississippi y que se extiende hasta Alabama y Georgia. Estudios morfométricos y de herbario muestran que *C. sanguinolentus* y *C. louisianensis* son taxonómicamente indistinguibles, y *C. louisianensis* se trata como un sinónimo de *C. sanguinolentus*. La mala hierba extendida, *C. sanguinolentus*, que previamente se creyó restringida al hemisferio este, se cita aquí como nueva para Norte América, y se presentan datos de su frecuencia, distribución y ecología en el sureste de los Estados.

INTRODUCTION

Cyperus sanguinolentus Vahl is widely distributed in the Eastern Hemisphere, where it has been cited as a weed (Holm et al. 1991; Mingyuan & Dehu 1970; Reed 1977; Kühn 1982). It is known from northeastern Africa, the Middle East, India, Sri Lanka, central Asia, southeastern Asia, China, Taiwan, Japan, Korea, the Philippines, Indonesia, Malaysia, and Australia (Clarke 1894; Holm et al. 1991; Kükenthal 1935–1936; Ohwi 1965; Mingyuan & Dehu 1970; Kern 1974; Reed 1977; Kühn 1982; Haines & Lye 1983; Wilson 1993) but has not been previously reported from the Western Hemisphere.

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Cyperus sanguinolentus is highly variable. Kükenthal (1935–1936) segregated five varieties and named seven forms, including six under the typical variety. Kükenthal's (1935–1936) infraspecific taxonomy of *C. sanguinolentus* is difficult to use, since he provided neither keys nor parallel descriptions of the taxa. Kern (1974) treated four subspecies, including the typical one, for Malaysia, and others (e.g., Ohwi 1965; Haines & Lye 1977) have treated additional infraspecific taxa. Table 1 compares infraspecific taxonomies of Kükenthal (1935–1936) and Kern (1974). Further research on this widespread and variable species throughout its range is needed for a more complete understanding of its infraspecific variation; however, such is beyond the scope of our study to determine the range, distribution, taxonomic relationships, and status of *C. sanguinolentus* in North America.

Its bifid style and lenticular achene with achene angle adjacent to rachilla clearly place *C. sanguinolentus* into subgenus *Pycreus*. Clarke (1894, 1908) segregated *Pycreus* as a genus and treated the taxon as *Pycreus sanguinolentus* Nees in subgenus *Reticulatae* section *Vestitae*. Kükenthal (1935–1936) adopted a broader definition of *Cyperus*, incorporating this taxon into subgenus *Pycreus* section *Sulcati* of that genus. The floral scales of *C. sanguinolentus* are distinctive, being characterized by lateral grooves (or *sulci)* typical of section *Sulcati* and, as its specific epithet implies, blood-red floral scale pigmentation. Although some recent authors (e.g., Koyama 1985; Goetghebeur 1986, 1989; Adams 1994; Bruhl 1995) fragment *Cyperus* and segregate *Pycreus* at the rank of genus, we have followed the more conservative generic taxonomy of Kükenthal (1935–1936) and Corcoran (1941), which, with some modification, is still widely used (e.g., Kern 1974; Haines & Lye 1977; Tucker 1983, 1987, 1994).

In 1977, Thieret described a new species, *C. louisianensis*, from specimens he collected at two close sites in Tangipahoa Parish, Louisiana. Thieret (1977) placed *C. louisianensis* in subgenus *Pycreus*, noted its similarity with *C. sanguinolentus*, and provided several contrasting characteristics separating it from *C. sanguinolentus* (Table 2) and a dichotomous key distinguishing it from related North American species in subgenus *Pycreus*. *Cyperus louisianensis* was listed by the Department of Interior, United States Fish & Wildlife Service, in *category two* among endangered or threatened species (Anonymous 1993). Until Bryson and Carter (1994) showed it was widespread and weedy in southern Mississippi, *C. louisianensis* was thought to be a narrow endemic restricted to two sites in southeastern Louisiana.

In 1993, the first author was contracted by the United States Fish & Wildlife Service to prepare a status survey on *C. louisianensis*, which provided the initial financial support for this study. The major objectives of the survey were to seek additional populations of *C. louisianensis* and additional collections in herbaria, to review its status as a potentially rare plant, and to examine its taxonomic relationship with the Old World weed *C. sanguinolentus*. In this report, we provide a complete record of our field and herbarium investigations into the distribution, ecology and taxonomic relationships of *C. louisianensis* with *C. sanguinolentus*.

Table 1. Infraspecific taxonomy of *Cyperus sanguinolentus*.

Kükenthal (1935–1936) - worldwide treatment	**Kern (1974) - *Flora Malesiana***
C. sanguinolentus Vahl	*C. sanguinolentus* Vahl
var. *sanguinolentus*	ssp. *sanguinolentus*
f. *rubro-marginatus* (Schrenk) Kük.	not treated
f. *neurotropis* (Steud.) Kük.	not treated
f. *flaccidulus* (Boeck.) Kük.	not treated
f. *cyrtostachys* (Miq.) Kük.	ssp. *cyrtostachys* (Miq.) Kern
f. *melanocephalus* (Miq.) Kük.	ssp. *melanocephalus* (Miq) Kern
f. *humilis* Kuk.	[=ssp. *melanocephalus*]
var. *micronux* (C.B. Clarke) Kük.	not treated
var. *teysmannii* (Boeck.) Kük.	ssp. *teysmannii* (Boeck.) Kern
var. *korshinskii* (Meinsh.) Kük.	not treated
var. *pratorum* (Korotky) Kük.	not treated
var. *areolatus* (R. Br.) Kük.	not treated
f. *setaceus* Kük.	not treated

Table 2. Comparison of *Cyperus louisianensis* and *C. sanguinolentus* (fide Thieret 1977).

C. louisianensis	***C. sanguinolentus***
Achenes elliptic to elliptic-obovate	Achenes orbicular-obovate
Achenes rather flattened (thickness-length ratio: 0.25–0.30)	Achenes turgid (thickness-length ratio: 0.40)
Floral scales well imbricated and flat along the margin	Floral scales often barely imbricate, at least proximally, permitting some see through; frequently involute along the margin

MATERIALS AND METHODS

Field studies.—Systematic intensive field surveys for *C. louisianensis* populations in southeastern Louisiana and southern Mississippi were made by the authors during the periods 15–21 September 1993 and 14–18 October 1993. Subsequently, the authors have continued to search sporadically for this taxon when time and circumstances have allowed. Thieret's (1977) published account and more recent collections from the type locality with additional documentation, kindly provided by Nelwyn Gilmore, Louisiana Natural Heritage Program, were used to relocate the holotype locality in Tangipahoa Parish, Louisiana. Attempts to re-locate Thieret's paratype locality were unsuccessful, which is not surprising since habitat in the vicinity of this site was substantially altered by highway and commercial construction activities. Observations at the holotype locality showed the species to be locally abundant along the margin of a shallow artificial pond and nearby ditches in the flatwoods, habitat greatly altered by humans. Searches of potential habitat began outward from the holotype locality. Habitat descriptions, estimates of population size, and voucher specimens were made when populations were found.

Greenhouse studies.—Transplants and plants of *C. louisianensis* started from seeds were maintained under controlled conditions in a greenhouse at the United States Department of Agriculture, Agricultural Research Service, Jamie Whitten Delta States Research Center, at Stoneville, Mississippi. Observations on these plants by the second author were made in order to understand better the life history and phenology of *C. louisianensis*, especially to determine whether it is annual or perennial.

In greenhouse experiments, seeds of *C. louisianensis* were sewn in flats on top of a 6 cm-deep mixture of a Bosket silt loam soil (Mollic Hapludaf) and sphagnum (50% v/v) in the first week of March, June, September, and December in 1994, 1995, and 1996. Trays were watered from beneath to prevent seed and soil disturbance. Individual *C. louisianensis* seedlings (> 5 cm tall) were transplanted into 15 cm-diameter pots and watered from beneath. The greenhouse was maintained at 30 to 35° C day and 25 to 30° C night, at 60 to 75% relative humidity, and without supplemental lighting. In 1994 and 1995, flowering and fruiting plants of *C. louisianensis* were transplanted from several sites in Hancock County, Mississippi, and St. Tammany Parish, Louisiana, into 15 cm-diameter pots and maintained under the same greenhouse conditions as plants grown from seeds. Data were taken on date of seedling emergence, date of flowering and fruiting, and plant longevity.

Herbarium and morphometric studies.—Specimens of *C. louisianensis* and *C. sanguinolentus* were borrowed from selected herbaria (BRIT, GH, MO, NY and US) in order to examine the variation in *C. louisianensis* and its taxonomic relationship with *C. sanguinolentus*. Quantitative data on the achene characteristics used by Thieret (1977) to distinguish *C. louisianensis* from *C. sanguinolentus* were taken from these specimens and from our own collections. Five achenes from each of 13 specimens of *C. louisianensis* and 20 specimens of *C. sanguinolentus* were examined. A Bausch & Lomb stereozoom (6X–30X) dissecting microscope with ocular micrometer was used to measure various achene dimensions (Table 3, Fig. 1), and ratios (Table 3) derived from these measurements were used to analyze differences in the plane shapes of achenes used by Thieret (Table 2) to distinguish *C. louisianensis* and *C. sanguinolentus*. Minitab release 11.21 (Anonymous 1996) was used to analyze these data statistically and to construct scatter diagrams for comparing variation in *C. louisianensis* and *C. sanguinolentus*. Representative spikelets from selected specimens were photographed using an Olympus™ SZ40 stereozoom dissecting microscope equipped with a Kodak™ DC120 zoom digital camera. Our more numerous recent collections were used with Thieret's (1977) original description and type materials to prepare a revised description and an illustration.

RESULTS

Distribution and ecology of *Cyperus louisianensis*.—Since 1993, our field surveys have revealed numerous populations (>40) of *C. louisianensis* in southeastern Louisiana and

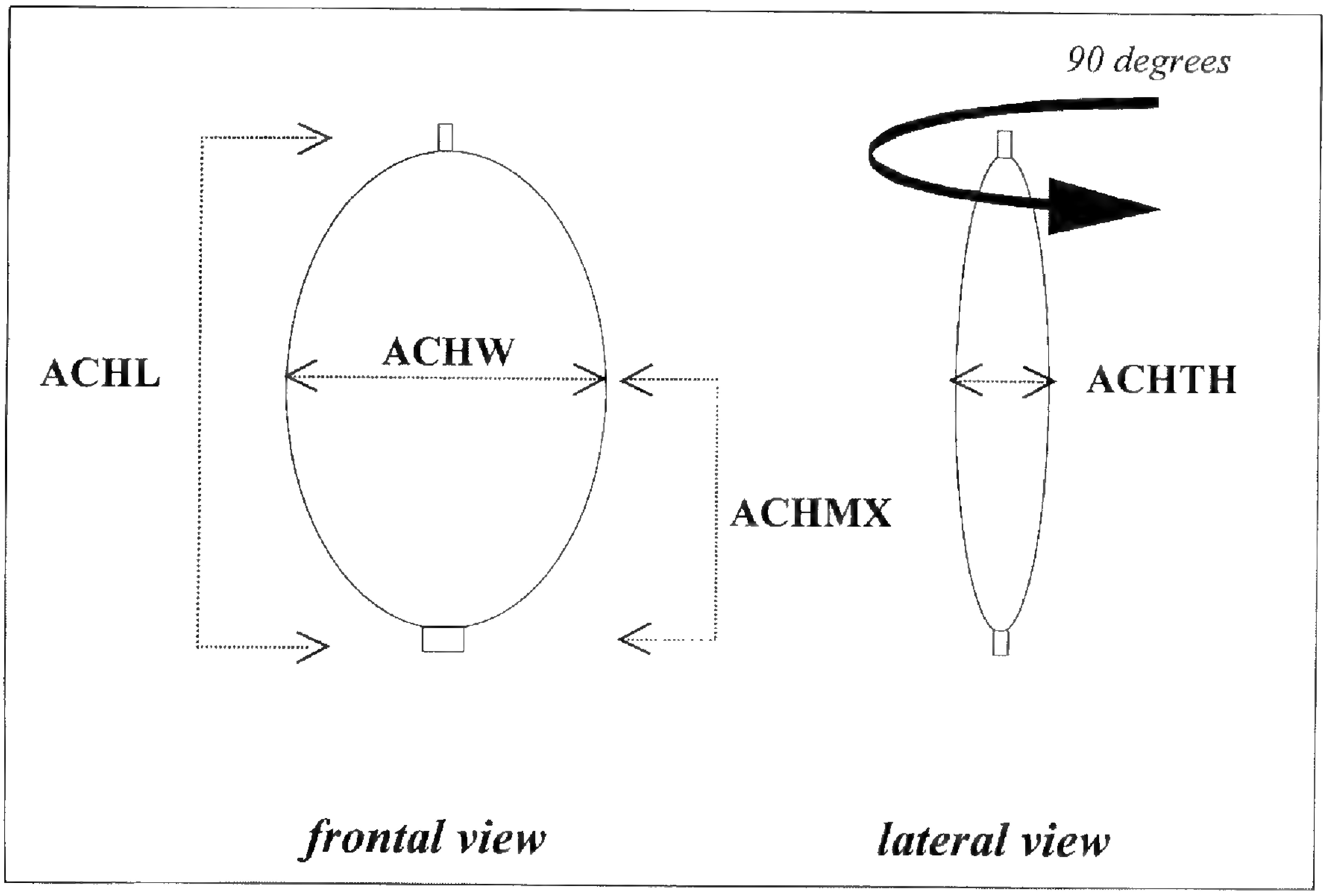

Fig. 1. Frontal and lateral aspects of achene showing dimensions measured in comparing *Cyperus louisianensis* and *C. sanguinolentus*.

Table 3. Quantitative characters and ratios employed in analysis of specimens of *Cyperus louisianensis* and *C. sanguinolentus*. Ratios defining plane shapes adapted from Stearn (1992).

ACHL	Achene length (mm)
ACHW	Achene width (mm)
ACHMX	Achene distance from base to widest point (mm)
ACHTH	Achene thickness (mm)
ACHTH/ACHL	Ratio used by Thieret (1977).
ACHL/ACHW	Ratio approximates achene outline, e.g. elliptic (2:1), ovate & obovate (3:2), orbicular (1:1).
ACHL/ACHMX	Ratio approximates achene outline, e.g., elliptic & orbicular (2:1), ovate (<2:1), obovate (>2:1).

southern Mississippi and isolated populations in southern Alabama and southeastern Georgia. *Cyperus louisianensis* appears to be most abundant in Hancock County, Mississippi, and adjacent St. Tammany Parish, Louisiana. Field observations show that *C. louisianensis* is weedy, often locally abundant, and restricted to periodically disturbed habitats, especially those maintained by mowing, such as ditches and edges of artificial ponds, where it appears to be aggressive and frequently forms dense stands often in association with other introduced and native weeds (Table 4).

Greenhouse observations.—In greenhouse experiments, *C. louisianensis* plants emerged from mid- and late May until mid-September each year; plants flowered from late August until mid-December, with peak flowering in early September to early October; and plants subsequently fruited. *Cyperus louisianensis* plants emerging later in the year were shorter at flower initiation than those emerging earlier, suggesting that *C. louisianensis* is photoperiodic. Most of our field collections were made from September 16 through December 9 (see specimen citations for the U.S.A.), with peak fruiting observed and mature plants collected in mid-October; however, a few fruiting plants were observed and/or collected in April and May following a very mild winter (1993–1994). If indeed *C. louisianensis* is photoperiodic, this may account for the few collections of it from May until mid-September by us and by other botanists. All *C. louisianensis* plants transferred into the greenhouse from the field and those grown from seeds in greenhouse experiments died shortly after fruiting, showed no evidence of perennation and, thus, consistently exhibited an annual habit.

Relationship with *Cyperus sanguinolentus*.—Thieret (1977) was limited by a small number of specimens collected from only two sites located less than 10 miles apart. Our larger sample from a wider geographical area shows that *C. louisianensis* is more variable than previously thought in the diagnostic achene characters used by Thieret (1977) to separate it from *C. sanguinolentus*. Figure 2 shows some of the spikelet variation observed in herbarium specimens of *C. sanguinolentus* and *C. louisianensis*. Of the numerous specimens of *C. sanguinolentus* we have examined from throughout the Old World, certain ones from Japan [e.g., *M. Furuse s.n.*, 30 Sep 1959 (GH); *M. Furuse s.n.*, 11 Oct 1960 (GH); *Hutoh 11517* (NY); *Okamoto NSM 584* (BRIT, NY)] are indistinguishable from *C. louisianensis* in general and in spikelet (Fig. 2) and achene characteristics used by Thieret (1977). Our field and herbarium observations show considerable variation in the degree of development of pigmentation and *sulcus* in floral scales. At least some of the variation in floral scale pigmentation appears related to photoperiod and temperature. Field observations in the southeastern United States show that in mid-September the floral scales are typically pale with only faint pigmentation, and by mid-October they are deeply pigmented (cf. Figs. 2A and 2B). Opposite sides of an individual spikelet may also vary greatly in pigmentation (cf. Figs. 2G and 2H). Scatter diagrams (Figs. 3–6) show *C. louisianensis* and *C. sanguinolentus* are indistinguishable with regard to the critical achene characteristics used by Thieret (1977) to separate them.

DISCUSSION

Cyperus louisianensis is widely distributed in the coastal plain of the southeastern United States and is often locally abundant in habitats subject to periodic artificial disturbance and maintenance. Distribution, frequency, and habitat of *C. louisianensis* are indicative of a semi-aggressive weed, not of a narrow endemic species. Furthermore, it appears that the range of this taxon is apparently expanding in the southeastern United States and that its dispersal has possibly resulted in part from road construction and maintenance

TABLE 4. Composite list of taxa associated with *Cyperus louisianensis* in the southeastern United States.

Acer rubrum L.
Acmella oppositifolia (Lam.) Jansen
Andropogon virginicus L.
Aneilema nudiflora (L.) Brenan
Aster tenuifolius L.
Axonopus fissifolius (Raddi) Kuhlm.
Bacopa caroliniana (Walt.) Robins.
Boehmeria cylindrica (L.) Sw.
Boltonia diffusa Ell.
Carex longii Mack.
Centella asiatica (L.) Urb.
Colocasia esculenta (L.) Schott
Cuphea carthagensis (Jacq.) Macbr.
Cyperus compressus L.
C. croceus Vahl
C. cuspidatus H.B.K.
C. difformis L.
C. distinctus Steud.
C. elegans L.
C. esculentus L.
C. filicinus Vahl
C. flavescens L.
C. flavicomus Michx.
C. haspan L.
C. iria L.
C. odoratus L.
C. ovatus Baldwin
C. pilosus Vahl
C. polystachyos Rottb.
C. pseudovegetus Steud.
C. retrorsus Chapm.
C. rotundus L.
C. strigosus L.
C. surinamensis Rottb.
C. virens Michx.
Dichondra sp.
Diodia spp.
Echinochloa spp.
Eclipta prostrata (L.) L.
Eleocharis microcarpa Torr.
E. obtusa (Willd.) Schult.
E. quadrangulata (Michx.) R. & S.
E. tuberculosa (Michx.) R. & S.
Eleusine indica (L.) Gaertn.
Erigeron vernus (L.) T. & G
Fimbristylis annua (All.) R. & S.
F. autumnalis (L.) R. & S.
F. decipiens Kral
F. miliacea (L.) Vahl
F. tomentosa Vahl
Conoclinum coelestinum (L.) DC.
Fuirena breviseta (Cov.) Cov.
Gratiola sp.
Hedyotis uniflora (L.) Lam.
Hydrocotyle umbellata L.
Ipomoea sp.
Iva annua L.
Jacquemontia tamnifolia (L.) Griseb.
Juncus spp.
Kyllinga brevifolia Rottb.
K. odorata Vahl
K. pumila Michx.
Leersia hexandra Swartz
Lilaeopsis sp.
Lippia nodiflora (L.) Greene
Ludwigia octovalvis (Jacq.) Raven
L. repens J.R. Forst.
Lycopus sp.
Magnolia virginiana L.
Mikania scandens (L.) Willd.
Mitreola sessilifolia (Gmel.) G. Don
Myrica cerifera L.
Oxypolis filiformis (Walter) Britt.
Panicum repens L.
Paspalum notatum Flüggé
P. urvillei Steud.
Phyllanthus urinaria L.
Polygonum hydropiperoides Michx.
Polypremum procumbens L.
Rhynchospora corniculata (Lam.) Gray
Sacciolepis indica (L.) Chase
Sagittaria sp.
Salix nigra Marshall
Scleria reticularis Michx.
Setaria sp.
Solidago sp.
Sorghum halapense (L.) Pers.
Sporobolus indicus (L.) R. Br.
Stenotaphrum secundatum (Walt.) Kuntze
Urochloa platyphylla (Munro) Webst.

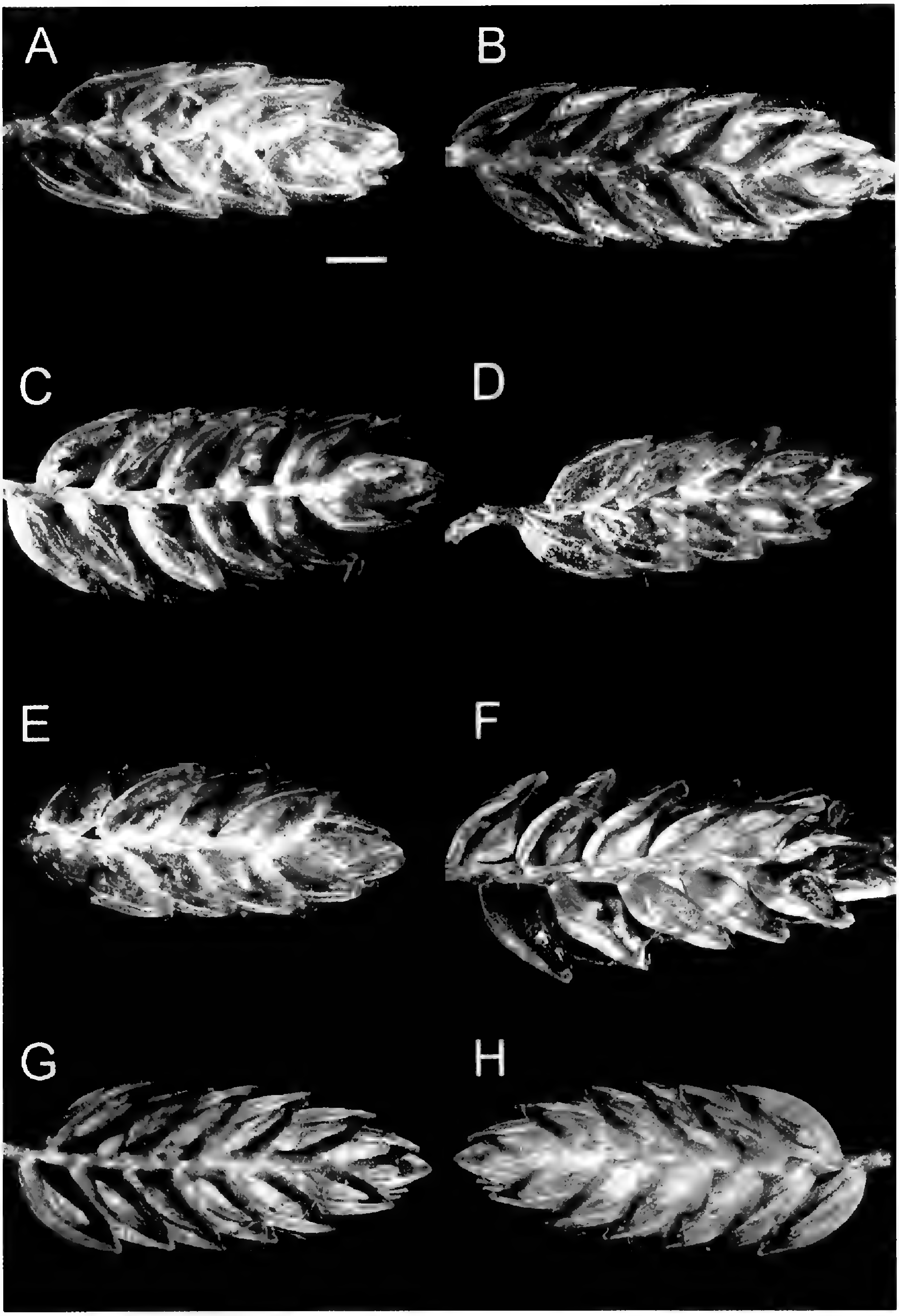

FIG. 2. Spikelet variation in *Cyperus sanguinolentus* and *C. louisianensis*.—A. U.S.A., 16 September 1993, *Carter 11342*.—B. U.S.A., 18 October 1993, *Carter 11562*.—C. U.S.A., *Carter 11579*.—D. Japan, 11 Oct 1960, *M. Furuse s.n.*—E. Japan, *Hotoh 11517*.—F. China, *Tsang 20665*.—G & H. Opposite sides of same spikelet, Japan, *K. Okamoto NSM 584*. Scale bar = 1 mm.

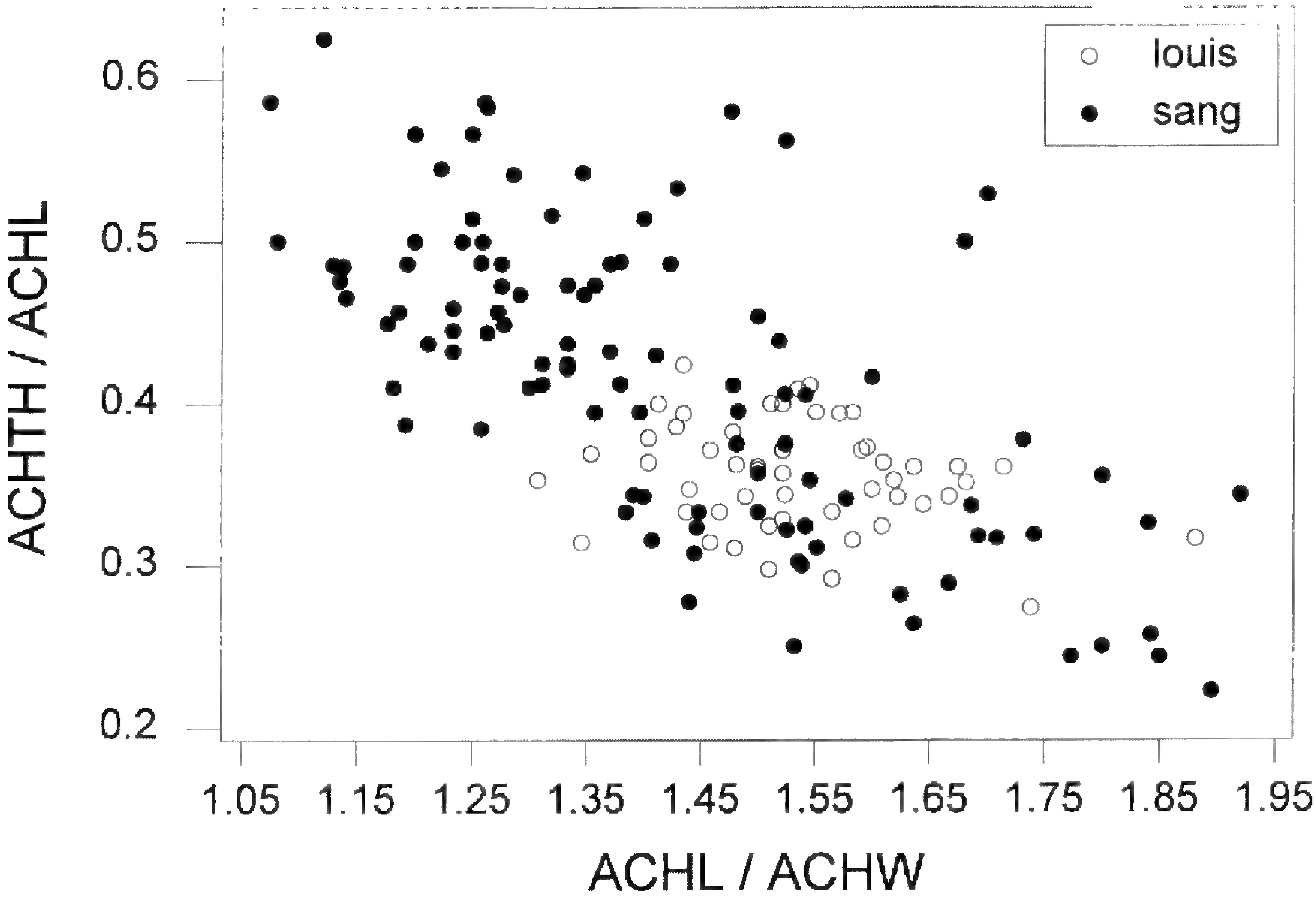

Fig. 3. Two-dimensional scatter diagram showing relationship between *Cyperus sanguinolentus* and *C. louisianensis* with regard to critical ratios defining achene shape; character abbreviations keyed in Table 2.

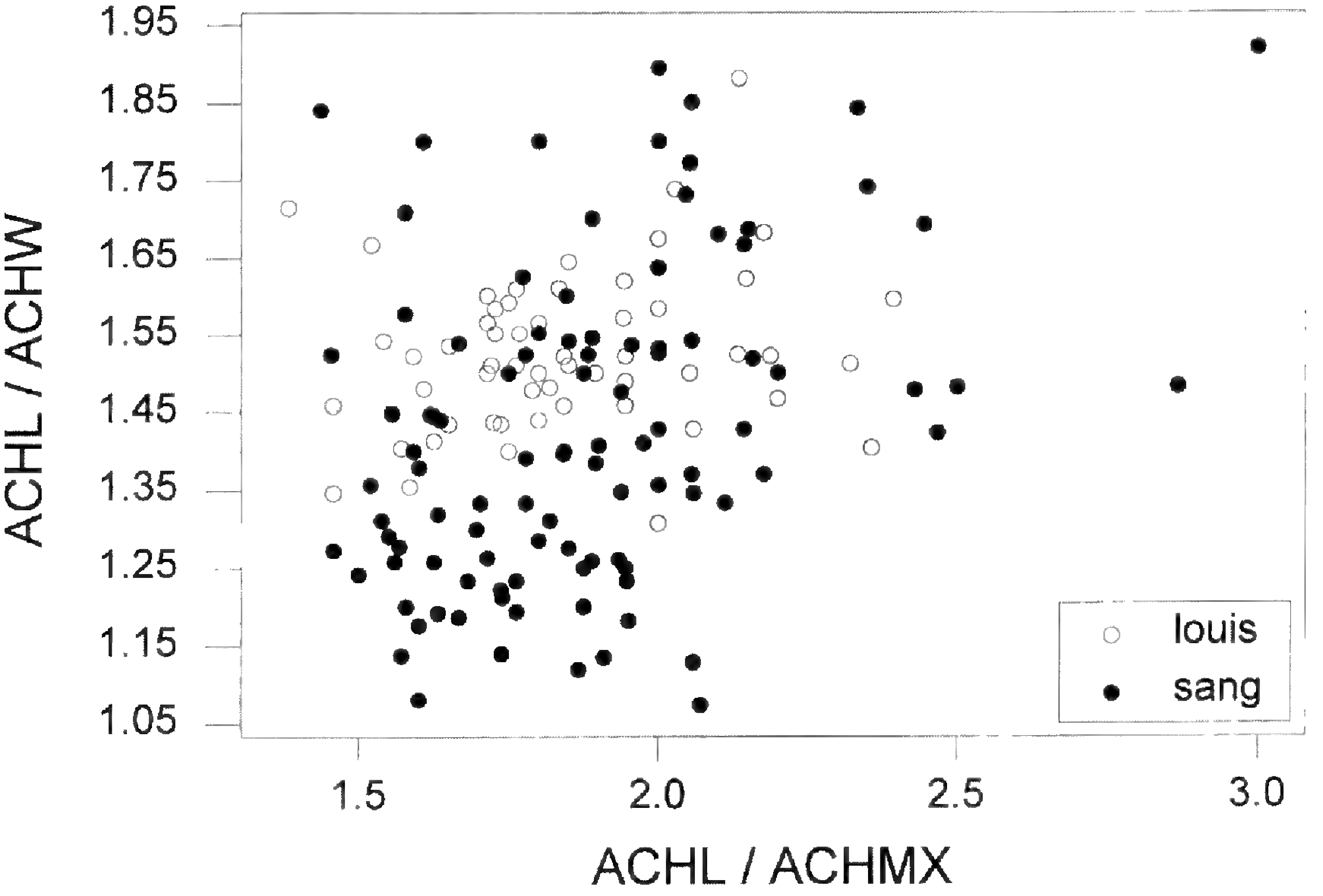

Fig. 4. Two-dimensional scatter diagram showing relationship between *Cyperus sanguinolentus* and *C. louisianensis* with regard to critical ratios defining achene shape; character abbreviations keyed in Table 2.

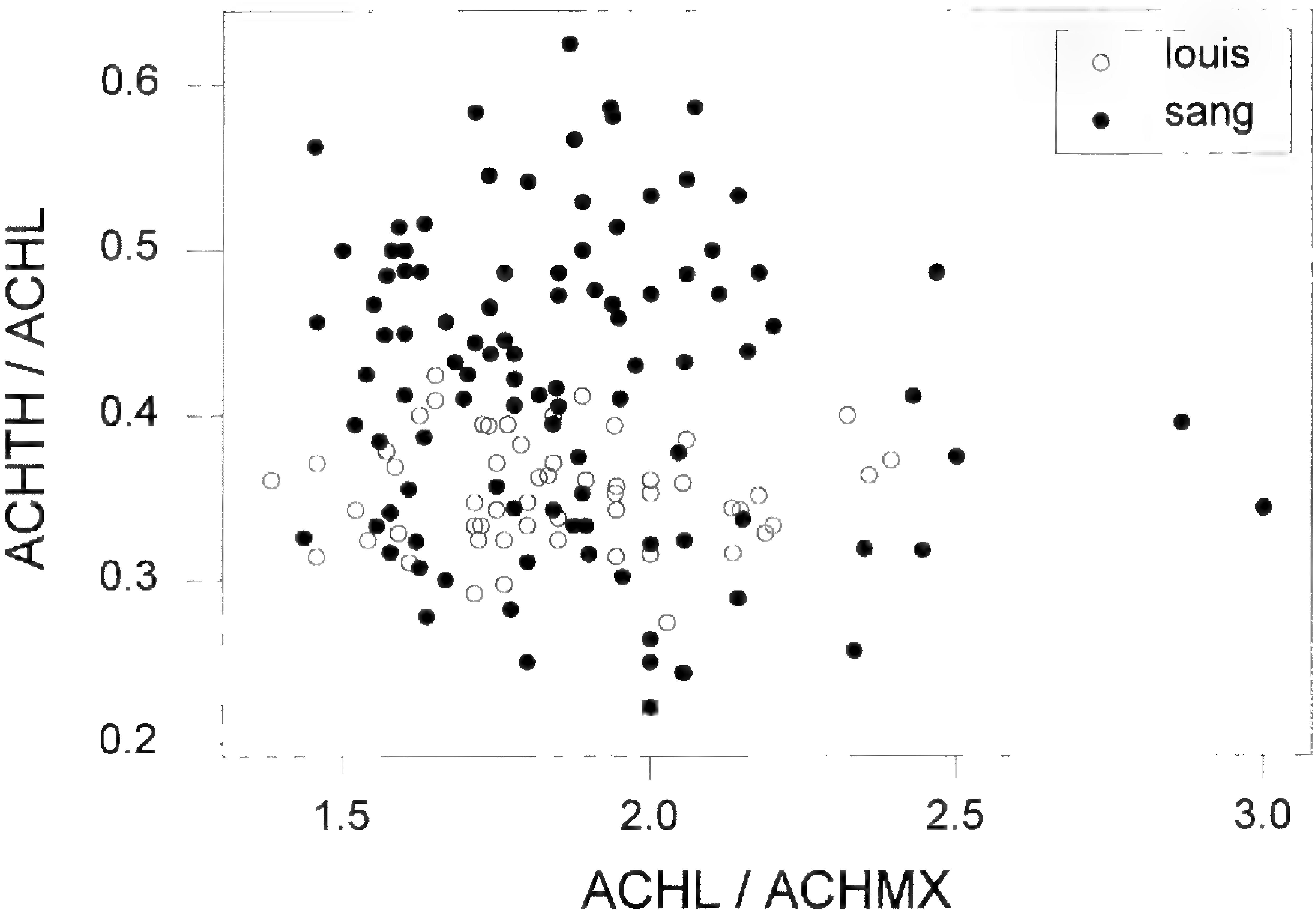

Fig. 5. Two-dimensional scatter diagram showing relationship between *Cyperus sanguinolentus* and *C. louisianensis* with regard to critical ratios defining achene shape; character abbreviations keyed in Table 2.

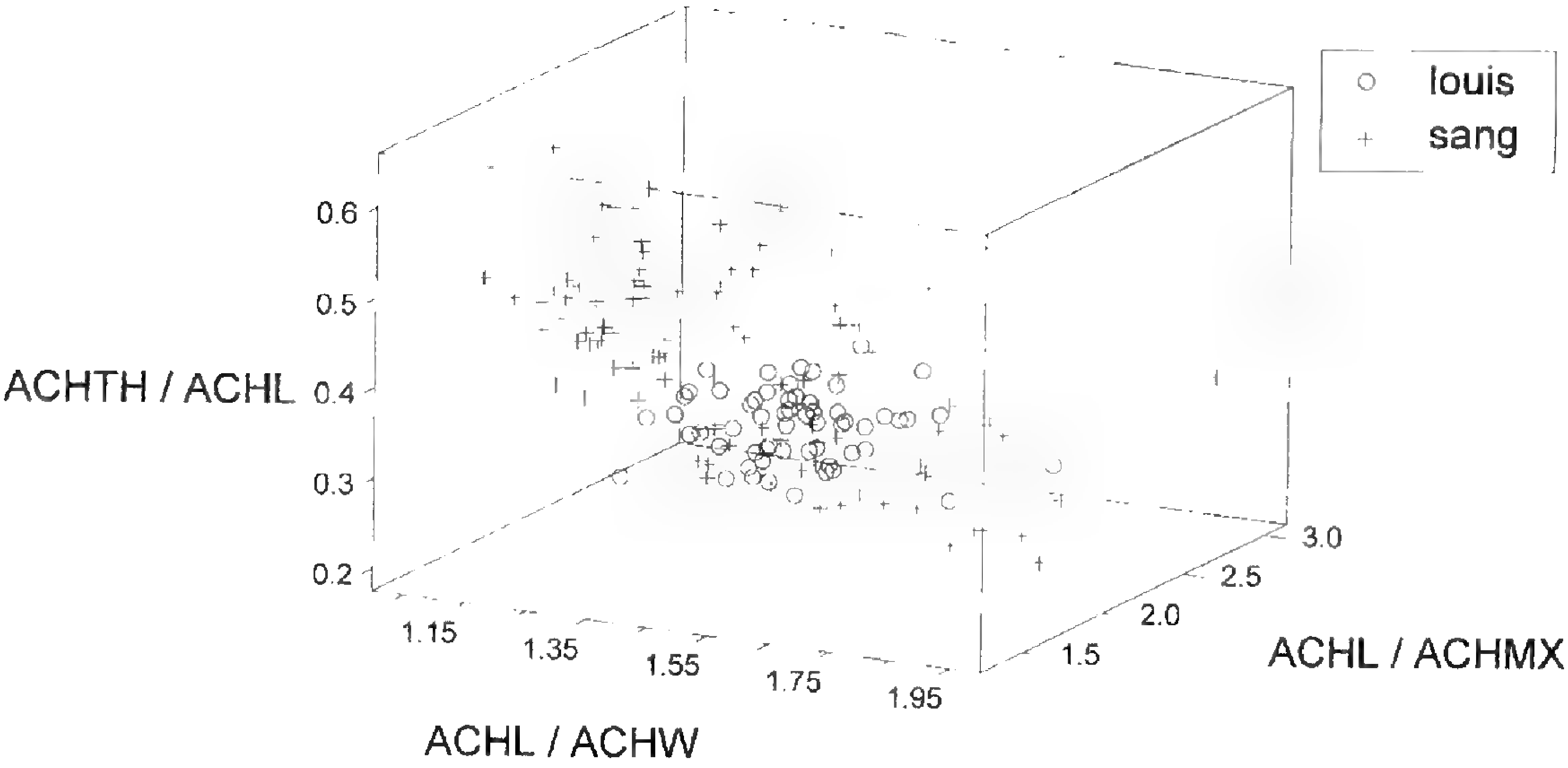

Fig. 6. Three-dimensional scatter diagram showing relationship between *Cyperus sanguinolentus* and *C. louisianensis* with regard to three critical ratios defining achene shape; character abbreviations keyed in Table 2.

activities, as suggested for *C. entrerianus* Boeck. (Carter 1990). At Kings Bay Submarine Base, where extensive populations were found in Camden County, Georgia, road rights-of-way are maintained by work crews traveling from Alabama under contractual service agreements with the Department of Defense (pers. comm., R. Wilkerson). Thus, it is possible that achenes of *C. louisianensis* were accidentally dispersed into Georgia from Alabama, or elsewhere, with the transport of mowing equipment.

Thieret (1977) distinguished *C. louisianensis* from *C. sanguinolentus* based on its more overlapping floral scales and its more elliptical and more flattened achenes (Table 2). Our results indicate the New World populations called *C. louisianensis* are encompassed within the total range of variation exhibited by the more variable widespread Old World weed, *C. sanguinolentus*, and are most similar to certain specimens from Japan. Furthermore, as shown in Figures 3–6, the United States specimens are less variable than those from the Old World, which is consistent with the "founder principle" (Mayr 1942; Davis & Heywood 1973) and would be expected in a case of accidental long-distance dispersal. Although typification of the plethora of synonyms and accepted infraspecific names under *C. sanguinolentus* (Table 1) is beyond the scope of this study, it appears the United States specimens are closest to *C. sanguinolentus* var. *sanguinolentus* (*fide* Kükenthal 1935–1936) or *C. sanguinolentus* ssp. *sanguinolentus* (*fide* Kern 1974).

The presence of *C. sanguinolentus* in the southeastern United States is not unexpected for the following reasons. (1) It has been cited as an agricultural weed in the Eastern Hemisphere (Mingyuan & Dehu 1970; Kern 1974; Kühn 1982; Holm et al. 1991). (2) Reed (1977) listed it among foreign weeds posing "potential problems in the United States." (3) There are numerous other examples of weedy *Cyperus* spp. and other sedges in the southeastern United States introduced from Asia or elsewhere (Carter 1990; Bryson & Carter 1992; Bryson & Carter 1994; Carter et al. 1996; Carter & Bryson 1996; Bryson et al. 1996; Bryson et al. 1997; McKenzie et al. 1998). (4) Kral (1971) reported *Fimbristylis* spp. (Cyperaceae), common in current and former rice-growing areas of the United States, that were likely introduced from Asia with rice (*Oryza sativa* L.) agriculture. (5) Historically, rice was grown in Hancock County, Mississippi, where *C. louisianensis* is most abundant (Anonymous 1959, 1982).

CONCLUSIONS

Cyperus louisianensis is much more widespread than previously thought (Thieret 1977; Bryson & Carter 1994). It is locally common in southern Mississippi and southeastern Louisiana, and satellite populations have been found in southern Alabama and southeastern Georgia. Its habitat and frequency are characteristic of a weed, and its range and frequency are likely to increase, particularly in the outer Coastal Plain of the southeastern United States.

Specimens of *C. louisianensis* from the United States are morphologically indistinguishable from certain Old World specimens of *C. sanguinolentus*. Thus, we think the two are conspecific and treat *C. louisianensis* as a synonym of *C. sanguinolentus*. Herein, we

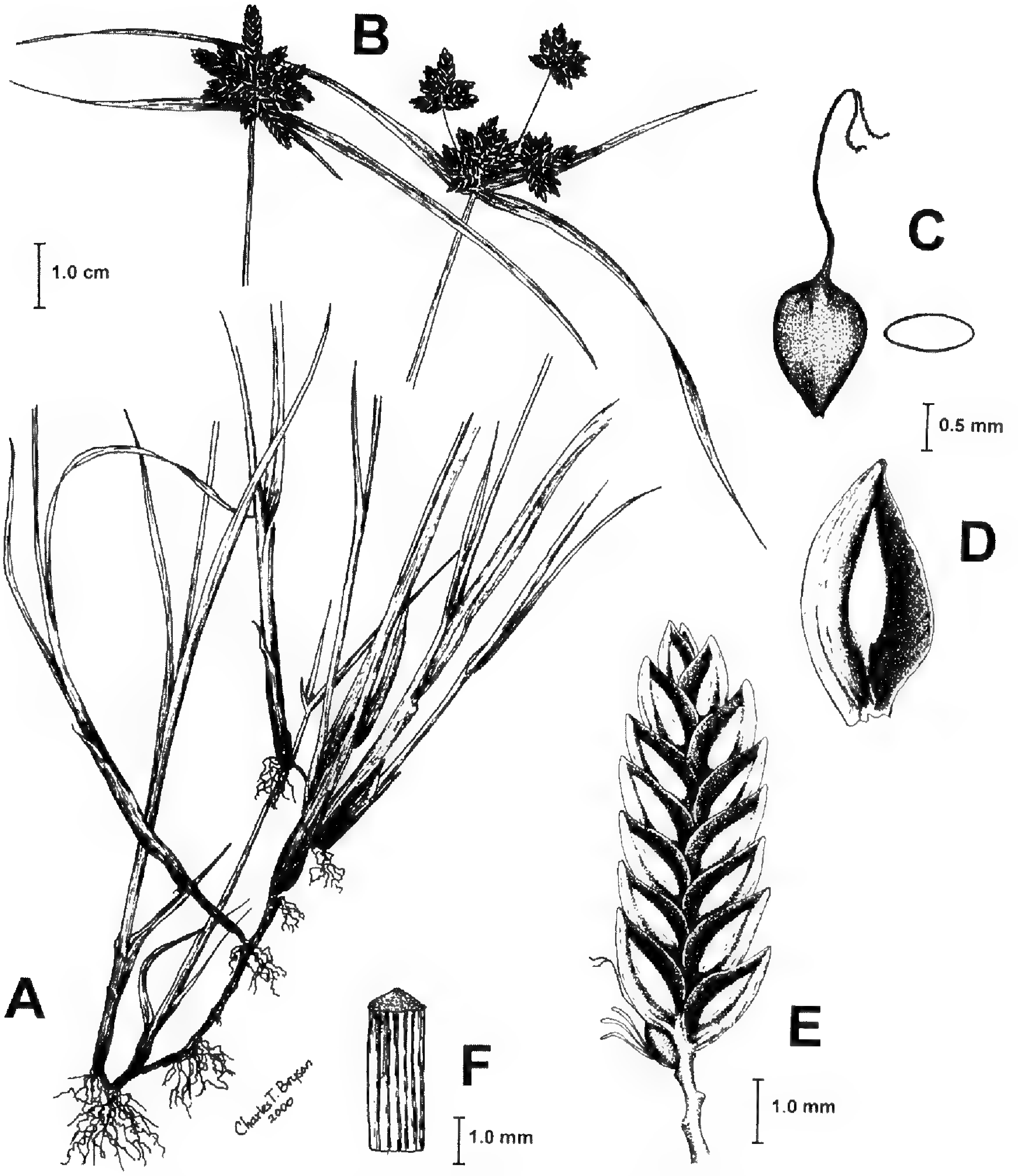

Fig. 7. *Cyperus sanguinolentus* Vahl.—A. Habit, base of plant (*Bryson 14608 & MacDonald*).—B. Inflorescences (left, *Bryson 14610 & MacDonald*; right, *Bryson 13276*).—C. Achene with stigma, style, and cross section outlined (*Bryson 13276*).—D. Floral scale (*Bryson 13276*).—E. Spikelet (*Bryson 13276*).—F. Stem section (*Bryson 13276*).

report *C. sanguinolentus* (including *C. louisianensis*) as new to the United States and North America and provide revised synonymy, description, illustration (Fig. 7), distribution map (Fig. 8), and specimen citations. Additional duplicates collected by the authors will be distributed later.

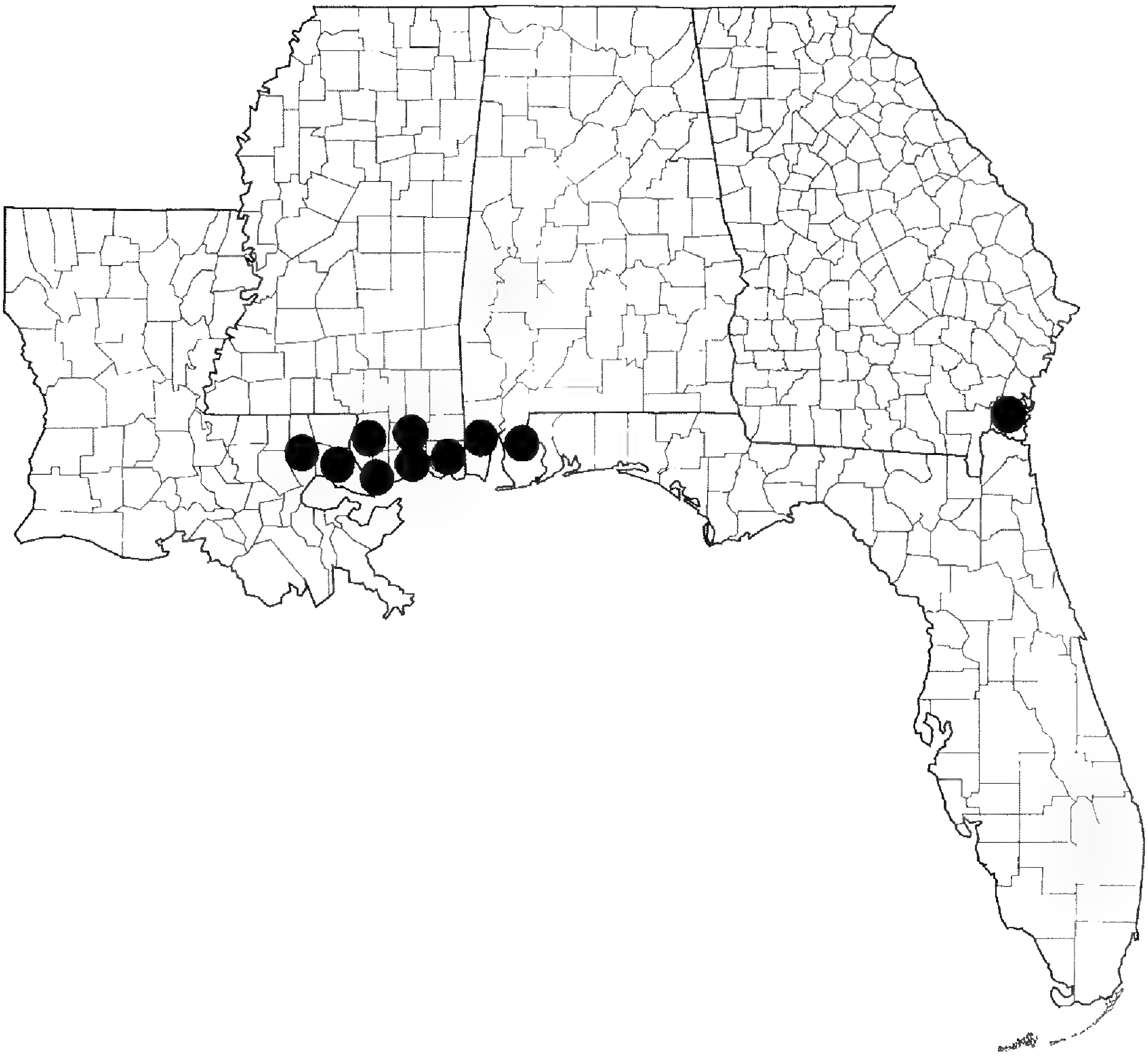

Fig. 8. Distribution by county of *Cyperus sanguinolentus* in the southeastern United States.

DICHOTOMOUS KEY TO *CYPERUS SANGUINOLENTUS* AND RELATED NORTH AMERICAN SPECIES

1a. Floral scales membranous, bilaterally sulcate (with two narrowly elliptic translucent lateral grooves); floral scales usually at least marginally suffused with reddish pigmentation.

  2a. Stamens 2; style divided nearly to base; style branches conspicuously exserted beyond floral scale, exposed portions about as long as floral scale; plants cespitose; plants of northeastern and upper mid-western United States. _____ **C. diandrus** Torr.

  2b. Stamens 3; style divided less than half its length; style branches not so conspicuously exserted, exposed portions less than half as long as floral scale; plants decumbent, appearing stoloniferous by development of series of lateral branches from lower nodes; plants of southeastern United States. _____ **C. sanguinolentus** Vahl

1b. Floral scales firmer, subcoriaceous, not laterally sulcate; floral scales usually brownish, blackish or reddish with pigmentation more-or-less uniformly distributed.

3a. Inflorescence usually appearing capitate; style divided less than half its length; style branches inconspicuous; bracts divaricate to reflexed; plants rhizomatous; plants ranging from southwestern United States southward through much of tropical America. ____ **C. niger** Ruiz & Pav.

3b. Inflorescence usually with 1 or more pedunculate rays; style divided more than half its length; style branches conspicuous, mostly projecting beyond floral scale; bracts mostly divaricate to spreading; plants cespitose, usually in spreading clumps; plants widespread in United States. ____ **C. bipartitus** Torr.

Cyperus sanguinolentus Vahl, Enum. Pl. 2:351. 1805. *Pycreus sanguinolentus* (Vahl) Nees, Linnaea 9:283. 1835. Type: INDIA. Uttar Pradesh: NW Himalaya, Distr. Tehri-Garhwál, 3000 ft, Oct 1894, *Gamble 15117* (L) [typ. cons. prop., Kukkonen 1995].

Cyperus louisianensis J.W. Thieret, Proc. Louisiana Acad. Sci. 40:23. 1977. Type: U.S.A. Louisiana. Tangipahoa Parish: ca. 7 mi E of Ponchatoula, along road to Lee's Landing, 1 Oct 1972, *Thieret 33585* (Holotype: GH!; Isotypes: DUKE, KNK, LAF, NC, OS). Paratypes: U.S.A. Louisiana. Tangipahoa Parish: junction of Ponchatoula-Madisonville highway and road to Lee's Landing, ca. 7 mi E of Ponchatoula, 18 Oct 1970, *Thieret 32609* (DUKE, GH!, KNK).

Annual herb, appearing stoloniferous by repeated development of decumbent vegetative lateral branches from lower nodes. Stems (6.5–)12–38(–60) cm long, 0.7–2.0 mm wide, trigonous. Leaves (1–)3–7; bases sheathing; blades linear, (3–)5–11(–16.5) cm long, (1–)2–3.5 mm wide. Primary inflorescence bracts 2–3(–4), linear; longest (1–)3–12(–19) cm long, 1–3 mm wide. Inflorescence terminal, usually appearing capitate, or with 1–3 pedunculate rays to 4 cm long. Spikelets narrowly ovate-elliptic, 4–10(–15) mm long, 2.2–3.0 mm wide, with 8–32 floral scales. Floral scales mostly closely imbricate, membranous, ovate, 1.8–2.7 mm long, carinate; keel green, 3–5 nerved; sides variable in color, usually variegated whitish, reddish brown to sanguineus, each with a narrowly elliptic translucent sulcus devoid of pigment; reddish pigment and sulcus generally becoming more conspicuous late season. Stamens 3; anthers 0.3–0.6 mm long. Style bifid one-third to one-half its length; stigmas exserted. Achene lenticular, biconvex, 1.0–1.4 mm long, 0.6–0.9 mm wide, 0.3–0.5 mm thick, elliptic to obovate, usually asymmetrical near apex along side adjacent to rachilla; surface reticulate, grayish brown to brown. Fig. 7.

Distribution and habitat.—Widely distributed weed in tropical and subtropical regions of the Eastern Hemisphere; central and eastern Asia, Japan, southeastern Asia, Indonesia, Malaysia, Philippines, Australia, and eastern Africa. Introduced into the outer coastal plain of the southeastern United States of North America, ranging from southeastern Louisiana into southwestern Alabama with an isolated station in southeastern Georgia (Fig. 8). In the southeastern United States often locally common and weedy in periodically disturbed sites with high hydro-period soils (e.g., road ditches, margins of artificial ponds, etc.).

Phenology.—In the southeastern United States, flowering and fruiting from September until frost and sporadically earlier.

Specimens examined. **North America. U.S.A. ALABAMA. Baldwin Co.:** Foley, 1 / Sep 1994, *Burkhalter 14368* (VSC). **Mobile Co.:** Mobile, Battleship Park, Hwy. US 90, 30 May 1994, *Mears 94-25* (ctb, VSC); 12 Sep 1995, *Carter 12705* (VSC). **GEORGIA. Camden Co.:** Kings Bay Submarine Base, 0.2 mi E jct. U.S.S. Henry L. Stimson Dr. and James Madison Rd., U.S.S. Henry L. Stimson Dr., 11 Oct 1996, *Carter 13873* (VSC); just N jct. U.S.S. Benjamin Franklin Rd. and U.S.S. Georgia Ave., U.S.S. Georgia Ave., 25 Oct 1996, *Carter 13939* (VSC); ca. 100 m N jct. U.S.S. Benjamin Franklin Rd. and U.S.S. James Madison Rd., U.S.S. James Madison Rd., 25 Oct 1996, *Carter 13940* (VSC); ca. 200 m S jct. U.S.S. Henry L. Stimson Dr. and U.S.S. Kamehameha Ave., U.S.S. Kamehameha Ave., 25 Oct 1996, *Carter 13941* (VSC); 0.09 mi N jct. U.S.S. Daniel Webster Rd. and U.S.S. Benjamin Franklin Rd., U.S.S. Daniel Webster Rd., 25 Oct 1996, *Carter 13954* (VSC); ca. 300 m E Franklin Gate, S side U.S.S. Benjamin Franklin Rd., 4 Dec 1996, *Carter 13962* (VSC). **LOUISIANA. St. Tammany Parish:** Goodbee, 12 Oct 1960, *Hebert 377* (MISS); Hwy. US 190, 0.35 mi E jct. Hwy. US 190 and LA 1077 in Goodbee, 18 Sep 1993, *Carter 11367* (VSC); Slidell, Hwy. US 190E, 0.84 mi W jct. Hwy. US 190E and I-10, 15 Oct 1993, *Carter 11490* (VSC); Slidell, ICG Railroad right-of-way, 0.14 mi N jct. Hwys. LA 433 and US 11, 15 Oct 1993, *Carter 11505* (VSC); Slidell, Hwy. US 190, 0.10 mi W jct. Hwys. US 190 and US 11, 16 Oct 1993, *Carter 11539* (VSC); Slidell, Hwy. US 190, 1.4 mi W jct. Hwys. US 190 and US 11, 16 Oct 1993, *Carter 11540* (VSC); Lacombe, Hwy. US 190 at Tranquility Road, 16 Oct 1993, *Carter 11541* (VSC); Slidell, Hwy. US 11, 250 ft. S jct. Hwy. US 11 and Carollo Avenue, 17 Oct 1993, *Carter 11558 & Bryson* (VSC), *Bryson 13218 & Carter* (ctb, VSC); Slidell, Hwy. I-10, S jct. Hwys. I-10 and US 190, 17 Oct 1993, *Carter 11561 & Bryson* (VSC); Slidell, SW jct. Hwys. I-10 and LA 533, 17 Oct. 1994, *Bryson 14565 & MacDonald* (ctb, VSC). **Tangipahoa Parish:** ca. 7 mi SE Ponchatoula, ca. 1 mi N Lees Landing, 16 Nov 1989, *Gilmore 3977* (VSC), *Gilmore 3978* (ctb, VSC); 19 Sep 1993, *Carter 11374* (VSC); Ponchatoula, Hwy. LA 22, 0.5 mi E jct. LA 22 and North First Street, 17 Sep 1993, *Carter 11355* (VSC); Ponchatoula, Hwy. LA 22, W jct. Hwy. LA 22 (E. Pine Street) and West Street, 18 Sep 1993, *Carter 11372* (VSC). **MISSISSIPPI. Hancock Co.:** Hwy. MS 43, 0.44 mi N jct. Hwy. US 90 and MS 43 in Waveland, 16 Sep 1993, *Carter 11342* (VSC); 0.8 mi N jct. US 90 and MS 43 in Waveland, 16 Oct 1993, *Bryson 13166 & Carter* (ctb, SWSL, VSC), 17 May 1994, *Bryson 13535* (ctb, VSC); Hwy. MS 43, 5.25 mi E jct. Hwys. MS 43 and I-59 in Picayune, 18 Oct 1993, *Carter 11567 & Bryson* (VSC), *Bryson 13265 & Carter* (ctb, SWSL, VSC); 9.0 mi NW jct. Hwys. 43 and 603 in Kiln, Hwy. MS 43, pipeline crossing, 18 Oct 1993, *Carter 11568 & Bryson* (VSC); 17 May 1994, *Bryson 13542* (ctb, VSC); 21 Oct 1997, *Bryson 16217* (ctb, SWSL, VSC); N of Kiln, 0.6 mi. S jct. of Hwys. MS 43 and MS 603, 18 Oct 1993, *Bryson 13267 & Carter* (ctb, SWSL); Kiln, Hwy. MS 43, 0.6 mi S jct. Hwys. MS 43 and MS 603, 18 Oct 1993, *Carter 11569 & Bryson* (VSC); Kiln, Hwy. MS 43, vicinity Shifalo Baptist Church and Kiln Post Office, 18 Oct 1993, *Carter 11570 & Bryson* (VSC), *Bryson & Carter 13268* (ctb, SWSL, VSC); 21 Oct 1997, *Bryson 16216* (ctb, VSC); jct. of Hwys. MS 43 and I-10 between Kiln and Waveland, 18 Oct 1993, *Carter 11571 & Bryson* (VSC); SE jct. Hwys. I-10 and MS 43, 18 Oct 1993, *Bryson & Carter 13271* (ctb, SWSL, VSC), 17 May 1994, *Bryson 13534* (ctb, VSC); E of Picayune, 5.8 mi E jct. Hwys. I-59 and MS 43, 16 Oct 1994, *Bryson 14537 & MacDonald* (ctb, SWSL, VSC); Mississippi Welcome Center, SE jct. Hwys. I-10 and MS 607, 17 Oct 1994, *Bryson 14567 & MacDonald* (ctb, SWSL, VSC); Kiln, NW jct. Hwy. MS 43 and Kiln-Delisle Road, 17 Oct 1994, *Bryson 14597 & MacDonald* (ctb, SWSL, VSC); Waveland, Nicholson Avenue, 0.2 mi S jct. Hwys. US 90 and MS 43, 18 Oct 1994, *Bryson 14608 & MacDonald* (ctb, SWSL, VSC); Waveland, Central Avenue, between Central Avenue and RR just W Washington Street, 18 Oct 1994, *Bryson 14610 & MacDonald* (ctb, SWSL, VSC); Waveland, NW jct. Hwys. US 90 and MS 43, 7 Dec 1994, *Bryson 14709* (ctb, SWSL, VSC); Waveland, NW jct. Hwys. US 90 and MS 43, 21 Oct 1997, *Bryson 16214* (ctb, VSC), 20 Nov 1998, *Bryson 16939 & Sudbrink* (ctb, SWSL, VSC); Waveland, 1.2 mi S Hwy. US 90 on Nicholson Avenue, then 1.6 mi E on Central Avenue, 21 Oct 1997, *Bryson 16215* (ctb, SWSL, VSC). **Harrison Co.:** Orange Grove Community Center Park, W Hwy. US 49, 0.3 mi N jct. Hwys. US 49 and I-10, 16 Oct 1993, *Bryson 13164 & Carter* (ctb, SWSL, VSC), *Carter 11544 & Bryson* (VSC); Orange Grove, Hwy. US 49, 1.1 mi S jct. Hwy. US 49 and O'Neal Road, 18 Oct 1993, *Bryson 13276* (ctb, SWSL, VSC); N Gulfport, Harrison Drive, 0.3 mi W jct. Harrison Drive and M.L. King Jr. Blvd., 18 Oct 1993, *Carter 11574* (VSC); Popps Ferry Road, 3.32 mi

W jct. Popps Ferry Road and D'Iberville Boulevard (Hwy. MS 67), 18 Oct 1993, *Carter 11577* (VSC); NW jct. Hwys. I-10 and US 49, 18 Oct 1993, *Bryson 13279* (ctb, SWSL, VSC); Long Beach, SE jct. Klondyke and Commission Road, 18 Oct 1994, *Bryson 14606 & MacDonald* (ctb, SWSL, VSC). **Jackson Co.:** Pascagoula, SE jct. Washington Ave. and Louise St., vic. Bayou Casotte, T8S R5W S17, 16 Sep 1991, *Bryson 11032* (ctb, NY, NYS, VSC); 16 Sep 1993, *Carter 11337* (VSC); St. Martin, Rosefarm Road, 0.2 mi N jct. Old Fort Bayou Road and Rosefarm Road, 18 Oct 1993, *Carter 11579* (VSC); vicinity St. Martin, 1.13 mi W jct. Old Fort Bayou Road and Yellow Jacket Boulevard, 18 Oct 1993, *Carter 11580* (VSC); vicinity St. Martin, Old Fort Bayou Road, 0.19 mi E jct. Old Fort Bayou Road and Yellow Jacket Drive, 18 Oct 1993, *Carter 11581* (VSC); Pascagoula, 16 Oct 1994, *Bryson 14547 & MacDonald* (ctb, VSC); Moss Point, SE jct. Hwys. I-10 and MS 63, 16 Oct 1994, *Bryson 14550 & MacDonald* (ctb, SWSL, VSC); Latimer, 1.2 mi N jct. Hwys. I-10 and MS 609, 1.2 mi N Tucker and Cook Roads, along Tucker Road, 16 Oct 1994, *Bryson 14559 & MacDonald* (ctb, SWSL, VSC); Pascagoula, on Hwy. US 90, 1.5 mi. W jct. of Hwys. US 90 and MS 63, 6 Nov 1994, *MacDonald 8195 & Leidolf* (ctb, SWSL); N Ocean Springs, Hwy. I-10, E mi marker 50, 19 Oct 1994, *Bryson 14636* (ctb, SWSL, VSC). **Pearl River Co.:** Picayune, Hwy. MS 43, 0.50 mi W jct. Hwys. MS 43 and I-59, 18 Oct 1993, *Carter 11562* (VSC), 28 Oct 1998, *Bryson 16874 & Sudbrink* (ctb, VSC); Picayune, frontage road W Hwy. I-59, ca. 250 m N jct. Hwys. MS 43 and I-59, 18 Oct 1993, *Bryson 13222 & Carter* (ctb, SWSL, VSC), *Carter 11565 & Bryson* (VSC), 29 Oct 1998, *Bryson 16900 & Sudbrink* (ctb, SWSL, VSC), 9 Nov 1999, *Bryson 17730 & Sudbrink* (ctb, SWSL, VSC); Picayune, N side of Hwy. MS 43, 0.5 mi. W jct. of Hwys. MS 43 and I-59, 18 Oct 1993, *Bryson 13257 & Carter* (ctb, SWSL, VSC); Picayune, SW jct. Hwys. I-59 and MS 43 S, 19 Oct 1994, *Bryson 14634* (ctb, SWSL, VSC); Picayune, 21 Oct 1997, *Bryson 16212* (ctb, VSC); Picayune, 21 Oct 1997, *Bryson 16213* (ctb, VSC). **Stone Co.:** Wiggins, NW jct. Hwys. US 49 and MS 26, 22 Oct 1997, *Bryson 16219* (ctb, VSC).

EURASIA. RUSSIA. Primorski, Distr. Michaelowsky, Repevka Valley, 12 Sep 1929, *Baianova 647* (NY). **BHARAT (INDIA).** Bengal, *Griffith s.n.* (NY); Hassan District, Mysore, tank near Dandiganahalli, 11 Nov 1971, *Hooper & Gandhi HFP 2401* (MO); Sikkim, *J.D. Hooker s.n.* (NY); Maharashtra, Nagpur, Ambala, 2-10-1962, *Donde D28* (NY); Chamba, Khajiar, 11.7.1936, *Koelz 8833* (NY); Pahlgam, 16 Aug 1920, *Stewart & Stewart 5709* (NY); Srinagar, Dal Lake, 13 Jul 1917, *Stewart 3274* (NY); Kulu, Rotang Pass, Sep 1930, *Koelz 1359* (NY). **PAKISTAN.** Baltistan, ca. 1.5 mi E Skardu, alt. Ca. 7500 ft, 26 Aug 1955, *Webster 6585* (GH); Skardu to Shigar, 8 Jul 1940, *Stewart 20472* (NY); Kishenganga Valley and road to Nanga Parbat, below Wangat, Sind Vy., 7 Aug 18080, *Stewart & Stewart 18080* (NY). **NEPAL.** Kali Gandaki, *Stainton, Sykes & Williams 9238* (GH, NY); Kali Gandaki, Tatopani, S of Dana, 30 Aug 1954, *Stainton, Sykes & Williams 7591* (NY); Bongakhani, 22 Aug 1954, *Stainton, Sykes & Williams 3954* (BRIT, NY); Aruna Valley, Sedua, NW of Num, 31 May 1956, *Stainton 485A* (NY); Samri Khola, 7 Apr 1953, *Gardner 141* (NY); Argam, near Pokhara, 11.9.1954. *Stainton, Sykes & Williams 7178* (NY); Jajarkot District, Maina gaon, 12 Aug 1979, *Rajbhandara & Roy 4585* (NY); Rukum District, Gija gaon, 18 Sep 1982, *Rajbhandara & Malla 6535* (NY); Sindjuli District, Patlebhanjyang, 22 Dec 1975, *Shakya & Rajbhandara 3343* (NY); Dolakha District, Lamabagar to Hum, 16 Jul 1977, *Rajbhandara & Roy 1538* (NY). **CEYLON.** Amparia District, Senanaike Samudra, Padagoda, 6 Feb 1971, *Koyama 13983* (GH); Peradeniya, 29 Dec 1967, *Comanor 690* (NY); Central Province, Kandy District, ca. 5 mi SE Gampola, 24 Oct 1974, *Davidse & Sumithraarachchi 7924* (NY); Sabaragamuwa Prov., Ratnapura District, 11 mi E Deniyaya, 22 Oct 1974, *Davidse 7886* (MO, NY); Northwestern Prov., Wilpattu National Park, Manikepola Uttu, 24 Mar 1968, *Heart & Cooray 13460* (NY); Amparai District: Senanaike Samudra, Padagoda, 6 Feb 1971, *Koyama & Balakrishnan 13983* (NY). **CHINA.** Prov. Hainan, Janfengling, *Chow 78471* (GH); Prov. Hunan Sheng, Xinning Xian, Ziyun Shan, 13 Sep 1984, *Li Zhen-yu et al. 1826* (MO); Prov. Hupeh, 1885-88, *Henry 2907* (GH); Prov. Kiangsi, Dagangshan, Fenyi City, 24 Aug 1985, *Yao 9193* (GH, NY); Prov. Sikang, 1935-36, *Wang 66442* (GH); Shanxi, Kolan Hsien, 31 Aug 1929, *Tang 173* (NY); Sichuan, Dujiangyan, E of Longxi, 6 Sep 1988, *Boufford & Bartholomew 24675* (MO, NY); Kweichow, Aug 1930, *Tsiang 6512* (NY), Nov 1930, *Tsiang 9542* (NY); Manchuria, Prov. Kininensis, 18 Jul 1896, *V. Komarov 219* (NY); Kwangtung Prov. Chong Uen Shan near Kau Fung, 2-30 Nov 1932, *Tsang 20665* (NY); Yunnan, *Ducloux 252* (NY);

Hong Kong, Lantao Island, Tungchung, Taishui-hang, 29 Sep 1940, *Taam 1819* (NY). **TAIWAN.** Niitagagun, Hosya, Kusunokizinzya, 14 Oct 1935, *S. Suzuki s.n.* (MO); Little Quemoy, 16 Sep 1961, *Chuang 4469* (GH); Botel Tobago, 16 Aug 1972, *Chang 7110* (NY). **JAPAN.** Hondo, Yamanakako in Kai, 3 Aug 1952, *K. Okamoto NSM 584* (BRIT, NY); Prov. Tootoomi, Pref. Shidzuoka, Hondo, 30 Sep 1959, *Miyoshi Furuse s.n.* (GH), 11 Oct 1960, *Miyoshi Furuse s.n.* (GH); Prov. Kadzusa, Pref. Chiba, Hondo, 5 Sep 1962, *Miyoshi Furuse s.n.* (GH); Prov. Yamashiro: Mt. Hieizan, Shirakawamichi, 9 Sep 1931, *Tagawa 617* (NY); Pref. Mie, Ogurusu, Kiwa-cho, Minamimuro-gun, 17 Nov 1977, *Mimoro, Tsugaru & Deguchi 4289* (MO); Pref. Settsu, Ashiya, 10 Sep 1954, *Hutoh 11517* (NY).

SOUTHEASTERN ASIA. VIETNAM. Tonkin, Chapa, *Petelot 6099* (NY). **THAILAND.** Phetchabun, Phu Miang, 2.10.1967, *Schimizu et al. T.11391* (NY); Chiang Mai, Doi Intanoid, 13 Sep 1974, *Larsen & Larsen 34512* (NY); Maehongson, Khun Yuam, 7 Sep 1974, *Larsen & Larsen 34254* (NY). **INDONESIA.** Lesser Sunda Islands, Flores, near Keli Moetoe, Kampong Ndoearia, 8-6-1938, *Jaag 1801* (GH); Java, Mt Gedeh, Tjibodas, 30 Apr 1950, *Kern 7998* (GH). **PHILIPPINES.** Northern Luzon, Prov. Benguet, Trinidad, 28 Sep 1904, *Williams 1972* (GH, NY).

AUSTRALIA. QUEENSLAND. Moreton District, Brisbane, 5 Aug 1937, *Blake 12965* (GH).

AFRICA. Eritrea. Ocule Cusai, 16 Sep 1902, *Pappi 1799* (NY).

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BOOK REVIEW

Peter Thomas. 2000. **Trees: Their Natural History.** (ISBN 0-521-45963-X, pbk.) Cambridge University Press, 110 Midland Avenue, Port Chester, NY 10573-4930, U.S.A. $24.95 pbk., 286 pp. Line drawings.

From the first sentence in Chapter One, "Everyone knows what a tree is: a large woody thing that provides shade," you know that the book you are about to read is written by someone who has both a sense of humor and general enthusiasm about trees. Peter Thomas, lecturer in environmental sciences at Keele University, UK, brings together information scattered through myriads of journals and books from all parts of the world into one concise text, *Trees: Their Natural History*. Not only vital to healthy ecosystems, but also unparalleled in the range of materials they provide for human use, trees are a fascinating group of plants. This book—written for a non-technical audience—answers such questions as: How do trees work? How are they designed? And how do they grow and reproduce? And in fewer than 300 pages, Thomas provides a comprehensive introduction to the natural history of trees covering their biology and ecology.

Beginning with a preface and an overview of trees, then followed by eight chapters that more specifically address the parts of trees and how they live and die. Chapter Two covers the leaves, Chapter Three the trunk and branches, Chapter Four the roots, Chapter Five flowers, fruits, and seeds, Chapter Six, "The growing tree," Chapter Seven, the shape of trees; Chapter Eight, "New trees from old," and Chapter Nine, "Health, damage, and death." The book is then concluded by a list of further reading and an index. Boxes, black and white photographs, and black and white line drawings are abundant throughout and used appropriately. Another pleasing feature is the list of further reading that follows each chapter. These lists are chapter specific and contain books and journal references not listed in the list of further reading at the end of the book.

The author succeeds in his goal to "draw together strands of information to create a readable book that would answer common questions about trees, set right a number of myths and open up the remarkable world of how trees work, grow, reproduce and die." While written for lay audiences, the book is substantially scientific and the references at the end of each chapter offer the reader more specific academic follow-up information as they desire. *Trees: Their Natural History* would be suitable for introductory botany classes studying trees as well as lay readers looking for answers to questions they've wondered about for years.—*Kevin D. Janni, Botanical Research Institute of Texas, kjanni@brit.org.*

CYPERUS (SUBG. *QUEENSLANDIELLA*) *HYALINUS* (CYPERACEAE) NEW TO THE UNITED STATES AND THE WESTERN HEMISPHERE

Richard Carter

Herbarium, Biology Department
Valdosta State University
Valdosta, GA 31698-0015, U.S.A.

Randy L. Mears

11399 SW 66th Street
Miami, FL 33173, U.S.A.

ABSTRACT

Cyperus hyalinus Vahl is reported from Dade County, Florida, U.S.A. This paleotropical species has not been previously reported from the Western Hemisphere. Its taxonomy and pest potential are discussed. A dichotomous key to the subgenera of *Cyperus* in the United States, technical description, and photographs are provided, and collection data and voucher specimens are cited.

RESUMEN

Se cita *Cyperus hyalinus* Vahl del condado de Dade, Florida, U.S.A. Esta expecie paleotripical no ha sido citada previamente del hemisferio occidental. Se discute su taxonomía y su potencial como mala hierba. Se ofrece una clave dicotómica de los subgéneros de *Cyperus* en los Estados Unidos, descripción técnica, y fotografías, y se citan los datos de la recolección y los pliegos testigo.

INTRODUCTION

In late 1999, the second author discovered a population of an unknown *Cyperus* species in Dade County, Florida. Specimens were sent to the first author for determination and were identified by him as *C. hyalinus* Vahl. *Cyperus hyalinus* has a wide paleotropical distribution, ranging from eastern Africa, Madagascar, Mauritius, India, Sri Lanka, tropical Australia (Queensland), and Malaysia (Kükenthal 1935–1936; Kern 1974; Haines & Lye 1983; Koyama 1985). This remarkable little sedge has not been previously reported from the Western Hemisphere.

The taxonomic relationships of *C. hyalinus* are obscure, and its nomenclature is complex. In addition to *Cyperus*, the species has been treated in the segregate genera *Pycreus*, *Kyllinga*, and *Queenslandiella*. It has also been placed in various subgenera of *Cyperus*, i.e., subg. *Kyllinga* (Kern 1974), subg. *Mariscus* (Kükenthal 1935–1936), subg. *Pycreus* (Clarke 1884), and subg. *Queenslandiella* (Govindarajalu 1975; Haines & Lye 1983). Its lenticular achene, bifid style, compressed spikelets with multiple flowers and fruits, and open anthelate inflorescence suggest a relationship with subgenus *Pycreus*. However, persistent scales and disarticulating spikelets defy placement there and indicate an affinity with *Kyllinga* or *Mariscus*. Because its treatment as a *Pycreus*, *Kyllinga*, or *Mariscus* is problematical, one could segregate it in the monotypic genus *Queenslandiella*; however, consistency would require the segregation of other genera from *Cyperus*, which would upset current nomenclature. Based upon a study of its anatomy, Govindarajalu (1975) placed *C. hyalinus* in monotypic subg. *Queenslandiella* of *Cyperus*. Until there is unequivocal molecular evidence to the contrary, we think a broadly defined *Cyperus* similar to the concept of Haines and Lye (1983) is of value in conserving current nomenclature. Thus, we treat this species in *Cyperus* subg. *Queenslandiella*.

Our objectives herein are to report *C. hyalinus* new to Florida, U.S.A., and the Western Hemisphere and to provide a dichotomous key, technical description, notes, and photographs to facilitate its identification in the United States.

TAXONOMY

KEY TO THE SUBGENERA OF *CYPERUS* IN THE UNITED STATES

1\. Spikelet rachilla remaining attached to rachis, not basally articulated; floral scales and achenes disarticulating from base to apex of rachilla.

  2\. Style branches 3; achenes trigonous.

    3\. Spikelets variously arranged, but not in digitate clusters; plants of various habitats; kranz anatomy present. ________ subg. **Cyperus** L.

    3\. Spikelets in digitate clusters; plants of hydric to mesic habitats; kranz anatomy absent. ________ subg. **Anosporum** C.B. Clarke [=subg. *Pycnostachys* C.B. Clarke]

  2\. Style branches 2; achenes lenticular (rarely turgid and subterete).

    4\. Spikelets laterally compressed; achene angle adjacent to rachilla. ________ subg. **Pycreus** (Beauv.) A. Gray

    4\. Spikelets cylindrical; achene face adjacent to rachilla. ________ subg. **Juncellus** (Griseb.) C.B. Clarke

1\. Spikelet, floral scale, and achene articulation not as above.

  5\. Style branches 3; achenes trigonous; spikelet basally articulated and deciduous as a unit with floral scales and achenes still attached *or* spikelet breaking apart transversely into 1-fruited segments.

    6\. Spikelet basally articulated, deciduous as a unit with floral scales and achenes still attached to rachilla. ________ subg. **Mariscus** (Vahl) C.B. Clarke

    6\. Spikelet breaking apart transversely into 1-fruited segments. ________ subg. **Diclidium** (Schrad. ex Nees) C.B. Clarke [=subg. *Torulinium* (Desv.) Kük.]

  5\. Style branches 2; achenes lenticular to plano-compressed; spikelet basally articulated, deciduous as a unit with floral scales and achenes still attached to rachilla.

    7\. Floral scales more than 2 per spikelet; flowers and fruits more than 1 per spikelet; inflorescence an open anthelus of mostly pedunculate spikes; achenes plano-compressed. ________ subg. **Queenslandiella** (Domin) Govind.

    7\. Floral scales 2 per spikelet; flowers and fruits 1 per spikelet; inflorescence capitate, of 1–several dense sessile spikes; achenes lenticular. ________ subg. **Kyllinga** (Rottb.) J.V. Suringar

Cyperus subg. **Queenslandiella** (Domin) Govind., Reinwardtia 9:194. 1975.

Inflorescence an open anthelus of mostly pedunculate spikes. Spikelets with 2 or more flowers and achenes, basally articulated, falling intact. Floral scales and achenes persistent. Style bifid. Achene plano-compressed, angle adjacent to rachilla. Kranz (chlorocyperoid) anatomy. Subgenus monotypic.

Cyperus hyalinus Vahl, Enum. Pl. 2:329. 1805. Type: INDIA (C). *Queenslandiella mira* Domin, Biblioth. Bot. 85:416. 1915. *Mariscopsis suaveolens* Cherm. Bull. Mus. Hist. Nat. (Paris) 25:60. 1919. *Pycreus hyalinus* (Vahl) Domin, Biblioth. Bot. 85:417. 1915. *Mariscopsis hyalinus* (Vahl) F. Ballard, Bull. Misc. Inform. Kew 9:458. 1932. *Queenslandiella hyalina* (Vahl) F. Ballard in Hook. Icon. Pl. 33:t. 3208. 1933. *Kyllinga hyalina* (Vahl) T. Koyama, J. Jap. Bot. 51:313. 1976.

Loosely cespitose aromatic annual herb. Roots fibrous, brown. Stems glabrous, trigonous, 3–14 cm × 1-2 mm. Leaves 3–7, basal; bases sheathing; blades 4–15 cm × 2–5 mm. Primary inflorescence bracts 4–8, mostly exceeding rays, longest to 12 cm long, 2–4 mm wide. Inflorescence anthelate; rays 3–8, longest 2.5–4 cm long; spikes simple (rarely with short basal branch), mostly pedunculate, oblong-ovate, (7–)12–20 mm × 8–15 mm, with (5–)12–17 mostly divaricate spikelets; rachis grooved, winged. Bracteoles narrowly triangular to aristate, 0.4–2.2 mm long, membranous. Spikelet prophylls rounded to acute, 0.7–1.4 mm long, membranous. Spikelets laterally compressed, narrowly ovate to elliptic, 4.1–5.7 × 1.9–2.2 mm, deciduous; rachilla wing ca. 0.5 mm wide, membranous. Floral scales 4–7 [3–4 fertile], imbricate, broadly ovate, 2.1–2.4 mm long, mucronate, membranous; keel green, scabrid; wings yellowish to whitish to pale green; lateral nerves 6–8. Stamens 2; anthers narrowly oblong, 0.4–0.5 mm long. Style bifid, divided ca. 3/4 of its length. Achene brown, broadly oblong to suborbicular, 1.0–1.4 × 1.0–1.1 mm, plano-compressed, 0.3 mm thick, gibbous, truncate-retuse, minutely puncticulate. Fig. 1.

Phenology.— In the United States, flowering late July through November.

Distribution.—In the Old World, ranging from eastern Africa, Madagascar, Mauritius, India, Sri Lanka, tropical Australia (Queensland), and Malaysia (Kükenthal ibid.; Kern 1974; Haines & Lye 1983; Koyama 1985). Herein reported new to the Western Hemisphere, where so far it is restricted to southern Florida, U.S.A. Fig. 2.

Voucher specimens. **U.S.A. FLORIDA. Dade Co.:** E side of Miami International Airport, just N of Perimeter Rd, road shoulder, sandy soil, 26 Oct 1999, *Randy Mears s.n.* (EIU, FLAS, MICH, MO, US, USF, VDB, VSC).

DISCUSSION

Cyperus hyalinus (Fig. 1) is readily distinguished from all other congeners by the following combination of characteristics: broadly oblong, truncate-retuse, plano-compressed achene; bifid style; 3–4-flowered, deciduous, flattened spikelets; membranous, yellowish to pale greenish, 6-nerved, mucronate floral scales with scabrid keel; and open anthelate inflorescence. Morever, dried specimens exhibit the distinctive odor of fenugreek (*Trigonella foenum-graecum* L.), previously noted by various authors (e.g., Kern 1974; Govindarajalu 1975; Bruhl 1995) and also characteristic of *C. fuscus* L., *C. setigerus* Torr. & Hook, and *C. squarrosus* L. (see McKenzie et al. 1998).

Herein, the range of *C. hyalinus* is extended to North America (Fig. 2), where it is the most recent in a series of exotic *Cyperus* spp. reported new to the United States (Carter

FIG. 1. *Cyperus hyalinus* Vahl.—A. Scanned image of pressed and dried specimen (*R. Mears s.n.*, 26 Oct 1999), scale bar=1 cm.—B. Photograph of spikelet, scale bar=1 mm.—C. Photograph of achenes, scale bar=1 mm.

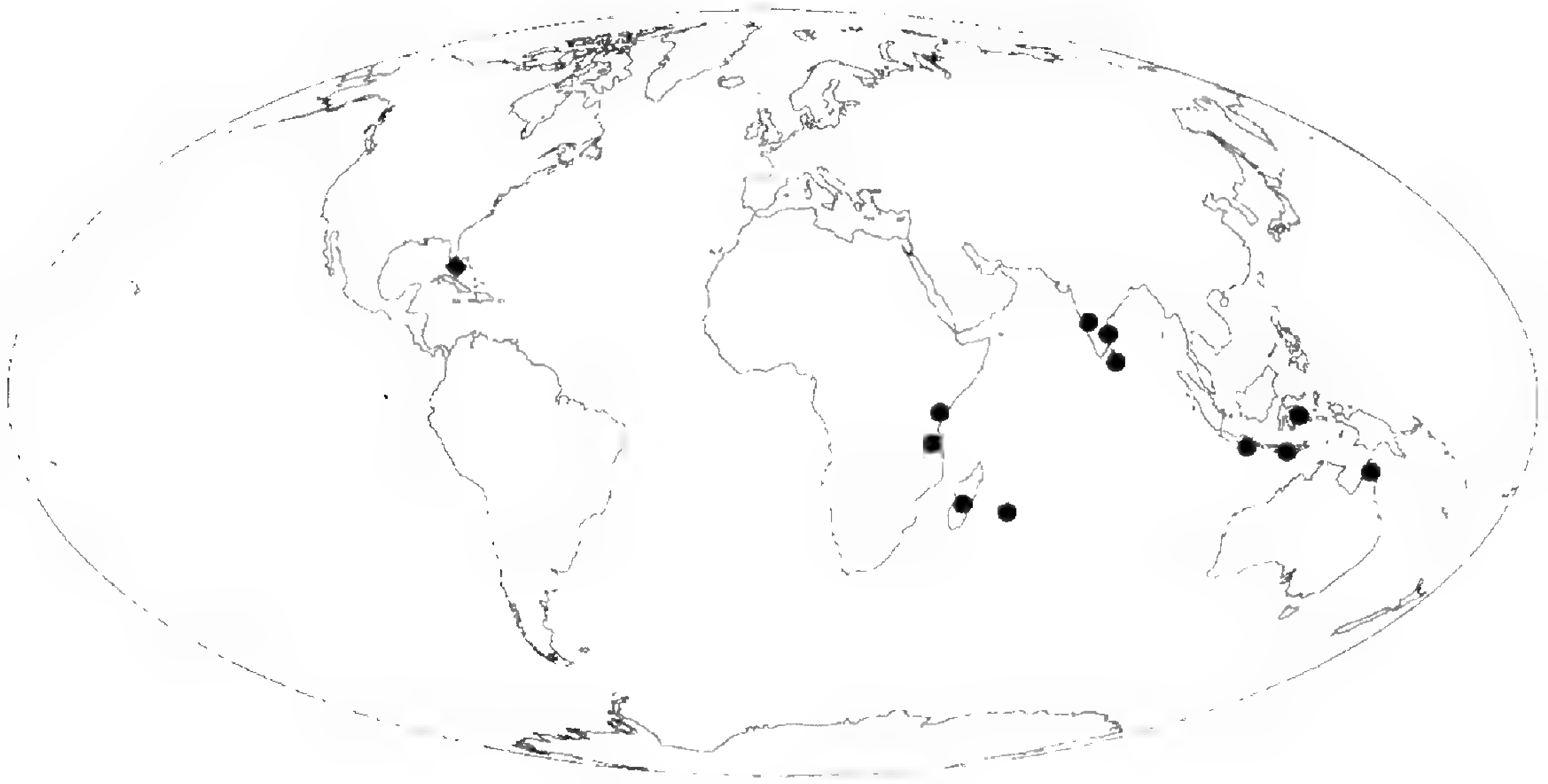

FIG. 2. The worldwide distribution of *Cyperus hyalinus* Vahl based upon specimens cited herein (diamond) and literature citations (Ballard 1932, 1933; Kükenthal 1935–1936; Kern 1974; Haines & Lye 1983; Koyama 1985).

1990; Carter et al. 1996; Carter & Bryson 2000). The broad dispersal of such species is not surprising given their weedy nature, their copious production of small fruits, and the current ease and frequency of rapid, long-distance transportation of humans and cargo. Its rarity and proximity to the Miami International Airport suggest a recent introduction of *C. hyalinus* via shipment of air-freight.

In addition to the original population growing along an open, sandy road shoulder, the second author has discovered another one about one-half mile away along a railroad right-of-way. Plants were observed again at these sites in July 2000 associated with *Bidens alba* (L.) DC., *Cenchrus incertus* M.A. Curtis, *Chamaesyce hirta* (L.) Millsp., *C. hyssopifolia* (L.) Small, *C. maculata* (L.) Small, *Dactyloctenium aegyptium* (L.) Willd. ex Asch. & Schweinf., *Polypremum procumbens* L., *Setaria parviflora* (Poir.) Kerguélen, *Sida elliottii* Torr. & A. Gray, and *Tridax procumbens* L.

The occurrence of *C. hyalinus* in Australia, Madagascar, Mauritius, and Zanzibar is sporadic (Ballard 1932, 1933), and it does not appear to exhibit aggressive or invasive properties in southern Florida. Thus, currently *C. hyalinus* would not seem to threaten native biota in the United States, and its tropical distribution in the Old World suggests establishment is unlikely in more temperate regions of North America. However, it should be monitored and additional populations sought in southern Florida, especially in light of its description as "a weed of sandy soils, near sea level" in eastern Africa (Haines & Lye 1983).

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LEGUMES FROM THE CENTRAL PART OF THE STATE OF CHIHUAHUA, MEXICO

A. Eduardo Estrada C. and Alfonso Martínez M.

Facultad de Ciencias Forestales
Universidad Autónoma de Nuevo León
A.P. 41, 67700, Linares, N.L. MEXICO

ABSTRACT

Our study of the legumes from the central part of the state of Chihuahua records 42 genera and 117 species. The number of genera/number of species for each of the three leguminous subfamilies are: Lotoideae 27/77; Mimosoideae 8/28; Caesalpiniodeae 7/12. Oak-pine forest had the highest number of species. Genera with the highest number of species are: *Dalea* (19), *Acacia* (11), *Phaseolus* (7), *Desmodium* (6), and both, *Senna* and *Mimosa* (5). *Dalea*, *Desmodium* and *Phaseolus* are most common on oak-pine forest communities, while *Acacia*, *Senna*, and *Mimosa* are most common on shrublands and grasslands.

RESUMEN

Nuestro estudio de leguminosas en la porción central del estado de Chihuahua registró 42 géneros y 117 especies. El número de géneros/número de especies para cada una de las tres subfamilias es: Lotoideae 27/77; Mimosoideae 8/28; Caesalpinioideae 7/12. Los géneros con mayor número de especies son *Dalea* (19), *Acacia* (11), *Phaseolus* (7), *Desmodium* (6) y *Senna* y *Mimosa* con (5). *Dalea*, *Desmodium* y *Phaseolus* son mas comunes en los bosques de encino-pino, mientras que *Acacia*, *Mimosa* y *Senna* son mas comunes en matorrales y pastizales.

INTRODUCTION

Legumes are constituted by three subfamilies of plants Mimosoideae, Caesalpinioideae and Lotoideae, and they are the second most diversified group of plants in Mexico after Asteraceae (Sousa & Delgado 1993). Legumes are found in all plant communities of the country, and are one of the dominant groups of plants in north Mexico. They are found on several types of shrublands of Nuevo Leon and Chihuahua (pers. obs.).

The study area covers 7500 km^2, is located at 28° 15'–29° 05' N, 105° 07'–107° 35' W, and includes the eight municipios, Aldama, Aquiles Serdan, Chihuahua, Coyame, General Trias, Julimes, Meoqui and Riva Palacio on a surface of 7500 km^2 (Fig. 1). The study area includes two physiographic provinces (Anónimo 1987), the eastern part of the Sierra Madre Occidental and Sierras y Llanuras del Norte, which has two subprovinces, Bolson de Mapimi and the Sierras Plegadas del Norte. Most rocks are sedimentary or volcanic origin from the Quaternary Period. Most mountains in the area are acidic intrusive igneous rocks from Tertiary Period and metamorphic rocks (limestone) outcrops from the Mesozoic Era, and from the Lower Cretaceous Period (Anónimo 1981). The three main climate types for the area are: (1) very dry semi-warm, characterized by summer rains, the winter rainfall less that 5% of total, the winter cool—characteristic of western part of

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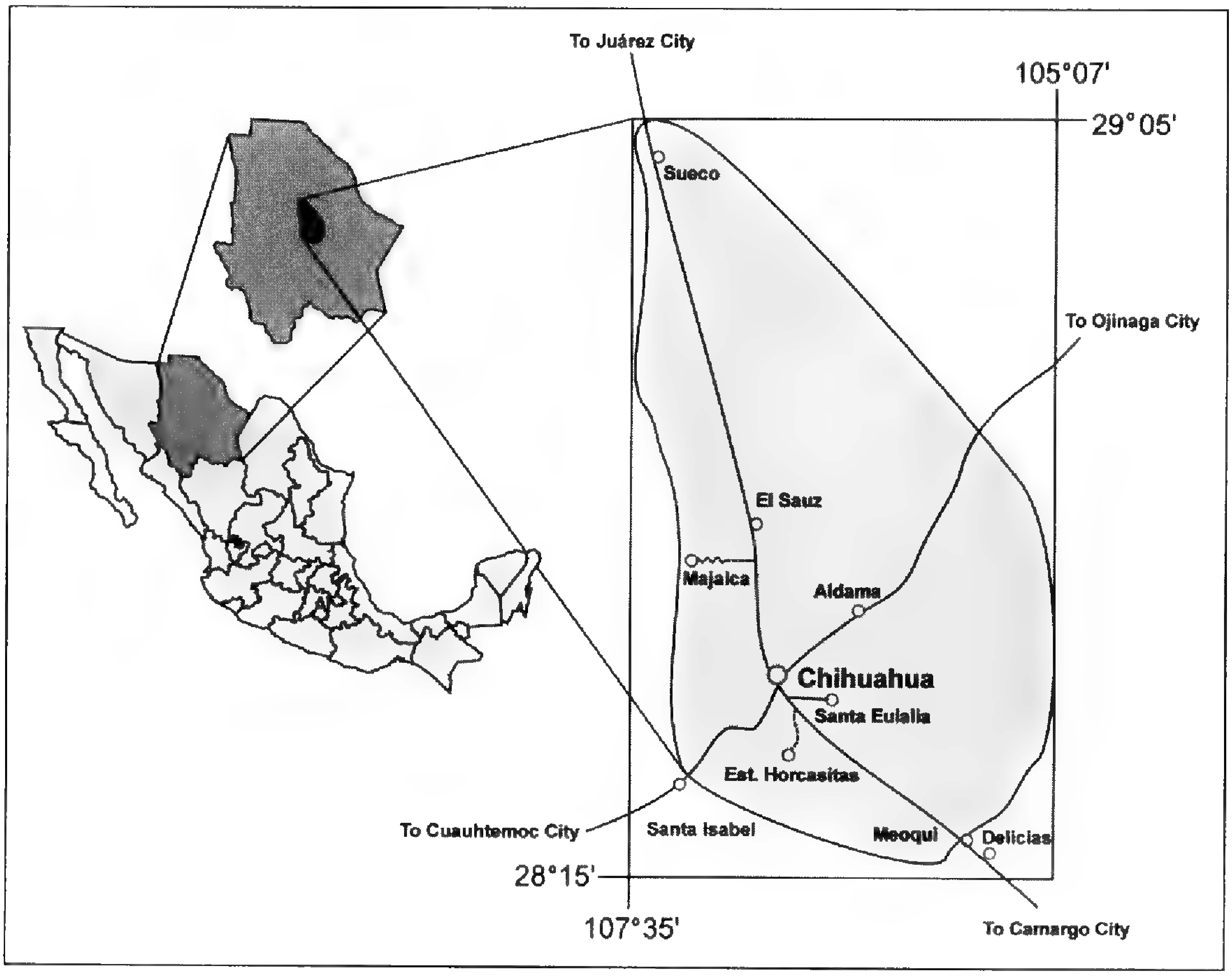

Fig. 1. Map showing study area.

study area, (2) dry, temperate, with summer rains, winter rainfall less than 5% of total, summer warm—occurring as a N-S-oriented 30–40 km wide strip in central part of study area; (3) Semi-warm, semidry temperate, with summer rains, the winter ranges 5–10.2% of total, summer warm—found on high plains and small mountains ranges at 1600–2400 m elev. These climatic types are mapped as BWhw(w), BSokw(w) and BS_1kw, respectively, in Garcia (1973).

There are three main vegetative communities, grasslands, shrublands and oak-pine forest (Rzedowski 1978). *Bouteloua, Sporobolus,* and *Hilaria* are the dominant genera in the grassland landscape, *Bouteloua gracilis* Lag, *B. curtipendula* (Michx.) Torr., *B. eriopoda* (Torr.) Torr., *B. hirsuta* Lag., *Sporobolus airoides* (Torr.) Torr., *Hilaria mutica* (Buckl.) Benth., *Eragrostis intermedia* Hitchc., *E. lehmaniana* Nees, *Enneapogon desvauxii* Beauv., and *Lycurus phleoiodes* H.B.K.,. are the dominant grassland species found. Shrubland communities have mostly low elements, seldom over 2.5 m tall, forming subthorn shrublands (Anónimo 1981), where *Larrea tridentata* (Sess. & Moc. ex DC.) Cav., *Flourensia cernua* DC., *Acacia neovernicosa* Isely, *A. constricta* Benth., *A. schaffneri* (Wats.) Herm., *Lycium berlandieri* Dun., *Koeberlinia spinosa* Zucc., *Condalia ericoides* (A. Gray) M.C. Johnst., *Yucca elata* (Engelm.) Engelm., *Opuntia* spp., *Mimosa* spp., *Celtis pallida* Torr., *Parthenium argentatum* Gray and *P.*

incanum Kunth are the predominant species (Anónimo 1978). Oak-Pine forests are located in mountain areas, north of Cd. Chihuahua, especially Sierra El Nido and Parque Nacional Cumbres de Majalca, and 30–40 km west of Cd. Chihuahua in direction to Cd. Cuauhtemoc. *Quercus-Juniperus* and *Pinus-Quercus* associations are present; most common oak species are *Quercus chihuahuensis* Trel., *Q. grisea* Liebm. and *Q. emoryi* Torr., and in the lower hills and plains, where the woodlands contact the grasslands, *Juniperus monosperma* (Engelm.) Sarg. is more frequent, often forming savanaah. Higher and cooler areas of the mountains have *Quercus hypoleucoides* A. Camus, *Q. arizonica* Sarg., *Q. rugosa* Nee, *Q. grisea* Liebm., *Q. depressipes* Trel., *Pinus cembroides* Zucc., *P. engelmanii* Carr., *P. chihuahuana* Engelm. and *Juniperus deppeana* Steud. Southeast of Cd. Chihuahua *Prosopis glandulosa* Torr. var. *torreyana* (L. Benson) I.M. Johnst., forms dense shrubby areas (mezquital), especially along roadsides and disturbed areas from Cd. Chihuahua to Estación Horcasitas, 25 km SW form Cd. Chihuahua (Anónimo 1981). Pressed and dried vouchers are stored in the herbarium CFNL; incomplete sets are deposited at ANSM, BRIT, MEXU, NMC and TEX (Holmgren & Holmgren 1990).

METHODS

During 1994–1998 numerous routes through all plant communities of the central part of the state of Chihuahua were sampled. On each site where legumes were collected, main vegetation type, geographic coordinates, nearest towns, altitude and slope were recorded. Nine hundred and fifty samples of legumes were collected in this study.

DISCUSSION

Only a partial geographical representation of legumes exist for Mexico. Regional studies have in particular contributed to the knowledge of these plants. Of particular merit are, for southern Mexico, Standley and Steyermark (1946), and Woodson et al. (1980); for central, Matuda (1980), and Rzedowski and Rzedowski (1979); for southwest, McVaugh (1987); for northeastern, Correll and Johnston (1970), Isely (1981), Estrada and Marroquin (1991), Carranza and Villarreal (1997), and Ramos (1999); for northwestern, Munz (1959), Kearney and Peebles (1960), Shreve and Wiggins (1964), Isely (1981), Spellenberg et al. (1996), and Estrada et al. (1997). These studies show distribution, diversity, and ecology of legumes in this country, while this research focuses on additional knowledge on presence, distribution and ecological aspects of the legumes in northern Mexico.

In this study, 42 genera, 117 species and 36 varieties of legumes from the central part of the state of Chihuahua were recorded. Lotoideae has the highest number of genera and species with 27 and 77 respectively, followed by Mimosoideae with 8 and 28 and Caesalpinioideae, with 7 and 12. Appendix 1 shows the taxa by family, and vegetation type(s) where they were more frequently found. *Dalea, Acacia, Desmodium* and *Phaseolus* are the most diverse genera, each with 5 or more species. These genera have species in the three main plant communities. *Dalea* is the genus with more species (19), nine of which occur in pine-oak forest, eight are dominant in grasslands, while six are typical of matorral. The eleven species of *Acacia* mainly occur in plains and low sierras under 1700 m elevation, except for *A. angustissima* that grows in mountainous areas mainly associated to *Bouteloua* grasslands. *Acacia constricta and A. noevernicosa* are the dominant species in matorral communities. Five out of seven *Phaseolus* species are exclusive to pine oak-forest in the cooler parts of the region (Sierra El Nido and Majalca), above 1800 m elevation. All of *Desmodium* species occur in oak or pine forest, only *D. neomexicanum* occurs in the three dominant communities. None of the *Astragalus* species occurs in forest areas, while all of them occur in grassland communities. No species of Caesalpinoideae occur in pine or oak forest, the five species of *Senna* were seldom found in low numbers in matorral and grassland. Most *Mimosa* species were often associated with oak forests, in particular those formed by *Quercus emoryi* and *Q. grisea*, and matorral. In both communities, *M. aculeaticarpa* is the most abundant.

Highest number of legume species were recorded on oak-pine forests (33) and *Bouteloua* grasslands (31). Oak Forest and Pine Forest, each have a similar number of legume species, 21 and 20 respectively. In shrublands where *Acacia* is dominant, 25 species of legumes were recorded, three times the number of species recorded in *Larrea* and *Flourensia* shrubland. Within different grassland association, the *Sporobolus* and *Hilaria* types are areas with lowest legumes, with 9 and 6 species respectively, although they shelter some characteristic species from these plant communities such as *Hoffmanseggia* spp., *Astragalus* spp. and *Peteria scoparia*. Several species are found mainly in disturbed and overgrazed areas, they are *Acacia farnesiana, Mimosa aculeaticarpa* var. *biuncifera, Prosopis glandulosa* var. *torreyana*, *Acacia schaffneri* var. *bravoensis, Crotalaria pumila, Chamaecrista nictitans* and *Senna lindheimeriana*; the last three are found as roadside weeds. *Prosopis glandulosa* var. *torreyana* is one of the main species associated with median grassland (*Bouteloua* spp.) in central plains, especially in the area between Chihuahua-El Sueco and Chihuahua-Estación Horcasitas. *Acacia farnesiana* occurs throughout Mexico (Clarke at al. 1989), except for Chihuahua. In this study we found it occasionally in abandoned agricultural lands, close to human settlements and next to roads, around Cd. Aldama.

Eight legume species (7.5%) are introduced, *Caesalpinia gilliesii, Parkinsonia aculeata, Albizia julibrissin, Medicago sativa; Medicago lupulina, Lablab purpureus, Robinia pseudoacacia*, and *Wisteria sineneis*, the latter three are cultivated as ornamental plants. Eighty eight species are native of northern Mexico, some of them occur in southern U.S. From the approximately 135 genera and 1724 legume species present in Mexico (Sousa & Delgado 1993), 31.1% and 7.1% of them respectively are present in the study area. Grasslands and shrublands cover 95% of the studied area, but they have lower legume diversity than oak-pine forest, which represent only 5% of the surface. Total taxa recorded are distributed in a 7500 km^2 surface (lower than a tenth part of the state territory) on three main vegetal communities from the seven recognized for the state of Chihuahua (Anónimo 1978). A very different and heterogeneous relief, altitude, climate and vegetation association on the western part of the state of Chihuahua, reveal a constant legume species diversity, especially on cooler oak, pine, oak-pine forests and subtropical shrublands. Spellenberg et al. (1996) list 30 genera and 65 legume species from Parque Nacional Cascada de Basaseachi; Estrada et al. (1997) list 21 genera and 53 species in Babicora Lake. Table 1 shows the affinities of legumes in the three studied areas. The most oustanding contrast in the areas is the presence of 14 genera in central Chihuhahua, absent from Basaseachi and Babicora (*Desmanthus, Peteria, Painteria, Albizia, Prosopis, Zapoteca, Hoffmanseggia, Pomaria, Parkinsonia, Lablab, Melilotus, Nissolia, Pediomelum, Robinia,* and *Wisteria*), and seven genera in Basaseachi, absent from Babicora and Central Chihuahua, these are *Conzattia, Pithecellobium, Lysiloma,* typical of moist warm environments and *Erythrina, Lathyrus, Marina* and *Minkelersia.* In Babicora no Caesalpinioideae occurs, while in Basaseachi, three species were found, all of which had tropical affinity. *Dalea* is conspicuously more abundant in the center of the state than in the other two areas, fourteen of the central species are absent in Babicora and Basaseachi. All of these are from semiarid climates. *Desmodium* is more diverse in Basaseachi, seven of its species, that are absent in the other two areas, are more common in moist environments. Perhaps the greater species diversity of legumes found for the central part of the state reflects the variation on climate, soil and topography of this region. These three factors are in sharp contrast in plains, sierras and mountains, and thus affect the distribution and abundance of different taxa.

TABLE 1. Subfamilies, genera and species of legumes in three regions of the state of Chihuahua.

	Basaseachi Spellenberg et al. (1996)	**Babicora Estrada et al. (1997)**	**Central Chihuahua**
Subfamilies	3	2	3
Total genera	30	22	42
Total species	65	53	117
Genera/species Caesalpiniodeae	3/3	0	7/12
Genera/species Mimosoideae	4/6	3/4	8/28
Genera/species Lotoideae	23/56	19/49	27/77
Genera exclusive to the region	9	0	15
Genera with more than three species	7	5	11
***Acacia* species**	3	1	11
***Dalea* species**	7	9	19
***Desmodium* species**	14	8	6
***Mimosa* species**	0	1	5
***Phaseolus* species**	4	4	7

APPENDIX 1

Subfamilies, genera and species of legumes are recorded for the central part of the state of Chihuahua and plant communities where most frequently found. **HG,** *Hilaria* Grassland; **SG,** *Sporobolus* grassland; **BG,** *Bouteloua* grassland; **SL,** Shrubland (*Larrea* as dominant); **SF,** Shrubland (*Flourensia* as dominant); **SA,** Shrubland (*Acacia* as dominant); **SP,** Shrubland (*Parthenium* as dominant); **OF,** Oak forest; **OPF,** Oak-Pine forest; **PF,** Pine Forest; **D,** Disturbed Areas; **C,** Cultivated.

MIMOSOIDEAE

Acacia angustissima (P. Miller) Kuntze. var. *chisosiana* Isely [**SA, SF, BG**]
Acacia angustissima (P. Miller) Ktze. var. *texensis* (T. & G.) Isely [**SA, SL**]
Acacia berlandieri Benth. [**SA**]
Acacia biaciculata S. Wats. [**BG, HG, SG, SA**]
Acacia constricta A. Gray [**SA**]
Acacia farnesiana (L.) Willd. [**D**.]
Acacia glandulifera S. Wats. [**SA, SF**]
Acacia greggii A. Gray var. *arizonica* Gray [**BG, SA, SP**]
Acacia greggii Gray var. *greggii* [**SA, SP**]
Acacia neovernicosa Isely [**SA, SF, SP, SL**]
Acacia roemeriana Scheele [**SA**]
Acacia schaffneri (Wats.) Herm. var. *bravoensis* Isely [**D, SA, SL**]
Acacia wrightii Benth. [**SA**]
Albizia julibrissin Durazz. [**C**]
Calliandra conferta Gray [**SA, SL, SP, BG**]
Calliandra eriophylla Benth. var. *eriophylla* [**SA, SL**]
Calliandra humilis Benth. var. *reticulata* (A. Gray) L. Benson [**OF, OPF**]
Calliandra humilis Benth. var. *humilis* [**OF, OPF**]
Desmanthus cooleyi (Eat.) Trel. [**BG, SA, SL, OF**]
Desmanthus. virgatus (L.) Willd. [**BG, SA, SF**]
Mimosa aculeaticarpa Ort. var. *biuncifera* (Benth.) Barneby [**D, SA, OF**]
Mimosa dysocarpa Benth.[**BG, OF, OPF**]
Mimosa emoryana Benth. var. *chihuahuana* (B. & R.) Barneby [**OF, SA**]
Mimosa emoryana Benth. var. *emoryana* [**OF, SA**]
Mimosa pringlei Wats. var. *pringlei* [**SA, OF**]
Mimosa texana (Gray) Small var. *texana* [**SA, SF**]
Painteria elachistophylla (Watson) Britton & Rose [**SA, SL**]
Painteria leptophylla (DC.) Britton & Rose [**BG, OPF**]
Prosopis glandulosa Torr. var. *torreyana* (L. Benson) M.C. Johnst. [**BG, SG, SA SL, SF**]
Prosopis laevigata (H. & B. ex Willd.) M.C. Johnst. [**SL**]
Prosopis pubescens Benth. [**SL**]
Zapoteca media (Mart. & Gal.) H. M. Hern. [**OF**]

CAESALPINIOIDEAE

Chamaecrista nictitans (L.) Moench ssp. *nictitans* var. *mensalis* (Greenm.) Irwin & Barneby [**BG, D**]
Caesalpinia gilliesi (Hook.) Benth. [**SG, C**]
Hoffmanseggia glauca (Ort.) Eifert. [**BG, HG, SG**]
Parkinsonia aculeata L. [**D**]
Pomaria jamesii (T. & G.) Walp. [**HG, GS, BG**]
Pomaria multijuga (S. Watson) B. B. Simpson [SA] (cited by Simpson 1998).
Senna bauhinioides (Gray) Irwin & Barneby [**HG, SG, BG, SL, SF, SA**]
Senna lindheimeriana (Scheele) Irwin & Barneby [**D, BG**]
Senna pilosior (Macbride) Irwin & Barneby [**SP, SL**]
Senna ripleyana (Irwin & Barneby) Irwin & Barneby [**SL, SF, BG**]
Senna wislizeni (Gray) Irwin & Barneby var. *wislizeni* [**SL, SF, SA**]

LOTOIDEAE

Aeschynomene fascicularis Schlecht. [**SA, BG**]
Astragalus allochorus Gray var. *playanus* (Jones) Isely [**BG, D**]
Astragalus mollissimus Torr. var. *earlei* (Greene ex Rydb.) Tidest. [**SG, HG, BG**]
Astragalus mollissimus Torr. var. *irolanus* (Jones) Barneby [**BG. SG**]
Astragalus nuttalianus A. DC. var. *austrinus* (Small) Barneby [**BG, HG, SA**]
Astragalus pringlei Wats. [**BG, D, SA**]
Astragalus quinqueflorus S. Wats. [**BG, HG**]
Astragalus wootonii Sheld. [**D, BG, SA, SF**]
Cologania angustifolia H.B.K. [**OPF, OPF**]
Cologania obovata Schlecht. [**PF, PF**]
Coursetia caribaea (Jacq.) Lavin var. *sericea* (Gray) Lavin [**OF, BG**]
Coursetia caribaea (Jacq.) Lavin var. *caribaea* [**OF**]
Coursetia glabella (Gray) Lavin [**OPF, PF**]
Crotalaria pumila Ort. [**D, SA**]
Dalea brachystachya Gray [**D, SL, SA**]
Dalea filiformis Gray [**PF, OPF**]

Dalea foliolosa (Ait.) Barneby var. *foliolosa* [**OPF, PF**]
Dalea formosa Torr. [**SL, SA, SF, SP**]
Dalea grayi (Vail) L.O Williams [**OPF, OF, PF**]
Dalea humilis G. Don. [**PF, OPF**]
Dalea jamesii (Torrey) T. & G. [**BG**]
Dalea lachnostachya Gray [**SL, SA**]
Dalea leporina (Aiton) Bullock [**BG, OPF, OF**]
Dalea leucostachya Wats. var. *leucostachya* [**OF, OPF**]
Dalea lutea (Cav.) Willd. var. *lutea* [**SA, OPF**]
Dalea mollis Benth. [**BG**]
Dalea nana Torr. var. *carnescens* (Rydb.) K. & P. [**BG SA**]
Dalea neomexicana (Gray) Cory var. *neomexicana* [**BG**]
Dalea pogonathera Gray var. *pogonathera* [**BG, SA, SF, SP, SG, HG**]
Dalea prostrata Ortega [**BG**]
Dalea versicolor Zucc. var. *glabrescens* (Rydb.) Barneby [**OPF, PF**]
Dalea versicolor Zucc. var. *sessilis* (Rydb.) Barneby [**OPF, PF**]
Dalea viridiflora Wats. [**OPF**]
Dalea wrightii Gray [**BG**]
Desmodium angustifolium DC. [**OF**]
Desmodium batocaulon Gray [**OPF, PF**]
Desmodium hartwegianum Hemsl. var. *hartwegianum* [**PF, OPF**]
Desmodium neomexicanum Gray [**SA, OF, BG**]
Desmodium grahamii Gray [**OF, BG**]
Desmodium retinens Schlecht. [**OPF**]
Eysenhardtia spinosa Engelm. [**SA, SP**]
Galactia macreii M.A. Curtis [**OF**]
Galactia wrightii Gray [**SA, D**]
Indigofera montana Rose [**OPF, PF**]
Indigofera ornithopodioides Schlecht. & Cham. [**SA, OF**]
Lablab purpureus (L.) Sweet [**C**]
Lotus greenei (Woot. & Standl.) Ottley ex Kearney & Peebles [**OPF, PF**]
Lotus oroboides (H.B.K.) Ottley ex Kearney & Peebles [**OF, OPF**]
Lotus plebeius (Brandeg.) Barneby [**PF**]
Lupinus aff. *delicatulus* Sprague & Riley [**PF**]
Lupinus ehrenbergii Schlecht. [**OF, OPF**]
Macroptilium gibbosifolium (Ort.) A. Delgado [**BG, D, OPF**]
Medicago sativa L. [**D, BG**]
Medicago lupulina L. [**BG**]
Melilotus indicus (L.) All. [**D**]
Melilotus officinalis L. [**D**]
Nissolia pringlei Rose [**SF, SA, SL, D**]
Nissolia wislizeni (Gray) Gray [**SF, BG**]
Pediomelum palmeri (Ock.) Grimes [**SG, BG**]
Peteria scoparia Gray [**BG, SG, HG**]
Phaseolus acutifolius Gray [**SA, OF**]
Phaseolus angustissimus Gray [**BG**]
Phaseolus grayanus Woot. & Standl. [**OF, OPF, PF**]
Phaseolus leptostachyus Benth. [**OF, OPF, PF**]
Phaseolus parvulus Greene [**OF, OPF, PF**]
Phaseolus ritensis Jones [**OPF, OF**]
Phaseolus vulgaris L. [**D**]
Rhynchosia macrocarpa Benth. [**SA, OF, OPF**]
Rhynchosia senna Gill ex Hook. var. *angustifolia* (Gray) Grear [**D, SA**]
Robinia pseudoacacia L. [**D, C**]
Sophora gypsophila B.L.Turner & Powel [**SG, SA, SF**]
Tephrosia tenella Gray [**SA**]
Trifolium amabile H.B.K. var. *amabile* [**OPF, PF**]
Trifolium carolinianum Michx. [**OPF, PF**]
Trifolium wormskioldii Lehm. var. *ortegae* (Greene) Barneby [**OPF, PF**]
Vicia ludoviciana Nutt. ssp. *ludoviciana* [**OPF, PF**]
Vicia pulchella H.B.K. ssp. *pulchella* [**OPF, PF**]
Wisteria sinensis (Sims.) Sweet [**D, C**]
Zornia gemella (Willd.) Vog. [**SA, OF, OPF**]
Zornia reticulata Sm. [**OF, OPF**]

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A VASCULAR FLORA SURVEY OF CALCASIEU PARISH, LOUISIANA

Ray Neyland and Billie J. Hoffman

Department of Biological & Environmental Sciences
McNeese State University
Lake Charles, LA 70609, U.S.A.

Mark Mayfield and Lowell E. Urbatsch

Department of Plant Biology
Louisiana State University
Baton Rouge, LA, 70803, U.S.A.

ABSTRACT

Located in southwestern Louisiana, Calcasieu Parish is composed of five major vegetation regions. These regions are defined by their respective vascular plant composition and physiography. A field survey of the vascular flora of the approximately 2,844 square kilometers that make up the Parish was conducted from August 1995 to October 2000. Additionally, specimens housed in various Louisiana herbaria were examined to complete the survey. Names of the 1,147 specific and subspecific entries representing 147 families found during this survey have been compiled in an annotated catalogue that includes collector name and collection number for one representative specimen and a designation as to whether each species is considered native or introduced. Vegetation regions where each species occurs are included in the catalogue. An additional 134 taxa reportedly collected in Calcasieu Parish that were not discovered during our field research nor located during our visits to other herbaria are also listed. *Euphorbia texana* is reported new for Louisiana.

Key Words: Vascular Plant Survey, Calcasieu Parish, Louisiana

RESUMEN

Localizado en el suroeste de Louisiana, la parroquia de Calcasieu está compuesta por cinco regiones de vegetación principales. Estas regiones se definen por su composición florística y su fisiografía. Una prospección de campo de la flora vascular de los aproximadamente 2,844 kilómetros cuadrados que componen la parroquia fue realizada desde agosto de 1995 a octubre de 2000. Adicionalmente, especímenes albergados en varios herbarios de Louisiana fueron examinados para completar el estudio. Los nombres de las 1,147 entradas especificas y subespecíficas que representan las 147 familias encontradas durante esta prospección se han compliado en catálogo comentado que incluye nombre del colector y número de la recolección de un espécimen respresentativo y una designación de cada especie sobre si se considera nativa o introducida. Se incluyen en el catálogo las regiones de vegetación en que vive cada especie. Se listan también 134 taxa adicionales citados como colectados en la parroquia de Calcasieu que no se encontraron durante la investigación de campo ni en las visitas o otros herbarios. *Euphorbia texana* se cita como nueva para Louisiana.

Located in southwestern Louisiana, Calcasieu Parish lies adjacent to Beauregard Parish to the north, Jefferson Davis Parish to the east, Cameron Parish to the south and the State of Texas to the west (Fig. 1). Summers in the Parish are hot and humid; winters are warm but are occasionally interrupted by freezing temperatures (Hardner 1960; Roy &

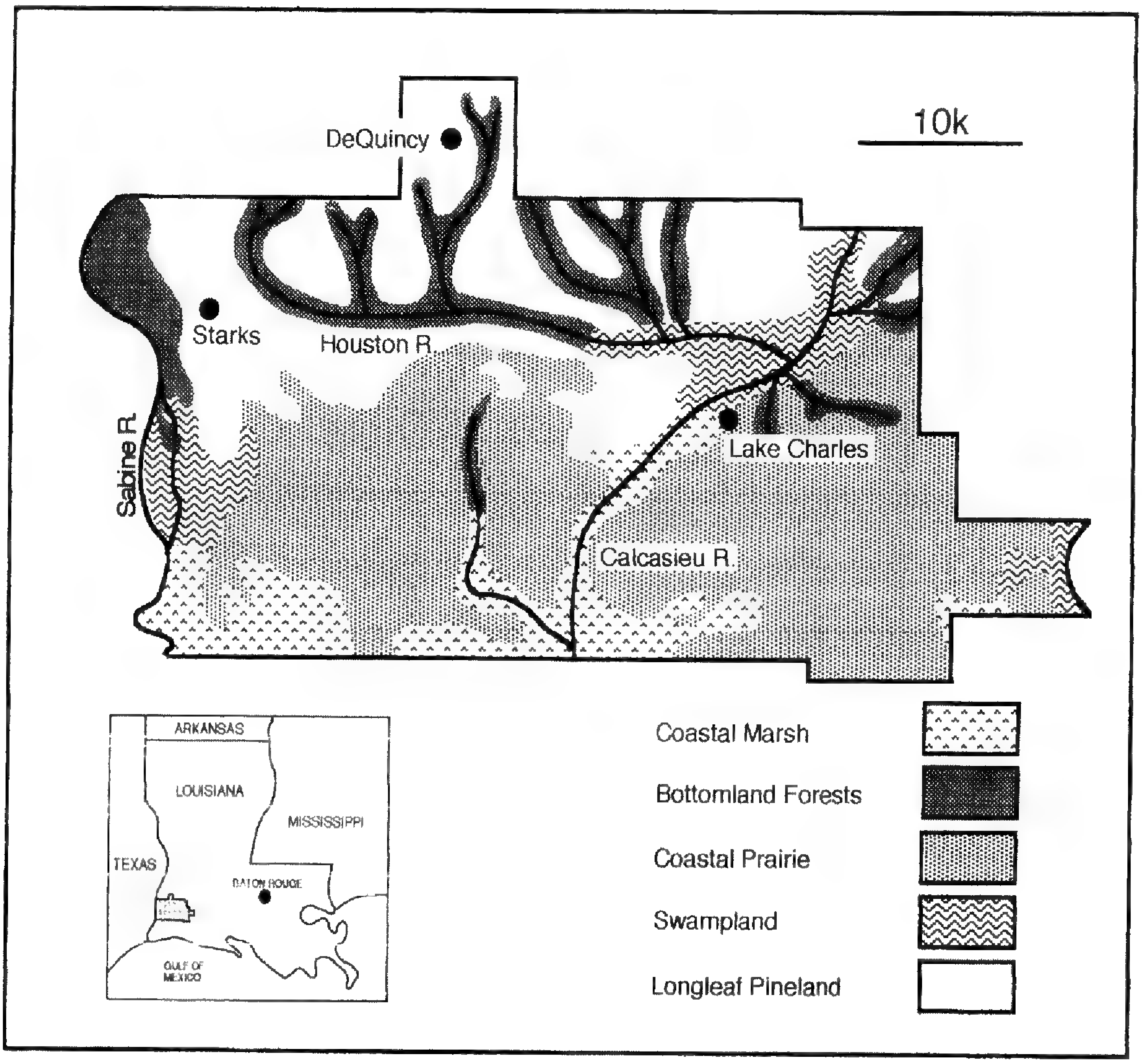

Fig. 1. The major vegetational regions of Calcasieu Parish, Louisiana. Inset shows the location of the Parish within the State.

Midkiff 1988). Annual precipitation averages 135.1 cm (Roy & Midkiff 1988). The Parish is occasionally impacted by hurricanes.

Elevation in Calcasieu Parish ranges from sea level to 29 meters (Roy & Midkiff 1988). The Calcasieu and Houston rivers drain the central and eastern portions of the Parish, and the Sabine River (Hardner 1960) drains the western portion. The Sabine Diversion Channel runs west to east near the center of the Parish and diverts water from the Sabine into the Calcasieu River. The Intracoastal Waterway is situated in the extreme southern part of the Parish and runs from Calcasieu Lake to the Sabine River. Barge traffic is extensive in the Intracoastal and to a point north of Lake Charles on the Calcasieu River (Jones et al. 1954; Roy & Midkiff 1988). A deep-water port is located in Lake Charles (Jones et al. 1954).

Calcasieu Parish lies in the West Gulf Coastal Plain geomorphic province (Fenneman 1938). Surface sediments are of Recent and Pleistocene deposits, and are underlain by

Tertiary rocks (Hardner 1960; Roy & Midkiff 1988). The recent deposits generally consist of fine sand, silt and clay and occur along the southern edge of the parish and in the Sabine and Calcasieu river valleys (Hardner 1960). The Pleistocene deposits consist of stream-transported sediment washed down during the past four glaciation periods (Hardner 1960).

Approximately 46% of the Parish's land is devoted to either agriculture or rangeland; approximately 23% is woodland; 11% is marsh, 4% swamp and the remaining area is urban (Roy & Midkiff 1988). Land use is primarily devoted to producing timber, raising cattle, and growing rice and soybeans. Large petroleum-related industries are present in the Parish and are concentrated around the area of West Lake.

The purpose of this study is to survey Calcasieu Parish for all vascular plants that are native or introductions that appear to be naturalized and to define and map the vegetation regions the Parish. Cultivars and introductions that do not appear to be naturalized are excluded from the survey.

METHODS

Approximately 2,000 plant collections from Calcasieu Parish were made between August, 1995 and October 2000. Voucher specimens were prepared using standard herbarium practices and are housed in the McNeese State University (MCN) herbarium. Specimens from the following Louisiana herbaria were examined to complete this survey. These herbaria include: University of Louisiana at Lafayette (LAF); Louisiana State University (LSU), University of Louisiana at Monroe (NLU) and Tulane University (NO).

Specimens were identified primarily through the use of the following references: Allen (1992); Correll & Correll (1941); Correll & Johnston (1970); Cronquist (1980); Duncan (1975); FNA (1993, 1997); Godfrey (1988); Godfrey & Wooten (1979, 1981); Gould (1975); Radford et al. (1968) and Small (1933). For divisions Filicophyta (ferns), Lycopodiophyta (lycopods), Equisetophyta (horestails), and Coniferophyta (conifers), nomenclature follows FNA (1993). For Magnoliophyta (angiosperms) subclasses Magnoliidae and Hamamelidae, nomenclature follows FNA (1997). For all remaining subclasses, nomenclature follows Kartesz (1999). Appropriate experts were consulted to help identify problematic taxa. These experts include Charles Allen, (Poaceae; NLU); Doug Goldman (*Calopogon*); John Hays (*Agalinis*; University of Louisiana, Monroe); Phil Hyatt (Carex; United States Forestry Service, Pineville, LA); David Moore (various rare taxa; United States Forestry Service, Pineville, LA); Guy Nesom (Asteraceae; North Carolina Botanical Garden); Latimore Smith (various rare taxa; National Heritage Program, Louisiana Department of Wildlife & Fisheries, Baton Rouge, LA).

From an analysis of plant collection data and recent soil survey maps (Roy & Midkiff 1988), vegetation regions within Calcasieu Parish were defined and mapped.

RESULTS

Collections made by the authors form the majority of the annotated list of vascular plants for Calcasieu Parish (Appendix I). The list includes 1,147 specific and subspecific entries representing 147 families and 530 genera. Twenty-nine ferns, lycopods and horsetails account for about 3% of the Calcasieu Parish flora and six gymnosperms account for less than 1%. The remaining flora consists of angiosperms. About 15% of the Calcasieu Parish flora are introductions.

One-hundred and thirty-four taxa reportedly collected in Calcasieu Parish (MacRoberts 1988; Thomas & Allen 1993, 1996, 1998) that were not discovered in field research nor located during our visits to other herbaria are listed in Appendix II. Likely reasons why we were unable to locate these specimens were that they were: 1) on loan; 2) misfiled; 3) overlooked; 4) resident in herbaria not visited. When both confirmed and unconfirmed lists are added, the total number of native and naturalized taxa attributable to Calcasieu Parish is 1,281.

Three-hundred and two species, not previously recorded in the Parish, were discovered during this study. ***Euphorbia texana*** Boiss. is a new record for Louisiana. Five vegetation regions were identified and mapped for the Parish (Fig. 1).

DISCUSSION

Calcasieu Parish is noteworthy for the extreme transition from pinelands in the north to prairie and brackish marsh in the south. Bottomland hardwoods and swamps are associated with the Calcasieu, Sabine and Houston Rivers. Five vegetation regions in Calcasieu Parish are recognized (Fig. 1) and are discussed in terms of soil characteristics, current uses, and dominant species composition.

Coastal Prairie. –This region is characterized by soil that ranges from loamy to clayey, is medium in fertility and is used primarily for urban development, cropland and pastureland (Roy & Midkiff 1988). The main crops are soybeans and rice (Roy & Midkiff 1988). Most of the rice farming is done on the prairie because of its low altitude, low relief and the impervious nature of its subsoil (Jones et al. 1954). Extensive farming and urbanization has heavily impacted the prairie region. Dominant trees in the better-drained soils of higher elevations include *Liquidambar styraciflua*, *Pinus elliottii*, *Pinus taeda*, *Quercus alba*, and *Nyssa sylvatica*. Trees in poorly drained soils of lower elevations include *Quercus nigra*, *Quercus phellos* and *Platanus occidentalis*. Herbaceous plants typically are weedy and include many species of grasses and sedges.

Coastal Marsh.—This region is very low in relief and rarely rises more than 1.5 meters (Jones et al. 1954). Soils in the coastal marsh region range from soft organic to firm mineral clay. These soils are poorly drained, subject to flooding and used primarily for wildlife habitat, recreation and rangeland (Roy & Midkiff 1988). The coastal marsh region is inhabited mostly by grasses and sedges, and is typically devoid of trees (Jones et al. 1954); however *Sapium sebiferum* and *Zanthoxylum clava-herculis* are common along roadsides. Marshes are either fresh or brackish. In general, marshes become more saline the closer they lie to the coast.

Approximately 9,906 hectares of brackish marsh occur in the Parish. Salinity ranges from 0.42 to 28.08 parts per thousand (ppt) with a mean of 8 ppt (Roy & Midkiff 1988).

Marsh associated with the Calcasieu River may be saline up to a point just north of Lake Charles where the river is dammed. Common brackish-marsh herbaceous plants include: *Spartina alterniflora*, *Distichlis spicata*, *Juncus* sp. and *Scirpus* sp. Approximately 7,020 hectares of fresh-water marsh occurs in the Parish. Common fresh-water herbaceous plants include: *Alternanthera philoxeroides*, *Eichhornia crassipes*, *Typha latifolia*, *Pontederia cordata*, and *Sagittaria* sp.

Swampland.—This region makes up about 4% of the parish. Soils are level, fluid, and loamy or clayey throughout (Roy & Midkiff 1988). Swamps are primarily used for wildlife habitat and for recreation. Major swamplands are associated with the Calcasieu River in the northeastern part of the Parish and with the Sabine River in western Calcasieu. Dominant trees include *Nyssa aquatica*, and *Taxodium distichum*.

Longleaf Pineland.—This region was clear cut around 1900 and now serves primarily as forest range and cropland (Roy & Midkiff 1988). However, a few relatively undisturbed sites within the Parish retain many of their original characteristics and are recognizable communities. We recognize four major communities within this region: hillside seepage bogs, semi-evergreen broadleaf acid seep forests, sodic flatwoods and acid flatwoods.

A single hillside seepage bog occurs in Calcasieu Parish northeast of DeQuincy. This bog appears to be the headwaters of a small unnamed stream. A semi-evergreen broadleaf acid seep forest occurs along the sandy ravine adjacent to the bog. Distinctive herbaceous species in the bog include *Rhynchospora oligantha*, *Sarracenia alata*, and *Utricularia cornuta*.

An area of sodic flatwoods (sensu Smith 1996) occur in the western part of Calcasieu's longleaf pineland vegetation region. These flatwoods are typically saturated during the winter and spring but may become very dry during summer droughts. Herbaceous species are often prairie like and include *Spartina spartinae*, *Chaetopappa asteroides*, *Evolvulus sericeus*, and *Liatris punctata*. The understory woody vegetation is stunted.

A few recognizable acid flatwoods (sensu Smith 1996) occupy the central part of the longleaf pine region within Calcasieu Parish. This community is level to gently rolling with small elevated areas termed "pimple mounds" by Holland et al. (1952). Under natural conditions and frequent fires, these savannahs support a sparse canopy of longleaf pine with few other tree species (Bridges & Orzell 1989). Distinctive herbaceous species in these savannahs include *Stylisma aquatica*, and *Platanthera nivea*. The planting of pine plantations and protecting from fire have nearly eliminated these communities in the Parish.

Bottomland Forests.—This region occurs along the narrow flood plains of the Calcasieu River and its tributaries and along the Sabine River near the Texas border. Soils in this region are level, poorly drained, and loamy throughout (Roy & Midkiff 1988). Dominant trees that occur in bottomland forests include *Liquidambar styraciflua*, *Quercus alba*, *Q. falcata*, *Carya* sp., *Platanus occidentalis*, *Taxodium distichum*, *Pinus taeda*, and *Fraxinus caroliniana*.

APPENDIX 1

Specific and subspecific entries are catalogued within their respective divisions. Angiosperms are further divided into the classes Liliopsida (monocots) and Magnoliopsida (dicots). Taxa are listed alphabetically by family, genus, and species within each category. The format used is species name, authority, reference, and whether the species is considered native or introduced. Taxa that are designated by an asterisk (*) following the author citation are introductions that appear to be naturalized. Authorities are abbreviated according to Brummitt and Powell (1992). A specimen reference includes the name of the collector, the collection number and the herbarium where the vouchered specimen is located. Frequently cited collectors are abbreviated as: A = Allen; B = Brown; C = Cocks; N = Neyland; M = Mayfield; T = Thieret; Th = Thomas. Unless otherwise indicated, specimens from the abbreviated collectors are housed in the following herbaria: A = NLU; B = LSU; C = NO; N = MCN; M = LSU; T = LAF; Th = NLU. One specimen each from Duke University (DUKE), New York Botanical Garden (NY), Missouri Botanical Garden (MO), United States National Herbarium (US) and Vanderbilt University (VDB) are referenced in the annotated list. Following the collection data is an abbreviation for the vegetation region where each species typically occurs: prairie (Pr); fresh marsh (FM); saline marsh (SM); swampland (S); longleaf pineland (Pi); bottomland forests (B). Although not a vegetation region, disturbed areas such as pastures, fallow fields, ditches, urban areas and roadsides are collectively abbreviated (D). Additionally, parasites are designated by (P), lithophytes by (L) and epiphytes by (E). Finally, taxa that have been designated as critically imperiled within Louisiana (S1), imperiled due to their rarity or vulnerability to extirpation (S2), rare and local throughout the state or found locally in a restricted region of the state (S3), reported from Louisiana but without conclusive evidence (SR), or of historical occurrence but no records within the past 20 years (SH) are designated. The Natural Heritage Program of the Louisiana Department of Wildlife and Fisheries determined these rankings.

APPENDIX 1

ANNOTATED CATALOGUE OF SPECIES FOR CALCASIEU PARISH, LOUISIANA

EQUISETOPHYTA

EQUISETACEAE

Equisetum hyemale L. ssp. *affine* (Engelm.) Calder & Taylor, *N 564* **B**

FILICOPHYTA

ASPLENIACEAE

Asplenium platyneuron (L.) B.S.P., *Maples 96* (MCN) **B**

AZOLLACEAE

Azolla caroliniana Willd., N 728, **FM, S**

BLECHNACEAE

Woodwardia areolata (L.) T. Moore, *N 29/* **B, S**

Woodwardia virginica (L.) Sm., *N 1293* **Pi**

DENNSTAEDTIACEAE

Pteridium aquilinum (L.) Kuhn var. *pseudocaudatum* (Clute) Heller, *Maples 97* (MCN) **B, D, Pi**

DRYOPTERIDACEAE

Athyrium filix-femina (L.) Roth ssp. asplenioides (Michx.) Hulten, *Maples 209* (MCN) **B**

Onoclea sensibilis L., *Maples 296* (MCN) **B**

Polystichum acrostichoides (Michx.) Schott, *N 1133* **B**

LYGODIACEAE

Lygodium japonicum (Thunb.) Sw.,* *N 268* **B, FM, D**

OPHIOGLOSSACEAE

Botrychium biternatum (Savigny) L.Underwood, *Maples 106* (MCN) **B**
Botrychium dissectum Spreng., *N 1563* **B**
Ophioglossum crotalophoroides Walt., *N 1215* **B, D**
Ophioglossum nudicaule L.f., *N 1149* **D**
Ophioglossum petiolatum L., *Parker 533* (NLU) **B**

OSMUNDACEAE

Osmunda cinnamomea L., *N 1245* **Pi**
Osmunda regalis L.var.*spectabilis* (Willd.) A.Gray, *N 294* **B, FM**

POLYPODIACEAE

Pleopeltis polypodioides (L.) E. G. Andrews & Windham, *Maples 95* (MCN) **E**

PTERIDACEAE

Pteris vittata L., *N 1415* **L**

SALVINACEAE

Salvinia minima Baker, *N 261* **FM**

THELYPTERIDACEAE

Macrothelypteris torresiana (Gaudich.) Ching,* *Maples 213* (MCN) **B**
Phegopteris hexagonoptera (Michx.) Fée, *N 384* **B**
Thelypteris dentata (Forssk.) E.P. St. John, *N 1146* **B**
Thelypteris hispidula (Dcne) Reed var. *versicolor* (R. St. John) Lellinger, *N 269* **B, D, FM, S**
Thelypteris kunthii (Desv.) Morton, *T 13387* **B**

LYCOPODIOPHYTA

ISOETACEAE

Isoetes melanopoda Gay & Durieu, *Brooks & Maples 817* (MCN) **D**

LYCOPODIACEAE

Lycopodiella alopecuroides (L.) Cranfill, *N 793* **Pi**
Lycopodiella appressa (Chapm.) Cranfill, *N 792* **Pi**
Pseudolycopodiella caroliniana (L.) Holub, *N 1081* **Pi**

SELAGINELLACEAE

Selaginella apoda (L.) Spring, *N 499* **D, Pi**

CONIFEROPHYTA

CUPRESSACEAE

Juniperus virginiana L. var. *virginiana*, *N 512* **B, Pr**
Taxodium distichum (L.) Rich., *N 607* **FM, BM, S**

PINACEAE

Pinus echinata P. Mill., *Miller 5* (MCN) **Pi, Pr**
Pinus elliottii Engelm.,* *Miller 6* (MCN) **D, Pi, Pr**
Pinus palustris P. Mill., *N 791* **Pi**
Pinus taeda L., *N 476* **D, Pi, S**

MAGNOLIOPHYTA (Magnoliopsida)

ACANTHACEAE

Hygrophila lacustris (Schlecht. & Cham.) Nees, *N 1402* **S**
Justicia ovata (Walt.) Lindau, *N 641* **B, S**
Ruellia caroliniensis (Walt.) Steud., *N 1353* **B, D**
Ruellia humilis Nutt., *N 1334* **D, Pr,**
Ruellia pedunculata Torr., *A 15122* **D, Pi, Pr, D**

ACERACEAE

Acer negundo L., *N 1731* **D**
Acer rubrum var. *drummondii* (Hook. & Arn. ex Nutt.) Sarg., *N 467* **B, S**
Acer rubrum L. var. *rubrum*, *N 1623* **Pi**
Acer saccharinum L.,* *N 1386* **D**

AMARANTHACEAE

Alternanthera philoxeroides (Mart.) Griseb.,* *N 1292* **BM, D, FM, S**
Amaranthus albus L., *Th 66904* **D**
Amaranthus blitum L.,* *T 31617* **D**
Amaranthus cannabinus (L.) Sauer, *N 1003* **BM, FM**
Amaranthus spinosus L., *N 812* **D, Pr**
Amaranthus viridis L., *N 1127* **BM, FM, D**
Froelichia gracilis (Hook.) Moq., *Pias 4499* (LSU) **D, Pi**

ANACARDIACEAE

Rhus copallina L., *N 609* **D, P**
Toxicodendron radicans (L.) Kuntze, *N 1426* **B, D, FM, Pi, Pr**

ANNONACEAE

Asimina parviflora (Michx.) Dunal, *T 29432* **B**

APIACEAE

Bowlesia incana Ruiz & Pav., *John s.n.* (NLU) **D**
Centella erecta (L. f.) Fern., *N 666* **D, Pi, Pr**
Chaerophyllum tainturieri Hook., *N 448* **D, Pr**
Ciclospermum leptophyllum (Pers.) Sprague ex Britton & Wilson,* *N 530* **B, D, FM**
Cicuta maculata L. var. *maculata*, *N 267* **D, BM, FM**
Cynosciadium digitatum DC., *A 16406* (LAF) **D, Pr**
Daucus carota L.,* *N 1373* **D**
Eryngium integrifolium Walt., *N 952* **Pi, Pr**
Eryngium prostratum Nutt. ex DC., *N 655* **D, Pi**
Eryngium yuccifolium Michx., *N 736* **Pi, Pr**
Hydrocotyle bonariensis Comm. ex Lam., *N 1352* **BM, D**
Hydrocotyle umbellata L., *N 1360* **D, S**
Hydrocotyle verticillata Thunb., *N 706* **D, S**
Limnosciadium pinnatum (DC.) Math. & Constance, *N 538* **D, Pr**

Limnosciadium pumilum (Engelm. & A. Gray) Math. & Constance, *A 16406* **D, Pr**
Oxypolis filiformis (Walt.) Britton, *N 784* **Pi**
Ptilimnium capillaceum (Michx.) Raf., *N 652* **D, BM, FM, S**
Ptilimnium costatum (Ell.) Raf., *T 27955* **B, Pi, S**
Sanicula canadensis L., *N 1320* **B**
Spermolepis inermis (Nutt. ex DC.) Math. & Constance, *Th 14386* **D, Pr**
Trepocarpus aethusae Nutt. ex DC., *Th 14422* **B, Pr**
Zizia aurea (L.) K. Koch, *N 1750* **B**

APOCYNACEAE
Amsonia ludoviciana Vail, *Gilmore & Smith 3543* (LSU) **Pr** (S3)
Amsonia tabernaemontana Walt., *N 1218* **D, Pi, Pr**
Amsonia repens Shinners, *Misgreth s.n.* (NLU) **Pi**
Apocynum cannabinum L., *N 822* **D, Pr**
Trachelospermum difforme (Walt.) Cory, *N 658* **B**

AQUIFOLIACEAE
Ilex ambigua (Michx.) Torr., *N & M 1581* (MCN) **Pi**
Ilex coriacea (Pursh) Chapm., *N 1501* **Pi**
Ilex decidua Walt., *N 477* **B, Pr**
Ilex opaca Aiton, *N 759* **B, Pr, S**
Ilex vomitoria Aiton, *N 328* **B, Pr, S**

ARALIACEAE
Aralia spinosa L., *N 892* **B, Pr**

ARISTOLOCHIACEAE
Aristolochia reticulata Jacq., *T 29428* **B**
Aristolochia serpentaria L., *N 1418* **Pi**

ASCLEPIADACEAE
Asclepias hirtella (Pennell) Woods., *T 67028* **D**
Asclepias lanceolata Walt., *N 713* **Pi**
Asclepias longifolia Michx., *N 677* **Pi**
Asclepias obovata Ell., *N 280* **Pi**
Asclepias perennis Walt., *N 262* **S**
Asclepias variegata L., *N 1763* **Pi**
Asclepias viridis Walt., *N 543* **D, Pi, Pr**
Matelea gonocarpos (Walt.) Shinners, *N 688* **B**

ASTERACEAE
Acmella oppositifolia var. *repens* (Walt.) R.K. Jansen, *N 1048* **D**
Ambrosia artemisiifolia L., *N 1021* **BM, D, Pr**
Ambrosia psilostachya DC., *N 1422* **D, Pr**
Ambrosia trifida L., *N 380* **D, Pr**
Arnoglossum ovatum (Walt.) H. Robins., *N 291* **D, Pi, Pr**
Aster dumosus L., *N 1571* **Pi**
Aster fragilis Willd., *M & N 2627* (MCN) **B**
Aster lateriflorus (L.) Britt., *M & N 2628* (LSU) **Pr**
Aster patens Aiton, *McWilliams 244* (LAF) **D, Pr**
Aster praealtus Poir., *N 714* **D, Pi**
Aster subulatus var. *ligulatus* Shinners, *N 435* **B, D, Pi**
Aster tenuifolius L., *N 1422* **BM**
Baccharis halimifolia L., *N 389* **BM, D, Pr**
Bidens aristosa (Michx.) Britton, *N 385* **D, FM, Pr, S**
Bidens bipinnata L., *N 1038* **D, Pr**
Bidens frondosa L., *N 1102* **D, FM, S**
Bidens laevis (L.) B.S.P., *N 1634* **D, FM, S**
Bigelowia nuttallii L.C. Anderson, *N 994* **Pi**
Boltonia asteroides (L.) L'Hér., *N 1126* **D, FM, Pi**
Boltonia diffusa Ell., *N 937* **BM, Pr**
Borrichia frutescens (L.) DC., *N 693* **BM**
Calyptocarpus vialis Less.,* *N 635* **D, Pr**
Chaetopappa asteroides (Nutt.) DC., *N 1513* **Pi** (S2?)
Chaptalia tomentosa Vent., *N 1194* **Pi**
Centaurea biebersteinii DC.,* *N 1771* **D**
Chrysopsis mariana L., *N & M 1593* (MCN) **Pi**
Chrysopsis pilosa Nutt., *N 942* **Pi**
Cirsium horridulum Michx., *N 1255* **D, Pi, Pr**
Conoclinium coelestinum (L.) DC., *N 263* **D, Pi, Pr**
Conyza bonariensis (L.) Cronq.,* *Th 66922* **D, Pr**
Conyza canadensis (L.) Cronq., *N 1458* **D, Pr**
Coreopsis lanceolata L., *N 1221* **D, Pi, Pr**
Coreopsis linifolia Nutt., *N 1633* **Pi**
Coreopsis tinctoria Nutt. var. *tinctoria*, *N 790* **D, Pr**
Dracopis amplexicaulis (Vahl) Cass., *N 1390* **D**
Echinacea sanguinea Nutt., *N 651* **D, Pi**
Eclipta prostrata (L.) L., *N 698* **D, FM, S**
Elephantopus carolinianus Raeusch., *N 1105* **B**
Elephantopus nudatus A. Gray, *N 1510* **B**
Elephantopus tomentosus L., *N 274* **B**
Erechtites hieraciifolia (L.) Raf. ex DC., *N 1139* **D, B**
Erigeron philadelphicus L., *N 1135* **D, Pr**
Erigeron strigosus Muhl. ex Willd., *N 1773* **D, Pr**
Erigeron tenuis Torr. & A. Gray, *N 546* **D, Pr**
Eupatorium altissimum L., *N 1125* **D, Pi, Pr**
Eupatorium capillifolium (Lam.) Small, *N 391* **D, Pr**
Eupatorium compositifolium Walt., *N 1528* **D, Pr**
Eupatorium glaucescens Ell., *N 1491* **Pi**
Eupatorium hyssopifolium L., *A 16144* (LAF) **D, Pi**
Eupatorium leucolepis (DC.) Torr. & A. Gray, *N 973* **Pi**
Eupatorium mohrii Greene, *A 11133* (LAF) **Pi**
Eupatorium perfoliatum L., *N 899* **D, B**
Eupatorium rotundifolium L., *N 737* **D, Pi**
Eupatorium semiserratum DC., *A 16120* (LAF) **Pi**
Eupatorium serotinum Michx., *N 951* **BM, FM**
Eurybia hemisphericus (Alexander) Nesom, *N 1023* **Pi**
Euthamia gymnospermoides Greene, *Th 98160* **D, Pr**

Euthamia leptocephala (Torr. & A. Gray) Greene, *N 1045* **BM, Pr**
Gaillardia aestivalis (Walt.) H.F.L. Rock, *N 718* **Pi**
Gaillardia pulchella Foug., *N 1225* **D**
Gamochaeta pensylvanica (Willd.) Cabrera, *N & M 1713* (MCN) **D**
Gamochaeta purpurea L., *N 1367* **D, Pr**
Grindelia papposa Nesom & Suh *Pias & Thomas 4515* (LSU) **Pr**
Gymnostyles anthemifolia Juss.,* *T 30610* **D**
Helenium amarum (Raf.) H.F.L. Rock, *N 1389* **D, Pr**
Helenium drummondii H.F.L. Rock, *N 577* **Pi**
Helenium flexuosum Raf., *N 660* **B, D, S**
Helenium vernale Walt., *Gilmore 3589* (LSU) **Pi**
Helianthus angustifolius L., *N 1119* **Pi**
Helianthus annuus L., *N 823* **D, Pr**
Helianthus debilis ssp. *cucumerifolius* (Torr. & A. Gray) Heiser *Correll & Correll 9625* (LSU) **Pi**
Helianthus mollis Lam., *N 935* **D, Pi, Pr**
Heterotheca subaxillaris (Lam.) Britt. & Rusby, *N 1545* **D, Pr**
Hieracium longipilum Torr., *C s.n.* **Pi**
Hymenopappus artemisiifolius DC., *N 1276* **D, Pi**
Hypochaeris microcephala (Sch.-Bip.) Cabrera,* *N 1263* **D**
Hypochaeris radicata L.,* *N & M 1722* (MCN) **D**
Ionactis linariifolius (L.) Greene, *N & M 1606* (MCN) **Pi**
Iva angustifolia DC., *N 1120* **D**
Iva annua L., *N 1090* **D**
Iva frutescens L., *N 1469* **BM**
Krigia cespitosa (Raf.) Chambers, *N 1753* **D**
Krigia dandelion (L.) Nutt., *Hester s.n.* (LAF) **D**
Lactuca canadensis L., *N 1446* **D, Pr**
Lactuca floridana (L.) Gaertn., *N 372* **D, Pr**
Liatris acidota Engelm. & A. Gray, *N 295* **Pi**
Liatris aspera Michx., *N 1515* **Pi**
Liatris elegans (Walt.) Michx., *N 919* **Pi**
Liatris punctata Hook., *N 1566* **Pi** (S1?)
Liatris pycnostachya Michx., *N 936* **Pi**
Liatris squarrosa (L.) Michx., *N 920* **Pi**
Marshallia caespitosa Nutt. ex DC., *N 1280* **Pi**
Marshallia graminifolia var. *cynanthera* (Ell.) Beadle & F.E. Boynt., *N 287* **Pi**
Mikania cordifolia (L. f.) Willd., *Th 23840* **D, FM, S**
Mikania scandens (L.) Willd., *N 371* **D, FM, S**
Oligoneuron nitidum (Torr. & A. Gray) Small, *N 857* **Pr**
Oligoneuron rigidum var. *glabratum* (E.L. Braun) Nesom, *C s.n.* **D**
Parthenium hysterophorus L.,* *N 1529* **D**
Pityopsis graminifolia (Michx.) Nutt., *N 855* **Pi**
Pluchea camphorata (L.) DC., *N 375* **BM, D, FM, S**
Pluchea foetida (L.) DC., *N 804* **D, FM, Pi, S**
Pluchea odorata (L.) Cass., *N 1002* **BM, D, FM, Pr, S**
Pluchea rosea Godfrey, *N 292* **BM, D, FM, Pi**
Pseudognaphalium obtusifolium (L.) ssp. *obtusifolium* Hilliard & Burtt, *N 1035* **Pi**
Pterocaulon virgatum (L.) DC., *T 20612* **Pr** (S1)
Pyrrhopappus carolinianus (Walt.) DC., *Costanza 67* (MCN) **D**
Ratibida columnifera (Nutt.) Woot. & Standl., *T 28897* **Pr**
Rudbeckia grandiflora (D. Don) J.F. Gmel. ex DC., *Robichaux 4* (MCN) **D, Pi**
Rudbeckia hirta L., *N 1330* **D**
Rudbeckia subtomentosa Pursh, *N 1500* **B**
Rudbeckia texana (Purdue) Cox & Urbatsch, *N 676* **D**
Senecio glabellus Poir., *N 1181* **D, Pr, S**
Silphium gracile A. Gray, *N 421* **D, Pi, Pr**
Silphium radula Nutt., *C s.n.* **Pr**
Silphium integrifolium Michx., *Th 98155* **D, Pr**
Silphium laciniatum L., *T 31489* **Pr**
Smallanthus uvedalius (L.) McKenzie ex Small, *N 927* **B**
Solidago caesia L., *N 1556* **Pi**
Solidago canadensis var. *scabra* Torr. & A. Gray, *N 1580* **D, Pi, Pr**
Solidago odora Aiton, *N 1544* **D, Pi**
Solidago rugosa P. Mill., *N & M 1599* (MCN) **D, Pr**
Solidago sempervirens var. *mexicana* (L.) Fern., *N 1363* **BM, FM**
Solidago stricta Aiton *Urbatsch 2090* (LSU) **BM, FM, Pi**
Solidago tortifolia Ell., *N 1543* **Pi**
Soliva mutisii Kunth,* *N 1758* **D**
Soliva sessilis Ruiz & Pav.,* *N 451* **D**
Sonchus asper (L.) Hill,* *N 518* **D**
Sonchus oleraceus L.,* *N 518* **D**
Symphyotrichum pratensis (Raf.) Nesom, *N & M 1607* (MCN) **Pi**
Taraxacum officinale G.H. Weber ex Wigg.,* *N 1136* **D**
Verbesina virginica L., *N 1068* **B, D**
Vernonia gigantea (Walt.) Trel. ex Branner & Coville ssp. *gigantea*, *N 1463* **Pi**
Vernonia missurica Raf., *N 1083* **Pi, Pr**
Vernonia texana (A. Gray) Small, *N 1430* **Pi**
Youngia japonica (L.) DC.,* *N 433* **D**

BERBERIDACEAE

Podophyllum peltatum L., *N 1683* **B**

BETULACEAE

Betula nigra L., *N 1099* **B**
Carpinus caroliniana Walt., *N 464* **B**
Ostrya virginiana (P. Mill.) K. Koch, *N 758* **B**

BIGNONIACEAE

Bignonia capreolata L., *N 1203* **B, Pi, S**
Campsis radicans (L.) Seem. ex Bureau, *N 279* **B, D, Pi, Pr**
Catalpa bignonioides Walt., *N 1274* **D, Pr**

BORAGINACEAE

Heliotropium curassavicum L., *N 1307* **BM, FM**
Heliotropium indicum L.,* *N 993* **D, Pr**
Heliotropium procumbens P. Mill., *C s.n.* **D**
Myosotis macrosperma Engelm., *N 1233* **B, D, S**

BRASSICACEAE

Capsella bursa-pastoris (L.) Medik,* *N 1152* **D**
Cardamine bulbosa (Schreb. ex Muhl.) B.S.P., *N 1179* **B**
Cardamine debilis D. Don, *N 1212* **D**
Cardamine pensylvanica Muhl. ex Willd., *N 441* **D, Pr, S**
Coronopus didymus (L.) Sm.,* *N 1171* **D, Pr**
Lepidium virginicum L., *N 1173* **D, Pr**
Raphanus raphanistrum L.,* *T 28864* **D**
Rorippa sessiliflora (Nutt.) Hitchc., *N 1205* **D, Pr**
Rorippa teres (Michx.) Stuckey, *N 1177* **D, Pr, S**

BUDDLEJACEAE

Polypremum procumbens L., *N 707* **Pi**

CABOMBACEAE

Brasenia schreberi J.F. Gmel., *N 870* **S**
Cabomba caroliniana A. Gray, *N 1392* **S**

CACTACEAE

Opuntia humifusa (Raf.) Raf. var. *humifusa*, *N 1791* **D**

CALLITRICHACEAE

Callitriche heterophylla Pursh, *N 1168* **D, S**
Callitriche peploides Nutt., *N 1159* **D, S**

CAMPANULACEAE

Lobelia appendiculata A. DC., *N 1298* **D, Pi**
Lobelia cardinalis L., *N 374* **B, S**
Lobelia flaccidifolia Small, *N 576* **Pi**
Lobelia puberula Michx. var. *puberula*, *N 1122* **D, Pi**
Lobelia puberula var. *pauciflora* Bush, *N 1570* **Pi**
Triodanis perfoliata var. *biflora* (Ruiz & Pavon) Bradley, *N 1206* **D, Pr**
Triodanis perfoliata (L.) Nieuwl. var. *perfoliata*, *N 502* **D, Pr**

CAPRIFOLIACEAE

Lonicera japonica Thunb.,* *N 347* **B, D, Pi, Pr, FM, S**
Lonicera sempervirens L., *N 650* **D, Pi, B**
Sambucus canadensis L., *N 613* **D, FM, Pr, S**
Viburnum dentatum L., *N 275* **B, D, S**
Viburnum nudum L., *N 1498* **B**

CARYOPHYLLACEAE

Cerastium glomeratum Thuill.,* *N 438* **D, Pr**
Sagina decumbens (Ell.) Torr. & A. Gray, *N 437* **D, Pr**
Silene antirrhina L., *N 1209* **B, D**
Spergularia salina (L.) Griseb., *N 1305* **BM**
Stellaria media (L.) Cirillo,* *N 474* **D, Pr**

CELASTRACEAE

Euonymus americana L., *N 416* **B**

CERATOPHYLLACEAE

Ceratophyllum demersum L., *N 704* **BM, FM**

CHENOPODIACEAE

Chenopodium ambrosioides L.,* *T 29422* **D**
Salicornia bigelovii Torr., *Montz 2296* (LAF) **BM**
Suaeda linearis (Ell.) Moq., *N 1433* **BM**

CISTACEAE

Lechea mucronata Raf., *T 31636* **D, Pi**
Lechea pulchella Raf., *N & Komo 1782* **Pi**

CLUSIACEAE

Hypericum brachyphyllum (Spach) Steud., *N 1404* **D, Pi**
Hypericum cistifolium Lam., *Th 89297* **FM, Pi**
Hypericum crux-andreae (L.) Crantz., *N 946* **D, FM, Pi, S**
Hypericum densiflorum Pursh, *N 1403* **B, D, Pi, Pr**
Hypericum drummondii (Grev. & Hook.) Torr. & A. Gray, *N 1473* **B, Pi**
Hypericum hypericoides (L.) Crantz, *N 329* **D, B, Pi, Pr**
Hypericum mutilum L., *N 1075* **B**
Hypericum setosum L., *N 286* **Pi**
Triadenum tubulosum Walt., *N 1111* **S**
Triadenum walteri J. G. Gmel., *N 1112* **S**

CONVOLVULACEAE

Calystegia sepium (L.) R. Br.,* *N 1443* **BM, FM**
Dichondra carolinensis Michx., *N 452* **D**
Evolvulus sericeus Sw., *N 1761* **Pi**
Ipomoea coccinea L.,* *N 840* **D, S**
Ipomoea cordatotriloba Dennst. var. *cordatotriloba*, *N 376* **D, Pr, S**
Ipomoea lacunosa L., *N 1492* **B, D, S**
Ipomoea pandurata (L.) G. Mey., *N 781* **B, D**
Ipomoea purpurea (L.) Roth,* *N 951* **D**
Ipomoea quamoclit L.,* *N 1523* **D**
Ipomoea sagittata Cav., *N 679* **BM, FM**
Ipomoea wrightii A. Gray,* *N 847* **D, Pr**
Jacquemontia tamnifolia (L.) Griesb., *N 390* **D**
Stylisma aquatica (Walt.) Raf., *N 1382* **Pi**

CORNACEAE

Cornus drummondii C.A. Mey., *N 1314* **B**
Cornus florida L., *Costanza 69* (MCN) **B, S**
Cornus foemina P. Mill., *N & M 1602* (MCN) **B, S**

CRASSULACEAE
Penthorum sedoides L., *N 1100* **B, D, S**

CURCURBITACEAE
Cucumis melo L.,* *N 996* **D**
Melothria pendula L., *N 270* **B, D, FM, BM, S**

CUSCUTACEAE
Cuscuta cuspidata Engelm., *N 1482* **P**
Cuscuta glomerata Choisy, *N 1795* **P**
Cuscuta indecora Choisy, *N 689* **P**
Cuscuta pentagona Engelm. var. *pentagona*, *N 1401* **P**

CYRILLACEAE
Cyrilla racemiflora L., *N 856* **B, Pi**

DROSERACEAE
Drosera brevifolia Pursh, *N 469* **D, Pi**

EBENACEAE
Diospyros virginiana L., *N 1315* **B, Pi**

ELATINACEAE
Elatine triandra Schkuhr, *Givens 2788* (LSU) **D**

ERICACEAE
Monotropa uniflora L., *Brooks 343* (MCN) **B**
Rhododendron canescens (Michx.) Sweet, *N 659* **B, S**
Vaccinium arboreum Marshall, *N 1237* **B**
Vaccinium stamineum L., *N 494* **B, S**
Vaccinium elliottii Chapm., *N 1189* **B, S**
Vaccinium virgatum Aiton, *T 16966* **Pi**

EUPHORBIACEAE
Acalypha gracilens A. Gray, *T 29398* **D, Pr**
Acalypha monococca (Engelm. ex A. Gray) L., *N 1612* **Pi**
Acalypha ostryifolia Riddell, *N 848* **D**
Acalypha rhomboidea Raf., *N 962* **D**
Acalypha virginica L., *N 1629* **D, Pi**
Caperonia palustris A. St.-Hil., *N 789* **D, Pr**
Chamaesyce hypericifolia (L.) Millsp.,* *Walker s.n.* (MCN) **D**
Chamaesyce hyssopifolia (L.) Small,* *N 825* **D**
Chamaesyce maculata (L.) Small, *N 968* **D**
Chamaesyce nutans (Lag.) Small, *N 801* **D**
Chamaesyce serpens (Kunth) Small, *N 1432* **D**
Cnidoscolus texanus (Muell. Arg.) Small, *N 1272* **D**
Croton capitatus Michx., *N 733* **D**
Croton glandulosus L., *N 963* **D, Pr**
Croton willdenowii G.L.Webster, *N 1779* **D**
Euphorbia corollata L., *N 305* **Pi, Pr**
Euphorbia dentata Michx., *N 1046* **D**
Euphorbia heterophylla L.,* *N 1011* **D**
Euphorbia meganoesos Featherman, *N 686* **D**
Euphorbia texana Boiss., *N & M 1716* (MCN) **D**
Phyllanthus polygonoides Nutt., *Th 66994* **D**
Phyllanthus urinaria L.,* *N 915* **D**
Sapium sebiferum (L.) Roxb.,* *N 350* **B, BM, D, FM, Pr**
Sebastiania fruticosa (Bartr.) Fern., *N 691* **S**
Stillingia sylvatica Garden ex L., *N 1846* **Pi**
Tragia smallii Shinners, *Th 66995* **Pi**
Tragia urticifolia Michx., *N & M 1591* (MCN) **Pi**
Vernicia fordii (Hemsl.) Airy-Shaw,* *N 1220* **B**

FABACEAE
Acacia farnesiana (L.) Willd., *N 620* **BM, FM, S**
Aeschynomene indica L., *N 849* **D, Pr**
Albizia julibrissin Durz.,* *N 709* **D**
Amorpha fruticosa L., *N 1377* **D, Pr**
Apios americana Medik., *N 1507* **B**
Astragalus distortus Torr. & A. Gray, *C s.n.* **Pi**
Baptisia alba var.*macrophylla* (Larisey) Isely, *N 608* **D, Pr**
Baptisia bracteata var. *laevicaulis* (A. Gray ex Canby) Isely, *N 700* **Pi**
Baptisia sphaerocarpa Nutt.*Lasseigne 1417* (LAF) **Pi**
Centrosema virginianum (L.) Benth., *N 860* **D, Pi, Pr**
Cercis canadensis L., *N 461* **B, S**
Chamaecrista fasciculata (Michx.) Greene, *N 340* **D, Pr**
Chamaecrista nictitans (L.) Moench ssp.*nictitians*, *N 918* **D**
Crotalaria sagittalis L. *Lasseigne 1579* (LAF) **Pi**
Dalea candida Willd., *N 1775* **Pr**
Dalea purpurea Vent., *T 31493* **Pi**
Desmanthus illinoensis (Michx.) MacM. ex B. L. Robins. & Fern., *N 784* **D**
Desmodium ciliare (Willd.) DC., *C s.n.* **D, Pi**
Desmodium glabellum (Michx.) DC., *N 983* **B**
Desmodium paniculatum (L.) DC., *N 377* **B**
Dioclea multiflora (Torr. & A. Gray) Mohr, *N 1448* **B**
Erythrina herbacea L., *N 656* **B, D, Pi**
Galactia volubilis (L.) Britt., *N 931* **D, S**
Gleditsia aquatica Marshall, *N & Komo 1737* (MCN) **B, S**
Gleditsia triacanthos L., *N & Komo 1635* (MCN) **S**
Glottidium vesicarium (Jacq.) Harper, *N 1027* **D, BM, FM**
Kummerowia striata (Thunb.) Schindl.,* *Lasseigne 1434* (LAF) **D, Pi**
Lespedeza cuneata (Dum-Cours.) G. Don,* *Lasseigne 1597* (LAF) **D**
Lupinus texensis Hook.,* *N 1223* **D**
Medicago arabica (L.) Huds.,* *N & Komo 1670* (MCN) **D**
Medicago lupulina L.,* *N 442* **D**

Medicago minima (L.) L.,* *Conrad 1* (MCN) **D**
Medicago polymorpha L.,* *N 1174* **D**
Melilotus officinalis (L.) Lam.,* *Lasseigne 1564* (LAF) **D**
Melilotus indicus (L.) All.,* *N 509* **D**
Mimosa hystricina (Small ex Britton & Rose) B.L. Turner, *N 1344* **D, Pi, Pr**
Mimosa microphylla Dry., *Zebryk 2252* (NLU) **Pi**
Mimosa nuttallii B.L. Turner, *Th 129572* **D, Pi**
Mimosa strigillosa Torr. & A. Gray, *N 752* **D, Pr**
Neptunia lutea (Leavenworth) Benth., *N 1348* **D, Pr, Pi**
Orbexilum pedunculatum (P. Mill.) Rydb. var. *pedunculatum*, *B 13531* (NLU) **D, Pi, Pr**
Orbexilum simplex (Torr. & A. Gray) Rydb., *N 1343* **Pi**
Parkinsonia aculeata L.,* *N 571* **D**
Pueraria montana (Lour.) Merr. var. *lobata* (Willd.) Maesen & Almeida,* *N 710* **D**
Rhynchosia latifolia (Nutt.) Torr. & A. Gray, *Chevalier 16* (MCN) **Pi**
Rhynchosia minima (L.) DC., *N 1026* **D, Pi**
Rhynchosia reniformis (Pursh) DC., *Ware s.n.* (NLU) **D, Pi**
Rhynchosia tomentosa (L.) Hook. & Arn., *Pias 4520* (LSU) **Pi**
Robinia pseudoacacia L.,* *N 511* **D**
Senna obtusifolia (L.) Irwin & Barneby, *N 753* **D**
Sesbania drummondii (Rydb.) Cory, *N 618* **D, BM, FM**
Sesbania herbacea (P. Mill.) McVaugn, *N 830* **D, BM, FM**
Sesbania punicea (Cav.) Benth.,* *Lasseigne 1564* (LAF) **D, BM, FM**
Strophostyles helvula (L.) Ell., *N 928* **D, Pr**
Strophostyles umbellata (Muhl. ex Willd.) Britton, *N 1540* **D, Pr**
Stylosanthes biflora (L.) B.S.P., *N 719* **Pi, Pr**
Tephrosia onobrychoides Nutt., *N 1396* **Pi**
Trifolium campestre Sturm, *Walker s.n.* (MCN) **D**
Trifolium dubium Sibth.,* *Milsom 3* (MCN) **D**
Trifolium incarnatum L.,* *N 1685* **D**
Trifolium pratense L.,* *N 673* **D**
Trifolium reflexum L., *C s.n.* **Pr**
Trifolium repens L.,* *N 449* **D, Pr**
Trifolium resupinatum L.,* *N 1359* **D, Pr**
Vicia ludoviciana Nutt., *N 446* **D, Pi**
Vigna luteola (Jacq.) Benth., *N 997* **D, BM**
Wisteria floribunda (Willd.) DC.,* *N 1232* **D**
Wisteria frutescens (L.) Poir., *N 1740* **B**

FAGACEAE

Castanea pumila P. Mill., *N & Komo 1617* (MCN) **Pi**
Fagus grandifolia Ehrh., *N 458* **B**
Quercus acutissima Carruthers,* *N 1785* **D**
Quercus alba L., *N 1562* **B**
Quercus falcata Michx., *N 646* **B, D, Pi**
Quercus hemisphaerica Bartr., *T 28035* **D, Pi**
Quercus incana Bartr., *T 25652* **Pi**
Quercus laurifolia Michx., *N 1082* **B, S**
Quercus lyrata Walt., *N 667* **B, S**
Quercus margarettiae Ashe ex Small, *M 2920* **Pi**
Quercus marilandica Muench, *N 666* **D, Pi**
Quercus michauxii Nutt., *N 325* **B, Pi**
Quercus nigra L., *N 507* **B, D, Pi, Pr, S**
Quercus pagoda Raf., *N 1142* **B**
Quercus phellos L., *N 668* **Pi**
Quercus shumardii Buckl., *N & M 1717* **B**
Quercus similis Ashe, *T 33547* **Pi**
Quercus stellata Wangenh., *N 1083* **Pi**
Quercus texana Buckley, *N & Kitt 1704* **D, Pi**
Quercus virginiana P. Mill., *N 475* **B, D, Pi, Pr**

GENTIANACEAE

Centaurium pulchellum (Sw.) Druce,* *N 1301* **D, Pr**
Eustoma exaltatum (L.) Salisb. ex G. Don., *N 786* **D, BM, FM**
Sabatia calycina (Lam.) Heller, *N 1104* **D, Pi, S**
Sabatia campanulata (L.) Torr., *N 1429* **D, Pi**
Sabatia campestris Nutt., *N 1311* **D, FM, Pi, Pr**
Sabatia dodecandra L. (B.S.P.) var. *foliosa* (Fern.) Wilbur, *Barr 102* (LSU) **Pi**
Sabatia gentianoides Ell., *N 739* **Pi**

GERANIACEAE

Geranium carolinianum L., *N 445* **D, Pr**

GROSSULARIACEAE

Itea virginica L., *N 491* **S**

HALORAGACEAE

Myriophyllum aquaticum (Vell.) Verdc.,* *N 336* **D, FM**
Myriophyllum heterophyllum Michx., *N 721* **D, FM, S**
Myriophyllum pinnatum (Walt.) B.S.P., *Coe 8* (MCN) **D, FM, S**
Myriophyllum spicatum L.,* *N 1124* **D, FM, BM**
Proserpinaca palustris L., *N 623* **D, FM, S**
Proserpinaca pectinata Lam., *N 1249* **D, Pi, S**

HAMAMELIDACEAE

Hamamelis virginiana L., *N 323* **B**
Liquidambar styraciflua L., *N 1214* **B, D, Pi, Pr**

HIPPOCASTANACEAE

Aesculus pavia L., *N 1221* **B**

HYDROPHYLLACEAE

Hydrolea ovata Nutt. ex Choisy, *N 300* **D, Pi, Pr**
Nemophila aphylla (L.) Brummitt, *N 519* **D, B**
Phacelia hirsuta Nutt., *N 480* **D, Pr**

JUGLANDACEAE

Carya alba (L.) Nutt. ex Ell., *N 1084* **Pi**
Carya aquatica (Michx. f.) Nutt., *N 1042* **B**
Carya cordiformis (Wangenh.) K. Koch, *N & M 1628* (MCN) **B**
Carya glabra (P. Mill.) Sweet, *N 1085* **B, Pi**
Carya illinoinensis (Wangenh.) K. Koch, *N 1128* **D**
Carya ovata (P. Mill.) K. Koch, *N 1061* **Pi**
Juglans nigra L.,* *N 1512* **D, Pi**

LAMIACEAE

Hedeoma hispida Pursh, *N 1326* **D, Pr**
Hyptis alata (Raf.) Shinners, *N 738* **D, Pi, Pr**
Lamium amplexicaule L.,* *Costanza 43* (MCN) **D**
Lycopus rubellus Moench, *N 1079* **D, FM**
Lycopus virginicus L., *N 1509* **Pi**
Monarda lindheimeri A. Gray, *Correll & Correll 9572* (LSU) **Pi**
Monarda punctata L., *N 841* **D, Pr**
Perilla frutescens (L.) Britt.,* *N 1268* **D**
Physostegia digitalis Small, *N 750* **D, Pr**
Physostegia longisepala Cantino, *N 643* **D, Pi** (S2)
Physostegia virginiana (L.) Benth. ssp. *praemorsa* (Shinners) Cantino, *N 1097* **D, Pi, S**
Prunella vulgaris L., *N 1368* **D**
Pycnanthemum albescens Torr. & A. Gray, *N 903* **D, Pi, Pr**
Pycnanthemum tenuifolium Schrad., *N 678* **D, Pi**
Salvia azurea Lam., *N 1050* **D, Pr**
Salvia coccinea Buchoz ex Etlinger,* *Coto 45* (MCN) **D**
Salvia lyrata L., *Costanza 9* (MCN) **D, Pi**
Scutellaria cardiophylla Engelm. & A. Gray, *T 23535* **Pi**
Scutellaria drummondii Benth., *Th 66861* **Pi**
Scutellaria integrifolia L., *N 578* **B, Pi**
Stachys crenata Raf., *N 1176* **D**
Stachys floridana Shuttlew. ex Benth., *N 1217* **D**
Teucrium canadensis L., *N 1844* **D**
Teucrium cubense Jacq., *N 1302* **D**
Trichostema dichotomum L., *N 1537* **Pi**

LAURACEAE

Cinnamomum camphora (L.) Presl,* *N 606* **B, D, Pr**
Persea palustris (Raf.) Sarg., *N 904* **B, S**
Sassafras albidum (Nutt.) Nees., *N 1187* **D, Pi, Pr**

LENTIBULARIACEAE

Pinguicula pumila Michx., *N 1253* **Pi**
Utricularia cornuta Michx., *N 1746* **Pi**
Utricularia foliosa L., *N 1464* **FM**
Utricularia gibba L., *N 654* **D, S**
Utricularia inflata Walt., *N 473* **FM, S**
Utricularia juncea Vahl, *N 1508* **Pi**
Utricularia macrorhiza LeConte, *Curry 1479* (LSU) **FM, S**
Utricularia radiata Small, *N 495* **S**
Utricularia subulata L., *N 1217* **Pi**

LINACEAE

Linum medium (Planch.) Britt. var. *texanum* (Planch.) Fern., *N 619* **D, Pr**
Linum striatum Walt., *N 1774* **D, Pi**

LOGANIACEAE

Gelsemium sempervirens (L.) J. St.-Hil., *N & Komo 1675* (MCN) **B, D, Pi**
Mitreola petiolata (J. F. Gmel.) Torr. & A. Gray, *N 743* **D**
Mitreola sessilifolia (J. F. Gmel.) G. Don, *N 303* **D, S**

LYTHRACEAE

Ammannia coccinea Rottb., *N 980* **D**
Cuphea carthagenensis (Jacq.) Macbr.,* *N 844* **D, FM, Pr**
Didiplis diandra (DC.) Wood, *N 1752* **D**
Lythrum alatum Pursch var. *lanceolatum* (Ell.) Torr. & A. Gray ex Rothrock, *N 339* **D, FM**
Rotala ramosior (L.) Koehne, *N 924* **D, FM**

MAGNOLIACEAE

Liriodendron tulipifera L.,* *N 1535* **D**
Magnolia grandiflora L., *N 1381* **B**
Magnolia virginiana L., *N 1242* **Pi, S**

MALVACEAE

Callirhoe papaver (Cav.) A. Gray, *N 1331* **D**
Hibiscus aculeatus Walt., *N 282* **D, Pi**
Hibiscus moscheutos L. ssp. *lasiocarpus* (Cav.) O.J. Blanchard, *N 1427* **D, BM, FM**
Hibiscus moscheutos L. ssp. *moscheutos* L., *N 1444* **D, S**
Kosteletzkya virginica (L.) Presl. ex A. Gray, *N 1434* **BM**
Malvaviscus arboreus Dill. ex Cav. var. *drummondii* (Torr. & A. Gray) Schery,* *N 1472* **D, Pr**
Modiola caroliniana (L.) G. Don, *N 1732* **D, Pr**
Sida rhombifolia L., *N 726* **D**
Sida spinosa L., *Th 66905* **D**

MELASTOMATACEAE

Rhexia alifanus Walt., *N 284* **Pi**
Rhexia lutea Walt., *N 1385* **Pi**
Rhexia mariana L. var. *mariana*, *N 653* **D, Pr, Pi**
Rhexia petiolata Walt., *N 283* **Pi**
Rhexia virginica L., *N 290* **Pi**

MELIACEAE

Melia azedarach L.,* *N 610* **D**

MENISPERMACEAE

Cocculus carolinus (L.) DC., *N 1504* **D**

MOLLUGINACEAE

Mollugo verticillata L., *N 1405* **D, Pr**

MORACEAE
Fatoua villosa (Thunb.) Nakai,* *N 1143* **B**
Maclura pomifera (Raf.) Schneider,* *N 1036* **B, D**
Morus alba L.,* *N 514* **D**
Morus rubra L., *N 1503* **B, D, Pi, Pr**

MYRICACEAE
Myrica cerifera L., *N 351* **B, D, Pi, Pr**
Myrica heterophylla Raf., *N & M 1598* (MCN) **Pi**

NELUMBONACEAE
Nelumbo lutea (Willd.) Pers., *N 1005* **BM, FM**

NYCTAGINACEAE
Boerhavia erecta L., *N 1093* **D**

NYMPHEACEAE
Nuphar advena (Aiton) Aiton f., *N 542* **D, BM, FM, S**
Nymphaea elegans Hook., *N 1006* **BM** (S1/S2)
Nymphaea odorata Aiton, *N 1064* **D, BM, FM**

NYSSACEAE
Nyssa aquatica L., *N 662* **S**
Nyssa biflora (Walt.) Sarg., *N 333* **B, Pi, Pr**
Nyssa sylvatica Marshall, *N 1250* **Pi**

OLEACEAE
Chionanthus virginicus L., *N 1210* **B, S**
Fraxinus americana L., *N & Komo 1619* (MCN) **B, Pi**
Fraxinus caroliniana P. Mill., *N 664* **S**
Fraxinus pennsylvanica Marshall, *N 1016* **B**
Ligustrum japonicum Thunb.,* *N 735* **D**
Ligustrum lucidum Aiton f.,* *N & M 1595* (MCN) **Pi**
Ligustrum sinense Lour.,* *N 348* **D, Pr**

ONAGRACEAE
Gaura lindheimeri Engelm. & A. Gray, *N 574* **D, Pi, Pr**
Gaura longiflora Spach, *N 941* **D**
Gaura parviflora Douglas ex Lehm., *N 1406* **D, BM**
Ludwigia alternifolia L., *Brooks 394* (MCN) **B, D, FM**
Ludwigia decurrens Walt., *N 859* **D, FM, Pr, S**
Ludwigia glandulosa Walt., *N 922* **D, FM, S**
Ludwigia hirtella Raf., *N 1395* **Pi**
Ludwigia leptocarpa (Nutt.) Hara, *N 975* **D, BM, FM**
Ludwigia linearis Walt., *N 1053* **D, FM, Pr, S**
Ludwigia microcarpa Michx., *Orzell & Bridges 5760* (LSU) **Pi** (S1)
Ludwigia octovalvis (Jacq.) P.H. Raven, *N 378* **D, FM, S**
Ludwigia palustris (L.) Ell., *N 923* **D, S**
Ludwigia peploides (Kunth) P.H. Raven, *N 921* **D, S**
Ludwigia pilosa Walt., *Th 81866* **D, FM, S**
Ludwigia sphaerocarpa Ell., *N 1076* **D, FM, Pi, S**
Ludwigia uruguayensis (Cambess) H. Hara, *N 740* **D, BM, FM, S**
Oenothera biennis L., *N 1022* **D**
Oenothera grandis (Britt.) Smyth, *Givens 1887* (LSU) **D**
Oenothera heterophylla Spach, *N 1453* **D**
Oenothera laciniata Hill, *N 560* **D**
Oenothera linifolia Nutt., *N 1241* **Pi**
Oenothera spachiana Torr. & A. Gray, *Givens 1888* (LSU) **D, Pr**
Oenothera speciosa Nutt., *N 1321* **D**

OROBANCHACEAE
Epifagus virginiana (L.) Barton, *N 419* **B**

OXALIDACEAE
Oxalis debilis var. *corymbosa* (DC.) Lour.,* *N & M 1718* (MCN) **D**
Oxalis rubra St.-Hil.,* *N 1231* **D**
Oxalis dillenii Jacq., *Costanza 11* (MCN) **D**

PAPAVERACEAE
Argemone albiflora Hornem., *N 1736* **D**

PASSIFLORACEAE
Passiflora incarnata L., *N 346* **D**
Passiflora lutea L., *N 273* **B, D, S**

PHYTOLACCACEAE
Phytolacca americana L., *N 629* **D**

PLANTAGINACEAE
Plantago aristata Michx., *N 596* **D**
Plantago heterophylla Nutt., *DeLeny 1* (MCN) **D**
Plantago major L., *N 642* **D**
Plantago virginica L., *N 444* **D**

PLATANACEAE
Platanus occidentalis L., *N 513* **B, S**

POLEMONACEAE
Phlox pilosa L., *N 1277* **D, Pi**

POLYGALACEAE
Polygala crenata James, *T 25650* **Pi**
Polygala cruciata L., *N 289* **Pi**
Polygala incarnata L., *N 1760* **Pi**
Polygala leptocaulis Torr. & A. Gray, *N 712* **D, Pi, Pr**
Polygala mariana P. Mill., *N 566* **Pi**
Polygala nana (Michx.) DC, *N 675* **Pi**
Polygala polygama L., *N 1747* **Pi**
Polygala ramosa Ell., *N 288* **Pi**
Polygala verticillata L., *N 625* **D**

POLYGONACEAE
Brunnichia ovata (Walt.) Shinners, *N 829* **B, S**
Polygonum cespitosum Blume, *N 1115* **D, Pr**
Polygonum densiflorum Meisn., *N 826* **D, S**
Polygonum hydropiperoides Michx., *N 344* **D, FM, S**
Polygonum pensylvanicum L., *N 1009* **D, FN, S**

Polygonum punctatum Ell., *N 382* **D, FM, Pr, S**
Rumex chrysocarpus Moris, *N 827* **D, S**
Rumex crispus L.,* *N 1308* **D**
Rumex hastatulus Ell., *N 592* **D**
Rumex obovatus Danser,* *N 1362* **D**
Rumex pulcher L.* *Hebert 4* (MCN) **D, Pr**
Rumex verticillatus L., *N 1229* **D, FM, S**

PORTULACACEAE

Claytonia virginica L., *N 1198* **B**
Portulaca oleracea L., *N 811* **D**
Portulaca pilosa L., *N 1886* **D**

PRIMULACEAE

Anagallis arvensis L.,* *N 1361* **D, PI, PR**
Anagallis minima (L.) Krause, *N 1182* **D**
Lysimachia radicans Hook., *N 690* **S**
Samolus ebracteatus Kunth, *N 1347* **D, BM** (S1)
Samolus valerandi L., *N 1269* **B, D, S**

RANUNCULACEAE

Anemone caroliniana Walt., *Brooks 379* (MCN) **D, Pi**
Clematis crispa L., *N 762* **B, D, S**
Clematis terniflora DC.,* *N 271* **D**
Delphinium carolinianum Walt., *Lemmon 1204* (LSU) **Pi**
Ranunculus fascicularis Muhl. ex Bigelow, *Mistretta s.n.* (NLU) **D, Pr**
Ranunculus muricatus L.,* *N 1180* **D**
Ranunculus parviflorus L.,* *Mistretta s.n.* (NLU) **D**
Ranunculus pusillus Poir., *N 1169* **D, FM, S**
Ranunculus sardous Crantz,* *N 621* **D**
Ranunculus sceleratus L., *N 1164* **D, FM, S**
Ranunculus trilobus Desf.,* *T 30626* **D**

RHAMNACEAE

Berchemia scandens (Hill) K. Koch, *N 1391* **B, D, Pi, S**
Frangula caroliniana (Walt.) A. Gray, *N 1474* **B**

ROSACEAE

Aronia arbutifolia (L.) Ell., *N 1574* **Pi**
Crataegus marshallii Eggl., *N 1204* **B**
Crataegus opaca Hook. & Arn., *N 1683* **B**
Crataegus viridis L., *N 1071* **B, S**
Duchesnea indica (Andrz.) Focke,* *Ashworth 19* (MCN) **D**
Geum canadense Jacq., *N 1354* **S**
Prunus caroliniana (P. Mill.) Aiton, *N 1031* **B, D**
Prunus serotina Ehrh., *N 462* **B, D**
Prunus americana Marshall, *N & M 1601* (MCN) **B**
Pyrus calleryana Decne.,* *N 1072* **D**
Pyrus communis L.,* *N 829* **D**
Rosa bracteata Wendl.,* *N 1356* **D**
Rubus argutus Link, *N 1290* **D, Pi, S**
Rubus trivialis Michx., *N 1257* **D, Pi, Pr**

RUBIACEAE

Cephalanthus occidentalis L., *N 715* **FM, S**
Diodia teres Walt., *N 955* **D, Pi, Pr**
Diodia virginiana L., *N 341* **D, Pr, S**
Galium aparine L., *N 1165* **B, D, Pr**
Galium parisiense L.,* *T 29393* **D**
Galium tinctorium (L.) Scop., *N 591* **D, Pr, S**
Hedyotis nigricans (Lamb.) Fosb., *N 581* **D, Pr**
Houstonia micrantha (Shinners) Terrell, *N 449* **D**
Houstonia pussila Schoepf., *N 440* **D, Pr**
Mitchella repens L., *N 276* (MCN) **B**
Oldenlandia boscii (DC.) Chapm., *N 1477* **B, Pi**
Oldenlandia uniflora L., *N & M 1610* (MCN) **Pi**
Sherardia arvensis L.,* *N 439* **D**

RUTACEAE

Poncirus trifoliata (L.) Raf.,* *N 1213* **B**
Ptelea trifoliata L., *N 1734* **B**
Zanthoxylum clava-herculis L., *N 1306* **D, Pr**

SALICACEAE

Populus deltoides Bartr. ex Marshall, *N 1370* **B, D**
Salix babylonica L.,* *N 1536* **D**
Salix humilis Marshall, *T 22975* **Pr** (S2)
Salix nigra Marshall, *N 468* **D, S**

SAPINDACEAE

Cardiospermum halicacabum L., *N 1000* **D**
Koelreuteria paniculata Laxm.,* *N 1554* **D**

SAPOTACEAE

Sideroxylon lanuginosum Michx. ssp. *oblongifolium* (Nutt.) T.D. Pennington, *N & M 1625* (MCN) **Pi**
Sideroxylon lycioides L., *N & M 1603* (MCN) **Pi**

SARRACENIACEAE

Sarracenia alata (Wood) Wood, *N 1496* **Pi**

SAURURACEAE

Saururus cernuus L., *N 639* **S**

SAXIFRAGACEAE

Lepuropetalon spathulatum (Muhl.) Ell., *N 1216* **D**

SCROPHULARIACEAE

Agalinis fasciculata (Ell.) Raf., *N 1055* **D, Pi, Pr**
Agalinis filicaulis (Benth.) Pennell, *N 1538* **Pi** (S1)
Agalinis heterophylla (Nutt.) Small ex Britt., *N 1546* **D**
Agalinis oligophylla Pennell, *N 1567* **Pi**
Agalinis purpurea L. Pennell, *N 405* **Pi**
Agalinis tenuifolia (Vahl) Raf., *Joor s.n.* (NLU) **D, Pi**
Agalinis viridis (Small) Pennell, *Urbatsch 2087* (LSU) **D**
Aureolaria pectinata (Nutt.) Pennell, *Givens 4265* (LSU) **Pi**
Aureolaria virginica (L.) Pennell, *N 1486* **Pi**
Bacopa caroliniana (Walt.) Robins., *N 299* **D, FM, S**

Bacopa monnieri (L.) Wettst., *N 1400* **D, FM, S**
Bacopa repens (Sw.) Wettst., *N 342* **D**
Bacopa rotundifolia (Michx.) Wettst., *N 1446* **D, FM**
Buchnera americana L., *N 1345* **Pi**
Castilleja coccinea (L.) Spreng., *Featherman s.n.* (LSU) **Pr**
Gratiola brevifolia Raf., *N 298* **D, S**
Gratiola pilosa Michx., *N 1452* **Pi, S**
Gratiola ramosa Walt., *Allison 296* (MO) **D, FM**
Gratiola virginiana L., *N 460* **D, S**
Lindernia dubia (L.) Pennell var. *anagallidea* (Michx.) Cooperrider, *N 1454* **D, FM, Pi, S**
Mazus pumilus (Burm. f.) Steenis,* *N 368* **D, B**
Mecardonia acuminata (Walt.) Small, *N 1103* **D, FM, Pi, S**
Mecardonia procumbens (P. Mill.) Small, *N 1490* **D, S**
Micranthemum umbrosum (J.F. Gmel.) Blake, *N 699* **D, S**
Mimulus alatus Aiton, *N 902* **S**
Nuttallanthus canadensis (L.) D.A. Sutton, *N 563* **D**
Pedicularis canadensis L. *Pennell 1012* (NO) **B**
Penstemon laxiflorus Pennell Small, *N 1248* **Pi**
Seymeria cassioides (Walt.) Blake, *N 1525* **Pi**
Scoparia dulcis L., *N 1080* **D, Pi, Pr, S**
Verbascum thapsus L.,* *N 1313* **D**
Veronica arvensis L.,* *N 1140* **D**
Veronica peregrina L.,* *N 1141* **D**
Veronica persica Poir.,* *N 472* **D**

SOLANACEAE
Calibrachoa parviflora (Juss.) D'Arcy., *N 1530* **BM**
Lycium barbarum L.,* *C s.n.* **D**
Physalis angulata L., *N 1494* **D, PR**
Physalis cordata P. Mill., *Correll & Correll 9566* (LSU) **D**
Physalis pubescens L., *N 926* **D, PR**
Solanum carolinense L., *N 754* **D, Pr**
Solanum ptychanthum Dunal, *N 766* **D, Pr**

SPHENOCLEACEAE
Sphenoclea zeylanica Gaertn.,* *N 343* **D, Pr**

STERCULIACEAE
Melochia corchorifolia L.,* *N s.n.* **D**

STYRACACEAE
Halesia diptera Ellis, *N 466* **B**
Styrax americanus Lam., *N 1275* **B, S**
Styrax grandifolius Aiton, *Nogle s.n.* (LAF) **B**

SYMPLOCACEAE
Symplocos tinctoria (L.) L'Hér., *N 465* **B, S**

TAMARICACEAE
Tamarix gallica L.,* *N 1303* **BM, D**

TILIACEAE
Tilia americana L. var. *caroliniana* (P. Mill.) Castigl., *N 1558* **Pi**

ULMACEAE
Celtis laevigata Willd., *N 1043* **B, Pr, S**
Planera aquatica J.F. Gmel., *N 1195* **B, S**
Ulmus alata Michx., *N 611* **B, Pi**
Ulmus americana L., *N & M 1720* (MCN) **B**

URTICACEAE
Boehmeria cylindrica (L.) Sw., *N 318* **B, S**
Parietaria floridana Nutt., *Montz 3030* (LSU) **BM**
Pilea pumila (L.) A. Gray, *N 1106* **B, S**
Urtica chamaedryoides Pursh, *N 1729* **D**

VALERIANACEAE
Valerianella radiata (L.) Dufr., *N 1340* **D, Pr**

VERBENACEAE
Callicarpa americana L., *N 272* **B, Pi, Pr, S**
Glandularia canadensis (L.) Small, *Milsom 18* (MCN) **D, Pi**
Glandularia pulchella (Sweet) Troncoso.,* *N 1224* **D**
Lantana camara L.,* *N 1116* **D**
Phyla lanceolata (Michx.) Greene, *N 1369* **BM, D, FM, Pr**
Phyla nodiflora (L.) E. Greene, *N 1366* **BM, D, FM, Pi**
Verbena brasiliensis Vell.,* *N 630* **D**
Verbena halei Small, *N 520* **D**
Verbena rigida Spreng.,* *N 544* **D**
Verbena scabra Vahl, *N 898* **BM, FM**
Verbena xutha Lehm., *Montz 2294* (LSU) **D**

VIOLACEAE
Viola affinis LeConte, *N 1150* **B, S**
Viola lanceolata L., *N 1252* **Pi**
Viola missouriensis Greene, *Blackwood 1* (LSU) **B**
Viola pedata L. *King 7* (MCN) **Pi**
Viola X *primulifolia* (pro sp.), *N 418* **Pi**
Viola sagittata Aiton, *C s.n.* **Pi**
Viola septemloba House, *N 456* **B, Pi**
Viola walteri House, *N 1215* **B**

VISCACEAE
Phoradendron leucarpum (Raf.) Reveal & M.C. Johnston, *N 1144* **P**

VITACEAE
Ampelopsis arborea (L.) Koehne, *N 612* **B, FM, S**
Parthenocissus quinquefolia (L.) Planch., *N 387* **D, Pi, Pr**
Vitis cinerea Engelm., *N 930* **B**
Vitis mustangensis Buckl., *N 702* **D, BM**
Vitis rotundifolia Michx., *N 533* **B, Pi, S**
Vitis vulpina L., *N 265* **B, D, Pi**

MAGNOLIOPHYTA (Liliopsida)

AGAVACEAE

Manfreda virginica (L.) Salisb. ex Rose, *N 782* **D, Pi, Pr**
Yucca aloifolia L., *N 998* **D**

ALISMATACEAE

Echinodorus cordifolius (L.) Griseb., *N 1078* **D, FM, S**
Echinodorus berteroi (Spreng.) Fassett, *N 1012* **D, FM**
Sagittaria calycina Engelm. var. *calycina*, *Th 30114* **D, FM**
Sagittaria lancifolia L., *N 1442* **BM, D, FM**
Sagittaria graminea Michx., *N 345* **D, FM, Pr**
Sagittaria latifolia Willd., *N 727* **D, FM**
Sagittaria papillosa Buch., *Tallman 19* (LSU) **D, FM, S**
Sagittaria platyphylla Engelm., *N 312* **BM, D, FM**

ARACEAE

Arisaema dracontium (L.) Schott, *N 493* **B**
Arisaema triphyllum (L.) Schott ssp. *quinatum* (Buckl.) Huttleston, *N 500* **B**
Colocasia esculenta (L.) Schott,* *N 1037* **D, FM**
Peltandra virginica (L.) Schott, *N 492* **D, FM, S**
Pistia stratioites L., *N 869* **D, FM**

ARECACEAE

Sabal minor (Jacq.) Pers., *N 638* **S**
Sabal palmetto (Walt.) Lodd. ex Schult. & Schult.,* *N 1506* **D**

BROMELIACEAE

Tillandsia recurvata (L.) L., *N 1846* **E**
Tillandsia usneoides (L.) L., *N 1376* **E**

BURMANNIACEAE

Apteria aphylla (Nutt.) Barnh., *N 1621* **Pi**

COMMELINACEAE

Commelina diffusa Burm. f., *N 978* **B, D, FM**
Commelina erecta L., *N 809* **D, Pr**
Commelina virginica L., *N 901* **B, S**
Tradescantia hirsutiflora Bush, *N 1207* **D, Pr**
Tradescantia occidentalis (Britton) Smyth, *Th 89238* **Pr**
Tradescantia ohiensis Raf., *N 1220* **BM, D**
Tradescantia reverchonii Bush, *Orzell & Bridges 7112* (NLU) **Pi**

CYPERACEAE

Carex abscondita Mackenzie, *N & M 1726* (MCN) **B**
Carex albicans Willd. var. *australis* (Bailey) J. Rettig, *M & N 2771* (MCN) **B**
Carex annectens (Bickn.) Bickn., *M & N 2766* (MCN) **Pr**
Carex basiantha Steud., *N & M 1728* (MCN) **B**
Carex cherokeensis Schwein., *N & M 1724* (MCN) **D, Pr**
Carex complanata Torr. & Hook., *N 604* **B**
Carex debilis Michx., *N & M 1727* (MCN) **B**
Carex digitalis Willd., *M & N 2772* (MCN) **B**
Carex flaccosperma Dewey, *N 553* **Pr**
Carex frankii Kunth, *N 637* **D, Pr**
Carex glaucescens Ell., *N 802* **B, D, Pi**
Carex intumescens Rudge, *N 603* **B**
Carex joorii Bailey, *T 20606* **B, FM**
Carex leavenworthii Dewey, *N & M 1715* (MCN) **D**
Carex lupulina Willd., *Th 14405* **D, Pr**
Carex microdonta Torr. & Hook., *M & N 2765* (MCN) **Pr**
Carex oxylepis Torr. & Hook., *N & M 1723* (MCN) **B**
Carex reniformis (Bailey) Small, *M & N 2775* (MCN) **B**
Carex styloflexa Buckl., *N & M 1725* (MCN) **B**
Carex verrucosa Muhl., *Orzell & Bridges* (NLU) **BM, FM**
Carex vulpinoidea Michx., *A 10021* (LAF) **D, Pr**
Cladium mariscus (L.) Pohl ssp. *jamaicense* (Crantz) Kukenth., *N 747* **BM, FM**
Cyperus articulatus L., *N 984* **BM, D, FM, S**
Cyperus compressus L., *Th 66923* **D, Pr**
Cyperus croceus Vahl, *N 745* **D, Pr**
Cyperus elegans L., *N 995* **D, Pr**
Cyperus entrerianus Boekler, *Carter 8130* (VDB) **D**
Cyperus erythrorhizos Muhl., *N 866* **BM, FM**
Cyperus esculentus L., *N 805* **D, FM**
Cyperus flavescens L., *N 1077* **D, Pi**
Cyperus giganteus Vahl,* *B 9719* **FM**
Cyperus haspan L., *N 819* **D, Pr**
Cyperus iria L.,* *N 867* **D, Pr**
Cyperus odoratus L., *N 694* **BM, FM**
Cyperus oxylepis Nees ex Steud., *T 23505* **D, FM**
Cyperus pilosus Vahl,* *C s.n.* **D**
Cyperus polystachyos Rottb. var. *texensis* (Torr.) Fern., *N 991* **D, Pr**
Cyperus pseudovegetus Steud., *N 910* **D, Pr**
Cyperus retrorsus Chapm., *N 834* **D, Pr**
Cyperus rotundus L.,* *N 1013* **D, Pr**
Cyperus strigosus L., *N 911* **D, Pr, FM**
Cyperus surinamensis Rottb., *T 31645* **D, B**
Cyperus virens Michx., *N 663* **B, D, S**
Eleocharis acicularis (L.) Roem. & Schult., *Th 87978* **D, Pr**
Eleocharis baldwinii (Torr.) Chapm., *N 927* **D**
Eleocharis microcarpa Torr., *N 615* **D, Pr**
Eleocharis montana (Kunth) Roem. & Schult., *N 605* **D, Pr**
Eleocharis montevidensis Kunth, *N 528* **D, Pr**
Eleocharis obtusa (Willd.) Schult., *T 29415* **D, Pr**

Eleocharis parvula (Roem. & Schult.) Link, *N 1034* **D, BM, FM**
Eleocharis quadrangulata (Michx.) Roem. & Schult., *N 587* **D**
Eleocharis tricostata Torr., *Th 48235* **Pi**
Eleocharis tuberculosa (Michx.) Roem. & Schult., *N 949* **D, S**
Fimbristylis annua (All.) Roem. & Schult., *N 964* **D, Pr**
Fimbristylis autumnalis (L.) Roem. & Schult., *N 1040* **D, Pr**
Fimbristylis caroliniana (Lam.) Fern., *N 820* **D, Pr**
Fimbristylis miliacea (L.) Vahl,* *N 863* **Pr**
Fimbristylis puberula (Michx.) Vahl, *Th 30109* **D, Pr**
Fimbristylis tomentosa Vahl, *Th 84877* **D, Pr**
Fimbristylis vahlii (Lam.) Link, *B 17774* **B, D**
Fuirena breviseta (Coville) Coville, *N 1423* **D, FM**
Fuirena squarrosa Michx., *N 950* **FM**
Isoleppis carinata Hook. & Arn. ex Torr., *N 1745* **D, Pr**
Isolepis molesta (M.C. Johnson) S.G. Sm., *T 30614* **BM**
Kyllinga brevifolia Rottb., *Th 66924* **D, Pr**
Kyllinga odorata Vahl *Lievens 1265* (LSU) **D, FM**
Kyllinga pumila Michx., *N 913* **D, Pr**
Rhynchospora caduca Ell., *N 908* **Pr**
Rhynchospora cephalantha A. Gray, *Orzell & Bridges 7404* (NLU) **Pi**
Rhynchospora colorata (L.) H. Pfeiffer, *Watson 90* (MCN) **D, Pi, Pr**
Rhynchospora corniculata (Lam.) A. Gray, *Joyce 407* (LAF) **D, BM**
Rhynchospora divergens Chapm. ex M.A. Curtis, *Givens s.n.* (LSU) **Pi, S** (S1)
Rhynchospora elliottii A. Dietr., *Th 14366* **D, Pr**
Rhynchospora fascicularis (Michx.) Vahl, *N 1424* **D, Pi**
Rhynchospora filifolia A. Gray, *Orzell & Bridges 6983* (NLU) **Pi**
Rhynchospora globularis (Chapm.) Small, *N 527* **D, Pr**
Rhynchospora glomerata (L.) Vahl., *T 31652* **D, Pi**
Rhynchospora gracilenta A. Gray, *N & M 1596* **Pi**
Rhynchospora inexpansa (Michx.) Vahl, *N 723* **D, Pi**
Rhynchospora latifolia (Baldwin ex Ell.) Thomas, *N 301* **D, Pi, Pr**
Rhynchospora macrostachya A. Gray, *N 969* **D, S**
Rhynchospora microcarpa Baldwin ex A. Gray, *Orzell & Bridges 7120* (LSU) **D, FM**
Rhynchospora miliacea (Lam.) A. Gray, *Featherman s.n.* (LSU) **B, S**
Rhynchospora mixta Britton ex Small, *N 907* **S**
Rhynchospora nitens (Vahl) A. Gray, *C s.n.* **Pi**
Rhynchospora oligantha A. Gray, *N & M 1594* (MCN) **Pi**
Rhynchospora perplexa Britton, *Th 89309* **Pr**
Rhynchospora plumosa Ell. *Joyce 288* (LAF) **Pi**
Rhynchospora pusilla Chapm. ex M.A. Curtis, *B 13825* (NLU) **D, BM**
Rhynchospora rariflora (Michx.) Ell., *Th* et *al.89449* **Pi, S**
Rhynchospora tracyi Britton, *C s.n.* **Pi, S** (SH)
Schoenoplectus maritimus (L.) Lye, *T 30614* **BM, D**
Schoenoplectus robustus (Pursh) M.T. Strong, *N 1579* **D, BM**
Schoenoplectus tabernaemontani (K.C. Gmel.) Palla, *Montz 6497* (LSU) **D**
Scirpus californicus (C.A. Meyer) Steud., *Th 89218* **D, BM, FM**
Scirpus cyperinus (L.) Kunth, *T 31682* **FM, S**
Scleria baldwinii (Torr.) Steud., *Orzell & Bridges 6870* (NLU) **D, Pi**
Scleria ciliata Michx., *A 15119* **Pi**
Scleria georgiana Core, *B 13828* (NLU) **Pi, S**
Scleria oligantha Michx. *Joyce 405* (LAF) **Pi**
Scleria pauciflora Muhl. ex Willd., *Th 129557* **Pi**
Scleria reticularis Michx., *Pias et al. 445* (LAF) **Pi, S**
Scleria triglomerata Michx., *N 1748* **Pi**
Scleria verticillata Willd., *Orzell & Bridges 5759* (NLU) **Pi, S** (S1)

DIOSCOREACEAE

Dioscorea villosa L., *N 1264* **B**

ERIOCAULACEAE

Eriocaulon decangulare L., *N 796* **Pi**
Lachnocaulon anceps (Walt.) Morong, *N 1219* **Pi**

HYDROCHARITACEAE

Egeria densa Planch.,* *N 720* **BM, FM, S**
Limnobium spongia (Bosc) Steud., *N 1025* **BM, FM, S**
Ottelia alismoides (L.) Pers.,* *N 1007* **BM**
Vallisneria americana Michx., *N 1467* **BM**

HYPOXIDACEAE

Hypoxis hirsuta (L.) Coville, *N 334* **B, D, Pi**

IRIDACEAE

Herbertia lahue (Molina) Goldblatt ssp. *caerulea* (Herbert) Goldblatt, *N 1273* **D, Pr**
Alophia drummondii (Graham) R. C. Foster, *Weber 26* (MCN) **Pi**
Iris brevicaulis Raf. *Whatley 2197* (LAF) **FM**
Iris pseudacorus L.* *Ashworth 29* (MCN) **D**
Iris virginica L., *N 521* **D, FM, S**
Sisyrinchium angustifolium P. Mill., *N & M 1714* (MCN) **B**
Sisyrinchium atlanticum Bicknell, *N 526* **D, Pi, Pr**

Sisyrinchium rosulatum Bicknell, *N 1191* **D**
Sisyrinchium sagittiferum Bicknell, *N 501* **D, Pr**

JUNCACEAE

Juncus acuminatus Michx., *Giltner 393* (MCN) **D, Pi, Pr**
Juncus biflorus Ell., *Th 89245* **Pi**
Juncus brachycarpus Engelm., *Brooks 608* (MCN) **D, Pi, Pr**
Juncus bufonius L., *T 23506* **D, Pi, Pr**
Juncus dichotomus Ell., *Brooks 610* (MCN) **D, Pi, Pr**
Juncus diffusissimus Buckl., *N 722* **D, Pi, Pr**
Juncus dudleyi Wiegand, *Th 81581* **Pr**
Juncus effusus L., *N 543* **D, FM, Pr**
Juncus elliottii Chapm., *Brooks 609* (MCN) **D, Pi, Pr**
Juncus marginatus Rostk., *Giltner 516* (MCN) **D, FM, Pi**
Juncus nodatus Coville, *Giltner 391* (MCN) **D, FM, Pi**
Juncus polycephalus Michx., *Giltner 523* (MCN) **D, Pi**
Juncus repens Michx., *Giltner 522* (MCN) **D, Pi, Pr**
Juncus roemerianus Scheele, *Giltner 487* (MCN) **BM, Pr**
Juncus scirpoides Lam., *N 550* **D, Pi, Pr**
Juncus tenuis Willd., *N 756* **D, S, Pr**
Juncus validus Coville, *N 755* **D, FM, Pi**

LEMNACEAE

Lemna minor L., *N 1087* **S**
Lemna valdiviana Phil., *N 744* **S**
Spirodela polyrrhiza (L.) Schleid., *N 1086* **S**
Spirodela punctata (G.F.W.Mey.) C.H.Thompson, *N 628* **S**
Wolffia brasiliensis Weddell, *N 1208* **S**
Wolffia columbiana Karst., *N 1151* **S**
Wolffiella lingulata (Hegelm.) Hegelm., *N 1154* **S**

LILIACEAE

Aletris aurea Walt., *N 565* **Pi**
Aletris farinosa L., *N 566* **Pi**
Allium canadense L. var. *canadense*, *N 1228* **B, D, Pr**
Allium canadense var. *mobilense* (Regel) Ownbey, *N 1297* **B, D, Pr**
Cooperia drummondii Herbert, *Th 66940* **Pr** (S1/S2)
Crinum americanum L., *N 785* **BM, FM, S**
Habranthus tubispathus (L'Hér.) Traub, *N 1784* **D**
Hymenocallis liriosome (Raf.) Shinners, *N 1196* **BM, FM, Pi, S**
Melanthium virginicum L., *N & Komo 1777* **Pi**
Nothoscordum bivalve L., *N 1089* **D, Pr**
Schoenolirion croceum (Michx.) A. Gray, *N 1218* **Pi**
Trillium gracile Freeman, *N 455* **B**
Zephyranthes grandiflora Lindl., *N 1417* **D**

NAJADACEAE

Najas guadalupensis (Spreng.) Magnus, *Haynes 2504* (LAF) **D, BM, FM**

ORCHIDACEAE

Calopogon oklahomensis D.H. Goldman, *Pennell 10242* (NY) **Pi**
Calopogon tuberosus (L.) B.S.P., *N 1341* **Pi**
Corallorrhiza wisteriana Conrad, *N 1706* **B**
Epidendrum conopseum R. Br., *Correll & Correll 9660* (DUKE) **E**
Habenaria repens Nutt., *N 974* **S**
Listera australis Lindl., *N 1689* **B**
Platanthera ciliaris (L.) Lindl., *N 1497* **Pi**
Platanthera cristata (Michx.) Lindl., *N 1790* **Pi**
Platanthera flava (L.) Lindl., *N & Komo 1781* **Pi**
Platanthera nivea (Nutt.) Luer, *N 1410* **Pi**
Pogonia ophioglossoides (L.) Ker-Gawl., *N 1336* **Pi**
Spiranthes cernua var. *odorata* (Nutt.) Correll, *N 348* **S**
Spiranthes longilabris Lindl., *N* & Komo 1804 **Pi**
Spiranthes praecox (Walt.) S. Watson, *N 582* **Pi**
Spiranthes vernalis Engelm. & A. Gray, *N 669* **BM, D, FM, Pi, Pr**
Tipularia discolor (Pursh) Nutt., *N 1624* **B**

POACEAE

Agrostis hyemalis (Walt.) B.S.P., *N 548* **D**
Andropogon gerardii Vitman, *Brooks 595* (MCN) **Pi, Pr**
Andropogon glomeratus (Walt.) B.S.P. var. *glomeratus*, *N 1056* **D**
Andropogon gyrans Ashe var. *gyrans*, *B et al. 8674* **Pi**
Andropogon ternarius Michx., *T 31890* **Pr**
Andropogon virginicus L., *T 27991* **D**
Anthaenantia rufa (Nutt.) Schult., *Brooks 794* (MCN) **Pi**
Anthaenantia villosa (Michx.) P.Beauv., *Brooks 594* (MCN) **Pi**
Aristida longispica Poir., *T 28008* **D, Pi, Pr**
Aristida oligantha Michx., *T 9644* **D, Pi, Pr**
Aristida palustris (Chapm.) Vasey, *N 1600* **Pi**
Aristida purpurascens Poir., *Brooks 802* (MCN) **D, Pi, Pr**
Arundinaria gigantea (Walt.) Muhl., *N 264* **B, Pi**
Axonopus fissifolius (Raddi) Kuhlm., *N 914* **D**
Axonopus furcatus (Fluegge) Hitchc., *B et al. 8668* **D, S, Pi**
Bothriochloa exaristata (Nash) Henrard, *Th 98153* **D, Pr**
Bothriochloa ischaemum (L.) Keng,* *N 1018* **D**
Bothriochloa laguroides (DC.) Herter ssp.

torreyana (Steud.) Allred & Gould, *Th 66885* **D**

Bothriochloa longipaniculata (Gould) Allred & Gould, *Th 84788* **D**

Bouteloua hirsuta Lag., *C s.n.* **D** (SR)

Brachiaria platyphylla (Munro ex Wright) Nash, *N 828* **D**

Brachiaria texana (Buckl.) S.T. Blake, *Th 66891* **D**

Briza minor L.,* *Costanza 3* (MCN) **D**

Bromus catharticus Vahl,* *N 631* **D**

Bromus japonicus Thunb. ex Murr,* *A 4608* **D**

Buchloe dactyloides (Nutt.) Engelm.,* *Chase 6114* (US) **D**

Cenchrus incertus M.A. Curtis, *N 912* **D**

Chasmanthium latifolium (Michx.) Yates, *N 1051* **B, S**

Chasmanthium laxum (L.) Yates var. *laxum*, *Th 14372* **B, S**

Chloris canterai Arechav.,* *McKenzie 223* (LSU) **D**

Chloris virgata Sw., *N 697* **D**

Cinna arundinacea L., *C s.n.* **B**

Coelorachis rugosa (Nutt.) Nash, *A 16163* **D, Pi**

Coelorachis cylindrica (Michx.) Nash, *B 13811* (NLU) **D, Pi, Pr**

Cynodon dactylon (L.) Pers.,* *N 537* **D**

Dactyloctenium aegyptium (L.) P. Beauv.,* *N 894* **D**

Dichanthelium aciculare (Desv. ex Poir.) Gould & C.A. Clark, *B et al. 8646* **Pi, Pr**

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *acuminatum*, *N 597* **Pi, Pr**

Dichanthelium acuminatum (Sw.) Gould var. *lindheimeri* (Nash) Gould & C.A. Clark, *A 4601* **D**

Dichanthelium commutatum Schult., *N 317* **D**

Dichanthelium dichotomum (L.) Gould var. *dichotomum*, *A 16403* **Pi**

Dichanthelium dichotomum (L.) Gould var. *ensifolium* (Baldw. ex Ell.) C. A. Clark, *A 3596* **Pi**

Dichanthelium dichotomum (L.) Gould var. *tenue* (Muhl.) Gould & C. A. Clark, *T 25624* **Pi**

Dichanthelium laxiflorum (Lam.) Gould, *B et al. 8598* **D**

Dichanthelium leucothrix (Nash) Freckman, *A 4419* (LAF) **Pi**

Dichanthelium scabriusculum (Ell.) Gould & C.A. Clark, *N 586* **Pi**

Dichanthelium scoparium (Lam.) Gould, *N 598* **D**

Dichanthelium sphaerocarpon (Ell.) Gould var. *sphaerocarpon*, *N 498* **D**

Dichanthelium strigosum (Muhl. ex Ell.) Freckman var. *leucoblepharis* (Trin.) Freckman, *B 8669* **Pi**

Digitaria ciliaris (Retz.) Koeler, *A 4593* (LAF) **D**

Digitaria cognata (J. A. Schultes) Pilger var. *cognata*, *B et al. 8661* **Pi**

Digitaria filiformis (L.) Koeler, *Brooks 792* (MCN) **Pi**

Digitaria ischaemum (Schreb. ex Schweigger) Muhl.,* *N 1094* **D**

Digitaria violascens Link* *N. & Komo 1619* **D**

Distichlis spicata (L.) Greene, *N 987* **BM**

Echinochloa colona (L.) Link,* *N 1425* **D**

Echinochloa crus-galli (L.) P. Beauv.,* *N 852* **D**

Echinochloa muricata (P. Beauv.) Fern.,* *Brooks 300* (LSU) **D**

Echinochloa walteri (Pursh) Heller,* *N 865* **BM, FM, S**

Eleusine indica (L.) Gaertn.* *Gaskin 30* (MCN) **D**

Elymus virginicus L., *N 696* **D**

Eragrostis bahiensis Schrad.,* *A 4432* (LAF) **D**

Eragrostis barrelieri Daveau,* *Th 66893* **D**

Eragrostis campestris Trin., *Th 66892* **Pi, Pr**

Eragrostis glomerata (Walt.) L.H. Dewey, *N 1123* **B, D**

Eragrostis hirsuta (Michx.) Nees, *T 20620* **D, Pr**

Eragrostis hypnoides (Lam.) B.S.P., *N 970* **B, D**

Eragrostis lugens Nees, *B et al. 8622* **D, Pr**

Eragrostis pectinacea (Michx.) Nees, *N 970* **B, D**

Eragrostis refracta (Muhl.) Scribn., *B et al. 8652* **D, Pi**

Eragrostis secundiflora Presl, *N 939* **D**

Eragrostis spectabilis (Pursh) Steud., *N 400* **D, Pr**

Eremochloa ophiuroides (Munro) Hack.,* *N & M 1627* (MCN) **D**

Eustachys caribaea (Spreng.) Herter* *McKenzie 114* (LSU) **D**

Eustachys petraea (Spreng.) Herter, *N 985* **D**

Festuca arundinacea Schreb.,* *N 1117* **D**

Hordeum pusillum Nutt., *Brooks 613* (MCN) **D**

Leersia hexandra Sw., *N 977* **BM, FM, Pr**

Leersia lenticularis Michx., *N 1054* **D**

Leersia oryzoides (L.) Sw., *N 977* **D**

Leptochloa fascicularis (Lam.) A. Gray, *Th 66898* **BM, FM**

Leptochloa mucronata (Michx.) P. Kunth, *Th 66899* **B, D**

Leptochloa nealleyi Vasey, *N 842* **BM, FM**

Leptochloa uninervia (Presl) Hitchc. & Chase, *Th 81568* **D**

Limnodea arkansana (Nutt.) L.H. Dewey, *s. nom. s.n.* (LAF) **D**

Lolium arundinaceum S.J. Derbyshire,* *Edgerton s.n.* (LSU) **D**

Lolium perenne L.,* *N 1772* **D**

Melica mutica L., *N 444* **Pi**

Muhlenbergia capillaris (Lam.) Trin., *A 16119* **Pi, Pr**

Oplismenus setarius (Lam.) Roem. & Schult.,* *T 20534* **Pi**
Oryza sativa L.,* *N 891* **D, Pr**
Panicum anceps Michx. var. *anceps*, *N 797* **D**
Panicum brachyanthum Steud., *Brooks 795* (MCN) **D**
Panicum dichotomiflorum Michx., *N 893* **D**
Panicum repens L., *N 989* **BM, D, FM**
Panicum rigidulum var. *pubescens* (Vasey) LeLong, *B et al. 8677* **Pi**
Panicum rigidulum Bosc ex Nees var. *rigidulum*, *Gilmore & Smith 3461* (NLU) **D, FM, Pi**
Panicum verrucosum Muhl., *N 1062* **D, Pi**
Panicum virgatum L., *N 836* BM, **Pi, Pr**
Paspalum bifidum (Bertol.) Nash, *Brooks 807* (MCN) **Pi**
Paspalum boscianum Fluegge, *B 5370* **D**
Paspalum conjugatum Bergius, *T 20530* **D**
Paspalum dilatatum Poir.,* *Augustus 50* (MCN) **D**
Paspalum distichum L., *N 992* **BM, D, FM**
Paspalum floridanum Michx., *A 16138* (LAF) **D, Pi, Pr**
Paspalum hydrophilum Henrard,* *N 854* **D**
Paspalum laeve Michx., *Augustus 80* (MCN) **D**
Paspalum lividum Trin., *Th 14381* **BM, D, FM**
Paspalum minus Fourn., *T 31649* **D, Pi**
Paspalum notatum var. *saurae* Parodi,* *Augustus 79* (MCN) **D**
Paspalum plicatulum Michx., *Augustus 11* (MCN) **D**
Paspalum praecox Walt., *Brooks 805* (MCN) **Pi, Pr**
Paspalum setaceum Michx., *B et al. 8611* **D**
Paspalum urvillei Steud.,* *N 940* **D**
Pennisetum glaucum (L.) R. Br.,* *N 779* **D**
Phalaris angusta Nees ex Trin., *Dutton & Taylor 1333* (NLU) **D**
Phalaris caroliniana Walt., *N 551* **D**
Phanopyrum gymnocarpon Vasey, *N 1108* **B, S**
Phragmites australis (Cav.) Trin., *N 787* **BM**
Poa annua L.,* *N 443* **D**
Poa autumnalis Muhl. ex Ell., *Griggs 17* (LSU) **B**
Polypogon monspeliensis (L.) Desf.,* *N 1222* **D**
Rottboellia cochinchinensis (Lour.) W. Clayton,* *Walker s.n.* (MCN) **D**
Saccharum baldwinii Spreng., *N 1052* **D, Pi**
Saccharum giganteum (Walt.) Pers., *N 1047* **D**
Sacciolepis striata (L.) Nash, *B et al. 8679* **D, Pi**
Schizachyrium scoparium (Michx.) Nash, *Brooks 806* (MCN) **D, Pi**
Schizachyrium tenerum Nees, *Th 98157* **Pi**
Setaria faberi Herrm.,* *T 28865* **D**
Setaria parviflora (Poir.) Kerguelen, *N 945* **D**
Setaria pumila (Poir.) Roemer & Schult.,* *McKenzie & Urbatsch 135* (LSU) **Pr**
Sorghastrum elliottii (Mohr) Nash, *N 1533* **D, Pi**
Sorghastrum nutans (L.) Nash, *T 27992* **D, Pi, Pr**
Sorghum bicolor (L.) Moench.,* *Th 66889* **D**
Sorghum halepense (L.) Pers.,* *N 569* **D**
Spartina alterniflora Loisel., *N 1153* **BM**
Spartina patens (Aiton) Muhl., *N 1408* **BM**
Spartina spartinae (Trin.) Hitchc., *N 1551* **BM, Pi**
Sphenopholis obtusata (Michx.) Scribn., *A & Vincent 10022* (LAF) **D, Pi**
Sporobolus compositus (Poir.) Merr. var. *compositus*, *B 8658* **BM, FM, Pr**
Sporobolus compositus var. *drummondii* (Trin.) Kartesz & Gandhi, *B 8620* **Pi, Pr**
Sporobolus indicus (L.) R. Br., *N 851* **D**
Sporobolus junceus (Michx.) Kunth, *N 1608* **D, Pi, Pr**
Sporobolus silveanus Swall., *T 31899* **Pi** (S2/S3)
Steinchisma hians (Ell.) Nash, *N 601* **D**
Stenotaphrum secundatum (Walt.) Kountz, *N 705* **D**
Tridens ambiguus (Ell.) Schult., *Th 98149* **Pi, Pr**
Tridens flavus (L.) Hitchc., *B et al. 8583* **D, Pi**
Tridens strictus (Nutt.) Nash, *N 1552* **D**
Tripsacum dactyloides (L.) L., *N 319* **D**
Vulpia octoflora (Walt.) Rydb., *N 552* **D**
Zizania aquatica L., *N 1459* **BM, FM**
Zizaniopsis miliacea (Michx.) Doell. & Asch., *N 1008* **BM, FM, S**

PONTEDERIACEAE

Eichhornia crassipes (Mart.) Solms,* *N 1409* **D, BM, FM, S**
Heteranthera limosa (Sw.) Willd., *N 845* **D, BM, FM**
Pontederia cordata L., *N 266* **D, FM, S**

POTAMOGETONACEAE

Potamogeton diversifolius Raf., *N 799* **D, FM, S**
Potamogeton nodosus Poir., *N 1041* **FM, BM, S**
Potamogeton pusillus L., *N 1393* **BM, FM**

SMILACACEAE

Smilax bona-nox L., *N 486* **B, D, Pi, Pr, S**
Smilax glauca Walt., *N & M 1630* (MCN) **B, D**
Smilax laurifolia L., *N 1413* **Pi, S**
Smilax pumila Walt., *N 1132* **B**
Smilax rotundifolia L., *N 534* **D, Pi**
Smilax smallii Morong, *N 606* **B, D, S**
Smilax tamnoides L., *N & M 1632* (MCN) **B, S**
Smilax walteri Pursh, *N 731* **B, S**

TYPHACEAE

Typha angustifolia L.,* *N 1364* **BM, FM**
Typha domingensis Pers., *N 1318* **BM, D**
Typha latifolia L., *N 1318* **D, FM, S**

XYRIDACEAE

Xyris ambigua Bey. ex Kunth, *N 795* **D, Pi**

Xyris baldwiniana Schult., *N 1768* **Pi**
Xyris caroliniana Walt., *N 794* **Pi**
Xyris difformis var. *curtissii* (Malme) Kral, *N & M 1614* (MCN) **Pi**
Xyris difformis Chapm. var. *difformis*, *Th 14369* **D, Pi**
Xyris drummondii Malme (*MacRoberts & MacRoberts 3905* MCN) **Pi**
Xyris fimbriata Ell., *Orzell & Bridges 7407* (LSU) **Pi**
Xyris jupicai Rich., *N 1060* **D, Pi**
Xyris laxifolia var. *iridifolia* (Chapm.) Kral, *N 335* **Pi, S**
Xyris stricta Chapm., *N 862* **Pi**
Xyris torta Sm. in Rees, *N & M 1592* (MCN) **Pi**

APPENDIX II

Taxa reportedly collected in Calcasieu Parish by either MacRoberts (1988) or by Thomas and Allen (1993 1996 1998) that were not discovered during our field research nor located during our visits to other herbaria are listed. Taxa are listed alphabetically by family, genus, and species within each division.

APPENDIX II

UNVERIFIED TAXA REPORTED FOR CALCASIEU PARISH

DRYOPTERIDACEAE
Woodsia obtusa (Spreng.) Torr.

ACANTHACEAE
Ruellia noctiflora (Nees) A. Gray
Ruellia strepens L.

ANNONACEAE
Asimina triloba (L.) Dunat

APIACEAE
Polytaenia nuttallii DC.

ASTERACEAE
Arnoglossum plantagineum Raf.
Chloracantha spinosa (Benth.) Nesom
Cirsium carolianum (Walt.) Fern. & Schub.
Coreopsis gladiata Walt.
Coreopsis pubescens Ell. var. *debilis* (Sherff) E.B. Smith
Echinacea angustifolia DC.
Echinacea pallida (Nutt.) Nutt.
Erigeron pulchellus Michx.
Eupatorium altissimum L.
Eupatorium incarnatum Walt.
Eupatorium pilosum Walt.
Eupatorium pinnatifidum Ell.
Euthamia graminifolia (L.) Nutt.
Helianthus simulans E.E. Wats.
Heliopsis helianthoides (L.) Sweet
Hymenopappus scabiosaeus L'Hér,
Senecio tomentosus Michx.
Solidago nemoralis Aiton
Solidago speciosa Nutt.
Symphyotrichum subulatum (Michx.) Nesom

BRASSICACEAE
Lepidium densiflorum Schrad.
Sinapis arvensis L.

CALLITRICHACEAE
Callitriche pedunculosa Nutt.

CAMPANULACEAE
Lobelia nuttallii J.A. Schultes

CISTACEAE
Helianthemum carolinianum (Walt.) Michx.
Lechea minor L.
Lechea racemulosa Michx.
Lechea tenuifolia Michx.

CONVOLVULACEAE
Convolvulus arvensis L.

ERICACEAE
Vaccinium corymbosum L.

FABACEAE
Baptisia nuttalliana Small
Desmodium glutinosum (Willd.) Wood
Desmodium obtusum (Muhl. ex Willd.) DC.
Desmodium perplexum Schub.
Kummerowia striata (Thunb.) Schind.
Neptunia pubescens Benth.
Trifolium carolinianum Michx.

GENTIANACEAE
Sabatia stellaris Pursh
Sabatia angularis (L.) Pursh
Sabatia brachiata Ell.

CLUSIACEAE
Hypericum galioides Lam.

Hypericum gentianoides (L.) B.S.P.
Hypericum gymnanthum Engelm. & A. Gray
Hypericum nudiflorum Michx. ex Willd.

EUPHORBIACEAE
Chamaesyce hirta (L.) Millsp.
Chamaesyce prostrata (Aiton) Small
Croton lindheimerianus Scheele
Croton monanthogynous Michx.
Euphorbia spathulata Lam.
Euphorbia pubentissima Michx.
Phyllanthus caroliniensis Walt.

LAMIACEAE
Monarda fistulosa L.
Physostegia intermedia (Nutt.) Engelm. & A. Gray
Pycnanthemum muticum (Michx.) Pers.
Scutellaria parvula Michx.

LENTIBULARIACEAE
Utricularia vulgaris L.

LINACEAE
Linum berlandieri Hook
Linum floridanum (Planch.) Trel.
Linum sulcatum Riddell

LOGANIACEAE
Spigelia marilandica L.

LYTHRACEAE
Lythrum lineare L.

MALVACEAE
Callirhoe involucrata (Torr. & A. Gray)

NYCTAGINACEAE
Boerhaavia diffusa L.

ONAGRACEAE
Ludwigia repens J. Forst.

OXALIDACEAE
Oxalis violacea L.

PLANTAGINACEAE
Plantago rugelii Decne.
Plantago wrightiana Dcne.

POLYGALACEAE
Polygala curtisii A. Gray
Polygala cymosa Walt.
Polygala grandiflora Walt.
Polygala lutea L.

POLYGONACEAE
Polygonum convolvulus L.

RANUNCULACEAE
Delphinium virescens Nutt.
Ranunculus laxicaulis Darby
Ranunculus platensis Spreng.

RHAMNACEAE
Ceanothus americanus L.

ROSACEAE
Crataegus aestivalis L.
Crataegus crus-galli L.
Crataegus sabineana Ashe
Crataegus spathulata Michx.
Fragaria virginiana Duchesne
Potentilla simplex Michx.
Prunus angustifolia Marshall

RUBIACEAE
Galium pilosum Aiton
Galium trifidum L.
Galium uniflorum Michx.
Houstonia caerulea L.
Houstonia purpurea L.

SCROPHULARIACEAE
Agalinis pinetorum Pennell
Castilleja indivisa Engelm.
Gratiola neglecta Torr.
Verbascum virgatum Stokes

SOLANACEAE
Physalis heterophylla Nees
Solanum americanum P. Mill.
Solanum eleagnifolium Cav.

TAMARICACEAE
Tamarix ramosissima Ledeb.

URTICACEAE
Parietaria pensylvanica Muhl. ex Willd.

VERBENACEAE
Verbena bonariensis L.
Verbena litoralis Kunth

VIOLACEAE
Viola langloisii Greene

AGAVACEAE
Yucca filamentosa L.

CYPERACEAE
Carex leptalea Wahl
Cyperus polystachyos Rottb. var. *polystachyos*
Eleocharis elongata Chapm.
Eleocharis macrostachya Britt.
Eleocharis palustris (L.) Roem. & Schult.

IRIDACEAE
Sisyrinchium langloisii Greene

LEMNACEAE
Lemna obscura (Austin) Daubs

ORCHIDACEAE
Calopogon barbatus (Walt.) Ames

Platanthera integra (Nutt.) A. Gray ex Beck
Spiranthes cernua (L.) L. C. Rich.
Spiranthes ovalis Lindl.

POACEAE
Agrostis elliottiana Schult.
Aristida ramosissima Engelm. ex A. Gray
Bromus racemosus L.
Dichanthelium ovale var. *addisonii* (Nash) Gould & C.A. Clark
Dichanthelium ovale var. *ovale* (Ell.) Gould & C.A. Clark
Dichanthelium villosissimum (Nash) Freckman
Digitaria sanguinalis (L.) Scop.
Digitaria villosa (Walt.) Pers.
Eragrostis elliottii S. Wats.
Hackelochloa granularis (L.) Kuntze
Leersia virginica Willd.
Paspalum dissectum (L.) L.
Paspalum langei (Fourn.) Nash
Paspalum repens Berg.
Paspalum vaginatum Sw.
Saccharum brevibarbe (Michx.) Pers.
Triticum aestivum L.

APPENDIX III

REJECTED TAXA PREVIOUSLY REPORTED FOR CALCASIEU PARISH

APIACEAE
Ptilmnium nuttallii (DC.) Britt.

ASTERACEAE
Liatris spicata (L.) Willd.
Marshallia obovata (Walt.) Beadle
Rudbeckia fulgida Aiton
Rudbeckia maxima Nutt.
Solidago radula Nutt.

EUPHORBIACEAE
Cnidoscolus stimulosus (Michx.) Engelm. & A. Gray

FABACEAE
Baptisia bracteata Muhl. ex Ell. var. *leucophaea*
Lespedeza capitata Michx

JUGLANDACEAE
Carya texana Buckl.

LAMIACEAE
Physostegia pulchella Lundell
Salvia reflexa Hornem.

LAURACEAE
Persea borbonia (L.) Spreng.

RANUNCULACEAE
Anemone berlandieri Pritz.

SALICACEAE
Salix caroliniana Michx.

SARRACENIACEAE
Sarracenia flava L.

POACEAE
Aristida longispica Poir. var. *geniculata* (Raf.) Fern.

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ESTABLISHING ETHNOBOTANICAL CONSERVATION PRIORITIES: A CASE STUDY OF THE KALLAWAYA PHARMACOPOEIA

Kevin D. Janni

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, TX 76102-4060, U.S.A.
kjanni@brit.org

Joseph W. Bastien

Department of Anthropology and Sociology
University of Texas, Arlington
Arlington, TX 76019, U.S.A.

ABSTRACT

The Kallawaya herbalists of Bolivia follow a healing tradition over a millennium old. Twenty-eight plants of the indigenous pharmacopoeia have been documented in both 16th and 17th century historical literature and contemporary ethnobotanical research. This continuity has bio-cultural implications representing not only useful medicinal plants but also traditional cultural knowledge. These plants and their antiquity of use represent the cultural heritage of the Kallawaya and should be considered along with the biodiversity priorities of local conservation programs. The rapid loss of biological diversity and local knowledge is putting modern ethnobotany at the risk of becoming decadent, before becoming a discipline. Analysis of indigenous pharmacopoeias can be an effective means of determining bio-cultural importance and establishing ethnobotanical conservation priorities. The following case study discusses a selected group of plants that have ethnomedical importance and also various economic uses. The utilization of these plants over time represents their bio-cultural importance and priority for conservation and sustainability efforts.

KEY WORDS: Bolivia, Conservation, Ethnobotany, Kallawaya, Pharmacopoeia

RESUMEN

Los herboristas Kallawaya de Bolivia siguen una tradición de curación de más de un milenio. Se han documentado veintiocho plantas de la farmacopea indígena en la literatura histórica de los siglos XVI y XVII y de la investigación etnobotánica contemporánea. Esta continuidad tiene implicaciones bio-culturales que representan no sólo plantas medicinales útiles sino también conocimiento cultural tradicional. Estas plantas y su antigüedad de uso representan la herencia cultural de los Kallawaya y debe ser considerada en los programas de conservación junto con las prioridades de biodiversidad. La pérdida rápida de diversidad biológica y conocimiento local está poniendo a la etnobotánica moderna en el riesgo de hacerse decadente antes de llegar a ser una disciplina. El análisis de las farmaconpeas indígenas puede ser un método efectivo de determinar la importancia bio-cultural y establecer las prioridades de conservación etnobotánicas. El siguiente caso de estudio discute un grupo selecto de plantas que tienen importancia ethnomédica junto con usos económicos variados. La utilización de estas plantas a lo largo del tiempo representa su importancia bio-cultural y los esfuerzos para la conservación y uso sostenido.

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INTRODUCTION

The Kallawaya herbalists of Bolivia are renowned throughout Argentina, Bolivia, Chile and Peru (Bastien 1987) (Fig. 1). Living at altitudes of 2700–4300m and frequently traveling to communities in varied ecological zones, the Kallawaya have not only established a continuity in Andean folk medicine, they have also had the opportunity to greatly augment their pharmacopoeia along the way (Bastien 1983; Abdel-Malek et al. 1996; Janni & Bastien n.d.). They follow a medical tradition from the Tihuanaco (400–1145), Mollo (1145–1453), Inca (1438–1532), Spanish (1532–1825), and Bolivian Republic (1825–present) periods (Oblitas-Poblete 1969; Bastien 1982, 1983, 1987; Abdel-Malek et al. 1996). The Kallawaya utilize nearly 900 plants (Girault 1987) of the 2000 medicinal plants reported in all of Bolivia (De Lucca & Zalles-Asin 1992). In contemporary times a syndicate of herbalists known as the Society for Bolivian Traditional Medicine (SOBOMETRA) has been responsible for preserving and disseminating Kallawaya herbal knowledge, while the Servicio Integrado en Salud (SIENS) clinics in La Paz utilize both physicians and Kallawaya herbalists to provide integrated ethnomedical and biomedical treatment (Abdel-Malek et al. 1996).

Compiled from a survey of historical and ethnobotanical literature are 28 plants that have been present in the health and healing practices of the Kallawaya since pre-Columbian times. This indigenous cultural knowledge extends deep into Kallawaya ethnohistory and offers compelling reasons for the conservation of bio-cultural diversity. By targeting plants in indigenous pharmacopoeias for conservation priority we not only help sustain traditional cultural knowledge and biological diversity, but also the ethnomedical practices of the community. Focusing ethnobotanical research on community level priorities helps target plants of cultural importance that frequently go unnoticed by global conservation programs that are, "...the action of outsiders who are culturally and politically detached from the threatened environments and who identify species for conservation through western economic models" (Etkin 1998). Discussion of the conservation priorities of ethnobotanical research has been unjustifiably rare (Alcorn 1995; Benz et al. 1996; Etkin 1998; Eisner & Beiring 1994; Laird et al. 1997; Posey & Balée 1989) and deserves further attention and investigation.

METHODS

Data on pre-Columbian (before European invasion) uses of medicinal plants were compiled by a survey of the historical literature (Anonimo 1703; Calancha 1638; Cobo 1891, 1892, 1893; Contreras & Valverde 1650; Jimeneza 1965; Monardes 1569; Oviedo 1535; Polo de Ondegardo 1585; Vega 1609; Yacovleff & Herrera 1935). Information on medicinal plants was often fragmentary and incomplete, but fourteen plants had two or more references. Information from modern ethnobotanical literature was considerably more substantial and was compiled to see what plants had persisted since pre-Columbian-era. Data on the Kallawaya pharmacopoeia were compiled by Bastien (1982, 1983, 1987), including information on therapeutic uses and non-medicinal or economic uses. The

Fig. 1 Geographical location of the Kallawaya Indians. (From Bastien 1987 with permission of University of Utah Press).

Kallawaya reportedly have an unwritten pharmacopoeia of over 900 medicinal plants. For the purpose of this study, the pharmacopoeia is limited to published information and follows the nomenclature therein (Bastien 1982, 1983, 1987).

Relative importance values were calculated for each plant using a normalized number of pharmacological properties (PH) and a normalized number of body systems (BS) treated.This approach follows the one used by Bennett and Prance (2000) for measuring the relative importance of plants in indigenous pharmacopoeias and is primarily a measure of the versatility of each plant in relation to the pharmacopoeia as a whole. For example, *Minthostachys andina* is used to treat 10 body systems, the most of any plant in the pre-Columbian pharmacopoeia. Therefore, it has a normalized BS value of 1 (10/10). *Erythroxylum coca* is used to treat six body systems, four less than *Minthostachys andina*. The BS value for *E. coca* is 0.6 (6/10). *Minthostachys andina* has seven pharmacological properties, again the most of any pre-Columbian plant in the Kallawaya pharmacopoeia. Thus its PH value is 1(7/7). The combined PH and BS values of *M. andina* equal 2.0, which is then divided by two and multiplied by 100 to calculate the relative importance of pre-Columbian *M. andina*, 100. This approach is useful for calculating the relative importance of a plant by taking into account the differences in number of pharmacological properties and body systems treated. For example, *E. coca* has five pharmacological properties and treats six body systems giving it a pre-Columbian relative importance of 65. *Nicotiana rustica* also has five pharmacological properties, but treats only five body systems, giving it a relative importance of 60. The relative importance scores for each plant reflect differences in versatility.

The relative importance of each pre-Columbian plant is then analyzed comparatively with its relative importance in contemporary times. By taking an average of pre-Columbian relative importance and contemporary relative importance we find the overall relative importance of each plant. For example, *E. coca* has a pre-Columbian relative importance of 65 and a contemporary relative importance of 70, thus having an overall relative importance of 68. By comparative analysis, those plants used in pre-Columbian times are recognized for their continuity. Seven plants, *Psoralea pubescens, Mutisa acuminata, Salvia haenkii, Verbena hispida, Peperomia anaequifolia, Gnaphalium quadichaudium, Ambrosia peruviana*, are included in this table because they were cited in the literature without specific pharmacological or therapeutic details other than being medicinal. There is no known pre-Columbian importance for these plants, but their contemporary relative importance is included. This comparative analysis is designed to show the changes in number of pharmacological properties and body systems treated between pre-Columbian and contemporary times. Medical terminology follows that of Dorland's Medical Dictionary (1980) and discussed in Bastien (1982, 1983, 1987).

RESULTS

There are 28 plants in the Kallawaya pharmacopoeia cited in historical literature (Table 1). This is a small portion of the Kallawaya pharmacopoeia and information on these plants and others in the modern literature is considerably more comprehensive. These plants have a wide variety of therapeutic uses (19 in all) mainly as analgesics, diuretics, antiseptics, and expectorants (Table 2). Aside from medicinal uses there are 12 plants that overlap economically as aromatics, ornamentals, dyes, foods, intoxicants, etc (Table 3). *Minthostachys andina* recorded an overall relative importance of 80, the highest of all 28 pre-Columbian plants (Table 4). Three plants, *Erythroxylum coca, Urtica flabellate,* and *Nicotiana rustica*, scored in the sixties and only one plant, *Polypodium angustifolium*, scored

Table 1. Pre-Columbian medicinal plants of the Kallawaya pharmacopoeia.

Genus, species (Family)	Vernacular Name	References
Ambrosia peruviana Willd. (Asteraceae)	Malco	5, 9, 10
Azorella biloba Schlecht. (Apiaceae)	Yareta	3
Baccharis pentandii DC. (Asteraceae)	Chilca	3, 5
Calceolaria cuneiformis R&P. (Schrophulariaceae)	Ava Zapatilla	3
Calceolaria aff. *engleriana* (Schrophulariaceae)	Puru Puru	3
Chenopodium ambrosioides L. (Chenopodiaceae)	Paico Lombrio	5, 6, 8, 10
Cinchona calvisa Wedd. (Rubiaceae)	Quina Cascarilla	2, 3, 10
Datura sanguinea L. (Solanaceae)	Floripondio	2, 3
Equisetum bogotense HBK. (Equisetaceae)	Cola de Caballo	3
Erythroxylum coca Lam. (Erythroxylaceae)	Coca	3,6
Gentiana lutea L. (Gentianaceae)	Pencacuc	3
Gnaphalium quadichaudium DC. (Asteraceae)	Wira Wira	4
Minthostachys andina Benth. (Lamiaceae)	Muña	3, 10
Mutisa acuminata R&P. (Asteraceae)	Chinchircuma	10
Myroxylon balsamum L. (Fabaceae)	Quina Quina	3, 10
Nasturtium officinale R.Br. (Brassicaceae)	Berro	3, 9
Nicotiana rustica L. (Solanaceae)	Sayre	3, 6, 7, 8
Peperomia inaequalifolia R&P. (Piperaceae)	Conqona	3, 6
Plantago tomentosa Lam. (Plantaginaceae)	Llanten	3, 5, 10
Polypodium angustifolium SW. (Polypodiaceae)	Calaquala	3, 10
Polystichum aculeatum SW. (Polypodiaceae)	Helecho Macho	3, 10
Psoralea pubescens Pers. (Fabaceae)	Bilyea	1
Psittacanthus cuneifolius R&P. (Loranthaceae)	Suelda con Suelda	3
Salvia haenkii Benth. (Lamiaceae)	Savia Grande	3, 10
Senecio tephosiodes Turcz. (Asteraceae)	Mamanlipa	3
Solanum radicans L.f. (Solanaceae)	K'umasillo	3, 9
Urtica flabellate H.B.K. (Urticaceae)	Ortega	3, 10
Verbena hispida R&P. (Verbenaceae)	Verbena	3, 9

1. Anonimo 1703
2. Calancha 1638
3. Cobo 1891–93
4. Contreras and Valverde 1650
5. Jimenez de la Espada 1965
6. Vega 1609
7. Polo de Ondegardo 1585
8. Monardes 1569
9. Oviedo 1535
10. Yacovleff and Herrera 1935

in the fifties (Table 4). Twenty-three of the 28 pre-Columbian plants have a relative importance under 50. Seven plants, *Polypodium angustifolium, Plantago tomentosa, Cinchona calvisa, Gentiana lutea, Polystichum aculeatum, Psittachanthus cuneifolius,* and *Solanum radicans,* show an increase in pharmacological properties and body systems treated

TABLE 2. Therapeutic properties of Pre-Columbian medicinal plants in the Kallawaya pharmacopoeia. **A** = analgesic. **A1** = antiseptic. **A2** = astringent. **C** = cardiotonic. **D** = disinflammatory. **D1** = Diuretic. **D2** = diaphoretic. **D3** = demulcent. **E** = emetic. **E1** = expectorant. **F** = febrifuge. **R** = refrigerant. **R1** = resolvent. **S** = stomachic. **S1** = sudorific. **S2** = Stimulant. **T** = tranquilizer. **V** = vermifuge. **V1** = vulnerary.

Species	**A**	**A1**	**A2**	**C**	**D**	**D1**	**D2**	**D3**	**E**	**E1**	**F**	**R**	**R1**	**S**	**S1**	**S2**	**T**	**V**	**V1**
Ambrosia peruviana	x																x		
Azorella biloba						x													
Baccharis pentandii	x				x														
Calceolaria cuneiformis								x											
Calceolaria engleriana																	x		
Chenopodium ambrosioides	x											x							
Cinchona calvisa		x									x								
Datura sanguinea	x									x									
Equisetum bogotense		x				x			x										
Erythroxylum coca	x		x								x			x	x				
Gentiana lutea																x			
Gnaphalium quadichaudium										x									
Minthostachys andina	x					x				x			x	x		x			
Mutisa acuminata				x						x									
Myroxylon balsamum	x	x															x		
Nasturtium officinale					x						x								
Nicotiana rustica	x					x				x									
Peperomia inaequalifolium	x	x																	
Plantago tomentosa			x		x									x				x	
Polypodium angustifolium		x	x		x	x			x										
Polystichum aculeatum			x				x			x								x	
Psoralea pubescens		x			x					x	x								
Psittacanthus cuneifolius																x			
Salvia haenkii						x									x				
Senecio tephosiodes			x			x								x					
Solanum radicans							x				x								x
Urtica flabellate						x								x					
Verbena hispida							x				x								
Totals	9	6	5	1	5	8	3	1	2	7	6	1	1	5	2	3	3	2	1

throughout time. The other 21 plants show a decrease in PH and BS values between pre-Columbian usage and present. These differences could be attributed to the scant and fragmentary historical documentation of pre-Columbian medicinal plants.

OBSERVATIONS AND DISCUSSION

Analysis of the pre-Columbian pharmacopoeia elucidates the importance of medicinal plants to the health and healing practices of the Kallawaya. Outside the pharmacopoeia these plants are culturally useful as food, for hygienic purposes, ornamental, and other purposes. These twenty-eight plants are arguably important parts of the traditional cul-

Table 3. Other uses of Pre-Columbian medicinal plants in the Kallawaya pharmacopoeia. **A** = aromatic. **B** – used to make broom. **D** = dye. **E** = embalming. **F** = food. **H** = horse injuries. **H1** = Hygiene. **I** = intoxicant. **O**= ornamental. **R** = resin to catch birds.

Species	**A**	**B**	**D**	**E**	**F**	**H**	**HI**	**I**	**O**	**R**
Ambrosia peruviana			x							
Baccharis pentandii						x				
Calceolaria engleriana									x	
Datura sanguinea									x	
Erythroxylum coca								x		
Minthostachys andina	x								x	
Myroxylon balsamum				x						
Nasturtium officinale					x		x			
Nicotiana rustica								x		
Peperomia inaequalifolia	x					x				
Psittacanthus cuneifolius										x
Solanum radicans		x								

tural, environmental, and biological knowledge of the Kallawaya. Along with plants having a pre-Columbian continuity, the Kallawaya have integrated exotic plants into their pharmacopoeia (Janni & Bastien n.d.). Despite the integration of exotic species into the pharmacopoeia, the 28 plants discussed herein have retained much of their cultural and medicinal importance for over a thousand years.

The diversity of therapeutic uses of these plants is remarkable. Clearly, by the time of Spanish invasion, the Kallawaya had actively investigated the phytomedicinal potential of the local and regional flora. The diversity of therapeutic uses indicates the ethnomedical sophistication of the Kallawaya, and offers a picture of the health and healing concerns of pre-Columbian Kallawaya culture. This information is useful in understanding the epidemiological fluctuations of the Kallawaya throughout time by revealing the patterns of health and sickness that enable us to ask questions as to why they changed. Also, by compiling such data we find the plants that are not only important medicinally, but also have been an integral part of Kallawaya cultural heritage.

Many ethnobotanical investigations compile information in an effort to identify potential new drugs; we have compiled this information to identify plants of cultural importance as well as plants of priority for biological conservation and sustainability programs. Local efforts in conservation offer greater potential results than those of western economists because they represent the intimate local knowledge of the native ecology and long experience with the species in question (Etkin 1998). Assessing the significance of specific taxa with cultural and ecological importance gives us a framework by which conservation of local biota is based on local values (Benz et al. 1996).

The list of 28 plants discussed herein describes a portion of the pharmacopoeia that has been analyzed based on local values. The long-standing persistence of these plants in the Kallawaya pharmacopoeia indicate continued cultural reliance on these taxa in ethnomedical and economic practices. The versatility of these species within the

Table 4. Relative importance values of selected medicinal plants in the Kallawaya pharmacopoeia. **16–17th PH** = number of pharmacological properties sited in 16th & 17th Century Literature. **16–17th Rel PH** = relative number of pharmacological properties sited in 16th &17th Century Literature. (normalized to the maximum value of 1). **16–17th BS** = number of body systems treated, sited in 16th & 17th Century Literature. **16–17th Rel BS** = relative number of body systems treated, sited in 16th & 17th Century Literature. (normalized to the maximum value of 1). **16–17th RI** = relative importance of 16th & 17th Century Medicinal Plants. **20th PH** = number of pharmacological properties, 20th Century. **20th Rel PH** = relative number of pharmacological properties. (normalized to the maximum value of 1). **20th BS** = number of body systems treated, 20th Century. **20th Rel BS** = relative number of pharmacological properties, 20th Century. **20th RI** = relative importance of medicinal plants, 20th Century. **ORI** = overall relative importance. **RI** = ((Rel PH + Rel BS)/2) x 100. **ORI** = (16–17th RI + 20th RI)/2.

Species	**16–17th PH**	**16–17th Rel PH**	**16–17th BS**	**16–17th Rel BS**	**16–17th RI**	**20th PH**	**20th Rel PH**	**20th BS**	**20th Rel BS**	**20th RI**	**ORI**
Minthostachys andina	7	1.0	10	1.0	100	3	0.6	4	0.6	60	80
Erythoxylum coca	5	0.7	6	0.6	65	3	0.6	5	0.8	70	68
Urtica flabellata	5	0.7	7	0.7	70	3	0.6	3	0.5	55	63
Nicotiana rustica	5	0.7	5	0.5	60	2	0.4	5	0.8	60	60
Polypodium angustifolium	2	0.2	1	0.1	15	5	1.0	6	1.0	100	58
Baccharis pentandii	2	0.2	7	0.7	45	2	0.4	4	0.6	50	48
Equisetum bogotense	5	0.7	5	0.5	60	2	0.4	2	0.3	35	48
Plantago tomentosa	2	0.2	3	0.3	25	4	0.8	4	0.6	70	48
Senecio tephosiodes	5	0.7	4	0.4	55	1	0.2	4	0.6	40	48
Myroxylon balsamum	7	1.0	5	0.5	75	1	0.2	1	0.2	20	48
Cinchona calvisa	2	0.2	2	0.2	20	3	0.6	5	0.8	70	45
Chenopodium ambrosiodes	2	0.2	4	0.4	30	2	0.4	4	0.6	50	40
Azorella biloba	3	0.4	2	0.2	30	2	0.4	3	0.5	45	38
Psoralea pubescens	0	0.0	0	0.0	00	4	0.8	4	0.6	70	35
Mutisa acuminata	0	0.0	0	0.0	00	2	0.4	6	1.0	70	35

Table 4. continued

Species	16–17th PH	16–17th Rel PH	16–17th BS	16–17th Rel BS	16–17th RI	20th PH	20th Rel PH	20th BS	20th Rel BS	20th RI	ORI
Datura sanguinea	3	0.4	3	0.3	35	1	0.2	3	0.5	35	35
Gentiana lutea	1	0.1	1	0.1	10	3	0.6	4	0.6	60	35
Polystichum aculeatum	2	0.2	1	0.1	15	3	0.6	3	0.5	55	35
Psittacanthus cuneifolius	2	0.2	2	0.2	20	2	0.4	4	0.6	50	35
Solanum radicans	1	0.1	1	0.1	10	2	0.4	3	0.5	45	28
Salvia haenkii	0	0.0	0	0.0	00	3	0.6	3	0.5	55	28
Verbena hispida	0	0.0	0	0.0	00	4	0.8	2	0.3	55	28
Calceolaria cuneiformis	3	0.4	1	0.1	25	1	0.2	2	0.3	25	25
Peperomia inaequifolia	0	0.0	0	0.0	00	2	0.4	3	0.5	45	23
Gnaphalium quadichaudium	0	0.0	0	0.0	00	2	0.4	3	0.5	45	23
Calceolaria engleriana	2	0.2	2	0.2	20	1	0.2	1	0.2	20	20
Nastrium officinale	1	0.1	1	0.1	10	1	0.2	2	0.3	25	18
Ambrosia peruviana	0	0.0	0	0.0	00	2	0.4	2	0.3	35	18

pharmacopoeia and outside it also makes conservation priorities more compelling. Several taxa are used for more than one therapeutic (Table 2) or pharmacological (Table 4) property and several are used for a variety of economic uses (Table 3). Conservation initiatives focused on biological diversity alone neglect the socio-cultural importance of some taxa. By using ethnobotanical research to target taxa of such importance we have a chance to protect biological diversity and in the process also protect and sustain traditional cultural knowledge, indigenous health care systems, and plants of particular cultural significance. Conservation and sustainability initiatives that focus on community level priorities allow us to work on several problems at once. Direction based from an ethnobotanical perspective (e.g. analyzing indigenous pharmacopoeias) gives us the opportunity to address problems of social, cultural and biological importance. The data discussed here provides only a part of a broader investigation that should include fieldwork and interviews to more accurately determine current social and biological needs.

The loss of local knowledge and biological diversity should be the primary concern of every ethnobotanist. Organizing at local levels with an ethnobotanical framework simultaneously protects biological and cultural diversity. Losing tribal elders and the knowledge they encapsulate is losing information on the biological environment of the surrounding area. Conservation and sustainability programs that are sensitive to biocultural issues like these will help protect traditional cultural knowledge and biodiversity for future generations.

CONCLUSION

Analysis of the pre-Columbian continuity of the Kallawaya pharmacopoeia reveals plants of cultural and medicinal importance that should be targeted for conservation and sustainability programs. The persistence of use of these plants throughout centuries of healing, as well as their role outside the pharmacopoeia for a variety of economic uses elucidates the importance of these plants to the cultural heritage of the Kallawaya. By focusing conservation efforts on plants of cultural importance we not only recognize indigenous environmental knowledge, we also have the opportunity to protect biological diversity. With overwhelming predictions of 60,000 plus higher plant species to become extinct by the middle of the next century, ethnobotany must be a leader in identifying conservation and sustainability priorities by analysis of local needs. Just as local knowledge has been tapped for new drug leads, we must go to it in the future to determine conservation priorities.

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CRYPTOCORYNE BECKETTII (ARACEAE), A NEW AQUATIC PLANT IN TEXAS

David J. Rosen

U.S. Army Corps of Engineers
Galveston District, P.O. Box 1229
Galveston, TX 77553, U.S.A.

The genus *Cryptocoryne* Fisch. ex Wydl. comprises approximately 50 species distributed on islands and coastal areas of South East Asia (Mühlberg 1982). *Cryptocoryne beckettii* Thw. ex R. Trim., a native of Sri Lanka (Mühlberg 1982), was collected in 1996 in the San Marcos River in the City of San Marcos. This taxon has not been previously reported in Texas according to Jones et al. (1997), Hatch et al. (1990), and Correll and Johnston (1970). Large, naturalized colonies of *C. beckettii* were observed growing in open shallow riffles as well as in shaded deep pools. *Cryptocoryne beckettii* is a valued aquarium plant collected in the wild and widely exported (Nicolson 1987). The occurrence of this species in the San Marcos River is likely due to escape from cultivation or dumping of aquariums as has been proposed for the introduced aquatic fern *Ceratopteris thalichtroides* by Hannan (1969). A description of *C. beckettii* modified from Nicolson (1987) and illustration (Fig. 1) follow.

Cryptocoryne beckettii Thw. ex R. Trim. J. Bot. 23:269. 1885.

Perennial, rhizomatous emergent-submerged herbs. Leaves basal with elongate, sheathing petioles to 15 cm; blades glabrous, ovate to narrowly ovate, 3–9(–13) cm long, (1–)1.5–3.5(–4) cm wide, upper surface green to dark green to brown and marbled to red-brown, lower surface red-tinged to more or less brownish or green; veins usually conspicuously red; apex acute to acuminate; base obtuse to cordate, margin entire, sometimes undulate; submerged specimens mostly with larger, thinner leaves, often brownish marbled. Inflorescence (not seen) short peduncled; spathe 4–12(–20) cm long, limb greenish brown, narrowly ovate, 0.5–1.2 cm wide, 1.5–3 cm long, twisted, upright to somewhat recurved and twisted; spadix 1.0 cm long.

There are three closely related species, *C. walkeri* Schott, *C. wendtii* de Wit, and *C. undulata* Wendt. A key to separate the four taxa can be found in Nicolson (1987).

Voucher specimen: **TEXAS. Hays Co.:** San Marcos River, exposed bottom across from sewage treatment plant, 08 Aug 1996, *Rosen 202* (SAT, SWT).

ACKNOWLEDGMENTS

I am indebted to Don Bryne (Suwannee Labs, Florida) for his determination of the *Cryptocoryne* material to species and Collete Jacono (USGS) for her enthusiasm and assistance. Thanks are expressed to Stanley D. Jones and two reviewers for their helpful comments.

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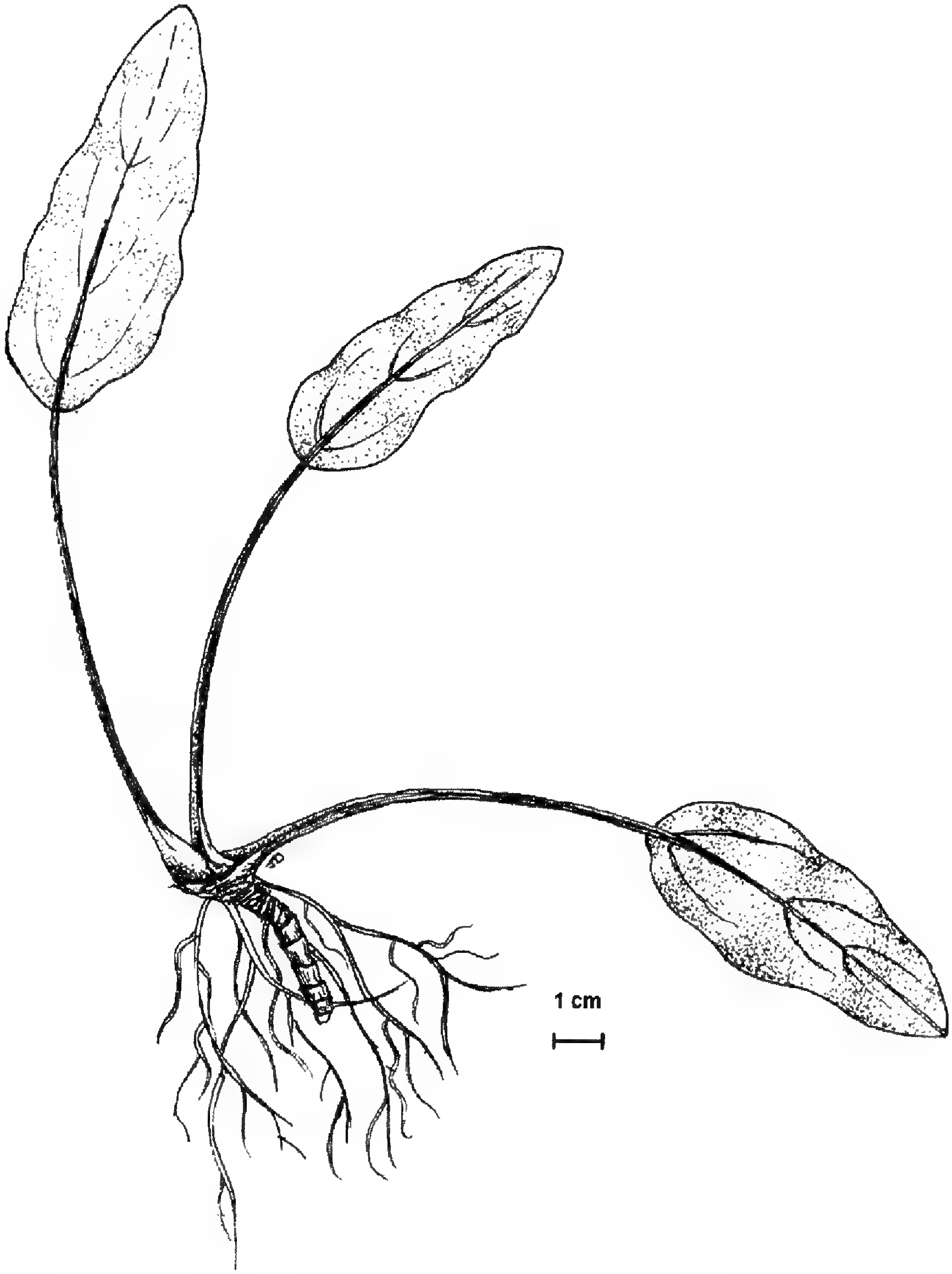

Fig. 1. *Cryptocoryne beckettii* (Drawn by J.E. Dawson III from herbarium specimen).

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BOOK REVIEW

D.M. Persall. 2000. **Paleoethnobotany. A Handbook of Procedures, second edition.** Academic Press, 525 B Street, Suite 1900, San Diego, CA 92101-4495, U.S.A.

Eleven years after its debut, *Paleoethnobotany: A Handbook of Procedures* returns in second edition. This classic by University of Missouri-Columbia anthropologist Deborah Pearsall is back -700 pages in all- in updated form. In the time between editions major advances were made in the field of phytolith analysis, as well as a general growth in paleoethnobotanical literature. Pearsall makes appropriate updates and responds to the critics of the first edition by making this edition more global in scope, correcting an imbalance in the first book in favor of New World examples. Also new is the final chapter on integrating biological data into paleoethnobotanical analysis. This chapter makes a case that reconstructing past human diets may be the biggest and most immediate contribution by the field of paleoethnobotany.

The book is laid out in six chapters followed by references and an index. Chapter one, "The Paleoethnobotanical Approach" includes an introduction to the field, a historical overview and a discussion of the nature and status of ethnobotany. Chapters two and three are devoted to macroremains and the techniques for recovering, identifying and interpreting them. Chapter four, "Pollen Analysis" covers the nature and production of pollen, field sampling, laboratory analysis, and a discussion of issues and directions in archaeological pollen analysis. Chapter five, "Phytolith Analysis," covers the nature and occurrence of phytoliths and methods of field sampling, lab testing, and interpreting the results. Chapter 6, "Integrating Biological Data," is the most welcomed addition to this volume. Broken into two parts, "Indicators of Diet and Health" and "The Interplay of Dietary Indicators," respectively, Pearsall gives a welcomed big-picture framework to the field. Part one of chapter six discusses indirect dietary factors, such as botanical and faunal data, and then discusses direct indicators like gut contents and coprolites, stable isotopes, trace elements, and skeletal indicators of nutrition and health. Part two of chapter six discusses predictions from dietary indicators, combined indicators for eight neotropical diets, and two archeological case studies from Ecuador and Peru. This chapter is a valuable addition to the annals of paleoethnobotanical literature by developing an approach for integrating and evaluating multiple lines of evidence concerning diets. Pearsall discusses eight diets chosen to represent diets spanning the transition from hunting and gathering to agriculture in the New World tropics, which is then illustrated by two Neotropical case studies. Reconstructing diets is an important archaeological and bio-anthropological issue by which investigation can help us understand how past populations survived and prospered. This chapter is followed by a list of references and closed by a general index. Black and white figures and tables appear frequently throughout to illustrate concepts discussed therein.

Paleoethnobotany: A Handbook of Procedures is valuable for its comprehensive outline of approaches and techniques of research, but more importantly, it exists as the only book of its kind. Pearsall has made an effort to make the book accessible to both anthropologists and botanists and succeeds admirably. My only complaint is the $150 price that is simply an outrageous amount to ask from a student or professional. I would be more tempted to require a smaller, less comprehensive, text for a class in lieu of the heavy price tag.—*Kevin D. Janni.*

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THYMELAEA PASSERINA (THYMELAEACEAE) NEW TO TEXAS

Walter C. Holmes

Department of Biology
Baylor University
Waco, TX 76798-7388, U.S.A.
walter_holmes @baylor.edu

John F. Pruski

United States National Herbarium
Department of Botany
Smithsonian Institution, Washington, DC 20560-0166, U.S.A.
pruski.john@nmnh.si.edu

Jason R. Singhurst

Wildlife Diversity Program
Texas Parks and Wildlife Department
Austin, TX 78704, U.S.A.
jason.singhurst@tpwd.state.tx.us

Thymelaea passerina (L.) Cosson & J. Germain was first reported in the United States by Pohl (1955). In reporting *T. passerina* as new to Ohio, Vincent and Thieret (1987) presented an expanded account of the occurrence of the species in the United States, mentioning its presence in Illinois, Iowa, Kansas, and Nebraska. Additionally, *Thymelaea passerina* has also been reported from Alabama (Webb et al. 1997), Mississippi (Wofford & DeSelm 1988), Washington (USDA, NRCS 1999), and Wisconsin (Harriman 1979). The species is not cited in any of the recent references or checklists treating the flora of Texas (Correll & Johnston 1970; Hatch et al. 1990; Johnston 1990; Jones et al. 1997), nor is it included in Diggs et al. (1999) in their flora of the north central part of the state. A description of the species and pertinent synonymy follow.

Thymelaea passerina (L.) Cosson & J. Germain, Syn. Fl. Env. Paris, ed. 2, 360. 1859. (**Fig. 1**).
Stellera passerina L., Sp. Pl. 559. 1753. Complete synonymy given by Tan (1980).

Taprooted annual to 55–60 cm tall; stems erect, slender, simple or more commonly with few to several ascending branches in distal half, glabrous or weakly pilose distally, yellowish green; leaves alternate, simple, exstipulate, sessile or nearly so, linear-lanceolate, 7–15 mm long, 1–2 mm wide, stiffly chartaceous or subcoriaceous, glabrous or less commonly abaxially weakly puberulent, apex acute, margins entire. Inflorescence axillary, flowers often 3 but ranging from 1–7 in distal leaf axils, cluster commonly subtended by 2 green bracts, bracts lanceolate to broadly so, to ca. 1.5 mm long, basally ciliate; flowers bisexual, actinomorphic, perigynous, sessile, 2–3 mm long, corollas absent, sepals 4, weakly

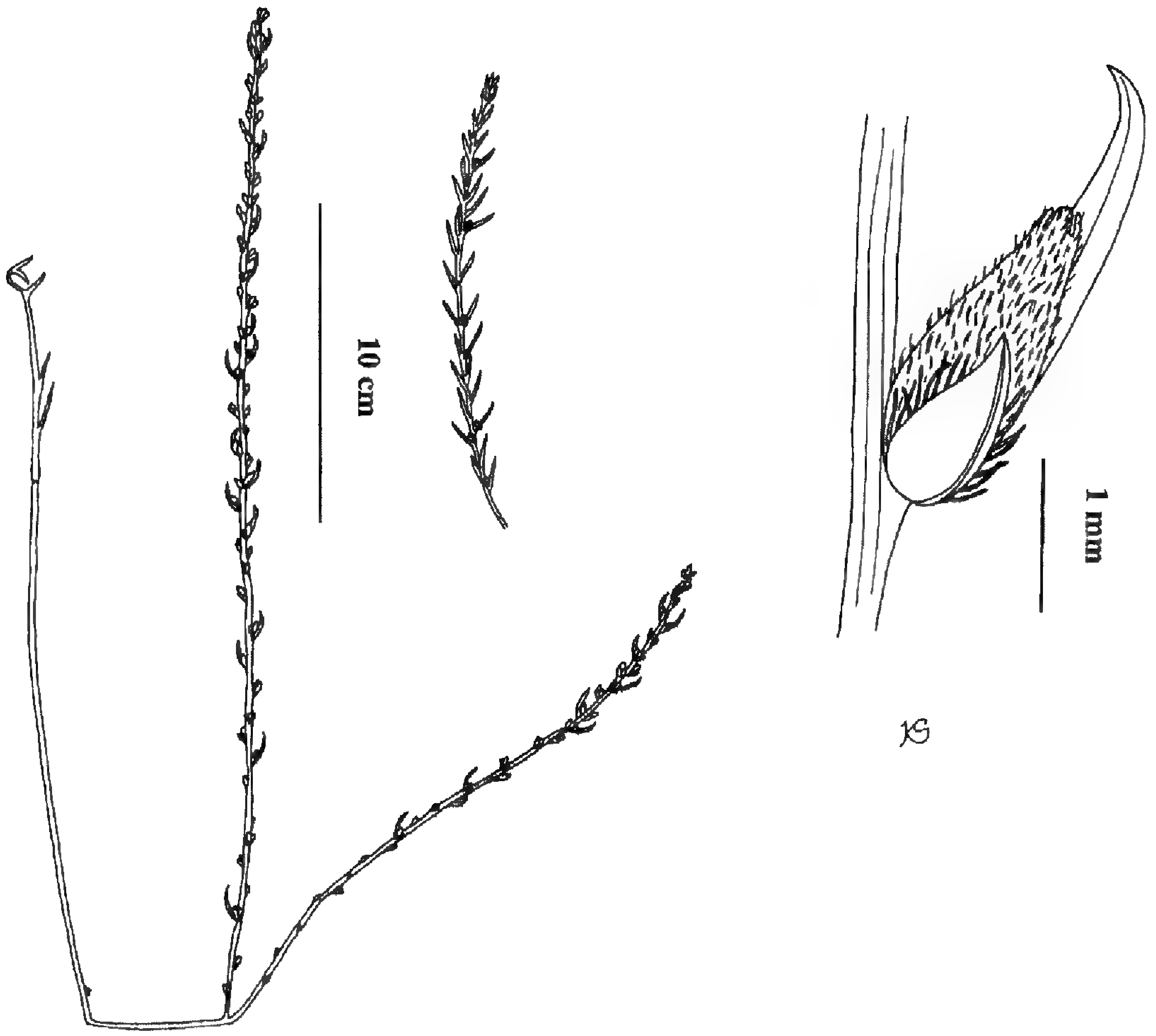

Fig. 1. *Thymelaea passerina*. Left, habit; Center, younger branch before loss of some leaves; Right, persistent hypanthium with enclosed fruit. [From Vincent and Thieret in Sida 12:77. 1987. Used with permission.]

petaloid, manifested as minute (ca. 0.5 mm long) ovate to lance-ovate greenish yellow lobes with obtuse apices on top of the urceolate, persistent hypanthium, hypanthium and calyx lobes substrigose, stamens episepalous, 8, bicyclic, included, filament much shorter than the anther thecae, ovary superior, apically hirsute-villous, subtended by a hypogynous disk, bicarpellate but unilocular by abortion, style one, terminal, short, ovule one, pendulous. Fruit a dry, indehiscent, 1-seeded, 1-locular capsule, apically beaked, enclosed within the persistent hypanthium; seed ovoid, 2–3 mm long, brown to black. Chromosome number 2n = 18.

This Eurasian weed of *Thymelaea* section *Lygia* (Tan 1980) has been reported within the United States from Alabama (Webb et al. 1997), Illinois (Mohlenbrock & Ladd 1978), Iowa (Pohl 1955), Kansas (McGregor et al. 1986), Mississippi (Wofford & DeSelm 1988), Nebraska (Pohl 1955), Ohio (Vincent & Thieret 1987), Washington (USDA, NRCS 1999), Wisconsin (Harriman 1979), and is here newly documented for the flora of Texas. It has also been introduced into Australia. Flowering time for the North American populations ranges from (April) June to September.

Specimens cited: **TEXAS. Denton Co.:** approximately 5 mi E of Sanger on FM 455, 24 Jun 1999, *Singhurst 8156* (BAYLU, TEX, US). **Fannin Co.:** 0.5 mi E of Haile Community on FR 1550, N 33.51173, W 96.05437, 5 Jun 1999, *Holmes 10173 & Singhurst* (BAYLU, TEX, US).

We believe that the species was likely introduced to Texas through the use of agricultural machinery imported from further north and used to harvest wheat, the dominant crop in both areas. The Denton County specimen is from the Cross Timbers and Prairies vegetational region of the state, an area characterized by slightly acidic to acidic sandy loam soils (Correll & Johnston 1970). Associated species included *Dalea purpurea, Indigofera miniata* (Leguminosae), *Froelichia floridana* (Amaranthaceae), *Helianthemum georgianum, Lechea mucronata, L. tenuifolia* (Cistaceae), *Hypericum drummondii* (Hypericaceae), and *Krameria lanceolata* (Krameriaceae). The Fannin County specimen occurred in the margins of roads and wheat fields in clay over limestone "chalk" on the Gober Limestone Formation of the Blackland Prairie vegetation region of the state. Common associates included *Asclepias asperula* (Asclepiadaceae), *Forestiera pubescens* (Oleaceae), *Hypericum perforatum* (Hypericaceae), *Rhus aromatica* (Anacardiaceae), *Sedum pulchellum* (Crassulaceae), and *Sophora affinis* (Leguminosae).

The documentation of *Thymelaea passerina* as new to Texas is not only a report of a new genus and species to the known non-cultivated flora of the state, but another family, the Thymelaeaceae. Jones et al. (1997), in their checklist of the vascular flora for the state, included two species of Thymelaeaceae, *Daphne cannabina* Wall. (= *D. papyracea* Wall. ex Steud. according to Huxley 1992) and *D. cneorum* L., but both of these are cultivated and not known to escape in Texas.

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We thank James Solomon (MO) and Michael Nee (NY) for searching for specimens of North American *Thymelaea passerina* in MO and NY, respectively; and Aaron Goldberg (US) and Monique Reed for helpful comments on the manuscript. We are grateful to Tom Wendt (TEX) for providing other assistance and to Michael Vincent (MU) and John Thieret (KNK) for their helpful reviews and permission to use the illustration.

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REDISCOVERY OF *RIBES NIVEUM* (GROSSULARIACEAE) IN COLORADO

Timothy W. Chumley[1] and Ronald L. Hartman

Department of Botany
University of Wyoming
Laramie, WY 82071-3165, U.S.A.

While conducting a floristic survey of central Colorado (Chumley 1998), two collections of a gooseberry from the Cañon City area, Fremont County, proved to be *Ribes niveum* Lindl. These collections represent the rediscovery of a taxon known in Colorado from a single, neglected gathering by T.S. Brandegee in 1873 (*Brandegee 697*, Sinnott 1985). These new collections come from the drainage of Cottonwood Creek, 13 to 15 miles northwest of Cañon City. Wilson Creek, the Brandegee locality, is 3–4 miles to the east or ca. 8 miles northwest of Cañon City. Field work in 1997 verified that *R. niveum* still occurs along Wilson Creek.

The Brandegee specimen was cited by Porter and Coulter (1874) as *R. irriguum* Douglas, a species of the Pacific Northwest. Rydberg (1906) excluded this taxon from his treatment of the Colorado flora. Presumably, he did not examine the material and ignored the taxon due to its great disjunction from its normal range (being one of several species "accredited to Colorado but not the intervening states," page xii). The occurrence of "*R. irriguum*" has been similarly ignored or overlooked in subsequent treatments of the flora (Harrington 1954; Weber 1953, 1967, 1990; Weber & Wittmann 1992, 1996). Sinnott (1985) examined the Brandegee collection in preparing his treatment of *Ribes* section *Grossularia* and determined it to be *R. niveum*, another species of the Pacific Northwest, rather than *R. irriguum* (*R. oxyacanthoides* L. ssp. *irriguum* (Douglas) Q.P. Sinnott). This is consistent with Porter and Coulter's description of the specimen, which matches *R. niveum* and not *R. irriguum*. Sinnott, however, failed to relocate the Colorado population. Examination of the specimen (*Brandegee 697*) at the Missouri Botanical Garden confirmed his determination, and the new collections document its persistence in Colorado for over 120 years.

The normal geographical range of *R. niveum* is in three separate areas: the northern group of populations are in southeastern Washington, eastern and northeastern Oregon, and adjacent western and central Idaho; the middle group, southeastern Oregon, southern Idaho, and adjacent northeastern Nevada; and the southern group, west-central Nevada (Churchill, Lander, Pershing, and possibly Nye counties; Holmgren 1997; Sinnott

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[1] Current address: Section of Integrative Biology, School of Biological Sciences, University of Texas at Austin, Austin, TX 78712, U.S.A.

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1985). The marked disjunction to the east or southeast is most curious. A possible clue to its occurrence in Colorado prior to settlement was found in an account of the Long expedition to the Rocky Mountains in 1820 (Goodman & Lawson 1995). Edwin James, the botanist of the expedition, collected a specimen of *Ribes* in the area that was determined by Torrey and Gray as *R. irriguum*. A description of the fragment provided by Torrey and Gray (1838–1843) indicates that it was not *R. niveum* but most likely *R. inerme* Rydb. Goodman and Lawson were unable to locate the specimen and thus could not confirm its identity. The presence of *R. niveum* in the region therefore is not documented before Brandegee's collection in 1873. Prior to that time, Cañon City was a major gateway and supplier to the gold and silver mines of South Park and Leadville, and it is possible that *R. niveum* was introduced into Colorado from the Pacific Northwest during the 1860s by gold or silver miners. It is also possible that Native Americans may have been responsible for dispersal since the localities are close to old Ute trails into South Park. Brandegee's collection may thus represent the parental population at or near its initial point of establishment.

The plants were in flower by mid-June, in fruit by late July. Fruits persisted through at least early October. They were found growing along creeks or dry washes in pinyon-juniper on sandy soils derived from gneiss. Interestingly, *R. niveum* in Colorado always grows in clumps with other woody taxa including *Ptelea trifoliata* L., *Ribes cereum* Douglas, *Ericameria (Chrysothmanus) nauseousus* (Pall. ex Pursh) G.L. Nesom & G.I. Baird, *Rhus trilobata* Nutt., and *Quercus gambellii* Nutt. This could indicate dispersal of seeds by birds.

In floral features, the Colorado material of *R. niveum* is a close match with material from the main geographical range. The most striking characters of *R. niveum* are those of the stamens. With the petals extended or erect, the stamens surpass them by 2 to 3 mm; filaments range from 7 to 9 mm in length. Furthermore, both the anthers and filaments are at least moderately pubescent with prominent silky hairs. All other Colorado species have glabrous filaments and anthers. Vegetatively, *R. niveum* has a distinctive rich reddish brown bark on new growth and is unarmed except for stout spines at the nodes. *Ribes lacustre* (Pers.) Poir. may have a similar hue, but the internodes are usually quite spiny. Another species, *R. inerme*, shares similarities in leaf shape, but the young twigs are pale yellow. With age the bark of most Colorado gooseberries becomes gray and exfoliates, exposing a dark reddish brown interior.

Leaf blades of specimens of *R. niveum* collected at the three known sites in Colorado are moderately to densely covered with minute, stalked glands mixed with erect to curved eglandular trichomes. Those in the main populations to the west and northwest vary from glabrous and ciliolate to densely clothed in minute, erect to curved eglandular trichomes only, although the petioles often have stalked glands. Due to the fickle nature of glandular trichomes in many groups of plants and the variability in pubescence in populations over the main geographical range of this taxon, this difference may not be significant.

In Weber and Wittmann (1996), *R. niveum* keys to lead 10b, where it matches fruits and flowers glabrous externally, but differs in anthers purple, greenish with age vs. white. Ignoring anther color, it would key to *R. inerme* (11a), although not easily. For an excellent treatment of *Ribes* that is largely relevant to Colorado, the reader is referred to the *Intermountain Flora* (Holmgren 1997). All but two Colorado taxa are treated: *R. americanum* Mill., a species of the plains and northeastern North America, and the questionable introduction (W. Jennings, Louisville, CO, pers. comm.), *R. divaricatum* Douglas. *Ribes coloradoense* Coville is placed in synonymy with the major disjunct (to the northwest), *R. laxiflorum* Pursh.

It is always possible that additional populations of *Ribes niveum* remain to be discovered east of the Continental Divide in Colorado. Two recent floristic projects have contributed substantially to our understanding of the distribution of species of *Ribes*, and to vascular plants in general, in this area (see http://www.rmh.uwyo.edu). The first, the Central Colorado project, which led to the rediscovery of *R. niveum* (Chumley 1998), included the Mosquito and Rampart ranges and Pikes Peak. It extended from Morrison (near Denver) west to Webster and Hoosier passes, south on the west side along the crest of the Mosquito Range to near Salida and south on the east side to Pueblo. The second, the Sangre project, included the Sangre de Cristo and Wet mountains, Mesa de Maya, and the Spanish Peaks. It was to the south from the first area, with the Arkansas River, in part, forming the boundary in common. Cañon City is on the Arkansas River, north side, midway along this line of contiguity. The Sangre project extended from Pueblo west to Monarch Pass, south on the west side to North Pass, Saguache, San Luis, and the New Mexico line and south on the east side to Trinidad and Branson (collections mostly by B. Elliott and R. Hartman). Together, these two study areas cover nearly 10,000 mi^2 for which ca. 27,500 numbered collections were obtained. In the process, 322 populations of nine of the 13 species of *Ribes* reported for Colorado (Weber & Wittmann 1992 and this report) were sampled during four field seasons (1995–96, 1998–99). Despite the high level of intensity in collecting, no new sites for *R. niveum* were discovered south of the Arkansas River.

Specimens collected: **COLORADO. Fremont Co.:** Sand Gulch south along a drainage intersecting Sand Gulch Road, ca. 15 air mi NW of Cañon City, 16 Jun 1995, *Chumley 895* (RM); Cottonwood Creek, ca. 13.5 air mi WNW of Cañon City, 25 Jul 1995, *Chumley 2454* (RM); along Wilson Creek and surrounding hills to the east, ca. 7.8 air mi NW of Cañon City, 28 Jun 1997, *Chumley 6887* (RM).

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ALOPECURUS MYOSUROIDES AND *SCLEROCHLOA DURA* (POACEAE) NEW TO LOUISIANA

John K. Saichuk

LSUAGCenter
Cooperative Extension Service
Crowley, LA 70527-0497, U.S.A.

Charles M. Allen

Biology Department
University of Louisiana at Monroe
Monroe, LA 71209, U.S.A.

William D. Reese

Biology Department
University of Louisiana at Lafayette
Lafayette, LA 70504-2451, U.S.A.

Two recent collections from Morehouse Parish in northeast Louisiana are apparently the first records for the state. Specimens of *Alopecurus myosuroides* Huds. and *Sclerochloa dura* (L.) Beauv. were collected from the same field on the same day. Neither species is in Allen (1993) or Thomas and Allen (1993). *Sclerochloa dura* (L.) Beauv was reported for Louisiana by MacRoberts (1977) and then excluded by Allen (1980). Brandenburg et al. (1991) did not find any records for this species from Louisiana but did report it for all three adjacent states: Arkansas, Mississippi, and Texas. *Alopecurus myosuroides* Huds. is listed by the USDA-NRCS (1999) database from adjoining Mississippi and Texas as well as Alabama, Kansas, New Mexico, and most east and west coast states.

Voucher specimen (*Alopecurus myosuroides* Huds.): **LOUISIANA. Morehouse Parish:** Rice field area on the Harold Tucker farm, about 7.7 mi due S of the Arkansas/Louisiana state line near the intersection of Sunshine and Tucker roads, E side of Tucker road about 0.5 mi S of Sunshine Road, field fallow through the winter and not flooded, scattered throughout the field and along the edges, 27 Apr 2000, *Saichuk s.n.* (LAF, NLU).

Voucher specimen (*Sclerochloa dura* (L.) Beauv.): **LOUISIANA. Morehouse Parish:** Rice field area on the Harold Tucker farm, about 7.7 mi due S of the Arkansas/Louisiana state line near the intersection of Sunshine and Tucker roads, E side of Tucker Road about 0.5 mi S of Sunshine Road, field fallow through the winter and not flooded, growing along the field road, 27 Apr 27 2000, *Saichuk s.n.* (LAF, NLU).

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GAMOCHAETA SIMPLICICAULIS (ASTERACEAE: GNAPHALIEAE) IN GEORGIA

Guy L. Nesom

North Carolina Botanical Garden
Coker Hall CB 3280
University of North Carolina
Chapel Hill, NC 27599-3280, U.S.A.

Two collections extend the known range of *Gamochaeta simplicicaulis* (Willd. ex Spreng.) Cabrera into Georgia. This native South American species was previously first reported from North America in North Carolina, South Carolina, Florida, and Alabama (Nesom 1999). An additional collection from Florida confirms its presence in that state; the previously cited Florida specimen also was collected in Walton County by H.A. Davis. These new records are unequivocal in identity. The hospitality of the staff at BRIT/VDB is greatly appreciated.

Voucher specimens: **FLORIDA. Walton Co.:** 4.5 mi S of Freeport, by overflow pond, 12 Jul 1972, *Davis 16204* (VDB). **GEORGIA. Bulloch Co.:** wet pine woods 1 mi S of Statesboro, 8 Aug 1975, *Kral 56228* (VDB). **Wayne Co.:** longleaf pine-turkey oak sandridge by US 301 at S side of Jesup, 8 Aug 1975, *Kral 56320* (VDB).

REFERENCE

Nesom, G.L. 1999. *Gamochaeta simplicicaulis* (Asteraceae: Gnaphalieae) in four southeastern states and new for North America. Sida 18:1259–1264.

BOOK NOTICES

Bobby J. Ward. 1999. **A contemplation Upon Flowers: Garden Plants in Myth and Literature.** (ISBN 0-88192-469-5, hbk.). Timber Press. Inc., The Haseltine Building, 133 S.W. Second Avenue. Suite 450. Portland, OR 97204-3527, U.S.A. (503-227-2878, 503-227-3070 fax; www.timberpress.com). $24.95 hbk. 447pp. Line drawings.

This work represents extensive reading and intensive delving into the subject. Not only does the author describe the genus and species of some eighty-three plants and their natural origins, he also relates them when possible to native wild species. Beginning with etymological accounts of scientific names and common names, he narrates myths and legends and cites poetry and prose referring to the species from the works of authors throughout the range of Western literature. Well-indexed by authors' names and, separately, by plants (binomial as well as common), this work besides being pleasurable reading may have particular value as a source of tales and quotations to enliven talks to general audiences.—*Joann Karges.*

Harold W. Lawrence. 1999. **Douglas Chandor: An English Artist and His Texas Garden.** (No ISBN, hbk.) Antler Press, 317 Cleveland Ave., Weatherford, TX 76086, U.S.A. (No price given), 173 pp., b/w photographs.

Douglas Chandor painted portraits of royalty, of world leaders, of business tycoons and society matrons, and in the rocky ground of Weatherford, Texas, he created an extensive garden that eventually reached national recognition. "White Shadows," later Chandor Gardens, opened to the public in the 1940s. Eclectic in style, the gardens employed principles of English landscape gardening with many Oriental features. Chandor is quoted as having said, ""God gave me the talent to paint the pictures so that I could sell them to get the money to build the garden."

Contents.—Introduction. **1)** Early Years in the U.S.; **2)** Chandor and Kuteman Family Matters; **3)** Douglas and Ina Chandor: A life shared; **4)** The Studio and the Garden; **5)** Public Response to the Garden; **6)** Journals; **7)** Chandor's Garden Library; Appendix A: FDR Letter; Appendix B: Malcolm Vaughn's Brochure; Appendix C: A list of Douglas' Gardening Books; and Bibliography.—*Joann Karges.*

Andreé Millar. 1999. **Orchids of Papua New Guinea.** (ISBN 0-88192-438-5, hbk.). Timber Press. Inc., The Haseltine Building, 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (503-227-2878, 503-227-3070 fax; www.timberpress.com). $34.95 hbk. 128 pp, 271 color photos, 14 b/w illustrations, 1 map.

From the close-up and intimate photos of flowers, to habitat shots to beautiful landscapes, the 271 color photographs by Ron and Margaret Mackay are enough to make you want to grow orchids or at least visit Papua New Guinea. What a passion or should I say an obsession!

From the dustjacket.—"A thoroughly revised and updated version of Millar's earlier book on the same subject, Millar is the first to attempt this vast subject since the German occupation of New Guinea ended more than sixty years ago. Covering both epiphytic and terrestrial orchids, this book is a truly personal account of the author's experience with the orchids. Decades of study—obsession? love?—of the orchids native to this geographically diverse land have produced an incredibly detailed and authoritative record of what grows where and what it looks like." The 203 species are accounted for in 26 subtribes and each genus is divided into sections as in Schlechter's *Orchidaceae of German New Guinea*; species in each section are in alphabetical order.—*Barney Lipscomb.*

SIDA 19(2): 414. 2000

GEORGE JONES GOODMAN

(1904–1999)

A MEMOIR

Cheryl A. Lawson

1 W. MacArthur
Shawnee, OK 74804, U.S.A.

The University of Oklahoma and the State of Oklahoma lost their most distinguished and renowned plant taxonomist on May 23, 1999, with the death of Dr. George J. Goodman, Regents Professor Emeritus and Curator Emeritus of the Bebb Herbarium.

Dr. Goodman was born November 5, 1904, in Evanston, Wyoming, to Arthur and Elizabeth Jones Goodman. As a young girl his mother had come in 1886 to this country from Wales, and Dr. Goodman would proudly point out that half of him was a first-generation American. A ranch, located some twenty-five miles south of Evanston and homesteaded by his Grandfather Goodman in 1883, is where Dr. Goodman spent the first five years of his life. His love of the outdoors and the West thus began.

After graduating from Evanston High School in 1922, Dr. Goodman, who had no plans to attend college, worked as a ranch hand, as a clerk in a drug store, as a sacker in a grain elevator, as a salesman of pianos and phonographs and of contract printing, and as a compass man for the U.S. Forest Service in the Kaibab of Arizona. About 1925 and during the time he was delivering groceries in Ogden, Utah, Dr. Goodman's father bought another ranch which was located due south of Evanston a mile over the Utah line. Dr. Goodman went to that ranch in the spring of 1926, and very soon thereafter an event occurred that would begin his botanical career which lasted nearly three-quarters of a century!

Dr. Edwin Payson, a botany professor from the University of Wyoming who had done his graduate work on the Cruciferae at the Missouri Botanical Garden under Dr. Jesse M. Greenman, and his wife Lois came to Evanston to find someone to take them up into the Uintah Mountains to collect plants. It was there that they learned of George Goodman, who by that time had already climbed several peaks in the Uintah Mountains. They made their way to the Goodman Ranch and camped there for a week or two. Dr. Goodman took them up to Stillwater Fork and Hayden's Peak where Sereno Watson had collected in 1869 on the King Expedition.

Impressed by the young man who became their guide, the Paysons suggested to Dr. Goodman that he should go to college and offered to give him a room for the year and to try to find him a job on the Laramie campus. After a discussion with his parents, who decided a year of college couldn't hurt, Dr. Goodman agreed to go. While still camped at the Goodman Ranch, the Paysons wrote to Dr. Aven Nelson, botany professor and herbarium curator, and told him they had someone they thought would make a good person to work in the herbarium mounting plants. Dr. Nelson wrote back, and when the Paysons told Dr. Goodman he had the job in the herbarium, he had no idea what an herbarium was. He didn't ask, but learn he did!

The Medicine Bow Mountains, located just to the west of Laramie, became a favorite collecting site during the three years and a summer Dr. Goodman spent obtaining his bachelor of arts degree with honors in botany. It was to these mountains that he would return many, many summers throughout his life. Whether he was there to teach at the University of Wyoming Science Camp or just to enjoy his cabin at 10,000 feet, he was in the mountains he loved.

In 1929 Dr. Goodman received a Rufus J. Lackland Fellowship from Washington University in St. Louis to do graduate work at the Missouri Botanical Garden under Dr. Jesse M. Greenman. His new roommate and soon-to-be closest friend was C. L. Hitchcock (Hitchy) who would become professor of botany and curator of the herbarium at the University of Washington, Seattle, and a major contributor to the *Flora of the Pacific Northwest.* Lured by *Eriogonum* and *Lycium,* Goodman and Hitchcock headed out to collect in the West in the summer of 1930.

This trip which began in June followed Route 66 through southern Missouri, Oklahoma, and the Texas panhandle. This was the first time Dr. Goodman had been in Oklahoma, and while no plants were collected until they reached Portales, New Mexico, on June 14, he remembered seeing in Oklahoma a curious, dicotyledonous plant with flowers that looked like an orchid. Three years later, after coming to the University of Oklahoma, he learned that he was looking at *Krameria.*

The Goodman/Hitchcock collecting trip was bountiful. Over five-thousand sheets were collected and later divided into sets which were then sold mostly to large herbaria throughout the country in order to finance the trip. Sites such as the Chiricahua Mountains of Arizona and the Abajo Mountains of Utah had been infrequently collected. From their collections a few new taxa resulted.

Throughout their lives Hitchy continued to tease George Goodman about events which transpired during that summer in the field: At Mesa Verde Dr. Goodman expounded lengthily to two gentlemen on where to buy the cheapest gas in Monument Valley. One of the men proved to be the vice-president of Bethlehem Steel! Hitchy never did agree with Dr. Goodman on whether they had seen a mountain lion or a wolf in the Kaibab forests in northern Arizona. Nor could Hitchy believe that the herds of horses there were wild.

The two repaired in one day as many as fourteen blowouts on the tires of their panel truck, lived on strawberry jam, and had a lifetime's worth of fun. Even as late as 1992 Dr. Goodman clearly recounted for me the events of that trip.

Dr. Goodman completed his doctoral degree at Washington University and the Missouri Botanical Garden in 1933 and came once again to Oklahoma, but this time as an assistant professor of botany and curator of the herbarium at the University of Oklahoma, Norman. However, a job offer in 1936 from Iowa State College took Dr. Goodman to Ames.

During three of the summers in Iowa Dr. Goodman had the opportunity to return to the southwest to collect in the Lukachukai Mountains in the northeast corner of Arizona. He and Hitchy had seen these mountains in the distance as they drove north toward Mexican Hat, Utah. Very few botanists had by that time collected in the Lukachukai Mountains. Among those who accompanied him was Lois Payson, who had been instrumental in beginning Dr. Goodman's botanical career and who had been widowed in the spring of 1927. The group camped near Canyon de Chelly and collected on the Navajo Reservation. Lasting friendships developed with the wonderful Navajo. On one occasion at least they were invited to an Indian ceremony, which lasted the entire night. This association with the Navajo people made a lasting impression upon Dr. Goodman.

Fortunately for those of us who came later as students to the University of Oklahoma, Dr. Goodman accepted in 1945 the offer from Dr. George L. Cross, a former colleague and close friend in the OU Botany Department and by then president of the University of Oklahoma, to return to OU and the Bebb Herbarium. During his tenure as curator, Dr. Goodman built the collection from a few thousand plant specimens into one that before his retirement in 1975 would amass nearly a quarter-million specimens. Today the Bebb Herbarium houses the world's finest collection of the flora of Oklahoma, along with strong holdings of the flora from surrounding states, the southwestern United States, the Great Plains, and Mexico.

The University of Oklahoma recognized Dr. Goodman's exceptional contribution to the University and to the Bebb Herbarium by appointing him Regents Professor in 1967. He was also awarded the Distinguish Service Citation, the University's highest honor, in 1978.

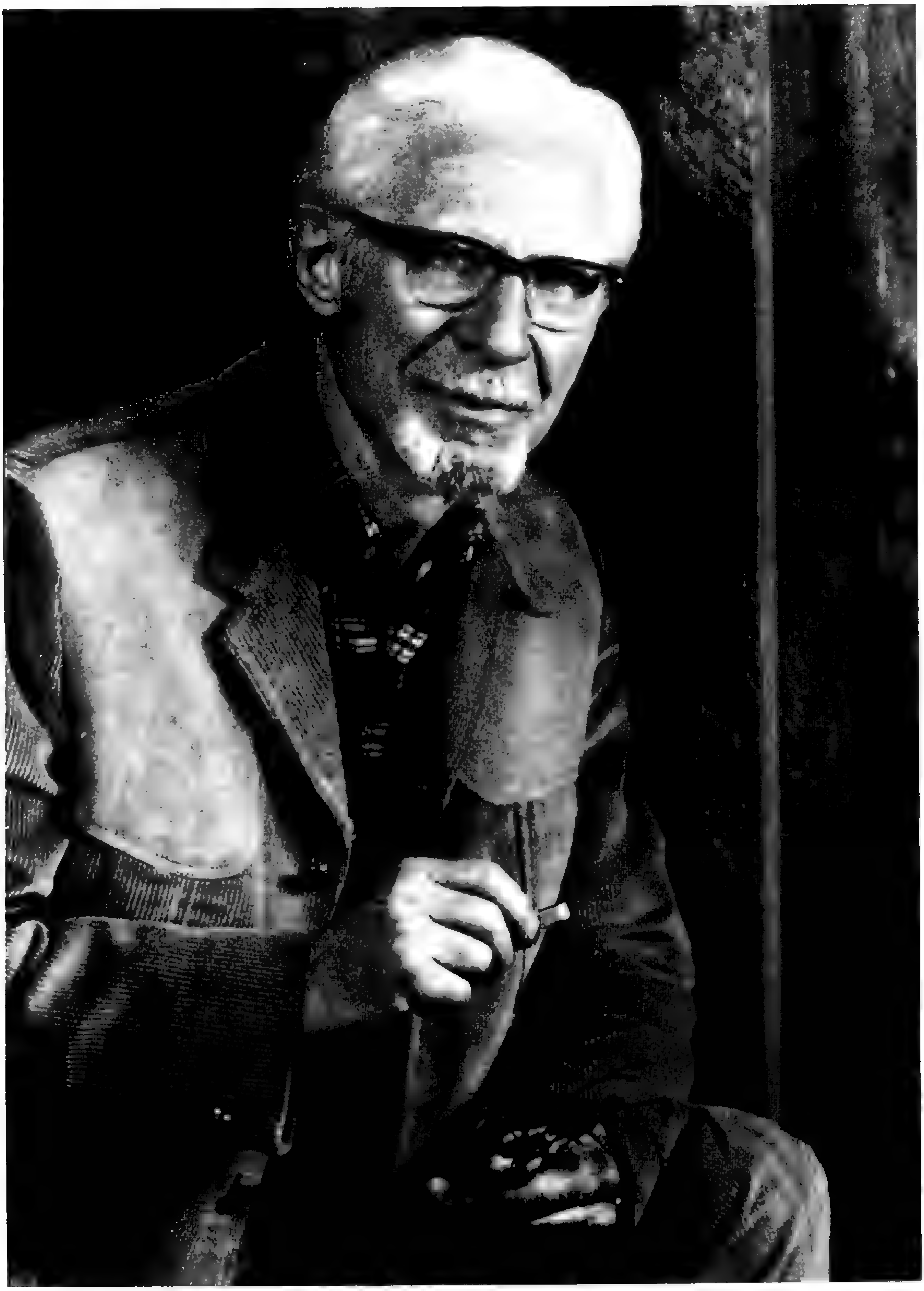
Dr. Goodman possessed not only a lively intellectual curiosity and an exhaustive knowledge of plants, but also a warmth and cordiality that would make the herbarium a place where colleagues and students gathered over the years for meetings, parties, and informal coffee and conversation.

During his career as a botanist Dr. Goodman came to be known as a leading expert in the field of plant taxonomy for Oklahoma and the western United States. He authored seventy-three publications, described thirty-six new plant taxa, made eleven new combinations, and had four plants named for him.

Dr. Goodman was a charter member of the American Society of Plant Taxonomists, the International Association of Plant Taxonomists, the Society for the Study of Evolution, the Southwestern Association of Naturalists, and the Colorado-Wyoming Academy of Science. In addition, he was a member of Phi Beta Kappa, Phi Kappa Phi, Phi Sigma, Sigma Xi, and the Oklahoma Academy of Science. He received the Phi Sigma Ortenburger Award and the Oklahoma Academy of Science Award of Merit in addition to the Distinguished Service Citation from the University of Oklahoma.

I was Dr. Goodman's last graduate student. We continued to work side by side both in the field and in the herbarium for nearly a quarter century after his so-called "retirement." During the field work for our book, *Retracing Major Stephen H. Long's 1820 Expedition: The Itinerary and Botany* (OU Press, 1995), we traveled over 10,000 miles through

George J. Goodman among the junipers at the top of the hogbacks near the Chasm of the South Platte River, Douglas Co., Colorado, June 30, 1981.



George J. Goodman, spring, 1975.

Nebraska, Colorado, New Mexico, Texas, and Oklahoma. Our field trips in the West following the route of this expedition were full of episodes which we recounted in our book. Working as I did with Dr. Goodman was an incredible experience filled with indelible memories.

Dr. Goodman was as enthusiastic about life as he was about plants. Once when asked how he would describe his life, Dr. Goodman replied, "It's been a blast!" It, too, was a "blast" for those of us lucky enough to have had him in a part of our lives!

In August, 1999, Dr. Goodman's ashes were taken by Marcia, his wife of fifty years, his daughter Sula Grace Henrichsen, and other relatives and friends to the vicinity of West Glacier Lake near Centennial, Wyoming, in the Medicine Bow Mountains. The circle closed, and he was back for perpetuity in the mountains he loved.

NESTA DUNN EWAN
NOVEMBER 8, 1908–SEPTEMBER 13, 2000
A MEMOIR

Anne S. Bradburn

Tulane University Herbarium
Dept. of Ecology and Evolutionary Biology
Tulane University
New Orleans, LA 70118-5698, U.S.A.

The History of Natural History has lost another champion. Although she was most often in the background, those of us who were fortunate enough to know the Ewans were always aware that Nesta's contributions to Joe's writing were indispensable. She was a meticulous researcher spending days tracking down the most minute details. Hers was the final authority on matters of grammar, style, and punctuation.

Born near Saskatoon, in Saskatchewan, Canada, Nesta with her family moved to California where she attended the University of California at Los Angeles, earned a degree in botany in 1933, and met another young botanist, Joseph Ewan, whom she married in Reno, Nevada in 1935. They produced three daughters, Kathleen Harris of Mandeville, Louisiana who with her husband Dick did so much to make their latter years enjoyable, Dorothy Nemecek of Chattanooga, Tennessee, and Marjorie Ewan who now lives in Albuquerque, New Mexico. All share their parents love of nature, if not book collecting, and have happy memories of family camping trips. There are five grandchildren.

During their next 64 years together the Ewans also produced nearly 500 titles. Beginning in 1963 with "John Lyon, Nurseryman and Plant Hunter, and his Journal, 1799–1814" published in the Transactions of the American Philosophical Society (n.s. 53: pt.2.), Nesta was frequently listed as co-author. Her participation was more widely recognized after "Ewania: the writings of Joe and Nesta Ewan" was published in 1989 (The American Botanist, Booksellers, Chillicothe, Illinois).

During their 40 years at Tulane, Nesta was famous for providing fabulous Sunday brunches to generations of graduate students. David White, now Professor of Biology at Loyola University, fondly remembers devouring stacks of buckwheat cakes loaded with jams and jellies, a tradition which continued after the Ewans moved to the Missouri Botanical Garden in Saint Louis.

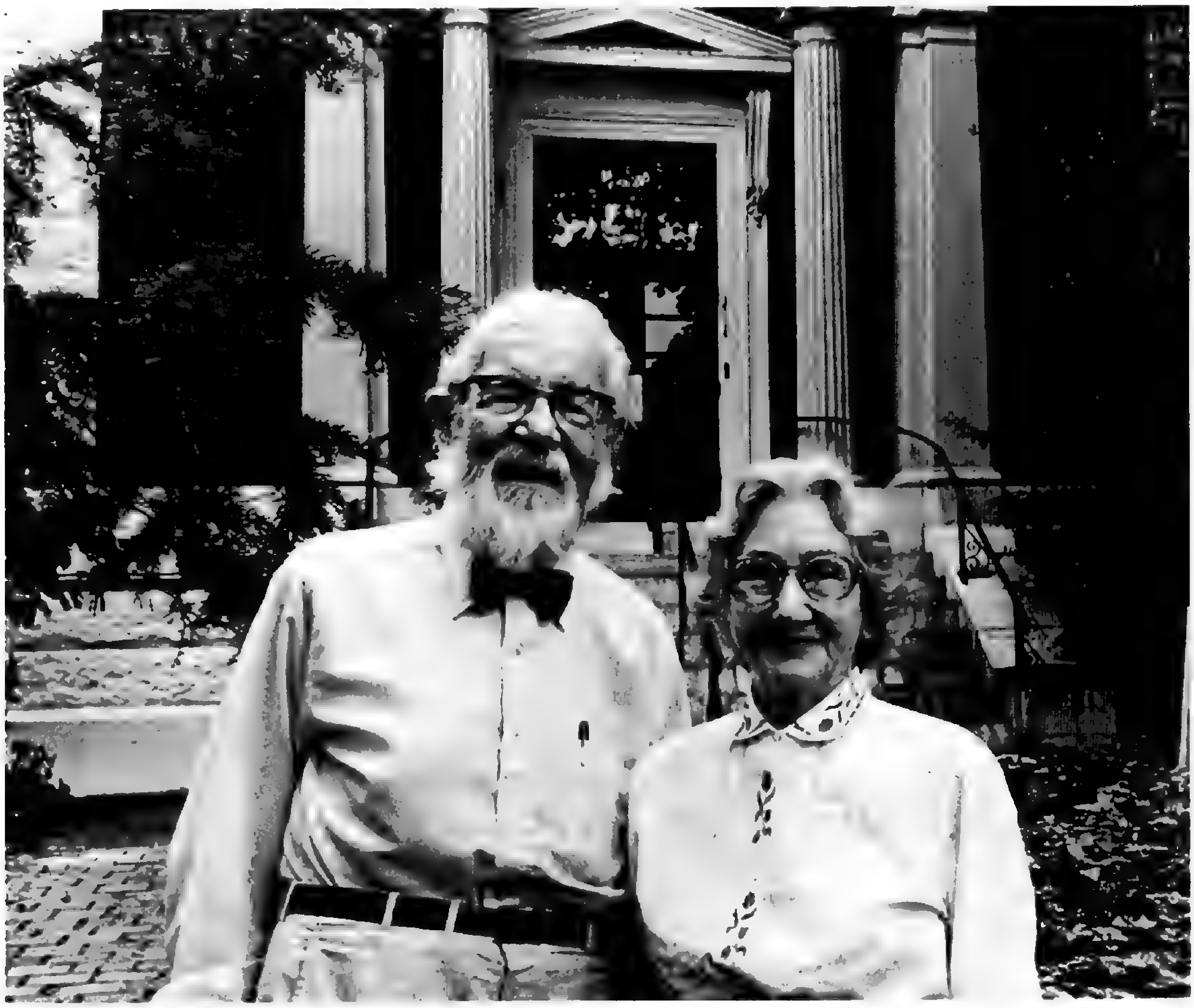
Once established in the old Museum building where they had palatial quarters and for the first time ample space for their burgeoning library, Nesta told me "When I die I don't have to go to heaven, I am already there." Joe and Nesta were both great lovers of plants, animals, and the great outdoors, and they reveled in the morning walks through the splendor of the Gardens. So while we at Tulane missed them sorely, we were glad indeed that they had found a wonderful place to continue their studies.

SIDA 19(2): 421 – 423. 2000

Nesta Dunn Ewan
May 1994
Mandeville, Louisiana

A lasting tribute was made to the couple in 1994 when they were jointly presented the Henry Shaw Medal by the Garden for their many contributions to botany and the history of science.

Small in statue, Nesta was a giant of a woman. A true personification of the adage "Behind every great man, there is an equally great woman." We shall not see her like again soon.



Nesta and Joe Ewan
September 1994

BOOK REVIEWS

RICHARD V. FRANCAVIGLIA. 2000. **The Cast Iron Forest: A Natural and Cultural History of the North American Cross Timbers.** (ISBN 0-292-72515-9, hbk.; 0-292-72516-7, pbk.). Univ. of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A (512-471-4032). $45.00 hbk., 24.95 pbk. 269 pp., 15 color and 52 b&w photos, 8 maps, 12 line drawings, 6" × 9".

More than anything else, *The Cast Iron Forest* portraits the Cross Timbers, conceptualized as a region, as having a life of its own, growing and changing with time and captivating those that enter, including the author. While the book is an objective analysis of historical maps, travel diaries, economic statistics, and census records, many passages reveal an intensely personal fascination with the Cross Timbers. Richard Francaviglia is a historical geographer at the University of Texas at Arlington. Like many professionals and others transplanted to Texas, he has been nourished by Texas pride and now finds that his roots have grown deep into the Cross Timbers sandy clay.

Francaviglia begins the book by developing the concept of "Cross Timbers" from several perspectives: "The Cross Timbers...are a forested archipelago largely surrounded by a sea of prairie. Centered roughly between the 97th and 98th meridians, the Cross Timbers vegetation comprises generally north-south trending belts of scrubby oak trees." Next, "...the Cross Timbers typically appears as dense stands of post oak and blackjack oak trees that rarely exceed about thirty feet in height, but that are visible for a considerable distance across the prairie." And "...the term...Cross Timbers referred to a large area that consisted of a swath of trees stretching north of Waco along the Brazos River of Texas and extending far north into...present-day Oklahoma." He then examines the natural history—the geology, soil, and climate correlated with the vegetation, and the important constituent species. The conclusion is: "...they are considered a separate region largely because they are mostly surrounded by prairie, and would otherwise would not be so noticeable. Throughout the Cross Timbers, then, the distinctive oak forests are framed by prairie and developed on sandstone [emphasis his]."

The bulk of the book, however, is an examination of historical maps and writings to trace the history of the conceptualization of the region in the minds of the Native Americans, Spanish/French explorers, and Anglo settlers and farmers, and finally the contemporary urbanites. This is the real strength of the book and a significant contribution to the non-technical literature. In so doing, Francaviglia is able to trace the perceptions through 5- and 10-year intervals. Use of these historical data necessarily involves interpretations of why certain features were or were not added to maps and diaries, and readers will want to keep that in mind. However, his interpretations appear to be reasonable and without particular ideological bias. Especially fascinating is the argument that prevailing perceptions (e.g. "dangerous and evil," "barrier to travel," "plentiful source of wood and game") often influenced political, economic, and cultural responses of the public and governments.

As a reader not interested so much in the historical aspects, I bogged down in some of the detail. It seemed to me that surely every map and every written reference published before 1900 is described. In fact, the author appears also to have gotten somewhat lost in the details and introduced some inconsistencies. For example, he discusses the Cross Timbers on important maps of 1849 and 1853, concluding (p. 104), "By the mid-nineteenth century, the Cross Timbers appear on a wide variety of popular maps" and "Historical geographer Ralph Brown observed that the Cross Timbers 'achieved much notoriety of a favorable sort' by the mid-nineteenth century." However, just two paragraphs later (p. 106) states, "By the mid-nineteenth century, the Cross Timbers thus began to lose their status as a landmark."

The author's transition to the twentieth century is marked by a move from documenting travels, Indian skirmishes, and log-cabin architecture to outlining farming patterns, population shifts, popular regional identity, and increasing conservation awareness. Even regional literary works, graphic art, and music are reviewed. One of the nicest features of the book is, in the last chapter, a four-page bulleted outline of the topics covered and a six-page summary of the author's interpretation of the region's history.

Before *The Cast Iron Forest* was written, the literature on the Cross Timbers region was largely scattered and not readily available. However, this book provides, without being academically technical, references to most or all of the historically significant writings. Although enthusiasts of regional heritage will find it especially interesting, it is essential reading for anyone wanting a good overview and knowledge of the natural and cultural history of this "cast iron" region.—*Roger W. Sanders, Associate Collections Manager, Botanical Research Institute of Texas.*

DENNIS W. WOODLAND. 2000. **Contemporary Plant Systematics, Third edition.** (1-883925-25-8, hbk.). Andrews University Press, 213 Information Services Bldg., Berrien Springs, MI 49104-1700, U.S.A (616-471-6134, http://www.andrews.edu/press) $64.99 hbk. 560 pp., numerous b&w photos and line drawings, CD of over 4,700 color images

Contemporary Plant Systematics flows from Woodland's teaching experience to fill the needs of his own students. His goal in writing a text is to provide "a well-illustrated, broad-view, beginning text that would give the students, wherever they may live in the world, sufficient botanical understanding of vascular plants that would utilize the changing world of global information." In some ways he has succeeded and in others he has not.

The book is divided roughly into three portions. Printed page tabs, which mark the chapters and other divisions, are a helpful innovation. The first four chapters cover an introduction of systematics as a subject, nomenclature, identification tools, and field and herbarium methods. The second section (5 chapters) is by far the largest. It encompasses an extensive survey of pteridophyte, gymnosperm, and angiosperm families with each group preceded by an explanation of special characteristics and terms. The last six chapters cover more advanced topics: history of the field, including contemporary systems and methods of analysis; pertinent literature; origins of the vascular plant groups; a survey of morphological, chemical, and other criteria; conservation issues; and the role of botanical gardens.

The field and identification portion (early chapters) is thorough, but the other chapters on principles sometimes lack depth. For example, speciation is covered in one page and one diagram. Likewise, in the discussion of phenetic and cladistic methods, relevant terms are defined and sample dendrograms and cladograms are illustrated. However, there is neither an attempt to explain how the distances are calculated nor examples worked out to help the student assimilate the methods. An appendix with simple four-taxon problems, mathematical algorithms, character and distance tables, and step-by-step solutions would be very helpful.

Woodland is to be congratulated for the innovative chapter on conservation. In it he covers the major conservation issues that pertain to preserving biodiversity, including genetic engineering of organisms. Conservation is rarely addressed by texts in plant systematics but is an endeavor that systematists are invariable drawn into during their careers. His survey of botanical gardens is a nice addition, but many instructors would rather exchange this information for more detail on principles. The chapter on taxonomic criteria is also strong because each major topic is contributed by an authoritative researcher: Nels Lersten on plant anatomy, Rolf Sattler on morphology, Loren Rieseberg on molecular systematics, Cliff Crompton on palynology, Peter Holland on ecology and biogeography, and Woodland on cytology.

The weakest portion is tne large, page-consumptive survey of families. Each family is treated in a box with a set of drawings and short paragraphs covering: habit, stem, and/or chemical characters; leaves; reproductive structures; distribution; economic value; and fossil record. Woodland is to be commended for including the major tropical and arid-adapted families of angiosperms and, thus, giving a global perspective. Unfortunately, the illustrations are generally of poor quality. Much page space is wasted and reduction for printing has thickened and fused lines and obscured details that might have been in the originals. Most of the close-ups do not show the distinctive features they are supposed to illustrate. Example: Anther flaps are not shown on anthers of Lauraceae. Fourteen families of (the 27 recognized) leptosporangiate homosporous ferns are treated; neither the drawings nor the descriptions are especially helpful to the novice in differentiating or recognizing any particular segregate family. To a certain extent, the included CD of the University of Wisconsin's *Photo Atlas of the Vascular Plants* makes up for these deficiencies, but I found the interface to be less than self-explanatory and the images to include too few floral dissections.

There is a number of annoying minor problems (the examples listed here either remain uncorrected from the second edition or were introduced with the third). The hardback binding is low quality and probably will not hold up well with extended use. The typesetting was poorly proofed. For example, on page 410 one finds "from a wide spectra [sic] of sources" and on page 416 "phyllomes (e.g., leaf and leaf homologs), and trichomes (homes [sic])." In Table 1.1 illustrating the taxonomic hierarchy, the Magnoliineae is listed as the suborder under the Asterales and above the Asteraceae! A number of the drawings were redrawn with permission from various sources, especially Cronquist's *An Integrated System of Classification of Flowering Plants.* In an apparent oversight, Correll and Correll's *Flora of the Bahama Archipelago*, in which Pricilla Fawcett's plate of *Zamila pumila* was published (Fig. 25), is not cited as the source of the original from which the illustration of *Zamia* (p. 64) was undoubtedly redrawn.

Whether other instructors will find this book useful for adoption will depend on how closely their students' backgrounds and needs and their own teaching philosophy matches Woodland's. *Contemporary Plant Systematics* would be more cost-effective if the family surveys (and illustrated glossary of morphological terms) were replaced with a short, several-page synopsis of groups of families and if the book were designed to use a professionally illustrated companion atlas, such as Wendy Zomlefer's *Guide to Flowering Plant Families.—Roger W. Sanders, Associate Collections Manager, Botanical Research Institute of Texas.*

M.S. Mani and J.M. Saravanan. 1999. **Pollination Ecology and Evolution in Compositae (Asteraceae).** (ISBN 1-57808-058-4, pbk.). Sciences Publishers, Inc., P.O. Box 699, May Street, Enfield, NH 03748, U.S.A. $49.50 + shipping. 166 pp. Line drawings, tables, and figures.

Mani and Saravanan have produced a very thorough account of our current understanding of the details of pollination in the largest and most complex family of flowering plants. The book begins with a brief summary of past and current research on pollination in general and on Compositae in particular. This section is particularly well referenced, and is a wonderful resource for anyone interested in the topic. An entire section of the book is devoted to an analysis of the groups of insects that are commonly found on the flowers in the Composite family, and on their effectiveness as pollinators. Special note is made of those insects that, while serving as pollinators, may also do considerable damage to the plants as well. There are six chapters devoted to detailed discussion of specific parts of the composite capitulum, and their development in relation to pollination. One chapter presents a detailed discussion of the overall structure and multitude of variations found in the capitula of this family. This chapter is particularly well illustrated with line drawings, showing detailed comparisons of the arrangement of florets, and the involucres. A second, particularly well-illustrated chapter, discusses the variety of shapes, sizes and colors of the florets, and how this diversification can be directly linked with effectiveness of pollination. An entire chapter is also devoted to the wide variety of shapes and sizes of stamens, styles and stigmas. This chapter points out the importance of the structural differences of these organs, and how pollinators have influences the evolution of those differences. Chapters on nectaries and pappus complete the discussion of the specializations found in composite capitula. Mixed in with the chapters on each of the floral organs is a section on sexual polymorphism within the Compositae. In this author's opinion, this chapter is a bit misplaced, and would better fit in with the discussion on the overall structure of the capitulum. However, other than being misplaced within the overall context of the book, the chapter is well written and well referenced. The final three chapters bring all of this information together with a well-presented discussion of floral biology, pollination and evolutionary trends within the family. This book is very well written and thoroughly researched. It includes a glossary of terms which is quite useful, especially for those not familiar with terminology specific to the Compositae. The entire volume is well references, with nearly 450 citations contributing significantly to the importance of this work. I would recommend this volume to all students of the Compositae, and to anyone who is interested in pollination biology in general.—*Debra Trock.*

Alan Hopkins (Editor). 1999. **Grass: Its Production and Utilization. Third Edition.** (ISBN 0-632-05017-9, pbk.). Blackwell Science Ltd., 350 Main Street, Malden, MA 02148-5018, U.S.A. Distributed for Blackwell Science by Iowa State University Press, 2121 South State Street, Ames, IA 50014-8300, U.S.A. (Orders: 800-862-6657, 515-292-0155; www.isupress.edu). $49.95 pbk. xiii + 440 pp., numerous figures.

It has been a treat to review this book, and here is why: for many years I was a biology professor at Kansas State University, which is located in the tallgrass prairie of a notably grassy state. There I was familiar with the native grasslands, plus the management and utilization of grasslands for many purposes. The book under review centers upon British grasslands, and it offers a different dimension to an American's thinking about grasslands.

The text consists of fifteen chapters that are essentially free-standing essays of about 15–30 pages, each with a several page list of references. Most of the cited papers are from the past decade. There are chapters on pastures, herbage production, weeds & pests in grasslands, feeding values of grass (50 pages), conservation, forage and grazing behavior, landscape and wildlife, etc. There is no coverage of grassland systematics. Two chapters drew my attention; one on sward establishment and renovation, and the other on amenity grassland. The climate of Britain comfortably supports lawns of great expanse (swards), and tough turf for athletic or decorative purposes (amenity grass), and the approach to lawn and turf management is rather different from what we are accustomed to. The introductory chapter is an absolute gem for summarizing the thrusts of book and for supplying a grass-oriented land-use map of Great Britain.

How useful would this book be to a North American biologist? Anyone dealing with the applied ecology and physiology of grasslands would find it relevant, especially anyone whose studies focus on intensely managed grasslands. The literature citations are particularly valuable, for they are largely from the European literature that is less commonly surveyed by Americans.—*Theodore M. Barkley, Botanical Research Institute of Texas.*

Cheryl Hazeltine and Barry Lovelace. 1999. **The New Central Texas Gardener.** (ISBN 0-89096-871-3, pbk.). Texas A&M University Press, College Station, TX 77843-4354, U.S.A. (409-845-1436, 409-847-8752 fax). $24.95 hbk., $14.95 pbk. 204 pp., 4 pp. color plates, b/w illustrations.

This "basic gardening text for Central Texans," is a slightly updated version of the 1980 publication by Hazeltine and Joan Filvaroff, entitled *The Central Texas Gardener.* The authors' stated purpose in this new edition is "to provide new gardeners and gardeners new to Central Texas information and advice about landscaping design for function and esthetic appeal; wise plant selection; and garden practices that work."

As in the 1980 book, Hazeltine and Lovelace provide information on plants suited to the growing conditions of this area. A new feature of *The New Central Texas Gardener* is a chapter on "Tools of the Trade," which includes brief descriptions of garden equipment and information sources—books, magazines, and internet sites. In addition, xerigraphy and creating special gardens and ponds are briefly described and discussed. Illustrative material includes maps, ink drawings of plants by Kate Bergquist, and an 8-page section of color photographs. A month-by-month calendar for planting concludes the book.

Although advertised for "amateur and seasoned gardeners," the latter will find it somewhat elemental, while those familiar with the earlier edition and with recent central Texas gardening literature will discover little new information.—*Joan H. Swaim.*

Robert W. Kiger, Charlotte A. Tancin, and Gavin D.R. Bridson. 1999. **Index to Scientific Names of Organisms Cited in the Linnaean Dissertations Together With a Synoptic Bibliography of the Dissertations and a Concordance for Selected Editions.** (ISBN 0-913196-67-3, hbk.). Hunt Institute for Botanical Documentation, Carnegie Mellon University, Pittsburgh, PA 15213-3890, U.S.A. Price unknown. 300 pp. 6 b/w figures, 8" × 11".

Carl Linnaeus, the 18th Century grandsire of systematics, saw 186 dissertations prepared under his direction at the University of Uppsala. They represent a trove of information, some of which was undoubtedly prepared by Linnaeus himself. The original dissertations were printed and circulated at the time of their defense, but were later collected and republished in several editions, two of which were edited by Linnaeus under the title *Amoenitates academicae.*

This book indexes all of the formal (i.e., "scientific") names used in the Linnaean dissertations, and notes where each name is found in the original dissertation and in the collected editions. There is a bibliographic catalog of the original dissertations, plus a succinct overview of the several collected editions. A concordance is provided to tie original dissertations to their locations in the collected editions.

Of necessity, the introductory essay is brief, but clear and to the point. The authors use conventional bibliographical styles and the work is easy to navigate. Were I to quibble, I would wish for an explanation of the Lidén numbers, which are used to catalog the dissertations.

The dissertations retain some currency in contemporary biology because many are significant in matters of nomenclatural priority, and because the texts of all represent the thinking and attitudes of a group of capable people who were among the earliest to consider the flora and fauna from a world perspective.

Biologists of every stripe always have been addicted to scribbling, and their products crowd the libraries, often to be slowly forgotten. But, a fact is a fact regardless of when it was observed, and the writings of the past are not merely space-fillers. Those among us who have the skill and facilities to make the great wealth of old information comfortably accessible to the rest of us deserve our thanks and good wishes. May they continue their work.—*Theodore M. Barkley, Botanical Research Institute of Texas.*

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BOOK NOTICES

Marie Caillet, J. Farron Campbell, Kevin C. Vaughn, and Dennis Vercher (editors). 2000. **The Louisiana Iris; the taming of a native American wildflower.** Second Edition. (ISBN 0-88192-477-6, hbk.). Timber Press. Inc., The Haseltine Building, 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (503-227-2878, 503-227-3070 fax; www.timberpress.com). $34.95 hbk. 254 pp., 111 color photos, 5 watercolors, 11 b/w photos, 14 line drawings, 11 tables.

The beardless Louisiana irises (subsection *Apogon*) belong to series *Hexagonae* of the genus *Iris* in the family Iridaceae. The greatest concentration of species is in the State of Louisiana, hence the name Louisiana irises. They comprise a unique group in the iris family and perhaps are the most distinctive in color and in form. I've seen some in cultivation and I can attest to that fact. The main objective of this book is to interest people all over the world in growing Louisiana irises. The editors have given growers an incredible amount of information about Louisiana irises and have emphasized the how-to-aspects of adaptability, propagation, culture, and hybridizing. These wonderful irises will grow with moderate to excellent results in most of the United States and in many foreign counties. "In a very short amount of time, the Louisiana iris had made its way into the hearts of both gardeners and amateur hybridizers." Members of the Society for Louisiana irises and the current editors are to be congratulated for having done a terrific job in promoting the beautiful Louisiana Irises.

Contents.—**1)** History of Louisiana Irises; **2)** Classification and Species; **3)** Description of the Louisiana Iris; **4)** Collecting of the Species and Natural Hybrids; **5)** Propagation of Louisiana Irises; **6)** History of Hybridizing to 1988; **7)** History of Hybridizing since 1988; **8)** Tetraploid Hybridizing; **9)** Objectives in Hybridizing; **10)** Culture; **11)** Landscaping with Louisiana Irises; **12)** Flower Arranging with Louisiana Irises; Appendix A, Society for Louisiana Irises; Appendix B, Popular Cultivars of Louisiana Irises; Appendix C, Mary Swords DeBaillon Medal; Glossary; References; and Index of Plant Names.—*Barney Lipscomb.*

Stanley L. Bentley. 2000. **Native Orchids of the Southern Appalachian Mountains.** (ISBN 0-8078-2563-8, hbk.; 0-8078-4872-7, pbk.). Univ. of North Carolina Press, P.O. Box 2288, Chapel Hill, NC 27515-2288, U.S.A. (800-848-6225, 919-966-3829 fax; www.uncpress.unc.edu). $39.95 hbk; $24.95 pbk. xviii + 256 pp., 119 color photographs.

Another orchid book. Well, maybe not! This is quite a guide filled with great photography of 52 species of orchids found in the mountains of southern Appalachians. That is to say, a region encompassing western Virginia and North Carolina and eastern West Virginia, Kentucky, and Tennessee. This book is quite a treat for you amateur naturalists or professional botanists who happen to live, vacation or botanize in the southern Appalachians. Each species is provided with a scientific name and common name(s), a description of the flower (color, shape, and size), information on flowering time, distribution and typical habitat. The author offers much advice when hunting for orchids, but one piece of advice I thought was most interesting was to carry binoculars. Have you ever used binoculars to look for orchids? Well, you just might want to consider it according to the author. "Time after time, when I have spotted a plant high on a bank, well past the 'telling for sure' point, binoculars have saved me from having to scramble up the bank to try and determine its species. As the years go by, I appreciate more than ever the steps saved by my trusty binoculars."

Contents.—Preface, Acknowledgments, Please do not Dig Native Orchids, Introduction, What is an orchid?, Rarity among Orchids, Looking for Wild Orchids, Special Orchid Places in the Southern Appalachians, Preserving Wild Orchids and Their Habitat, Using This Book, List of Native Orchid Genera of the Southern Appalachians, Glossary, Bibliography, and Index. —*Barney Lipscomb.*

TED L. PETIT and JOHN P. PEAT. 2000. **The color Encyclopedia of Daylilies.** (ISBN 0-88192-488-1, hbk.). Timber Press. Inc., The Haseltine Building, 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (503-227-2878, 503-227-3070 fax; www.timberpress.com). $49.95 hbk., 8 1/2" × 11", 296 pp., 1300 color photos.

The title of this book is most descriptive and just about says it all. There is plenty of color and it is encyclopedic. What an undertaking and what a beautiful book the authors have given us. There were certainly plenty of daylilies to choose from. The authors point out that it was a daunting task to select which daylilies to include out of the 40,000 plus daylilies registered at completion of the manuscript. "Ted Petit and John Peat's simple and concise text on the history, botany, and horticulture of daylilies along with their collection of photographic contributions from colleagues around the world combine to create the most comprehensive and exhaustive work on daylilies to date. No other book so completely catalogs the world of daylilies."

Contents.—Foreword; Preface and Acknowledgments; **1)** The Daylily Plant; **2)** History of the Daylily; **3)** History of Daylily Hybridizing; **4)** Singles; **5)** Eyed and Patterned Daylilies; **6)** Doubles; **7)** Spiders, Variants, and Unusual Forms; **8)** Polytepal Daylilies; **9)** Small and Miniature Daylilies; **10)** Hybridizing; **11)** Cultivation; **12)** Daylilies of the Future; Appendix A, Additional Resources; Appendix B, Sources for Daylilies; Bibliography; and Index of Pictured Cultivars.—*Barney Lipscomb.*

PETER GOLDBLATT and JOHN MANNING. 2000. **Wildflowers of the Fairest Cape.** (ISBN 0-620-24787-8, pbk.). Red Roof Design cc, Cape Town, SOUTH AFRICA. Available from Timber Press. Inc., The Haseltine Building, 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (503-227-2878, 503-227-3070 fax; www.timberpress.com). $34.95 hbk., 8 1/4" × 11", 315 pp., 663 color photos, 1 color map.

"OH Lord, how manifold are thy works! in wisdom hast thou made them all: the earth is full of thy riches."—*David, Psalm 104:24.* And the fairest cape (Cape of Good Hope) has its share of botanical riches! No wonder it is referred to as one of the botanically richest areas of the earth. I don't think anyone will argue that point. The two eminent botanists, Goldblatt (Missouri Botancial Garden, St. Louis) and Manning (National Botanical Institute, South Africa) detail 652 of the most common or conspicuous wildflowers to be found there. Many of the botanical wonders there are presently in cultivation. One visit to South Africa or one look at this book and you too will gasp at the beauty. Well done thou good and faithful servants!

Contents.—Preface; The Cape Floral Kingdom; Introduction; Climate and Rainfall; Fynbos and Renosterveld; Wildflowers Routes: The Cape Peninsula, The West Coast, The Bokkeveld and Hantam, The Olifants River Valley and the Lambert's Bay Coast, The Mountain Passes, The South Coast; How to use this Book; Wildflower Schedule; Wildflower Route Map; Quick Guide to the Families; Illustrations; Descriptions; Glossary; and Index.—*Barney Lipscomb.*

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BILL MALCOLM and NANCY MALCOLM. 2000. **Mosses and Other Bryophytes. An Illustrated Glossary.** (ISBN 0-473-06730-7, hbk.). Micro-Optics Press, Box 320, Nelson, NEW ZEALAND. Available from Timber Press. Inc., The Haseltine Building, 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (503-227-2878, 503-227-3070 fax; www.timberpress.com). $39.95 hbk., 5 7/8" × 8 1/4", 220 pp., 968 color photos, 22 line drawings.

This color glossary covers mosses, liverworts, and hornworts. According to the authors, "The three groups were chosen because even though they're not closely related, their structure and life cycles are similar enough that a term which applies to one often applies to the other two as well." Nearly 1000 photos—representing nearly 400 species—were taken at various levels of magnification, mostly with a microscope. A scale bar is provided with each photo caption. The authors have included alternative meanings for contentious terms, noted entries having the same or similar meanings, and cross-referenced terms used elsewhere in the glossary. Terms in the glossary are printed in **boldface**. Example: **mucronate** — ending **abruptly** in a short point (**mucro**) (*compare with* **apiculate**, ending in a point somewhat longer than a **mucro**, and **cuspidate**, ending in an even longer point that's also stouter). More than one illustration is provided for terms that describe highly variable structures such as the spines and papillae of leaves, or brood bodies and leaf cell lumina. The glossary would definitely be useful to students and teachers as there are several illustrations of bryophytes that often are studied in the laboratory.

Contents.—Introduction; Mosses and Other Bryophytes an Illustrated Glossary; Further Reading; and Illustration Index.—*Barney Lipscomb.*

W. ARTHUR WHISTLER. 2000. **Tropical Ornamentals: A Guide.** (ISBN 0-88192-475 X, pbk.; 0-88192-448-2, hbk.). Timber Press. Inc., The Haseltine Building, 133 S.W. Second Avenue. Suite 450. Portland, OR 97204-3527, U.S.A. (503-227-2878, 503-227-3070 fax; www.timberpress.com). $34.95 pbk., $59.95 hbk. 542 pp. 458 color photos, 50 line drawings, 6" × 9".

There is no doubt this book is about mostly tropical ornamentals and a few others. Many of the most common tropical ornamentals are found in cultivation throughout the world and they are beautifully pictured here. There are some species covered in the book that are not tropical, but they are cultivated in tropical areas (*Gaillardia pulchella, Helianthus annuus, Helianthus argophyllus, Solidago nemoralis,* etc.). The 400 plus plants treated in this book are arranged in alphabetical order by scientific name and not common name. You can find the common name in the index. This of course allows closely related plants to be placed together. About two-thirds of the plants are in 20 plant families and are accounted for in an appendix, Twenty Common Plant Families. Each plant is organized as follows: **Genus and family; Scientific name and authority; Synonyms; Distinguishing characteristics**; and **Description**. It really is a guide to the plants most frequently encountered in gardens of the tropics. The photos are splendid. This is an excellent reference on tropical plants in cultivation.

Contents.—Preface, Introduction, Organization of the Information in *Tropical Ornamentals*, The Tropical Ornamental Plants, Twenty Common Plant Families, Identification Key, Glossary, and Index.—*Barney Lipscomb.*

Christopher Lloyd. 2000. **Christopher Lloyd's Garden Flowers: Perennials, Bulbs, Grasses, Ferns.** (ISBN 0-88192-492-X, hbk.; 0-88192-448-2, hbk.). Timber Press. Inc., The Haseltine Building, 133 S.W. Second Avenue. Suite 450. Portland, OR 97204-3527, U.S.A. (503-227-2878, 503-227-3070 fax; www.timberpress.com). $39.95 pbk. CAN 54.95 hbk. 448 pp. 69 color photos, 50 line drawings, 71/2" × 10".

This is a one man band covering everything from *Acanthus* to *Zigadenus*. Interestingly enough, the author says, "All the plants included have come within my experience during a long life of gardening, and most I have grown myself at some time." So, I guess if you don't find your favorite plant in the reference, then I suppose it is one not grown by the author; surely that will include a lot of plants. However, if you are lucky and consult just one of the plants in this book you will perhaps get everything the author has learnt, thought, seen, tried, likes, or regrets about the plant, and that could be your lucky day! It certainly is one man's perspective, but what a perspective considering it is Christopher Lloyd's lifetime study.

Contents.—Introduction, Genera [ca. 372], Glossary, Sources of Photographs, and Index.—*Barney Lipscomb.*

Robert H. Mohlenbrock. 1999. **The Illustrated Flora of Illinois: Sedges: Carex.** (ISBN 0-8093-2074-6, hbk.). Southern Illinois University Press, P.O. Box 3697, Carbondale, IL 62902-3697, U.S.A. (618-453-6633, 618-453-1221 fax; danseit@siu.edu). $59.95 hbk. 328 pp. 159 line drawings, 159 maps.

Wow! This is volume 14 of the *Illustrated Flora of Illinois* series; the sixth and last volume devoted to monocots. The 159 detailed illustrations by Paul Nelson are excellent and will aid any person in the identification of these species. A key to all the species is included. The usual stuff is included with each species: Genus species, place of publication, synonymy, description, common name, habitat, range, and Illinois distribution (with map of Illinois); this is followed by a discussion of the nomenclature and habitat of the species.

From the dustjacket.—"Since more than three-fourths of the species of *Carex* in Illinois are inhabitants of wetlands, an understanding of the genus is critical for those working in wetlands. Amateur and professional botanists well find the information extremely valuable, as will environmental and conservation groups, garden clubs, farm bureaus, home extension groups, scout organizations, and school libraries. Persons working in natural areas programs and in rare and endangered species programs and those working on environmental impact assessments and wildlife management projects will also find the information pertinent."—*Barney Lipscomb.*

S.T. Runkel and D.M. Roosa. 1999. **Wildflowers and Other Plants of Iowa Wetlands.** (ISBN 0-8138-2174-6, pbk.). Iowa State University Press, 2121 South State Avenue, Ames, IA 50014, U.S.A. (Orders: 1-800-862-6657; www.isupress.edu). $24.95 pbk. 372 pp. Color photos.

From the Preface.—"With the increasing awareness of the importance of wetlands, a book was needed to help the non-specialist understand how wetlands are classified and to aid in the identification of wetland plants. There are wonderful taxonomic books available, however, they are often so technical that all but professional taxonomists become discouraged. These manuals are often regional in scope and contain many plants that do not occur in the local area. This tends to frustrate many users, particularly beginners. We think wetlands are grand places. We want you to enjoy them as we do. Hence, we offer this book as a starting place for those who wish to learn more about Iowa's wetlands and wetland plants. Plant descriptions are presented by habitat (terrestrial or aquatic), then refined by habit (e.g. floating or submerged) or by taxonomic group (e.g., ferns and allies or trees and shrubs). Common names vary throughout the country, so we have included those in frequent use, although others may be used regionally or locally. We have also included the plant's Latin name, along with the authority."

RONALD J. TAYLOR. 1998. **Desert Wildflowers of North America.** (ISBN 0-87842-376-1, pbk.). Mountain Press Publishing Company, P.O. Box 2399, Missoula, MT 59806, U.S.A. (406-728-1900, 800-234-5308). $24.00 pbk. 349 pp. 500 + color photos, line drawings, maps.

From the back cover.—"Each spring, when rainfall and temperatures combine in just the right way, hundreds of wildflowers transform the deserts of North America into a sea of vibrant color. With descriptions and photographs of more than 500 species of flowering plants, this full-color filed guide leads casual visitors and certified desert rats alike through the flora of the blooming desert. The book includes an overview of desert ecology, a simplified botanical key, and an illustrated glossary that will help even novice wildflower fans identify desert plants with confidence."

Contents.—Preface; Introduction; Desert Wildflowers; Key to Identifying North American Desert Wildflowers to Family; Plant Anatomy Illustrations; Glossary [illustrated]; Selected References; and Index. *Desert Wildflowers of North America* covers the Mojave, Sonoran, Painted, Chihuahuan, and Great Basin deserts. This book was planned and written for the amateur botanist and anyone who appreciates wildflowers, particularly in desert environments. The plants are arranged alphabetically by family, that is the common name of the family, i.e. Acanthus Family, Allthorn Family, Amaranth Family, Barberry Family, etc. The book does not cover or list plants on a desert-by-desert basis, specific flowering times, nor does it treat the Mexican component of the Sonoran and Chihuahuan deserts. Because there is overlap in the desert flora of the United States and Mexico, it certainly would be useful in Mexico.—*Barney Lipscomb.*

JEAN ANDREWS. 1999. **The Pepper Trail: History and Recipes from Around the World.** (ISBN 1-57441-070-9, hbk.). University of North Texas Press, P.O. Box 311336, Denton, TX 76203-1336, U.S.A. (Orders: 800-826-8911, 940-565-4590 fax). $50.00 hbk. 264 pp. 57 color illustrations, 7 maps, 7" × 12".

From the dustjacket.—"Veteran afficionados and newcomers on the pepper trail will enjoy this stunning addition to Jean Andrew's classic work on peppers. Andrews, who has been called 'the first lady of chili peppers,' 'the godmother of the chili world,' as well as her own registered trademark 'The Pepper Lady,' follows the spice trade and early movements of capsicums along the spice roads, through much of turkey and the Middle East, Africa and Monsoon Asia (India, Nepal, Bhutan, Sri lanka, Thailand, and Indonesia) plus the Sichuan and Hunan provinces in China and the Silk Route. This latest offering of Andrews's research includes previous undiscovered facts, such as the etymology of the word 'cayenne.'"

"The first spice to be used by may, peppers are currently 'hot' in Mexico, Guatemala, much of the Caribbean, most of Africa, parts of South America, India, Bhutan, Malyasia, the United States—Louisiana, Texas, and the Southwest—plus Korea."

"A chapter on what makes a pepper a pepper includes detailed descriptions and illustrations of twenty-seven separate varieties of the capsicum, as well as miscellaneous cultivars and detailed directions on working with fresh and dried peppers, including how to choose and use them and how to care for them."

Contents.—Foreword; **Part I**, The Pepper: How Our Food Got Hot; **Part II**, Preparation & Recipes; Notes; Bibliography; Subject Index; and Recipe Index.

Here is everything you every wanted to know about Peppers and maybe then some! Check out the recipes! I didn't count them all but many are listed for the following dishes: Soups & Salads; Meat, Fowl, and Seafood; Vegetarian; Sauces; Breads; Desserts; and Preserves and Condiments. I just can't imagine Chilli Pepper Jelly, especially when I was raised on Wild Plum Jelly, but who knows? —*Barney Lipscomb.*

Conley K. McMullen. 1999. **Flowering Plants of the Galápagos.** (ISBN 0-8014-8621 1, pbk.; 0-8914-3710-5, hbk.). Cornell University Press, Sage House, 512 E. State Street, Ithaca, NY 14850, U.S.A. (Orders: 800-826-8911, 940-565-4590 fax). $59.95 hbk., $29.95 pbk. 370 pp. 266 color photos, 1 map, 6" × 9".

From the back cover.—"The Galápagos are home to a wide-ranging assortment of unusual plants and animals. The islands became famous as the site of Charles Darwin's research leading to his theory of evolution by natural selection, and their magnificent flora and fauna continue to draw visitors from around the world. Based on the author's sixteen years of fieldwork and featuring his exceptional photography, *Flowering Plants of the Galápagos* is the first accessible and in depth, yet compact, guide to the plant life of the area.

Contents.—Foreword; Preface; Acknowledgments; Galápagos Islands Map; How to Use This Guide, Illustrated Plant Terms; A Brief Introduction to the Galápagos Islands; Plant Descriptions, Plant Key; Glossary; Literature Cited; Appendix 1: List of Galápagos Islands Flowering Plants Treated in the Text; Appendix 2: Selected Visitor Sites and Flowering Plants Likely to Be Encountered; and Index.

Other than just flipping pages through the nice photographs to identify your plant in "hand," one must first determine and select the appropriate growth form. The 390 species are arranged in the book in one of five groups, i.e. tree, shrub, herb, vine, and cactus. Each of the five groups is then divided into groups based on how a plant's leaves are typically arranged on its stems. Options include alternate, opposite, whorled, clustered, and basal. Next, each of these categories is subdivided based on flower color. The choices are white, yellow or orange, pink, red or purple, blue, green, and brown. Once you have made your selection, there is a page number that takes you to the appropriate subsection. "Once the appropriate subsection is located, the reader simply has to thumb through the photographs until he or she finds one that matches the specimen in question."—*Barney Lipscomb.*

William A. Weber (Editor). 2000. **The American Cockerell: A Naturalist's Life, 1866–1948.** (ISBN 0-87081-544-X, hbk.). University Press of Colorado, 5589 Arapahoe Avenue, Suite 206C, Boulder, CO 30303, U.S.A. Distributed by: University of Oklahoma Press, Book Distribution Center, 4100 28th Ave., N.W. Norman, OK 73069-8218, U.S.A. (Orders: 800-627-7377, 800-735-0476 fax). $29.95 hbk. 352 pp. 7 b/w photos, line drawings.

From the dustjacket.—"In *The American Cockerell: A Naturalist's Life, 1866–1948*, botanist William A. Weber pulls together pieces of the life of T.D.A. 'Theo' Cockerell, a man who was an internationally known scientist, a prolific writer, and a highly regarded teacher at the University of Colorado in Boulder. The elder brother of the noted scholar Sir Sydney Cockerell, Theo labored in relative obscurity in America while his brothers and their families were basking in the limelight of smart British society."

"Despite his alienation from his elite background, he nevertheless became a great teacher; a mentor, a kindly artist and writer of rhymes for children, and the greatest specialist on bees in the world. His contribution to the understanding of wild bees is monumental—he catalogued over 900 species in Colorado alone, and he assiduously collected them wherever he traveled. By 1938 he had published the names and descriptions of 5,480 new species and subspecies. Despite his accomplishments in entomology, however, T.D.A. Cockerell resisted specialization. He was also an early supporter of women's rights, a Morrisian socialist, an avid reader; an author of almost 4,000 published scientific papers, book reviewers, and discussion of social issues."

"Pieced together from T.D.A.'s little known autobiographical writings, The *American Cockerell* demonstrates this extraordinary individual's tremendous breadth of interest, competence, and talent."

Contents.—Foreword by Norma LeVeque; Joseph A. Ewan on Cockerell; Acknowledgments; Cockerell Chronology; Autobiographical Papers; Philosophical Papers; Academic Matters; Miscellaneous; Life and Habits of Bumblebees; Postcript; Biographies, Obituaries, and Notices; Endnotes; and Index.

W.H. Fisher. 2000. **Rain Forest Exchanges: Industry and Community on an Amazonian Frontier.** (ISBN 1-56098-983-1, pbk.). Smithsonian Institution Press, 470 L'Enfant Plaza, Suite 7100, Washington, D.C. 20560-0950, U.S.A. (Orders: PO Box 960, Herndon, Va 20172-0960; 1-800-782-4612). $19.95 pbk. 222 pp. 11 figures, 4 maps.

From the back cover.—Drawing on both historical sources and indigenous informants, William H. Fisher argues that decisions to cooperate with frontier industries are best understood by taking into account the power of native social systems to shape the acquisition of trade goods. Charting the history, politics, economics, and ecology of the regions, he tells how subsistence practices such as hunting and gardening have been altered be sedentarization, how villagers interact with Indian-agency and extractive-firm personnel, and how notions of barter or sale only loosely describe the transfer of goods that take place in the village. In *Rain Forest Exchanges*, Fisher contends that efforts to encourage conservation and sustainable practices among indigenous Amazonian groups remain problematic unless, in addition to the influence of the frontier, the dynamics of each groups social and economic organization are recognized.—*Review forthcoming in Sida 19(3), 2001.*

W.K. Chapman, V.A. Chapman, A.E., Bessette, A.R. Bessette, and D.R. Pens. 1998. **Wildflowers of New York in Color.** (ISBN 0-8156-0470-X, pbk). Syracuse University Press, Syracuse, NY 13244-5150, U.S.A. $24.95 pbk. 164 pp. 350 + color photos.

From the back cover.—*Wildflowers of New York in Color* is a field guide that will give nature enthusiasts instant access to the diverse and beautiful flora of the state. It contains over 350 photographs and concise descriptions, written in easy-to-follow, nontechnical language. The color illustrations have been selected for their scientific accuracy as well as their aesthetic quality. This field guide is keyed in a manner that easily leads the reader to major groups based on flower color and other physical characteristics. *Wildflowers of New York in Color* contains descriptions of both commonly encountered and rarer, protected species. Included are color illustrations and descriptions of species not seen in other field guides. Nomenclature has been updated to reflect current usage. This book will be an indispensable companion for nature lovers and anyone interested in the wildflowers of New York.

D.J. Raynal and D.J. Leopold. 1999. **Landowner's Guide to State-Protected Plants of Forests in New York.** (ISBN 0-9670681-0-X, pbk). State University of New York, College of Environmental Science and Forestry, Syracuse, NY, U.S.A. $19.95 pbk. 92 pp. Color photos.

From the Introduction.—The purpose of this book is to present the key diagnostic characteristics of the protected plants that are found in forests of New York State using photographs and brief nontechnical descriptions of the plants and their habitats. A great variety of plant communities occur in New York State. Open canopy communities (i.e., lacking continuous forest cover) include salt and freshwater marshes, bogs, shrub thickets, and alpine meadows. Closed canopy or forest communities include southern oak-pine, oak hickory, northern hardwoods, elm-ash-maple swamp, and boreal spruce-fir forests. Some of these species also occur in open canopy communities, especially during early stages of succession. Following information about the identification and ecology of each protected species is information about its rarity status. Many species listed here are not yet truly rare in New York state, but are protected by state law so that they are not as likely to become rare. These species are legally regarded as "exploitably vulnerable," because of their beauty and tendency to be collected, they are protected. All of our native orchids, nearly all of the ferns, many species in the lily family, and other showy native species are included in this category; some of these species also are very rare.

Dennis W. Magee and Harry E. Ahles. 1999. **Flora of the Northeast: A Manual of the Vascular Flora of New England and Adjacent New York.** (ISBN 1-55849-189-9, hbk.). The University of Massachusetts Press, Box 429, Amherst, MA 01044, U.S.A. $69.95 hbk. 1214 pp. 995 line drawings, 2433 range maps, 6" × 9".

From the dustjacket.—"Designed as both a reference work and year-round field manual, this volume contains more than 2,400 range maps and 995 line drawings. For botanists, naturalists, and students interested in an up-to-date treatment of the vascular flora of greater New England, it will be an invaluable resource.

The geographic scope of the work extends from the Canadian border south through Long Island and west to the Hudson River. The "General Keys" section contains fourteen keys that include such groups as aquatic plants, vines, and woody plants in winter condition. For both woody and herbaceous families, the keys cover flowering as well as fruiting condition.

The "Descriptive Flora" section includes keys to all of the genera and species, descriptions of the families and genera, and accounts of the individual species. The latter incorporate information on wetland site index, rare status, wildlife food value, food and medicinal value for humans, and poisonous or hallucinogenic properties.

The distributions of more than 2,400 species are presented on range maps, and book includes line drawings of 995 species, showing diagnostic features designed to clarify descriptions used in the keys. Near the end of the volume there are two matrices of diagnostic characteristics, one for dicots and one for woody plants in winter condition. These matrices can be used to identify a specimen displaying limited information, or to find examples of given vegetative, flower, or fruit characteristics for use in teaching."

The line drawings, although not for every species, and the range maps, are nice features of the flora. In some cases not all of the couplets in the keys are lettered. The latter branches of lead couplets—in many of the keys—are not lettered. That doesn't make the key wrong, but sometimes it is a little confusing.—*Barney Lipscomb.*

BOOK (CD-ROM) NOTICES

RICK DARKE. 2000. **The Color Encyclopedia of Ornamental Grasses on CD-ROM.** (ISBN 0-88192-479-2, PC format only, Windows 95 or higher). Timber Press. Inc., The Haseltine Building, 133 S.W. Second Avenue. Suite 450. Portland, OR 97204-3527, U.S.A. (503-227-2878, 503-227-3070 fax; www.timberpress.com). $59.95 CD-ROM. 721 color photos.

This is the CD-ROM version of Darke's hard copy reference, *Color Encyclopedia of Ornamental Grasses.* In addition to grasses, there are grass-like plants included on the CD, i.e. sedges, rushes, restios, and cat-tails; selected bamboos are included as well. The CD version includes nearly 24 new plants and 200+ color photos not found in the hardcover. The photos from the CD can be printed in full color for use in design work, plant identification, and nursery signage. There is an Interactive USDA Zone Map, a useful "Search" function that allows you to track down plants and plant names, as well as other useful features.—*Barney Lipscomb.*

DAVID A. ZAHLER and EDWARD C. JENSEN. 1999. **Conifers of the Pacific Northwest [on CD-ROM.].** Oregon State University College of Forestry, Forestry Media Center, 248 Peavy Hall, Corvallis, OR 97331-5702, U.S.A. (541-737-4702, 541-737-3759 fax; http://osu.orst.edu/Dept/fmc; forestrm@ccmail.orst.edu). Price unknown. CD-ROM.

"The diverse topography and climate of the Pacific Northwest combine to create t variety of habitats in which conifers flourish. Nearly 30 species of conifers grow naturally here, organized into 4 families and 13 genera. Many other species of conifers have been introduced from other parts of the world and thrive here with minimal care.

The purpose of this program is to take the mystery out of identifying our most important native conifers—and to share a bit of their ecology and natural history. Especially in the larger genera it will help immensely if you first learn to distinguish one genus from another, and then focus your attention on the different species that occur within each genus.

IBM Compatible PCs; 486 DX, SX or greater; Windows 95, Windows NT 3.51, or later; 8 MB of available RAM; 8- or 16-bit sound card. MACINTOSH; All Macintosh with 8 MB of available RAM and sound capabilities.

The educational product won a Bronze Award in the Information Technology category at the 1999 Agricultural Communicators in Education Critique & Awards Program."

BOOKS RECEIVED

Daniel B. Ward and Robert T. Ing. 1997. **Big Trees. The Florida Register.** (ISBN 1-885258-06-2, pbk.). Florida Native Plant Society. $20.00 pbk. viii + 223 pp.

From the Preface.—"This Florida Register documents 610 native and 243 non-native trees, for a total of 853 listed trees. For each individual tree, information is given as to its common and scientific name, its measurements in terms of circumference of trunk, height, and spread of canopy, its location, owner, and nominator, and its rank as a champion or other status among the elite trees of Florida. Of these documented trees, 151 of the native species and 13 of the non-natives are National champions, while 106 of the natives and 118 of the non-natives are Florida champions."

Contents.—Preface; Foreword; Introduction; Inventory of Big Trees; Giants of Yesteryear; How They Died; Rates of Growth; Largest and Smallest; Species Ranked by Height; The "Average" Champion; Large Vines; County Tree-Find List; Nominators and Owners; Acknowledgments; Selected References; Appendices: **A.** What Is a Tree? **B.** Mechanics of the Survey. **C.** Memorandum of Understanding. **D.** How to Nominate a Champion Tree. **E.** How to Measure a Champion Tree. **F.** Evaluation of the Formula. **G.** A Case of Volume Measurement; **H.** William Bartram's Big Trees; and Index to Scientific and Common Names.

David E. Brown, Frank Reichenbacher, and Susan E. Franson. 1998. **A Classification of North American Biotic Communities.** (ISBN-87480-562-7, pbk.). University of Utah Press, 1795 E. South Campus Drive, Suite 101, Salt Lake City, UT 84112-9402, U.S.A. (801-585-9786, 801-581-3365 fax). $19.95 text; $20.00 map; book and map set, $34.95. 152 pp. 118 b/w figures (photos, maps), 8" × 12".

From the back cover.—*A Classification of North American Biotic Communities* describes a hierarchical classification system for biotic communities from the Arctic circle to Panama. It includes 115 photographs, each illustrating an example of a specific community. Intended as a first step in establishing a universal standard for inventorying habitats, this system uses existing classifications of North American natural environments.

The "North American Biotic Communities" map provides a dramatic and useful illustration of the biotic communities delineated in the volume.

Contents.—List of Figures; List of Tables; Acknowledgments; Introduction; **1)** The Biogeographical Approach; **2)** The Classification System; **3)** The Biotic Communities of North America Map; Plates; Literature Cited; and Literature Consulted.

Teresa Cabrera Cachón. 1999. **Orquídeas de Chiapas.** (ISBN 968-5025-44-4, hbk.). Consejo Estatal para la Cultura y las Artes de Chiapas, Polyforum Mesoamericano, Calzada Andrés Serrra Rojas s/n., Tuxtla Gutiérez, Chiapas, CP 29040, MÉXICO. Approx. $74.00 hbk. 196 pp. Color photos, 9" × 12".

Contents.—Presentación; Prefacio; Introducción; Características de la familia; Partes de la planta; Partes de la flor; Partes de la columna; Clasificación; Fichas de las especies; Esquemas de formas; Mapa de Regiones Fisiográficas del Estado; Glosario; Bibliografía; Lista de Especies de la familia Orchidaceae para Chipas; and Indice de nombres científicos.

SIDA 19(2): 438. 2000

Daphne Gail Fautin, Douglas J. Futuyma, and Frances C. James (editors). 1999. **Annual Review of Ecology and Systematics. Volume 30.** (ISBN 0-8243-1430-1, hbk.; ISSN 0066-4167). Annual Reviews Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, U.S.A. (650-493-4400, 800-523-8635, 650-424-0910 fax; www.AnnualReviews.org). $120.00 hbk. 641 pp., b/w illustrations and one color plate.

Annual Review of Ecology and Systematics for 1999 is packed once again with a mix of articles on ecology and systematics. Volume 30 has a total of 21 articles followed by a Subject Index, Cumulative Index of Contributing Authors, and a Cumulative Index of Chapter Titles, Volumes 26–30.

Contents.—

The Origin and Early Evolution of Turtles
Uses of Evolutionary Theory in the Human Genome Project
Streams in Mediterranean Climate Regions: Abiotic Influences and Biotic Responses to Predictable Seasonal Events
Choosing the Appropriate Scale of Reserves for Conservation
Conspecific Sperm and Pollen Precedence and Speciation
Global Amphibian Declines: A Problem in Applied Ecology
Using Phylogenetic Approaches for the Analysis of Plant Breeding System Evolution
Evolution of Diversity in Warning Color and Mimicry: Polymorphisms, Shifting Balance, and Speciation
Consequences of Evolving with Bacterial Symbionts: Insights From the Squid-Vibrio Associations
The Relationship Between Productivity and Species Richness
Analysis of Selection on Enzyme Polymorphisms
Polymorphisms in Systematics and Comparative Biology
Physical-Biological Coupling in Streams: The Pervasive Effects of Flow on Benthic Organisms
Astrobiology: Exploring the Origins, Evolution, and Distribution of Life in the Universe
Evolution of the Eastern Asian and Eastern North American Disjunct Distributions in Flowering Plants
Full of Sound and Fury: The Recent History of Ancient DNA
Do Plant Populations Purge Their Genetic Load? Effects of Population Size and Mating History on Inbreeding
Historical Extinctions in the Sea
Gene Flow and Introgression From Domesticated Plants into Their Wild Relatives
Resistance of Hybrid Plants and Animals to Herbivores, Pathogens, and Parasites
Evolutionary Computation: An Overview

Barbara L. Bowling. 2000. **The Berry Grower's Companion.** (ISBN 0-88192-489-X, hbk.). Timber Press. Inc., The Haseltine Building, 133 S.W. Second Avenue. Suite 450. Portland, OR 97204-3527, U.S.A. (503-227-2878, 503-227-3070 fax; www.timberpress.com). $29.95 hbk. 308 pp. 40 color photos, 25 b/w illustrations 17 tables, 6" × 9".

Table of Contents.—Preface; Acknowledgments; Introduction; **1)** General Principles; **2)** Berries in the Landscape; **3)** Strawberries; **4)** Brambles; **5)** Blueberries; **6)** Grapes; **7)** Minor Crops; Appendix: North American Nursery Sources for Berry Plants; Glossary; References and Other Resources; Plant Name Index; and Subject Index.—*Review forthcoming in Sida 19(3), 2001.*

G. Terry Sharrer. 2000. **A Kind of Fate: Agricultural Change in Virginia, 1861-1920.** (ISBN 0-8138-2569-5, hbk.). Iowa State University Press, 2121 South State Street, Ames, IA 50014-8300, U.S.A. (Orders: 800-862-6657, 515-292-0155; www.isupress.edu). $49.95 pbk. 256 pp., b/w photos, 6" × 9".

From the dustjacket.—"*A Kind of Fate: Agricultural Change in Virginia, 1861-1920* addresses how modern agriculture in Virginia developed as a result of widening social acceptance of government intervention in agricultural affairs: an infusion of capital from increasing commodity prices, land values, and credit; and biological research to combat diseases. In addition to descriptive quotes from the period, poignant photographs capture the essence of these farmers' daily trials and triumphs."

Contents.—Acknowledgments; Introduction; **1)** Swept Away: Disease: Epidemics and Epizootics, A New Order of Things, Untenable Country; **2)** New Needs, Old Ideas: The Dogma of "Soil Fertility," Crops and Crises; **3)** Toil and Trouble: Life in the Country, Debt, Taxes, and Despair; **4)** Professing Change: Growing Knowledge: The Virginia Agricultural Experiment Station, Reaching the Farmers; **5)** The New Farming: Drive for Production, Dairying: Progressive Exemplar, Capital and Credit; **6)** Reforming Fate: Farmers and Tenants, The Rural Life Movement in Virginia, End of an Era; Conclusion: Two Generations; Bibliography; and Index.

J.K. Morton and Joan M. Venn. 2000. **The Flora of Manitoulin Island and the Adjacent Islands of Lake Huron, Georgian Bay and the North Cannel. Third Edition.** (ISSN 0317-3348, pbk.). University of Waterloo Biology Series, Number 40. Biology Series, Department of Biology, University of Waterloo, Waterloo, ON, CANADA N2L 3G1 (519-888-4567, ext. 3751; 519-746-0614 fax; jvenn@sciborg.uwaterloo.ca). $37.45 spiral bound (Canada); $37.50 spiral bound (outside Canada); $50.83 hbk. (Canada); $50.00 hbk. (outside Canada). 374 pp., 124 color photos, 997 range maps, 7" × 10".

"Manitoulin Island and the many smaller islands in the surrounding waters of Georgian Bay, Lake Huron and the North Channel, in the Great Lakes Region of Canada, is an area of unique biological interest with a remarkably rich flora (about ˘ of the total vascular flora of Canada)."

The Flora accounts for 1350 kinds of vascular plants. The 997 distribution maps are computer drawn from a database of over 66,000 records from the region. "Introductory chapters deal with the geology, climate, post-glacial history, vegetation, conservation and history of botanical exploration in the region." The 124 colored illustrations are real nice and represent the more interesting and beautiful plants of the region.

Text and the maps have been completely revised in the 3rd edition; the color figures are unchanged from the 2nd edition. There is no family key nor do families have keys to genera and genera to species; an occasional key is provided to species.—*Barney Lipscomb.*

Ronald M. Lanner. 2000. **Conifers of California.** (ISBN 09628505-3-5, pbk.; 09628505-4-3, hbk.). Cachuma Press, P.O. Box 560, Los Olivos, CA 93441, U.S.A. (805-688-0413; cachuma@silcom.com). $24.95 pbk., $36.95 hbk. 288 pp., 54 original full-page watercolor illustrations, 7" × 9".

From the cover.—"*Conifers of California* is the first book devoted to all of the state's conifers. Its author, Ronald M. Lanner (professor emeritus, Utah State University) has explored, studied, and taught about forest trees in the West for 40 years. In *Conifers of California* he shares his expertise and introduces each of California's cone-bearers in an engaging text that serves as both natural history and field guide. Lanner's narratives are accompanied by detailed identification information, watercolor botanic illustrations by the late Eugene O. Murman, color photographs of each species by well-known landscape photographers, and distribution maps."

Contents.—Preface; Acknowledgments; Eugene O. Murman, the Artist; The Names of Trees; Cones; Pinaceae, The Pine Family; Cupressaceae, The Cypress Family; Taxodiaceae, The Baldcypress Family; Taxaceae, The Yew Family; Appendices: **A:** California's Soft Pines and Hard Pines; **B:** Conifer Hybrids in California; **C:** A Key to the Genera Based on Characters of Mature; **D:** A Key to the Genera Based on Leaf Characters From Lower Crown Branches; **E:** Alphabetical List of Conifers Growing Naturally Within California; Annotated Bibliography; and Index.

I must say the watercolor botanical illustrations are mouth watering! They are beautiful. And the photography is stunning and shows off the fascinating and often picturesque California landscape. The book is beautifully designed and would make a wonderful coffee table addition anywhere.—*Barney Lipscomb.*

Deni Bown. 2000. **Aroids: Plants of the Arum Family. Second Edition.** (ISBN 0-88192-485-7, hbk.). Timber Press. Inc., The Haseltine Building, 133 S.W. Second Avenue. Suite 450. Portland, OR 97204-3527, U.S.A. (503-227-2878, 503-227-3070 fax; www.timberpress.com). $34.95 hbk. 468 pp. 108 color photos, 50 line drawings, 6" × 9".

Table of Contents.—Foreword to Second Edition; Foreword to the First Edition; Preface; Acknowledgments; Introduction; **1)** Variations on a Theme; **2)** Of Tails and traps and the Underworld; **3)** Woodlanders; **4)** Aquatics and Amphibians; **5)** A Place in the Sun; **6)** In the Shadows; **7)** Towards the Light; **8)** The Titans; **9)** An Acquired Taste; **10)** Acids and Crystals; Aroids in Cultivation; Checklist of Aroid Genera; Glossary; References; and Index.—*Review forthcoming in Sida 19(3), 2001.*

Dorothy J. Callaway and M. Brett Callaway (Editors). 2000. **Breeding Ornamental Plants.** (ISBN 0-88192-482-2, hbk.). Timber Press. Inc., The Haseltine Building, 133 S.W. Second Avenue. Suite 450. Portland, OR 97204-3527, U.S.A. (503-227-2878, 503-227-3070 fax; www.timberpress.com). $34.95 hbk. 359 pp. 88 color photos, 10 b/w photos, 26 line drawings, 26 tables, 6" × 9".

Preface; Acknowledgments; **1)** Genetics and its Applications; **2)** Plant Breeding—Practical Matters; **3)** Breeding Daylilies (*Hemerocallis*); **4)** Breeding Daffodils; **5)** Breeding Siberian Iris; **6)** Breeding Hostas; **7)** Breeding Ornamental Aroids; **8)** Breeding AfricanViolets; **9)** Breeding Gesneriads; **10)** Breeding Amaryllis; **11)** Breeding Penstemon; **12)** Breeding Rhododendrons and Azaleas; **13)** Breeding *Kalmia*: Mountain Laurel and its relatives; **14)** Breeding Camellias; **15)** Breeding Lilacs: Plant of History, Plant for Tomorrow; **16)** Breeding Magnolias; **17)** Breeding Oaks: A New Frontier; Appendix: Sources of Plant Breeding Supplies; Glossary; Notes on Contributors; and Index of Plant Names.—*Review forthcoming in Sida 19(3), 2001.*

KAY YATSKIEVYCH. 2000. **Field Guide to Indiana Wildlfowers.** (ISBN 0-253-21420-3, pbk.). Indiana University Press, 601 N. Morton Street, Bloomington, IN 47404, U.S.A. (Orders: 800-842-6796, 812-855-8507 fax). $17.95 pbk. 372 pp. 640 color photos, line drawings, 5" × 8".

Contents.—Preface; Acknowledgments; Introduction: Included species, Species numbers, Photographs, Drawings, Scientific names, Authors of scientific names, Vernacular names, Measurements of plant parts; Main paragraph of species entry: Sizes of plants and flowers, Distinguishing characteristics, Habitats and localities, Blooming dates, Status in the state, Federal status; Glossary; What is a flower?; Aster family terminology; Flower finder; Photos and text; Selected references; and Index.

This is a nicely done wildflower guide; Hoosiers should be proud.—*Review forthcoming in Sida 19(3), 2001.*

ALAN E. BESSETTE, WILLIAM C. ROODY, and ARLEEN R. BESSETTE. 2000. **North American Boletes: A Color Guide to the Fleshy Pored Mushrooms.** (ISBN 0-8156-0588-9, hbk.). Syracuse University Press, Syracuse, NY 13244-5160, U.S.A. $95.00 hbk. 396 pp. 450 color photos, 7" × 10".

Contents.—Preface; Acknowledgments; North American Boletology in Brief; Introduction to the Boletes; Typical Bolete Fruiting Body: Macroscopic Features; How to Use This Book; How to Identify Boletes; Field Key to the Boletes; Descriptions of Bolete Genera and Species; Undescribed Boletes, *Hypomyces*, and Pseudoboletes; Appendixes; Glossary; References; Index to Common Names; and Index to Genera Species.—*Review forthcoming in Sida 19(3), 2001.*

GIL NELSON. 2000. **The Ferns of Florida. A Reference and Field Guide.** (ISBN-1-56164-197-9, pbk., 1-56164-193-6, hbk.). Pineapple Press, Inc., P.O. Box 3899, Sarasota, FL 34230, U.S.A. (www.pineapplepress.com). $27.95 hbk. 208 pp. 200 + color photos, 6" × 9".

From the back cover.—"At least 163 kinds of ferns have been recorded in Florida. From northern species whose southern ranges extend into the rolling uplands of the state's northern tier to tropical treasures that spill over the state's southern tip, Florida is without parallel in fern diversity and number. No other like-sized region of the continental United States can boast such an expanded assortment.

This field guide is the first in 25 years to treat this amazing variety of ferns. Following in the tradition of John K. Small's 1931 *Ferns of Florida,* and Robert Long and Olga Lakela's 1976 edition of the same name, this new volume catalogs and illustrates all of Florida's native and naturalized fern species. Color plates feature more than 200 images, some of which include rare species never before illustrated in color. Rare and hard-to-find species such as some of our spleenworts and filmy ferns are included, as well as such common species as the cinnamon fern pictured on the front cover.

Clearly written detailed descriptions, along with helpful identification tips and a selection of botanical keys all of which are based on field observations help readers identify plants in the wild. Also included are notes on each species' growth form and habitat, as well as general remarks about its botanical and common names, unique characteristics, garden use, and history in Florida.

Other important features of the book include a complete glossary, a section on the fern life cycle and structure, a history of fern study in Florida, a discussion of some of the state's best natural ferneries, and an extensive bibliography."—*Review forthcoming in Sida 19(3), 2001.*

Ken E. Rogers. 2000. **The Magnificent Mesquite.** (ISBN 0-292-77105-3, hbk.). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. (512-471-4032). $24.95 hbk. 167 pp., 18 color photos, 2 line drawings, 5 maps, 12 tables, 5" × 9".

From the dustjacket.—The mesquite tree has deep roots in the American Southwest, literally and figuratively. A reliable source of food and shelter even in the severest droughts, it sustained American Indians for centuries. Today, mesquite is widely popular for barbecuing, woodworking, furniture making, flooring, sculpture, jewelry, and food products ranging from honey to jelly and syrup. Even ranchers, who one fought to eradicate mesquite s an invasive weed, have come to value its multiple uses on well-managed rangeland.

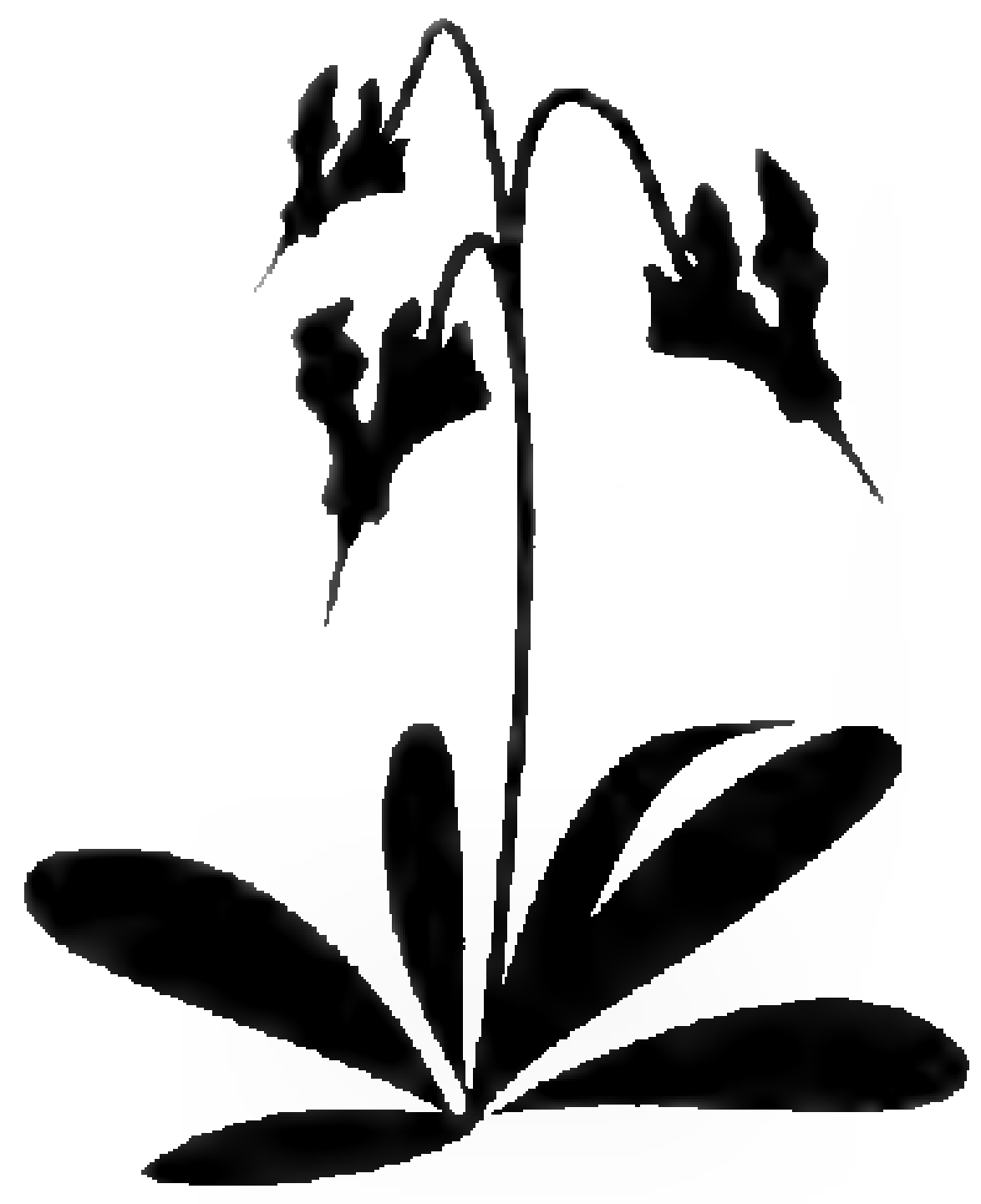
In this book written especially for a general readership, one of the world's leading authorities on mesquite presents a wealth of information about its natural history and commercial, agricultural, and woodworking uses. Ken Rogers describes the life cycle, species, and surprisingly wide distribution of the mesquite, which is native or naturalized not only in the Southwest and Mexico, but also in India, Africa, Australia, South America, and Hawaii. He discusses the many consumer and woodworker uses of mesquite at length—even giving instructions for laying a mesquite wood floor and making mesquite bean jelly. He also looks into the ways that people are using mesquite in nature, from rangeland management in the Southwest to desertification prevention in arid countries. Color photographs and maps complement the very readable text.

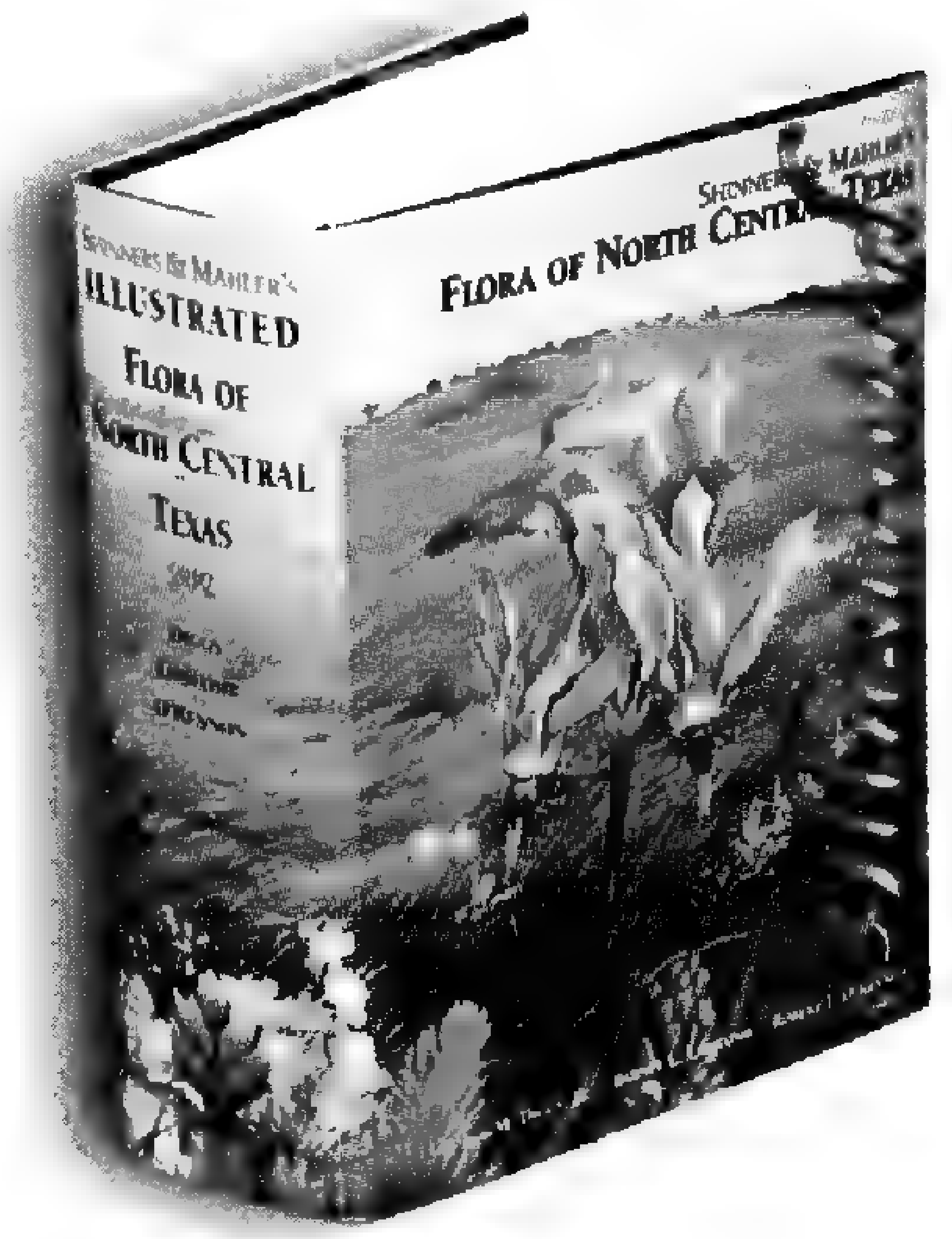
Contents.—Introduction; Mesquite: What Is It"; Predators of Mesquite; Mesquite in Texas And the Southwestern United States; The Uses of Mesquite; The Mesquite in Verse; Worldwide Aspects of *Prosopis;* Texas Ebony—Mesquite's Astonishing Cousin; Mesquite's Future; Appendix I. The Genus *Prosopis* (Family Leguminosae/Fabaceae) and Its Species; Appendix 2. Sources of Information; References and Further Reading; and Index.—*Review forthcoming in Sida 19(3), 2001.*

John J. Wiens. 2000. **Phylogenetic Analysis of Morphological Data.** (ISBN 1-56098-816-9, pbk.; 1-56098-841-X, hbk.). Smithsonian Institution Press, PO Box 960, Herndon, VA 20172-0960, U.S.A. (Orders: 800-782-4612). $26.95 pbk., $49.95 hbk. 220 pp. Black/white figures, 6" × 9".

Contents.—**1)** Molecules Verses Morphology In Systematics: Conflicts, Artifacts, and Misconceptions; **2)** Character Selection and the Methodology of Morphological Phylogenetics; **3)** Discovery of Phylogenetic Characters In Morphometric Data; **4)** The Usefulness of Ontongeny in Interpreting Morphological Characters; **5)** Coding Morphological Variation Within Species and Higher Taxa for Phylogenetic Analysis; **6)** Hybridization and Phylogenetics; Special Insights From Morphology; **7)** Using Stratigraphic Information in Phylogenetics; **8)** Logical Problems Associated With Including and Excluding Characters During Tree Reconstruction and Their Implications for the Study of Morphological Character Evolution; and Index.—*Review forthcoming in Sida 19(3), 2001.*

WHAT THEY ARE SAYING ABOUT....





"You don't have to be a botanist to use it! All the tools you need to teach plant taxonomy, family characters, classification, etc. Excellent introductory materials on the history and geology of North Central Texas. Great for identifying indigenous plants in an ecosystem! Essential for student wildflower collection projects! Use this one book instead of five, it has it all."
—*Sharon Foster*, 7th grade teacher,
Fort Worth Country Day School

"The best available, user-friendly source of information about our native and naturalized plants. This book should be in the library of every gardener, landscape architect, horticulturist, urban planner, farmer, rancher, and wildflower enthusiast."
—*Howard Garrett, The Dirt Doctor*

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—*Marshall Johnston*, Co-author,
Manual of the Vascular Plants of Texas

"The *Illustrated Flora on North Central Texas* is a magnificent work. This abundantly illustrated volume will not only be of use to those people wanting to identify Texan plants, it will be a model of how a local flora should be prepared."
—*Sir Ghillean Prance* FRS
Director, Royal Botanic Gardens, Kew

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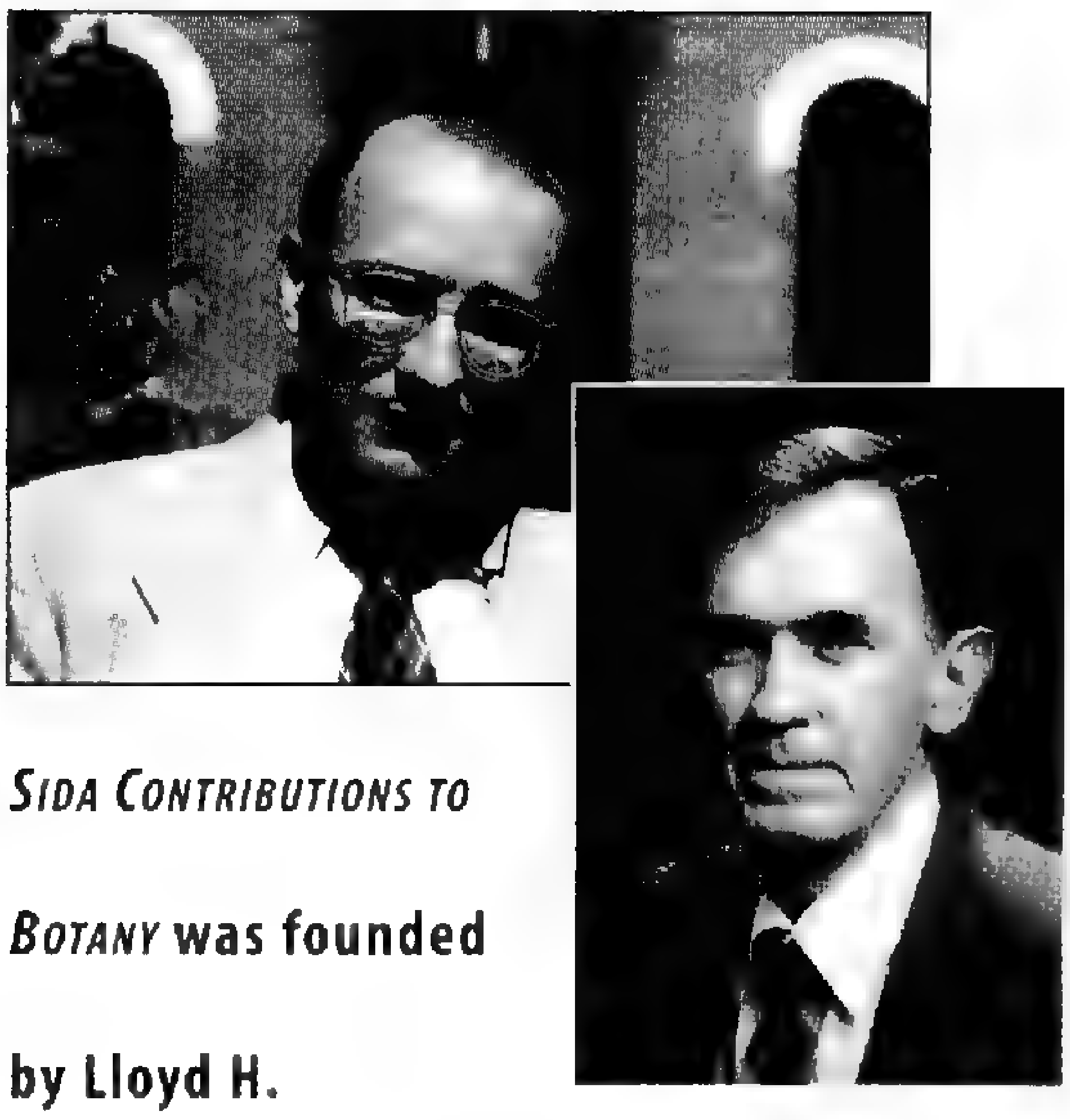

SIDA CONTRIBUTIONS TO BOTANY was founded by Lloyd H. Shinners, above left in 1962. Inherited by William F. Mahler, Director Emeritus of BRIT, above right, in 1971, and since 1993 it has been published by BRIT.

Barney L. Lipscomb, Editor

Botanical Research Institute of Texas

509 Pecan Street

Fort Worth, Texas 76102-4060, USA

817 332-4441 / 81/ 332 4112 FAX

Electronic mail: sida@brit.org

Home page at the URL: http://www.brit.org/sida/

John W. Thieret, Associate Editor

Dept. of Biological Sciences

Northern Kentucky University

Highland Heights, KY 41099 USA

Félix Llamas, Contributing Spanish Editor

Dpto. de Botánica, Facultad de Biologia

Universidad de León

E-2471 León, SPAIN

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W. Takeuchi

Botanical Research Institute of Texas (BRIT)
c/o Lae National Herbarium and
Papua New Guinea Forest Research Institute
P.O. Box 314, Lae, Morobe Province 411
PAPUA NEW GUINEA
wtakeuchi@global.net.pg

M. Golman

Divisional Manager
Papua New Guinea Forest Authority
PNG National Forest Service
P.O. Box 5055, Boroko
National Capitol District
PAPUA NEW GUINEA
mgolman@datec.com.pg

ABSTRACT

In recent years, Papuasian surveys patterned on rapid-assessment formats have become increasingly popular for developing floristic estimates of site value. Although some of the results have been widely disseminated, there have been few attempts at overall synthesis despite the obvious need for such review. A commentary on botanical exploration and documentation during the past decade is provided, with particular focus on connections between current conditions and the fulfillment of goals implicit in comprehensive bioinventory.

TOK IGO PAS (MELANESIAN TOK PISIN)

Long nau tasol, ibin igat luksave na wok painim aut ibin kamap planti moa long ol bus na diwai bilong Papuasia. Maski ibin igat sampela save bilong wok painim aut istap na ibin kamap long planti hap nabaut, ibin igat wok traim tasol i kamap long dispela wok bilong painim haumas bus na diwai istap long Papuasia. Dispela em i ripot o toksave long ol wok painim aut wei ikamap long ten pela yia igo pinis na luksave long wok ibai kamap bihain taim long wei bilong painim aut ol diwai na bus.

ABSTRACT

近年、植物学的見地からの地域の重要性を評価するための方法として、ラピッドアセスメント方式によって行なわれるパプアジア調査が増加しており、幾つかの科学的調査結果が広く発表されている。これらの研究の総括が、将来の研究の発展に必要な指針となることは明らかであるにもかかわらず、そのための努力は怠られてきた。本論文では、現在の研究方法で本来我々が求めている成果を本当にあげられているかどうかの検証に焦点を当てながら、過去10年間の植物調査と発表論文に関する論評を行なう。

INTRODUCTION

In spite of its status as a global center for biotic diversification, Papua New Guinea (PNG) has the dubious distinction of being one of Malesia's most inadequately surveyed nations. Stevens (1989) had defined the relatively well-collected areas in PNG as having a collections density of 50–100 specimens per 100 sq km. But even by this easy measure, the well-collected localities identified by his criterion were primarily confined to a few principal drainages and high mountains. Recent analysis shows that the background level of collection density averages less than 25 per 100 sq km over New Guinea as a whole (Conn 1994), a rate substantially below the standard regarded by Stevens as a minimal baseline. Within the Malesian region, only the Celebes and Sumatra have comparably low collection indices (Stevens 1989). Although Steenis (1950) had estimated that 50 years of coordinated exploration would be required to document the New Guinea flora, the rate of documentation has not improved since that assessment was made, and has in fact dramatically declined within the last 30 years (cf. Conn 1994). If rational conservation strategies and land-use policies are to be devised and implemented by indigenous agencies, the present trends in documentation must be reversed. The urgency for corrective action is especially acute when the target country represents a biodiversity hotspot within which social and economic changes are expected to intensify.

Papua New Guinea's population growth rate of 2.3% is now one of the highest in the Pacific region. From a present base of 4.7–5.0 million, the number of people is expected to double by 2024 (Gumoi & Sekhran 1995). The demographic projections are especially consequential because an estimated 84% of the population is rural, and all such households are dependent to some degree on slash and burn agriculture (ibid). Currently, an estimated 200,000 hectares of land are cleared annually for subsistence, from which 20,000–30,000 hectares represent natural-growth forest permanently removed by various clear-cut operations including industrial logging (Filer 1995).

With the anticipated increases in human population, subsistence activities are expected to progressively mimic the effects of forest clear-felling as fallow cycles are accelerated (Louman & Nicholls 1995). When PNG enters the steep part of the predicted population growth curve, serious environmental impacts are likely to occur. There are already mounting indications of impending failure in the subsistence systems of several provincial areas due to intensification of cropping rotations (Levett & Bala 1995).

At present, PNG still retains 70% of its primary forest cover (McAlpine & Quigley 1998) and is one of only four tropical countries with extensive tracts of original vegetation (Suzuki 1993). This remarkable state of preservation has unfortunately fostered a complacency among science professionals by encouraging an expectation that current inadequacies in documentation can always be reversed by future action. The underlying assumptions are not likely to persist however. Time will start running out sometime during the next generation.

The poor state of floristic documentation has many and significant manifestations in Papuasian botany. A disproportionate number of taxa are known from single collections, and taxonomic knowledge even at family level is often highly superficial (Johns 1993). Virtually nothing can be said of the basic biology and populational variation for many of the most important Papuasian plant groups (Stevens 1989). While it is generally conceded that certain mountainous areas are hotspots for floristic endemism, it is impossible to identify low-elevation centers with the scanty data at hand. Some consequences of the past emphasis on high elevation exploration can be seen in recent results from The Nature Conservancy's lowland survey of Josephstaal, where 8 species were newly described from accessible sites near the principal national highway in Madang Province (Huynh 2000; Takeuchi 2000a, 2001). Lowland environments are preferred venues for economic development, so there is considerable potential for floristic losses in this zone. Continued neglect of botanical documentation in lowland habitats can have severe consequences in any future intensification of commercial logging, considering that over 50% of PNG's loggable forests (as defined by industry standards) are in the lowlands (Louman & Nicholls 1995). Of the forest blocks currently representing merchantable stands, 67% also occur in medium-crowned lowland hill forest (sensu Paijmans 1975; or forest category Hm on Hammermaster & Saunders 1995), a vegetation type which is probably Papuasia's richest floristic formation (Louman & Nicholls 1995).

Several competent observers have enumerated localities of particular value and urgency for exploratory survey within PNG (Johns 1993; Steenis 1950; Stevens 1989). A common thread extending through all these recommendations is that the exploration status of highlighted areas has hardly improved since the time of the Steenis commentary. Very little has changed with respect to the quantity and quality of botanical data over the past several decades. The lack of substantive progress adversely affects taxonomic and ecological assessments, and ultimately impedes sustainable management and development within the areas in question.

SOCIAL AND INFRASTRUCTURAL CONSIDERATIONS

In PNG, any activity requiring access to natural resources must include consideration of the traditional land tenure system. An estimated 97% of the country is under customary ownership, subject to complex systems of usage rights and social relationships which are themselves superimposed over a multitude of cultural-linguistic traditions (Crocombe 1974; Holzknecht 1995). Alienated land and properties otherwise under governmental control are virtually nonexistent. Irrespective of endorsements from external agencies, the final arbiters in land-use issues are the village clans and landowners of specific forest blocks (i.e., the 'papa graun').

Because so many prerogatives reside with local villagers, direct negotiations with the customary tenants are mandatory for any scientific program. This is not so easily done when an investigation's principals are overseas-based. Due to the proliferation of advocacy groups with environmentalist agendas, many landowners have also become conditioned to regard extractive activities on their land (particularly by foreigners) with considerable suspicion. This situation applies especially to bioprospecting. Survey operators do well to avoid prospective collecting altogether, because of objections that have been raised in relation to such activities. Any contemplated project would be required to explain its activities to an oftentimes skeptical and uninformed audience. Having a functional knowledge of the lingua franca (Melanesian tok pisin) is essential.

A significant consequence of the primacy of customary rights in Papuasia is that certain Western mechanisms for permit issuance and resource access are culturally irrelevant in PNG. There is for example, no such requirement as a 'plant collecting permit.' Even if such permits were established by government agencies, they could never be enforced at the local level where botanical collecting actually occurs. Only the customary landowners can grant approval for removal of materials from their territory. Paradoxically, while this eliminates much of the bureaucracy characteristic of Eurocentric management systems, survey operations are often rendered more complicated and unpredictable, because the activities are entirely subject to the whims of individual landowners.

Modern commentators have been unanimous in expressing a need for developing local capacity as a prerequisite for longterm assessment and management of PNG's biodiversity (Beehler 1993; Conn 1994; Damas 1998; Johns 1993; Sekhran & Miller 1995). Public sector agencies in PNG are subject to unpredictable changes in government support due to shifts in political direction. Based on previous trends, it is very unlikely that vital commitments to science capacity building will occur through in-country funding. Collaborative studies are a potentially effective means for improving internal capabilities when appropriate agencies are engaged as partners in research. Programs which provide for participation of qualified counterparts can make longterm contributions to bioinventory, but the partnerships must be carefully selected and not merely convenient.

The PNG infrastructure in science has experienced profound changes over the last thirty years. During the colonial administration and for a brief time afterwards, many of the functions associated with floristic survey were centrally invested in highly capable units such as Lae Herbarium (LAE) and the former Department of Forests. Government facilities in the 1960s and early 70s virtually monopolized plant exploration within PNG. In contrast, nongovernment organizations (NGOs) were conspicuous by their overall absence from activities involving botanical documentation. However after PNG became a sovereign state, the capabilities of national agencies for floristic work progressively declined as budgets were subjected to a political reordering of priorities (cf. Conn 1994). The earlier priorities are unlikely to be restored in the future because institutional and social realities have been so completely transformed. For example, there are now no Ph.D.-level professionals in the PNG National Forest Service, and currently only one M.Sc. recipient is serving with the national herbarium.

To some extent, these trends in agency capabilities have been mitigated within the last 10 years by countervailing developments in the nongovernmental sector. A seminal event was the Conservation Needs Assessment (CNA, Beehler 1993), the first countrywide plan to define comprehensive priorities for conservation and research action. The CNA stimulated establishment of a multitude of Wildlife Management Areas (WMAs) and of associated projects based on the Integrated Conservation and Development (ICAD) model (cf. Saulei & Ellis 1998). Not coincidentally, many of the post-CNA initiatives encompass at least in part, the areas prioritized by the CNA. Together with these developments, a number of NGO entities have assumed effective jurisdiction over the WMAs and their landowner groups. Many of PNG's prime wilderness environments are presently included under NGO/Management Area partnerships. The total biodiversity represented by such partnerships is very substantial even though the arrangements collectively comprise only ca. 8% of the PNG land area. In addition, a large backlog of sites is under consideration for future conservation action.

The combined effect of these events is that the hierarchy of PNG science-related administration has been transformed by the creation of a new infrastructure. Due to the relative recency of the new arrangements, there has been little change in the way biological surveys are conducted in PNG. However nearly all the WMA-related NGOs maintain a fulltime presence within their respective wards, so the opportunities for achieving effective community integration with surveys are now very promising. The WMAs typically include resident-coordinators and protocols for maintaining continuous liaison with landowner groups, critical functions that government interests can no longer provide in the remote areas. From an operational perspective, each of the NGO/WMA combinations is the equivalent of a research facility. The elements for multilateral surveys combining professional and village participants are thus in place, requiring only that the individual components be drawn together under a common plan. A future schedule for comprehensive bioinventories could be constructed using the government planning instruments on one hand and community level implementors composed of WMA/NGOs on the other. Linkages of this sort are already the basis for several contemplated operations.

PARATAXONOMIST ENHANCEMENT OF SURVEYS

The sheer numbers of species involved in documentation and inventory are overwhelming when approached from traditional perspectives in collection and curation. Time honored traditions in tropical exploration are no longer adequate to the tasks of acquiring and analyzing large collection sets. A revised approach to floristic documentation is clearly required, and is perhaps best adapted from the experiences of entomologists faced with problems similar to those in botanical inventory.

Through refinement of comparable methodologies first developed by INBio in Costa Rica (Janzen et al. 1993), PNG-based researchers at the Parataxonomy

Training Center (PTC) have devised practical solutions to the time demands presented by intensive sampling in rich tropical habitats (Basset et al. 2000; Novotny et al. 1997). Their approach has been to train local villagers (as parataxonomists) in the fundamentals of collecting, specimen sorting, identification, and computer-based data management. The few international professionals are primarily engaged as instructors, quality control agents, and ultimately as data interpreters. By focusing the intervention of individuals to the points where their expertise is most effective, the research process is thus streamlined and accelerated. The immediate product of these arrangements is that extensive specimen sets have been acquired and processed within time frames that would ordinarily require prohibitive inputs. The demonstrated success of such organization in entomology by itself shows that the protocols can work for botany. Insects after all, exceed the floristic diversity by several orders of magnitude.

As an example of the enhancements offered by the new procedures, within a period of 5 years the PTC studies in insect herbivory have collected, sorted, and mounted over 100,000 specimens of leaf-chewing and sap-sucking insects representing ca. 1,300 species (cf. Basset et al. 2000; Novotny et al. 1997). Such outputs considerably exceed those obtained by conventional efforts without parataxonomist assistance. Over 40 scholarly papers have been published by the research team, in stark contrast to the normal downtime between study inception and publication (usually 4.6 years) for the kind of eco-entomological inquiry being undertaken by PTC researchers (Erwin 1995). These improvements are a direct result of the use of parataxonomists in time-intensive actions such as collecting and sorting, allowing other participants to optimize their own activities on cost-effective schedules. With the marked increases in sampling outputs, new insights have emerged which could only have arisen from statistically large datasets, such as are now being generated by the new protocols. The PTC sampling program has led to a reevaluation of insect-plant relationships, with wide-ranging implications for understanding the components of invertebrate diversity in tropical systems (Basset et al. 2000; Novotny et al. 1997). In an analogous manner, quantitatively boosted floristic surveys have the promise of spawning comparable advances in our knowledge of the taxonomy and ecology of the Papuasian/Malesian flora. This is especially likely when the existing sampling coverage for plants is so erratic and sparse.

A significant factor in the success of the PTC operation is the fact that instructors and students share fulltime residence in a combined laboratory-dormitory complex while pursuing common research objectives. Continuous interactions between mentor-trainers and parataxonomists instill a sense of fraternity and purpose which is not easily replicated by conventional projects, even though the latter may otherwise superficially mimic the PTC program structure and objectives. Preservation of the social relationships will be crucial to effective transferance of the parataxonomist concept to floristic survey. Similar patterns for success were previously pioneered at the Christensen Research Institute (Orsak 1993) and more recently by the Village Development Trust. Botanical planners should note the methodological paradigms, particularly the conditions contributing to their effectiveness, as the implications for floristic survey are both timely and considerable.

A point worth repeating is that the parataxonomist concept has been thus far applied primarily by entomologists. Unfortunately the botanical profession has been slow to recognize that many problems of biological sampling in the tropics are universal, and applicability of successful techniques is likely to cut across disciplinary lines. Especially with traditional cultures such as PNG, folk knowledge of plants is often more extensive than the corresponding base for insects (Basset et al. 2000) so plants are actually very appropriate subjects for parataxonomist-assisted investigation (Novotny pers. comm.).

If comprehensive parataxonomy programs are attempted within PNG, complementary improvements will be required in the facilities associated with biological documentation. Development of local capacities for floristic survey is unlikely to achieve lasting results if the physical security of collections (and other survey products such as databases) cannot be assured inside the host country. This can be a problem in developing societies where funding priorities for science are generally low. A permanent institutional base will also be needed, and is best achieved through the development of organizations specifically devoted to parataxonomy, rather than by placing parataxonomists in preexisting herbaria or government institutions. With scientific facilities in the public domain, there is likely to be an administrative bias favoring professional staff over individuals without formal credentials. The continuity of parataxonomists in such environments would be less secure than in a mission-specific unit such as PTC.

Steenis's estimate of a 50-year cycle of coordinated exploration is operationally impossible. In its reliance on outdated concepts of how such inventories should be achieved, it is also incompatible with the social realities of contemporary Papuasia. Existing funding facilities are unlikely to support such extended programs of deferred realization anyway. As long as limiting factors devolve exclusively upon a small number of highly trained professionals, whether indigenous or foreign, it is doubtful that real progress will be made toward the goals implicit in comprehensive survey. Only by significant expansion of the workforce, like that afforded by parataxonomy, will the inventory process be able to encompass the diversity within Papuasian forest ecosystems. Methodologies which improve existing rates of floristic documentation are especially urgent in view of the habitat destruction which has occurred in Malesia since the time of van Steenis (cf. *inter alios* Kiew 1990).

Future surveys should include teams composed of purpose-trained parataxonomists. Participation by landowners will also permit outputs to be amplified across the board, resulting in survey yields substantially higher than conventional expeditions. A collateral advantage of community involvement is the associated opportunity for integrating traditional knowledge systems into the collections documentation. Ethnobotanical inquiry can be easily assimilated when local inhabitants are engaged in surveys.

Although there is clearly a general failure of floristic documentation in Papuasia, little attention has been explicitly devoted to the way field operations are actually conducted. Yet that should be the logical starting point in any analysis, because how collections are acquired and the limitations associated with their acquisition, cannot help but affect everything else which follows. In any such examination, probably the most obvious limiting factor which would emerge is the ineffectiveness of existing collecting methods.

In the early days of the PNG Forest Service, rifle fire was often used to bring down fertile branches from the canopy. Nowadays, in a country where high-powered firearms require special permits, this is no longer a viable option for a number of reasons, not least of which being that possession of such weapons would attract undesirable attention to the collecting teams. In order to obtain specimens from high canopies, local climbers are thus employed on nearly all surveys. Selected trees are also frequently cut down. Both methods are very time consuming however, and it is not unusual for a single collection obtained by such means to take a half hour or even longer. Other procedures using slingshots, extensible poles, wire saws, etc. are useful only in certain situations, and also require a substantial amount of practice before the field assistants can achieve reasonable proficiency.

The search for suitable gatherings is often lengthy just in itself. Especially in mature growth, where the forest biomass and collection targets are located far above the ground, few taxa will be within easy reach. Under prevailing conditions, a collector with several assistants can expect to obtain an average of only 30 taxa per day. Daily tallies tend to be higher in regrowth and montane vegetation because of their lower statures, but generally a botanist will not take more than 50 numbers even under favorable circumstances. Add to these considerations the fact that collectors in logistically difficult environments are often burdened by institutional quotas for multiple duplicates, and the time/cost demands are increased even further.

Efforts diverted to the preparation of duplicate samples detract from the documentation process. The international herbaria with significant traditions in Papuasian botany are few in number, so a point of diminishing returns is quickly reached when distributing specimens. Collections consisting of numerous duplicates are very inefficient in terms of the costs in obtaining those duplicates. Floristic inventory is better served by securing small sets (3 duplicates) of different conspecific numbers rather than by obtaining single numbers with many duplicates. On the former procedure population variation can be effectively assessed, while the latter procedure contributes little.

The reasons for the inadequate documentation of the Papuasian flora can be entirely understood at the most immediate and basic operational level: that of the individual collector laboring in the bush. No matter how much individual effort is expended, the *per capita* outputs are not going to increase to an extent necessary to reverse the current trends in botanical inventory. Since personal yields are not amenable to improvement, the common sense alternative is to expand the workforce. The most practical and socially realistic means of achieving this in traditional societies is through the application of parataxonomists.

An unfortunate fact of contemporary surveys is that parataxonomy-assisted outputs in themselves cannot achieve all the desired objectives. Even when survey collections attain respectable volumes, many past efforts have suffered from the myopic attitude that the botanical gatherings are an end in themselves. Oftentimes there has been no attempt to disseminate findings, or even to assemble the results into any kind of usable form. These omissions discourage rationalization of resource management within the surveyed areas, which in practical terms is probably the most important downstream product from biosurveys.

Perhaps the best example of the preceding circumstance is provided by current developments in the April-Salumei region of East Sepik Province. No other classical locality in Papuasia is of such critical historical-biotic value, owing to the fact that nearly all of Ledermann's interior sites from the 1912–13 Kaiserin-Augusta (Sepik) Expedition fall within this tract (cf. Veldkamp et al. 1988). Although key localities in the Hunstein Range were revisited by CSIRO botanists Hoogland and Craven in 1966, and by a National Geographic sponsored contingent in 1989, there is still no compilation of surviving specimens from the now mostly-destroyed Ledermann sets, nor any published compendium from the subsequent Hunstein expeditions.[1] In the meantime, scores of significant discoveries have been recognized from the newer surveys, including 6 species of *Freycinetia* from the 1989 expedition alone (Huynh 1999). The recovery of the endemic genus *Sepikea*, formerly known only from an illustration in Schlechter (1923), has also occurred in recent years (B.L. Burtt, pers. comm.). These developments go unnoticed by resource planners because the discoveries are reported in technical journals which are inaccessible to government agencies or are discussed only within a small circle of botanical collaborators. The April-Salumei tract is currently a focal point of contention between conservation, landowner, logging, and mining interests (cf. Bakker 1994; Filer & Sekhran 1998), and a variety of future land uses is now under planning consideration. The results of uninformed action in a locality with such unique biotic and scientific-historical values are potentially devastating.

It is thus an imperative that liaising mechanisms be erected for ensuring that surveys connect directly with the agencies responsible for priority-setting

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[1] There is an unpublished report (Sohmer et al. 1991) but it contains many misidentifications.

in wilderness territories. It is not sufficient to establish links between universities, herbaria, or NGOs with community-level jurisdictions over survey sites. These entities do not possess the statutory powers for determining policies and priorities in the resource operations (e.g., forestry and mining) which have the greatest potential impacts on the environment. Without critical inputs to the planning facilities in government, surveys may end up as mere information-gathering exercises from habitats which subsequently disappear. At a minimum, floristic inventories should be consciously directed to the Forest Planning Division of the PNG Forest Authority, and to the Nature Conservation Division of the Office of Environment and Conservation.

THE RELATIONSHIP TO COMMUNITY AND FLORISTIC PATTERNS

In the last decade, a substantial amount of data has been acquired from many of PNG's forest environments. The greater part of this work has been conducted under the auspices of NGOs operating within their respective conservation areas. A discouraging aspect of many such studies is that they are either never formally published, or otherwise appear in publications of limited readership and distribution. In the following discussion, several distinct but interrelated issues are considered, in some cases drawing upon data which are available locally, but not readily accessible to the wider scientific community. The commentary addresses selected topics in **1)** morphospecies enumeration, **2)** floristic richness on environmental gradients, and **3)** the relationship between collections in Lae Herbarium to timber concessional activity.

1) Morphospecies enumeration.—Although the size of its flora is of considerable general interest, there is little consensus on the number of plant species within Papuasia (cf. Collins et al. 1991; Frodin 1984; Good 1960; Hoft 1992; Johns 1993; Womersley 1978). The only sure way of gauging the total floristic inventory for PNG is through systematic revision, but it will be many generations before a *Flora Malesiana*-style compilation can be concluded (Geesink 1990).

In spite of such concerns, the locality-specific inventories are the most important ones for planning purposes. While flora-wide summaries may be of broad conceptual interest, they do not provide the sort of information which is relevant at operational levels. Management actions are typically evaluated and implemented for specific localities, and this requires detailed information on the floristic profiles of individual tracts. Even if many plant families will remain unrevised through the foreseeable future, the enumeration of Papuasian morphospecies and the determination of their spatial distributions is an achievable objective. Knowledge of the local components of floristic diversity is a basis for rationalized priority-setting and decision-making at the level of agency implementation. And ultimately it is the conservation of local diversity which is the foundation for future floristic inquiry even though the larger regional patterns provide the basis for placing the local knowledge in context.

Species checklists are thus of greater practical significance for planning and conservation than is generally conceded, if they are used in conjunction with other information sources. However, unless the compilations accurately reflect current taxonomy and are periodically reviewed and adjusted, they can be an actual disservice to government planners and managers. In this connection, attempts to automate the process of plant identification through interactive keys have promise as a heuristic and practical tool, although the methodology is likely to be constrained by limited access to computer resources within countries such as PNG.

2. Floristic richness on environmental gradients.—The total number of Papuasian plant morphospecies enclosed within individual territories, on elevational or horizontal environmental gradients, is also still unknown. Recent intensive surveys at Crater Mt. have produced the highest single-locality census thus far achieved in PNG (i.e. 1,200 morphospecies: Takeuchi 1999, 2000b) but the counts are not comprehensive. Inventories intending to evaluate total floristic content within environmentally variable tracts must eventually quantify species richness between habitats. A problem for any manager working with limited resources is the question of how to apportion survey effort through time and space to a targeted flora.

In the Neotropics the answer to this issue would be relatively straightforward. The number of tree species is inversely related to elevation, with the highest counts in the lowlands and with richness falling progressively with altitude (Gentry 1988). When the emphasis is on evaluating the tree flora (as is usually the case with forestry operations), surveys would produce maximized returns by concentrating at low elevations. A salient qualification however, is that neotropical richness seems to be highest in the montane zone (cf. Henderson et al. 1991) if all plants (including nontree species) are considered, so the optimal sampling plan for surveys would be dependent on the objectives.

In Papuasian habitats floristic richness patterns are more equivocal and complex than those reported by Gentry (1988) and are generally consistent with Henderson et al. (1991) if the nontree component is considered. On New Ireland, tree counts have been reported as declining monotonically with elevation in the manner of the Neotropics (Takeuchi & Wiakabu 1997). However this result has not been replicated and may be an artefact of widely separated sampling stations. Foster (1997), by employing a continuous line sampling methodology, concluded that the species richness curve for New Ireland has a mid-elevation bulge, being highest at 750 m and diminishing above and below that level. Kulang et al. (1997) reported maximum species totals at 1,000 m elevation along an altitudinal sequence in Madang Province. In a similar study, species diversity from forest habitats on New Britain attained maximum values between 600–800 m (Balun et al. 1996). Previously, the 1995 Bismarck-Ramu survey had determined the 600 m level as being floristically richest among examined sites

(Hedemark et al. 1997). Although the lowland-montane ecotone has not been critically evaluated in Papuasia, there are converging indications that the point of highest floristic development lies somewhere in or near that transition. An obvious implication for local conservation initiatives is that this interval should thus serve as the botanical core for protected areas. Future surveys can increase their efficiency by allocating more time to the low montane ecotone instead of attempting equal coverage of all habitats on an altitudinal gradient. The lowland rainforest and the high montane forests are apparently less diverse, so survey effort should be allocated accordingly.

The substantial variation (600–1,000 m) in the elevations of beta diversity maxima suggests influence of local factors. From the differences between sites it is also apparent that the richest communities can be identified only by actual survey, and not by extrapolation from results obtained in other areas. Site-specific vegetational histories, climatic considerations including *Massernerhebung* (cf. Grubb & Stevens 1985), substrate distinctions, sampling methodology, etc., are factors probably responsible for the contrasts between locations.

Even while the argument from raw numbers seems clear enough, the situation is still obscured by considerations of quality. Plant species do not have the same value, at least from conservation perspectives. The local endemic is understandably valued more than widely distributed taxa, so richness is only one aspect of site assessment. Due to difficulties in generating the required data, there are no published accounts comparing endemism between different Papuasian environments. This is an obvious lacuna which should be considered in future inventories. Although the unrevised status of many plant families is a serious constraint, preliminary estimates could be obtained by using the taxa covered in modern treatments.

It is also appropriate to note that while previous efforts have attempted to quantify relationships between beta diversity and elevation, the critical variable is not elevation but the forest classification unit. In whatever manner the forest/community type is defined, whether by species composition, physiognomy, or a combination of both, it is really the forest type which underpins the richness variation. Elevation is an obvious environmental control but its effects are manifested through the vegetation formation or 'life zone,' and it is certainly not the only controlling factor. Knowing which forest formations have the highest number of species, in both absolute and proportional terms, is thus a more meaningful focus for inquiry than any site-specific relationship between richness and elevation *per se*. This is especially true because the same species and/or vegetation types often have different elevational ranges at different locations, which is at least partly responsible for the inconsistent results obtained by current investigations on elevation-dependent richness. On anecdotal grounds, it is apparent for example, that many plant taxa have anomalous low-elevational occurrences on ultrabasics. There are also the *Massernerhebung* induced permutations, to cite another obvious influence (cf. the 'melange effect' in Grubb & Stevens 1985).

Establishing correlations between forest units and floristic diversity is complicated by the existence of several contrasting systems for forest classification in Papuasia (i.e., Hammermaster & Saunders 1995; Johns 1977; Paijmans 1975, 1976; Saunders 1993). The first scheme however, is now supported by a GIS (Geographic Information System) augmented by transparency overlays for the pre-existing 1:500,000 scale topographic maps (Australian Survey Corps) and also with separately issued 1:100,000 scale maps showing the various forest units for all of PNG. It thus provides a very useful foundation for planning and executing the surveys needed to resolve outstanding issues.

3. The relationship between collections in Lae Herbarium to timber concessional activity.—Recent summaries (Balgooy et al. 1996; Welzen 1997) from the *Flora Malesiana* suggest that New Guinea has the highest rates of floristic endemism in Malesia. Based on current revisions, most of the endemic species appear to be concentrated in montane habitats. Using selected genera, Heads (in press) arrives at some of the same conclusions regarding relationships between montane environments and endemism.

Collection densities in Papuasia are very clearly skewed in favor of montane areas (Conn 1994), so to a certain extent phytogeographic summaries will be affected by the sampling inequalities. The greater part of the LAE holdings (and thus the overseas duplicates resulting from them) originate from the Mamose[2] region and the Highlands (cf. Fig. 1), so it is inevitable that a certain bias has been introduced into distributional summaries derived from such a foundation. The magnitude of such biases can be inferred from the geographical unevenness of collections in the Lae Herbarium, as summarized in Table 1.

The core of the PNG national collections in botany consists of the NGF and LAE series specimens (1–49,999 on the New Guinea Force numeration and thereafter with higher numbers on the LAE sequence). The institutional sets currently end at ca. 85,000. Both the NGF and LAE sequences have many blank intervals consisting of number blocks which were assigned to past collectors but never actually used. A substantial amount of material was also rejected or destroyed after the collections had been recorded. Back-numbering of contemporary gatherings has been employed in an attempt to fill in these gaps but there are still much fewer collections than indicated by the institutional number. Table 1 is thus based on a manual count of archived labels physically represented by corresponding specimens in the herbarium.

The NGF and LAE series constitute approximately 25% of the estimated 275,000–300,000 specimens in the national herbarium, though it should be

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[2] Mamose region is the administrative unit composed of West Sepik, East Sepik, Madang, and Morobe Provinces.

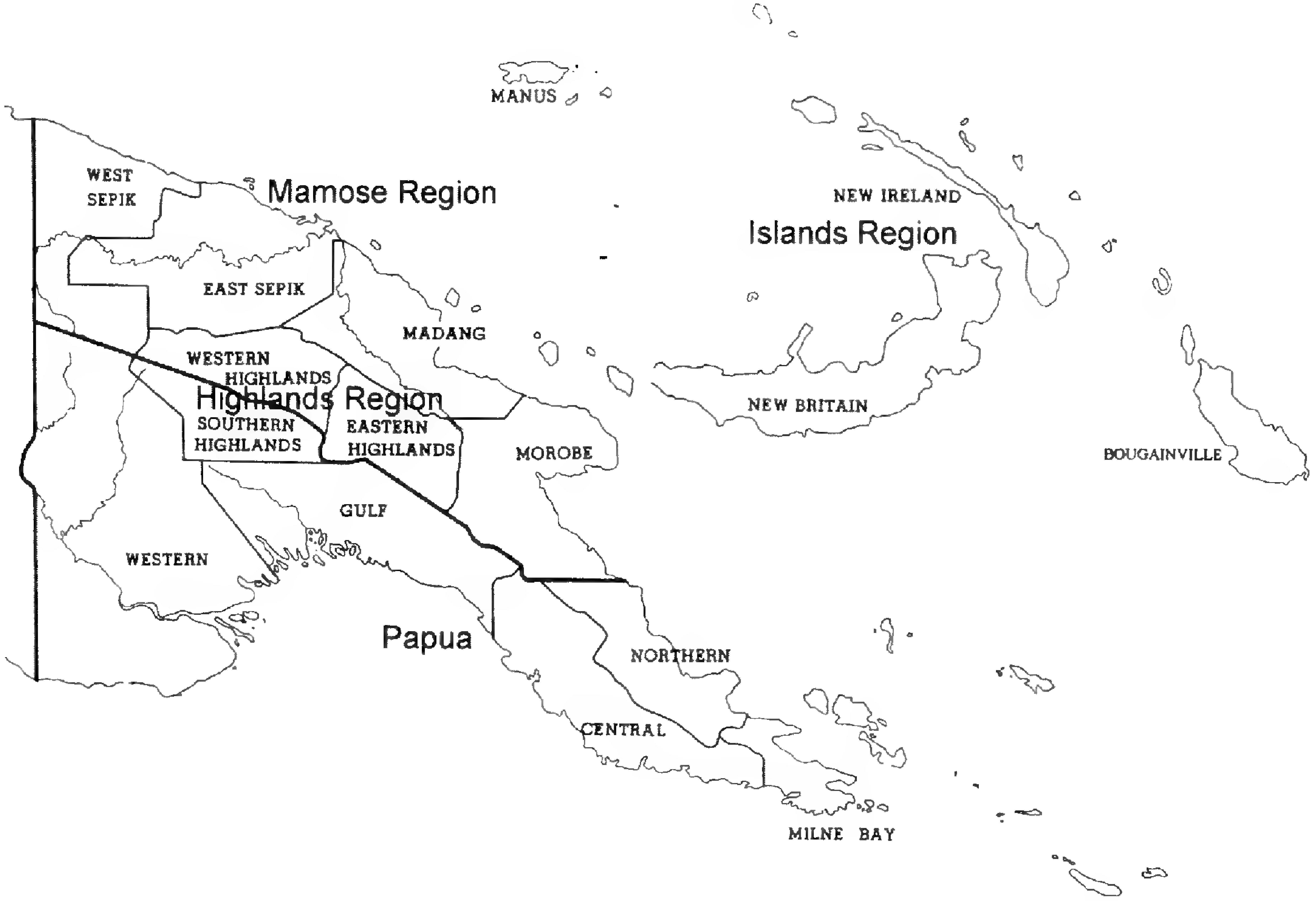


Fig. 1. Provinces of Papua New Guinea. The Western Highlands are composed of Enga in the western half and Western Highlands Province s. str. in the eastern part. In similar fashion the Eastern Highlands are divided respectively into Chimbu (Simbu) and Eastern Highlands Province s. str. The Southern Highlands have geological affinities to the Australian craton rather than to the Island Arc terranes (Pigram & Davies 1987).

TABLE 1. Representative profile of plant collections at Lae Herbarium tabulated by province and region of origin (from NGF, LAE, and CSIRO series numbers).

Province	Counts	% of Total Sample
	HIGHLANDS REGION	
Chimbu	8,060	8.86
Eastern Highlands	5,837	6.42
Enga	38	0.04
Western Highlands	3,844	4.23
Subtotal Highlands Region	17,779	19.6
	ISLANDS REGION	
East New Britain	1,701	1.87
Manus	896	0.98
New Ireland	1,418	1.56
North Solomons (Bougainville)	2,475	2.72
West New Britain	4,104	4.51
Subtotal Islands Region	10,594	11.6
	MAMOSE REGION	
East Sepik	3,396	3.73
Madang	3,485	3.83
Morobe	25,509	28.04
West Sepik	6,082	6.69
Subtotal Mamose Region	38,472	42.3
	PAPUAN REGION	
Central	8,262	9.08
Milne Bay	5,404	5.94
Northern	1,520	1.67
Subtotal Papuan Peninsula	15,186	16.7
Gulf	1,666	1.83
Western	3,691	4.06
Southern Highlands	3,569	3.92
Subtotal Papuan Austrocraton	8,926	9.8
Total	90,957	100.0

noted that the size of the total holdings is not accurately known and tends to be overstated because of discontinuities in the recording system. A major data recovery effort would be required to collate locality information on most of the remaining collections. The notable exceptions are the early CSIRO sets obtained by L. Craven, T. Hartley, P. Heyligers, R. Hoogland, K. Paijmans, and R. Schodde. The LAE duplicates by these collectors are entered in herbarium logbooks and have been easily incorporated into Table 1. Approximately 91,000 specimen numbers are included in the combined tallies (Table 1).

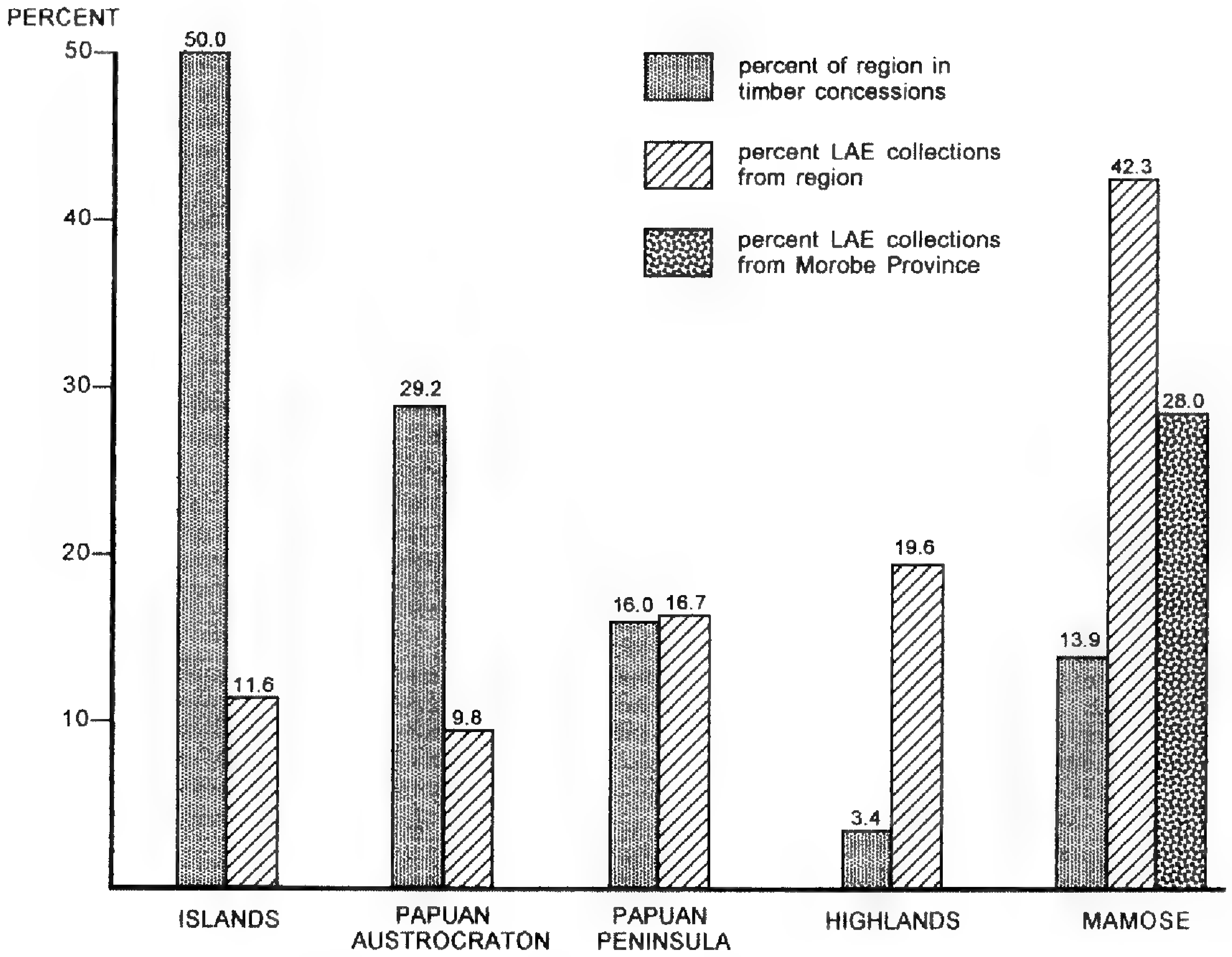


Fig. 2. Relationship between contemporary logging intensity and the relative distribution of historical LAE collections. The percentage of specimens from Morobe Province is shown as a separate bar next to the cumulative percentage for Mamose region. In general, the highest proportion of timber concessions are in areas with the least botanical documentation, thus severely constraining forest planning and management.

The obvious preponderance of specimens from Morobe and adjacent provinces, and the opposing paucity of material from Western and Gulf, are apparent even from casual inspection of the national collections. With 28% of the collections, Morobe Province is very disproportionately represented. The disparities clearly reflect the concentration of Forest Service facilities and infrastructure at Lae and Bulolo. A similar situation is shown by the relatively high numbers of specimens from Central Province, especially from the Brown River and the Sogeri areas, owing to their proximity to Port Moresby.

If timber concessions are tabulated by province and region (Table 2), a general inverse relationship is evident between the distribution of existing concessions and the collections coverage of the corresponding areas (Fig. 2). The provinces most susceptible to logging impacts (Islands region and the Austro-geoprovince) have the fewest herbarium specimens as reflected in the LAE sample, while the best documented regions (Mamose and Highlands) have relatively little logging activity. This inverse relationship shows that future forest sector development is likely to be most intense in areas which are floristically the least known, and

TABLE 2. Summary of timber concessional areas in Papua New Guinea tabulated by province and region.

Province	Total Concessional Area (ha)	% of Province in Concessions
	HIGHLANDS REGION	
Chimbu	0	0.0%
Eastern Highlands	0	0.0%
Enga	43,483	3.7%
Western Highlands	83,129	9.8%
Subtotal Highlands Region	126,612	3.4%
	ISLANDS REGION	
East New Britain	577,287	38.2%
Manus	51,734	24.6%
New Ireland	564,631	58.7%
North Solomons (Bougainville)	101,120	10.8%
West New Britain	1,552,628	74.8%
Subtotal Islands Region	2,847,400	50.0%
	MAMOSE REGION	
East Sepik	630,949	14.4%
Madang	387,870	13.5%
Morobe	276,751	8.2%
West Sepik	681,255	18.9%
Subtotal Mamose Region	1,976,825	13.9%
	PAPUAN REGION	
Central	484,778	16.2%
Milne Bay	225,101	15.8%
Northern	358,096	15.9%
Subtotal Papuan Peninsula	1,067,975	16.0%
Gulf	2,536,478	74.9%
Southern Highlands	39,241	1.5%
Western	2,028,312	20.7%
Subtotal Papuan Austrocraton	4,604,031	29.2%

may thus involve considerable biodiversity risk.

Documentation action is especially imperative for localities where concessional activity is currently occurring or imminent (cf. Fig. 3, reproduced from Papua New Guinea Forest Authority 1998). Floristic data is required not only to rationalize the logging plans for affected areas, but also to assess the postharvest consequences of forest felling. The opportunity for discovering localized species and of recording populational variation could be otherwise irretrievably lost.

Judging from historical patterns of collecting and future forestry needs, the highest-priority documentation targets should be the lowlands of Papua and the

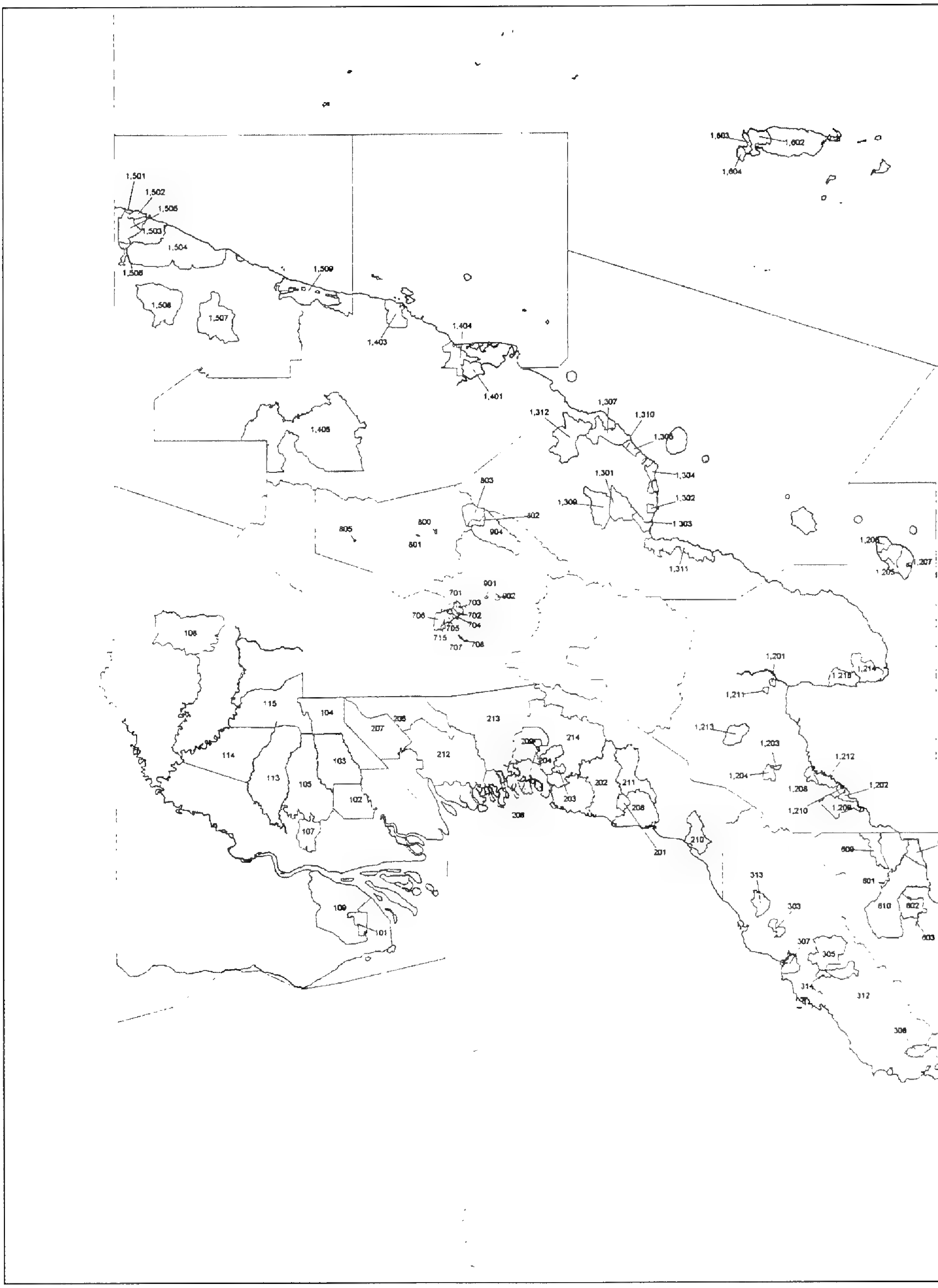
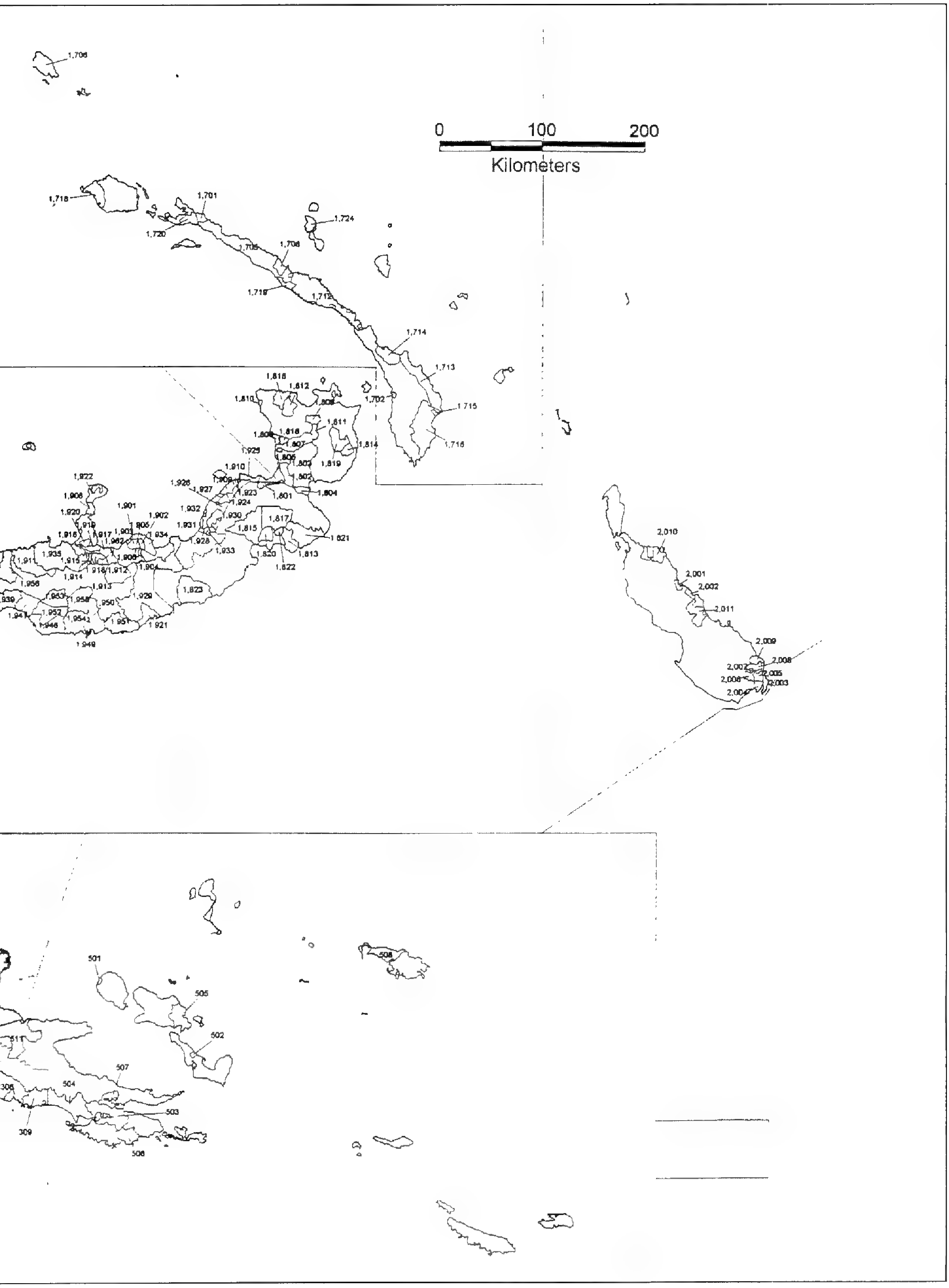


FIG. 3. Map of the timber concessions in Papua New Guinea.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Austrocraton subregion, particularly Gulf Province. This does not necessarily mean that such environments are more speciose or significant, only that the flora there is comparatively less explored and at greater risk of alteration before it has been documented. Based on Fig. 3, New Britain should also be a priority target, but much of the island has been previously logged and taxonomic losses have presumably already occurred as a result of forest removal (oil palm plantations now cover large sections of West New Britain). In contrast, Gulf environments are primarily in natural growth.

DISCUSSION

Papuasian bioinventories involving expeditions and contingents of highly trained specialists are relicts from a bygone era. Institutional and social realities within a rapidly evolving PNG indicate the appropriateness for change, even though the manifestations of such need are obscured by the misconceptions imposed by international and cultural distance. Existing failures in documentation are certainly not attributable to a lack of collective scientific interest or dedication of past workers. The deficiencies are principally methodological. The evidence of the last 100 years shows that conventional itineraries are not going to achieve adequate collections saturation of critical environments within acceptable time frames. As long as the burdens of inventory are borne primarily by an elite professional corps, the documentation of PNG's biotic richness will continue to be an elusive objective. The human assets for survey must be applied in more effective ways than previous programs or the deficiencies will persist. Unfortunately time is running out.

Past attempts at floristic inventory have been institutionally centralized, expeditionary, brief, logistically intensive, and with participation by a select membership. Future operations will need to become decentralized, continuous, participatory, and effected primarily by personnel that are preferably actually living at the sites being subjected to bioevaluation. Parataxonomists and the infrastructure to support them, are necessary elements in achieving such outcomes. The new schedules will also have to be acutely responsive to emerging grassroots assertion of community ownership rights and the resulting demands for stakeholder participation in all activities involving customary resources. Unless there is a major rethinking and overhaul of existing strategies, the objectives outlined by van Steenis half a century ago are unlikely to be realized.

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A LEAF BLADE ANATOMICAL SURVEY OF *MUHLENBERGIA* (POACEAE: MUHLENBERGIINAE)

Paul M. Peterson
Department of Botany
National Museum of Natural History
Smithsonian Institution
Washington, DC 20560-0166, U.S.A.

Yolanda Herrera-Arrieta
CIIDIR Unidad Durango
COFAA Instituto Politécnico Nacional
Apartado Postal 57
Durango, Dgo., C.P. 34000, MÉXICO

ABSTRACT

Muhlenbergia includes 151 species of mostly New World origin; 133 species are indigenous to North America [although many of these range to Central America (33) and South America (14)]; 38 species occur in Central America (a single species is endemic); 25 species occur in South America (10 are endemic); and only six endemic species are known to occur in southern Asia. No modern subgeneric classification within the genus exists and species relationships are not clear. An anatomical survey of the leaf blade as viewed in transverse section has provided a unique set of 16 characters to test previous hypothesized relationships. A cladistic analysis utilizing these 16 characters was performed on all but three species of *Muhlenbergia*. Based on this analysis *Muhlenbergia* appears to be divisible into three major anatomical groups corresponding to two subgenera (*M.* subg. *Muhlenbergia*, and *Trichochloa*) and two sections (*M.* sect. *Epicampes* and *Podosemum*) in *M.* subg. *Trichochloa*. Even though the presence of sclerosed phloem is an important apomorphy in the evolution of species in *Muhlenbergia* subg. *Trichochloa*, it appears to have evolved twice since it occurs in four other species. Our study suggests that in *Muhlenbergia* subg. *Muhlenbergia* the C_4 photosynthesis, PCK subtype was a single evolutionary event since these species occur as a clade or an uninterrupted grade in our phylogenetic analysis.

RESUMEN

Muhlenbergia incluye 151 especies originarias principalmente del Nuevo Mundo; 133 especies son nativas de Norteamérica [aunque muchas de ellas llegan a distribuirse hasta Centro y Sudamérica (33 y 14 respectivamente)]; 38 especies habitan en Centroamérica (sola una especie es endémica); 25 especies se encuentran en Sudamérica (10 son endémicas); y solamente seis especies endémicas se distribuyen por el sur de Asia. No existe una clasificación subgenérica moderna del género y las relaciones entre las especies no son claras. Un reconocimiento anatómico de las hojas en sección transversal ha proporcionado un conjunto único de 16 caracteres para probar las relaciones hipotéticas previas. Se llevó a cabo un análisis cladístico utilizando estos 16 caracteres de todas (excepto tres) las especies de *Muhlenbergia*. En base a este análisis *Muhlenbergia* parece ser divisible en tres grandes grupos anatómicos correspondientes a dos subgéneros (*M.* subg. *Muhlenbergia* y *Trichochloa*) y dos secciones (*M.* sec. *Epicampes* y *Podosemum*) en *M.* subg. *Trichochloa*. Aún cuando la presencia de floema esclerosado es una apomorfía importante en la evolución de las especies de *Muhlenbergia* subgénero *Trichochloa*, parece que ha evolucionado dos veces ya que se presenta en cuatro especies. Nuestro estudio sugiere que dentro de *Muhlenbergia* el subtipo de fotosíntesis C_4 PCK en las especies del subgénero *Muhlenbergia* fué un evento evolutivo sencillo, ya que estas especies aparecen como un clado o un grado ininterrumpido en nuestro análisis filogenético.

SIDA 19(3): 469 – 506. 2001

The subtribe Muhlenbergiinae (Poaceae: Chloridoideae: Eragrostideae) was first circumscribed by Pilger (1956) to include only species of *Muhlenbergia* Schreb. with narrow single-flowered spikelets, firm glumes often shorter than the awned lemmas, and cylindrical caryopses. In this same treatment Pilger recognized *Epicampes* J. Presl [=*Muhlenbergia* subg. *Trichochloa* A. Gray, *M.* sect. *Epicampes* (J. Presl) Soderstr.] in subtribe Sporobolinae Ohwi. Pilger further divided *Muhlenbergia* into eight sections: *Acroxis* (Trin.) Bush, *Bealia* (Scribn.) Pilg., *Cinnastrum* (E. Fourn.) Pilg., *Clomena* (P. Beauv.) Pilg., *Muhlenbergia*, *Podosemum* (Desv.) Pilg., *Pseudosporobolus* Parodi, and *Stenocladium* (Trin.) Bush,. Subsequent authors have agreed that Pilger's infrageneric treatment of *Muhlenbergia* was not particularly phylogenetically informative (Soderstrom 1967; Pohl 1969; Morden 1985; Peterson and Annable 1991). More recently the following six genera have been shown to share common ancestry and have been placed in the Muhlenbergiinae: *Bealia* Scribn., *Blepharoneuron* Nash, *Chaboissaea* E. Fourn., *Lycurus* Kunth, *Muhlenbergia*, and *Pereilema* J. Presl (Duvall et al. 1994; Peterson 2000; Peterson et al. 1995, 1997).

Many agrostologists have erected segregate genera to emphasize critical features of the large and diverse genus, *Muhlenbergia*. Desvaux (1810) recognized the genus *Podosemum*, based on the caespitose, open-panicled, and long-awned *M. capillaris*. Palisot de Beauvois (1812) described the genus *Clomena* based on the annual *M. peruviana*, and Presl (1830) described *Epicampes* based on *M. robusta*. Two relatives of the type species of the genus (*M. schreberi*), *M. glomerata* and *M. andina*, were given generic status by Link (1833) as *Dactylogramma* and by Thurber (1863) as *Vaseya*, respectively. Nuttall (1848) described the genus *Calycodon* based on the widespread and often important range grass, *M. montana*. The only other generic name given to a species presently placed in *Muhlenbergia* is *Crypsinna*, described by Fournier (1886) and based on *M. macroura*. Hitchcock's (1935) transfer of many of these segregate genera to *Muhlenbergia* has been followed by most American and European botanists. The morphological characters that delimit the genus are spikelets with single perfect florets and hyaline or membranous lemmas with three usually prominent veins. These characters are not at all unique within the Eragrostideae and seem to be possessed by about half of the genera in the tribe.

The morphological diversity within *Muhlenbergia* is tremendous. Annuals less than 2 cm tall (*M. depauperata*, *M. minutissima*, *M. peruviana*, *M. ramulosa*) are not uncommon and there are numerous strongly caespitose perennials over 2 m tall (*M. gigantea*, *M. mutica*, *M. robusta*). Rhizomes and/or stolons are found in 1/4 of the species and there is a single species (*M. dumosa*) that has a growth form similar to bamboos. Leaf blades can be flat, involute, or folded with a variety of pubescence types located on the abaxial and/or adaxial surface. All species of *Muhlenbergia* have open or contracted (spike-like) panicles with the branches generally re-branched. At maturity or anthesis, the angle of the branches spreading from the culm axis and the total width of the inflorescence are diagnostic characteristics used to separate the species. Pedicel orientation can vary from appressed or spreading, to nodding and reflexed from the branches, and the pedicels can be either round or flattened in cross section. Most species of *Muhlenbergia* have single-flowered spikelets although there are two species that are occasionally 2 or 3-flowered (*M. asperifolia* and *M. uniflora*). The lemma is perhaps the most critical structure, and its features such as length, presence or absence of an awn or mucro, pubescence type and location, shape, and color can all be used to differentiate among the species. The single lemma is 3-veined (1-veined in *M. palmirensis*) with a stout central vein and two lateral veins, although the lateral veins are sometimes very hard to discern with a good (20X) dissecting microscope. The caryopsis has a fused pericarp and is usually free from both the lemma and palea in most species of Muhlenbergia, however the length, shape and to lesser extent color are highly variable.

At last tally, *Muhlenbergia* consisted of 151 species (Peterson 2000). The distribution of *Muhlenbergia* is almost entirely New World where 133 species are indigenous to North America [although many of these range to Central America (33) and South America (14)]; 38 species occur in Central America (a single species is endemic); 25 species occur in South America (10 are endemic); and only six endemic species are known to occur in southern Asia. One obvious hypothesis is that the genus arose where it is most diverse today, i.e., northern Mexico/southwestern U.S., and has since radiated. For a dispersal event, the longer the distance from the place of origin, would in theory, lessen the chance of a successful introduction. Therefore, there are many species of *Muhlenbergia* in North America, fewer in Central America, even fewer in South America, and finally very few in Asia. So far, all ten species in the subtribe Muhlenbergiinae that have been investigated genetically (Peterson and Herrera A. 1995; Peterson and Morrone 1998; Peterson and Ortíz-Diaz 1998; Peterson et al. 1993; Sykes et al. 1997) exhibit a north to south migration pattern, including *Muhlenbergia torreyi* (Peterson and Ortíz-Diaz 1998).

All species of *Muhlenbergia* previously examined exhibit kranz (C_4) leaf anatomy, particularly the parenchyma sheath subtype which is common in species occupying the most arid regions (Brown 1977; Hattersley 1984; Hattersley and Watson 1992). Two main subtypes, NAD-ME (nicotinamide adenine dinucleotide co-factor malic enzyme) and PCK (phosphoenolpyruvate carboxykinase) have been found, verified by biochemical assay, to occur within *Muhlenbergia* (Gutierrez et al. 1974; Hattersley and Browning 1981; Brown 1977; Hattersley and Watson 1976, 1992). These two biochemical subtypes differ in their predominant C_4 acid that is transported from primary carbon assimilation tissue (usually the mesophyll) to the photosynthetic carbon reduction (PCR) tissue (kranz sheath = parenchyma bundle sheath) [see Hattersley and Watson 1992]. There usually is an associated anatomical structure in PCK-like species that is diagnostic, such as, a looser arrangement of chlorenchyma tissue continuous between adjacent vascular bundles. In typical NAD-ME species the chlorenchyma is tightly radiate and usually separated from one vascular bundle to the next by a column of colorless cells. These differences have historically been used to separate these two subtypes; however, it has been shown in *Enneapogon* Desv. ex P. Beauv., *Eragrostis* Wolf, *Eriachne* R. Br., *Panicum* L., *Pheidochloa* S. T. Blake, *Triodia* R. Br., and *Triraphis* R. Br. that these anatomically PCK-like genera are actually biochemically NAD-ME (Ohsugi et al. 1982; Prendergast et al. 1986, 1987).

The first major anatomical investigation of *Muhlenbergia* was done by Holm (1901) who looked at 10 species and was able discern three groups: woodland types (= *M.* subg. *Muhlenbergia*); dry, rocky mountain slopes [= *M.* subg. *Trichochloa*, sect. *Epicampes* and other species]; and *M. filipes* (= *M.* subg. *Trichochloa*, sect. *Podosemum*). Holm (1901) pointed out that from an anatomical view-point these characteristics might prove useful in dividing *Muhlenbergia* into sections or subgenera.

Schwabe (1948) later investigated 22 species of *Muhlenbergia* that occur in South America and found that they correspond to four major groups: hygrophytes or mesic species (= *M.* subg. *Muhlenbergia*), xerophytic annuals one, xerophytic annuals two (= *M.* subg. *Muhlenbergia*), xerophytic perennials, and psammophytic perennials (= *M.* subg. *Trichochloa*, sect. *Podosemum*). Schwabe (1948) also suggested that *Muhlenbergia* should be separated from the genera of Agrostideae and incorporated into the Eragrosteae.

On the basis of leaf blade transectional anatomy and morphology Soderstrom (1967) distinguished two subgenera in *Muhlenbergia*, *Muhlenbergia* and *Podosemum* (= *Trichochloa*, an older name), and divided *M.* subg. *Trichlochloa* into two sections, sect. *Podosemum* and sect. *Epicampes*. Soderstrom placed 46 species of *Muhlenbergia*, which have partially sclerosed phloem and caps of sclerenchyma associated with the primary vascular bundles, into *M.* subg. *Trichochloa*. *Muhlenbergia* sect. *Epicampes* was characterized as having a compound keel (midvein) composed of primary and secondary vascular bundles sunken in a confluent mass of thick-walled parenchyma, whereas *M.* sect. *Podosemum* had a simple midvein composed of a single primary vascular bundle with additional tertiary vascular bundles present (Soderstom 1967).

Two years later Pohl (1969) completed a revision of 12 closely related species that he believed to represent the entire *M.* subg. *Muhlenbergia* in North America. Principal differences among the species in this study were size of the bulliform cells, size and degree of radial orientation of the chlorenchyma, and the extent to which the chlorenchyma was organized into discrete units surrounding each vascular bundle. Using morphological characteristics of the rhizome (possession of very short internodes with imbricate scales) and leaf blade (thin, flat blades with low length/width ratios), Pohl distinguished these species from others in the genus. However, these same characteristics are seen in *M. californica*, a species of the mountains and valleys of southern California, and many other species common to the southwestern United States/Mexico.

Morden and Hatch (1987, 1996) investigated the anatomical and morphological variation within the *M. repens* complex, which consists of six species in North and South America. Anatomical data supported the placement of *M. squarrosa* (Trin.) Rydb. as a synonym of *M. richardsonis*, and supported the recognition of two varieties of *M. villiflora*.

Peterson et al. (1989) and Peterson and Annable (1991) investigated 29 annual species of *Muhlenbergia* and found 14 characters useful in distinguishing four major species groups. Species of group (1) had flat blades, two tertiary vascular bundles between primary vascular bundles, vascular bundles positioned on the median layer, distinctly radiate and compact chlorenchyma cells separating adjacent vascular bundles, and fan-shaped central bulliform cells. Species of groups (2, 3 & 4) shared three characteristics: 1) indistinctly or incompletely radiate and loosely arranged chlorenchyma cells, 2) chlorenchyma cells continuous between vascular bundles, and 3) shield-shaped central bulliform cells (= *M.* subg. *Muhlenbergia*).

More recently a biosystematic study investigating the anatomy of the *M. montana* complex (consisting of 15 species) has been completed (Herrera-Arrieta 1998; Herrera-Arrieta and Grant 1994). Herrera-Arrieta and Grant used 18 characters to differentiate among these species and found four major species groups. Important characters appear to be the central midrib structure (similar in size to the other primary vascular bundles or presence of a prominent central midvein), the depth of the adaxial and abaxial furrows, sclerenchymatous girder development between the parenchyma bundle sheath and the epidermis, and epidermal vestiture (glabrous or papillose).

Leaf anatomical characters within the Poaceae as viewed in transverse section have long been recognized as important diagnostic features used to determine systematic relationships, and have been critical in elucidating infrageneric relationships within *Muhlenbergia* (Herrera-Arrieta and Grant 1993; Holm 1901; Morden and Hatch 1987; Peterson 2000; Peterson and Annable 1991; Peterson et al. 1989; Pohl 1969; Soderstrom 1967). A preliminary summary of our anatomical analysis is presented in Peterson (2000) where two subgenera, *M.* subg. *Muhlenbergia* and subg. *Trichochloa*, and a possible third group, '*Clomena*' are recognized. In this current paper we will give a detailed summary of the anatomical features as viewed in cross section of 148 of the possible 151 species within *Muhlenbergia* and present a subgeneric hypothesis that most closely reflects a cladistic analysis of the data. This is the first anatomical survey of nearly all species within this large variable genus.

MATERIALS AND METHODS

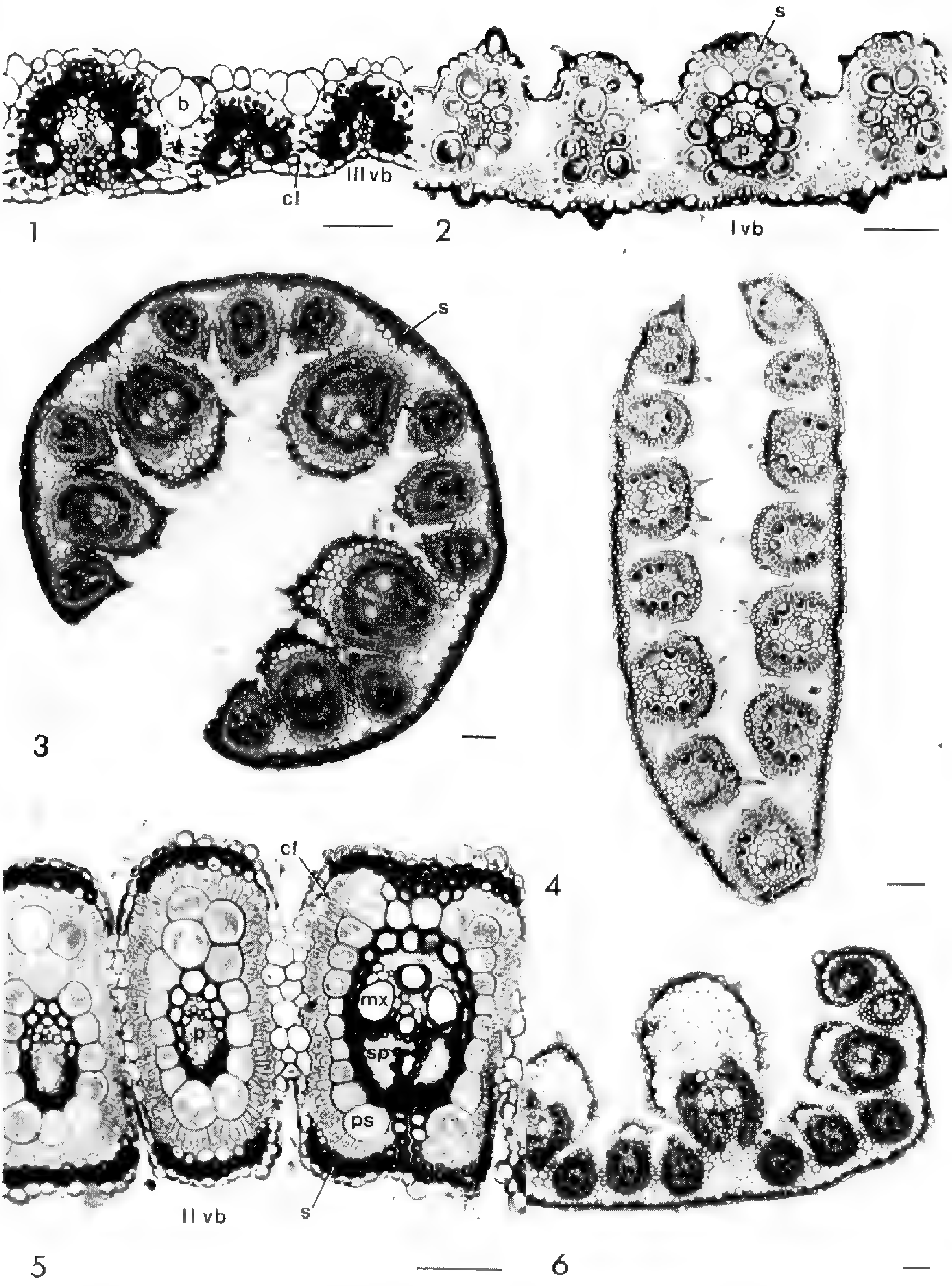
Over the last 16 years fresh field-collected leaf blades were obtained from North, Central, and South America, as well as China for anatomical study (Appendix 1). Five mm long leaf blade segments from the central third of the mid-culm region were fixed in FAA (10 parts EtOH; 1 part glacial acetic acid; 2 parts 37% formaldehyde; 7 parts distilled water). A few species (less than 5%) were studied from dried herbarium specimens because fresh field collected material was unavailable. Leaf blades were first desilicified in 100% hydrofluoric acid (HF) for 48 hours in order to ease microtomy, then dehydrated using 30, 50, 70, 90, 95, and 100% (twice) ethanol, graded into xylene (twice) and transferred to xylene: paraffin oil (1:1, steps 1 hour minimum). Blades were then dehydrated by using 2-2 dimethoxypropane (DMP), acetone, and tertiary butyl alcohol (TBA) series while in a vacuum. Infiltration was accomplished using two, six hour minimum changes of liquid paraffin before being embedded. The tissue was softened using 95% EtOH: Glycerin: HF (8:1:1) to improve slicing (Foster and Gifford 1947). A standard rotary microtome set at 6-10 :m thickness was used and sections were stained with safranin/fast green or 0.05% toluidine blue (Berlyn and Miksche 1976). Samples were examined and photographed on an Olympus BH-2 photomicroscope using Kodak TMAX black and white or Ektachrome color slide film.

Anatomical descriptions were completed following the procedure for standardizing comparative leaf anatomy in grasses as outlined by Ellis (1976). For purposes of comparison and standardization, primary vascular bundles (I°) are defined as containing large metaxylem elements on either side of the protoxylem elements with additional lysigenous cavities, and are usually associated with sclerenchyma girders or strands (Ellis 1976; Peterson et al. 1989). Secondary vascular bundles (II°) resemble 1° vascular bundles by having distinguishable xylem and phloem but lack large metaxylem elements and lysigenous cavitities. Tertiary vascular bundles (III°) contain indistinguishable xylem and phloem areas and are usually smaller than the I° and II° vascular bundles.

A list of the anatomical characters and their states used in all ensuing analyses appears in Table 1; a list of specimens used in this study is given in Appendix 1; and a complete data set is given in Appendix 2. The 153 taxon by 16 character data set was analyzed with WinClad2000. Parsimony heuristic analysis was performed with NONA (Goloboff 1998; Nixon 1999). We used 10 random taxon order replications in NONA, with TBR swapping holding 20 trees, followed by TBR swapping (to completion) holding up to 200 trees. A hard collapse of all unsupported nodes was selected to produce the cladogram in Figure 17. Since we were not testing for monophyly of the genus, the outgroup species were constrained, i.e., there were no synapomorphies supporting the *Muhlenbergia* clade.

TABLE 1. List of anatomical characters used in the cladistic analyses, their states, and comments.

1. **Adaxial furrow depth:** 1 = <1/5 blade thickness; 2 = 1/5-2/5 blade thickness; 3 = 1/2 or more than blade average thickness.
2. **Primary vascular bundle shape:** 1 = rounded; 2 = obovate/elliptic; 4 = rectangular. The overall outline is used to determine the shape. This includes the chlorenchyma and epidermis surrounding each vascular bundle.
3. **Vascular bundle outline size:** 1 = equal, primary vascular bundles about the same size as secondary and tertiary vascular bundles; 2 = subequal, secondary and tertiary vascular bundles 4/5 the size of primary vascular bundles; 3 = unequal, secondary and tertiary vascular bundles <2/3 the size of primary vascular bundles.
4. **Median (keel) vascular bundle structure:** 1 = simple keel, with only a single primary vascular bundle; 2 = compound keel, a single primary vascular bundle with only two additional tertiary vascular bundles; 3 = complex compound keel, with three or more additional primary, secondary, and/or tertiary vascular bundles. In state 1 there are no associated parenchyma cells, whereas state 2 and 3 have parenchyma cells involved in forming the compound keel.
5. **Vascular bundle position:** 1 = one level, centered at same level from adaxial to abaxial surface; 2 = two or three levels, usually closer to the abaxial surface.
6. **Vascular bundle composition:** 1 = with primary and secondary vascular bundles; 2 = with primary and tertiary vascular bundles; 3 = with primary, secondary, and tertiary vascular bundles. A primary vascular bundle (I°) contains two or more large metaxylem elements on either side of the protoxylem elements with additional lysigenous cavities and has distinguishable xylem and phloem. A secondary vascular bundle (II°) resembles a I° vascular bundle by having distinguishable xylem and phloem but lacks large metaxylem elements and lysigenous cavities. A tertiary vascular bundle (III°) contains indistinguishable xylem and phloem areas and is usually smaller than a I° and/or II° vascular bundle.
7. **Chlorenchyma arrangement:** 1 = radiate, compact; 2 = loosely arranged. State 1 corresponds with C_4 NAD-ME species where the chlorenchyma is not contiguous between each adjacent vascular bundle. State 2 corresponds with C_4 PCK species where the chlorenchyma is contiguous between each adjacent vascular bundle.
8. **Crown of inflated cells (adaxial) in primary vascular bundles:** 1 = absent; 2 = present. The inflated areas are usually composed of parenchyma or collenchyma cells. In addition there may be sclerenchyma cells.
9. **Central bulliform cells shape:** 1 = circular- or irregular-shaped; 2 = almost fan-shaped to shield-shaped. State 2 is found when the bulliform cells do not form a complete column from the adaxial to the abaxial surface. In state 1 there is a column (contiguous between the adaxial and abaxial surface) of bulliform/colorless cells separating each adjacent vascular bundle.
10. **Number of secondary and/or tertiary vascular bundles between consecutive primary vascular bundles:** 1 = 1-3; 2 = 4 or more.
11. **Median vascular bundle structure:** 1 = not differentiated from other primary vascular bundles; 2 = differentiated from other primary vascular bundles.
12. **Median vascular bundle (abaxial) projection:** 1 = flattened, not enlarged; 2 = enlarged, bulbous with many strands of sclerenchyma.
13. **Sclerosed phloem in primary vascular bundles:** 1 = absent; 2 = present. State 2 is characterized by strands of sclerenchyma cells that divides the phloem.
14. **Sclerenchyma (adaxial) development in primary vascular bundles:** 1 = absent to a few fibers; 2 = one or two layers; 3 = three or more layers.
15. **Sclerenchyma (abaxial) development in the primary vascular bundles:** 1 = one or more layers, continuous along the width of the blade; 2 = one or more layers, discontinuous, only present below the vascular bundles; 3 = absent to a few fibers.
16. **Inflated cells (abaxial) in primary vascular bundles:** 1 = present; 2 = absent. The inflated areas are usually composed of parenchyma or collenchyma cells. In addition there may be sclerenchyma cells. This character is similar to number 8 but found on the abaxial surface.



Figs. 1–6. Leaf blade anatomy of *Muhlenbergia*, adaxial surface uppermost in all photographs, except in 3 where the blade is involute. **1.** *M. ciliata* with shallow adaxial furrows (<1/5 leaf thickness), shallow abaxial grooves opposite the vascular bundles, loosely arranged chlorenchyma, only primary and tertiary vascular bundles present, and shield-shaped bulliform cells. **2.** *M. pauciflora* showing a flat lamina, medium adaxial furrows (1/5 – 1/3 leaf thickness), rounded primary vascular bundle shape, adaxial ribs opposite all vascular bundles, conic abaxial girder of sclerenchyma between each vascular bundle, vascular bundles centered in one level, unsclerosed phloem, sclerenchyma of only a few abaxial

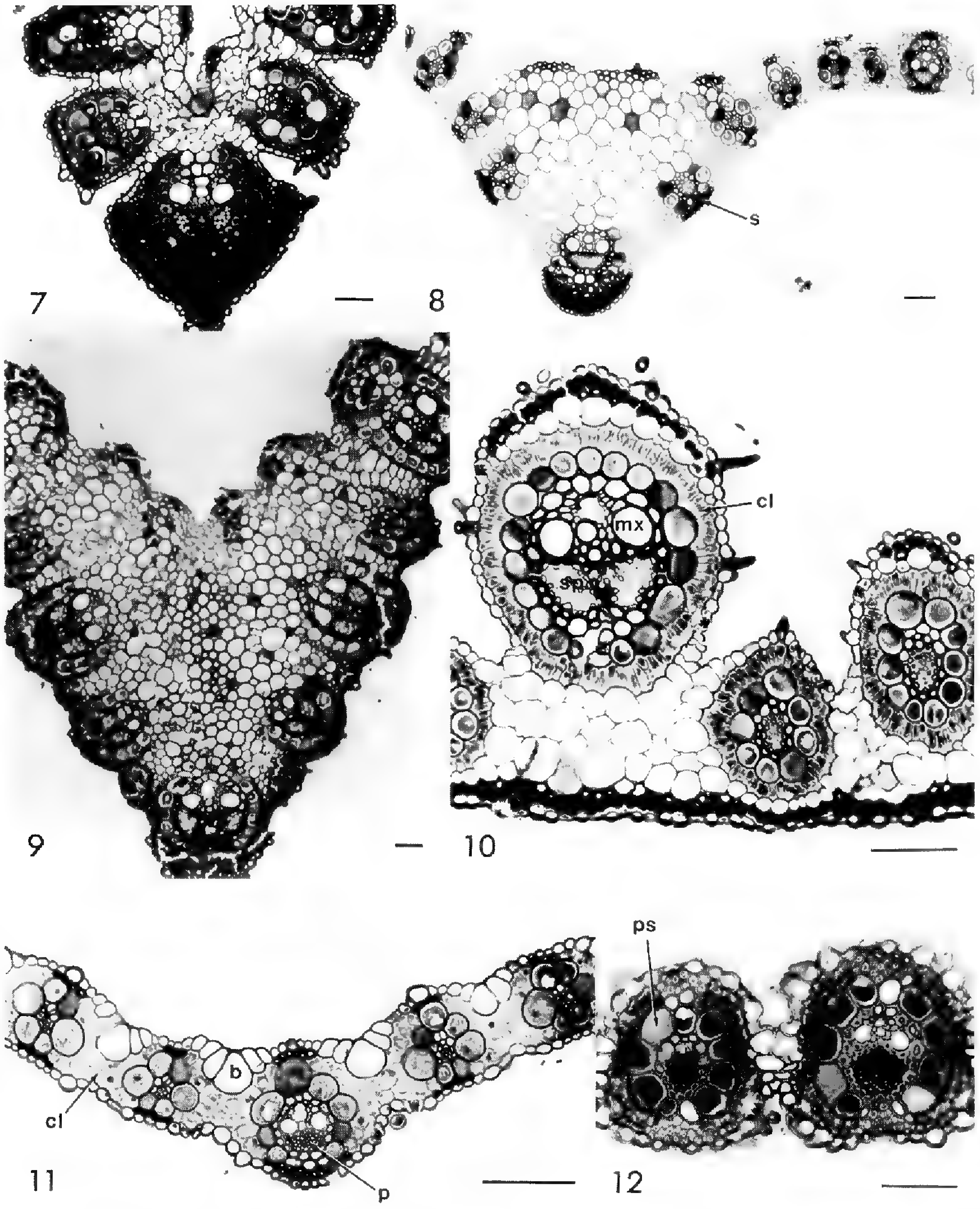
All autapomorphies were not included in the final cladogram because they add no additional information for inferring relationships among two or more taxa.

RESULTS AND DISCUSSION

The results and discussion are interpreted in two parts: 1) a general description combining all species of *Muhlenbergia*, and 2) results of the cladistic analysis.

General Description of Leaf Structure.—Lamina (blades) are sometimes undulating, to more commonly flat, outwardly bowed, less commonly involute (Fig. 3), or folded (Fig. 4.). The angle formed by the two arms is broadly V or U shaped to expanded, occasionally loosely involute. Adaxial furrow depth in comparison to the leaf thickness can be slight, shallow (< 1/5 leaf thickness, Figs. 1, 11, 16), medium (1/5 to 1/3 leaf thickness, Figs. 2, 13), or deep (1/2 leaf thickness, Figs. 3, 10), and in the form of clefts located between all vascular bundles. Adaxial ribs are commonly present opposite all vascular bundles (Fig. 2), the same size to generally smaller than abaxial ribs, to less frequently absent with shallow groves opposite the vascular bundles (Fig. 1). Primary vascular bundle shape varies from rounded (Figs. 2, 4), to obovate/elliptic (Figs. 3, 6, 10) or rectangular (Figs. 5, 13, 14); secondary and tertiary vascular bundles also exhibit the same variation in shape. The secondary and tertiary vascular bundles are generally of the same size as the primary vascular bundles (Fig. 4), to about 4/5 the size of the primary vascular bundles (Fig. 5), or very unequal, less that 2/3 the size of the primary vascular bundles (Fig. 6). Abaxial projection of the median vascular bundle or midrib caused by sclerenchyma is sometimes large and with a protruding ridge (Fig. 7), to inconspicuous, often flat to round (Fig. 4).

and adaxial fibers, and intercostal sclerenchyma. **3.** *M. dubia* with an involute lamina, deep adaxial furrows (1/2 or more than blade thickness), obovate/elliptic vascular bundle shape, adaxial crown of inflated cells, abaxial inflated cells, simple keel with only a single primary vascular bundle, tertiary and secondary vascular bundles <2/3 the size of the primary bundles, with secondary and tertiary vascular bundles positioned closer to the abaxial surface, 15 total vascular bundles per blade, one to three secondary and tertiary vascular bundles between each primary bundle, one or two layers of continuous abaxial sclerenchyma, and a sclerenchyma cap along the blade margins. **4.** *M. brevivaginata* with primary and tertiary vascular bundles about the same size, a simple keel, rounded vascular bundles, an undifferentiated median vascular bundle, centered vascular bundles, and 13 vascular bundles per blade. **5.** *M. pubigluma* with secondary and tertiary vascular bundles that are about 4/5 the width of the primary bundles, two secondary or tertiary vascular bundles between each primary bundle, rectangular vascular bundle shape, centered vascular bundles, tightly radiate chlorenchyma, a column of colorless cells separating each vascular bundle, sclerosed phloem, parenchyma bundle sheath extensions, one or two layers of adaxial sclerenchyma development in the primary bundles, and discontinuous abaxial sclerenchyma development in the primary bundles. **6.** *M. nigra* showing obovate/elliptic vascular bundle shape, tertiary and secondary vascular bundles that are <2/3 the length and width of the primary vascular bundles, tightly radiate chlorenchyma, an adaxial crown of inflated cells, abaxial inflated cells, and secondary and tertiary vascular bundles positioned closer to the abaxial surface. Scale bars = 50 µm; symbols as follows: b = bulliform cell; cl = chlorenchyma, I vb = primary vascular bundle; II vb = secondary vascular bundle; III vb = tertiary vascular bundle; mx = metaxylem; p = phloem; ps = parenchyma bundle sheath; s = sclerenchyma; sp =sclerosed phloem.



Figs. 7–12. Leaf blade anatomy of *Muhlenbergia*, adaxial surface uppermost in all photographs. **7.** *M. lehmanniana* with an abaxial projecting midrib of sclerenchyma, with only primary and secondary vascular bundles present, medium vascular bundle differentiated from other primary vascular bundles composed of a complex compound keel with three or more primary and secondary vascular bundles, and abaxial sclerenchyma of two to four discontinuous layers. **8.** *M. japonica* with an abaxial enlarged and bulbous projection of the median vascular bundle, a complex compound keel consisting of a primary vascular bundle and two tertiary vascular bundles with associated parenchyma, with only primary and tertiary vascular bundles, loosely arranged chlorenchyma, and five tertiary vascular bundles between each primary. **9.** *M. gigantea* with a complex compound keel consisting of three or more primary, secondary, and/or tertiary vascular bundles with associated parenchyma, tightly radiate chlorenchyma, and sclerosed phloem. **10.** *M. rigida* showing a primary, tertiary, and secondary vascular bundle (left to right), vascular bundles at three different levels, tightly

The median vascular bundle or midrib is a simple keel (Fig. 4) consisting of a single vascular bundle without associated parenchyma, a compound keel (Fig. 8) consisting of one primary and two secondary or tertiary vascular bundles with associated parenchyma, or a complex compound keel (Fig. 9) consisting of three or more primary, secondary, and/or tertiary vascular bundles with associated parenchyma. All vascular bundles are commonly situated with their position in the median layer of the blade, at the same distance from the adaxial and abaxial leaf surface (Figs. 2, 4, 5, 11, 13), or are occasionally closer to the adaxial surface (Figs. 3, 6, 10) at two or three levels. Vascular bundle composition consists of primary and secondary only in the same blade (Fig. 7), only primary and tertiary in the same blade (Figs. 1, 8, 11). The presence of primary, secondary, and tertiary vascular bundles combined in one blade is not as common (Figs. 3, 6, 10). The total number of primary vascular bundles varies from 5 to 15 (four in *M. fastigiata*, nine in *M. pauciflora*, 15 in *M. gigantea*). Secondary and/or tertiary vascular bundles are arranged in a regular fashion between consecutive primary vascular bundles, and the number varies between 1–3 (Figs. 3, 4, 6), or 4–8 (Fig. 8).

The chlorenchyma tissue consists of two major types (arrangements). It can be composed of a single radiate layer of tightly packed tabular cells that surround each vascular bundle [NAD-ME, centripetally positioned photosynthetic carbon reduction (PCR) cell chloroplasts, XyMS+ and PCR cell outlines that are even in transverse section; see Hattersley and Watson 1992] and is separated by uni-, bi- or tri-serial columns of colorless/bulliform cells (Figs. 3–6, 9, 10, 12–15). Or it can be composed of tabular cells that are indistinctly radiate and continuous between the bundles [PCK type, defined as centrifugal/evenly distributed PCR cell chloroplasts (with grana), XyMS+ and presence of PCR cell wall suberized lamella, in Hattersley and Watson's (1992) sense] (Figs. 1, 11, 16). Colorless cells (Figs. 5, 12, 13) are smaller or similar in size and shape to bulliform cells and are often inflated. A crown of inflated cells is sometimes present over the primary vascular bundles on the adaxial surface and these inflated cells can be found over the secondary vascular bundles as well (Figs. 3, 6, 7, 10, 14). Inflated cells sometimes can be found separating the primary vascular bundles from the epidermis on the abaxial surface (Figs 3, 6, 10). Strips of

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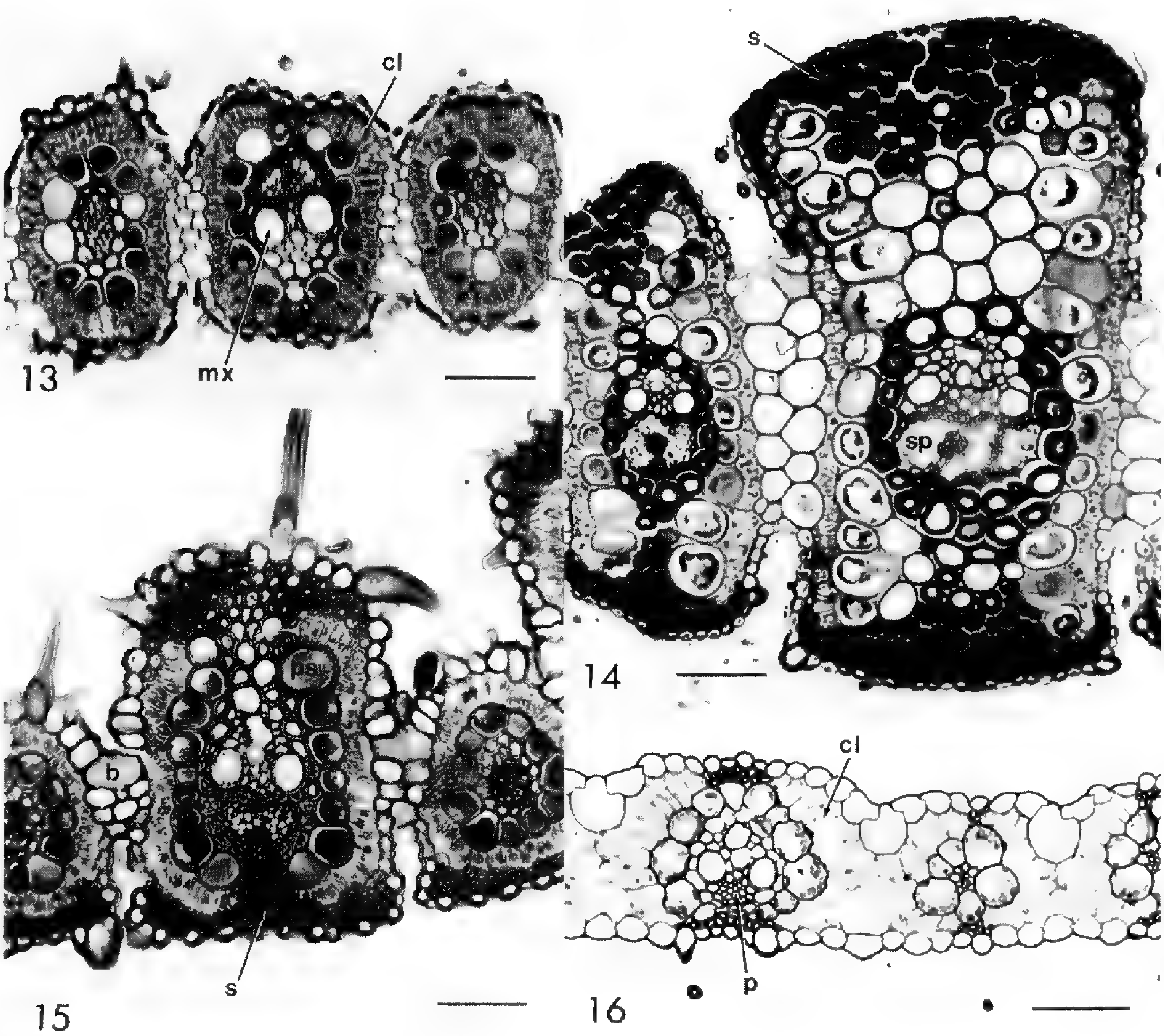
radiate chlorenchyma, obovate/elliptic vascular bundle shape, deep adaxial furrows 1/2 or more than the blade thickness, sclerosed phloem, continuous abaxial sclerenchyma, an adaxial crown of inflated cells, abaxial inflated cells, and three or more layers of adaxial sclerenchyma in the primary vascular bundles. 11. ***M. schreberi*** **with 4 – 11 primary vascular bundles between each tertiary vascular bundle, shallow adaxial furrows, centered vascular bundles, loosely arranged chlorenchyma, shield-shaped bulliform cells, and a single layer of adaxial and abaxial (discontinuous) sclerenchyma development in the vascular bundles. 12.** ***M. asperifolia*** **with radiate chlorenchyma, unsclerosed phloem, and a column of colorless cells separting the two vascular bundles. Scale bars = 50 μm; symbols as follows: b = bulliform cell; cl = chlorenchyma, mx = metaxylem; p = phloem; ps = parenchyma bundle sheath; s = sclerenchyma; sp = sclerosed phloem.**



Figs. 13–16. Leaf blade anatomy of *Muhlenbergia*, adaxial surface uppermost in all photographs. **13.** *M. lindheimeri* with adaxial furrows 1/5 – 1/3 the blade thickness, rectangular vascular bundle shape, centered vascular bundles, non-sclerosed phloem, tightly radiate chlorenchyma, a column of colorless cells separating each vascular bundle, three or more layers of adaxial sclerenchyma, and one or more layers of discontinuous abaxial sclerenchyma. **14.** *M. expansa* with rectangular vascular bundles, sclerosed phloem, tightly radiate chlorenchyma, an adaxial crown of inflated cells in the primary vascular bundle, abaxial and adaxial interrupted parenchyma bundle sheath, abaxial girder of sclerenchyma fibers, circular shaped bulliform cells, three or more layers of adaxial sclerenchyma, and many layers of discontinuous abaxial sclerenchyma. **15.** *M. curvula* with non-sclerosed phloem, tightly radiate chlorenchyma, abaxial and adaxial interrupted parenchyma bundle sheath, abaxial girder of sclerenchyma fibers, three or more layers of adaxial sclerenchyma, many discontinuous layers of abaxial sclerenchyma. **16.** *M. microsperma* shallow adaxial furrows, with loosely arranged chlorenchyma, shield-shaped central bulliform cells, and a few adaxial and abaxial sclerenchyma fibers in the primary bundles. Scale bars = 50 μm; symbols as follows: b = bulliform cell; cl = chlorenchyma, mx = metaxylem; p = phloem; ps = parenchyma bundle sheath; s = sclerenchyma cells; sp =sclerosed phloem.

well-defined and regular bulliform cells are present in the epidermis and are distinct from normal epidermal cells. Bulliform cells can be closely associated with the colorless cells. Bulliform and colorless cells together form the uni-, bi-, or tri-seriate columns which extend from the adaxial furrow to the abaxial epidermis separating the vascular bundles (Figs. 5, 12, 13), or the columns do not extend to the abaxial surface (Fig. 2). The central bulliform cell can be circular to fan-shaped (Fig. 14) or narrower than deep, shield-shaped (Figs. 1, 11, 16). Outer tangential epidermal cell walls are unthickened to slightly thickened, with cells of similar size. Macrohairs have a sunken, nonconstricted base and are embedded between bulliform and/or colorless cells.

The phloem of the primary vascular bundles can be homogeneous or unsclerosed (Figs. 2, 12, 14) or interrupted with sclerenchyma or sclerosed (Figs. 5, 10, 14) where it adjoins the mestome sheath. Two enlarged metaxylem vessels are present adjacent to the phloem and one or two other enlarged protoxylem vessels are located adaxially to the phloem (Figs. 2, 5, 10, 13). Metaxylem vessels are small, not wider than the parenchyma sheath cells, slightly thickened, and circular in outline. A mestome sheath surrounds the xylem and phloem. The mestome cells are small with uniformly thickened walls in all bundles (Figs. 2, 5, 10, 13, 14).

Bundle sheaths in the primary vascular bundles sometimes include extensions (Fig. 5) and are entire (form a complete circle) to adaxially interrupted, or adaxially and abaxially interrupted (Figs. 14, 15) by a broad girder of a few to many sclerenchyma fibers (Figs. 14, 15), or colorless inflated cells (Fig. 14). Secondary and tertiary vascular bundle parenchyma sheaths are mostly entire, not interrupted, to abaxially interrupted in some species. The median vascular bundle parenchyma sheath is mostly abaxially interrupted, to interrupted on both sides, or less frequently not interrupted. Commonly 6–21 cells form the parenchyma sheath of primary vascular bundles (Figs. 2, 5, 10–12, 15, 16), with up to 24 cells found in some species (Fig. 14), while 3–14 cells commonly comprise parenchyma bundle sheaths of secondary (Figs. 5, 10) and tertiary (Figs. 1, 11, 16) vascular bundles.

Adaxial and abaxial sclerenchyma development is extremely variable, from a few fibers (Fig. 1) to 1–3 layers or strands (Figs. 5, 10, 14). In a few species a continuous layer of sclerenchyma can form beneath the epidermis on the adaxial or more commonly abaxial surface (Figs. 3, 4, 6, 10). Sclerenchyma is usually present along the margins of the blades forming a "cap" that may be rounded or pointed (Figs. 3, 4). This sclerenchyma cap adjoins normal mesophyll cells. Sclerenchyma is usually absent between each vascular bundle where there are no continuous sclerenchyma layers. However, a few species, *M. pauciflora* (Fig. 2) and M. *seatonii*, form a conic abaxial girder of intercostal sclerenchyma. An abaxial projection of midrib caused by sclerenchyma is sometimes enlarged and bulbous (Figs. 7, 8).

Cladistics.—For the overall analysis of 148 species (plus two infraspecific taxa) of *Muhlenbergia* and four outgroup species representing four genera (*Eragrostis acutiflora*, *Erioneuron avenaceum*, *Leptochloa virgata*, and

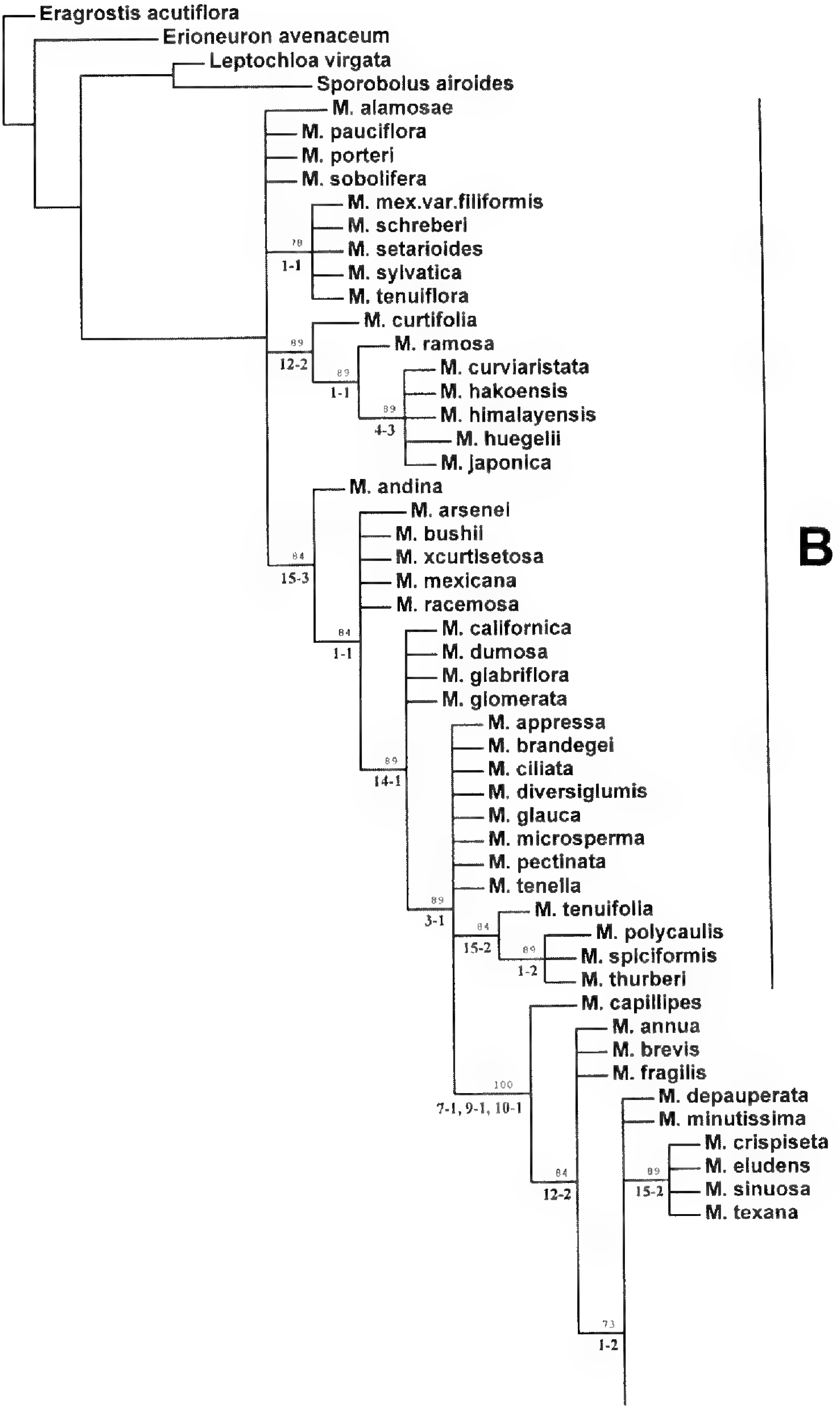
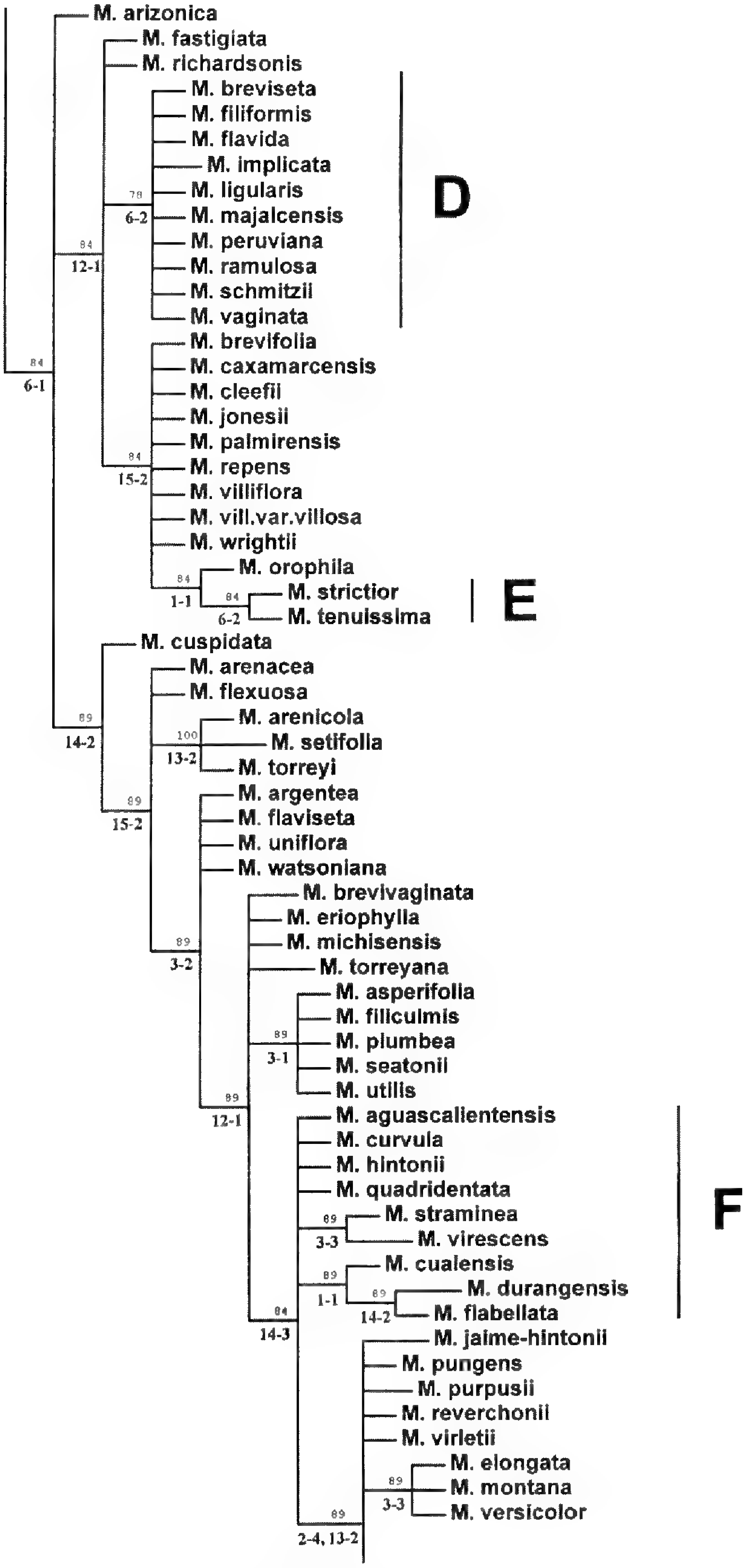


Fig. 17. One of 20 equally parsimonious trees (length = 97 steps, CI = 0.30; RI = 0.89) analyzing 148 species of *Muhlenbergia* with *Eragrostis acutiflora*, *Erioneuron avenaceum*, *Leptochloa virgata*, and *Sporobolus airoides* used as



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outgroups. Numbers above a branch are bootstrap values and numbers below indicate the character followed by the state. Groups A-F are discussed in the text.

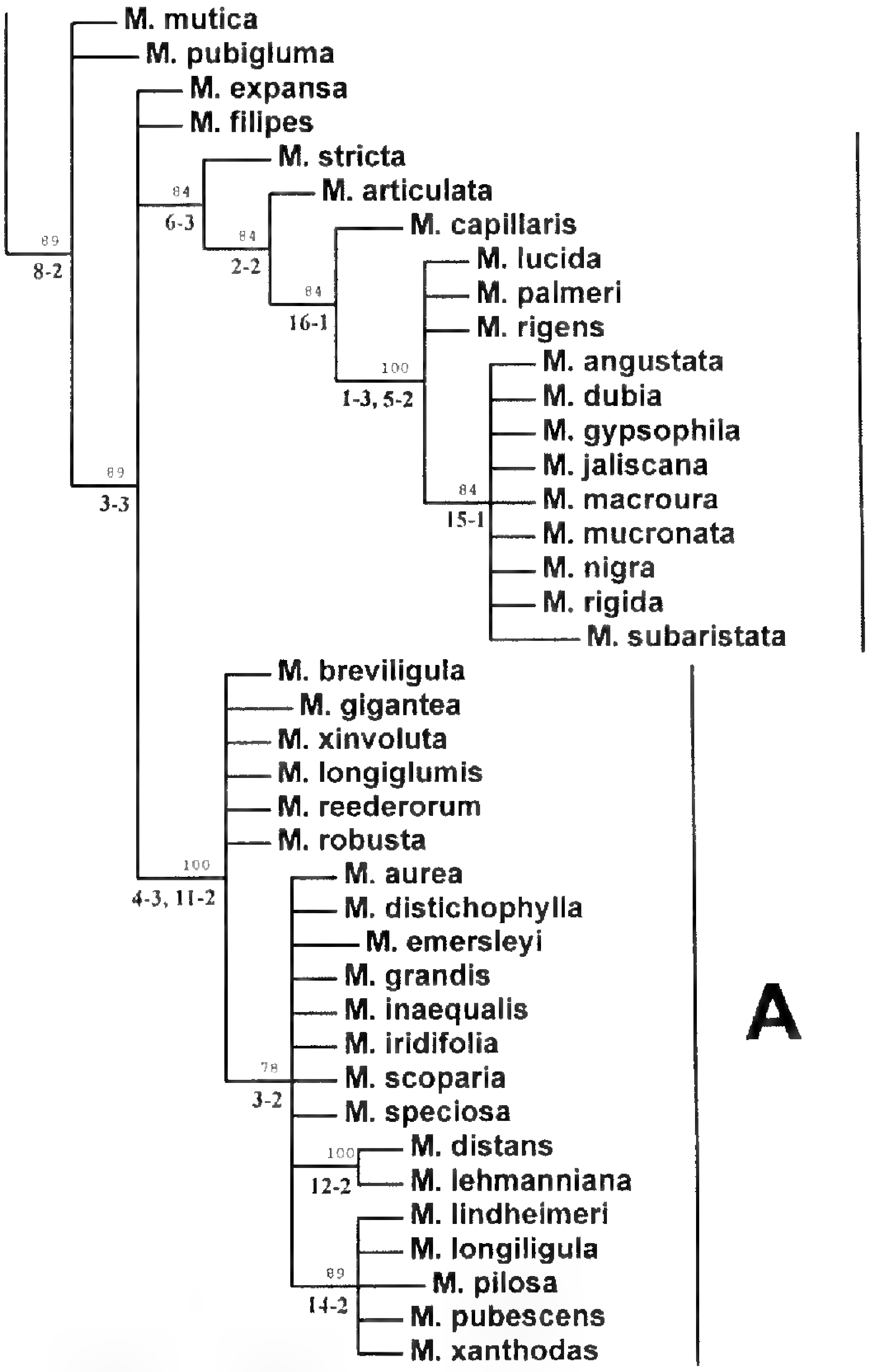

Fig. 17 Continued

Sporobolus airoides) were used simultaneously and in all possible combinations. All possible combinations were obtained by changing the order of each outgroup listed in the data set and sequentially eliminating one, two or three of the outgroups. These 200 trees from the single overall analysis are 97 to 99 steps long, with a consistency index (CI) of 0.30 and a retention index (RI) of 0.89. Twenty of these 200 trees were only 97 steps long and therefore one of these was randomly selected for illustration (Fig. 17). As indicated in the methods, there were no synapomorphies supporting monophyly of the *Muhlenbergia* clade, therefore the outgroup species were constrained. These 16 anatomical characters are not, by themselves robust enough to test for monophyly within the genera of Muhlenbergiinae, Eragrostideae, or the entire Chloridoideae.

There is little resolution in the strict consensus tree for the overall analysis (using the 200 trees). However, the strict consensus tree separates a clade (Fig. 17A) containing *M. aurea, M. breviligula, M. distans, M. distichophylla, M. emersleyi, M. gigantea, M. grandis, M. inaequalis, M. x involuta, M. iridifolia, M. lehmanniana, M. lindheimeri, M. longiglumis, M. longiligula, M. pilosa, M. pubescens, M. reederorum, M. robusta, M. scoparia, M. speciosa,* and *M. xanthodas* (bootstrap value of 100%); a clade (when rooted with *Erioneuron avenaceum* in a separate analysis at 0.28 CI and 0.88 RI) or a grade (B), when rooted with *Eragrostis acutiflora* in a separate analysis) containing the following 37 species: *M. alamosae, M. andina, M. appressa, M. arsenei, M. brandegei, M. bushii, M. californica, M. ciliata, M. curtifolia, M. x curtisetosa, M. curviaristata, M. diversiglumis, M. dumosa, M. glabriflora, M. glauca, M. glomerata, M. hakoensis, M. himalayensis, M. huegelii, M. japonica, M. mexicana* var. *mexicana, M. mexicana* var. *filiformis, M. microsperma, M. pauciflora, M. pectinata, M. polycaulis, M. porteri, M. racemosa, M. ramosa, M. schreberi, M. setarioides, M. sobolifera, M. spiciformis, M. sylvatica, M. tenella, M. tenuiflora, M. tenuifolia,* and *M. thurberi* (bootstrap value of 100%); and a grade of all other species in the genus. The former group of 21 species all appear to be members of *M.* subg. *Trichochloa,* sect. *Epicampes* (Soderstrom 1967; Peterson 2000). Two apomorphies support a clade (Fig. 17, clade A): complex compound keels with three or more additional primary, secondary and/or tertiary vascular bundles [character 4(3)] and median vascular bundles that are differentiated from other primary vascular bundles [character 11(2)]. However, complex compound keels [character 4(3)] appear in five additional species in two clades. One of these clades, containing *M. curviaristata, M. hakoensis, M. himalayensis,* and *M. japonica,* is composed only of species endemic to southeast Asia.

We must point out that *M. mexicana* var. *mexicana* and *M. mexicana* var. *filiformis* occur in two separate clades (Fig. 17, grade A). Both species have identical scores for the data set. However, abaxial sclerenchyma development (character 15) is ambiguously scored as having one or more layers (state 2) or three or more layers (state 3) for each of these taxa. I am not completely familiar with the algorithm used in WinClad2000 but it appears that it selects either state 2 or 3 when reading ambiguous character scores. That would account for the inclusion of *M. mexicana* var. *filiformis* after the node supported by character 15(3), whereas *M. mexicana* var. *mexicana* was selected as 15(2). This is just one of the 20 shortest trees and most of the other trees include both varieties of *M. mexicana* in the same clade.

Three apomorphies of deep adaxial furrows greater than 1/2 the blade thickness [character 1(3)], vascular bundles positioned in two or three levels [character 5(2)], and inflated cells located below (abaxial to) the primary vascular bundles [character 16(1)] support a core group of 12 species (Fig. 17, clade C) that correspond to members of *M.* subg. *Trichochloa,* sect. *Podosemum* (*M.*

angustata, *M. dubia*, *M. gypsophila*, *M. jaliscana*, *M. lucida*, *M. macroura*, *M. mucronata*, *M. nigra*, *M. palmeri*, *M. rigens*, *M. rigida*, and *M. subaristata*). These 12 species plus *M. articulata*, *M. capillaris*, and *M. stricta* form a clade characterized by having vascular bundles composed of primary, secondary, and tertiary types [character 6(3)].

Muhlenbergia capillaris, *M. expansa*, and *M. filipes* are problematic since in other trees these species comprise a single clade or in separate clades. In 70 of the 200 trees these three species form a clade with the 14 previously discussed species tentatively placed in *M.* subg. *Trichlochloa*, sect. *Podosemum*. In all other trees they are aligned with species of *M.* subg. *Trichochloa* in a grade containing clades of each section (*Epicampes* and *Podosemum*). Therefore, placement in either section of *M.* subg. *Trichochloa* is premature. Interestingly, these three species were treated by Morden and Hatch (1989) as a single species with three varieties. Although they can be somewhat difficult to distinguish using gross morphological features, there appears to be sufficient differences in habitat, flowering time, and anatomical structure to warrant recognition at the species level. We believe these three species clearly belong in *M.* subg. *Trichochloa* since they form a clade with other members of sect. *Epicampes* and sect. *Podosemum* by possessing a crown of inflated cells just below (abaxial to) the primary vascular bundles [character 8(2)].

Soderstrom (1967) delineated *M.* subg. *Trichochloa* (as *M.* subg. *Podosemum*) based on possession of sclerosed phloem, caespitose perennial habit with erect, usually stout and robust culms, and glumes veinless or 1-veined. The single apomorphy (symplesiomorphy?) of sclerosed phloem [character 13(2)] appears to be an important character aligning at least 11 additional species in our analysis: *M. elongata*, *M. jaime-hintonii*, *M. montana*, *M. mutica*, M. *pubigluma*, *M. pungens*, *M. purpusii*, *M. reverchonii*, *M. setifolia*, *M. versicolor*, *M. virlettii*. All these species except *M. pungens* have the morphological characteristics that Soderstrom described for *M.* subg. *Trichochloa*. *Muhlenbergia pungens* is rhizomatous, decumbent near the base, and short (culms 20-70 cm tall). Based on our morphological observations *M. pungens* appears related to *M. arenacea*, *M. arenicola*, and *M. torreyi*. The last two species are the only other taxa in our study that have sclerosed phloem [character 13(2)]; however, these two species with *M. setifolia* always form a separate clade. There are no obvious morphological characteristics that align *M. setifolia* with either *M. arenicola* or *M. torreyi*. Therefore, the evolution of sclerosed phloem within *Muhlenbergia* appears to have occurred twice. Even though *M. montana* exhibits some individuals with sclerosed phloem, others lack this character state. *Muhlenbergia montana* was aligned with *M. straminea* and *M. virescens* in about half of the 200 trees and therefore should not be included in *M.* subg. *Trichochloa* at this time. These three densely caespitose species all have 3-veined upper glumes that are usually

3-toothed as well. It seems best to tentatively place these eight species (excluding *M. montana* and *M. pungens*) in *M.* subg. *Trichochloa* without further affinities.

These 200 trees in the overall analysis appear to support a group (Fig. 17, grade B) of 37 species with apomorphies of loosely arranged chlorenchyma [C_4 PCK type; character 7(2)] and fan- to shield-shaped bulliform cells without formation of a sclerenchyma girder from the adaxial to the abaxial surface [character 9(2)]. These 37 species correspond to *M.* subg. *Muhlenbergia*. All of these species except *M. arsenei* and *M. polycaulis* have an additional apomorphy of four or more secondary and/or tertiary vascular bundles between consecutive primary vascular bundle [Character 10(2)]. However, four species (*M. curtifolia*, *M. glauca*, *M. pauciflora*, and *M. thurberi*) exhibit both states for character 10. A homoplasious state in these 37 species is the occurrence of only primary and tertiary vascular bundles [character 6(2)] also shared with annual or short-lived perennial* (Fig. 17, clades D & E) species (*M. annua*, *M. brevis*, *M. breviseta**, *M. capillipes*, *M. crispiseta*, *M. depauperata*, *M. eludens*, *M. filiformis*, *M. flavida*, *M. fragilis*, *M. implicata*, *M. ligularis**, *M. majalcensis*, *M. minutissima*, *M. peruviana*, *M. ramulosa*, *M. schmitzii*, *M. sinuosa*, *M. strictior*, *M. tenuissima*, *M. texana*, *M. vaginata**). However, 120 of the 200 trees suggested direct descent, i.e., derived from a single common ancestor, for the derivation of this state [character 6(2)].

The evolution of C_4 photosynthesis in grasses is a complicated subject, however, it seems clear that the pathway has originated at least four times (Sinha and Kellogg 1996) or more (seven or more times in Brown 1977). One of those origins appears to be the subfamily Chloridoideae lineage (Renvoize and Clayton 1992). Our study suggests that in *Muhlenbergia* the PCK subtype of photosynthesis was a single evolutionary event [character 7(2)]. Since the occurrence of the PCK subtype is found in three of the four outgroup species (*Eragrostis acutiflora*, *Leptochloa virgata*, and *Sporobolus airoides*), it is not surprising that in all 200 trees this state appears plesiomorphic when rooted with these species. Hattersley and Watson (1992) hypothesized that the PCK subtype evolved from NAD-ME since in the C_4 acid cycle PCK subtype is an enhancement of the NAD-ME subtype, and PCK is only known in grasses and may therefore have evolved subsequent to the NAD-ME type which is known in other monocotyledons and dicotyledons. Jacobs (1987) earlier suggested that the PCK subtype is perhaps primitive since it is found in other groups, i.e., Panicoideae, whereas the NAD-ME subtype is restricted to Chloridoideae. We agree with Hattersley and Watson's assessment and prefer to view the development of the PCK subtype in *Muhlenbergia* as the derived state. An alternative hypothesis, although this would require additional morphological or molecular evidence, might be that the PCK species or *M.* subg. *Muhlenbergia* actually represent a separate lineage and deserves generic status.

The remaining 64 taxa (*M. aguascalientensis*, *M. annua*, *M. arenacea*, *M. arenicola*, *M. argentea*, *M. arizonica*, *M. asperifolia*, *M. brevifolia*, *M. brevis*, *M. breviseta*, *M. capillipes*, *M. caxamarcensis*, *M. cleefii*, *M. crispiseta*, *M. cualensis*, *M. curvula*, *M. cuspidata*, *M. depauperata*, *M. durangensis*, *M. eludens*, *M. eriophylla*, *M. fastigiata*, *M. filiculmis*, *M. filiformis*, *M. flabellata*, *M. flavida*, *M. flaviseta*, *M. flexuosa*, *M. fragilis*, *M. hintonii*, *M. implicata*, *M. jonesii*, *M. ligularis*, *M. majalcensis*, *M. michisensis*, *M. minutissima*, *M. montana*, *M. orophila*, *M. palmirensis*, *M. peruviana*, *M. plumbea*, *M. pungens*, *M. purpusii*, *M. quadridentata*, *M. ramulosa*, *M. repens*, *M. richardsonis*, *M. schmitzii*, *M. seatonii*, *M. sinuosa*, *M. sinuosa*, *M. straminea*, *M. strictior*, *M. tenuissima*, *M. texana*, *M. torreyana*, *M. torreyi*, *M. utilis*, *M. vaginata*, *M. villiflora* var. *villiflora*, *M. villiflora* var. *villosa*, *M. virescens*, *M. watsoniana*, and *M. wrightii*) seem to contain sympleisiomorphies, i.e., they lack anatomical synapomorphies. These species all exhibit radiate, compact chlorenchyma or the classical NAD-ME subtype characteristic of many chloridoid grasses [character 7(1)]; contain primary vascular bundles without sclerosed phloem [character 13(2)], although present in *M. arenicola*, *M. pungens*, and *M. torreyi*; have rounded vascular bundles [character 2(1)], although *M. torreyana* and *M. pungens* have obovate/elliptic or rectangular bundles; have simple keels [character 4(1)], although *M. torreyana* has a complex compound keel like species in *M.* subg. *Trichochloa* sect. *Epicampes*; and have circular or irregular to fan-shaped bulliform cells [character 9(1)]. Even though the cladistic analysis using these 16 anatomical characters does not suggest a monophyletic lineage for these 63 species, we prefer to recognize them informally as the 'Clomena' complex (Peterson 2000).

Within 'Clomena' there exists some resolution, for instance, a clade containing annual or short-lived perennial species (Fig. 17, clade D) is based on the occurrence of primary and secondary vascular bundles [character 6(2)]. Other annuals (*M. annua*, *M. brevis*, *M. crispiseta*, *M. depauperata*, *M. eludens*, *M. fragilis*, *M. minutissima*, *M. sinuosa*, and *M. texana*) occur as a grade. A grade (Fig. 17, grade F) within 'Clomena' containing *M. aguascalientensis*, *M. cualensis*, *M. curvula*, *M. durangensis*, *M. flabellata*, *M. hintonii*, *M. quadridentata*, *M. straminea*, and *M. virescens*, along with the remaining species in the analysis is also depicted. These species along with *M. argentea*, *M. crispiseta*, *M. eriophylla*, *M. filiculmis*, *M. flaviseta*, *M. jonesii*, *M. michisensis*, *M. montana*, *M. peruviana*, and *M. watsoniana* have been referred to as the *Muhlenbergia montana* complex (Herrera-Arrieta 1998; Herrera-Arrieta and De la Cerda-Lemus 1995; Herrera-Arrieta and Grant 1993,1994). This complex consists of highly caespitose species usually with a three-veined upper glumes, and in our analysis, leaf blades mostly with three or more layers of adaxial sclerenchyma in the primary bundles [character 14(3)]. The *Muhlenbergia repens* complex (Morden 1985, 1995; Morden and Hatch 1987, 1996) which includes *M. fastigiata*, *M. plumbea*, *M. repens, M. richardsonis, M. utilis* and *M. villiflora)* is not monophyletic, i.e., these species are found in two or more clades or as a grade with many additional species.

One of the two least homoplasious characters in the analysis is chlorenchyma arrangement (character 7, consistency index = 0.50). All species in *M.* subg. *Muhlenbergia* appear to be PCK [character 7(2)] whereas all other members of the genus are NAD-ME [7(1)]. Only two species are ambiguously scored for character seven, *M. glauca*, more than likely a member of *M.* subg. *Muhlenbergia*, and *M. capillaris*, clearly a member of *M.* subg. *Trichochloa*. Median vascular bundle structure (character 11, CI = 0.50) is the other least homoplasious character. All members of *M.* subg. *Trichochloa* sect. *Epicampes* have median vascular bundles that are differentiated from other primary vascular bundles [11(2)]. If you choose to disregard the outgroup species in the cladistic analysis, then within *Muhlenbergia* there is no homoplasy (CI = 1.00) for these two characters (7 & 11).

In conclusion, our data support the division of *Muhlenbergia* into two subgenera (*M.* subg. *Muhlenbergia* and *Trichochloa)* and two sections (*M.* sect. *Epicampes* and *Podosemum)* in *M.* subg. *Trichochloa*. Preliminary investigations of *Muhlenbergia* and relatives based on internal transcribed spacer region sequences of nuclear ribosomal DNA provide support for a clade containing only PCK species (= *M.* subg. *Muhlenbergia)* and another clade containing only *M.* subg. *Trichochloa* (Peterson, Columbus, Cerro Tlatilpa, and Kinney 2001). We prefer to view this partial classification based on anatomical characters as a work in progress and realize that with additional morphological and molecular data our understanding of the evolution of this genus will improve. We feel it is important to present this anatomical information since it is the first time the entire genus has been surveyed in this manner, therefore this serves as a foundation for further taxonomic research.

APPENDIX 1

Specimens used in this study, all housed at the United States National Herbarium (US) unless otherwise indicated. Those marked with an asterisk * appear in the figures. Collectors are abbreviated as follows: **A** = C.R. Annable; **AC** = S. Acevado; **B** = S.M. Braxton; **C** = A. Cortes O.; **CA** = M.A. Carranza; **CV** = A. Campos-Villanueva; **D** = C.H. Dietrich; **DC** = M. De la Cerda-Lemus; **DU** = W.C. Dunn; **G** = M.S. Gonzalez-Elizondo; **H** = Y. Herrera-Arrieta; **J** = E.J. Judziewicz; **K** = M.B. Knowles; **KI** = R.M. King; **L** = J. Linkins; **LB** = R.J. LeBlond; **M** = O. Morrone; **P** = P.M. Peterson; **PO** = M.E. Poston; **R** = N. Refulio-Rodriguez; **S** = R.J. Soreng; **V** = J. Valdes-Reyna; **VI** = J.A. Villarreal; **W** = A.S. Weakley.

APPENDIX 1.

TAXON	COLLECTORS	LOCALITY
M. aguascalientensis Y. Herrera & de la Cerda-Lemus	H&DC 1185	MEXICO. Aguascalientes: San Jose de Gracia, 12 km NW of La Congoja
M. alamosae Vasey	P&A 8293	MEXICO. Chihuahua: 76 mi W La Junta and 35.2 mi W Tomochic in Parque Nal. Cascada de Basaseachic
	P,A&V 10807	MEXICO. Chihuahua: Parque Natural Barranca del Cobre, 12.6 mi NE La Bufa and 2 mi S Basigochi
M. andina (Nutt.) Hitchc.	P&A 4982	USA. California: San Benito Co. 9.8 mi SW New Idria along Clear Creek
M. angustata (J. Presl) Kunth	P,A&PO 8817	ECUADOR. Provincia de Chimborazo: 8.9 km N Palmira on the Panamerican Hwy
M. annua (Vasey) Swallen	P&A 4036, 4053	MEXICO. Chihuahua: NW of Hernandez Javales
	P&A 4102	MEXICO. Durango: Navios
M. appressa C.O. Goodd.	P&A 4189	USA. Arizona: Graham Co. 6.6 mi SW Hwy 366 above jtn. with Hwy 666
	Holmgren & Holmgren 7051	(NY)USA. Arizona: Graham Co., Pinaleno Mts.
M. arenacea (Buckley) Hitchc.	P&A 5703	USA. Arizona: Cochise Co., Triangle T Road, 1.2 mi E Dragoon
	P,A&V 10033	MEXICO. Coahuila: 29.2 mi S Saltillo on Mex 54 to Concepcion del Oro
M. arenicola Buckley	P&A 5521	USA. Arizona: Cochise Co., 10 mi S Rucker Canyon on Tex Canyon Road & 6 mi NE Hwy 80.
	P,A&V 10032	MEXICO. Coahuila: 29.2 mi S Saltillo on Mex 54 to Concepcion del Oro
M. argentea Vasey	P,A&H 8044	MEXICO. Chihuahua: 15.3 mi S Mex 127 and 6.9 mi NE La Bufa
M. arizonica Scribn.	P&A 5329	USA. Arizona: Santa Cruz Co. 3.3. mi W Hwy 289 & Pena Blanca
M. arsenei Hitchc.	P&A 5142	MEXICO. Baja California: Sierra San Pedro Martir, 1.8 mi S Vallecitos
M. articulata Scribn.	P&K 13386	MEXICO. San Luis Potosi: 2.5 mi E Hwy 57 on road towards Guadalcazar
	P&K 13365	MEXICO. Nuevo Leon: ca 36 mi N Dr. arroyo on Hwy 61 towards Linares
M. asperifolia (Nees & Meyen ex Trin.) Parodi	P&A 4851	USA. Oregon: Klamath Co. 1.5 mi S Worden on Hwy 97
	P,A&M 10177*	ARGENTINA. Provincia Salta: at km 1137, 26.7 km SE Molinos on Hwy 40
M. aurea Swallen	M de Koninck 1954	GUATEMALA. Quetzaltenango: Retalhuleu

TAXON	COLLECTORS	LOCALITY
M. brandegei C. Reeder	Moran 9361	MEXICO. Baja California Sur: Isla Catalina
	P&A 4760	MEXICO. Baja California Sur: Isla La Partida
M. brevifolia Scribn. ex Beal	P,A&V 10811	MEXICO. Chihuahua: 12.6 mi NE of La Bufa and 2 mi S of Basigochi
M. breviligula Hitchc.	A.S. Hitchcock 9063	GUATEMALA. Guatemala city
M. brevis C.O. Goodd.	P&A 4005	USA. New Mexico: Grant Co., NE of San Lorenzo
	P&A 4030	MEXICO. Chihuahua: NW of Hernandez Javales
M. breviseta Griseb. ex E. Fourn.	A.S. Muller 1853	MEXICO. Veracruz: Orizaba
M. brevivaginata Swallen	P,D,B&K 13396	MEXICO. Sinaloa: 3 mi SW Estado de Durango and 2.2 mi S El Palmito on Hwy 40
	P,G&K 13660*	MEXICO. Durango: 7.3 mi S of Charcos on road towards San Juan de Michis
M. bushii R.W. Pohl	D.M. Moore 30573	USA. Arkansas: Benton Co., Monte Ne
M. californica Vasey	P&A 5013	USA. California: San Bernardino Co., Mtn. Home Village, along Mtn. Home Creek
M. capillaris (Lam.) Trin.	P,W&LB 14236	USA. North Carolina: Brunswick Co., Sunset Beach
M. capillipes (M.E. Jones) P.M. Peterson & Annable	P&A 5858 P 9604 MEXICO.	MEXICO. Chihuahua: 24 mi SW La Junta and approx. 44 mi N Creel, at P Arroyo Ancho crossing Chihuahua: 23 mi SW La Junta on road to Creel at the Puente Arroyo Ancho
M. caxamarcensis Laegaard &	P&R 14013	PERU. Depto. Cajamarca: Prov. Cajamarca, 18 km W of Central Plaza of Cajamarca up road to Cumbemayo Sanchez Vega
M. ciliata (Kunth) Trin.	P&A 4679*	MEXICO. Chiapas: 8.2 mi SE of San Cristobal de las Casas
M. cleefii Laegaard	Cleef & Florschutz 5578	COLOMBIA. Boyaca: Sierra Nevada del Cocuy, Alto Valle Lagunillas
M. crispiseta Hitchc.	P&A 4063	MEXICO. Chihuahua: 12.1 mi NE of El Vergel on Hwy 24
	P&A 4067	MEXICO. Chihuahua: 10.9 mi NE of El Vergel on Hwy 24
	P&A 4103	MEXICO. Durango: 5.4 mi W of Navios, 42 mi W of Durango
M. cualensis Y. Herrer & P.M. Peterson	Guzman 6090	MEXICO. Jalisco: E of Zimapan mine
M. curtifolia Scribn.	P&A 5631	USA. Arizona: Cocoino Co., Oak Canyon 22.5 mi SE of Fredonia on Forest Service Road 422
M. xcurtisetosa (Scribn.) Bush	G.P. Clinton 1892	USA. Illinois: Champaign
M. curviaristata (Ohwi) Ohwi	T. Koyama 6390	JAPAN. Honshu: Prov. Shinano, Togakushi, 2 km NW of Chusha
M. curvula Swallen	P,G&K 13636	MEXICO. Durango: 30 mi SE Mezquital on road to Charcos
	P 9686*	MEXICO. Guanajuato: 18.5 mi SE San Felipe on Mex 37 to Leon

TAXON	COLLECTORS	LOCALITY
	P,A&V 10056	MEXICO. Coahuila: 32 mi SE Saltillo and 8 mi SE JAme on road to Sierra La Viga
	P,A&V 10057	MEXICO. Coahuila: 32 mi SE Saltillo and 8 mi SE JAme on road to Sierra La Viga
M. cuspidata (Torr.) Rydb.	P&A 5544	USA. New Mexico: Grant Co., 8 mi E Central on Hwy 90
M. depauperata Scribn.	P&A 4082	MEXICO. Chihuahua: Just N of Villa Matamoros on Hwy 45
	P&A 4088	MEXICO. Durango: 64 km N of Durango on Hwy 45
	P&A 4091	MEXICO. Durango: 20 km S of Durango on road towards Aserradero La Flor
M. distans Swallen	P&A 5886	MEXICO. Chihuahua: 5.3 mi S of Cusarare on road to Guacnochi
	P&A 6010	MEXICO. Durango: 40 km W of Durango on Hwy 40, 6 mi W of Rio Chico
M. distichophylla (J.Presl) Kunth	P,D,B&K 13583	MEXICO. Chihuahua: Parque Natural Barranca del Cobre, 1 mi E of La Bufa
M. diversiglumis Trin.	P&A 4132	MEXICO. Durango: 18.6 mi W of El Salto, 81.2 mi W Dgo.
	P&A 4137	MEXICO. Durango: 22.7 mi W of La Ciudad on Hwy 40
	P&A 4147	MEXICO. Sinaloa: 2 mi E of Sta. Rita
	P&A 4163	MEXICO. Sinaloa: 1.1 mi NW of Mocorito
M. dubia E. Fourn.	P&A 5550	USA. New Mexico: Grant Co., 12 mi E Central on Hwy 90
	P&A 5558	USA. New Mexico: Grant Co., 0.7 mi NW junction Hwy 61 & 35, on Hwy 35
	P&A 5809	MEXICO. Chihuahua: Colonia Cumbres de Majalca, approx. 20 mi W Hwy 45, N of Chihuahua
	P,A&H 8028	MEXICO. Chihuahua: 25.6 mi S Creel on road to Batopilas
	P,V,VI 8391	MEXICO. Coahuila: SE San Antonio de las Alazanas & SE of Saltillo, at end of road near summit of Coah.
	P&A 10593	MEXICO. Coahuila: 87 mi NW Muzquiz on Hwy 53 towards Boquilla del Carmen
	P&A 10594*	MEXICO. Coahuila: 87 mi NW Muzquiz on Hwy 53 towards Boquilla del Carmen
	P&K 13328, 13330	MEXICO. Nuevo Leon: 6.7 mi W 18 de Marzo, up road towards Cerro del Potosi
M. dumosa Scribn. ex Vasey	P&A 5942	MEXICO. Chihuahua: 12 mi SE Balleza towards Parral
M. durangensis Y. Herrera	P,G&K 13644	MEXICO. Durango: 6 mi S Charcos on road towards San Juan de Michis
	H&AC 981 (CIIDIR)	MEXICO. Durango: Ca. 10 km W of San Juan de Michis
M. elongata Scribn. ex Beal	P&A 5680	USA. Arizona: Pima Co., Santa Rita Mts. Box Canyon, 7 mi W Hwy 83 on Forest Service Road 62
M. eludens C. Reeder	P&A 4014	USA. Arizona: Cochise Co., along Rucker Creek

TAXON	COLLECTORS	LOCALITY
	P&A 4096	MEXICO. Durango: 2.1 mi W of Rio Chico crosing, 21 mi W Dgo.
	P&A 4106	MEXICO. Durango: 5.4 mi W of Navios, 42 mi W of Durango
	P&A 4516	MEXICO. Chihuahua: 9.1 mi E of Cumbres de Majalca
M. emersleyi Vasey	P&A 5068	MEXICO. Baja California: Sierra San Pedro Martir, 0.6 mi E the W Park entrance
	P&A 5326	USA. Arizona: Santa Cruz Co. 3.3 mi W Hwy 289 & Pena Blanca
	P&A 7917	USA. New Mexico: Grant Co., Line along Hwy 78, 6 mi W of Mule Creek
	P&A 7918	USA. New Mexico: Grant Co., Line along Hwy 78, 6 mi W of Mule Creek
	P,A&H 8018	MEXICO. Chihuahua: 24.3 mi S Creel on road to Batopilas, at the Barranca El Cobre
	P,A&V 10765	MEXICO. Chihuahua: 35 mi W Balleza and 24 mi E Guachochi
	P,A&V 10805	MEXICO. Chihuahua: Parque Natural Barranca del Cobre, 12.6 mi NE La Bufa and 2 mi S Basigochi
M. eriophylla Swallen	G 1626 (CIIDIR)	MEXICO. Durango: Arroyo El Temazcal, 4 km al SW de Piedra Herrada
	H&C 930 (CIIDIR)	MEXICO. Michoacan: Cerro Ucarero, Zinapecuaro, 2 km al S de Querendaro
M. expansa (Poir.) Trin.	Boyce & Godfrey 1581	USA. North Carolina: Cumberland Co., 13 mi N of Fayetteville on route 15
	P,W&LB 14234*	USA. North Carolina: Columbus Co., Old Dock Savanna.
M. fastigiata (J. Presl) Henrard	P,A&M 10286	ARGENTINA. Provincia Jujuy: 4 km E of Tres Cruces on road to Humahuaca
	P,A&M 10321	ARGENTINA. Jujuy: 24 km W La Quiaca on Hwy 5 towards Sta Cabalina
M. filiculmis Vasey	P&A 5627	USA. Arizona: Coconino Co., Kaibab Plateau, 4 mi N Kaibab Lodge, Pleasant Valley, along Hwy 67
	P&A 7860	USA. Colorado: Saguache Co., NW of Saguache, 14 mi up Cochetopa pass road (F5750) from Hwy 114
	P&A 3994	USA. Arizona: Apache Co., E of McNary
	P&A 2648	USA. California: Tulare Co., Lion Meadow
M. filiformis (Thurb. ex S. Watson) Rydb.	P&A 3987	USA. Washington: Klickitat Co., Washington State Fish Hatchery
	P&A 3994	USA. Arizona: Apache Co., 7.4 mi E of McNary off Hwy 260
	P&A 4511	USA. Colorado: Pitkin Co., 13 mi S of Leadville on Hwy 24
M. filipes M.A. Curtis	E.P. Killip 42315	USA. Florida: Monroe Co., Big Pine Key
M. flabellata Mez	Pittier 3372	COSTA RICA. San Jose: Cerro Buena Vista
	Pohl & Davidse 11621	COSTA RICA. San Jose: Cerro Buena Vista

TAXON	COLLECTORS	LOCALITY
M. flavida Vasey	P&A 4138	MEXICO. Durango: 22.7 mi W of La Ciudad on Hwy 40
	P&A 4153	MEXICO. Sinaloa: 48.6 mi NE of Mococrito, 8.5 mi S of Surutato
	P&A 4162	MEXICO. Sinaloa: 1.1 mi NW of Surutato, 61.1 mi NE of Mocorito
M. flaviseta Scribn.	P&A 5911	MEXICO. Chihuahua: S side of Barranca El Cobre, approx. 20 mi S Cusarare on road to Guachochi
	H 993 (CIIDIR)	MEXICO. Durango: Parque El Tecuan, 58 km ESE of Durango on Hwy 40 to Mazatlan
	H&AC 982 (CIIDIR)	MEXICO. Durango: 4.5 km SW of San Juan de Michis on road to Piedra Herrada
M. flexuosa Hitchc.	J.F. Macbride s.n.	PERU. Huacachi: Estacion near Muna
M. fragilis Swallen	P&A 4017	USA. Arizona: Santa Cruz Co., SW of Camelo
	P&A 4024	USA. Arizona: Santa Cruz Co., Sycamore Canyon
	P&A 4554	MEXICO. Chihuahua: 13.5 mi W of Parral on Hwy 24
	P&A 4150	MEXICO. Sinaloa: 34.5 mi NE of Mocorito, 22.6 mi S of Surutato
M. gigantea (E. Fourn.) Hitchc.	P 13786	MEXICO. Nayarit: 8 mi E of Compostela on roads towards Chapalilla and Guadalajara
	P,D,B&K 13414*	MEXICO. Sinaloa: 3 mi SW Estado de Durango and 2.2 mi S El Palmito on Hwy 40
M. glabriflora Scribn.	R.M. Kriebel 5802	USA. Indiana: Daviess Co., 6 mi N of Washington
M. glauca (Nees) B.D. Jacks.	P&KI 8237	MEXICO. Chihuahua: 76 mi W La Junta and 35.2 mi W Tomochic in Parque Nacional Cascad Basaseachic
	P,A&V 10072	MEXICO. Coahuila: 17 mi SE Saltillo and 7.4 mi NW Jame at Bosque de Montana
	P&A 5511	USA. Arizona: Cochise Co., Chiricahua Mts., Red Rock Canyon, aprox. 2 mi Rucker Canyon Road
	P&A 5482	USA. Arizona: Cochise Co., 2.4 mi above Upper Picnic Area, Fort Huachuca Military Reservation
M. glomerata (Willd.) Trin.	P&A 5562	USA. New Mexico Catron Co., Canyon leading to Cliff Dwellings and upper end of Hwy 15
M. grandis Vasey	P,D,B&K 13413	MEXICO. Sinaloa: 3 mi SW Estado de Durango and 2.2 mi S El Palmito on Hwy 40
M. gypsophila Reeder & C. Reeder	P&K 13289	MEXICO. Nuevo Leon: 5.6 mi E junction Hwy 57 on Hwy 58 towards Linares
	P&K 13299	MEXICO. Nuevo Leon: 13.4 mi E Hwy 57 on Hwy 58 at crossin Rio Potosi

TAXON	COLLECTORS	LOCALITY
M. hakonensis (Hack. ex Matsum.) Makino	T. Tateoka s.n.	JAPAN. Hakone: Kanagwa ken
M. himalayensis Hack. ex Hook.	S&P 5666	CHINA. Xizhang (Tibet) Prov.: Markam Co. Ningjing Shan, Markham Range between Mekong & Yantze
M. huegelii Trin.	S&P 5324	CHINA. Sichuan Prov.: Wenchuan Co. W side of front range NW of Sichuan Basin
	S&P 5344	CHINA. Sichuan: Qiunglai Slan, ca 40 km W Wezlou and ca. 120 km NW Clongdu
M. hintonii Swallen	G.B. Hinton 3059	MEXICO. Mexico: crucero Temazcaltepec
M. implicata (Kunth) Trin.	P&A 4514	MEXICO. Chihuahua: 0.7 mi W of Nuevo Majalca, 8.5 mi W of Hwy 45
	P&A 4090	MEXICO. Durango: 20 km S of Durango on road towards La Flor
	P&A 4095	MEXICO. Durango: 2.1 mi W of Rio Chico crossing, 21 mi W of Durango on Hwy 40
M. inaequalis Soderstr.	A.S. Muller 953	VENEZUELA. Trujillo: Quebrada de Duri
M. xinvoluta Swallen	P&A 6267	MEXICO. Nuevo Leon: 10 mi E of Los Lirios and 12 mi W of Laguna de Sanchez
	P&A 6281	USA. Texas: Blanco Co., 0.3 mi E Hwy 280 on Tex 473
M. iridifolia Soderstr.	P&A 6133, 6135	MEXICO. Jalisco: 50 mi W of Ameca on road to Mascota
M. jaime-hintonii P.M. Peterson & Valdes-Reyna	V&C 2560	MEXICO. Nuevo Leon: La Joya, Cuesta Blanca, 15 km S of Aramberri
M. jaliscana Swallen	P&A 6137	MEXICO. Jalisco: 50 mi W of Ameca on road to Mascota
	P&A 6149	MEXICO. Jalisco: Pass above Talpa de Allende, 3.6 mi W of Rio Mascota
M. japonica Steud.	S&P 5240	CHINA. Yunnan Prov.: Fugong (N 1/2 Bijiang) Co. W slopes of Bilou Mts.
	S&P 5301*	CHINA. Kiangwang Shan: ca 15 km E of Dongchuan, ca 120 km NNE of Kunming
M. jonesii (Vasey) Htichc.	P&A 4857	USA. California: Siskiyou Co. Shasta-Trinity National Forest, 9.5 mi SE Hwy 97, on military pass road
M. lehmaniana Henrard	P&A 7372*	PANAMA. Province of Chiriqui: between Rio Quebrado
M. ligularis (Hack.)Hitchc.	P,A&PO 8884	ECUADOR. Provincia de Azuay: 5.6 km S LA Paz on the Panamerican Hwy, and 36.3 km N Ona
M. lindheimeri Hitchc.	P,A&V 10068*	MEXICO. Coahuila: 26.7 mi Se Saltillo and 2.7 mi SE Jame on road to Sierra La Viga
M. longiglumis Vasey	P 13710	MEXICO. Jalisco: 8.2 mi NW Cuautla on road towards Los Volcanes
M. longiligula Hitchc.	P&A 5408	USA. Arizona: Santa Cruz Co. Patagonia Mts., along road to Red Mt., 7.6 mi SE of Patagonia

TAXON	COLLECTORS	LOCALITY
	P&A 7919	USA. New Mexico: Grant Co., Line along Hwy 78, 6 mi W of Mule Creek
	P&KI 8207	MEXICO. Chihuahua: 33.7 mi W La Junta on road to Parque Nacional Cascada de Basaseachic
	P 9605	MEXICO. Chihuahua: 20.8 mi SW La Junta on road to Creel
M. lucida Swallen	P&A 5882	MEXICO. Chihuahua: 5.3 mi S Cusarare on road to Guachochi
	P,A&H 8039	MEXICO. Chihuahua: 10.7 mi S Mex 127 on road to Batopilas
M. macroura (Kunth) Hitchc.	P&CA 9769	MEXICO. Oaxaca: 11.4 mi W San Juan Mixtepec and 1.5 mi E San Isidro Chicahuaxtla
	P,A&V 10986	MEXICO. Michoacan: 8.4 mi SE Zacapu on Mex 15 towards Quiroga
M. majalcensis P.M. Peterson	P&A 4573	MEXICO. Chihuahua: E of Cumbres de Majalca
M. mexicana (L.) Trin.	P&A 4765	USA. Idaho: Lemni Co., 2.5 mi E of Salmon River on Warm Springs Creek
M. mexicana var. *filiformis* (Torr.) Scribn.	Morton 11689	CANADA. Ontario: Lake Timiskaming (Dawson Point)
M. michisensis Y. Herrera & P.M. Peterson	H&A 986 (CIIDIR)	MEXICO. Durango: San Juan de Michis, Potrero Las Escobas
M. microsperama (DC.) Trin.	P,A&PO 8913	ECUADOR. Provincia de Azuay: 10.2 km N Ona on the Panamerican Hwy
	P,J&KI 9060	ECUADOR. Provincia de Pichincha: 13 km N Calderon on the Panamerican Hwy
	P&A 4759	MEXICO. Baja California Sur: 25 km S of La Paz, W side of Isla La Partida
	P&A 4169	MEXICO. Sonora: 18.2 mi E of Los Tanques on road to Milpillas
	P&A 4023	USA. Arizona: Santa Cruz Co., Sycamore Canyon
	P,A&DU 3067*	USA. Nevada: Clark Co., Lake Mead
M. minutissima (Steud.) Swallen	P&A 3990	USA. Arizona: Coconino Co., W of Flagstaff
	P&A 4048	MEXICO. Chihuahua: 12 mi SW of Madera off Hwy 16 towards Cuauhtemoc
	P&A 4097	MEXICO. Durango: 3.2 mi W of Rio Chico crossing, 22.1 mi W of Durango on Hwy 40
	P&A 4515	MEXICO. Chuhuahua: 9.1 mi E of Cumbres de Majalca
M. montana (Nutt.)Hitchc.	P,A&H 8033	MEXICO. Chihuahua: 25.6 mi S Creel on road to Batopilas
	P&KI 8214	MEXICO. Chihuahua: 33.7 mi W La Junta on road to Parque Nacional Cascada de Basaseachic
	P&CV 9733	MEXICO. Oaxaca: 4.8 mi NW Tlaxiaco on road to San Juan Mixtepec

TAXON	COLLECTORS	LOCALITY
	P&A 9971	MEXICO. Tlaxcala: 5.2 mi N Tlaxco on Mex 119 to Zacatlan
	P&Kl 8171	USA. Arizona: Cochise Co., 10 mi W Portal on F542, E of Onion Pass
	P&A 5438	USA. Arizona: Santa Cruz Co. Patagonia Mts., 12.3 mi S Patagonia on Forest Service Road 49
M. mucronata (Kunth) Trin.	P&A 10778	MEXICO. Chuhuahua: 40 mi W of Balleza and 19 mi E of Guachochi
M. mutica (Rupr. ex E. Fourn.) Hitchc.	A.S. Hitchcock 6348	MEXICO. Veracruz: Orizaba
M. nigra Hitchc.	P&A 11081*	MEXICO. Mexico: 28.3 mi NE Temascaltepec on Mex 134 towards Toluca
M. orophila Swallen	P&A 11105	MEXICO. Mexico: 15.6 mi E Amecameca and 2 mi N Paso de Cortes
M. palmeri Vasey	P&Kl 8322	MEXICO. Tamaulipas: 63 mi SW Cd. Victoria on Mex 101 towards San Luis Potosi
	P&A 11134	MEXICO. San Luis Potosi: 45 mi NE San Luis Potosi on road towards Guadalcazar
	P&A 5478	USA. Arizona: Cochise Co., 3.1 mi above Upper Picnic Area, Fort Huachuca Military Reservation
	P&A 5681	USA. Arizona: Pima Co., Santa Rita Mts. Box Canyon, 7 mi W Hwy 83 on Forest Service Road 62
M. palmirensis Grignon & Laegaard	P,A&PO 8810	ECUADOR. Provincia de Chimborazo: 8.9 km N Palmira on the Panamerican Hwy
M. pauciflora Buckley	P&A 5715*	USA. Texas: Culberson Co., Guadalupe Mts., Pine Springs on Hwy 62 (180)
M. peruviana (P. Beauv.) Steud.	P&J 9308	ECUADOR. Provincia Cotopaxi: Lago Limpiopunga
	P&A 4071	MEXICO. Durango: 14 mi SW of El Vergel on Hwy 24
	P&A 4125	MEXICO. Durango: 7.0 mi W of El Salto on Hwy 40
M. pilosa P.M. Peterson, Wipff & S.D. Jones	P&A 11061	MEXICO. Mexico: 5 km NE of Tejupilco on Mex 134 towards Temascaltepec
M. plumbea (Trin.) Hitchc.	P,A&V 10765	MEXICO. Chihuahua: 35 mi W Balleza and 24 mi E Guachochi
M. polycaulis Scribn.	P&A 5406, 5407	USA. Arizona: Santa Cruz Co. Patagonia Mts., along road to Red Mt., 7.6 mi SE of Patagonia
	P,A&V 10764	MEXICO. Chihuahua: 35 mi W Balleza and 24 mi E Guachochi
M. porteri Scribn. ex Beal	P&Kl 8144	MEXICO. Chihuahua: 17 mi S of Nuevo Casas grandes on Mex 2
M. pubescens (Kunth) Hitchc.	P,D,B&K 13440	MEXICO. Durango: 4.5 mi N of Borbollones, N of Hwy 40
M. pubigluma Swallen	P&A 10593, 10594	MEXICO. Coahuila: 85.5 mi NW of Muzquiz on Hwy 53 towards Boquilla del Carmen
	P&K 13329*	MEXICO. Nuevo Leon: 6.7 mi W 18 de Marzo up road towards Cerro del Potosi

TAXON	COLLECTORS	LOCALITY
M. pungens Thurb. ex A. Gray	P&A 5614	USA. Arizona: Apache Co., 20 mi N St. Johnson Hwy 666 (61)
M. purpusii Mez	P&KI 8325	MEXICO. Tamaulipas: 63 mi SW Cd. Victoria on Mex 101 towards San Luis Potosi
M. quadridentata (Kunth) Trin.	P&A 6009	MEXICO. Durango: 40 km W Durango on Hwy 40, and 6 mi W Rio Chico
	P&A 11082	MEXICO. Mexico: 28.3 mi NE of Temascaltepec on Mex 134 towards Toluca
	H&C 906 (CIIDIR)	MEXICO. Mexico: Parque Nacional Nevado de Toluca
	H&C 899 (CIIDIR)	MEXICO. Oaxaca Ladera SW del Cerro Pelon, 500 m antes del mirador
	H&C 917 (CIIDIR)	MEXICO. Puebla: Ladera E del Popocatepetl, 10 km W de Santiago Salicintla
M. racemosa (Michx.) Britton, Sterns & Poggenb.	M.W. Talbot 814	USA. New Mexico: Santa Fe Co., Santa Fe Canyon
M. ramosa (Hack. ex Matsum.) Makino	S&P 5302	CHINA. Kiangwang Shan: ca 15 km E of Dongchuan, ca 120 km NNE of Kunming
M. ramulosa (Kunth) Swallen	P&A 4109, 4113	MEXICO. Durango: W of Navios
	P&A 4121	MEXICO. Durango: W of El Salto
	P&A 4621	MEXICO. Michoacan: E of Opopeo
M. reederorum Soderstr.	P&A 6026	MEXICO. Durango: 56 km W Durango,on Hwy 40
	P,G&K 13643	MEXICO. Durango: 6 mi S Charcos on road towards San Juan de Michis
	P,D,B&K 13408	MEXICO. Sinaloa: 3 mi SW Estado de Durango and 2.2 mi S El Palmito on Hwy 40
M. repens (J. Presl) Hitchc.	P&A 5422	USA. Arizona: Santa Cruz Co. Patagonia Mts., junction of Forest Service Road 135 & 49
M. reverchonii Vasey & Scribn.	P&A 6273	USA. Texas: Bexar Co. 5 mi N of San Antonio, city limits on Hwy 281
M. richardsonis (Trin.) Rydb.	P&A 4056	MEXICO. Chihuahua: 10 mi W of Cuahutemoc on Hwy 16
M. rigens (Benth.) Hook.	P&A 8110	MEXICO. Chihuahua: 5.6 mi N Cuahutemoc on Mex 23
	P&KI 8238	MEXICO. Chihuahua: 76 mi W La Junta in Parque Nacional Cascada de Basaseachic
	P,A&V 10870	MEXICO. Chihuahua: 52.5 mi SE Villa Matamoros and 1 mi N Ejido Revolucion
M. rigida (Kunth) Trin.	P,A&PO 8895	ECUADOR. Provincia de Azuay: 17.7 km N Ona on the Panamerican Hwy
	P,A&PO 8820	ECUADOR. Provincia de Chimborazo: 8.7 km W Alausi on road to Sibambe
	P&KI 8187	MEXICO. Chihuahua: 44.5 mi SE Madera on Mex 16 and 1 mi S Temosachic
	P&K 13300	MEXICO. Nuevo Leon: 13.4 mi E Hwy 57 on Hwy 58 at crossin Rio Potosi
	P&K 13301*	MEXICO. Nuevo Leon: 13.4 mi E Hwy 57 on Hwy 58 at crossin Rio Potosi
	P&KI 8316	MEXICO. Tamaulipas: 63 mi SW Cd. Victoria on Mex 101 towards San Luis Potosi

TAXON	COLLECTORS	LOCALITY
	P&CV 9707	MEXICO. Oaxaca: 6.5 mi NE Villa de Tamazulapan and 2 mi NE Teotongo
	P&CV 9728	MEXICO. Oaxaca: 5 mi SW Teposcolula and 2.5 mi NE Yolomecatl on Mex 125
	P&A 5455	USA. Arizona: Cochise Co., 2 mi SW Sunnyside along Forest Service Road 228
	P&A 5434	USA. Arizona: Santa Cruz Co. Patagonia Mts., 12.3 mi S Patagonia on Forest Service Road 49
M. robusta (E. Fourn.) Hitchc.	P,G&K 13594	MEXICO. Mexico: Durango: 5 mi E of Mezquital on road to Charcos
M. schmitzii Hack.	P&A 4631	MEXICO. Michoacan: 6.1 mi W of Ciudad Hidalgo on Hwy 15
M. scoparia Vasey	P&A 6079	MEXICO. Nayarit: 29 mi SW of Tepic on Hwy 15 to Guadalajara
M. schreberi J.F. Gmel.	P 14231*	USA. Maryland: Montgomery Co. Bethesda, 4520 Cheltenham Dr.
M. seatoni Scribn.	P&A 9946	MEXICO. Puebla: 3.5 mi SE Cd. Serdan on Mex 140
M. setarioides E. Fourn.	P&CV 9897	MEXICO. Oaxaca: 1.4 mi E Ayutla on Mex 179 towards Mitla
M. setifolia Vasey	P&K 13376	MEXICO. San Luis Potosi: 2.5 mi E Hwy 57 on road towards Guadalcazar
	P&A 5716	USA. Texas: Culberson Co., Guadalupe Mts., Pine Springs on Hwy 62 (180)
M. sinuosa Swallen	P&A 12590	MEXICO. Chihuahua: Sierra El Nido, 16.7 mi W of Hwy 45 on road up Los Prietos Canyon
M. sobolifera (Muhl. ex Willd.) Trin.	C.H. Bissell s.n.	USA. Connecticut: Rocky woods near Savage St.
M. speciosa Vasey	P,G&K 13626	MEXICO. Durango: 7 mi SE of Mezquital on road to Charcos
	P,D,B&K 13409	MEXICO. Sinaloa: 3 mi SW Estado de Durango and 2.2 mi S El Palmito on Hwy 40
M. spiciformis Trin.	P&A 6244	MEXICO. Coahuila: approx. 20 mi SE Saltillo on road to Los Lirios
	P&Kl 8334	MEXICO. Nuevo Leon: 3.8 mi S Allende on Mex 85 towards Montemorelos
	P&A 9896	MEXICO. Oaxaca: 1.4 mi E Ayutla on Mex 179 towards Mitla
	P&A 9945	MEXICO. Puebla: 3.5 mi SE Cd.Serdan on Mex 140
	P&A 10590	MEXICO. Coahuila: 85.5 mi NW Muzquiz on Hwy 53 towards Boquilla del Carmen
	P&Kl 8332	MEXICO. Tamaulipas: 55 mi SW Cd. Victoria on Mex 101 towards SanLuis Potosi
M. straminea Hitchc.	R. Endlich 1210	MEXICO. Chihuahua.
M. stricta (J. Presl) Kunth	P 13709	MEXICO. Jalisco: 8.2 mi NW Cuautla on road towards Los Volcanes
	P&Kl 8324	MEXICO. Tamaulipas: 63 mi SW of Ciudad Victoria on Mex 101 to San Luis Potosi
M. strictior Scribn. ex Beal	P&A 4520	MEXICO. Chihuahua: 21.1 mi W of Hwy 45, 0.4 mi E of Cumbres de Majalca
	P&A 4039	MEXICO. Chihuahua: 3.1 mi S of Hernandez Javales, 32 mi SW of Colonia Juarez
	P&A 4054	MEXICO. Chihuahua: 15.5 mi W of La Junta on road to Tomochic

TAXON	COLLECTORS	LOCALITY
	P&A 4098	MEXICO. Durango: 2.1 mi W of Rio Chico crossing, 21 mi W of Durango on Hwy 40
M. subaristata Swallen	F.W Pennel 18572	MEXICO. Durango: El Salto (aserradero)
M. sylvatica (Torr.) Torr. ex A. Gray	C.A. Weatherby 5139	USA. Connecticut: Stafford
M. tenella (Kunth) Trin.	P&A 4618	MEXICO. Michoacan: S of Uruapan on Mex 37
	P&A 4755	MEXICO. Nayarit: 10.2 mi W of Tepic on road to Miramar
M. tenuiflora (Willd.) Britton, Sterns & Poggen.	Ch.C. Deam 46,172	USA. Indiana: Noble Co., 5 mi SE of Albion
M. tenuifolia (Kunth) Trin.	P&A 4513	MEXICO. Chihuahua: 0.7 mi W of Nuevo Majalca, 8.5 mi W of Hwy 45
	P&A 8104	MEXICO. Chihuahua: 54.4 mi N Parral on Mex 24 to Chihuahua
	P&A 4059	MEXICO. Chihuahua: 3 mi NE of Parral on Hwy 45 towards Chihuahua
	P&A 4062	MEXICO. Chihuahua: 15.6 mi NE of El Vergel on Hwy 24
	P&A 4092	MEXICO. Durango: 21 mi of Rio Chico, 21 mi W of Durango on Hwy 40
	P&A 10514	USA. Texas: Jeff Davis Co., 7.5 mi SW Hwy 118 on Hwy 166, NE Valentine
M. tenuissima (J. Presl) Kunth	P&A 4751	MEXICO. Jalisco: 2 mi NW of Magdalena on Mex 15 and 15 mi from Guadalajara
M. texana Buckley	P 9613	MEXICO. Chihuahua: 10 mi SW La Junta on road to Creel
	P&A 4545	MEXICO. Chihuahua: Cascada de Basaseachic, 37 mi W of Tomochic, 0.6 mi from overlook
	P&A 4045	MEXICO. Chihuahua: 5.0 mi S of Hernandez Javales
	P&A 4019, 4021	USA. Arizona: Santa Cruz Co., 7 mi SW of Canelo on Hwy 83
M. thurberi (Scribn.)Rydb.	P&A 5618	USA. Arizona: Apache Co., Antelope House Overlook, N rim above Canyon del Muerto
	P&A 5619	USA. Arizona: Apache Co., Antelope House Overlook, N rim above Canyon del Muerto
	P&A 7870	USA. New Mexico: Rio Arriba Co., on Hwy 84, at Echo Amphitheater
M. torreyana (Schult.) Hitch.	P&L 8480	USA. New Jersey: Burlington Co., 0.1 mi N of Atlantic/ Burlington Co. lines on Hwy 206
M. torreyi (Kunth) Hitchc. ex Bush	P,A&M 10208	ARGENTINA. Provincia Salta: 48 km E of Cachi on Hwy 40 to Salta
	P&A 11364	ARGENTINA. Mendoza; San Carlos: near Estacion Arroyo Hondo on junctn road Hwy 40 & variant 40
	P&A 11418	ARGENTINA. Mendoza; Depto. Lujan de Cuyo: approx. 21 km SW Potrerillos on road toward San Jose

TAXON	COLLECTORS	LOCALITY
	P&A 11621	ARGENTINA. Tucuman; Depto. Tafi del Valle: 30 km SE Amaicha de Valle & 25 km NW Tafi del Valle
	P&A 11701	ARGENTINA. Salta; Depto. Chicoana: just E Piedra del Molino on Hwy 33 between El Carril and Cacni
	P&A 11726	ARGENTINA. Salta; Depto. San Carlos: 3 km S Isonza and 23 km N Amblayo
	P&A 5549	USA. New Mexico: Grant Co., 12 mi E Central on Hwy 90
M. uniflora (Muhl.) Fernald	J.V. Haberer 3266	USA. New York: Oneida Co., Forestforth
M. utilis (Torr.) Hitchc.	P&A 6259	MEXICO. Coahuila: 8 mi E of Los Lirios on road to Laguna de Sanchez
M. vaginata Swallen	P&A 4070	MEXICO. Chihuahua: 0.5 mi NE of El Vergel
	P&A 4111	MEXICO. Durango: 5.4 mi W of Navios, 42 mi W of Durango on Hwy 40
	P&A 4124, 4591	MEXICO. Durango: 7.0 mi W of El Salto on Hwy 40
M. versicolor Swallen	P&A 11053	MEXICO. Mexico: 1.1 mi N Tejupilco on Mex 134 towards Temascaltepec
M. villiflora Hitchc. var. *villiflora*	P&A 6228	MEXICO. San Luis Potosi: 10.3 mi NW Matehuala on road to Cedral, near Km marker 12
M. villiflora var. *villosa* (Swallen) Morden	J.R. & C.G. Reeder 4536	USA. Texas: Glasscock Co., 15 mi S of Stanton
M. virescens (Kunth) Kunth	P&A 5876	MEXICO. Chihuahua: 15 mi S San Juanito & 3 mi N Creel
	P&A 5589	USA. New Mexico: Catron Co., 2.1 mi E Hwy 180 on Forest Service Road 35, San Francisco Mts.
M. virletii (E. Fourn.) Soderstr.	P,D,B&K 13429	MEXICO. Durango: 2.4 mi N Borbollones, N Hwy 40
	P&CA 9709	MEXICO. Oaxaca: 10 mi NE Villa de Tamazulapan and 5.5 mi NE Teotongo
	P&CA 9723	MEXICO. Oaxaca: 2.6 mi E Teposcolula on Mex 125
	P&CA 9724	MEXICO. Oaxaca: 2.6 mi E Teposcolula on Mex 125
	P&CA 9729	MEXICO. Oaxaca: 5 mi SW Teposcolula and 2.5 mi NE Yolomecatl on Mex 125
M. watsoniana Hitchc.	Hernandez s.n. (HUAA)	MEXICO. Aguascalientes: San Jose de Gracia, Sierra Fria
M. wrightii Vasey ex J.M. Coult.	P&A 5592	USA. New Mexico: San Francisco Mts., Potato Patch, 3 mi E Hwy 180 on Forest Service Road 35
	P 9586	MEXICO. Chihuahua: 13 mi W Cuahutemoc on Mex 16
M. xanthodas Soderstr.	Hernandez & Sharp 311	MEXICO. Chiapas: Between Escuipulas and Cañada Honda

APPENDIX 2.
Data set used in the cladistic analysis.

Eragrostis acutiflora	2[12]111221221112[23]2
Erioneuron avenaceum	1211111111121232
Leptochloa virgata	[12]123122122212322
Sporobolus airoides	3[24]33232211212322
M. aguascalientensis	2121111111111322
M. alamosae	[12]132122122111222
M. andina	2121122122111232
M. angustata	323123121111 23[12]1
M. annua	1111121111121132
M. appressa	[12]111122122111132
M. arenacea	21111111111121[12]22
M. arenicola	21111111111122[12]22
M. argentea	212111111111212[23]2
M. arizonica	2111111111121132
M. arsenei	112112212111112[23]2
M. asperifolia	211111111111112[23]2
M. articulata	[23]231131211112322
M. aurea	2[24]23111211212322
M. brandegei	[12]111122122111132
M. brevifolia	2111111111111122
M. breviligula	2[24]33111211212322
M. brevis	111[12]121111211[23]2
M. breviseta	211112111111111[23]2
M. brevivaginata	2[14]21111111111212
M. bushii	1121122122111232
M. californica	1121122122111132
M. capillaris	2[24]3111[12]211112[23][23]1
M. capillipes	1121121111111132
M. caxamarcensis	211111111111111[12]2
M. ciliata	111112212211111[23]2
M. cleefii	2111111111111122
M. crispiseta	[12]111121111121122
M. cualensis	1121111111111322
M. xcurtisetosa	1121122122111232
M. curtifolia	21211221 2[12]121322
M. curviaristata	112312212212 12[23]2
M. curvula	[23][14]21111111111322
M. cuspidata	2111111111121232
M. depauperata	2111121111121132
M. distans	2[24]2[23]111211222322
M. distichophylla	2[24]23111211212322
M. diversiglumis	1111122122111132
M. dubia	3231231211112311
M. dumosa	1121122122111132
M. durangensis	1121231111111222
M. elongata	2[24]31111111112322
M. eludens	[12]1111211111211[23]2
M. emersleyi	[12]413111211212322
M. eriophylla	21211111111111[23]22
M. expansa	[23]431111211112322
M. fastigiata	2111111111111132
M. filiculmis	[23][14]1111111111[23][23]2
M. filiformis	2111121111111132
M. filipes	[23]431111211112322
M. flabellata	1121111111111222
M. flavida	[12]1111211111111[23]2
M. flaviseta	21211111111121[23]22
M. flexuosa	2111111111121222
M. fragilis	[12]111121111121132
M. gigantea	2433111211212222
M. glauca	111112[12]12[12]111132
M. glabriflora	1121122122111132
M. glomerata	1121122122111132
M. grandis	2[24]23111211212322
M. gypsophila	3231231211112311
M. hakoensis	1123122122121222
M. himalayensis	1123122122121222
M. hintonii	2121111111111322
M. huegelii	11221221221 21[12]22
M. implicata	2111121111111112
M. inaequalis	2423111211212322
M. xinvoluta	2433111211212322
M. iridifolia	2[24]23111211212322
M. jaime-hintonii	24111311111112[23]22
M. jaliscana	3231231211112311
M. japonica	1123122122121222
M. jonesii	2[14]111111111111[12]2
M. lehmanniana	2[24]23111211222322
M. ligularis	2111121111111132
M. lindheimeri	2423111211212222
M. longiglumis	2[24]331112112 12[23]22
M. longiligula	2[24]2311121[12]212222
M. lucida	3231231211112321
M. macroura	3231231211112311
M. majalcensis	2111121111111132
M. mexicana	112112212211 12[23]2
M. mex.var.filiformis	112112212211 12[23]2
M. michisensis	2121111111111222
M. microsperma	1111122122111132
M. minutissima	2111121111121132
M. montana	[23][14]3111111111[12][23]22
M. mucronata	3231231211112311
M. mutica	2[24]21111211112322
M. nigra	3231231211112311

M. orophila	1111111111111[12]22
M. palmeri	3231231211112321
M. palmirensis	211111111111122
M. pauciflora	212112212[12]111222
M. pectinata	11111221221111[23]2
M. peruviana	211112111111132
M. pilosa	2413111211212222
M. plumbea	2111111111112[23]2
M. polycaulis	2111122121111[23]2
M. porteri	2121122122111[12]22
M. pubescens	2[24]23111211212222
M. pubigluma	2421131211112[23]22
M. pungens	2421111111112[23]22
M. purpusii	2221111111112[23]22
M. quadridentata	[23]121111111111322
M. racemosa	11211221221112[23]2
M. ramosa	1121122122121[12][23]2
M. ramulosa	[12]111121111111132
M. reederorum	2433111211212322
M. repens	21111111111111[23]2
M. reverchonii	2[14]21111111112[23]22
M. richardsonis	211111111111132
M. rigens	3231231211112321
M. rigida	3231231211112311
M. robusta	2433111211212322
M. scoparia	2[24]23111211212322
M. schmitzii	211112111111132
M. schreberi	1121122122111222
M. seatonii	211111111111222
M. setarioides	1121122122111222
M. setifolia	2[12]31111111122122
M. sinuosa	211112111121122
M. sobolifera	2121122122111222
M. speciosa	2[24]23111211212[23]22
M. spiciformis	2111122122111[12][23]2
M. straminea	213111111111322
M. stricta	2431231211112[23]22
M. strictior	1111121111111[12]2
M. subaristata	3231231211112212
M. sylvatica	1121122122111222
M. tenella	11111221221111[23]2
M. tenuiflora	1121122122111222
M. tenuifolia	1111122122111122
M. tenuissima	1111121111111[23]2
M. texana	211112111121122
M. thurberi	211112212[12]111[12]22
M. torreyana	2[24]2311111111[12][23]2
M. torreyi	211111111122[23]22
M. uniflora	2[14]21111111121[12][12]2
M. utilis	211111111111[12]22
M. vaginata	2111121111111[23]2
M. versicolor	2[24]31111111112[23]22
M. villiflora	211111111111122
M. vill.var.villosa	211111111111122
M. virescens	3[12]3121111111[12][23]12
M. virletii	2[24]21111111112[23]22
M. watsoniana	2121111111121[23]22
M. wrightii	2[14]111111111[12]1122
M. xanthodas	2[24]231121211212222

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PSEUDOGNAPHALIUM AUSTROTEXANUM (ASTERACEAE: GNAPHALIEAE), A NEW SPECIES FROM SOUTHEASTERN TEXAS AND ADJACENT MEXICO

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, TX 76102-4060, U.S.A.

ABSTRACT

Pseudognaphalium austrotexanum Nesom, sp. nov., is described from collections in eleven counties of southern and southeastern Texas and from one locality in Nuevo León, Mexico. The new species is similar to *Pseudognaphalium viscosum*, which occurs in southwestern Texas and widely in Mexico and Central America; *P. austrotexanum* differs in its eglandular stems, non-decurrent leaves, smaller, fewer-flowered heads and keeled, apically rounded, apiculate phyllaries.

RESUMEN

Se describe ***Pseudognaphalium austrotexanum*** Nesom, sp. nov., a partir de recolecciones en once condados del sur y sureste de Texas y de una localidad en Nuevo León, México. La nueva especie es similar a *Pseudognaphalium viscosum*, del suroeste de Texas y muy común en México y América Central; *P. austrotexanum* se diferencia por sus tallos eglandulares, hojas no decurrentes, capítulos más pequeños y con menos flores, y filarios aquillados, apiculados y apicalmente redondeados.

In study of Gnaphalieae of Mexico and adjacent United States, various undescribed taxa and range extensions have come to light. The present paper reports a new species whose geographic range is centered in near-coastal and adjacent inland localities in southeastern Texas, some localities more than 100 airline miles from the coast (Fig. 2). One collection of the new species was made from the outskirts of the city of Monterrey, Nuevo León, Mexico.

Pseudognaphalium austrotexanum Nesom, sp. nov. (**Fig. 1**). TYPE: UNITED STATES. TEXAS. Jim Wells Co.: 10.1 mi S of Alice, railroad right-of-way, Santa Gertrudis Division of King Ranch, open brush on light brownish-gray, clayey, sand loam, 24 Nov 1954, *M.C. Johnston 542108* (HOLOTYPE: TEX!; ISOTYPE: SMU!).

Pseudognaphalio viscoso (Kunth) A. Anderb. duratione habitu foliis coarctatis linearibus subamplectentibus bicoloribus glandularibusque similis sed caulibus nonglandulosis foliis non-decurrentibus capitulis minoribus floribus paucioribus et phyllariis carinatis ad apicem rotundatis apiculatis differt.

Annual herbs from a woody taproot. Stems 3–7 dm tall, densely and closely white-tomentose-floccose, glabrescent, eglandular, strictly erect, unbranched until near the inflorescence or rarely more highly branched and "a large bushy herb" (fide comments on *Runyon 1954*). Leaves congested on very short internodes, continuing congested to immediately beneath the heads, the upper loosely to strictly ascending, the lower (moribund) loosely spreading to deflexed, the

Fig. 1. Habit of *Pseudognaphalium austrotexanum* (from the holotype, *Johnston 542108*).

blades epetiolate, linear to linear-lanceolate, 2–5 cm long, 1–3 mm wide, relatively uniform in size, shorter immediately below the heads, subclasping but not basally ampliate, auriculate, or decurrent, apically acute, strongly bicolored, the upper surface green, densely stipitate-glandular, otherwise glabrate, the lower surface densely and closely white-tomentose, the margins revolute, sometimes closely sinuate. Capitula 4.5-5 mm high, in tight glomerules, the glomerules usually borne in a flat-topped inflorescence 10–30 cm wide, the ultimate branches 1.5–4 cm long; phyllaries narrowly ovate to oblong or elliptic, persistently wooly at the base, the inner with an elongate stereome, gland-dotted near the apex, the outer ca. 2/3 as long as the inner. Outer, pistillate florets (in Mexico, 46–)76–102; inner, bisexual florets (6–)8–11. Cypselae oblong, brownish-yellow, 0.5–0.7 mm long, 4–6 striate-ridged longitudinally, minutely papillate; pappus of fragile, separate, basally caducous barbellate bristles.

Additional collections examined. **MEXICO. Nuevo Leon:** 7 mi SE of the Santa Catarina bridge in Monterrey on the Montemorelos highway, gravel pit of the Cia. Fundidora de Fierro y Acero, 2000 ft, reddish limestone and caliche gravel, 11 Nov 1959, *Johnston 4618* (TEX). **UNITED STATES. Texas. Brazoria Co.:** Brazoria National Wildlife Refuge, Bastrop Bayou, across bayou from N end of island, 27 Oct 1967, *Fleetwood 9149* (TEX); 3.5 mi E of Angleton, 9 Oct 1934, *Cory 11495* (GH). **Brazos Co.:** College Station, 3 Oct 1946, *Parks s.n.* (TEX). **Brooks Co.:** 5 mi N of Falfurrias, 28 Oct 1973, *Everitt s.n.* (SMU). **Frio Co.:** 13.6 mi NNW of Dilly on Hwy 117, scrub pasture, reddish soil, 31 Oct 1981, *Mahler 9225* (BRIT). **Harris Co.:** Seabrook, 18 Oct 1939, *Fisher 39038* (TEX). **Jim Hogg Co.:** 9 mi SW of Hebbronville, sandy loam, not plentiful, 10 Dec 1972, *Bone s.n.* (TEX). **Kenedy Co.:** near Rudolph, S of Norias, sandy knoll along highway, 3 Jan 1963, *Correll 26926* (NCU, TEX); 4.4 mi S of Armstrong, sandy sacahuiste prairie at edge of caliche flat, 29 Nov 1954, *Johnston 542266* (TEX); S of Armstrong on side of Hwy 96, sandy loam soil, scarce, only a few plants seen, 17 Oct 1938, *Runyon 1954* (TEX 2 sheets, US); Norias, highway right-of-way, dune sand, 4 Dec 1948, *Tharp, Johnson, and Webster 48 108* (TEX). **Matagorda Co.:** Matagorda, 14 Oct 1936, *Fisher 3661* (ARIZ, TEX, US). **San Patricio Co.:** 8 mi SW of Taft, near shore of Nueces Bay but above high tide level, soil not saline, 10 Nov 1956, *Jones 1261* (SMU); ca. 2 mi SE of Odem, in sandy open pasture, locally abundant, 31 Oct 1959, *Jones 3610* (TEX). **Uvalde Co.:** Uvalde, 1880, *Palmer 550* (GH).

These plants are similar to *Pseudognaphalium viscosum* (Kunth) A. Anderb. in general appearance and previously have been identified as that species. Plants of both species are taprooted annuals with white-tomentose, strictly erect stems mostly unbranched until the inflorescence, leaves linear to linear-lanceolate, strongly bicolored (green and glandular above, white-tomentose beneath), loosely to strictly ascending, crowded on short internodes and continuing to immediately below the heads, and basally subclasping but not strongly auriculate, phyllaries silvery, thin-hyaline, and achenes minutely papillate. They are distinguished by the following contrasts:

1. Capitula ca. 250-flowered, bisexual florets (13)16 29, pistillate florets ca. 200–250; inner phyllaries narrowly acute at apex, not apiculate, not keeled or with a barely perceptible thickening along the midrib; stems stipitate-glandular; leaves not basally ampliate or subclasping, the lower usually decurrent 3–6(–10) mm.
_______________ **Pseudognaphalium viscosum**

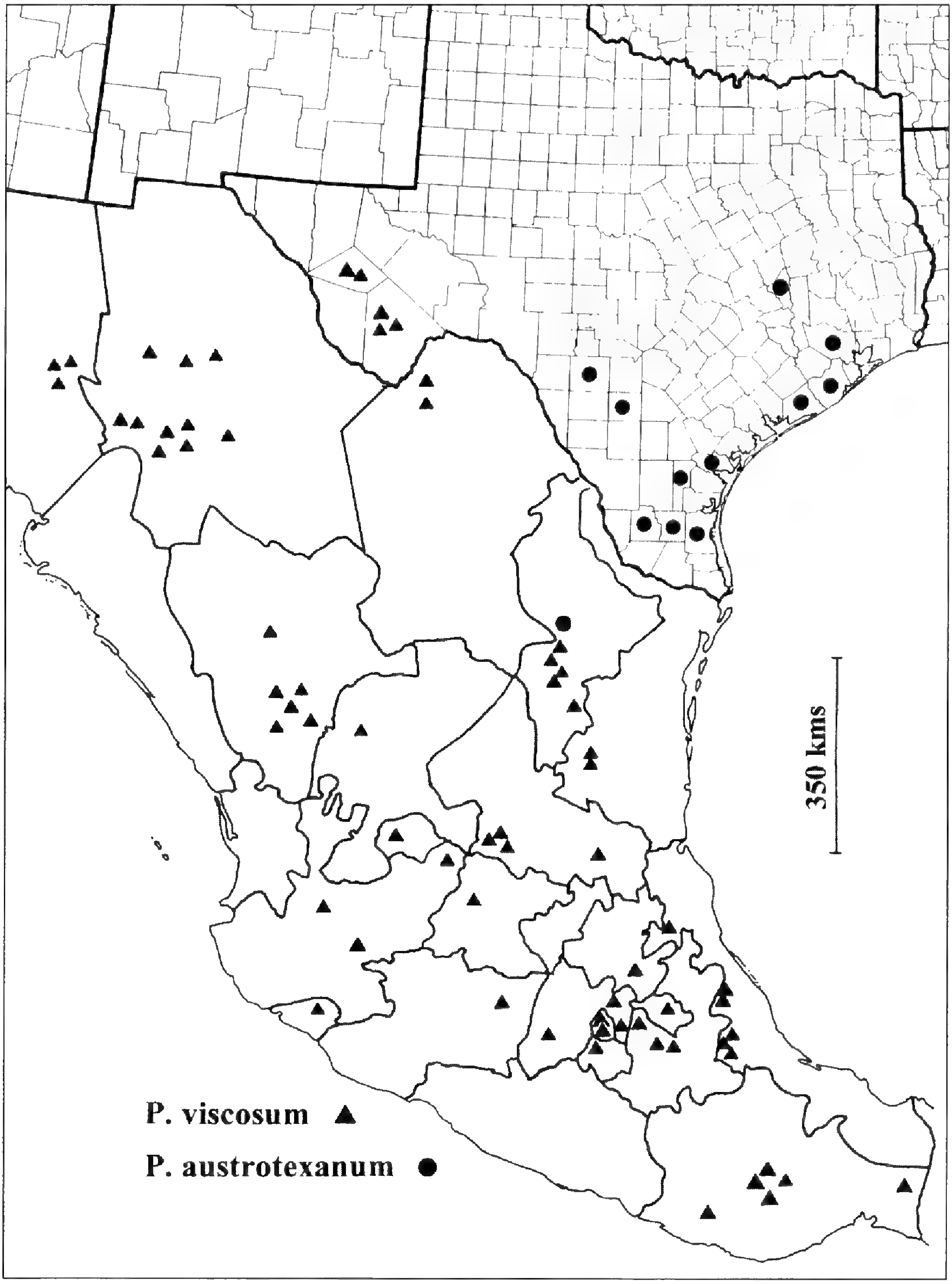

Fig. 2. Distribution of *Pseudognaphalium austrotexanum* and *Pseudognaphalium viscosum* in the United States and Mexico. The range of *P. viscosum* continues into Central America.

1. Capitula ca. 100-flowered, bisexual florets (6–)8–11, pistillate florets (46–)76–102; inner phyllaries apically rounded or acuminate, distinctly apiculate from a thickened and slightly raised midrib (keel); stems eglandular; leaves basally subclasping, not decurrent. ______ **Pseudognaphalium austrotexanum**

Pseudognaphalium viscosum is distributed through Mexico and Central America and also apparently is common on the Caribbean island of Hispaniola. In the United States, it is known only from southwestern Texas, widely separated by distance, habitat, and climate from *P. austrotexanum* (Fig. 2).

Plants of *Pseudognaphalium austrotexanum* were included by Correll and Johnston (1970) as "rare in s.e. Tex." with plants identified as *Gnaphalium macounii* Greene, a name that has sometimes been misapplied to *Pseudognaphalium viscosum*. The other Texas plants of "*G. macounii*" ("local in Rio Grande Plains and Trans-Pecos ... and the Llano region of the Edward Plateau") are *Pseudognaphalium viscosum* rather than *Pseudognaphalium* (*Gnaphalium*) *macounii* (Greene) Kartesz, which does not occur in Texas. The only known Mexican locality for *P. austrotexanum* is separated by about 200 kilometers from the closest Texas site, although the geology and topology are generally similar. The Nuevo León site is alongside a major highway, and a fruit may have been accidentally transported (vehicle-dispersal) from Texas.

The distinctiveness of *Pseudognaphalium austrotexanum* also has been recognized by several other botanists: Marshall Johnston (by notation); Billie Turner (pers. comm.); and Harvey Ballard (by annotation and pers. comm.).

ACKNOWLEDGMENTS

I am grateful to the staffs at BRIT, GH, TEX, and US for help during visits, to Billie Turner for arranging for the fine illustration by Linny Heagy, and to an anonymous reviewer for helpful comments.

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BOOK REVIEW

KAY YATSKIEVYCH. 2002. **Field Guide to Indiana Wild Flowers.** (ISBN 0-253-21420-3, pbk.). Indiana University Press, 601 North Morton Street, Bloomington, IN 47404-3797, U.S.A. (Orders: iupress.indiana.edu, 800-842-6796, 812-855-4203, 812-855-8507 fax). $17.95, 372 pp, 640 color photos, line drawings, 5 1/2" × 8 1/2".

How should a book review be done about a subject (Wild Flower Field Guides) that has seen a great revival during the past few decades? It seems to me that the importance of field guides goes far beyond their immediate practical usefulness of identifying a species of plant that might attract ones interest for a short moment. Here are some of my feelings about the significance of wild flowers and Kay Yatskievych's book.

Having seen springtime come and go for nearly thirty years in Indiana, and having contemplated that these springtimes have been rhythmically undergoing their ever-changing complex phenomena for at least 10,000 years in the glaciated parts of Indiana, I personally know that the places on earth where these flashes of springtime brilliance that I have witnessed in the virgin beech-maple and oak hickory forests in some of the State parks and State forests of Indiana are quickly vanishing.

What if an unexpected, terrible disaster such as a tornado, earthquake, fire, explosion, or even a terrorist act destroyed one of the fine buildings on the campus of Indiana University or Purdue University? By using the blueprints that were used to build the original structure, highly sophisticated, well-trained Indiana architects, engineers, and other scientists could draw up plans to replace the destroyed building exactly as it was, even to the minutest detail, such as the determination of the physical/chemical properties of the materials needed for the reproduction. Soil scientists and geologists could determine in great depth the physical/chemical conditions of the ground where the building stood.

But what if human population and social explosions such as urban sprawl, industrial development, cancerous shopping mall expansion, or even university campus development destroyed nearby pristine eco-habitats of beech-maple and oak-hickory forests? Where could the dynamic structural details of these rapidly vanishing, primeval treasures be found?

Where are the brilliant, highly sophisticated, well-trained architects, engineers, and other scientists, with great library and internet resources, who could draw up the plans for a virgin beech-maple forest that would be exactly like it was, even to the minutest detail of the myriads of unseen structural features represented by the millions of microscopic living creatures, before it was carelessly destroyed?

Kay Yatskievych has produced a field guide to 1,564 pieces (wild flower species) that might fit into the dynamic structure of these lost masterpieces. Just as the architects and engineers have their technical vocabularies to name and describe the pieces that go into their structures, Kay Yatskievych has provided us in 374 pages an easy to carry, detailed, and easy to use guide for naming and talking about many traits of these 1,564 species. Because of the excellent "flower finder" and other line drawings, color photos of examples of all genera, and clear word descriptions of important traits of each species, her guide will help plant lovers of all kinds know these "pieces of the puzzel of the forest" in much greater detail. Hopefully, some of the younger users of this book will be inspired to dig much deeper into the forests and uncover more of the interconnecting webs that help tie the dynamic structure together.—*Joe F. Hennen, Resident Research Associate, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

TAXONOMIC NOTES ON *KEYSSERIA* AND *PYTINICARPA* (ASTERACEAE: ASTEREAE, LAGENIFERINAE)

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, TX 76102-4060, U.S.A.

ABSTRACT

Keysseria is divided between Indonesia (9 species in New Guinea, Celebes, and Borneo) and the Hawaiian islands (3 species). The Hawaiian species are formally segregated here as ***Keysseria*** sect. ***Sandwicactis*** Nesom, sect. nov., on the basis of their bisexual and fertile disc florets (vs. functionally staminate in Indonesia) and other morphological differences in ray and disc corollas. *Keysseria pickeringii* A. Gray, endemic to Vanua Levu Island, Fiji, is excluded from *Keysseria* and formally recognized as ***Pytinicarpa pickeringii*** (A. Gray) Nesom, comb. nov. A nomenclatural update and summary are provided for *Pytinicarpa*, whose other two species are New Caledonian. The genera of Lageniferinae, including *Keysseria* and *Pytinicarpa*, are divided into seven "core genera" and five "peripheral genera"; a key to the core genera is provided.

RESUMEN

Keysseria está dividido entre Indonesia (9 especies en Nueva Guinea, Celebes, y Borneo) y las islas Hawai (3 especies). las especies Hawaianas se segregan formalmente aquí como ***Keysseria*** sect. ***Sandwicactis*** Nesom, sect. nov., en base a sus flósculos bisexuales y fértiles (vs. funcionalmente estaminadas en Indonesia) y otras diferencias morfológicas en las corolas centrales y periféricas. *Keysseria pickeringii* A. Gray, endémica de la isla Vanua Levu, Fiji, se excluye de *Keysseria* y se reconoce formalmente como ***Pytinicarpa pickeringii*** (A. Gray) Nesom, comb. nov. Se ofrece una puesta al día y resumen nomenclatural para *Pytinicarpa*, cuyas otras dos especies son de Nueva Caledonia. Los de Lageniferinae, que incluyen *Keysseria* y *Pytinicarpa*, se dividen en siete "centrales" y cinco "géneros periféricos"; se ofrece una clave para los géneros centrales.

Keysseria Lauterbach (Lauterbach 1914) is a genus of 12 species divided between Indonesia (9 species plus infraspecific taxa; Koster 1966) and Hawaii (3 species; Mill 1990, 1999 – see below). All of the Indonesian species occur in New Guinea; *K. radicans* (F. Muell.) Mattf. also is known from Celebes and *K. gibbsiae* (Merrill) Cabrera ex Steenis also occurs on Mt. Kinabalu in Borneo. The genus was treated as a member of Astereae subtribe Lageniferinae by Nesom (1994a, 2000) and a recent morphological and taxonomic overview is available (Nesom 2000).

The three Hawaiian species were transferred to *Keysseria* from *Lagenifera* Cass. by Cabrera (1966). Mill (1990, 1999) maintained them in a broadly conceived *Lagenifera*, indicating that *Keysseria* was to be regarded as a synonym. Swenson and Bremer (1994) also explicitly regarded *Keysseria* as a synonym of *Lagenifera*. Perspective on morphological distinctions among these genera is provided below in the key to the "core genera" of Lageniferinae.

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The Hawaiian plants of *Keysseria* are similar to the Indonesian ones in habitat, habit, and morphological details but differ as follows: disc florets with fertile ovaries (vs. functionally staminate), ray corollas usually deeply and asymmetrically 2–4-lobed at the apex (vs. apically entire), and disc corollas sometimes 5-lobed (vs. consistently 4-lobed). Mill (1990) noted that the Hawaiian species apparently are "from one founder;" in this summary of supraspecific taxonomy of *Keysseria*, they are treated as a separate section.

Keysseria Lauterbach, Repert. Spec. Nov. Regni Veg. 13:241. 1914. *Myriactis* Less. subg. *Hecatactis* F. Muell., Trans. Royal Soc. Victoria 1, 2:13. 1889. *Hecatactis* (F. Muell.) F. Muell. ex Mattf., Bot. Jahrb. Syst. 62:407. 1929. *Keysseria* sect. *Hecatactis* (F. Muell.) Mattf., Bot. Jahrb. 68:250. 1937. TYPE: *Keysseria papuana* Lauterbach (= *Keysseria radicans* (F. Muell.) Mattf.).

The nine Indonesian species constitute sect. *Keysseria*.

Keysseria Lauterbach sect. **Sandwicactis** Nesom, sect. nov. TYPE: *Keysseria erici* (C.N. Forbes) Cabrera.

Differt a *Keysseria* sect. *Keysseria* floribus discii ovariis fertilibus, corollis radii plerumque ad apicem 2–4-lobatis, et corollis discii aliquando 5-lobatis.

Species included: *K. erici*, *K. maviensis* (H. Mann) Cabrera, and *K. helenae* (C.N. Forbes & Lydgate) Cabrera.

The "core genera" of Lageniferinae

Lagenifera Cass. and genera similar to it have been grouped together as the subtribe Lageniferinae (Table 1) (Nesom 1994a). Three genera have been added to the Lageniferinae since the recent classification and overview: *Lagenocypsela* U. Swenson and K. Bremer (Swenson & Bremer 1994); *Pytinicarpa* Nesom (Nesom 1994b); and *Pappochroma* Raf. (Forbes & Morris 1996; Nesom 1994c, 1994d, 1998; synonyms = *Lagenopappus* Nesom and *Lagenithrix* Nesom). The 12 genera and approximately 71 species of Lageniferinae are distributed from India to southeast Asia, Australia, and various Pacific islands, except for the nine species of *Lagenifera* and *Myriactis* native to South America and Central America. Plants of the seven "core genera" of Lageniferinae (Table 1) are primarily characterized (with exceptions) by a herbaceous habit, leaves mostly in a basal rosette, heads borne singly on scapose or scapiform stems or few in a loose panicle, pistillate florets with reduced lamina and in several series, a tendency to produce functionally staminate disc florets, and flat, 2-nerved, epappose cypselae, commonly with a glandular apex or beak. The remaining five "peripheral genera," while similar in geography, may not be closely related to the others; they differ in combinations of various features, particularly in subterete, multinerved cypselae.

A key to the "core genera" provides perspective for the positioning of *Keysseria* and its distinction within the group.

Table 1. Composition of subtribe Lageniferinae.

"core genera"

Keysseria Lauterbach (12 species; Hawaiian Islands and Indonesia–New Guinea, Celebes, and Borneo)
Lagenifera Cass. (15 species; Australasia and South America)
Lagenocypsela U. Swenson & K. Bremer (2 species; New Guinea)
Myriactis Less. (ca. 19 species; Central America, South America, southeast Asia, Indonesia)
Pappochroma Raf. (9 species; Australia and Tasmania).
    Synonyms = *Lagenopappus* Nesom and *Lagenithrix* Nesom
Piora Koster (1 species; New Guinea)
Solenogyne Cass. (3 species; Australia, New Zealand)

"peripheral genera"

Pytinicarpa Nesom (3 species; New Caledonia and Fiji)
Rhamphogyne S. Moore (1 species; Rodrigues Island)
Rhynchospermum Reinw. (1 species; Japan, Korea, Ryukyus, Formosa, Malaysia, and India)
Sheareria S. Moore (2 species; southern and southeastern China)
Thespis DC. (3 species; southeast Asia)

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1. Pappus of barbellate bristles. ____ **Pappochroma**
1. Pappus none.
  2. Disc corollas infundibular, the tube abruptly opening into a broad limb, 4-lobed or 5-lobed; flowering stems leafy or scapiform; plants perennial and arising from a thick rhizome or a procumbent stem (*Keysseria*, *Piora*, and *Myriactis* p. p.) or annual from a thin base (*Myriactis* s. str.).
  2. Disc corollas tubular-funnelform, gradually opening into the limb, 5-lobed; flowering stems scapiform; plants short-lived, perennial, arising from a barely evident caudex region.
    3. Phyllaries narrowly lanceolate to linear, acute to acuminate; capitula radiate—lamina of ray florets strongly developed; cypselar beak well-developed, glandular. ____ **Lagenifera**
    3. Phyllaries elliptic-obovate to oblong, bluntly rounded to obtuse; capitula disciform—lamina of ray florets rudimentary or absent; cypselar beak pronounced to rudimentary or absent, the fruits mostly eglandular.
      4. Cypselar beak conspicuous; ovaries of disc florets completely absent; leaves entire. ____ **Lagenocypsela**
      4. Cypselar beak rudimentary or absent; ovaries of disc florets present, sterile; leaves toothed. ____ **Solenogyne**
        5. Annual or perennial herbs, not aromatic; leaves thin-herbaceous, flat-margined, sometimes subclasping but not basally dilated or sheathing, the basal often persistent but the cauline continuing unreduced in size halfway to nearly completely up the stem. ____ **Myriactis**
        5. Perennial herbs to subshrubs or shrubs, at least some species aromatic; leaves thickened to coriaceous, usually with revolute or deflexed margins, basally dilated and sheathing, evenly arranged along the stems or in rosulate clusters.
          6. Leaves of current year in a rosulate or subrosulate cluster, the heads

on long, scapiform peduncles; anthers with a short apical appendage. ______ **Keysseria**

6. Leaves densely and more or less evenly arranged on the stems, the heads without an evident peduncle; anthers without an apical appendage. ______ **Piora**

Transfer of *Keysseria pickeringii* to *Pytinicarpa*

Keysseria pickeringii, originally described by Gray (1861), is endemic to Vanua Levu Island, Fiji. Smith and Carr (1991, p. 302) noted "it is not possible to suggest a New Guinean relative of *Keysseria pickeringii*, which is remarkable for its very small heads and its costate achenes." This species, which has a basal rosette of narrow leaves loosely villous-strigose on both surfaces, monocephalous and minutely bracteate, scapiform stems, small, radiate heads, convex receptacles, functionally staminate disc florets, and subcylindric, eglandular cypselae 4 mm long with 8–10 longitudinal, strongly raised nerves and a truncate, epappose apex, is a member of the recently described genus *Pytinicarpa* Nesom (Nesom 1994b), which originally included two species from New Caledonia. Some features of *Pytinicarpa* (geography, solitary capitula on scapose stems, functionally staminate disc florets, epappose cypselae) suggest that it shares close ancestry with genera of Lageniferinae, but the conical-convex receptacles, ray florets in a single series, and multinerved, subcylindric cypselae are unusual in that subtribe.

Pytinicarpa pickeringii (A. Gray) Nesom, comb. nov. *Lagenophora pickeringii* A. Gray, Proc. Amer. Acad. Arts 5:121. 1861. *Keysseria pickeringii* (A. Gray) Cabrera, Blumea 14:307. 1966. TYPE: FIJI: Vanua Levu Island, Mathuata Mts., [ca. Jul 1840], *Wilkes Expl. Exped. s.n.* (HOLOTYPE: US!).

Pytinicarpa pickeringii differs from both New Caledonian species in its cypselar surface, which is minutely papillate, the center of each cell abruptly raised into a sharp point. In the New Caledonian species, these epidermal cells are similarly quadrate but the whole surface of each cell is convex and the cypselar surface has a "frothy" appearance. The relatively broad leaves of *P. pickeringii* are more like those of *P. sarasinii* (see below) rather than the linear leaves of *P. neocaledonia*, but those of *P. pickeringii* are obovate-spatulate, abruptly narrowed to a petiolar base, and the margins are shallowly crenulate-mucronulate (vs. oblanceolate, without a distinct petiolar portion, with margins coarsely toothed only near the apex).

There is some indication that the narrow "coronal rim" of the cypselae in *Pytinicarpa pickeringii* might have been sticky when fresh, which is a general feature of the Lageniferinae. This rim is similar to that illustrated for the cypsela of *P. sarasinii* (Nesom 1994b), where stickiness was not evident.

Nomenclature of New Caledonian *Pytinicarpa*

Lagenifera neocaledonica S. Moore predates *Brachyscome sarasinii* Daniker, which was the basionym for one of the two original species in *Pytinicarpa* (Nesom 1994b). Cabrera (1966), in his list of species excluded from *Lagenifera*, recognized that these two names refer to the same species. But because the epithet "neocaledonica" already exists in *Pytinicarpa* for the second species, *P. sarasinii* is the correct designation of the broad-leaved New Caledonian species named by Moore and Daniker. The two New Caledonian species are as follows.

1. **Pytinicarpa sarasinii** (Daniker) Nesom, Phytologia 76:138. 1994. *Brachyscome sarasinii* Daniker, Mitt. Bot. Mus. Univ. Zürich 142:479. 1933. TYPE: NEW CALEDONIA: Am obern Abhang des Mut. Koniambo bei der Mine Boume I, zerstreut im lichten Gebusch an felsigen stellen, 14 Jan 1925, *Daniker 880* (HOLOTYPE: Z).

   Lagenifera neocaledonica S. Moore, J. Linn. Soc. Bot. 45:345. 1921 (non *Pytincarpa* (*Brachyscome*) *neocaledonica* (Guill.) Nesom 1994). TYPE: NEW CALEDONIA: Taom, bare red serpentine earth, 2500 ft, rare, 2 Dec 1914, *R.H. Compton 2305* (HOLOTYPE: BM, photocopy!).

2. **Pytinicarpa neocaledonica** (Guill.) Nesom, Phytologia 76:138. 1994. *Brachyscome neocaledonica* Guill., Bull. Soc. Bot. France 84:61. 1937. SYNTYPES: NEW CALEDONIA: Gatope, *Viellard 2823* (AA! GH!); Néhoué, *Pancher 425* and *Deplanche 425*.

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A NEW SPECIES OF *SACCOGLOSSUM* (ORCHIDACEAE) FROM THE HANS MEYER RANGE, NEW IRELAND, PAPUA NEW GUINEA

N.H.S. Howcroft

ENB Balsa Industry Strengthening Project (ITTO)
PNG Forest Authority, POB 406
Rabaul, East New Britain 614
PAPUA NEW GUINEA
howcroft@daltron.com.pg

ABSTRACT

A new species, ***Saccoglossum takeuchii***, is described from the Hans Meyer Range in southern New Ireland, Papua New Guinea. The novelty is most closely related to *S. lanceolatum* L.O. Williams, but differs from the latter species in the size and shape of the petals, the lesser number of cilia-like stelids, the prominent dentation around the clinandrium, and by the differently shaped leaves.

ABSTRACT (MELANESIAN TOK PISIN)

Nupela kain orchid ***Saccoglossum takeuchii***, ol bin kisim long Hans Meyer Range insait long Nu Ailan, Papua New Guinea, em ol bin deskraibim. Em I wankain long *Saccoglossum lanceolatum* L.O. Williams. Dispela em minim olsem long sais na saip long petals, na namba long stelids na dentations bilong clinandrium, na saip long lip.

INTRODUCTION

The genus *Saccoglossum* is presently comprised of four taxa: *S. lanceolatum* L.O. Williams, *S. maculata* Schltr., *S. papuanum* Schltr., and *S. verrucosum* L.O. Williams. The latter species is recorded only from Irian Jaya whereas the others are known primarily from Papua New Guinea (PNG). O'Byrne (1994) suggested there are about 5 species and that some new ones could be expected from the PNG Highlands. In the orchid treatments for Vanuatu, the Solomon Islands, and Bougainville (Lewis & Cribb 1989, 1991) no records are provided for *Saccoglossum*. The new species extends the generic range to New Ireland and apparently marks the easternmost limit for the genus. The Hans Meyer species is most closely related to *S. lanceolatum* L.O. Williams but differs in the size and shape of the petals, the structure of the clinandrium, and to a lesser extent the shape of the leaves.

Saccoglossum takeuchii Howcroft, sp. nov. (**Fig. 1**). TYPUS: PAPUA NEW GUINEA. NEW IRELAND PROVINCE: Hans Meyer Range, 27 Jan 1994, *W. Takeuchi & J. Wiakabu 9601*, 27 Jan 1994 (HOLOTYPUS: LAE).

Species nova ad *Saccoglossum lanceolato* similans sed ab ea petalis ellipticis ad apices retusis ad bases subtruncatus, clinandrio stelidiis pauciora atque dentibus diversis praedentis perfacile distinguitur.

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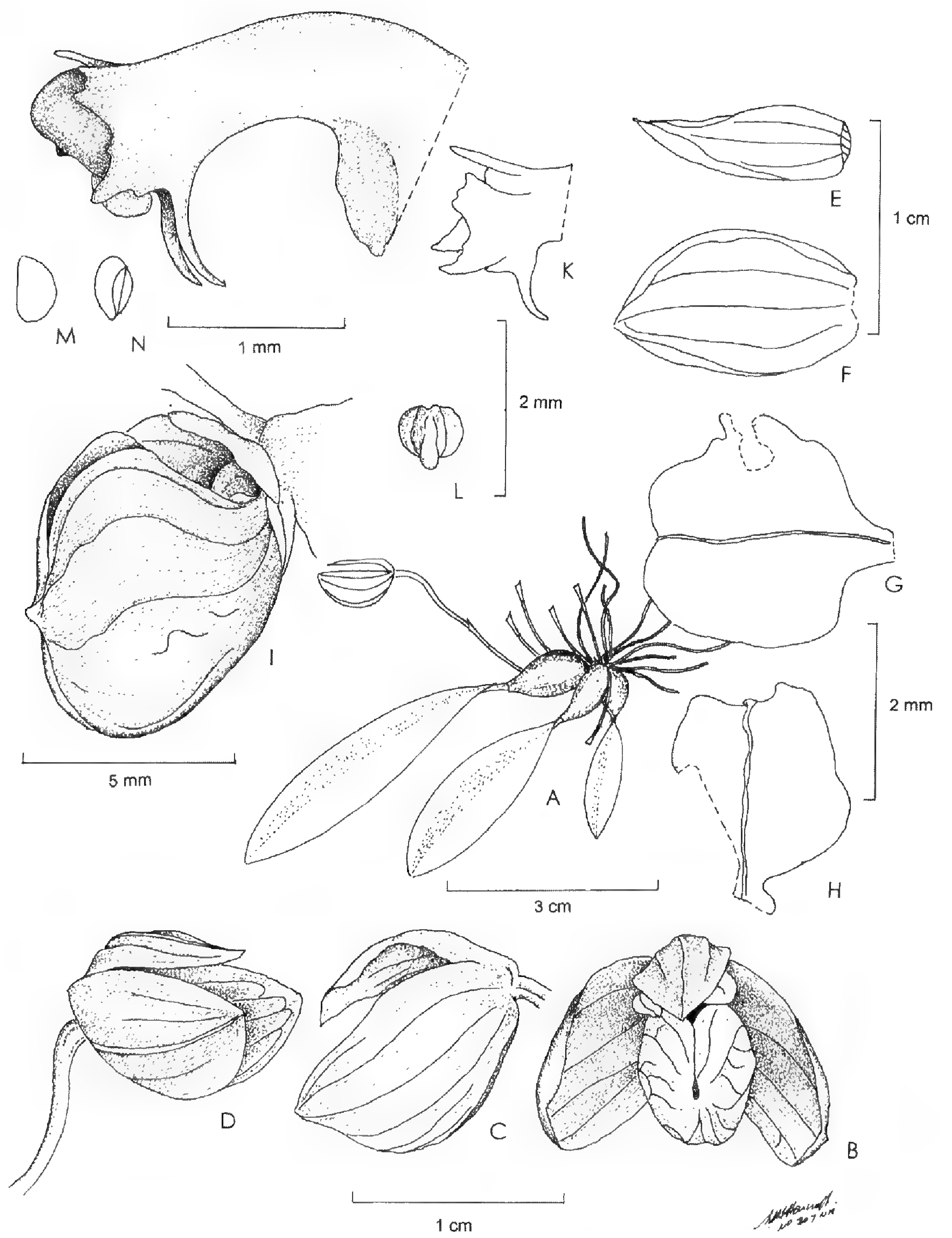

Fig. 1. *Saccoglossum takeuchi* (drawn from type material). A. Plant habit. B. Flower, front view. C–D. Flower lateral views. E–F. Dorsal and lateral sepals. G–H. Petals. I. Labellum, lateral view. J. Column with anther, lateral view. K. Column stelids, lateral view. L. Anther. M–N. Pollen, lateral and oblique ventral (scale as for L).

Epiphyte, erect to suberect, up to ca. 7 cm tall. *Rhizome* creeping, concealed by sheaths. *Pseudobulbs* obovoid, 1.25 to 1.5 cm long, up to 0.75 cm in diameter, unifoliate, surface smooth, yellow green. *Leaf* blade elliptic to lanceolate, 4.5–

5.5 × 1.0–1.7 cm, apically obtuse, base duplicative, sessile, surfaces glossy green, texture firm, costa impressed above. *Inflorescences* more or less fasciculate, lateral from base of the pseudobulb, erect, single flowered, peduncle short, 3.1–3.8 cm long, 0.2–0.3 mm in diameter, provided with a single sheath, glabrous. *Perianth* purple, glabrous; *dorsal sepal* ovate-lanceolate, 1.05 × 0.33–0.5 cm, slightly hooded, subacute; *lateral sepal* obliquely ovate, 1.18 × 0.66–0.70 cm, apiculate, glabrous; *petals* broadly obovate to obliquely quadrate, 0.28 × 0.24 cm, apically truncate, attenuate at base, glabrous, median nerve slightly raised and thickened; *labellum* saccate, 0.55–0.66 cm high, 0.55 cm broad, 0.78 cm long, front part incised; *column* arched, glabrous, thickened to the base and with a short, thick foot, ca. 0.24–0.25 cm long; *clinandrium* in two segments on either side, the lower with one cirrhose stelid on each side, the upper subpalmate with a subulate margin; *anther* cordate in outline with a raised, thickened keel, 0.07 × 0.08 cm; *ovary* with glabrous pedicel, ca. 1.3 cm long.

Distribution.—Known only from the Hans Meyer Range in New Ireland, Papua New Guinea.

Habitat.—Mossy montane forest on trees at ca. 1175 m elevation.

Etymology.—The new species has been named for Wayne Takeuchi, the principal collector of this orchid who submitted the type specimen to me for identification, together with many other orchids from New Ireland.

Notes.—The description and illustration of *Saccoglossum takeuchii* was made from spirit material. The new species differs in flower color from its congeners (based on Takeuchi's fieldnotes) and the floral parts are also smaller than those from previously described species.

ACKNOWLEDGMENTS

I wish to thank Wayne Takeuchi and Joe Wiakabu for providing the specimen of *Saccoglossum takeuchii* and John Pipoly for his help with the Latin diagnosis. To John Ohana a very special thanks for his assistance with the Melanesian Tok Pisin abstract.

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BOOK REVIEW

DENI BOWN. 2000. **Aroids: Plants of the Arum family (ed. 2).** (ISBN 0-88192-485-7, hbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $34.95, 468 pp, 108 color photos, 50 line drawings, 6" × 9".

Contents.—Foreword to the Second Edition, Peter C. Boyce; Foreword to the First Edition, Simon Mayo; Preface; Acknowledgments; Introduction.

1. Variations on a theme: What are aroids and where do they grow?
2. Of tails and traps and the underworld: Mechanisms of reproduction.
3. Woodlanders: Species of temperate woodland and higher altitudes of the tropics and subtropics.
4. Aquatics and Amphibians: Species of wetlands and water.
5. A place in the sun: Species of arid and seasonally dry regions.
6. In the shadows: Species of the tropical rainforest floor.
7. Towards the light: Tropical climbers and epiphytes.
8. The titans: Giant tuberous species of the tropics.
9. An acquired taste: Aroids as food plants.
10. Acids and crystals: The chemistry and toxicity of aroids.
    - Aroids in cultivation (with detailed notes on how to do it, arranged by genus and species).
    - Checklist of aroid genera (concise overview of classification, with number of species, distribution, habit, and ecology for each genus).
    - Glossary
    - References
    - Index

It's an amazing family—so much structural diversity and so much biological diversity—with about 109 genera and 3200 species. Philodendron (*Philodendron*), anthurium (*Anthurium*), green dragon and jack-in-the-pulpit (*Arisaema*), dumb cane (*Dieffenbachia*), duckweeds (*Lemna* and relatives), monstera (*Monstera*), pothos (*Pothos* and relatives), caladium (*Caladium*), golden club (*Orontium*), skunk cabbage (*Symplocarpus*), calla (*Calla*), taro (*Colocasia*), water lettuce (*Pistia*), cryptocoryne and lagenandra (*Cryptocoryne* and *Lagenandra*), titan arum (*Amorphophallus*), arum lily (*Zantedeschia*). ... even those with only a passing interest in horticulture know most of these names. And even the inside-oriented see these plants in aquaria, malls, and shady, highly tamed gardens. "Sweet flag" is out of the family (*Acorus calamus*, "The Aroid that never was," pp. 124–126) but still given discussion; the duckweeds are in (*Lemna* et al., "Deceptively delicate drifters," pp. 100–102).

The new edition of Bown's "Aroids" conveys so much interesting information with as much clarity and wit as anything botanical I've ever read. The beautiful photos are integral. The author intends the book as a general introduction to the family, "readable rather than only referable" but "sufficiently informative to attract enthusiasts who already grow these remarkable subjects," and as an offering "for all those who find structure and design in naure an endless fascination." You may want one copy for yourself, one for a friend, and one for the local public school library. *The Genera of Araceae* (S.J. Mayo et al. 1997, Kew Gardens) is more technical and more technically organized but a natural companion to the Bown volume.—*Guy L. Nesom, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

NOMENCLATURAL CHANGES IN PENNISETUM (POACEAE: PANICEAE)

Joseph K. Wipff

Pure Seed Testing, Inc.
P. O. Box 449
Hubbard, OR 97032 U.S.A.

ABSTRACT

During preparation of the account of *Pennisetum* Rich. for the *Manual of Grasses for North America*, it was determined that three taxa formerly treated under *Cenchrus* L. required new combinations in *Pennisetum*: ***P. setigerum*** (Vahl) Wipff, comb. nov., ***P. pennisetiforme*** (Hochst. & Steud. ex Steud.) Wipff; comb. nov., and ***P. somalensis*** (Clayton) Wipff, comb. nov.

RESUMEN

Durante la preparación del informe de *Pennisetum* Rich. para el *Manual of Grasses for North America*, se vio que taxa tratados previamente como *Cenchrus* L. necesitaban nuevas combinaciones en *Pennisetum*: ***P. setigerum*** (Vahl) Wipff, comb. nov., ***P. pennisetiforme*** (Hochst. & Steud. ex Steud.) Wipff; comb. nov., y ***P. somalensis*** (Clayton) Wipff, comb. nov.

There has been considerable debate concerning the generic limits of *Cenchrus* L. and *Pennisetum* Rich. The predominant character traditionally used to distinguish the two genera is fusion, or lack of fusion, of the bristles (e.g., Henrard 1935; DeLisle 1963; Clayton & Renvoize 1982; Filguerias 1984, Clayton & Renvoize 1986; Watson & Dallwitz 1992), but its variation across the two genera is continuous, making the placement of numerous species arbitrary (Webster 1987). DeLisle (1963), though basing his treatment on the traditional criteria of bristle fusion, recognized the difficulty in the interpretation of this character, and refined his generic criteria with the addition of the follow characters. *Pennisetum* has bristles that are seldom more than 0.2–0.4 mm wide, and the base of the fascicle rarely exceeds 0.5 mm in width; whereas in *Cenchrus*, "the spines usually 0.5 mm or (more) wider, and are generally united for a considerable distance above the base of the bur, with the base itself usually at least 1.5 mm in diameter. These characteristics, although admittedly arbitrary, are used in the present treatment of the genus *Cenchrus*" (DeLile 1963, p. 269). The increase in base diameter is probably a structural response to the fusion and thickening of the bristles and is closely correlated with bristle fusion. The more fusion and thickening of the bristles that occurs the wider the base of the fascicle must be to support them.

Filgueiras (1984), using criteria similar to that of DeLisle (1963), separated the two genera as follows. *Cenchrus* has fused bristles, at least basally, forming a basal disc at least 1 mm in diameter, whereas *Pennisetum* has bristles to the

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base, not forming a disc. Webster (1987) used only the presence of this disc or callus to separate the genera; in *Cenchrus* the callus is pronounced, with the apex flared to form a discoid receptacle, whereas in *Pennisetum* the pronounced callus is absent or, when present not differentiated as in *Cenchrus* species. Webster went on to say that this character allows for the separation of the species along traditional grounds, which is based on bristle fusion. In addition to fusion, Clayton and Renvoize (1986) and Watson and Dallwitz (1992) also mentioned that *Cenchrus* usually had 'spiny' bristles. However, Chase (1920) separated the two genera by bristle type, in addition to fusion: *Pennisetum* has bristles that are usually very slender, not rigid, and are free or rarely united at the very base; whereas *Cenchrus* has rigid bristles that are united below.

Webster (1988) stated that even within a number of species it is open to interpretation as to whether the bristles are fused or the callus flared. In regards to bristle fusion, *Pennisetum ciliare* (L.) Link is extremely variable and has been treated in both *Cenchrus* and *Pennisetum*. Hignight et al. (1991) evaluated 800 accessions of *P. ciliare* collected in South Africa and selected accessions based on extreme differences in morphology, including differences in bristle fusion. Thirteen of the most diverse morphological types were studied for morphology, cytology, and fertility. Five of these diverse morphologically types were used in hybridization studies with a sexual genotype (Bashaw 1969) of *P. ciliare*. Though they found most accessions to have at least some fusion, two of the accessions studied had a complete lack of bristle fusion. These plants were verified at Royal Botanical Gardens, Kew (K) to be *P. ciliare*. Hybridization studies with the sexual genotype showed a close relationship between the plants. Some of the F_1 progeny from the hybridization studies segregated for union of bristles similar to the bristle fusion found in *Cenchrus setigerus* Vahl. Hignight et al. (1991) concluded, "that bristle union is an arbitrary character that varies with genotype and is unreliable for the taxonomic classification of buffelgrass [*P. ciliare*]."

Read and Bashaw (1969) hybridized the same sexual accession of *P. ciliare* with an apomictic accession of *C. setigerus*. The resulting progeny represented a complete intergradation in morphology between the parents. Read and Bashaw concluded that the chromosome homology and cross-compatability of *P. ciliare* and *C. setigerus*, plus the high fertility and morphological intergradation, observed in the F_1 progeny provided overwhelming evidence of a very close relationship between the species and concluded that they belonged in the same genus.

Sohns' (1955) examination of fascicle organization in eight species of *Cenchrus* and six of *Pennisetum* suggests an additional differentiating character: whether the axis of the fascicle is prolonged as a, usually prominent, bristle (*Pennisetum*) or terminates into a spikelet and is not prolonged (*Cenchrus*). Unfortunately, the prolonged bristle in *Cenchrus setigerus* and *P. clandestinum*, although present, is less prominent than in the other species of *Pennisetum* studied and was overlooked by Sohns. This may be why most subsequent taxonomists considered the presence or absence of the prolonging bristle not to be of generic significance. Also, this character has historically been evaluated as a secondary character in conjunction with bristle fusion (e.g., DeLisle 1963), which is known to be arbitrary in its separation of the genera, and would explain why Sohns' character has appeared to be of little taxonomic value.

Avdulov (1931) and Nunez (1952) reported that the genus *Cenchrus* has a base number of x = 17. Pohl (1980) used chromosome base number as part of his generic criteria. He distinguished the two genera on the following characters. *Cenchrus* has inner bristles that are spine-like or pungent, are usually retrorsely scabrous, and usually have a base chromosome number of $x = 17$; whereas *Pennisetum* has bristles that are not spine-like or pungent and are antrorsely scabrous; and have base chromosome numbers of 5, 7, 8, or 9. However, despite these observations, Pohl later (Pohl & Davidse 1994), without explanation, followed Delisle (1963), Filgueiras (1984), and Clayton and Renvoize (1986) in his generic concept of *Cenchrus* and *Penniseum*.

From the examination of specimens of the following species of *Cenchrus* and *Pennisetum*: *Cenchrus agrimonioides* Trin., *C. biflorus* Roxb., *C. caliculatus* Cav., *C. distichopyllus* Griseb., *C. brownii* Roem. & Schult., *C. echinatus* L., *C. gracillimus* Nash, *C. longispinus* (Hack.) Fern., *C. pilosus* Kunth, *C. palmeri* Vasey, *C. platycanthus* Anderss., *C. spinifex* Cav., *C. tribuloides* L.; *Pennisetum advena* Wipff & Veldkamp, *P. alopecuroides* (L.) Sprengel, *P. annum* Mez, *P. bambusiforme* (Fournier) Hemsley, *P. basedowii* Summerh., *P. chilense* (Desv.) Jackson, *P. ciliare* (L.) Link, *P. clandestinum* Hoch. ex Chiov., *P. complanatum* (Nees) Hemsley, *P. crinitum* (Kunth) Sprengel, *P. distachyum* Rupr., *P. divisum* (Gmel.) Henr., *P. domingense* (Sprengel) Sprengel, *P. durum* Beal, *P. elymoides* (F. Muell.) Gardn., *P. flaccidum* Munro *ex* Griseb., *P. frutescens* Leeke, *P. glaucum* (L.) R. Br., *P. hohenackeri* Steud., *P. hordeoides* (Lam.) Steud., *P. intectum* Chase, *P. karwinskyi* Chase, *P. lanatum* Klotzsch, *P. latifolium* Sprengel, *P. macrostachys* (Brong.) Trin., *P. macrourum* Trin., *P. massaicum* Stapf, *P. mezianum* Leeke, *P. montanum* (Griseb.) Hack., *P. nervosum* (Nees) Trin., *P. occidentale* Chase, *P. orientale* Rich., *P. pauperum* Nees ex Steud., *P. pedicellatum* Trin., *P. pennisetiformis* (Hochst. & Steud. *ex* Steud.) Wipff, *P. peruvianum* (Döll) Trin., *P. petiolare* (Hochst.) Chiov., *P. polystachion* (L.) Schultes, *P. prieurii* Kunth, *P. prolificum* Chase, *P. purpureum* Schumach., *P. ramosum* (Hochst.) Schweinf., *P. rigidum* (Griseb.) Hack., *P. rupestre* Chase, *P. sagittatum* Henr., *P. setaceum* (Forsk.) Chiov., *P. setigerum*(Vahl) Wipff, *P. somalenisis* (Clayton) Wipff, *P. sphacelatum* (Nees) Dur. & Schinz, *P. squamulatum* Fresen., *P. tempisquense* Pohl, *P. thunbergii* Kunth, *P. tristachyon* (Kunth) Sprengel, *P. unisetum* (Nees) Benth., *P. villosum* R.Br. ex Fresn., *P. vulcanicum* Chase, and *P. weberbauri* Mez; as well as cytological examinations of 9 species of *Cenchrus* and 26 species of *Pennisetum*, and in addition to the cytological work already published (for a review see Jauhar 1981;

Wipff 1995; Schmelzer 1998), it is concluded that the generic interpretation that Pohl adopted in 1980 is correct phylogenetically. The degree of fusion of the bristles is generally unreliable at the generic level and should not be used as the primary character in separating the two genera.

The following characters are considered the most important in delineating the two genera:

Pennisetum: 1) bristles are not spine-like or pungent and are antrorsely scabrous (one South American species is both antrorse/retrorse); 2) the axis of the fascicle is prolonged as a, usually, prominent bristle; 3) inner bristles free or fused; and 4) have base chromosome numbers of 5,7,8, or 9.

Cenchrus: 1) inner bristles are spine-like or pungent, and usually retrorsely scabrous (when antrorsely scabrous, the inner bristles are fused and not grooved); 2) the axis of the fascicle terminates in a spikelet; 3) inner bristles are fused, at least at the base; and 4) have a base chromosome number of $x = 17$.

Though, there are still species in *Cenchrus* and *Pennisetum* whose generic placement still needs clarification. For example, *C. myosuroides* Kunth, which has a base number of x = 9 or 10 and a fascicle structure very different from *Cenchrus* s.s., as well as some South Pacific taxa. The process of obtaining the materials needed to resolve these problems has begun.

NEW COMBINATIONS IN THE *PENNISETUM CILIARE* COMPLEX

Pennisetum setigerum (Vahl) Wipff, comb. nov. BASIONYM: *Cenchrus setigerus* Vahl, Enum. Pl. 2:395. 1805. *Pennisetum vahlii* Kunth, nom. illeg., Rév. Gram. 1:49. 1829. *Pennisetum ciliare* (L.) Link var. *setigerum* (Vahl) Leeke, Z. Naturwiss. 79:22. 1907. *Cenchrus ciliaris* L. var. *setigerus* (Vahl) Maire & Weiler, Fl. Afr. Nord. 1:342. 1952. TYPE: Arabia. *Forsskål* (HOLOTYPE: C!).

Fisher et al. (1954) reported that the type of reproduction was identical between *Pennisetum ciliare* and *Cenchrus setigerus* and that there was continuous variation in morphological characteristics between the two species. He concluded that the two species are members of a single agamic complex. Snyder et al. (1955) also reported that these two species had similar reproductive behavior. Bashaw (1953), after studying the morphology, cytology, and mode of reproduction of *Cenchrus setigerus*, concluded that *C. setigerus* and *Pennisetum ciliare* were "much more closely related than our present classification indicates, perhaps even varieties of the same species." DeLisle (1963), after examining specimens of each taxon from throughout their range, only observed a few specimens that could be considered intermediates and recognized the two taxa as distinct species of *Cenchrus*.

Read and Bashaw (1969) hybridized a sexual genotype of *P. ciliare* with an apomictic genotype of *C. setigerus*. The resulting F_1 population consisted of both sexual and apomictic plants that represented a complete intergradation in morphology between the parents. They also stated that some of the hybrids were so different from either parent that populations from them might be mistaken for new species. The hybrids were highly fertile and had fewer quadrivalents and more bivalents than either parent. They concluded that the two species were certainly congeneric and possibly conspecific. They noted, however, that "They have been effectively isolated in nature by obligate apomixis and their morphological distinctness was sufficient to permit valid taxonomic treatment at the species level. It is also apparent that with sexuality in buffelgrass [*Pennisetum ciliare*], we are able to produce an unlimited number of distinctly different hybrids. At present it would be convenient to retain specific rank although we feel it would be justifiable to merge the species." (Read & Bashaw 1969, p. 806). Although they recognized both taxa as species of *Cenchrus*, Read and Bashaw stated that it might become necessary in the future to reconsider the generic rank of this entire agamic complex.

Pennisetum pennisetiforme (Hochs. & Steud. ex Steud.) Wipff, comb. nov. (**Figs. 1, 2**). BASIONYM: *Cenchrus pennisetiformis* Hochs. & Steud. ex Steud., Syn. Pl. Glumac. 1:109. 1854. TYPE: Saudi Arabia: Jedda, "In deserto pr. oppid. Deschedda.," 28 Jan 1836, *Schimper 973* [LECTOTYPE, here designated: P!; ISOLECTOTYPES: K! (3 sheets)]. Steudel (1854) cited two collections (*Schimper 973* and *974*) in the protologue. Sheets of these collections were examined from P and found to be similar. *Schimper 973* was chosen as the lectotype because duplicate sheets are known to exist at K, whereas presently there is only one sheet of *Schimper 974* known to be in existence.

Delisle (1963) considered *Cenchrus pennisetiformis* as part of *C. ciliaris*. Clayton (1982) reported that the boundary between *C. ciliaris* and *C. pennisetiformis* was indistinct, but that the species could be separated as follows: *Cenchrus pennisetiformis* has inner bristles basally connate for 1–2.5 mm of their length, is usually annual (short-lived perennial), smaller in stature and found mostly in sub-desert grasslands; whereas, *C. ciliaris* has the inner bristles basally connate for (0–)0.5–1.5 mm of their length, is a stout perennial, with or without rhizomes, usually forming a hard, knotty, sometimes almost woody base, and is found in deciduous bushland and wooded grasslands.

Pennisetum somalensis (Clayton) Wipff, comb. nov. BASIONYM: *Cenchrus somalensis* Clayton, Kew Bull. 32:3. 1977. TYPE: SOMALI REPUBLIC: Erigavo, 5000-7000 ft [1524–2133 m], under shade of bush and trees, Nov 1938, *A.S. McKinnon S221* (HOLOTYPE: K!).

Clayton (1977) reported that *C. somalensis* and *C. pennisetiformis* were closely related, but that *C. somalensis* is a densely tufted perennial with inrolled leaves about 1 mm wide; whereas, *C. pennisetiformis* is an annual, or short-lived perennial, with flat leaf blades, 2–5 mm wide.

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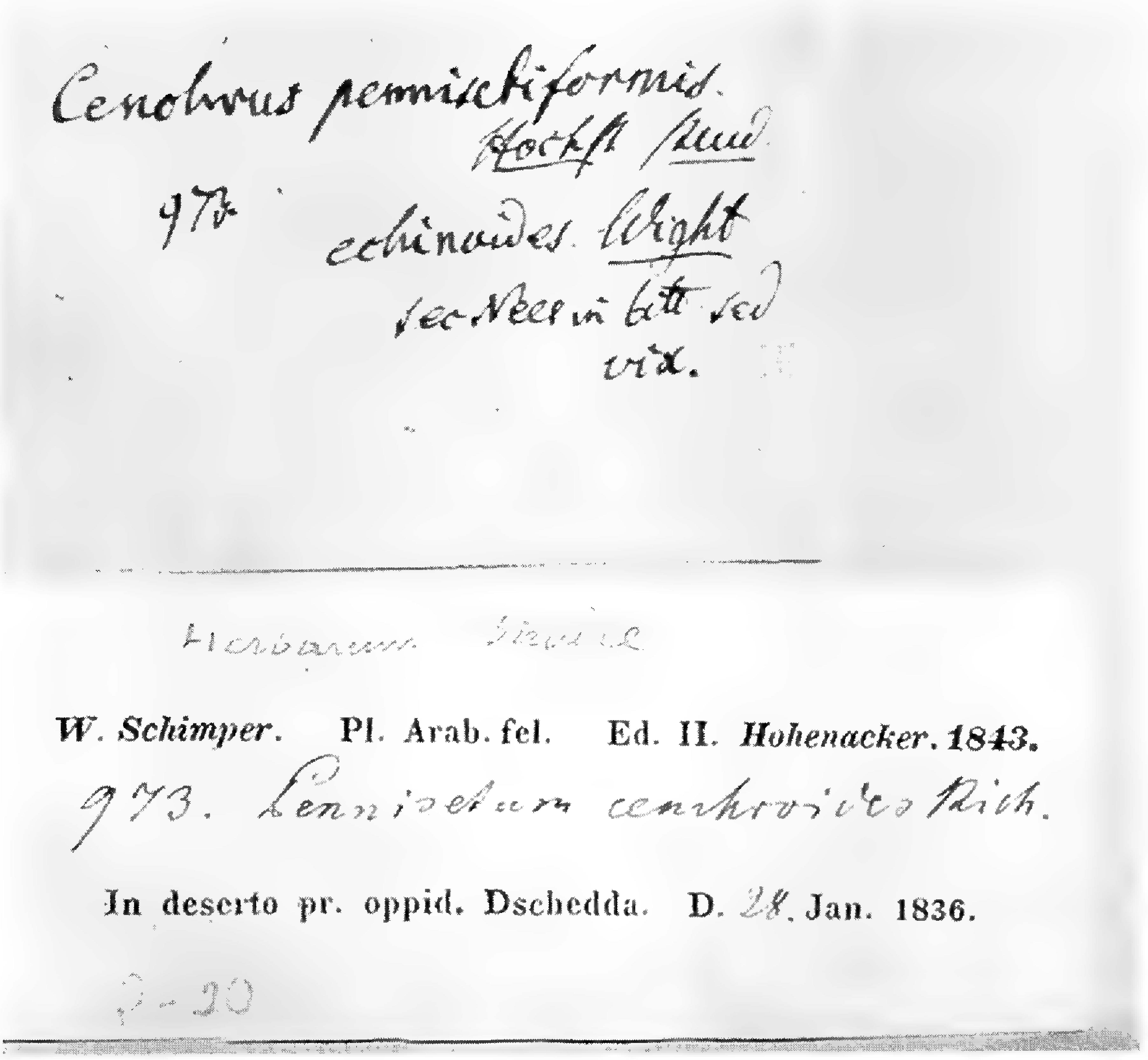
FIG. 1. Photograph of the lectotype (P) of *Pennisetum pennisetiforme*.



Cenchrus pennisetiformis. Hochst Steud
973 echinoides Wight
sec. Nees in litt. sed
vix.

Herbarium Steudel

W. Schimper. Pl. Arab. fel. Ed. II. *Hohenacker*. 1843.

973. Pennisetum cenchroides Rich.

In deserto pr. oppid. Dschedda. D. 28. Jan. 1836.

[illegible]

Fig. 2. Photograph of the label of the lectotype (P) of *Pennisetum pennisetiforme*.

preparing the manuscript, and for their editorial reviews of the manuscript, Alison Kelly (UTC) for her assistance with the digital images of the types, and UTC's assistance in obtaining loans of type specimens; and to Stanley Jones (BRCH) and two anonymous reviewers for their insightful comments.

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REEVALUATION OF *AYLACOPHORA* AND *PALEAEPAPPUS* (ASTERACEAE: ASTEREAE)

José M. Bonifacino

Departamento Científico de Plantas Vasculares
Facultad de Ciencias Naturales y Museo
Paseo del Bosque s/n, C.P. 1900 La Plata, ARGENTINA
mbonifa@museo.fcnym.unlp.edu.ar

Permanent address:
Laboratorio ed Botanica, Facultad de Agronomia
Casilla de Correos 1238, Montevideo, URUGUAY

Gisela Sancho

Department of Botany
National Museum of Natural History
Smithsonian Institution
Washington, DC 20560-0166, U.S.A.
sancho.gisela@NMNH.SI.EDU

Permanent address:
Departamento Científico de Plantas Vasculares
Facultad de Ciencias Naturales y Museo
Paseo del Bosque s/n, C.P. 1900 La Plata, ARGENTINA

ABSTRACT

Nardophyllum deserticola (Cabrera) Nesom and *Nardophyllum patagonicum* (Cabrera) Nesom are two endemic species from Argentinean Patagonia that were originally described under the monotypic genera *Aylacophora* and *Paleaepappus* in 1953 and 1969, respectively. In 1993, Nesom included *Aylacophora* and *Paleaepappus* within the genus *Nardophyllum*, arguing that the discontinuities between the paleaceous pappus of *Aylacophora* and *Paleaepappus* and the pappus bristles of *Nardophyllum* do not justify considering them as distinct genera. Careful observation of the herbarium material revealed that: 1) the pappus of *N. deserticola* and *N. patagonicum* consists of ca. 10 linear-elliptic paleae, while in remaining *Nardophyllum* species, the pappus is composed of ca. 30 bristles, and 2) the receptacular paleae of *Nardophyllum deserticola* and *Nardophyllum patagonicum* are wide and enclose the florets, while in *Nardophyllum* species, the paleae, if present, are narrow and do not enclose the florets. These observed discontinuities between *N. deserticola* and *N. patagonicum* with respect to the rest of *Nardophyllum* do support the consideration of both species as to two distinct monotypic genera, *Aylacophora* and *Paleaepappus*, respectively.

RESUMEN

Nardophyllum deserticola (Cabrera) Nesom y *Nardophyllum patagonicum* (Cabrera) Nesom son dos especies endémicas de la Patagonia argentina que fueron originalmente descritas bajo los géneros monotípicos *Aylacophora* y *Paleaepappus* en 1953 y 1969, respectivamente. Posteriormente en 1993, Nesom incluyó *Aylacophora* y *Paleaepappus* dentro del género *Nardophyllum* argumentando que las discontinuidades entre el papo paláceo de *Aylacophora* y *Paleaepappus* y el papo piloso de *Nardophyllum* no justifican considerar a éstos como géneros independientes. La observación detallada

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del material de herbario reveló que: 1) el papo de *N. deserticola* y *N. patagonicum* consiste en ca. de 10 páleas linear-elípticas, mientras que en el resto de las especies de *Nardophyllum*, el papo está compuesto por ca. 30 cerdas y 2) las páleas del receptáculo de *Nardophyllum deserticola* y *Nardophyllum patagonicum* son anchas y abrazan las flores, mientras que en el resto de las especies de *Nardophyllum*, las páleas, si están presentes, son más angostas y no abrazan las flores. Las discontinuidades observadas entre *N. deserticola* y *N. patagonicum* con el resto de *Nardophyllum* apoyan la consideración de ambas especies como dos géneros monotípicos independientes, *Aylacophora* y *Paleaepappus*, respectivamente.

Endemic to Argentinean Patagonia, *Nardophyllum deserticola* (Cabrera) Nesom and *Nardophyllum patagonicum* (Cabrera) Nesom are 2 of the 10 species recognized inside *Nardophyllum* Hook. & Arn. by Nesom (1993).

Nardophyllum deserticola and *N. patagonicum* were originally described by Cabrera under the monotypic genera *Aylacophora* and *Paleaepappus*. *Aylacophora* (Cabrera 1953) was characterized by its paleaceous receptacle, scaly pappus, and compressed cypselae with 2(–3) ciliate ribs. *Paleaepappus* (Cabrera 1969) was defined by its paleaceous receptacle and its pappus of 7–8 paleae. In contrast, *Nardophyllum* sensu Cabrera (1954) has receptacles naked or with only 3–6(–13) paleae, a pappus of bristles, and terete, more or less pubescent cypselae.

According to Nesom, the discontinuities between the paleaceous pappus of *Aylacophora* and *Paleaepappus* and the bristles of *Nardophyllum* pappus do not support their distinction from *Nardophyllum* because there is a tendency for the pappus bristles to be somewhat flattened in *Nardophyllum*.

However, according to our observations and the interpretation of the data gathered (see below), *Aylacophora* and *Paleaepapus* should be considered as independent genera from *Nardophyllum* as follows:

Aylacophora Cabrera, Bol. Soc. Argent. Bot. 4:266. 1953. TYPE SPECIES: *Aylacophora deserticola* Cabrera, Bol. Soc. Argent. Bot. 4:268. 1953. *Nardophyllum deserticola* (Cabrera) Nesom, Phytologia 75:362. 1993. **Fig. 1 A–D.** TYPE: ARGENTINA. PROVINCIA NEUQUÉN: Plaza Huincul, 12 Apr 1952, *A.L.Cabrera 11053* (HOLOTYPE: LP!; ISOTYPE: US!).

Shrub 50 cm high, densely branched; old branches aphyllous, bearing furrows; new branches with sparse nodes; leaves linear; capitula discoid, solitary at ends of branches; involucres globose; receptacles paleaceous, paleae wide, apically pubescent, each palea enclosing a floret; cypselae compressed, 2(–3) nerved, pubescent only on the ribs; pappus of 10–11 oblong scales no longer than 1.2 mm, in 1 series.

Ecology.—*Aylacophora deserticola* inhabits semidesert areas in Patagonia. The very few herbarium specimens of this species lead us to regard them as very narrowly distributed. According to Ing. Steibel (pers. comm.), *A. deserticola* Cabrera grows on edaphic communities in the Monte biogeographic province (Cabrera & Willink 1973), where it is present on sand dunes with very sparse shrub cover, associated with *Larrea divaricata*, *Atriplex lampa*, *Prosopis flexuosa*

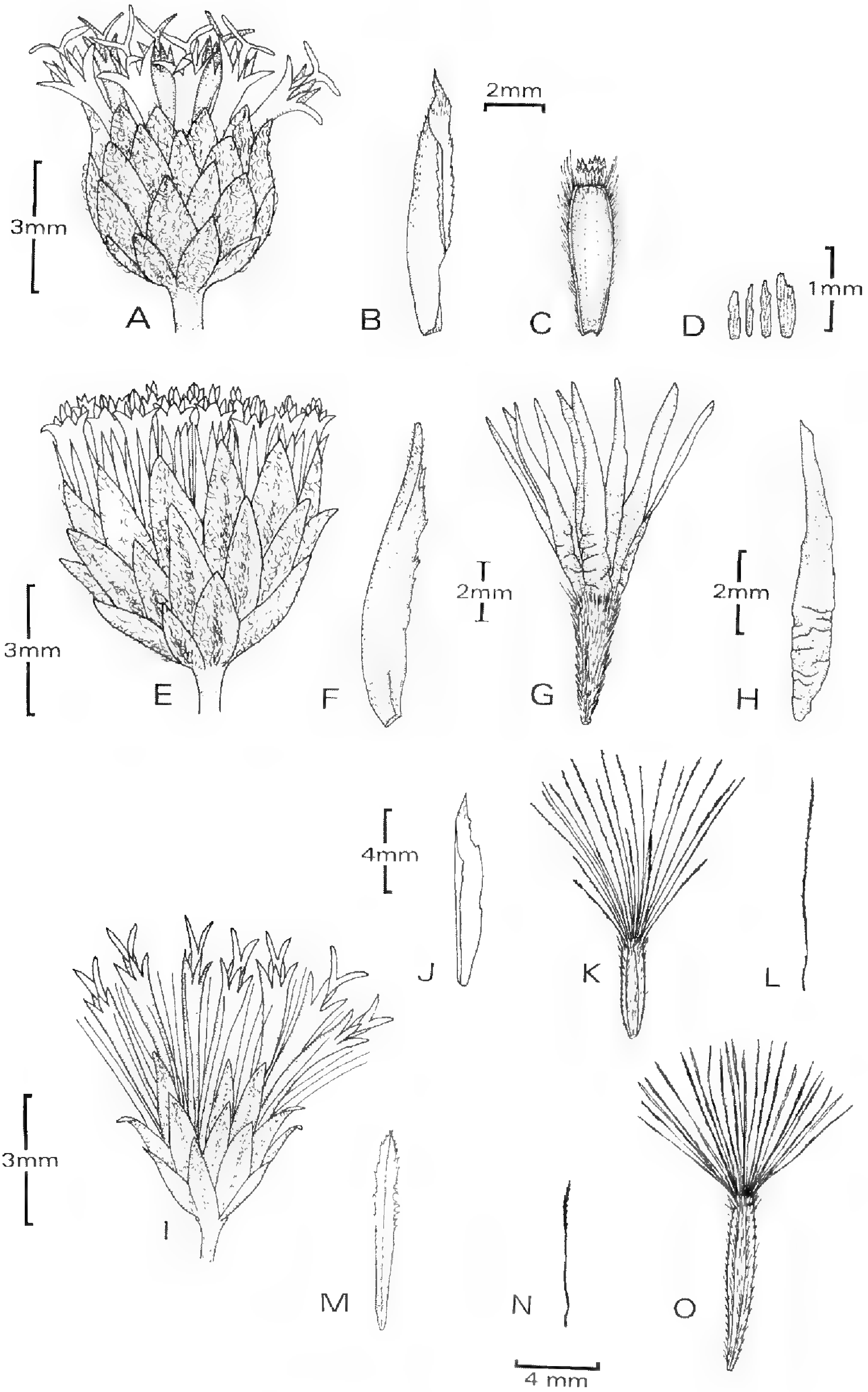

Fig. 1. **A–D,** *Aylacophora deserticola*. **A.** Capitulum. **B.** Receptacular palea. **C.** Cypsela. **D.** Pappus scales. **E–H.** *Paleaepappus patagonicus*. **E.** Capitulum. **F.** Receptacular palea. **G.** Cypsela with pappus. **H.** Pappus palae. **I–L.** *Nardophyllum bracteolatum*. **I.** Capitulum. **J.** Receptacular palea. **K.** Cypsela with pappus. **L.** Pappus bristle. **M–O.** *Nardophyllum bryoides*. **M.** Receptacular palea. **N.** Pappus bristle. **O.** Cypsela with pappus. (**A–D,** based on *Cabrera 11053*, LP; **E–H,** based on Rio Chico, 1900, *Ameghino s.n.*, LP; **I–L,** based on *Serra 77*, LP; **M–O,** based on *Ruiz Leal 27011*, LP)

var. *depressa*, *Senna aphylla* subsp. *divaricata*, *Chuquiraga erinacea*, *Gutierrezia solbrigii*, *Fabiana patagonica* and *Larrea cuneifolia*. *Aylacophora deserticola* has been collected in Argentina, Prov. Neuquen, Dptos. Confluencia, Cutralcó, Añelo, Pehuenches, and Zapala. West of Río Covunco and south of Río Neuquén in Dpto. Zapala, *A. deserticola* is the dominant species regarding surface cover. Flowering in the fall.

Paleaepappus Cabrera, Bol. Soc. Argent. Bot. 11:273. 1969. TYPE SPECIES: *Paleaepappus patagonicus* Cabrera, Bol. Soc. Argent. Bot. 11:273. 1969. *Nardophyllum patagonicum* (Cabrera) Nesom, Phytologia 75:362. 1993. Fig. 1 E–H. TYPE: ARGENTINA. Chubut, Rio Chico, "Aut. 1900," *Ameghino s.n* (HOLOTYPE: LP!)

Shrub densely branched, lateral branches sharp ended; leaves oblong to spatulate, coriaceous; capitula discoid, solitary at the ends of branches; involucres campanulate; receptacles paleaceous, paleae wide, apically pubescent, each enclosing a floret; cypselae terete, densely pubescent; pappi of 9–10 elliptic paleae 7 mm long, in 2 series.

Ecology.—*Paleaepappus patagonicus* inhabits semidesert areas in Patagonia. Knowledge of the ecology of *Paleaepappus* is scarce and speculative because the only record of this species is the type itself, and there is no ecological information on the label. The conservation status of this species could aptly be recorded as endangered.

Aylacophora and *Paleaepappus* are strongly segregated from *Nardophyllum* by characteristics of the elements of pappus such as number, shape, and number of series. The paleaceous pappus of *Aylacophora* and *Paleaepappus* contrast with the bristles in *Nardophyllum*. Intermediate states of pappus shape, like narrow paleae, have not been found in *Nardophyllum*, but occasionally, flat bristles have been found in *Nardophyllum*.

Nardophyllum circumscription

Nardophyllum Hook. & Arn. (1836) was described by Cabrera (1954) as shrubs densely branched, leaves alternate, small; heads solitary at the end of the branches; discoid capitula, involucre campanulate; receptacle small, convex, naked or with few paleae; cypselas turbinate, 4–5 ribbed, hairy; pappus composed of several bristles. The circumscription of *Nardophyllum* adopted here is the presented by Cabrera (1954) in his revision of the genus, where he included 7 species: *Nardophyllum armatum* (Wedd.) Reiche, *N. bracteolatum* Hauman, *N. genistioides* (Phil.) Gray, *N. bryoides* (Lam.) Cabrera, *N. chiliotrichioides* (Remy) A. Gray, *N. lanatum* (Meyen) Cabrera, and *N. obtusifolium* Hook. & Arn.

Paleaepappus and **Nardophyllum**

Contrasting with the pappus of *Paleaepappus* (Fig. 1 H), the pappus of *Nardophyllum* is composed of ca. 30 bristles 5–10 mm long (Fig. 1 L), sometimes flattened, especially at the apex (Fig. 1 N), arranged in 2–3(–5) series.

Involucres and shape of *Paleaepappus* cypselae are similar to those of *Nardophyllum*. Differences in number and shape of receptacular paleae are also found in these two genera. *Paleaepappus* has paleaceous receptacles with wide and apically pubescent paleae enclosing each floret (Fig. 1 F). The receptacular paleae of *Nardophyllum* are narrow, do not enclose the florets (Fig. 1 J and M), and vary from absent (*N. armatum*) to 3–6 (rarely more numerous, 9–13 in *N. bracteolatum*).

Aylacophora and **Nardophyllum**

The pappus of *Aylacophora* (Fig. 1 C and 1 D) contrast highly with the pappus of *Nardophyllum* (see above). In addition, other characters distinguish *Aylacophora* from *Nardophyllum*: the involucre of *Aylacophora* is globose (Fig. 1 A); its cypselae are compressed, 2(–3), and pubescent only on the ribs (Fig. 1 C). The involucre of *Nardophyllum* is campanulate to obconical (Fig. 1 I) and the cypselas are terete, (4–)5–7(–8) nerved and uniformly pubescent (Fig. 1 K and 1 O).

Aylacophora has a paleaceous receptacle with wide and apically pubescent paleae enclosing each floret. The number and shape of receptacular paleae of *Aylacophora* (Fig. 1 B) contribute to set this taxon apart from *Nardophyllum*.

Aylacophora and *Paleaepapus* were placed in the *Chiliotrichum* group (Zhang & Bremer 1993; Bremer 1994) that includes shrubs with mostly densely set, coriaceous, and often abaxialy tomentose leaves, and for most of the genera, paleate receptacles (Bremer 1994). Within this group there are intermediate morphotypes for pappus elements that range from terete bristles in *Chilliophyllum*, through narrow paleae in *Lepidophyllum* (Cabrera 1971), to paleae in *Aylacophora* and *Paleaepappus*. In addition, the number of receptacular paleae vary within the *Chiliotrichum* group. In reference to this character the variation observed within *Nardophyllum* is also present when comparing other genera of *Chiliotrichum* group, such as *Lepidophyllum* without paleae, *Chiliotrichum* with few paleae, and *Chiliophyllum* and *Chiliotrichiopsis* with fully paleate receptacles (Cabrera 1971, 1978). Because the gradation in pappus and receptacular paleae is inherent to the *Chiliotrichum* group itself, this variation cannot be an argument against the recognition of both *Aylacophora* and *Paleaepappus* as distinct from *Nardophyllum*.

Genera of *Chiliotrichum* Group (sensu Bremer 1994) can be identified as follows:

1\. Capitulum without ray florets.
  2\. Pappus of ca. 30 or more bristles arranged in 2–3(–5). ________ **Nardophyllum**
  2\. Pappus of 10 or fewer paleae arranged in 1–2 series.
    3\. Cypselas compressed, with hairs restricted to the ribs. ________ **Aylacophora**
    3\. Cypselas terete, wholly pubescent. ________ **Paleaepappus**
1\. Capitulum with ray florets.
  4\. Receptacles epaleate.
    5\. Ray corollas white or violet. ________ **Diplostephium**

5. Ray corollas yellow.
    6. Leaves opposite; pappus composed of a series of unequal paleaceous bristles. ____ **Lepidophyllum**
    6. Leaves alternate; pappus composed of 2 series of bristles. ____ **Parastrephia**
4. Receptacles paleate.
    7. Ray corollas white. ____ **Chiliotrichum**
    7. Ray corollas yellow.
        8. Pappus of terete bristles. ____ **Chiliophyllum**
        8. Pappus of linear, acute scales. ____ **Chiliotrichiopsis**

Nesom's reinstatement of *Nardophyllum scoparium* Philippi (Nesom 1993) is not accepted here. Presence of pistillate ligulate florets in the periphery (5–6) casts serious doubts about positioning this taxon inside *Nardophyllum*. The taxonomic placement of this Chilean species and its possible status as an undescribed genus allied to some genus inside *Chiliotrichum* group as Nesom suggests (pers. comm.) is being reviewed by one of us (JMB) and will be presented as a more comprehensive study of the *Chiliotrichum* group (in prep.).

According to Bremer (1994), *Aylacophora* and *Paleaepappus* are very similar and possibly sister groups. *Aylacophora* was related to *Nardophyllum* and *Chiliotrichiopsis* by Cabrera (1953); *Paleaepappus* was related to *Nardophyllum* and *Aylacophora* (Cabrera 1969). Our opinion, based on observations of cypselar morphology, number of series of the pappus elements, involucre shape, leaves shape and plant habit, favors a closer relationship between *Paleaepappus* and *Nardophyllum*.

Nesom (1993) suggest that the narrow, internally tomentose cauline sulcae of *Aylacophora* could be homologous with those found in some species of *Nardophyllum* and so denoting a closer relationship of *Aylacophora* to *Nardophyllum*. To complicate the matters further, the paleate receptacle of both *Aylacophora* and *Paleapapus*, would favor a closer relationship of these two genera with *Chiliotrichiopsis*, *Chiliophyllum* and *Chiliotrichum* instead, which are, as Nesom (1993) points out the closest relatives to *Nardophyllum* and all of them have a paleate receptacle (*Chiliotrichiopsis*, *Chiliophyllum* fully paleated, *Chiliotrichum* 15–21 paleae). Evidently, as Bremer (1994) states, the elucidation of the phylogenetic relationships among these genera demands a more comprehensive study of the *Chiliotrichum* group that is beyond the scope of this paper.

Segregation of *Aylacophora* and *Paleaepappus* from *Nardophyllum* on the basis of pappus shape is supported by other characters such as the shape of both cypsela and capitulum in *Aylacophora*, and the shape and quantity of receptacular paleae in both *Aylacophora* and *Paleaepappus*.

Although *Aylacophora* and *Paleaepappus* are closely related to the rest of *Nardophyllum* species, the discontinuities basically observed in the shape of the pappus elements, with no defined intermediate states, justify the consideration of both species as two distinct genera.

Our conclusion is supported by Nesom et al. (in press). These authors, based on features of the involucre and mainly on pappus morphology, have included a new Peruvian species of Asteraceae:Astereae inside *Chiliotrichiopsis* Cabrera (*Chiliotrichiopsis peruviana* Nesom, Robinson & Granda). Nesom et al. (in press) found that the pappus morphology is a good character to separate genera inside *Cihiliotrichum* group and concluded that Cabrera's narrow generic concept of *Nardophyllum* was a better description of the diversity inside *Chiliotrichum* group, therefore having independently arrived at the same conclusion we have, regarding the consideration of *Aylacophora* and *Paleaepappus* as distinct from *Nardophyllum*.

APPENDIX 1

Additional specimens examined of **Aylacophora deserticola** Cabrera. **ARGENTINA.** Neuquén, Plaza Huincul, 11 Dec 1996, *H. Troiani et al. 12503* (SRFA); Plaza Huincul, 11 Dec 1996, *H. Troiani et al. 12504* (SRFA); Paso de Los Indios a Cutralcó, 5 Feb 1999, *P. Steibel y H. Troiani 14074* (SRFA); Paso de las Bardas, 2 Feb 1999, *H. Troiani y P. Steibel 13920* (SRFA). Paso de Los Indios, 5 Feb 1999, *P. Steibel y H. Troiani 14069* (SRFA); Paso de Los Indios, 20 km hacia Cutralcó, 5 Feb 1999, *P. Steibel y H. Troiani 14073* (SRFA).

Nardophyllum. Nardophyllum armatum (Wedd.) Reiche. **ARGENTINA. San Juan:** Iglesia, camino a el Fierro, Cañada de La Zorra, 24 Jan 1974, *Cabrera & al. 24510* (LP); Pampa de Pauacán, entre las Aguaditas y Chepical, 12 Dec 1957, *Ruiz Leal 18945* (LP). **La Rioja:** Gral. Sarmiento, Río del Oro, Cordillera, 7 Feb 1947, *Hunziker 2197* (LP). **Catamarca:** Santa María, Campo Arenal, *Loerner 8* (LP). **Salta:** San Antonio de los Cobres, 29 Jan 1944, *Cabrera 8261* (LP). **Jujuy:** 1 km al W de la Quiaca, 11 Feb 1960, *Meyer & al. 21291* (LP); Rinconada, Cusi Cusi, Mar 1970, *Fabris & Zuloaga 7707* (LP); Humahuaca, Esquinas Blancas, 22 Ene 1966, *Cabrera & al. 17726* (LP); Abra Pampa, Feb 1937, *Castellanos 20229* (LP).

Nardophyllum bracteolatum Hauman. **ARGENTINA. Mendoza:** San Carlos, El Pedernal, 25 Mar 1916, *Sanzin 1810* (LP); Tunuyán, Paso del Portillo, Cuesta de los Afligidos, 29 Jan 1934, *Ruiz Leal 2052* (LP); San Carlos, Rincón de los Leones, 18 Jan 1941, *Ruiz Leal 7212* (LP); San Carlos, Arroyo de la Qda. "Casa de Piedra," 17 Jan 1952, *Serra 77* (LP).

Nardophyllum bryoides (Lam.) Cabrera. **CHILE. Magallanes:** Parque Nacional Torres del Paine, Lago Paine, 17 Jan 1999, *Bonifacino s.n.* (MVFA 28888). **ARGENTINA. Santa Cruz:** alrededores de El Chalten, 10 Feb 2000, *Bonifacino 304 & Romano* (MVFA); Güer-Aike, Est. Montedinero, Cabo Vírgenes, Nov 1974, *Molina 1* (LP); Río Gallegos, 5 Dec 1932, *Castellanos s.n.* (LP); Est. de las Vizcachas, Cerro de las Vizcachas, 17 Jan 1970, *Ruiz Leal 27019* (LP); a 2 km de Guarumba, 16 Jan 1970, *Ruiz Leal 27011* (LP); Lago Argentino, Parque Nacional Los Glaciares, Fitz Roy, 14 Feb 1975, *Cabrera & al. 25864* (LP). Tierra del Fuego. Est. Cullen, 52° 44' S, 68° 33' W, 5 Jan 1972, *Moore & Goodall 336* (LP); Bahía Lee. 52° 52' S 70° 16' W, 6 Nov 1971, *Moore 2339* (LP).

Nardophyllum chiliotrichoides (Remy) A. Gray. **ARGENTINA. San Juan:** Calingasta, Qda. Los avestruces (oeste de Cerro Castaño), Feb 1960, *Fabris & Marchionni 2354* (LP); Río Maurique a Portezuelo de Potrerillos, 23 Jan 1991, *Kiesling 768* (SI). **Chubut:** a 20 km al E de Cushamen, 31 Dec 1947, *Soriano 2786* (LP); Rawson, 12 km al S de Trelew, 7 Dec 1980, *Castroviejo & Lopez 2313* (SI). **CHILE. Santiago:** Cordillera del Río San Francisco, Fierro Carrera, Jan 1925, *Werdermann 621* (LP).

Nardophyllum lanatum (Meyen) Cabrera. **ARGENTINA. Mendoza:** Malargüe, ruta 40, 20 km al S de Calmuco, 1 Feb 1963, *Boelcke et al. 10420* (SI). **Neuquén :** Laguna Copi Leuquen, al S de Calmuco, 15 Feb 1942, *Burkart & al. 14425* (LP); Chos Malal, entre Río Barranca y Buta Ranquil, 8 Feb 1950, *Boelcke 4235* (LP). **CHILE. Colchagua:** Termas del Flaco, 19 Feb 1966, *Zöllner 833* (LP); Vegas del Flaco, al E de la Quebrada de los Ríos, falda SE del cerro, 7 Feb 1974, *Mahu 9858* (LP). **Valparaiso:** Cerro Roble, Cordillera de la Costa, 6 Mar 1966, *Zöllner 1402* (LP). **Ovalle:** *Geisse s.n* (LP 60269).

Nardophyllum obtusifolium Hook. & Arn. **CHILE. Magallanes:** San Gregorio, 26 Oct 1968, *Cekalovic 33903* (LP). **ARGENTINA. Santa Cruz:** Pto. San Julián, 1915, *Carete s/n* (LP); Corpen Aike, 20 km N Piedra Buena, Ruta 3, 3 Dec 1971, *Boelcke & al. 15339* (LP); Pampa del Castillo, 11 Feb 1936, *Scott de Brirabén & Birabén 17* (LP); Lago Bs. As., Los Antiguos camino a Pto. Moreno, 24 Nov 1965, *Correa & Nicora 3638* (LP); Puerto Deseado, Jan 1896, *Alboff 2169* (LP); Esquel, 2 Apr 1946, *Scolnik 306* (LP); Leleque, 13 Jan 1947, *Soriano 2341* (LP); Est. Pepita, Alto Río Senger, 13 Feb 1947, *Soriano 2585* (LP). **Neuquén:** Charahuilla, Arroyo Lapa, Feb 13 1939, *Chicchi 123* (LP); Laguna Blanca, 9 Jan 1966; camino a Ñirihuau, 16 Jan 1935, *Cabrera & Job 353* (LP). **Santa Cruz:** Col. Carlos Pellegrini, Est. La Flora, Dec 1979, *Von Thüngen 2* (LP).

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GEOGRAPHIC VARIATION AND TAXONOMY OF NORTH AMERICAN SPECIES OF *MIRABILIS*, SECTION *OXYBAPHOIDES* (NYCTAGINACEAE)

Richard Spellenberg and Sergio R. Rodríguez Tijerina[1]

Department of Biology
New Mexico State University
Las Cruces, NM 88003, U.S.A.

ABSTRACT

A revision of *Mirabilis*, section Oxybaphoides, Nyctaginaceae, in western North America is presented. *Mirabilis oligantha* (Standl.) J.F. Macbride, *M. oxybaphoides* (A. Gray) A. Gray, and *M. tenuiloba* S. Wats. remain as traditionally classified. *Mirabilis bigelovii* A. Gray, *M. californica* A. Gray ex Torr., *M. laevis* (Benth.) Curran, and *M. retrorsa* Heller are combined as a single species, *M. laevis*, and recognized as varieties, i.e., ***M. laevis*** var. ***villosa*** (Kellogg) Spellenb. (comb. nov.), ***M. laevis*** var. ***crassifolia*** (Choisy) Spellenb. (comb. nov.), *M. laevis* var. *laevis*, and *M. laevis* var. *retrorsa* (Heller) Jepson, respectively. Distribution maps are presented for each species, those for the varieties within the *M. laevis* complex also indicating geographic distribution of characters. The inspection of these maps was of importance in making taxonomic decisions. Lists of important collections are provided. Chromosome numbers are reported for the first time for *M. laevis* var. *villosa* ($2n = 30_{II}$), *M. laevis* var. *retrorsa* ($2n = 31\text{–}33_{II}$) and *M. oxybaphoides* ($2n = 30_{II}$).

RESUMEN

Se presenta una revisión de *Mirabilis*, sección Oxybaphoides, Nyctaginaceae, en el oeste de Norte América. *Mirabilis oligantha* (Standl.) J.F. Macbride, *M. oxybaphoides* (A. Gray) A. Gray, y *M. tenuiloba* S. Wats. permanecen tal como se clasificaban tradicionalmente. *Mirabilis bigelovii* A. Gray, *M. californica* A. Gray ex Torr., *M. laevis* (Benth.) Curran, y *M. retrorsa* Heller se combinan como una única especie, *M. laevis*, y reconocidas como variedades, i.e., ***M. laevis*** var. ***villosa*** (Kellogg) Spellenb. (comb. nov.), ***M. laevis*** var. ***crassifolia*** (Choisy) Spellenb. (comb. nov.), *M. laevis* var. *laevis*, y *M. laevis* var. *retrorsa* (Heller) Jepson, respectivamente. Se presentan mapas de distribución de todas las especies, y de las variedades en el complejo *M. laevis* indicando también la distribución geográfica de los caracteres. El estudio de estos mapas fue muy importante para tomar las decisiones taxonómicas. Se ofrecen listas de colecciones importantes. Se citan por primera vez números cromosomáticos de *M. laevis* var. *villosa* ($2n = 30_{II}$), *M. laevis* var. *retrorsa* ($2n = 31\text{–}33_{II}$) y *M. oxybaphoides* ($2n = 30_{II}$).

INTRODUCTION

Mirabilis L. is primarily a New World genus comprising 45–60 species distributed from southern Canada to southern South America, with one native to southern Asia (Bogle 1974; Heimerl 1934; Le Duc 1995). Species have been suspected of hybridization (Shinners 1951). In addition, some are known to be autogamous and even cleistogamous (Cruden 1973). Stamens and style curl tightly together in flowers of the species treated here, as in other arid-land *Mirabilis* in

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[1] Present address: Facultad de Agronomía, Universida Autónoma de Nuevo León, Apdo. Postal 358, C.P. 66450, San Nicolás de los Garza, Nuevo León, México.

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southwestern North America, probably effecting self-pollination as observed in *Boerhavia* (Chaturvedi 1989; Spellenberg 2001), species in other *Mirabilis* sections (Cruden 1973; Hernández 1990), and several other genera (Spellenberg & Delson 1977). Coupling hybridization with autogamy may produce individually rather uniform populations, but geographically complex variation patterns (Stebbins 1957).

Such complexes provided fertile ground for the description of numerous entities under taxonomic traditions of early in the 20th century, in which, because of locally uniform populations but widespread variation across a geographic region, taxonomic decisions may be subjective and perhaps utilitarian, following a philosophy expressed by Lewis (1963). Here, for example, more than 40 synonyms apply to our concept of *Mirabilis laevis* (Benth.) Curran and varieties. The taxonomic problems associated with *Mirabilis* were commented upon by Shinners (1951, p. 173) ("*Mirabilis* is surely one of the most troublesome of Southwestern genera, in nomenclature and taxonomy both.") and by Standley (1931a, p. 73) after several decades of study in the family ("I know of few groups of plants [*Neea*, *Torrubia*, *Mirabilis*] in which specific differences are so unstable and so baffling[;] ... no single character seems to be constant.") Turner (1993), conversely, in a rather refreshing approach to the taxonomy of the genus, noted that if emphasis on vegetative variation were minimized, and fruit characteristics were emphasized instead, the genus in Texas was taxonomically tractable.

Mirabilis was divided into six sections by Heimerl (1934; translated in part and reviewed in Le Duc 1995), one of which, *Oxybaphoides* A. Gray, was characterized by slightly accrescent involucres and fruits that are comparatively small and unornamented (Fig. 1). Heimerl included in it the North American species *M. oxybaphoides* (A. Gray) A. Gray, *M. californica* A. Gray (and close allies), a number of South American species, and one southern Asian species.

Mirabilis oxybaphoides has presented little taxonomic controversy at the species level since its description by Gray (1853) in the genus *Quamoclidion*. It is sufficiently distinct from other species of *Mirabilis* (as the genus is now generally construed) that it formed the monotypic genus *Allioniella* of Rydberg (1902). This classification was followed by Standley (1909, 1918) in several treatments of the family, but he was apparently unaware of its presence in Mexico, as it was not included in his treatment of the family for that nation (Standley 1911).

The remaining taxa of the section in North America were placed in a new genus *Hesperonia* by Standley (1909), who emphasized differences of fruit form, shape of the perianth, and number of flowers in the involucre. Standley recognized eight species and several subspecies, emphasizing shape, color, size of the fruit, and vegetative characters such as plant size, leave size and shape, and characteristics of vestiture. Jepson (1914) treated this as subgenus *Hesperonia* (Standl.) Jepson, including *M. californica* and *M. tenuiloba* S. Wats., noting also

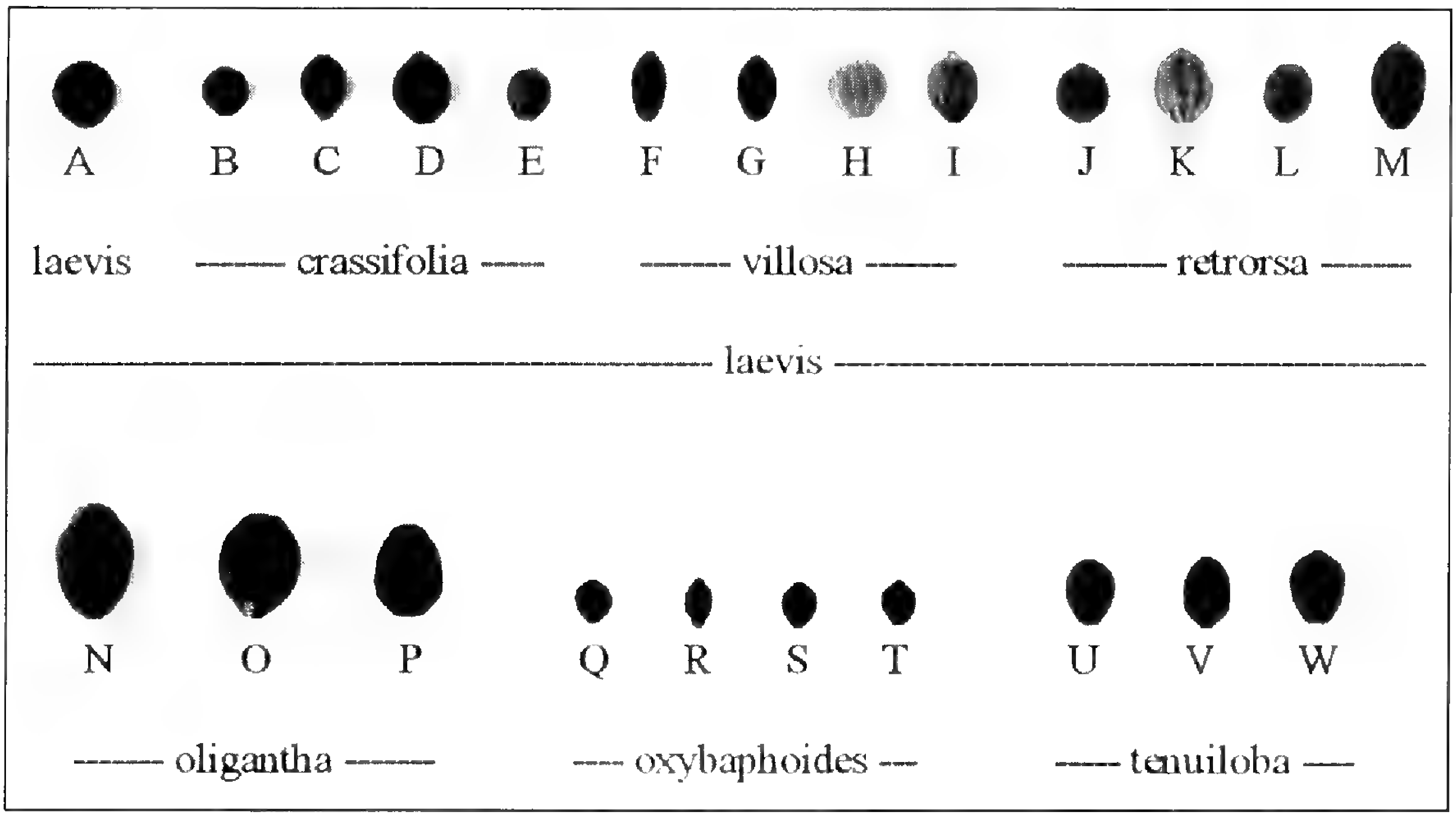

Fig. 1. Variation in fruits of Nyctaginaceae, section *Oxybaphoides*, in North America. Fruits are grouped by taxon (*Mirabilis laevis, M. oligantha, M. oxybaphoides, M. tenuiloba*). Those above the line "leavis" refer to varieties within *M. laevis*. Fruit above letter N is 7.5 mm long. Each letter refers to a fruit from a different collection. Collections, fully cited in Appendix 2 are identified by asterisk (*) following herbarium of deposition, are: A, *Brandegee s.n.*; B, *Palmer 886*; C, *Blakley 5657*; D. *Spellenberg 12336*; E. *Spellenberg 12335*; F, *Spellenberg 5444*; G, *Spellenberg 2982*; H, *Spellenberg 10206*; I, *Spellenberg 12332*; J, *Barneby 18303*; K, *Spellenberg 12342*; L,. *Spellenberg 12329*; M, *Eastwood 18313*; N, *Wiggins & Wiggins 15940*; O, *Gentry & Fox 11731*; P, *Moran 23808*; Q, *Johnston & Muller 603*; R, *Waterfall 12142*; S, *Columbus 637*; T, *Correll & Johnston 24516*; U, *Powell & B. L. Turner 1708*; V, *Wiggins & Wiggins 15863*; W, *Brandegee s.n.*

that *M. laevis* and *M. cedrosensis* (Standl.) Jepson were closely related if not the same as *M. californica*. Standley (1931b), upon completing studies of South American Nyctaginaceae, noted that characteristics used to distinguish North American genera allied to *Mirabilis* did not do so and also chose to unite all in an inclusive *Mirabilis*, a classification followed by most botanists since then. Of those taxa early placed in *Hesperonia* as they are recognized here, *M. oligantha* (Standl.) J.F. Macbride remains poorly known, *M. tenuiloba* has presented very few problems, but *M. laevis* has been a source of a plethora of names as taxonomists have attempted to deal with the variation presented by populations in the complex. The high points of these taxonomic meanderings are discussed under each of the taxa below.

Recently Le Duc (1993) described *Mirabilis russellii* Le Duc from the west coast of Mexico, placing the new species in the section *Oxybaphoides* because of its suffrutescent nature, campanulate perianth, and mucilaginous anthocarp (when wet). It rests very poorly in this section primarily because of general habit and anthocarp morphology. The single immature anthocarp available to us on the paratype at NMC generally resembles anthocarps of several other Mexican *Mirabilis* such as *M. sanguinea* Heimerl, *M. hintoniorum* Le Duc, and *M. urbanii* Heimerl, as figured in Le Duc's (1995) plate II. For the present treatment of section *Oxybaphoides* we exclude the species and suggest it lies more comfortably in section *Mirabilis*.

In this paper we examine the geographic variation and taxonomy of the most complex species in the section in North America, *Mirabilis laevis*, and we provide a key, descriptions, and distribution maps for the other three species in the section *Oxybaphoides* in the United States and Mexico. *Mirabilis laevis* and its component taxa have a tortuous taxonomic history that has resulted in many names published at the specific and infraspecific levels (Rodríguez 1992), based on differing generic, specific, and infraspecific concepts in the group. Generic concepts emphasized primarily the importance of the number of flowers per involucre, the shape of the fruit, and the degree of accrescence of the involucre. Specific or varietal decisions have primarily emphasized fruit shape and surface patterns, color of perianth, and nature of pubescence of foliage and stems.

MATERIALS AND METHODS

For this study more than 3000 herbarium specimens were examined from A, ARIZ, ASU, BRY, CAS, DS, GH, K, MO, NMC, NY, POM, RM, RSA, SD, UC, US, and UTC (abbreviations from Holmgren et al. 1990). From these specimens, 256 from the *M. laevis* complex were selected that had information about perianth color, possessed ripe fruits and at least midstem leaves, and had adequate data regarding place and date of collection. These specimens represent the morphological variation and geographic range of the taxa. They supplied data for morphological characteristics plotted in Figures 2 and 3 and described in treatments of taxa. Taxonomic decisions were made after study of specimens and the inspection of maps generated by plotting morphological characteristics geographically. Types or microfiches of types for basionyms were seen insofar as possible. From this information taxa were delineated that seemed to have some morphological, ecological and geographical reality. Those that showed considerable intergradation were recognized at the varietal level. The order of taxa in the treatment is based on perceived habitat specialization and reduction in number of fruits as generally compared to other *Mirabilis*.

We have separated detailed discussions of variation based on study of specimens in the *Mirabilis laevis* complex from the main taxonomic treatment and have included that in Appendix 1. Appendix 2 consists of standard citations of representative and/or cited specimens., including those that voucher chromosome counts.

Le Duc (1995) provides a key to the sections of *Mirabilis*.

TAXONOMY

Mirabilis sect. **Oxybaphoides** A. Gray in Torrey, Bot. Mex. Bound. 173. 1895. *Allioniella* Rydberg, Bull. Torrey Bot. Club 29:687. 1902; *Hesperonia* Standley, Contr. U. S. Natl. Herb. 12:360. 1909. TYPE: *Mirabilis oxybaphoides* (A. Gray) A. Gray.

Herbaceous to suffrutescent or shrubby perennials; root (of North American taxa; others unknown) long, cylindrical, cordlike; stems erect to decumbent or prostrate, densely to sparsely leafy. Leaves more or less evenly distributed, basal leaves larger, petiolate, distal leaves smaller, short-petiolate or sessile, margins plane. *Inflorescences* axillary and terminal in open or congested, few- or repeatedly-branched cymes; involucres bell-shaped, slightly accrescent, with 1 or 3 flowers inserted at base. *Perianth* broadly funnelform, abruptly flared from narrow tube, deeply 5-lobed; stamens 3–5. Fruit ellipsoid or obovoid, base not or slightly constricted, apex rounded, truncate, or somewhat nipple-like, surface with 0 or 5–10 indefinite or prominent lines, often somewhat furrowed, smooth or very slightly rugose, usually glabrous, mucilaginous when wetted.

A poorly understood section of about 10–20 species, North America, South America, southern Asia. Heimerl (1934) suggested there were about 23 species in the section, but considerable redefinition and consolidation of taxa in North America has reduced that number. Diversity is greatest in South America (Heimerl 1934).

KEY TO NORTH AMERICAN *MIRABILIS*, SECTION *OXYBAPHOIDES*

1. Involucres 3-flowered. ____ **1. M. oxybaphoides**
1. Involucres 1-flowered (very rarely 2 flowers).
    2. Fruits 6–8 mm long; perianth white, 15–18 mm long above the constriction. ____ **4. M. oligantha**
    2. Fruits 2.5–5.5 mm long; perianth white, pink, or magenta, 7–15 mm long above the constriction.
        3. Involucre in flower 7–10 mm long, the lobes narrowly lanceolate, at the base 1/4–1/3 as wide as long; perianth white or pale pink; leaf blades commonly 4 6 cm long, ascending. ____ **3. M. tenuiloba**
        3. Involucre in flower 3–6 mm long, the lobes triangular to lanceolate, at the base 1/3 to equally as wide as long; perianth white, pink, or magenta; leaf blades commonly 1–3.5 cm long, spreading or ascending. ____ **2. M. laevis**

1. Mirabilis oxybaphoides (A. Gray) A. Gray in Torr., U.S. & Mex. Bound. Bot. 173. 1859. *Quamoclidion oxybaphoides* A. Gray, Amer. Jour. Sci. 2, 15:320. 1853. *Allionia oxybaphoides* (A. Gray) Kuntze, Rev. Gen. Pl. 22:533. 1891. *Allionella oxybaphoides* (A. Gray) Rydb., Bull. Torrey Bot. Club 29:687. 1918. Type: at the foot of mountains east of El Paso, in the shade of high rocks, *Wright 596* (Lectotype, here designated: GH!, right side of sheet). Gray mixed Wright's field numbers *1223* (mountains near El Paso, in shade, procumbent, Sep 12, 1849) and *1322* (at the foot and in the shade of high rocks, fl. purple, Oct 14, 1849, noted on sheet to be probably Hueco Tanks). At this time it cannot be determined from which site either of the two specimens on the sheet originated. The one on the right is the more mature and representative; a second specimen originally at the Boston Society of Natural History, transferred to GH! in 1941, very closely resembles the plant on the right of the type sheet, is in a similar stage of maturity, and is a probable isolectotype.

Oxybaphus wrightii Hemsl., Biol. Centr. Amer. 3:3. 1882. TYPE: NORTH MEXICO: Chiricahui Mountains, *Wright* (HOLOTYPE: K). Hemsley sites only general locality and collector, without number or date. Gray (1853) cites *Wright 1721* (GH!), from Guadalupe Pass in the "Chiricahui Mountains," the collection probably seen by Hemsley. If from the present day Guadalupe Pass, the collection originated in the Peloncillo Mountains in New Mexico.

Mirabilis oxybaphoides var. *glabrata* Heimerl, Annuaire Conserv. Jard. Bot. Genève 5:180. 1901. *Allioniella oxybaphoides* var. *glabrata* (Heimerl) Standl., Contr. U.S. Natl. Herb. 12:357. 1909. TYPE: NEW MEXICO. LINCOLN CO.: El Capitan Mts., 31 Aug 1900, *F.S. & E.S. Earle 399* (HOLOTYPE: US!; ISOTYPE: NMC!).

Plants usually loosely clump-forming, herbaceous basally, the stems often intertangled and clambering through other vegetation. *Stems* ascending, spreading or decumbent, 0.2–1.2 m long, repeatedly branched, green throughout, puberulent in lines or throughout, glandular or not, the pubescence denser distally. *Leaves* thin or slightly fleshy; *petioles* up to 3.5 cm long on basal leaves, becoming progressively shorter distally, the distal leaves subsessile or on petioles to 4 mm long; *blades* of the basal and midstem leaves broadly deltoid or ovate, 1.5–8.0 cm long, 1.0–7.5 cm wide, glabrous or puberulent, and then often glandular, the base cordate, the apex usually acuminate or acute, sometimes rounded; distal leaves from broadly deltoid to lanceolate, 5–15 mm long, 3–10 mm wide, the base cordate or rounded. *Inflorescence* loosely and narrowly cymose or narrowly thyrsoid. *Involucres* solitary or loosely clustered at the ends of branches, or solitary in forks of branches or axils of leaves, on slender peduncles up to 17 mm long, glandular-puberulent, widely bowl-shaped in fruit, much broader than deep, 5–9 mm long, the 5 bracts united by their margins 1/3–1/2 their length, the lobes approximately equal, broadly triangular, 4–6 mm long, about as wide at the base, the apices acute. *Perianth* campanulate, purplish pink, pale pink, or occasionally white, sparsely viscid-puberulent externally, 5–9 mm long, about as wide, strongly constricted above the indurate base. *Fruits* 3 per involucre, olive or dark brown and black-mottled or evenly black, broadly obovoid to nearly spherical, ca. 2.5–3.5 mm long, the width ca. 70–90% of the length, smooth or very slightly rugulose, sometimes faintly marked with 5 shallow grooves (Fig. 1). $2n = 30_{II}$ (*Spellenberg & Soreng 5858*).

Distribution (Fig. 4).—Southern Nevada, southern Utah, and southern Colorado, south through Arizona, New Mexico, and western Texas to northern Chihuahua, western Coahuila, and western Nuevo León, in open woods, on banks in woodland, among brush or boulders, usually where somewhat moist, 1500–2600 m. Flowering (June–)August–October.

The species is readily recognized by the distinctive shape of the leaves. At the apex of the petiole the base of the blade is broadly cuneate within the sinus of the overall cordate base, the curve at each side of the base of the blade reversing in a sinuate manner before joining the petiole. The apex of the blade is usually acuminate. Very glandular-pubescent plants and glabrate plants may occur in the same population (*Spellenberg et al. 9681*). Plants may be sufficiently viscid to "catch little birds" (label data, *Vestal & Vestal 56*). Leaf shape is consistent throughout the range except in Nuevo León, where leaves on some plants are cordate-truncate at the base, rounded at the tip. On these plants the stems are little-branched and apparently ascending.

Plants were used by Native Americans to help heal "broken or bent" bones (label data, *Vestal & Vestal 408*).

2. **Mirabilis laevis** (Benth.) Curran, Proc. Calif. Acad. Sci., ser. 2, 1:235. 1888. *Oxybaphus laevis* Benth., Bot. Voy. Sulphur 44. 1844. *Hesperonia laevis* (Benth.) Standl., Contr. U.S. Natl. Herb. 12:363. 1909. *Quamoclidion laeve* (Benth.) Rydb., Bull. Torrey Bot. Club 29:687. 1902. TYPE: BAJA CALIFORNIA: Magdalena Bay, 1841, *Hinds s.n.* (HOLOTYPE: K!; photos of holotype NMC!).

Plants few-stemmed and clambering through other vegetation to many stemmed and forming clumps as wide or wider than tall; stems from the previous year often present and skeletal-white. *Stems* herbaceous or suffrutescent or clearly woody basally, 0.15–0.8 m long, erect or decumbent, repeatedly branched and appearing more or less dichotomous, glabrous, glabrate, puberulent, more or less scabrous, or viscid-villous, when pubescent, the pubescence denser distally, hairs spreading or retrorse; internodes 0.5–11.5 cm long. *Leaves* more or less fleshy, pubescent like the stem; *petioles* 1–22 mm on basal leaves, becoming progressively shorter distally, 0–4 mm long on distal leaves; *blades* of the basal and midstem leaves ovate, deltoid-ovate, ovate-rhombic, or subreniform, 1–4(–5.5) cm long, 0.5–3.5(–5) cm wide, the base cordate, truncate, or broadly obtuse, apex acute (occasionally attenuate), obtuse, or rounded, distal leaves lanceolate, lance-ovate, or ovate-rhombic, 5–17(–23) mm long, 3–11(–26) mm wide, the base cordate, truncate, or rounded. *Inflorescences* cymose or, in western races, more or less thyrsoid by partial suppression of one of the pair of axes. *Involucres* clustered and nearly sessile at the ends of branches, or solitary in forks of branches or axils of leaves, on peduncles 3–12 mm long, campanulate, 3–7 mm long in flower, enlarging about 1.5 × in fruit, the peduncles elongating slightly and deflexed; lobes of involucre 5, 1/3 as long to equalling the length of the tubular portion, slightly unequal, narrowly to broadly triangular or triangular-lanceolate, the base 1/3 to equal to the height. *Perianth* widely flared from a narrow constriction atop the indurate base, white, white with magenta veins, pink, lavender, or magenta, sparingly puberulent externally, 10–16 mm long, in full anthesis usually slightly wider. *Fruits* 1 (rarely 2) per involucre, gray or dark brown to almost black, ovoid, obovoid, or almost spherical, 3–5.5 mm long, 3–4 mm wide, glabrous, almost smooth to moderately rugose, often faintly mottled with darker brown or black, with or without 10 paler, diffuse longitudinal lines, becoming mucilaginous when wetted (Fig. 1).

Distribution (Figs. 2, 3).—United States from central California and eastern Oregon southward through southwestern Utah and central Arizona, south to Mexico in west-central Sonora and west-central Baja California Sur.

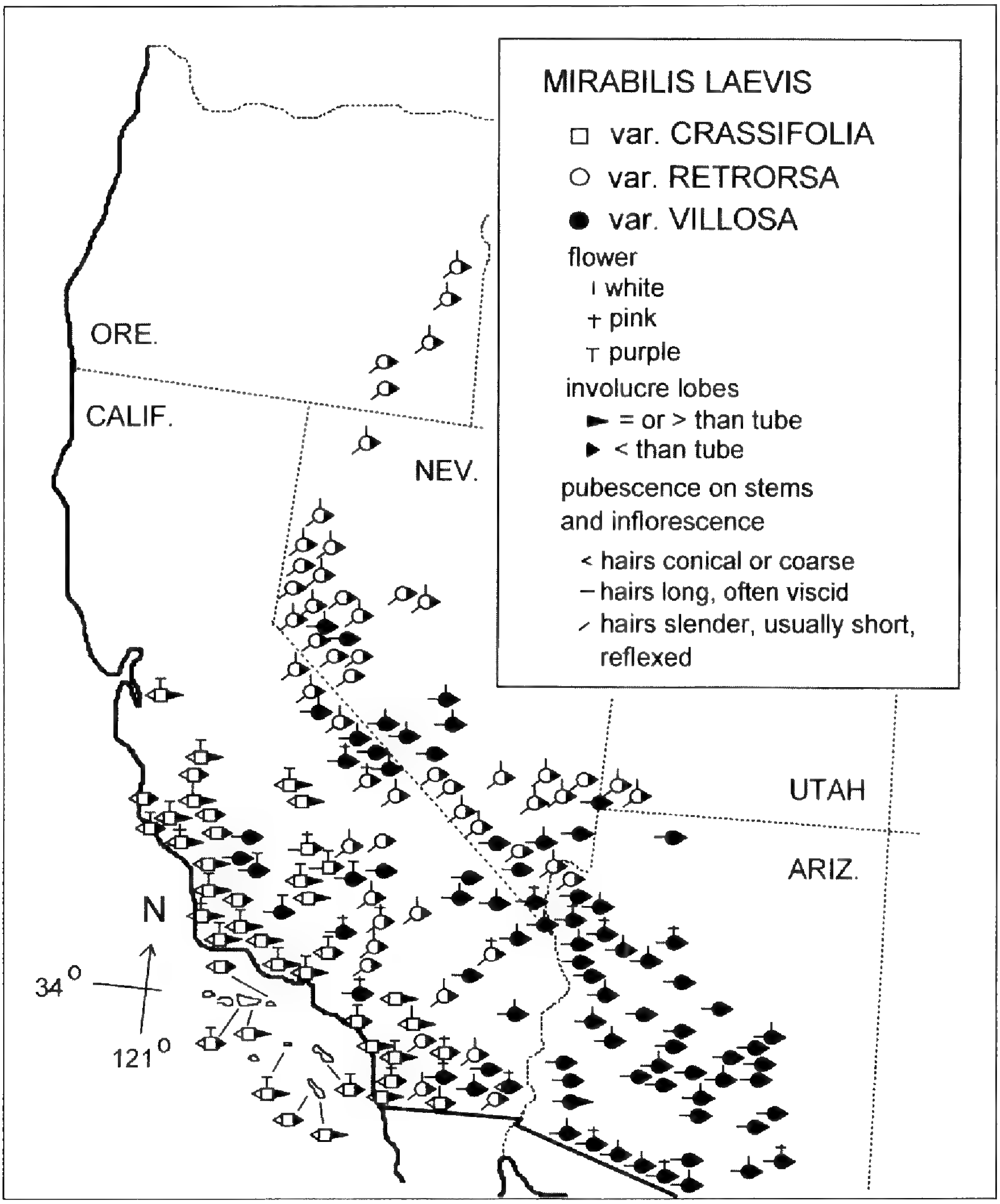

Fig. 2. Distribution of *Mirabilis laevis* varieties in western United States. Varieties as recognized in this treatment are indicated by open or closed circles or squares, and characters of specimen from that site are indicated by symbols attached to circle or square (as indicated in legend in inset). Map simplified from Rodríguez (1992).

We recognize four intergrading varieties based on morphological differences that serve to help delineate more or less distinct geographic races. For the past century authors have wrestled with the variation presented by these plants, some taking a rather conservative view and placing most forms in an inclusive *Mirabilis laevis*, others splitting variants as species or infraspecific taxa. Even on one of the syntypes (NY) of *Mirabilis californica*, the first of the variants to

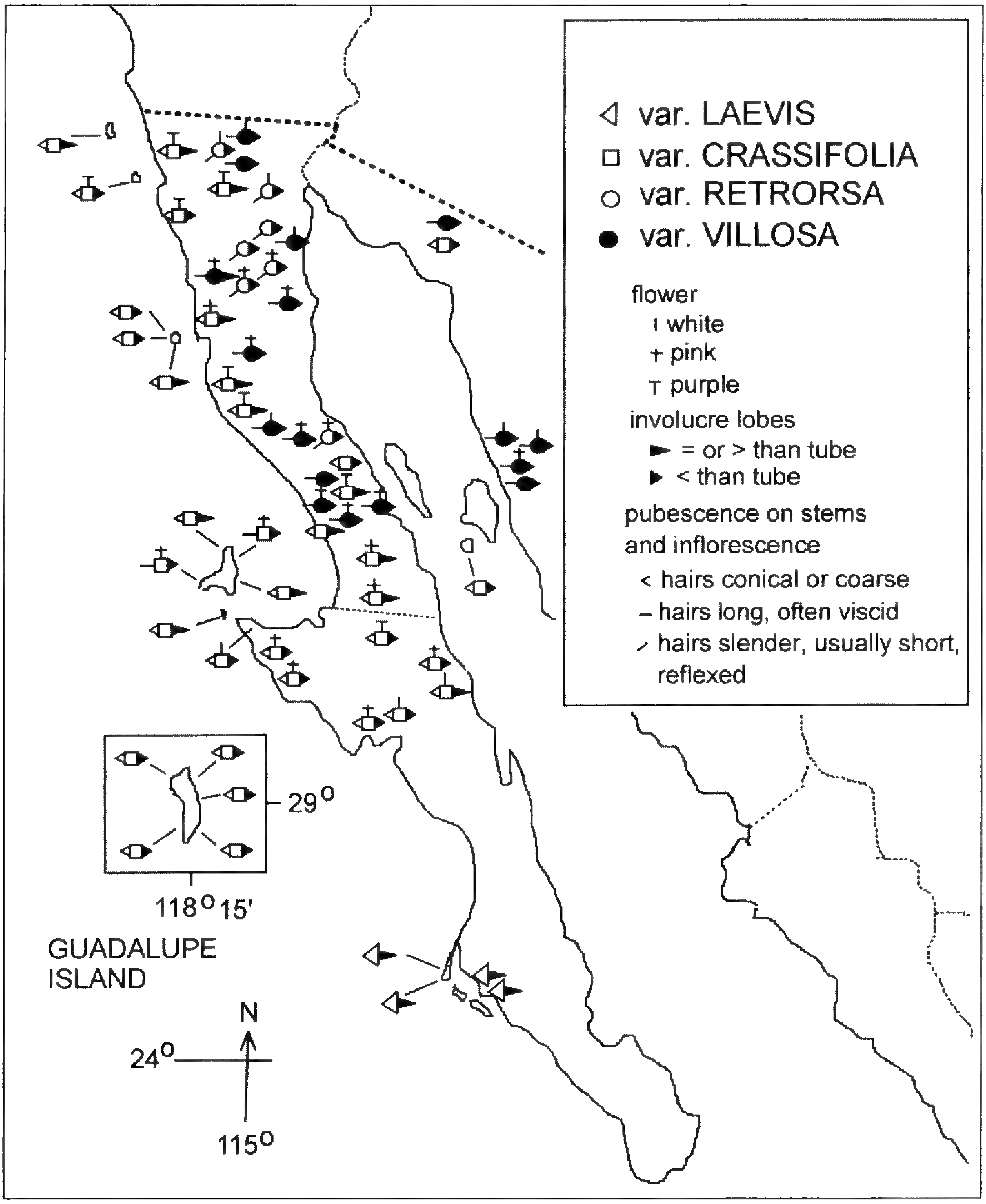

Fig. 3. Distribution of *Mirabilis laevis* varieties in western Mexico. Varieties as recognized in this treatment are indicated by open or closed circles, squares, or triangles, and characters of specimen from that site are indicated by symbols attached to circle or square (as indicated in legend in inset). Map simplified from Rodríguez (1992).

be split from *M. laevis*, the epithet "*leavis* Benth." appears on the collecting label along with "*Oxybaphus glabrifolius* Vahl." Curran (1888), in transferring *Mirabilis laevis* from *Oxybaphus* noted that plants recently brought from Magdalena Bay were "nearly but not quite glabrous, the inequality of the involucral lobes variable and often not greater than is found in our Californian forms." Wiggins (1964) placed all forms in the complex south of about 27° N in Baja California Sur into *M. laevis*, apparently ignoring populations to the north except for *Mirabilis californica* var. *cedrosensis*, which he noted to occur from San Clemente Island, California, southward on the west side of Baja California to the Vizcaíno Desert area (ca. 27°N). In that work Wiggins noted the inland specimens of *M. laevis* to be "quite viscid-puberulent to short-villous and often have the coarser and almost retrorse scabrous hairs on the upper stems that occur in forms of *M. californica*."

What was previously considered *Mirabilis californica* now comprises *M. laevis* var. *crassifolia*, which usually has an inflorescence with a more or less well defined central axis and shorter lateral branches, the entire shape being irregularly conical. We are terming this inflorescence form "thyrsoid." This contrasts to the much more openly and symmetrically forked inflorescences of many of the inland populations. We call these "cymose." The distinctions are not sharp.

KEY THE VARIETIES OF *MIRABILIS LAEVIS*

1. Plants glabrous or with a few hairs in distal parts; lobes of involucre lanceolate, width of base 1/2–2/3 times the height of lobe; perianth probably magenta. ______ **2a. M. laevis** var. **laevis**

1. Plants pubescent, rarely glabrate; lobes of involucre lanceolate to triangular, width of base 1/2–1 times height of lobe; perianth white, pink or magenta.
    2. Perianth pink or magenta, rarely white; width of lobe of involucre at base often 1/2–2/3 times height of lobe; plants pubescent, the pubescence usually not notably viscid nor retrorse (but hairs often stout and recurved along the coast); inflorescence commonly narrow and more or less thyrsoid. ______ **2b. M. laevis** var. **crassifolia**
    2. Perianth white, rarely pale pink; width lobe of involucre at base 2/3–1 times height of lobe; plants commonly notably viscid-pubescent or sparsely short-pubescent with retrorse hairs; inflorescences broad, cymose.
        3. Plants viscid-pubescent, hairs spreading, ascending or sometimes retrorse. ______ **2c. M. laevis** var. **villosa**
        3. Plants puberulent, hairs retrorse. ______ **2d. M. laevis** var. **retrorsa**

2a. Mirabilis laevis (Benth.) Curran var. **laevis**.

Stems glabrous. *Leaves* glabrous adaxially, with a few short straight hairs abaxially; *blades* of the basal and midstem leaves ovate or deltoid-ovate, 3–4 cm long, 2–3 cm wide, apex acute; distal leaves lanceolate, lance-ovate, or rhombic-ovate, 7–14 mm long, 2–5 mm wide. *Inflorescence* narrowly thyrse-like, with a long main axis and shorter side branches bearing near their tips involucres borne singly or in small clusters. *Involucres* 7–10 mm long, sparsely short viscid-villous, the bracts united 1/3–1/2 their length, the lobes lanceolate or ovate-lanceolate, acute. *Perianth* magenta. *Fruit* almost spherical, 4.5 mm long, 4 mm wide (Fig. 1).

Distribution (Fig. 3).—Apparently restricted to the vicinity of Magdalena

Bay, Baja California Sur, Mexico; habitat not recorded, 0–50? m. Flowering late winter and spring.

2b. Mirabilis laevis var. **crassifolia** (Choisy) Spellenb., comb. nov. *Oxybaphus glabrifolius* Vahl var. *crassifolius* Choisy in DC., Prodr. 13(2):431. 1849. TYPE: NOVA CALIFORNIA: 1833, *Douglas s.n.* (HOLOTYPE: G-DC [microfiche RSA!]).

Mirabilis californica A. Gray ex Torr. in W. H. Emory, Rep. U.S. Mex. Bound. 2(1):169, 173, plate 48. 1859. *Oxybaphus californicus* (A. Gray) Hook. in Benth. & Hook. f., Gen. Pl. 3:4. 1880. *Hesperonia californica* (A. Gray) Standl., Contr. U.S. Natl. Herb. 12:364. 1909. TYPE: CALIFORNIA: San Diego, sand hills, 1850, *C.C. Parry s.n.* (LECTOTYPE, here designated: NY!). In proposing the name, Gray states that *M. californica* came from "dry hills, San Diego, California," and then indicates the collectors "Parry, Thurber." On a sheet from the Torrey Herbarium at NY are three specimens. One, at the top, collected in Los Angeles by Mr. Rich is of no further concern. At the bottom of the sheet are two portions of plants associated with a single label, indicating the plants were collected by C.C. Parry on "sand hills" in San Diego in 1850. Because the statement on the label most closely matches the habitat described, and the specimen at the lower right of the sheet clearly is the source of the illustration for plate 48 (mistyped as plate 46 in the original description), we are selecting the material at the bottom of the sheet as the lectotype. SYNTYPES: San Diego, Wood Valley, May 1852, *Thurber 569* (2 specimens, GH!); *Bigelow*, Whipple Expedition, on the Colorado, 1853–54 (GH!, NY!) [which represents the var. *villosa* (Kellogg) Spellenberg, as delimited herein]; *Bigelow*, 21 Mar 1954 (GH!). At the time of publication Gray questioned whether *Oxybaphus laevis* Benth. might be the same as his new species, noting that the species is "commonly more or less pubescent, and rarely glabrate." Torrey (U.S. Rep. Expl. Miss. Pacific 4:131. 1857) assigned Bigelow specimens incorrectly to *Oxybaphus glabrifolius* Vahl. Gray, in the protologue of *M. californica*, cites Torrey's listing, correcting the placement of these specimens. Gray later, in the protologue of *M. bigelovii* alludes to the Bigelow specimens and indicates that this new taxon occurs "perhaps in California on the Colorado."

Hesperonia californica subsp. *microphylla* Standl., Contr. U.S. Natl. Herb. 12:365. 1909. TYPE: MEXICO. LOWER CALIFORNIA: San Martin Island [off the west coast of the state of Baja California], 12 Mar 1897, *Brandegee s.n.* (HOLOTYPE: UC!). PARATYPE: LOWER CALIFORNIA: Ensenada, 26 Apr 1893, *T.S. Brandegee s.n.* (UC!).

Hesperonia cedrosensis Standl., Contr. U.S. Natl. Herb. 12:362. 1909. *Mirabilis cedrosensis* (Standl.) Jepson, Fl. Calif. 459. 1914. *M. californica* var. *cedrosensis* (Standl.) Macbr., Contr. Gray Herb. 56:24. 1918. *M. laevis* var. *cedrosensis* Standl.) Munz, Man. South. Calif. 151. 1935. TYPE: MEXICO. BAJA CALIFORNIA: Cedros Island, 3 Apr 1897, *T.S. Brandegee s.n.* (HOLOTYPE: UC!). PARATYPES: CALIFORNIA: San Clemente Id., Oct. 1902, *Trask 14* (US!). California: San Clemente Id., May 1903, *Trask 193* (US!).

Hesperonia heimerlii Standl., Contr. U.S. Natl. Herb. 13:412. 1911. *Mirabilis heimerlii* (Standley) Macbride, Contr. Gray Herb. 56:24. 1918. TYPE: BAJA CALIFORNIA: Guadalupe Island, S end of island, 3 Mar 1889, *E. Palmer 886* (HOLOTYPE: US!: ISOTYPE GH!).

Mirabilis laevis var. *cordifolia* Dunkle, Bull. S. Calif. Acad. Sci. 40:108. 1941. TYPE: CALIFORNIA: San Clemente Island, Chinetti Canyon, 3 Apr 1939, *Dunkle 7234* (HOLOTYPE: RSA #350685!; ISOTYPE: RSA #464676!). Both specimens at RSA have been transferred from LAM; of the two the holotype has a hand written label with the word "type." Dunkle (1941) noted two variants in the same population, his new var. *cordifolia* intermixed with var. *cedrosensis*.

Stems often glabrous basally, viscid-pubescent or more or less scabrous distally. *Leaves* puberulent, viscid-villous, or more or less scabrous, sometimes becoming glabrate with age (or occasionally glabrous); *blades* of the basal and midstem leaves ovate-rhombic, subreniform, or deltoid-ovate, 1–4.5 cm long, 0.4–3.5 cm wide, the apex obtuse or acute, occasionally rounded; distal leaves lanceolate, lance-ovate, or ovate-rhombic, 5–14 mm long, 2–7 mm wide. *Inflorescence* often rather thyrse-like after the first few dichotomous branches, the branches short, the involucres in clusters along a main axis. *Involucres* 5–9 mm long, densely short viscid-villous or sometimes slightly scabrid, the bracts united 1/3–2/3 their length, the lobes ovate or ovate-oblong, obtuse or acute. *Perianth* pink, lavender, magenta, occasionally white. *Fruit* ovoid, 3–5 mm long, 2.7–3.7 mm wide, dark to pale gray-brown and mottled with dark gray-brown, tan, or red-brown, sometimes faintly and irregularly pale-striped (Fig. 1).

Distribution (Figs. 2, 3).—West-central California south along the coast, on the Channel Islands, and in the Coast Ranges to the Viscaino Desert, Baja California Sur and the coastal islands, Mexico; coastal bluffs, road banks, coastal scrub, grasslands, chaparral, oak woodland, often on rocky outcrops, 0–1830 m. Flowering most of the year, most vigorously in spring.

A particularly difficult area with regard to variation is around the southern end of the Sierra Nevada in California, where three of the varieties are in contact. *Howell 38179,* from the Lake Isabella region in Kern Co., illustrates very well the problematic classification of some specimens. It was first left unidentified in *Mirabilis*, then sometime later placed in an inclusive *M. laevis*; 9 years later was identified as *M. retrorsa*; 21 years later as *M. bigelovii* var. *bigelovii*, and shortly later placed in a variable var. *crassifolia*. The specimen combines the spreading leaves and (light) villous pubescence of var. *bigelovii*, the pointed leaves and rather long involucre lobes of var. *crassifolia*, and some retrorse hairs similar to var. *retrorsa*. Flower color was not given by the collector and is not evident from the specimen, but as judged from Spellenberg's collections from this area, flowers were probably white. Nearby, from the entrance to Kern River Canyon, comes *Howell 38142*, a late-season collection showing thyrsoid inflorescences of var. *crassifolia*, and fairly pointed leaves, but in other respects is the var. *villosa*; a similar, later collection (*Howell 38675*) from the same area notes "calyx rose." For plants from the lower reaches of the Kern River Canyon, Spellenberg's observations note flowers only pink to rose, yet if these plants were collected eastward they easily would be placed in more consistently white-flowered var. *villosa*. *Twisselman 8391*, from the same area, is more or less villous and has blunt leaves, in these respects similar to the var. *villosa*, but it has a more or less accrescent involucre with proportionately longer lobes, more reminiscent of var. *crassifolia*. Also seemingly intergradient to var. *villosa* is *Bedell 74-5* and *Twisselmann 198*, both from the north end of the Temblor Range in western Kern Co.; they have thick fleshy leaves that are blunt, short involucre lobes, but thyrsoid inflorescences; Twisselmann notes that flowers are "purple."

Mirabilis laevis var. *crassifolia* may also intergrade with *M. oligantha* in Baja California Sur (*Moran 18723*).

Much has been made of features of pubescence over the taxonomic history of this group. Even within var. *crassifolia* there is considerable variation. Near the coast, and particularly on the islands of northwestern Mexico, hairs are stout and conical, distinguishing *Hesperonia cedrosensis* and subsequent synonyms. This pubescence type is thoroughly intergradient to finer but still conical-based hairs common within the var. *crassifolia*. Fruit characteristics, such as those used to distinguish *H. heimerlii*, also an island population, seem to be completely inconsistent from population to population. Other specimen-based discussion focuses individually on characteristics that have been used to distinguish species in this complex and is found in Appendix 1.

The label on a specimen collected in Baja California (*Moran 12832*) notes the indigenous name and use "Yerba del Empacho.-bueno para el estomacho." The vernacular name is repeated on *Moran 23821* from Baja California Sur.

2c. Mirabilis laevis var. **villosa** (Kellogg) Spellenb., comb. nov. *Mirabilis californica* var. *villosa* Kellogg, Proc. Calif. Acad. Sci. 3:10. 1863. TYPE: CALIFORNIA. MONO CO.: Calif. Hwy. 182 10 m from Nevada border, Devil's Gate, canyon of East Walker River, *Spellenberg 12326*, 12 Jun 1996 (NEOTYPE, here designated: NMC!; ISONEOTYPES [!]: BYU, CAS, F, K, MEXU, MO, NY, RM, RSA, UC, US). Kellogg (1863) provides brief but clear description of a plant that matches the classic concept of *Mirabilis bigelovii* except that he notes his var. *villosa* to have a "pink perigonium" (rather than white). He notes the taxon to come "from the interior–Devil's Gate and Carson River..." but he cites no documenting specimens. We found no specimens that were seen by Kellogg, all perhaps having been destroyed in the 1906 San Francisco fire. During field work involving this complex Spellenberg could not find *Mirabilis* at the well known "Devil's Gate" along U.S. Hwy. 395 north of Bridgeport, Mono Co., Calif., nor were plants to be found along the upper portions of the West Walker River along this highway. In either place habitat seems incorrect. They do occur, however, at a lesser known "Devil's Gate" along the East Walker River (DeLorme Mapping 1990) northeast of Bridgeport, and this is presumed to be Kellogg's Devil's Gate. Plants from this site form the neotype series.

Mirabilis bigelovii A. Gray, Proc. Amer. Acad. 21:413, 1886. *Hesperonia bigelovii* (A. Gray) Standl. N. Amer. Fl. 21:235. 1918. TYPE: Grand Canyon, May 1885, *A. Gray s.n.* (HOLOTYPE: GH!). Gray cites his own collection in the protologue, indicating also that the type comes from "below Peach Spring" where the species is "common." The holotype has penned in Gray's hand on a printed label "Grand Canon" and "*Mirabilis bigelovii* n. sp.," but does not mention Peach Spring. In the protologue Gray alludes to Bigelow specimens, as discussed herein in the nomenclatural section under *Mirabilis californica*.

Mirabilis aspera Greene, Erythea 4:67. 1896. *Mirabilis californica* subsp. *aspera* (Greene) Parish, Muhlenbergia 3:125. 1907. *Hesperonia aspera* (Greene) Standl., Contr. U.S. Natl. Herb. 12:362. 1909. *M. californica* var. *aspera* (Greene) Jepson, Fl. Calif. 458. 1914. *M. laevis* var. *aspera* (Greene) Jepson, Man. Fl. Pl. Calif. 340. 1923.

M. bigelovii var. *aspera* (Greene) Munz, Man. S. Calif. 151. 1935. TYPE: CALILFORNIA: Mojave Desert, 14 Jun 1895, *Parish 3757* (HOLOTYPE: ND-G, photocopy at NMC!; ISOTYPES: GH!, UC!). Jepson (1914) indicates the type locality to be Hesperia, San Bernardino Co., California.

Mirabilis glutinosa A. Nelson, Proc. Biol. Soc. Wash. 17:92. 1905 [nomen illeg., later homonym of *M. glutinosa* Kuntze, Rev. Gen. 3(2):265, 1898, a Bolivian plant]. *Hesperonia glutinosa* Standl., Contr. U.S. Natl. Herb. 12:365. 1909. *Mirabilis limosa* A. Nelson, Bot. Gaz. 47:426. 1909 [a substitute name for the earlier illegitimate name]; *Hesperonia limosa* (A. Nelson) Standl., Muhlenbergia 5:104. 1909 [a superfluous name]. *Mirabilis californica* var. *glutinosa* Jepson, Fl. Calif., 1:458. 1914. *M. laevis* var. *glutinosa* (Jepson) Jepson, Man. Fl. Pl. Calif. 340. 1923. *M. laevis* subsp. *glutinosa* (A. Nelson) E. Murray, Kalmia 13:32. 1983. (same combination in Kalmia 12:22, 1982, based on incorrect basionym). TYPE: NEVADA: Karshaw, Meadow Valley Wash, 27 May 1902, *Goodding 967* (HOLOTYPE: RM!; ISOTYPES: DS!, MO!, NY!, POM!, UC!). The paratypes cited (NEVADA. WASHOE CO.: Pyramid Lake, 9 Jun 1903, *G.H. True 758* [RM!]; UTAH: St. George, 13 May 1902, *L.N. Goodding 778* [RM!]; duplicates at GH!, MO!) are the var. *retrorsa* in the present treatment).

Hesperonia aspera subsp. *villosa* Standley, Contr. U.S. Natl. Herb. 12:363. 1909. TYPE: CALIFORNIA: Mohave Desert, Cushenberry Springs, 2 Jun 1901, *S. B. Parish 4940* (HOLOTYPE: US!; ISOTYPE: NY!). PARATYPES: CALIFORNIA: Providence Mts., 26 May 1902, *T.S. Brandegee s.n.* (UC!). CALIFORNIA: Argus Mts., Shepherd Canyon, 30 Apr 1891, *Coville & Funston 741* (NY!, US!).

Hesperonia glutinosa subsp. *gracilis* Standl., Contr. U.S. Natl. Herb. 12:365. 1909. *H. limosa* subsp. *gracilis* (Standl.) Standl., Muhlenbergia 5:104. 1909. TYPE: ARIZONA, Sabino Canyon, 1892, *J.S. Toumey 471c* (HOLOTYPE: US!). PARATYPES: ARIZONA: without locality, 1876, *Palmer 644* (US!). ARIZONA: Tempe, 6 Apr 1896, *J.S. Toumey s.n.* (UC! - 2 sheets). CALIFORNIA: Colton, Feb 1881, *G.R. Vasey s.n.* (US! - 3 sheets, 2 apparently seen by Standley, 1 possibly not). NEW MEXICO: without locality, *G.R. Vasey s.n.*, 1881 (US!) [as Standley notes in the discussion of this paratype, the location is probably incorrect; Standley knew of no collections from New Mexico, and none have been seen in the present study. Ewan and Ewan (1981) indicate that Vasey was in central and northern New Mexico, well away from nearest known populations in Arizona, and that specimens were apparently sent back to Washington unlabelled, increasing the possibility of error. To Spellenberg, the New Mexico paratype appears very similar to Vasey paratypes from Colton, California, particularly US #22631].

Stems moderately to densely villous or viscid-villous, often with wavy hairs, or puberulent with ± retrorse hairs, the pubescence denser and increasingly viscid distally. *Leaves* ± fleshy, viscid-villous; *blades* of the basal and midstem leaves reniform-ovate, broadly deltoid-ovate, or suborbicular, 0.5–4 cm long, 1–3.7 mm wide. *Inflorescence* usually cymose, the branches ± equal throughout; *involucres* 5–7 mm long, the bracts united ca. 2/3 their length, the lobes ovate-triangular or ovate-oblong, obtuse or acute. *Perianth* white or pale pink, occasionally (especially in far western part of range) deep pink or purple. *Fruit* ellipsoid to obovoid or almost spherical, 4–6 mm long, 2.5–4 mm wide, gray-brown, dark charcoal-brown, or olive, often dark-mottled, often faintly marked with 10 paler longitudinal lines (Fig. 3). $2n = 30_{\text{II}}$ (*Spellenberg 5444*)

Distribution (Figs. 2, 3).—Southeastern Oregon through Nevada, southwestern Utah, southern California (primarily southeastern, but extending west as far as eastern San Luis Obispo Co.), western Arizona to Baja California and northwestern Sonora; roadbanks, slopes, open desert, often among brush or in open woodland, 35–2200 m. Flowering most of the year, most vigorously in spring.

In California the var. *villosa* (as *M. bigelovii*), has been considered to be from east of the Sierra Nevada and the Transverse Range. Nevertheless, around the San Joaquin Valley some plants of the var. *crassifolia* approach the var. *villosa* (e.g., *Ewan 10309; Hoover 3170; Raven et al 9240, Twisselmann 8377*) or cannot be excluded from it as here defined (e.g., *Bacigalupi et al. 5205; Eastwood & Howell 5839; Ferris & Bacigalupi 10350; Keck 2158*).

A vernacular name in Baja California recorded for this species is "Yerba de la Vieja" (*Moran 23774*).

From the type locality to the north plants are sporadic along the East Walker River and along the West Walker River where it exits from the Sierra Nevada and piñon pine vegetation into the Great Basin and its shrub association (*Spellenberg 12331, 12332*). Other plants in the region have much shorter, sparser pubescence and are more readily referable to the var. *retrorsa* (*Spellenberg 12327,12329, 12333*). No obvious habitat differences were detected between the two pubescence phases. Collection *12333* had flowers closed in mid-morning that were very slightly pinkish. Otherwise, all plants seen in flower had white perianths.

In discussing *M. aspera* on the Colorado and Mojave deserts, Parish (1907) notes intergradation along edges of range with *M. californica*, and places the former into the latter as a subspecies. Intergradation is particularly evident in perianth color – those plants from the zone of contact having pink (rather than red-purple or white) perianths. To the west, in the var. *crassifolia*, perianth color is usually red-violet, but white-flowered plants are known. To the east the var. *villosa* usually has a white perianth, occasionally with a pale pink tube, or rarely entirely pale pink. The pattern probably results from selection pressure of primarily diurnal pollinators in the west and nocturnal pollinators in the drier deserts to the east (Baker [1961] discusses various pollinators in *Mirabilis froebelii* (Behr) Greene, a species with red-violet flowers).

The pivotal nature of the var. *villosa* in the *Mirabilis leavis* complex is indicated by its extensive synonymy. As indicated by the discussion of variation as seen in various specimens (Appendix 1), the variety is variable and often intergrades with var. *crassifolia* and the var. *retrorsa*. In southeastern California and Baja California it is sometimes distinguished with difficulty from *M. tenuiloba*.

2d. Mirabilis laevis var. **retrorsa** (Heller) Jepson, Man. Fl. Pl. Calif. 340. 1923. *M. retrorsa* Heller, Muhlenbergia 2:193. 1906. *Hesperonia glutinosa* subsp. *retrorsa* (Heller) Standl., Contr. U.S. Natl. Herb. 12:365. 1909. *H. limosa* subsp. *retrorsa* (Heller) Standl., Muhlenbergia 5:104. 1909. *Mirabilis californica* var. *retrorsa* (Heller)

> Jepson, Fl. Calif. 458. 1914; *Hesperonia retrorsa* (Heller) Standl., N. A. Fl. 21:236. 1918. *M. bigelovii* var. *retrorsa* (Heller) Munz, Man. S. Calif. 151. 1935. TYPE: CALIFORNIA. MONO CO.: near the Southern Belle Mine, 25 May 1906, *Heller 8336* (HOLOTYPE: BKL on indefinite loan to NY!; ISOTYPES: DS!, GH!, NY!, MO!, US!).

Stems glabrous or with a few retrorse hairs below, sparsely to densely retrorse-puberulent distally, when densely pubescent, then often also ± viscid. *Leaves* ± fleshy, puberulent with retrorse hairs; *blades* of the basal and midstem leaves reniform-ovate, broadly deltoid ovate, or suborbicular, occasional orbicular-reniform, 0.5–3.5 cm long, 1–3.4 cm wide. *Inflorescence* usually cymose, the branches ± equal throughout; *involucres* 5–7 mm long, the bracts united ca. 2/3 their length, the lobes ovate-triangular or ovate-oblong, obtuse or acute. *Perianth* white or occasionally white tinged with pink at the base, rarely entirely pale pink. *Fruit* ellipsoid to obovoid or ± spherical, 3.5–5 mm long, 2.6–4 mm wide, occasionally slightly wider than long, gray-brown, dark charcoal-brown, or olive, occasionally dark-mottled, often faintly marked with 10 paler longitudinal lines (Fig. 1). $2n = 31\text{–}33_{II}$ (*Strother 1256*).

Distribution (Figs. 2, 3).—Southeastern Oregon, western and southern Nevada, southwestern Utah, northwestern Arizona, southern California, and northern Baja California; arid open areas among desert brush or in open woodland, often on banks, 60–2000 m. Flowering in spring, occasionally in winter, less frequently at other times.

In general, plants of the var. *retrorsa* are smaller, with smaller leaves, and apparently are more compact, providing more of a forking, repeating "wishbone" aspect (*Bagley 2098, Clemon and Jonsson 1690, Clokey & Templeton 5725, Munz 16449*), than most of those of var. *villosa*. Nevertheless, open sprawling plants with stems 3.5–4 dm long, with leaves 2+ cm long, and inflorescences ± thryse-like (*Peirson 7180*), resemble in aspect either the var. *crassifolia* or the var. *villosa*. Local environmental factors may also affect the phenotype; e.g., *Munz & Keck 4754* is a lanky plant with broad thin leaves. It is said to come from "among rocks along canyon" and may be a shade form. Plants indistinguishable from the tighter, smaller, northern forms of this variety occur as far south as the mountains of southern California (*Peirson 9846*) and Baja California (*Moran 14842*).

The variety *retrorsa* may co-occur with the var. *villosa* (see two specimens at DUD, *Train s.n.*, 30 Apr 1937, both from Darwin Falls Canyon; also *Duran 3455* [*retrorsa*] and *Mooney et al. 132* [*villosa*], both from Silver Canyon in the White Mountains). Munz noted his collections *13036* (var. *retrorsa*) to be not glutinous, *13037* (var. *villosa*) from the same site to be glutinous. The *Duran 3455* specimen cited immediately above has long internodes and spreading rounded leaves more typical of var. *villosa*, but has very short, mostly retrorse hairs; in respect to habit and pubescence it is intermediate between the two varieties. Mixed collections of the two are represented by *M. & E. Epling s.n.* and

Maguire & Holmgren 25193. The two also occur in close vicinity on the east side of the Sierra Juárez in northern Baja California (*Thorne, Boyd, et al. 61758* = var. *retrorsa*; *Thorne et al. 57784* = var. *villosa*).

As discussed for the var. *crassifolia*, Kern Co., California, is also an area of particular difficulty concerning the var. *retrorsa*. Numerous collections suggest intergradation with the var. *villosa*; e.g., very dense pubescence, clearly retrorse, is present in *Eastwood 3200*; on *Hall and Chandler 6882*, a similar plant from the same general region, the collectors note that the flowers are pure white and the plants are viscid. Further indicating the difficulty of satisfactorily classifying material from this area, two specimens collected very near one another a week apart in the same year each represent a different variety; *Voegelin 67* is nearest the var. *crassifolia*, whereas *Cole and Voegelin 120* is clearly var. *retrorsa*. Another pair of specimens from the same vicinity, in Red Rock Canyon (vicinity of Red Rock Canyon State Park) are the var. *retrorsa* (*Abrams 11877*) and a fairly lightly pubescent phase of the var. *villosa* (*Munz 1246*). *Howell 37115*, in its fairly dense but downward-flexed pubescence, approaches the var. *villosa*, and in its pointed leaves the var. *crassifolia* (flowers on the specimen appear to have been white). In this region of contact between the three varieties, ± typical plants of the var. *retrorsa* occur (*Howell 38667*).

3. Mirabilis tenuiloba S. Watson, Proc. Amer. Acad. Arts 17:375. 1882. *Hesperonia tenuiloba* (S. Wats.) Standley, Contr. U.S. Natl Herb. 12:363. 1909. TYPE: SOUTHERN CALIFORNIA: San Bernardino, 1880, *W.G. Wright 106* (HOLOTYPE: GH!; photo and fragment of holotype at DS!). According to note on labels of *Parish 6072*, the type locality is in West Canyon, western edge of the Colorado Desert, Riverside Co.

Plants forming leafy clumps 0.3–1 m or more in diameter, usually with many stems, herbaceous or somewhat suffrutescent basally. *Stems* ascending 0.2–1 m long, with few to many ascending branches, pale green or white at base, green distally, puberulent in lines or throughout, usually glandular-viscid, the pubescence denser distally. *Leaves* slightly fleshy; *petioles* to 2.2(–5) cm long on basal leaves, becoming progressively shorter distally, the distal leaves sessile or on petioles to 4 mm long and gradually intergrading to the bracts of the inflorescence; *blades* of basal and midstem leaves broadly deltoid or ovate, the largest often wider than long, 2–5(–8) cm long, 1.7–7.0(–12) cm wide, glabrate to glandular villous, the base rounded to cordate, the apex usually acute, sometimes rounded; distal leaves from broadly deltoid to lanceolate, often acuminate, 1–2 cm long, 7–15 mm wide, the base cordate or rounded. Inflorescence usually narrowly thyrsoid. *Involucres* densely clustered among distal leaves or bracts near ends of branches, on peduncles 0–2 mm long, glandular-pubescent, narrowly campanulate, deeper than broad, 7–16 mm long, the 5 bracts united by margins 1/3–1/2 their length, the lobes approximately equal, narrowly lance-oblong, 1/5–1/4 as wide at the base, the apices acute or attenuate. *Perianth* campanulate, white (rarely pink), sparsely viscid-puberulent externally, 13–18 mm long, about as wide, strongly constricted above the indurate base. *Fruits* 1 per involucre, dull reddish brown to almost black, rarely with 10 inconspicuous and very slightly paler lines, broadly ovoid to nearly spherical, 4–6 mm long, the width 60–85% of the length, smooth or very slightly rugulose, sometimes faintly marked with very shallow grooves (Fig. 1).

Distribution (Fig. 4).—Southern California, southwestern Arizona, and northwestern Sonora, south to Baja California Sur, on slopes, canyon sides, cliffs, and among rocks, or in gravel or sand in semi-arid and arid areas, 0–400(–900) m. Flowering late winter and spring, occasionally other times.

The species is from east of the mountains in southern California and from near the gulf in Baja California and therefore is mostly a desert species. It is known in Arizona only from the Tinajas Altas Mountains in Yuma Co., where it was collected in 1940 by L. Goodding (*s.n.*, 7 Mar 1940), the collection remaining unidentified for more than 50 years. It was rediscovered (*Felger & Broyles 92-613*) and reported from there by Felger (1993). As noted by Felger, the species was sympatric with *M. bigelovii* (= *M. laevis* var. *villosa*) (*Felger & Broyles 92-614*). A. and R. Nelson apparently collected *M. laevis* var. *retrorsa* (*3236*, but as *M. limosa*) in sympatry with *M. tenuiloba* (*3236a*), perhaps separating the collections later under the "*a*" number. The Nelson collection of *M. tenuiloba 3236a* has leaf tips more rounded than usual for the species, plants are less robust, and involucres in the shorter portion of the range for the species. It may be an introgressed plant. *Gander 1301*, a robust, more "typical" *M. tenuiloba*, among a number of other collections, is from the same canyon. Sympatry involving such similar perennial species provides the opportunity for hybridization. Occasional collections such as *Moran 8877* have involucres with triangular teeth 3–4 mm long, shorter than the tube, also suggesting intergradation with *M. laevis*.

MacBride (1918) considered *Chandler 5332*, from near Escondido in southern California, to be included in his concept of *M. tenuiloba* var. *polyphylla*, the only record north of Mexico for this entity. That specimen is here considered to be an extreme form of *M. laevis* var. *crassifolia*. Other somewhat similar specimens, having at maturity rather large involucres for *M. laevis* var. *crassifolia*, are from the Channel Islands (*see Blakley 5238, Clokey 4923, Raven 17655*).

The southernmost collection in Baja California Sur (*Wiggins et al. 258*) is much less pubescent that is characteristic of *M. tenuiloba*. The specimen was originally identified as *M. oligantha*.

4. **Mirabilis oligantha** (Standley) J.F. Macbride, Contr. Gray Herb. 56:23. 1918. *Hesperonia oligantha* Standley, Contr. U.S. Natl. Herb. 12:363. 1909. TYPE: BAJA CALIFORNIA: Calmalli, Jan-Mar 1898, *Purpus 82* (HOLOTYPE: UC!).

Hesperonia polyphylla Standley, Contr. U.S. Natl. Herb. 12:363–364. 1909. *Mirabilis polyphylla* (Standley) Standley, Publ. Field. Mus. Nat. Hist, Bot. Ser. 8:306. 1931. *M. tenuiloba* var. *polyphylla* (Standley) J.F. Macbride, Contr. Gray Herb. 56:23. 1918.

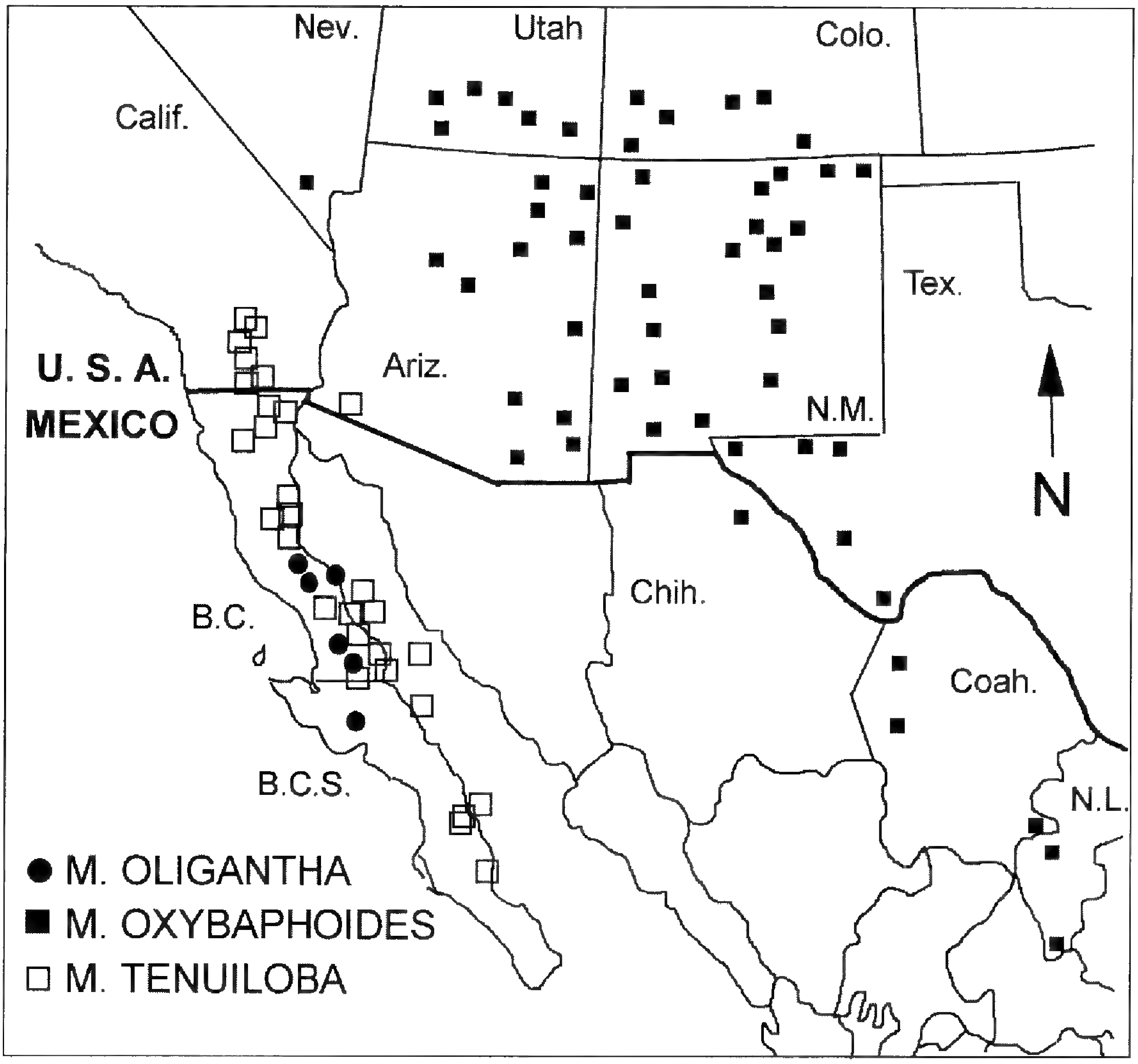

Fig. 4. Distribution of *Mirabilis oligantha*, *M. oxybaphoides*, and *M. tenuiloba* in North America.

> TYPE: BAJA CALIFORNIA: San Borga, 6 May 1889, *T.S. Brandegee s.n.* (HOLOTYPE: UC!). PARATYPE: LOWER CALIFORNIA: Gulf of California, Los Angeles Bay, 1887, *Palmer 600* (UC! on same sheet as holotype; duplicate of paratype at GH!, with month given as Dec).

Plants usually dense shrubs or subshrubs. *Stems* erect, ascending or spreading, 0.3–1.2 m long, repeatedly branched, with a whitish or gray exfoliating bark on older stems, glandular-puberulent, densely so distally, becoming glabrate with age. *Leaves* slightly fleshy; *petioles* 1–20 mm long, about 1/5–1/3 the length of the blade, becoming progressively shorter distally; *blades* of the midstem leaves broadly deltoid-ovate or ovate, about 2–5 cm long, 1.5–3 cm wide, sparsely to densely glandular puberulent, the base subcordate, rounded, or broadly cuneate, the apex acute, obtuse, or sometimes rounded; distal leaves progressively reduced from midstem leaves, from ovate to lanceolate, those among the flowers as small as 5 mm long, 2 mm wide, with a petiole of 1 mm long, the base rounded to cuneate. *Inflorescence* when well developed widely branching, the main axis zig-zag, or sometimes comparatively dense and thyrsoid. *Involucres* or solitary in forks of branches or axils of leaves, on slender peduncles 4–15 mm long that are deflexed after anthesis, glandular-puberulent, narrowly urn-shaped in flower, distended by the globose fruit, 7–10 mm long, the 5 bracts united by margins about1/2 their length, the lobes narrowly triangular or lanceolate, 4–5 mm long, 1/3–1/2 as wide at the base, the apices acute. *Perianth* campanulate, usually white, less often pinkish or lavender, sparsely puberulent externally, especially on the tube, 12–20 mm long, about as wide, strongly constricted above the indurate base. *Fruits* 1 per involucre, dark brown or nearly black, sometimes with 5 faint paler lines, ellipsoid, 6–8 mm long, smooth or slightly rugulose, sometimes faintly marked with 5 shallow grooves (Fig. 1).

Distribution (Fig. 4).—Central Baja California and northern Baja California Sur, on dry rocky slopes among desert shrubs and cacti, 50–600 m. Flowering fall to early spring, sometimes later.

Mirabilis oligantha is an endemic to the Baja California peninsula. A puzzling series of collections, mostly identified originally as *M. bigelovii*, come from the mountains of northern Baja California Sur, particularly from the vicinity of Picachos de Santa Clara, where *M. oligantha* has been collected (*Gentry 7717*). These plants may not have been so shrubby and stems may have been sprawling. They have rather sparse foliage, the progressively reduced leaves in the inflorescence characteristic of several *M. oligantha* specimens, and flowers borne singly or in few-flowered clusters. Involucres are small for *M. oligantha*, but have long lobes. Flower color noted on labels is white, pink, or lavender. *Mirabilis laevis* var. *crassifolia* occurs in the region, and the plants may represent intergradient forms. Such specimens have been annotated as that variety, with the note that they may be intergradient (*Gentry 7697, Moran 18723, Moran & Reveal 19671, 19689*).

Standley (1909) distinguished *Hesperonia oligantha* from other species in his key in part by stating that flowers are "purplish red." He also noted that stamens are "long exserted" in *M. oligantha*. Though the stamens are exserted somewhat in the species, as judged from herbarium specimens, the "long exserted" impression comes from Standley mistaking flowers as *Hesperonia* that actually are from some gamopetalous family, not Nyctaginaceae, attached as fragments to the holotype sheet. These flowers appear to have been dark in color. In 1911 and 1918 Standley did not mention flower color. Wiggins (1964) explicitly noted that *M. tenuiloba* has a white perianth and scarcely exserted stamens, and that *M. oligantha* (including *M. polyphylla*) has a white (or pink?) perianth, but for that species there is no mention of stamens. Of the 15 collections of *M. oligantha* seen, labels of five report the perianth as white or creamy white. One reports "white, slightly pinkish" (*Moran 23808*) and another "pale lavender" (*Gentry & Fox 11731*)

APPENDIX 1

Specimen-based discussion on characteristics that have been used to distinguish taxa in the *Mirabilis laevis* complex. Plants vary in many features, and often a collection used to illustrate one point also illustrates others. Specimen citations comprise Appendix 2.

Mirabilis laevis var. *crassifolia*

Pubescence of var. *crassifolia*.—The var. *crassifolia* is variable with regard to pubescence within populations (*Werff 4221* notes "plants conspicuously glandular, others not"), and intergrades with the vars. *retrorsa* and *villosa* to the east. The var. *crassifolia* usually has hairs that are noticeably broader at the base, somewhat or considerably coarser than the finer pubescence of the var. *villosa* or the short retrorse hairs of the var. *retrorsa*. Intergrades to the more villous var. *villosa* occur through much of range and are maintained in var. *crassifolia* primarily because of their relatively acute lower leaves, often comparatively long involucre lobes, and more or less thyrsoid inflorescences (*Daniel 1345; Gentry 8886; Templeton 11388; Thorne & Tilforth 41536*). Such plants are particularly common in the southern California mountains and in Baja California. Others, particularly from interior Baja California, have blunter leaves and slightly finer pubescence than coastal plants, and in this respect begin to approach the var. *villosa* (*Burgess 6095; Carter, Alexander & Kellogg 2522; Moran 18694*). These are retained in the var. *crassifolia* because of generally thyrsoid inflorescences and magenta or pink flowers. In California, specimen from near the coast in Ventura Co. has most of the characteristics of the var. *villosa*, i.e., long internodes, rounded leaves, villous pubescence, but has proportionately longer involucre lobes as in the var. *crassifolia* and flowers that are magenta to lavender (*Thompsom 1857*); plants to the north in Santa Barbara Co., are also similar (*Pollard s.n.*, 30 Sep 1956). Others from this region have more acute leaves and proportionately narrower and longer involucre lobes as in the var. *crassifolia* (*Bourell et al. 2938*), contrasting with other plants in the region such as *Hoover 7644*, which has rounded lower leaves and proportionately short involucre lobes, but which has strongly tapering hairs more consistent with var. *crassifolia*. Extremely lightly pubescent plants that have pointed leaves and rather long involucre lobes occur on western edge of the California desert (*Dunkle 3411*).

Standley (1909) established *Hesperonia cedrosensis* in large part on the conspicuous, conical, recurved hairs, the extreme in this feature resulting in ± hispidulous plants as occur on Cedros Island (*Henrickson 14453*). Plants with such hairs are almost entirely coastal but not necessarily insular (Standley 1918). Plants of the Viscaino region in central Baja California may have pubescence similar to the stout recurved trichomes of plants from Cedros Island (*Boyd, Ross & Appleby 8100; Gentry 7391*), as do plants along the northern Pacific coast of Baja California, which have notably pointed leaves (*Chisaki & Newcomb 525; Epling & Robinson s.n.*, 15 Feb 1935). Specimens that have stout recurved hairs interspersed with finer hairs occur on the Channel Islands (*Brandegee s.n.*, 25 Aug 1894; *Munz 6645*) and in the southern part of the range (*Wallace 176*). Others from the same islands show fewer recurved hairs and have somewhat more glandular puberulence (*Moran 6848*) or are barely recurved-pubescent at all but are more (*Eastwood 6387*) or less (*Breedlove 2874*) viscid-villous. The latter has rounded lower leaves reminiscent of the var. *villosa*, as do many plants on the Channel Islands, where larger, but not especially recurved, hairs may be mixed with a fine glandular hairs (*Raven 17307*). A very villous plant from these islands, thus similar to var. *villosa*, has long involucre lobes characteristic of var. *crassifolia* (*Thorne 37483*). Plants with large conical downward curved hairs may occur inland to the north, as in Fresno Co. (*Boolootian s.n.*, 6 Apr 1951).

Plants of var. *crassifolia* are not completely distinct from the var. *retrorsa*. *Howell 39241*, from Monterrey Co., is an open sprawling plant with pointed leaves as expected in the var. *crassifolia*, but has short calyx lobes and sparse retrorse hairs more similar to those of the var. *retrorsa*. Other collections, but from southern California, also well away from the main range of the var. *retrorsa* are lightly pubescent and have some retrorse hairs on stem, but have long involucre lobes more characteristic of the var. *crassifolia* (*Epling & Ellison s.n.*, 28 Mar 1930). Plants on the west slope of the southern Sierra Nevada approach var. *villosa* in their more or less villous pubescence, the hairs of which may be somewhat deflexed, and in their blunt leaves (*Benson 3214, Hoover 3170*); similar combinations of characteristics are found at the southern end of this mountain range where the geographic ranges of the three varieties come into contact (*Jepson 6752, Thorne 31702*). Along the contact zone of the var. *retrorsa* with the var. *crassifolia* in southern California are plants with retrorse hairs and white flowers, but with pointed leaves and rather long involucre lobes and conical hairs (*Kamb 902*).

A sparsely pubescent, lanky, very thin-leaved plant (*Munz et al. 2672*) appears to be an environmentally modified phase, having been collected on a "damp hillside."

Flower color of var. *crassifolia*.—Usually var. *crassifolia* has a deep rose or magenta perianth, intergrading through pink along the eastern edge of its range with the mostly white-flowered var. *villosa* (see discussion there). Nevertheless, and contrary to the key for *Hesperonia* by Standley (1909), within the range of var. *crassifolia*, sporadic variants with pale or white flowers are fairly frequent. "Flowers vary from purple to white" in populations in the northern part of range (Merced Co., *Lyon 932*) or "pale white with rose tint along veins" (San Benito Co., *Ewan 10309*, a plant very closely approaching var. *villosa*). Toward the southern end of the range plants with white (*Gentry 8694*; *Moran & Reveal 19671*; *Orcutt 219a*; *Reeder & Reeder 7259*), almost white (*Gray s.n.*), white tinged with pink (*Moran & Reveal 20006*), pure white veined red (*Trask s.n.*), white to light lavender (*Henrickson 8940*), or pale lavender (*Moran & Reveal 19870*) flowers occur, sometimes in mixed populations (*Ewan 7041* = white, *7042* = pink; *Moran 20414* = pink, *20415* = white). Pale-flowered, white-flowered, or mixed, populations in this region and along the eastern edge of the range are probably a response to selection pressures from nocturnal pollinators in the desert (e.g., *Jepson 6073, 8859*). Whitish-flowered plants also occur in the coastal scrub of Baja California (*Hodgson & Pinkava 3011*); white, pink and "red" flowers occur in the same population near the coast in southern California (*Hastings s.n.*,16 Apr 1941), and plants may occasionally have flowers white with red veins (*Trask 193*). *Trask 14*, however, from the same general locality, has magenta flowers. The last two specimens are paratypes of *H. cedrosensis*.

Leaf shape of var. *crassifolia*.—In an attempt to distinguish species in the complex, authors have reiterated features emphasized by Standley (1918), where leaves of the var. *crassifolia* (as *Hesperonia californica*) are said to be "... obtuse or acutish, ... most of them narrowed to the apex and never rounded" (Standley 1918). Leaves are illustrated with rather round apices in Torrey's (1859) original plate (# 48), which we believe is based upon the lectotype selected by us. At the northernmost known locality in the Coast Ranges, in Alameda Co., plants are much less pubescent than is common in the variety, but in may have either rounded midstem leaves (*Havlik 929*) or rather pointed leaves (*Spellenberg 12335*); the later clearly has the thyrsoid inflorescence characteristic of this variety. Plants with long internodes, spreading ± rounded or bluntly acute leaves, lightly glandular-villous pubescence, and rather cymose inflorescences from the interior coast ranges in San Benito and Merced counties are very close to var. *villosa*; flower color is not indicated on specimens (*Beylik 25; Hoover 4309; Spellenberg 12336*).

Inflorescence of var. *crassifolia*.—In their extremes, the differences between the thyrsoid inflorescence of western races and the neatly forked inflorescence of some eastern populations from the desert are notable. From the western edge of the Colorado Desert, where collectors mostly note rose perianths (rarely white - *Munz & Everett 16245*), plants are open, sprawling, and leafy, the inflorescences thyrse-like as the var. *crassifolia*. Nearby, on the sandy desert plain are plants more typical of var. *retrorsa*, less leafy in appearance, with recurved hairs, shorter erect or spreading stems, and an inflorescence that is much less thyrse-like, though it is still not neatly forked (*V. & A. Grant 15979*).

Fruits of var. *crassifolia*.—Various authors have indicated certain fruit shapes or surface pattern are distinctive for taxa, particularly at the varietal level. Munz & Keck (1968) indicate considerable variation in the fruit of a broadly delineated *M. laevis* (= var. *crassifolia* in sense of this paper), indicating the fruits to be "dark, sometimes mottled or pale-striate, smooth," but provide specific and limited characteristics for the fruit of infraspecific taxa of *M. bigelovii*. Standley (1918) also maintains limited variation for the fruits in his taxa within *Hesperonia*. In the var. *crassifolia* fruits may be obovoid, broadly ellipsoid, or ± globose, grayish brown, and very faintly dark-mottled (*Eastwood & Howell 2396, Philbrick B68 80, Solbrig 2670*); irregularly and faintly pale-striped and indefinitely dark-mottled (*Rose 63030*); pale gray-tan, mottled faintly with tan (*Wiggins 2054*); grayish brown mottled with red brown (*Spellenberg 10208*); dark charcoal brown, faintly mottled darker (*Youngberg 7*); dark brown, faintly mottled darker and very faintly striped, paler near the apex (*Munz & Harwood 3900*); grayish brown and mottled faintly slightly darker, with faint pale stripes at each end (*Havlik 929*).

Mirabilis laevis var. *retrorsa*

Pubescence of var. *retrorsa*.—Two collections from the Granite Mountains, eastern San Bernardino Co., Calif., indicate intergradation between var. *retrorsa* and var. *villosa*, and perhaps the low significance of pubescence characters in general. Both these plants are similar in general aspect, being small and well branched; *Stein 12* is glabrate, with a few downward-oriented hairs on the stems (a "good" var. *retrorsa*), whereas *Tilforth & Tilforth 1012* is villous. From the area of contact in southern California intermediate plants occur; *Gould 2248*, from the east base of the Coast Ranges in San Diego Co., has glandular villosity, some hairs downward directed, and white flowers as in var. *villosa*, but hairs with conical bases and thyrsoid inflorescences similar to var. *crassifolia*.

Flowers of var. *retrorsa*.—Flowers are usually white, but there occasionally are other color forms; white limb and rose throat (*Clemon & Jonsson 1690*); rose (*Twisselman 7280*); white and rose-pink at same site (*Hall and Chandler 6882, 6884*, respectively).

Inflorescence of var. *retrorsa*.—The very neatly forked branching characteristic of this variety is illustrated by *Peirson 8900, Holmgren & Holmgren 7697*, and *Twisselman 7280*. Near the area of contact with var. *crassifolia*, plants may have thyrsoid inflorescences (*Benson 3136, M. E. Jones s.n.*, 25 Apr 1906, *Winblad s.n.*, 2 Feb 1937); the Jones specimen also has unusually long involucre lobes for the variety.

Fruits of var. *retrorsa*.—Fruit shape and surface pattern are variable; ± globose, gray brown, not lined (*Reveal & Reveal 50*); ± globose, with 10 pale lines (*Henrickson 18257, Henrickson & Bekey 18288*); ± globose, yellowish brown, faintly darker mottled, not lined (*Ferris 7988*); broadly obovoid, dark, with 10 thin, pale lines (*Munz & Keck 7862, Peirson 8900*); broadly obovoid, smoky brown, not lined (*Spellenberg et al. 3151*); ellipsoid, dark brown and very faintly mottled, incompletely and faintly 10 lined pale (*Thorne 33848*). One population has plants occasionally with 2 fruits per involucre (*Spellenberg 12342*).

Leaves of var. *retrorsa*.—Leaves are usually obtuse or rounded at the tip. In the zone of intergradation to the var. *crassifolia* in southern California, intermediate plants may have acute leaves (*Henrickson 5557*). A pair of specimens suggest a strong genetic component to leaf shape and size, nature of pubescence, and involucre characteristics. Progeny from a collection with white flowers, small, acute leaves, and the pubescence of var. *retrorsa* from the north end of the Coachella Valley (*Munz and Everett 16245*) has retained these features (flower color not given) when grown in the Rancho Santa Ana Botanic Garden in Claremont (*Balls 19406*). A very acute-leaved phase of open habit is represented by *Henrickson 17348*.

Mirabilis laevis var. *villosa*

Involucre of var. *villosa*.—Ordinarily, the involucre lobes of the var. *villosa* are about 1/2–1/3 the length of the tube. Plants in southwestern Arizona have unusually long involucre lobes, equal to, or even slightly longer than, the tube. These may have resulted from introgression with *M. tenuiloba* (*Reeves & Lehto L20124, Harrison 11*). Some plants from the penninsula of Baja California have the dense viscid-villous pubesence of the var. *villosa* but more or less thyrsoid inflorescences characteristic of var. *crassifolia*, and involucre lobes about as long as the tube (e.g., *Carter 5449, Thorne et al. 62452*).

Flower color of var. *villosa*.—Flowers are usually white in this variety. All three varieties mix in the Sierra San Pedro Martir of Baja California, where pink- or purple-flowered villous plants occur (*Daniel 1414, Moran 24540*). Transition from pink to white is seen in specimens where the throat retains pink but the perianth limb is white (*M. Baker 4544, Palmer 208*). On the west side range of var. *villosa* a number of collections document color variation in flowers within populations or departure from the usually white perianths of more eastern plants; white or pink perianths (*Holmgren & Holmgren 6535*), white to lavender (*Munz & Hitchcock 12046*), deep lavender (*Wilken & Werner 7485*), or pink (*Cooper 2257* – a plant intermediate to var. *crassifolia* in its acute leaves). In southeastern California collections by Hall and Chandler note white (*7023*) and pink (*7024*) flowers to occur in the same vicinity. Pale pink, pink, lavender, or purple flower are also known from farther east (*Graham 3222; Henrickson 14004, Lloyd 2866; Train 1377; Wiggins 9648*). In Kern Co., California, characteristics of varieties are variously combined; *Twisselmann 8377* and *Keck 2158*, both from western part of the county are of open habit, have fairly large fruits, rather blunt leaves, and very villous pubescence, similar to "good" var. *villosa*, but in its "magenta" flowers and thyrsoid inflorescence it is more similar to the var. *crassifolia*. Eastward in the county, are plants with "rosy-purplish" perianths and lighter pubescence, with a few retrorse hairs, leaves spreading, large and blunt, overall with an aspect like var. *villosa*, but the lighter pubescence and spreading leaves characteristic also of var. *retrorsa* (*Howell 37226*).

Leaf shape of var. *villosa*.—Plants with acute leaf apices occur along or near line of contact with the var. *crassifolia* in southern California (*Peirson 1853; Roos s.n.*, 26 Mar 1966; *Thorne & Tilforth 40843; Tilforth & Dourley 340*). Sonoran plants often have ± acute leaves (*Spellenberg 5444; Van Devender & Kearns s.n.*, 18 Feb 1977). More or less typical plants with rounded leaf apices occur as far west as the Transverse Ranges of California (*Gustafson 1025*).

Pubescence of var. *villosa*.—In the mountains of southern California plants often are more sparsely pubescent in basal parts but are notably villous in upper parts (*Peirson 5356*). Lightly pubescent specimens in southwestern Arizona (*Peebles et al. 463*) approach the var. *retrorsa*, as do plants from southeastern California with the open habit and large, broad leaves of var. *villosa*, but with very short pubescence, often sparse on lower parts (*Robinson & Lindner c57*).

Inflorescences of var. *villosa*.—The dichotomous inflorescence characteristic of the desert races of *M. laevis* from east of the Sierra Nevada and the southern California coastal ranges is nicely illustrated by *Clokey and Anderson 6603*. Thyrse-like inflorescences more characteristics of the var. *crassifolia* occur in var. *villosa* well away from the range of the former in eastern Mojave Desert (*Charlton & Pitzer 1834*), or nearer to range of var. *crassifolia* in the southern California coastal ranges (*Holmgren & Holmgren 7539*) or in Baja California (*Wiggins 20832*).

Fruits of var. *villosa*.—Fruits in this variety vary from nearly globose to ellipsoid or obovoid, the surface mottled or striped. Example of variation are: fruits ± globose, grayish, with 10 very faint and indefinite pale lines (*Lloyd 2636, Munz 12465, Spellenberg 10206, Turner 62 2*); broadly obovoid, indefinitely pale-lined at base (*Morefield 4800, Spellenberg 2982*); ± globose, 10 faint, pale lines alternating with 10 diffuse darker lines (*Parish 3183, Munz 10930*); ± globose, very dark and dark-mottled, without lines (*J. & L. Roos 4182*); ellipsoid or obovoid, gray or brown and black- or dark-mottled (*Boyd et al. 2112, Felger & Valenzuela L. 86 180, Higgins 6378, Reeves & Lehto L20124, Roos s.n, Spellenberg 10205*); broadly obovoid, unlined, grayish brown (*Jepson 5959*) or faintly lined (*Jepson 5957*, same time and place).

APPENDIX 2

Representative and/or cited specimens. Specimens are cited by taxon, and within taxa geographically by country, state, and county, then alphabetically by collector. Those specimens that provided fruit for illustration in Figure 1 are indicated by and asterisk (*) following herbarium citation.

Mirabilis laevis var. **crassifolia**

MEXICO. BAJA CALIFORNIA: 21.9 mi E of El Rosario via Hwy. 1, 13 Oct 1981, *Burgess et al. 6095* (ARIZ, SD); 0.9 mi N of Rosario, 6 Feb 1953, *Chisaki & Newcomb 525* (ARIZ, GH, RM, SD, UC); San Matias Pass of Sierra San Pedro Martir, 20 May 1981, *Daniel 1345* (ASU); Cedros Id., ca. 2 mi S of lighthouse on E side, 23 Feb 1977, *Davidson 5488* (RSA); 5 mi N of San Quintin, 15 Feb 1935, *Epling & Robinson s.n.* (ARIZ, GH, NY, RM, UC); Mina Desengaña, ca.. 16 mi N of Punta Prieta, 30 Mar 1950, *Gentry 8886* (ARIZ); Cedros Id., ca. 1 mi S of village at Cabo Norte, 19 Jan 1975, *Henrickson 14453* (NMC); 1 km N of San Vicente, 6 Jan 1984, *Hodgson & Pinkava 3011* (ASU); South Todos Santos Id., 7 Apr 1948, *Moran 2802* (UC); Sierra San Borja, Rancho Carrizo, 20 Mar 1966, *Moran 12832* (SD); San Esteban Id., NE peak, 28 42'N, 112°35'W, 26 Apr 1966, *Moran 13051* (SD); San Martin Island, 21 Apr 1970, *Moran 17458* (RSA); 7 mi SE of Laguna Chapala, 18 Oct 1971, *Moran 18694* (ARIZ, RSA, SD); Guadalupe Island, south end of island, 30 Mar 1889, *Palmer 886* (US*); ca. 23 km NW of parador Cataviña [Santa Iñez], 15 Jun 1980, *Reeder & Reeder 7259* (SD); San Martin Island, 3 mi off cinder cone of San Quintin, 21 Feb 1986, *Thorne 61594* (RSA); Guadalupe Island, NE Anchorage, 28 -29 Mar 1988, *Thorne 63015*. **BAJA CALIFORNIA SUR:** NW end of Viscaino Peninsula on road from Bahia Tortugas to Punta Eugenia, 2 May 1993, *Boyd, Ross & Appleby 8100* (TEX); 26 km N of San Ignacio, 10 Jan 1948, *Carter, Alexander & Kellogg 2522* (ARIZ, UC); 8 mi N of San Juanico, 8 Mar 1939, *Gentry 4314* (ARIZ, GH); E bajada of Sierra Calvario, 10–15 Mar 1947, *Gentry 7391* (ARIZ, RSA, UC); Picachos de Santa Clara, 5–10 Nov 1974, *Gentry 7697* (SD); 2–3 mi E of Punta Eugenia, 13 Mar 1949, *Gentry 8694* (ARIZ); between Volcán Tres Virgenes and Cerro Azufre, 27 29'N, 112 34'W , 11 Apr 1973, *Henrickson 8940* (SD); Rancho la Laguna, Sierra San Francisco, 27 35'N, 113 02'W , 23 Nov 1976, *Moran 23821* (SD); 6 mi N of San Andrés, Arroyo Calvario, 10 Feb 1973, *Moran & Reveal 20006* (SD); Picachos de Santa Clara, 3 Feb 1973, *Moran & Reveal 19689 (SD), 19671* (ASU, POM; SD); Cerro Azufre, 27 30'N, 112 36'W , 20 Oct 1971, *Moran 18723* (SD; UC); Volcán las Tres Virgenes, 27°29'N, 112°36'W, 11 Apr 1973, *Moran 20414* (SD), *20415* (SD, UC); Arroyo Malarrimo 11 mi S of mouth, 6 Feb 1973, *Moran & Reveal 19870* (ASU, SD, UC). **U.S.A. CALIFORNIA. Alameda Co.:** W-facing slope of Mission Peak, 16 Jun 1980, *Havlik 929* (CAS); E side of Fremont on Mission Peak, 16 Jun 1996, *Spellenberg 12335* (F, MO, NMC*, NY, RSA, UC, US). **Fresno Co.:** Owens Mtn., 6 Apr 1951, *Boolootian s.n.* (JEPS); Owens Mt., 6 mi SE of Friant Dam, 9 May 1953, *Quibell 1890* (RSA). **Kern Co.:** Greenhorn Mts., Mt. Breckenridge, 3 Apr 1932, *Benson 3214* (UC); Oildale - Woody Road, 17 Apr 1938, *Hoover 3170* (DS, UC); entrance to Kern River Canyon, 7 Jul 1962, *Howell 38142* (CAS); Wofford, 7 Jul 1962, *Howell 38179* (CAS); Kern River Canyon, 21 Sep 1962, *Howell 38675* (CAS); Caliente, 15 Apr 1916, *Jepson 6752* (JEPS); 2.6 mi E of Caliente, 16 May 1963, *Thorne 31702* (RSA); Temblor Range, Cedar Canyon, 1 Jun 1952, *Twisselmann 198* (CAS); mouth of Kern Canyon, 11 Jun 1963, *Twisselman 8391* (CAS, RSA); 2 mi NE of Weldon, 5 May 1933, *Voegelin 67* (UC). **Los Angeles Co.:** San Clemente Island, 10 Jun 1962, *Blakley 5238* (SD); San Clemente Is., 25 Aug 1894, *Brandegee s.n.* (UC); Santa Monica Mts., Las Flores Canyon, 28 Mar 1930, *Epling & Ellison s.n.* (MO, RSA, UC); Los Angeles, 16 Apr 1904, *Grant 791* (ARIZ, CAS, DS, RSA); Los Angeles, May 1885, *Gray s.n.* (GH); Pacific Palisades, Temescal Canyon, 16 Apr 1941 *Hastings s.n.* (NY); Santa Catalina Id., S of Wilson's Harbor, 2 Mar 1941, *Moran 669* (RSA); San Clemente Id., 2 mi S of Eel Point, 18 Sep 1958, *Moran 6848* (DS, RSA, UC) [same site, 9 Mar 1959, *Moran 7170* (DS, RSA)]; San Clemente Id., E coast, 9 Apr 1923, *Munz 6645* (POM, UC); E of Zuma Beach, 4 Apr 1959, *Raven 13964* (RSA); San Clemente Id., S of Eel Point, 11 Apr 1962, *Raven 17307* (RSA, SD); San Clemente Id., just N of Guds, 9 May 1962, *Raven 17655* (RSA, SD); near isthmus on Santa Catalina Id., *Templeton 11388*, 25 Feb 1968 (RSA); Santa Barbara Id., Cat Canyon, 28 Apr 1968, *Thorne 37483* (RSA, SD); San Gabriel Mts., San Dimas Canyon, 9 Apr 1971, *Thorne & Tilforth 41536* (RSA); San Clemente Id., May 1903, *Trask sn* (A). **Merced Co.:** Mine Canyon near Little Panoche Valley, 6 Apr 1940, *Hoover 4309* (DS); Mine Creek 1.5 mi N of junction of Merced, Fresno, San Benito cos., 11 Apr 1935, *Lyon 932* (UC). **Monterrey Co.:** 6 mi From King City, 10 May 1936, *Eastwood & Howell 2396* (CAS, NY, UC); Redwood Gulch, 20 May 1960, *Hardham 5795* (RSA); 6 mi N of King City, San Lorenzo Creek, 7 May 1963, *Howell 39241* (RSA); 6 mi NE King City, 7 May 1963, *J. T. Howell 39241* (RSA); 6 mi NE of King City, 7 May 1963, *Rose 63030* (CAS, DS, RSA). **Riverside Co.:** Whitewater Canyon about 3 mi from mouth, 8 Apr 1932, *Ewan 7041* (POM); San Gorgonio Pass, 25 May 1914, *Jepson 6073* (JEPS); Whitewater Wash near Whitewater, 11 Apr 1948, *Kamb 902* (JEPS); Dry Morongo Wash, 2 May 1952, *Munz & Everett 16245* (RSA). **San Benito Co.:** ca. 6 mi SE of Panoche School, 12 May 1958, *Beylick 25* (RSA); Cherry Hill Sch. W of Llanada, 25 Apr 1937, *Ewan 10309* (RSA); 17.6 mi from New Idria on road to Panoche, 6 May 1956, *Raven et al. 9240* (RSA); Road 107, 14.5 km SE of junction with Little Panoche Rd, 27 km NW of New Idria, 17 Jun 1996, *Spellenberg 12336* (NMC*, NY, UC). **San Bernardino Co.:** Dry Morongo Creek, 6 Apr 1933, *Dunkle 3411* (RSA); Santa Ana River Canyon, 3 May 1919, *Munz, Street & Williams 2672* (POM); Hwy. 330 ca. 3 mi E of Highlands, 27 May 1990, *Spellenberg 10208* (NMC, NY, UC); Colliius Valley, Indian Canyon, 28 Apr 1920, *Jepson 8859* (JEPS); Fallbrook, 15 May 1920, *Munz & Harwood 3900* (RSA); San Diego, Chollas Valley, 1 Jan 1884, *Orcutt 219a* (MO). **San Luis Obispo Co.:** summit of Cottonwood Pass, 1 May 1949, *Hoover 7644* (CAS); Escondido, 5 Jun 1904, *Chandler 5332* (DS, GH, UC) (cited in new combination of *M. tenuiloba* var. *polyphylla*); 3 mi S San Clemente, 19 Mar 1966, *Wallace 176* (SD); Otay Lake, 12 Apr 1981, *Werff 4221* (SD); Cuyamaca Mts., 6 mi below Alpine, 20 Mar 1926, *Wiggins 2054* (SD); Camp Kearney Mesa, 7 Apr 1935, *Youngberg 7* (POM). **Santa Barbara Co.:** Santa Barbara Island, Cat Canyon, 4 May 1963, *Blakley 5657* (US*); toward Figueroa Mtn., 4 Apr 1986, *Bourell, Patterson & Timbrook 2938* (CAS); Santa Cruz Id., 17 May 1962, *Breedlove 2874* (DS); Santa Cruz Id., 9 Jun 1930, *Clokey 4923* (NY, RSA, UC); Santa Cruz Id., 16–17 Jul 1917, *Eastwood 6387* (CAS); Santa Barbara Id., Cat Canyon, 19 Mar 1968, *Philbrick B68 80* (RSA); W of Goleta, 20 Sep 1956, *Pollard s.n.* (CAS);;. **Ventura Co.:** 5 mi S of Filmore, 2 Apr 1958, *Solbrig 2670* (NY); 2 mi E of Point Mugu, 14 Mar 1959, *Thompson 1857* (CAS).

Mirabilis laevis var. **laevis**
MEXICO. BAJA CALIFORNIA SUR: Magdalena Bay, 18 Jan 1889, *T.S. Brandegee s.n.* (GH*); E base San Lazaro Mt., Santa Maria Bay, 30 Mar 1952, *Moran 3530*, SD; Magdalena Bay, without date, *Dr. Sung 28*, UC (#101225, mounted on sheet with *M. laevis* var. *crassifolia*).

Mirabilis laevis var. **retrorsa**
MEXICO. BAJA CALIFORNIA: Sierra Juárez, Arroyo e Toruno, 17 Mar 1968, *Moran 14842* (ASU, RSA); Cañon de Guadalupe, 32 09'N 115 48'W, 23 Mar 1986, *Thorne, Boyd, et al. 61758* (RSA); San Matias Pass, 6.2 mi E of Ejido San Matias, 20 Apr 1985, *Thorne and Charlton 60220* (RSA). **U.S.A. ARIZONA. Mohave Co.:** road from Chloride to the river, 13 May 1931, *Eastwood 18313* (CAS*). **CALIFORNIA. Inyo Co.:** Panamint Range, Emigrant Springs, 6 Apr 1935, *Clokey & Templeton 5725* (POM, NY, UC); White Mts., Silver Canyon, 1 Jun 1933, *Duran 3455* (CAS, POM, RSA); Panamint Mts., Surprise Canyon, 13 Jun 1930, *Ferris 7988*A (DUD, UC); ca. 25 air mi S of Olancha at Little Lake, 8 Jun 1979, *Henrickson 18257* (NMC); ca. 25 air mi SSE of Olancha, 12 Jun 1979, *Henrickson & Bekey 18288* (NMC, NY); Death Valley, S end, Bradbury Well, 9 Apr 1940, *Munz 16449* (POM, UC); Eureka Valley along Big Pine road, 13 May 1962, *Reveal & Reveal 50* (NY); ca. 25 air mi S of Olancha at Little Lake, 8 Jun 1979, *Henrickson 18257* (NMC); Darwin Falls Canyon, 30 Apr 1937, *Train s.n.* (DUD - 258204); Death Valley Natl. Mon., 25 Mar 1947, *Wiggins 11529* (DJD, UC). **Kern Co.:** Red Rock Canyon, 1 May 1927, *Abrams 11877* (POM); butte S of Mojave, 25 Mar 1932, *Benson 3136* (POM); 2 mi E of Weldon, 12 May 1933, *Cole & Voegelin 120* (UC); Mojave, 12 May 1913, *Eastwood 3200* (POM); Mojave - Randsburg region, 0.5 mi W of Big Bend, 1 Jun 1962, *Twisselman, 7280* (CAS); near Searls P.O., 8 May 1906, *Hall and Chandler 6882, 6884* (UC); California City land development land, 10 Apr 1974, *Holmgren & Holmgren 7697* (NMC, RSA); Kernville, 20 May 1962, *Howell 37115* (CAS); NE of Lake Isabella, 12 Jul 1962, *Howell 38667* (CAS); Red Rock Canyon, 13 May 1930, *Peirson 8900*, (POM, RSA); Sierra Way on N side of Lake Isabella, 5 km E of junction with Calif. Hwy. 178 at Bella Vista, 19 Jun 1996, *Spellenberg 12342* (NMC*, NY); Cache Creek, ca. 0.5 mi W of Big Bend, 1 Jun 1962, *Twisselman 7280* (CAS). **Los Angeles Co.:** Palmdale, May 1925, *M. & E. Epling sn*, (MO); Lovejoy Buttes, 17 Apr 1932, *Peirson 9846* (RSA). **Riverside Co.:** cultivated from *Munz & Everett 16245*, 26 May 1954, *Balls 19406* (RSA); Morongo Valley road ca. 1 mi N of Hwy 60, 7 Apr 1951, *V. & A. Grant 15979* (RSA); Indio, 26 Apr 1906, *M. E. Jones s.n.* (POM); Coachella Valley, 2 Feb

1937, *Winblad s.n.* (CAS); N base of Eagle Mts., 12 Apr 1949, *Munz 13036* (RSA); Dry Morongo Wash, NW end of Coachella Valley, 2 May 1952, *Munz & Everett 16245* (RSA) (seed source for *Balls 19406*); Shavers Well near Mecca, 9 Apr 1922, *Munz & Keck 4754* (POM, UC); ca. 4 mi S of Morongo Valley, 3 May 1964, *Thorne 33848* (DUD, RSA); Coachella Valley, 2 Feb 1937, *Winblad s.n.* (CAS)., **San Bernardino Co.:** Kramer Junction, 4 Jun 1987, *Bagley 2098* (RSA); S side Ord Mtn., 8 Apr 1988, *Boyd et al. 1726* (RSA); 19 mi E of Banning, 2.3 mi NW of Hwy 62 on rd to Big Morongo Canyon, 29 May 1971, *Henrickson 5557* (MO); 30 mi NNW of Barstow, N of Black Canyon, 28 May 1978, *Henrickson 17348* (RSA); Newberry Mts., 7 Apr 1924, *Munz & Keck 7862* (POM); S of Death Valley Natl. Mon., Avawatz Mts., 18 May 1973, *Spellenberg et al. 3151* (NMC); Granite Mts., 0.5 mi SW of Willow Spring Basin, 14 Apr 1978, *Stein 12* (RSA); ca. 8 mi W of Barstow, Iron Mtn., 21 Oct 1976, *Strother 1256* (UC - chromosome count by Strother reported on specimen). **San Diego Co.:** McCain Valley, 15 Apr 1987, *Clemons & Jonsson 1690* (SD); 6 mi E of Banner on Hwy 78, 5 Apr 1944, *Gould 2248* (UC); E end Santo Rosa Mts., 14 Apr 1927, *Peirson 7180* (RSA). **NEVADA. Clark Co.:** Las Vegas, Tuly's Ranch, 10 May 1905, *Goodding 2347* (GH); Goodsprings, S end Spring Mt. Range, 10 Jun 1938 *Train 1932* (NY). **Esmeralda Co.:** base of Montezuma Mts. W of Goldfield, 4 Jun 1919, *Tidestrom 9755* (RM). **Humboldt Co.:** Bilk Creek Mts., SW side of Black Mts, T34N, R33E, 22 May 1987 *Tiehm 11048* (CAS). **Lincoln Co.:** Pahranagat Valley, rd from Crystal Springs to Ash Springs, opposite Geer Ranch, 30 Aug 1938, *Train 2421* (A). **Lyon Co.:** East Walker River Rd., ca. 55 air km SE of Yerington, 13 Jun 1996, *Spellenberg 12327* (MO, NMC, NY, UC); East Walker River Rd. ca. 45 air km SE of Yerington, 13 Jun 1996, *Spellenberg 12329* (NMC*, NY); 3 km W of Wellington on Nev. Hwy. 208 1 km E of Douglas Co. line, 13 Jun 1996, *Spellenberg 12333* (MO, NMC, NY). **OREGON. Harney Co.:** 14 mi S on Toole Spring Rd., E of Alvord Lake, T36S R34E, 6 Jun 1964, *Holmgren & Reveal 870* (GH, NY); Pueblo Valley, 8.5 air mi NE of Fields, T37S R34E, 6 Jun 1964, *Homgren & Reveal 870* [sic] (NY). **Malheur Co.:** Owyhee River canyon, 9 mi upstream from Adrian, 25 May 1989, *Barneby 18303* (NY*); Owyhee River, T22S R45E S3, 17 Jun 1976, *Packard 76-107* (NY); Owyhee Canyon, 13 mi below dam, 15 Jun 1942, Peck 21227 (NY). **UTAH. Washington Co.:** Virgin River 12 mi NE of St. George, 18 May 1965, *Cronquist 10110* (NY, RSA); St. George, Black Hill, 16 Apr 1942, *Gould 1561* (GH); near Ft. Pierce, 14 May 1986, *Higgins 16468* (NY); 5 mi E Washington, Rock Cliffs, 20 May 1933, *Maguire & Blood 4390* (GH, POM).

Mirabilis laevis var. **villosa**

MEXICO. BAJA CALIFORNIA: Sierra San Pedro Martir, between Hwy. 3 and Rancho Mike, 20 May 1981, *Daniel 1414* (ASU); San Borja, 28 47'N 113 57'W , 20 Apr 1946, *Moran 1997* (UC); 3 mi N of El Alamo, 31 38'N, 116 01.5'W , 30 May 1970, *Moran 17644* (RSA, SD); ± 25 km of Tecate, Kumeyaay rancho of Ha-a, 32 22'N, 116 30'W , 10 Oct 1976, *Moran 23774* (SD); Sierra San Pedro Martir, 1 km NE of El Socorro, 30 58.5'N, 115 38.5'W , 20 Aug 1977, *Moran 24540* (SD); Sierra Juárez, on road to Ojos Negros, 18.3 mi SW of Laguna Hanson, 30 May 1983, *Thorne et al 55990* (RSA); Cañon de Guadalupe, 32 09'N 115 47.5'W , 18–20 Feb 1984, *Thorne et al. 57784* (RSA); W foothills of the Sierra de Juárez, near El Bashisha, 26 & 27 May 1987, *Thorne et al. 62452* (RSA); along road to San Matias Pass and Valle Trinidad, San Felipe Desert, 11 Nov 1967, *Wiggins 20832* (SD); E of Ensenada, 2 mi W of Coyote along rd between Ojos Negros and Laguna Hanson, 5 May 1969, *Wilken & Werner 7485* (UC). **BAJA CALIFORNIA SUR:** Cerro del Pinto, N of Portezuelo de San Antonio, 24 50.5'N, 110 44'W , 21 Feb 1970, *Carter 5449* (NMC). **SONORA:** Quitobaquito, 19 km W of Sonoita, 10 Apr 1986, *Felger & Valenzuela L. 86-180* (ARIZ); ca. 5 mi S of Puerto Libertad, 1 Apr 1980, *Spellenberg 5444* (ASU, CAS, ENCB, K, MEXU, NMC*, NY, RSA, UC, UNM, WTC); Punto Cirio, ca. 7 mi S of Puerto Libertad, 27 Apr 1962, *Turner 62-2* (ARIZ); Sierra Bacha, Punto Cirio near Libertad, 18 Feb 1977, *Van Devender & Kearns s.n.* (ARIZ); 19 mi NW of San Ignacio, 26 Feb 1979, *Walker 79H44* (ARIZ). **U.S.A. -- ARIZONA. Coconino Co.:** Red Lake, 17 May 1969, *Cazier s.n.* (ASU). **Graham Co.:** Camp Grant, 2 Apr 1867, *Palmer 208* (MO). **Maricopa Co.:** 33 32'30"W, 111 27'N, 9 Apr 1983, *M. Baker 4544* (ASU); Hassayampa Plain, Coyote Wash, 14 Mar 1979, *Fischer 5969* (ARIZ, ASU); Sierra Estrella Regional Park, 31 Mar 1968, *Pinkava 4739* (ASU, NMC); Sacaton Mts., 14 Oct 1925, *Peebles, Harrison & Kearney 463* (ARIZ). **Pima Co.:** Organ Pipe Natl. Mon., Ajo Mt., 11 Mar 1983, *Daniel 2586* (ASU, RSA); Sabino Canyon, Santa Catalina Mts., 2 Apr 1928, *Graham 3222* (DS); Tucson Mts., Picture Rocks Pass, 17 Apr 1977, *Van Devender et al. sn* (ARIZ); ca. 6 mi NW of Sells, 10 Apr 1973, *Spellenberg 2982* (NMC*, NY); **Pinal Co.:** SE Sierra Estrella, 23 Feb 1983, *Rea 290* (ARIZ, SD). **Yuma Co.:** W side Plomosa Mts., 27 Mar 1981 *Butterwick & Hillyard 7043* (ASU, CAS); SE side of Tinajas Altas Mts., Borrego Canyon, 16 Jun 1992, *Felger & Broyles 92-614* (ARIZ); Palm Canyon, 8 Oct 1977, *Harrison 11* (ASU); Tule Tank, 23 Mar 1935, *Kearney & Peebles 10890* (ARIZ, GH); Kofa Mts., Palm Canyon, 19 May 1976, *Reeves & Lehto L20124* (ASU). **CALIFORNIA. Fresno Co.:** Alcalde Canyon, 12 Jun 1938, *Eastwood & Howell 5839* (CAS); Coalinga-San Lucas Rd. 2.5 mi W of Coalinga, Alcalde Canyon, 28 May 1941, *Ferris & Bacigalupi 10350* (UC). **Imperial Co.:** ca. 20 mi NW of Winterhaven, 26 Mar 1973, *Higgins 6378* (NMC, NY); Jacumba Mts., 29 Mar 1974, *Holmgren & Holmgren 7539* (NMC, NY); Chocolate Mts., 8 Apr 1949, *J. & L. Roos 4182* (RSA); E side Chocolate Mts., 11.3 mi NW of Beal Well, 25 Mar 1941, *Wiggins 9648* (GH, UC). **Inyo Co.:** Panamint Canyon, 15 May 1906, *Hall & Chandler 7023, 7024*, (UC); Westgard Pass, 18 Jun 1963, *Lloyd 2636* (NY, UC); White Mts., Silver Canyon, 27 Jun 1963, *Lloyd 2866* (NY); White Mts., Silver Canyon, 7 Jun 1961, *Mooney, Andre & Wright 132* (DS); White Mts., Cottonwood Creek, 18 Jul 1988, *Morefield 4800* (NY); Death Valley Natl. Mon., 1 mi SE White Top Mtn., 3 Jun 1982, *Peterson 566* (RSA); Darwin Falls Canyon, 30 Apr 1937, *Train s.n.*, (DS-258167). **Kern Co.:** Cedar Canyon, *Bedell 74-5*, 11 Jul 1962 (CAS); E side of Walker Pass, 21 May 1962, *Howell 37226* (CAS); McClure Valley (near Kings Co. line), 4 May 1933, *Keck 2158* (DS); 9 mi N of Ricardo, 5 May 1932, *Munz 12465* (UC); Temblor Range, Ross Ridge, 4 Jun 1963, *Twisselman 8377* (CAS, RSA). **Los Angeles Co.:** 4 mi S of Gorman, 21 Jun 1978, *Gustafson 1025* (RSA); San Gabriel Mts., Arraster Creek, 10 May 1919, *Peirson 1853* (RSA); Mint Canyon, 16 Jun 1918, *Peirson 5356* (RSA); San Gabriel Mts., Little Sycamore Campground, 30 Jun 1971, *Thorne & Tilforth 40843* (RSA). **Mono Co.:** ca. 3 mi W of Benton Station, 31 May 1935, *Robinson & Lindner c57* (RSA). **Riverside Co.:** N end Palen Mts., 10 Mar 1988, *Boyd et al. 2112* (RSA); Banning, 6 May 1945, *Cooper 2257* (RSA); N base of Eagle Mts., 12 Apr 1949, *Munz 13037* (RSA); 2 mi SE Desert Center, 26 Mar 1966, *Roos s.n.* (RSA). **San Bernardino Co.:** Providence Mtns, 9 mi E of Mitchell Caverns Rec. Area, 7 May 1988, *Charleton & Pitzer 1834* (RSA); Horsethief Canyon, 5 Jun 1935, *Clokey & Anderson 6603* (NY, POM, RSA, UC); N Kingston Mts. 2 mi SW of Tecopa Pass, 13 May 1974, *Henrickson 14004* (RSA); Snay's Well, Mojave Desert, 14 May 1941, *Jepson 5957, 5959* (JEPS); Cushenberry Springs, 14 Jun 1927, *Munz 10930* (DS, POM); San Bernardino Mts. and E base, 16 Jun 1894, *Parish 3183* (NY); Hwy. 18 12 mi SW of Victorville, 27 May 1990, *Spellenberg 10205* (NMC, NY, UC); near Hesperia, 27 May 1990, *Spellenberg 10206* (NMC*, NY, RSA, TEX, UC); Morongo Valley, 14 Apr 1971, *Tilforth & Dourley 340* (ASU, RSA); Granite Mts., Snake Spring area, 18 May 1975, *Tilforth & Tilforth 1012* (RSA). **San Diego Co.:** Vallecito Wash 30.5 airline mi NW of Ocotillo, 26 Mar 1973, *Holmgren & Holmgren 6535* (NY); walls of Box Canyon, W. Colorado Desert, 2 Apr 1932, *Munz & Hitchcock 12046* (MO, UC). **San Luis Obispo Co.:** just E of summit of Cottonwood Pass on St. Hwy. 41, 24 May 1955, *Bacigalupi et al. 5205* (DS). **NEVADA. Clark Co.:** Sheep Mts., Hidden Forest, Deadman's Canyon, 30 Jun 1940, *Alexander & Kellogg 1811* (GH); 43 air mi S of Mesquite, mts. S of Virgin Mts., Hell's Kitchen, 8 May 1975, *Holmgren & Holmgren* 7926 (NY); Newberry Mts., Hiko Spring, 11 Apr 1938, *Train 1377* (NY). **Lyon Co.:** East Walker Road E., ca. 24 air km SE of Yerington, 13 Jun 1996, *Spellenberg 12331* (NMC); Nev. Hwy. 208 13 km ENE of Smith at E entrance to Wilson Canyon along West Walker River, 13 Jun 1996, *Spellenberg 12332* (MO, NMC*, NY). **Nye Co.:** 10 mi SW of Beatty above Buck Springs, 27 May 1945, *Maguire & Holmgren 25913* (GH, NY). **UTAH. Washington Co.:** Bulldog Knolls, T43S R18W S28, 30 Apr 1986, *Welsh and Baird 23706* (NY).

Mirabilis oligantha

MEXICO. BAJA CALIFORNIA: Cataviña arroyo ca. 5 km N of Santa Ynez, 6 Jun 1974, *Carter & Dempster 5865* (NMC); Cataviña, 23 Mar 1932, *Harvey 501* (US); Cataviña Mesa, 22 Apr 1952, *Gentry & Fox 11731* (LL*); Cataviñacito, 29 44'N, 114 45'W , 21 Nov 1976, *Moran 23808* (SD*); 1 mi S of Las Arrastras, 25 Mar 1960, *Wiggins & Wiggins 15940* (ARIZ, TEX*); E of El Marmol on trail to Gulf, 14 Feb 1935, *Shreve 6845* (ARIZ); 10.1 mi (by road) N of Bahía San Luís Gonzaga, 6 Oct 1967, *Hastings & Turner 67-10* (ARIZ, SD); Sierra de Volcán 4 mi E of El Marmol, 13 Feb 1935, *Wiggins 7571* (UC); Rancho Cataviña, 35 mi S of El Marmol, 8 Mar 1930, Wiggins 4406 (UC); San Francisquito Wash, 18.7 mi (by Road) SW of Bahía San Luís Gonzaga, 12 Oct 1963, *Hasting & Turner 63-158* (ARIZ). **BAJA CALIFORNIA SUR:** Picachos de Santa Clara, 5–10 Nov 1947, *Gentry 7717* (ARIZ).

Mirabilis oxybaphoides

MEXICO. CHIHUAHUA: Ca. 23 air mi ENE of Villa Ahumada, 12 Sep 1973, *Henrickson 12849* (NMC). **COAHUILA:** Arteaga, C. Los Camargos, 4 Aug 1980, *Hinton et al. 17926* (CIIDIR); Sierra del Pino, western ridge, W of camp at La Noria, 24 Aug 1940, *Johnston & Muller 603* (GH*, LL, TEX); Cañon de Calabasa, N wall of Sierra Mojada, 27 Oct 1941, *Stewart 2209* (LL, GH). **NUEVO LEON:** Hacienda Pablillo, Galeana, 5 Aug 1936, *Taylor 93* (TEX); Dist. Zaragoza, Puerto Pino, 19 Jun 1979, *Hinton 17556* (TEX); Dist. Arteaga, Canyon de Los Amargos, 4 Aug 1980, *Hinton 17926* (CIIDIR, TEX); Mcpio. Galeana, W slope Potosí, 29 Jun 1983, *Hinton et al. 18491* (GH, TEX). **U.S.A. ARIZONA. Apache Co.:** Canyon de Chelly Nat'l. Mon., 2 Sep 1972, *Halse 811* (ARIZ); ca. 1 mi N of Nelson Reservoir (SE Eager), 20 Sep 1975, *Lehto et al. 19057* (ASU, NMC); Little Colorado River, 0.15 mi S of jct AZ Hwy. 260 along AZ Hwy 273, around bridge over river, 30 Aug 1988, *Ricketson & Raechal 4364* (ASC, MO, NY, RSA, TEX, UC). **Cochise Co.:** Cedar Gulch, Paradise, 30 Sep 1907, *Blumer 2241* (GH); Dragoon Mts., N side of Mt. Glenn, 9 Sep 1983, *Daniel 3148* (ASU). **Coconino Co.:** Colton Ranch, field 1, 24 Aug 1957, *McDougal s.n.* (ARIZ); Sycamore Canyon Wilderness Area, 11 Oct 1969, *Pinkava et al. 5855* (ASU); 6 mi S of I-40 at Meteor Crater, 3 Sep 1981, *R. & D. Sauleda 6438* (ASU). **Navajo Co.:** Chuska Mts., E of Fort Defiance on ridge W of Coal Mine Wash, 12 Sep 1977, *Spellenberg 4893* (NMC). **Yavapai Co.:** Mingus Mountain, 3 Sep 1968, *Keil 3823* (ASU). **COLORADO. Chaffee Co.:** near junction of highways 285 and 291 NW of Salida, 20 Aug 1954, *Waterfall 12142* (TEX). **El Paso Co.:** W side of Colorado Springs at entrance to Queen's Canyon, S27 T13S R65W, 6 Jul 1996, *Kelso & Maentz 96-32* (NMC); W of entrance to Garden of the Gods, 14 Aug 1954, *Waterfall 12040* (TEX). **Montezuma Co.:** lower Spruce Canyon near jct. with Navajo Canyon, 17 Sep 1947, *Weber 3629* (ARIZ, NMC, TEX). **Montrose Co.:** Dolores River Canyon, 7.1 mi S of Sinbad Valley Rd., T49N, R18W, S34, 29 Aug 1985, *Franklin 2489* (GH). **Ouray Co.:** W of Ridgeway, 20 Aug 1920, *Payson 2308* (GH). **San Miguel Co.:** Norwood Hill, 20 Aug 1912, *Walker 508* (GH). **NEVADA. Clark Co.:** Charleston Mts., Little Falls, 3 Aug 1935, *Clokey 5454* (GH). **NEW MEXICO. Catron Co.:** 14 mi SW of Horse Springs, vic. Bat Cave, 19 Aug 1948, *Smith 208* (ARIZ, GH); Forest Rte. 95, Whitewater, 24 Sep 1972, *Tays GT-18* (ARIZ). **Cibola Co.:** Ramah Navajo, 22 Aug 1939, *Vestal & Vestal 56* (ECON), 10 Sep 1939, *Vestal & Vestal 408* (ECON). **Colfax Co.:** Philmont Scout Ranch, near Cimarron, South Ponil Canyon, 1 mi E of Pueblano Camp, 5 Aug 1968, *Hartman 2605* (TEX). **Doña Ana Co.:** S end Organ Mts., 24 Oct 1971, *Spellenberg 2738* (NMC); Organ Mts., 4 Sep 1897, *Wooton 587* (ARIZ). **Grant Co.:** Bear Mountain, near Silver City, 15 Sep 1903, *Metcalfe 696* (ARIZ, GH, NMC); ca. 5 air mi NW of Silver City on Bear Mountain, 6 Sep 1980, *Spellenberg & Soreng 5858* (NMC, NY) (chromosome count by D. Ward). **Lincoln Co.:** near Gray, Aug 1898, *Skehan 103* (GH); Oscura Peak, 26 Aug 1988, *Spellenberg et al. 9681* (MO, NMC, NY). **Luna Co.:** summit of Cooke's Peak, 20 Sep 1986, *Columbus 637* (NMC*). **Otero Co.:** ca. 5 air mi ENE of Alamogordo at High Rolls, 16 Sep 1988, *Spellenberg & Ward 9728* (NMC, NY). **Sandoval Co.:** Sky Village, S22 T14 R1W, Oct 1974, *Blankenhorn 214* (ARIZ). **San Miguel Co.:** 18 mi E of Las Vegas, M. E. O'Connor Trust Ranch, 2.8 mi S of Rte. 104, Mogote Trap, near gate to Crystal Pasture, 21 Aug 1982, *Hill & Levandoski 12161* (GH); near Pecos, 18 Aug 1908, *Standley 5063* (NMC). **Santa Fe Co.:** north of Glorieta, 24 Aug 1908, *Standley 5255* (NMC). **Sierra Co.:** Kingston, 5 Oct 1904, *Metcalfe 1459* (GH, NMC); W face of Caballo Mts. 8.6 mi by winding road E of Caballo Dam on Rio Grande, 8 Sep 1974, *Spellenberg 3936* (LL, NMC). **Taos Co.:** between Amalia and Ute Springs, 14 Aug 1973, *Holmgren & Holmgren 7169* (ASU, NMC). **TEXAS. Brewster Co.:** Chisos Mts., 23 Aug 1931, *Mueller 7994* (GH); Big Bend National Park, Lost Mine Peak, 12 Sep 1961, *Correll & Johnston 24516* (GH*, LL). **Chaffee Co.:** near junction of highways 285 and 291, 20 Aug 1954, *Waterfall 12142* (TEX*). **Culberson Co.:** Guadalupe Mts. Nat'l. Pk., Shumard Canyon, 29 Sep 1973, *Burgess 1631* (ASU); Guadalupe Mts. Nat'l Park, Bear Canyon trail to The Bowl, 16 Sep 1974, *Burgess 2657* (ARIZ). **Presidio Co.:** Sierra Tierra

Vieja, ca. 1/2 mi S of Vieja, 4 Oct 1941, *Hinckley 2184* (ARIZ, GH). **UTAH. Wayne Co.:** Aquarius Plateau, Utah 117 _ mi S of Grover, T30S, R5E, S2, 19 Aug 1965, *Holmgren et al. 2548* (TEX).

Mirabilis tenuiloba

MEXICO. BAJA CALIFORNIA: along trail from Guadalupe Cyn to Laguna Hanson, 32 10'N, 115 42'W , 13 Mar 1988, *Clemons & Jonsson 1999* (SD); canyon 3 mi from Bahia de Los Angeles village toward San Borja, 17 Feb 1963, *Cowan 2321* (CAS, GH, SD); Cocopa Mts., 22 Apr 1949, *Gentry 8712* (ARIZ, RSA, SD); first large canon W of Punta Diablo, 25 Mar 1959, *Moran 7251* (DS, SD); 29 mi N of San Luis Gonzaga, 30 08'N, 114 40'W , 20 Apr 1960, *Moran 8211* (SD); S end of North San Lorenzo Island, 24 Mar 1962, *Moran 8877* (CAS, SD); ca. 6 km SE of Puerto Refugio, 17 Mar 1977, *Moran 23949* (SD); Los Angeles Bay, Dec 1887, *Palmer 600* (GH, UC) (paratype of *Hesperonia polyphylla*); 41.6 mi S of Mexicali, 22 Mar 1970, *Powell & Turner 1708* (TEX, US*); Puerto Refugio, Punta Norte de la Isla Angel de la Guarda, 7 Feb 1986, *Tenorio L. & Romero de T. 10836* (RSA, TEX); Bahia de los Angeles, 12 Feb 1962, *Wiggins & Thomas 238* (US); 3/4 mi S of Puertocito, 21 Mar 1963, *Wiggins & Wiggins 15863* (ARIZ, DS, GH, TEX, US*); Arroyo la Bocana near Rancho Santa Ynez, 13 Mar 1991, *Van Devender et al. 91-410* (ARIZ, NMC). **BAJA CALIFORNIA SUR:** San Marcos Island, 23 Apr 1952, *Moran 3975* (UC); 29 Mar 1962, *Moran 9005* (SD); Carmen Id., Marquer Bay, 5 Apr 1962, *Moran 9199* (RSA, SD, UC); 1 mi S of Mission Los Dolores, 25 05'N, 110 54'W , 4 Dec 1959, *Wiggins, Carter, & Ernst 258* (UC). **SONORA:** Isla San Esteban, N side, 10 Apr 1968, *Felger et al. 17573* (ARIZ, RSA, SD, UC); Sierra de Rosario, Gran Desierto, 10 Mar 1973, *Felger 20652* (ARIZ, SD). **U.S.A. ARIZONA. Yuma Co.:** SE side of Tinajas Altas Mts., Borrego Canyon, 16 Jun 1992, *Felger & Broyles 92-613* (ARIZ, ASU, MO, RSA, TEX, UC); Tinajas Altas Mts., 7 Mar 1940, *Goodding s.n.* (ASU). **CALIFORNIA. Imperial Co.:** Colorado Desert, Coyote Wells, Apr 1905, *Brandegee s.n.* (US*); Coyote Wells, 16 Apr 1983, *Jonsson & Clemons 472* (SD); Painted Gorge, 8 Apr 1941, *Peirson 13075* (DS, RSA); In-Ko-Pah Mtns. along Hwy. 98, 5 Mar 1966, *Wallace & Wilkin 110* (RSA). **Riverside Co.:** Devil's Canyon above Coral Reef Ranch, 23 Feb 1931, *Ewan 4036* (CAS); West Cañon, western edge of the Colorado desert, 18 Apr 1907, *Parish 6072* (GH, NMC, TEX) (acc. to Parish's note, a topotype); Deep Canyon Wash, 11 Apr 1922, *Peirson 2917* (RSA); Deep Canyon drainage, S side lower Pipistrelle Canyon wash, 29 Mar 1973, *Zabriskie and Zabriskie 594* (RSA). **San Diego Co.,** Palm Canyon, Borego Valley, 17 Mar 1940, *Ramsey & Ramsey s.n.* (POM); Borego Desert, canyon, toward the Palms, 24 Mar 1939, *A. & R. Nelson 3236a* (DS); Borego Palm Canyon, 14 Apr 1936, *Gander 1301* (SD).

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A REVISION OF *SALVIA* SECTION *HETEROSPHACE* (LAMIACEAE) IN WESTERN NORTH AMERICA

Jay B. Walker[1]

Department of Botany and Microbiology
University of Oklahoma
Norman, OK 73019, U.S.A.

Wayne J. Elisens

Department of Botany and Microbiology
University of Oklahoma
Norman, OK 73019, U.S.A.

ABSTRACT

A revision of the western North American members of *Salvia* L. section *Heterosphace* Benth. is presented. Three species are here recognized: *S. roemeriana* Scheele, *S. henryi* A. Gray, and *S. summa* A. Nels. *Salvia davidsonii* Greenm. is treated as a synonym under *S. henryi*. We present a discussion of subgeneric relationships and morphological variation of the group, as well as keys to the species, distribution maps, illustrations, and a complete account of typification and synonymy for each species.

RESUMEN

Se revisan taxonómicamente los representantes norteamericanos occidentales de *Salvia* L. sección *Heterosphace* Benth. Aquí se reconocen tres especies: *S. roemeriana* Scheele, *S. henryi* Gray y *S. summa* A. Nels. Se trata *Salvia davidsonii* Greenm. como un sinónimo de *S. henryi*. Presentamos una discusión de las relaciones subgenéricas y variación morfológica del grupo, claves para las especies, mapas de la distribución, ilustraciones y un informe completo de la tipificación y sinonimia de cada especie.

INTRODUCTION

The genus *Salvia* L. (Lamiaceae) is the largest of the mint genera, consisting of over 900 species worldwide and nearly 500 species in the New World (Alziar 1988). The present taxonomic treatment revises the western North American members of section *Heterosphace* Benth., a group of closely allied species of *Salvia* native to southwestern United States and northern Mexico placed by Briquet (1897) in subgenus *Leonia* (La Llave & Lex.) Benth. Prior to this treatment, four species were recognized in this group: *Salvia roemeriana* Scheele, *S. summa* A. Nels., *S. henryi* A. Gray and *S. davidsonii* Greenm. All are restricted generally to limestone substrates and to north- or east-facing cliffs or slopes. These species produce chasmogamous, tubular flowers that are pink, red, or purple-colored and are presumably adapted for hummingbird pollination in the spring and fall, and produce cleistogamous flowers that are self-pollinated throughout the growing season.

There has been considerable variance surrounding proposed species relationships within this group of *Salvia* (Epling 1944, 1960; Spellenberg 1993). Much of the taxonomic confusion has related to character polymorphisms within the species and to unclear specific boundaries of S. *davidsonii*. Three

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[1] Current address: Department of Botany, University of Wisconsin-Madison, 132 Birge Hall, 430 Lincoln Drive, Madison, WI 53706, U.S.A.

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species are recognized in the present treatment: *Salvia summa*, *S. roemeriana* and *S. henryi*. *Salvia davidsonii* is synonomized with *S. henryi*.

Infrageneric relationships within *Salvia*

Despite its widespread distribution and the attention the genus has received horticulturally, there is no modern comprehensive taxonomic treatment of species or of infrageneric relationships within *Salvia*. The most recent classification of supraspecific taxa of *Salvia* (Hruby 1962) lists eight subgenera and 17 sections. Many of the subgenera and sections proposed in Hruby (1962) and proposed in the only two comprehensive treatments of the genus (Bentham 1848; Briquet 1897) are generally viewed as artificial (Hedge 1974). Over 400 new species of *Salvia* have been described since the last generic treatment in 1897 by Briquet.

The species studied in this treatment have been classified in Bentham's section *Heterosphace* by most previous workers (Briquet 1897; Fernald 1900; Neisess 1984). Section *Heterosphace* is notable in that it is the only one of the five sections of New World *Salvia* with both New and Old World members. The section is represented in the Old World by nine species native to South Africa, and one in central and eastern Africa (Hedge 1974). *Heterosphace* is represented in the New World by the southwestern USA species reported here and by *Salvia lyrata* L. of the southeastern United States. Other sections of *Salvia* native to the New World are: sects. *Audibertia* Benth. (15 species) and *Echinosphace* Benth. (4 species), both restricted to the California Floristic Province and adjacent deserts; sect. *Salviastrum* Scheele (3 species), restricted to Texas and northeast Mexico; and sect. *Calosphace* Benth. (ca. 470 species) which occurs primarily in Central and South America.

In all species of *Salvia*, only two stamens are functional; the other two stamens typical of the majority of Labiates are reduced to staminodes. In sect. *Heterosphace*, the upper two stamens are reduced to staminodes, and the lower two are fertile with the two thecae of each anther separated by an elongated connective. Whereas the majority of New World *Salvia* have sterile posterior anther thecae, sect. *Salviastrum* and sect. *Heterosphace* are unique in the New World because their posterior thecae consistently produce viable pollen. Section *Salviastrum* is distinguished from sect. *Heterosphace* by a dense annulus in the calyx and by simple leaves. Although the presence of an annulus was not noted in the initial description of sect. *Heterosphace* (Bentham 1832–1836), *S. henryi* and *S. summa* have a thin annulus, which may indicate a close relationship between sects. *Heterosphace* and *Salviastrum*. Section *Salviastrum* has been described as "...nearest *Heterosphace*, from which it differs in habit and in the calyx closed by hairs" (Torrey 1859). Further investigations into the relationship between these two groups are necessary based on their sharing of an annulus and the fertile posterior anther thecae. The relationship of species in these two sections to the Texas endemic *Salvia penstemonoides* Kunth & Bouche, which shares characters of both sections, has not been resolved.

MORPHOLOGY AND CHARACTER ANALYSES

Morphological investigations were conducted on 537 herbarium specimens from 13 herbaria (ARIZ, ASU, GH, MEXU, MO, NMC, NY, OKL, RM, RSA, SRSC, TEX, UTEP; Holmgren et. al. 1990) and on live plants collected from 29 native populations (listed with specimens examined). Each population collection was based on material from 5–10 individuals. Analyses of morphological variation were conducted on individuals or collections representing a total of 59 localities: 13 localities for *Salvia summa*, 22 localities for *S. roemeriana*, and 24 localities for *S. henryi*. Localities were selected to represent the geographic range and extent of morphological variation of each species. The specimens examined are indicated in the list of representative specimens examined for each species.

Morphological data were scored for thirty-seven characters that had been used previously to classify and identify species in the group. Results were tabulated and morphological characters were evaluated for their utility to discriminate among species in the group. Representative characters employed by past authors to distinguish among species include: height of plant, petiole length, leaf length, leaflet number, leaf shape, calyx length, calyx lip length, calyx pubescence, calyx tube length, corolla color, corolla length, corolla lip length, corolla shape, corolla throat width, exsertion of stamens, and symmetry of style branches (Epling 1960; Peterson ined.; Correll & Johnston 1970). The characters we found most useful in differentiating among species in this treatment are leaflet size, calyx length, calyx tube length, corolla length and color, and corolla lip length (Table 1).

Habit

Each species is a mildly aromatic perennial herb from a woody caudex; the stems generally die back to the rootstalk or to basal leaves in the winter. Height of the plant ranges from 1–9 dm; number of stems ranges from one to many. Observations among natural populations and plants cultivated in greenhouse conditions suggest that habit is variable and affected by environmental factors such as exposure to sun and availability of water. It is not unusual to find two plants of the same population demonstrating distinctly different growth habits, one with simple leaves and flowers in the axils of leaves, and the other with compound leaves and a distinct inflorescence. Such differences usually are associated with occurrence at the edge of a stream or on a cliff face above it. Individuals displaying such characteristics that are transplanted and grown in a greenhouse under equivalent environmental conditions assume similar growth forms.

TABLE 1. Variation among diagnostic morphological characters in three species of *Salvia* sect. *Heterosphace*.

	S. roemeriana **(N=22)** **mean (range)**	***S. henryi*** **(N=24)** **mean (range)**	***S. summa*** **(N=13)** **mean (range)**
Calyx Length (mm)	11.8(8–15)	10.2(7–13)	8.5(8–11)
Calyx Tube Length (mm)	6.8(5–9)	4.2(3–6)	3.1(2–5)
Corolla Length (mm)	33(24–47)	34(28–39)	39(26–48)
Corolla Lower Lip Length (mm)	7.1(6–9)	4.4(2–6)	8.3(7–12)
Ratio of Lateral Leaflet Length/ Terminal Leaflet Length	0.23(0.05–0.31)	0.61(0.44–1.16)	0.54(0.43–0.75)
Corolla Color	Red/Scarlet	Red/Scarlet	Pink/Purple

Leaf shape, division and texture

The plasticity of leaf characters also has been examined in experiments conducted under uniform greenhouse conditions. Individuals of *S. summa* with compound leaves of 5–7 leaflets in natural populations, consistently produce simple leaves when grown in the greenhouse with a daily watering regimen. *Salvia roemeriana* exhibits less plasticity than the other species, and consistently produces either simple leaves or leaves with 2–4 small lateral leaflets. Regardless of growth and environmental conditions, the terminal leaflet of *S. roemeriana* maintains a reniform to cordate shape; if lateral leaflets form, they are consistently less than 1/3 the length of the terminal leaflet (Table 1). The leaves of *S. henryi* and *S. summa* are rarely simple, and the lateral leaflets are greater than 1/3 the length of the deltoid terminal leaflet.

Salvia roemeriana is distinctive among the species examined due to the close resemblance of the basal and cauline leaves (Fig. 3). *Salvia henryi* and *S. summa* generally demonstrate dimorphic leaves; the basal leaves are compound, and the cauline leaves often simple and graded into the bracts of the inflorescence. In all three species, pubescence type varies between cauline and basal leaves. This variation is particularly evident in *S. summa* where the compound basal leaves generally have a thick vestiture of grayish trichomes and the simple cauline leaves are more sparsely pubescent. Whereas the basal and cauline leaf margins of *S. roemeriana* are generally crenate, those of *S. henryi* and *S. summa* are irregularly-toothed.

Pubescence

Pubescence is always present on vegetative and reproductive structures in these species, although indumentum is variable and includes pilose, setose, hirsute, densely rusty pubescent, white tomentose, and sparsely pubescent. The only pubescence character we find to be reliable in distinguishing species is that of the calyx; consistently hirsute in *S. henryi* and *S. summa* contrasted to a puberulous vestiture in *S. roemeriana*. Resinous dotting is always represented on stems, leaves and calyces, although it varies considerably between populations. Vegetative pubescence varies similarly and is not used to differentiate species in this treatment.

Inflorescence

The inflorescence of *S. roemeriana* is well-defined and raceme-like, with bracts to nearly 1.0 cm long and with 2–6 flowers/verticillaster. *Salvia henryi* and *S. summa* occasionally exhibit a well-defined inflorescence, but more often there is a gradation from solitary flowers in the axils of cauline leaves to a raceme-like inflorescence with 4–6 flowered verticillasters and bracts of 0.5 cm in length. Flowers borne in the axils of cauline leaves always are cleistogamous, whereas fully chasmogamous flowers are only borne in the verticillasters. In all species, the persistence and size of bracts is variable.

Cleistogamy and Polymorphism in Corolla Size and Shape

Two of the most taxonomically significant characters in sect. *Heterosphace* are corolla polymorphism and cleistogamy. Cleistogamy has been documented in the species studied here, as well as in the closely related *S. lyrata* of the southeastern USA (Uttal 1963) and in African species of the genus (Hedge 1974). Inflorescences of each of the species observed throughout a growing season under greenhouse conditions produce fertile flowers ranging from fully closed cleistogamous flowers less than 0.5 cm long, to barely open flowers of 1.0 cm in length, to fully developed flowers of 3.5 cm or more. With the initial flush of growth in the early spring, fully developed chasmogamous flowers are produced. As the season progresses, progressively smaller flowers are produced from the same indeterminate inflorescence. This was observed among *S. henryi*, *S. roemeriana*, and *S. summa*, and consisted of chasmogamous flowers grading to smaller flowers continued until exclusively cleistogamous flowers were produced in late spring and summer. In the fall, the sequence is often reversed; cleistogamous flowers grade into small chasmogamous flowers until eventually fully developed chasmogamous flowers are produced. In wild populations of *S. henryi*, *S. roemeriana* and *S. summa*, the only time of year when plants were not observed with cleistogamous flowers was in spring. All flowers, regardless of size, have fertile pollen and can produce four viable nutlets, although preliminary observations found a lower number of nutlets produced in fully chasmogamous flowers than in cleistogamous flowers. Despite variation in size and shape of the corolla, calyx and nutlet characters remain relatively constant.

Calyx

The calyx provides reliable characters by which to distinguish species (Fig. 1, A,D,G). The upper lip of the calyx is two or three-lobed and the lower is two-lobed. The calyces of all species are persistent, and the previous year's calyces are often found on the dried inflorescences adjacent to flowering inflorescences.

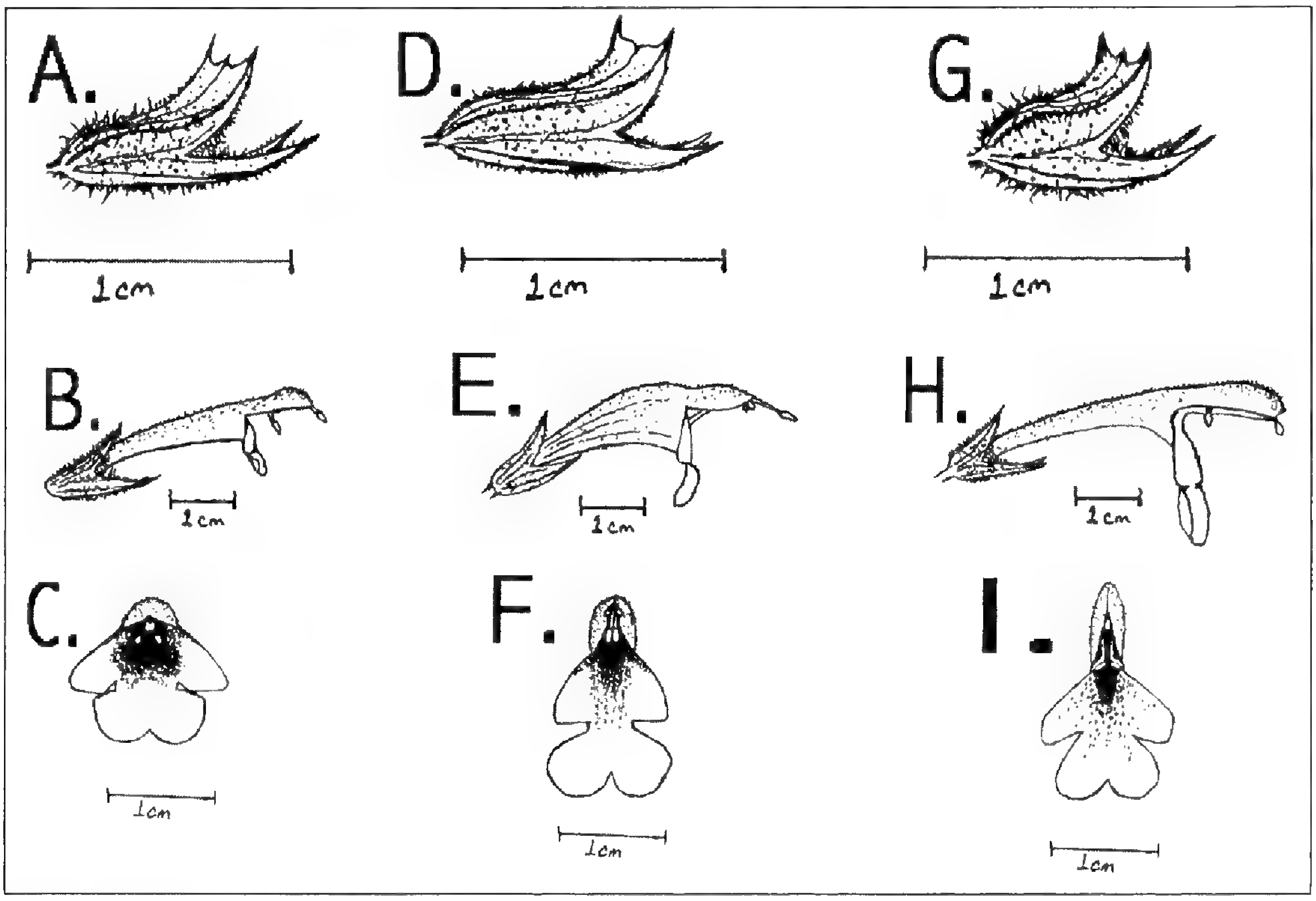

Fig. 1. Morphological features of western North American species of *Salvia* section *Heterosphace*. Floral morphology of *Salvia henryi* (A–C), *Salvia roemeriana* (D–F), and *Salvia summa* (G–I): A,D,G. Oblique view of calyx. B,E,H. Lateral view of corolla. C,F,I. Frontal view of corolla.

Salvia summa always has a shorter calyx tube than *S. roemeriana*, but calyx length and calyx tube length overlap between *S. summa* and *S. henryi* (Table 1). *Salvia roemeriana* and *S. henryi* are not significantly different ($p > 0.05$) in calyx length, but these species exhibit consistent differences in calyx pubescence and structure.

The calyces of both *Salvia summa* and *S. henryi* are hirsute pubescent, with ciliate nerves and a bearded sinus resulting from a thin annulus present in the calyx throats. The calyx of *Salvia roemeriana* is uniformly puberulous on the exterior of the calyx and naked within.

Salvia roemeriana has a repressed (0–0.2 mm) middle upper lobe of the calyx, compared to the larger middle upper calyx lobe in *S. summa* (average = 1.2 mm) and *S. henryi* (average = 1.0 mm). In addition, the apices of each calyx lobe of *S. henryi* and *S. summa* are generally rigid and spine-tipped, whereas the apices of *S. roemeriana* are less rigid.

Corolla

The corollas of these species are tubular and bilabiate; the upper lip has two lobes which are often folded together at the apex, and the middle lobe is the largest of the three lower lobes. Cleistogamy and polymorphism in corolla size and shape complicates the use of corolla characters in identification and classification. Because of size variation among corolla characters, only fully developed, chasmogamous flowers provide reliable morphological characters by which to classify and identify species.

The corolla characters most useful in distinguishing *S. summa* from the other species are differences in corolla length and color. Fully chasmogamous flowers of *S. roemeriana* and *S. henryi* average 3.4 cm long and are scarlet or red, whereas those of *S. summa* average 4.2 cm and are purple or pink (Table 1, Fig.1 B,E,H). Additionally, the corolla throat of *S. roemeriana* and *S. summa* is taller than wide, compared to *S. henryi* which is wider than tall (Fig. 1, C,F,I). Whereas *S. henryi* has a straight corolla, the corolla of *S. roemeriana* and *S. summa* is arcuate. Finally, although the length of the upper lip of the corolla does not significantly differ among the three species, the lower lip of *S. roemeriana* (avg. 7.1 mm) and *S. summa* (avg. 8.3 mm) is equal to or longer than their respective upper lips, and the lower lip of *S. henryi* (avg. 4.4 mm) is shorter than its upper (Table 1, Fig. 1). With fresh material, when the two lobes of the corolla are pressed together, only in *S. henryi* will the upper lobe exceed the lower.

Androecium

One of the diagnostic characters of *Salvia* section *Calosphace* is the fusion of the sterile posterior anther thecae into a rudder which blocks the throat of the corolla. In sect. *Calosphace* this rudder acts as a lever, which is pushed by the pollinator as it attempts to access the nectary at the base of the corolla (Serna & Ramamoorthy 1993). This action deposits the pollen on the head or back of the pollinator; the fulcrum of the lever is the junction of the filament and the elongate connective. A similar floral mechanism is shared by members of sect. *Heterosphace* except that the posterior thecae are fertile and not fused. In chasmogamous flowers, the posterior thecae block the throat of the corolla in *S. henryi* and *S. summa*, but do not block the throat of *S. roemeriana*, thereby affecting the lever mechanism of pollen deposition in the latter. The difference in thecal placement and mechanism is only visible in fresh material and is not observable on herbarium specimens. In fully chasmogamous flowers of *S. roemeriana*, the two staminodes develop to 5 mm in length; anthers were never observed to develop on the staminodes.

Gynoecium

Style characters, such as exsertion from galea and symmetry of stylar branches, have been used in previous treatments (Peterson, in ed.) to differentiate species, but our observations indicated these characters were not informative taxonomically. Whereas the upper style branch had previously been reported to be absent or less than 0.5 mm in *S. henryi* (Peterson, in ed.), our observations found considerably more variation (0 to 4.1 mm) in the upper branch of the style both in fresh and dried material. Symmetry of stylar branches was not found to vary significantly among the species included in this treatment. Variation in the length of the style was observed in *S. roemeriana* and *S. henryi*. For example, style lengths in fully developed, chasmogamous flowers on the same inflorescence of a plant representative of *S. henryi* ranged from 2.5 cm and included within the galea, to 4.1 cm and exserted 1.2 cm from the galea. Because heterostyly has been documented in sect. *Audibertia* (Neisess 1984), the role the variation in style length plays in *S. henryi* and *S. roemeriana* needs further investigation.

As with all species of *Salvia*, the bi-loculed, bi-carpellate ovaries of sect. *Heterosphace* divide to produce a maximum of four nutlets. A comparative study of nutlet characters for species in sect. *Heterosphace* and other sections of *Salvia* (J. Walker, unpublished data) showed uniformity in nutlet size and pericarp anatomy among *S. roemeriana*, *S. henryi*, and *S. summa*. Additional studies by Hedge (1970), Ryding (1995), and Wojciechowska (1958) indicate that pericarp anatomy is potentially useful for resolving supraspecific relationships in *Salvia* and for testing proposed taxonomic relationships among New World and Old World species of the genus. The uniformity in nutlet characters in the three species in question further support the closely related nature of these species.

CHROMOSOME NUMBERS

Mitotic counts made by the senior author yielded sporophyte chromosome numbers of $2n = 28$ among populations of *S. roemeriana*, *S. henryi*, and *S. summa*. The specimens used in chromosome counts are indicated in the list of representative specimens for each species. Published diploid counts of $2n = 28$ are represented in only three other species of *Salvia* (Hedge 1974), all of which are native to northern Africa and none of which is placed in sect. *Heterosphace*: *S. aegyptiaca* L. (also $2n = 12$, 26 reported), *S. chudaei* Battand. & Trab., and *S. taraxicifolia* Hook. (also $2n = 26$ reported; Goldblatt 1981). Of the ten African species currently placed in sect. *Heterosphace*, chromosome counts are known from only two, *S. nilotica* Juss. ex Jacq. ($2n = 30$) and *S. aurita* L.f. ($2n = 18$)(Hedge 1974). Radford et al. (1964) reported $2n = 18$ for *S. lyrata* L., the only other New World representative of sect. *Heterosphace*, although this count was not verified through a literature reference. Further investigations of chromosome number variation are needed to elucidate base numbers and the extent of polyploidy and aneuploidy in sect. *Heterosphace* and in the genus *Salvia*. However, Hedge (1974) reported base numbers $x = 7, 8, 9, 10$, and 11 for African species of *Salvia* and concluded that chromosome numbers shed "...little light upon species affinities or evolutionary developments in the genus."

GEOGRAPHIC DISTRIBUTION

Salvia roemeriana is the most widely distributed of the species investigated here; it ranges from south-central Texas to central Mexico (Fig. 2). In Mexico, the species is found throughout the state of Coahuila and is restricted to the

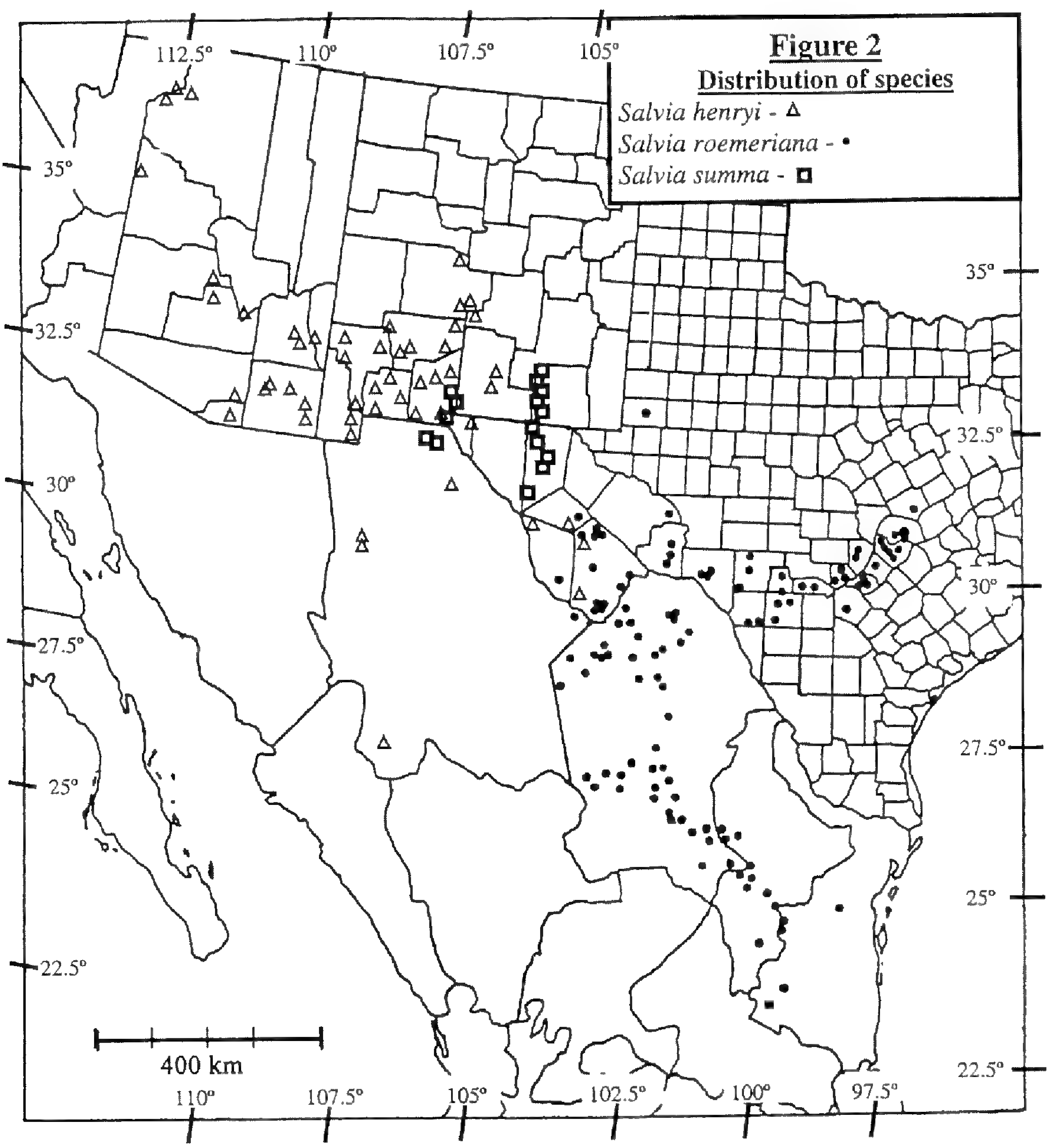

FIG. 2. Distribution of *Salvia henryi*, *Salvia roemeriana*, and *Salvia summa*.

Sierra Madre Oriental to southern regions of the state of Tamaulipas. The range of *S. henryi* is centered in south-central New Mexico and southeastern Arizona, with disjunct populations in the central and southern parts of the state of Chihuahua and as far west and north as the Grand Canyon region in Arizona. *Salvia summa* is restricted to limestone outcrops in mountain ranges of southeastern and south-central New Mexico.

Salvia summa, *S. henryi* and *S. roemeriana* are morphologically and geographically distinct and overlap in range with one another in only two regions (Fig. 2). In both of these areas of sympatry, hybridization, which is well documented in *Salvia* (Emboden 1971), may be present. The Oscura Mountains of south central New Mexico is a zone of sympatry between *S. summa* and *S. henryi*. Several collections from this area (*Spellenberg & Anderson 10865*, *Anderson & Morrow 5085*) exhibit intermediacy in vegetative and calyx characters between these species, which suggests interspecific hybridization. A similar example of sympatry and possible hybridization is the Big Bend region of Texas and Mexico, continuing northwest along the Rio Grande. This is the only region where the distributions of *S. henryi* and *S. roemeriana* overlap, and a number of collections demonstrate morphological intermediacy (*Hinckley 1669*, *Worthington 4425*). Plants from this area possess the calyx pubescence and spine-tipped calyx lobes of *S. henryi*, but have a suppressed middle upper lobe of the calyx and a red-tinged calyx, both of which are similar to *S. roemeriana*. Experimental studies are needed to test these hypotheses of hybridization.

TAXONOMY

Key to the Species

1. Corolla red; fully chasmogamous corolla less than 3.8 cm long
    2. Lower lip of corolla shorter than upper; corolla straight; calyx sinus bearded; lateral leaflets greater than 1/3 the length of the terminal. ______ **1. Salvia henryi**
    2. Lower lip of corolla equal to or longer than upper; corolla arcuate; calyx sinus naked; lateral leaflets less than 1/3 the length of the terminal. ______ **2. Salvia roemeriana**
1. Corolla pink to purple; fully chasmogamous corolla 3.8 cm to 4.8 cm long. ______ **3. Salvia summa**

1. Salvia henryi A. Gray (**Figs. 1 A,B,C**), Proc. Amer. Acad. Arts 8:368. 1872. TYPE: U.S.A. NEW MEXICO: on the Mimbres, May 1851, *Thurber 245* (LECTOTYPE, here designated: GH!; ISOLECTOTYPE: NY!). U.S.A. NEW MEXICO: Mimbres, *Henry s.n.* (SYNTYPE: GH! #1552). U.S.A. 1849. *Wright s.n.* (SYNTYPE: GH! #1551). U.S.A. NEW MEXICO: River Mimbres, *Bigelow s.n.* (SYNTYPE: NY! #7479).

Thurber 245 is selected as lectotype due to the complete nature of the collection, the presence of fully chasmogamous flowers, and its distribution at two major herbaria.

Salvia davidsonii Greenm., Proc. Amer. Acad. Arts 41:246. 1905. TYPE: U.S.A. ARIZONA: Chiricahua Mountains, Sep 1881, *Lemmon 3077* (LECTOTYPE, here designated: GH!). U.S.A. ARIZONA: Southern Arizona, *Lemmon 492*, (SYNTYPE:GH!) U.S.A. ARIZONA: Metcalf, Oct 1900, *Davidson 615* (SYNTYPE: GH!, RSA!).

Lemmon 3077 is selected as lectotype due to its being the most complete specimen, although still containing only cleistogamous flowers.

Salvia blumeri Greene *nom. nud.* U.S.A. ARIZONA: Chiricahua Mts., Paradise, Cedar Gulch, 24 Sep 1907, *Blumer s.n.* (GH!, MO!).

Perennial to 6 dm from woody caudex. Stems erect to trailing, generally unbranched, one to several. Stem puberulous to pilose or hirsute, sparsely resinous dotted. Basal leaves generally pinnately compound, 3–5(–7) foliate, terminal leaflet deltoid, lateral leaflets greater than 1/3 the length of the terminal. Cauline leaves often simple, deltoid or less frequently cordate/reniform and reduced upwards and grading into bracts. Margins of all leaves irregularly toothed and lobed. Leaf size and shape quite variable depending on environment and time of year.

Inflorescence raceme-like to 25 cm, verticillasters 5–10, each bearing 1–6 flowers. Lower-most bracts most often indistinguishable from uppermost leaves, the flowers thus appearing axillary in some instances. Bracts rarely deciduous. Calyx 8–11(–13) mm long, the tube 3–6 mm, hirsute outside, particularly on veins, puberulous inside with thin annulus, sinuses bearded. Lobes of calyx firmly mucronate, middle upper lobe 1 mm (occasionally suppressed). Calyx green throughout. Corolla red, puberulous, generally not arched, 3.0–3.8 cm, often reduced and cleistogamous. Upper lip of corolla galeate, 6–8 mm, lower middle lobe 2–6 mm, the lower lip of the corolla shorter than the upper. Corolla throat 5–6 mm in height, wider than tall. Upper anther thecae exserted as much as 6 mm from the galea, the lower anther thecae bent downward into throat of corolla. Style bifid, exserted from galea, top branch 1–2 mm, lower branch 2–6 mm. $2n = 28$.

Producing fully developed, chasmogamous flowers April-May. Cleistogamous flowers produced May-October.

Distribution and habitat.—Preferring limestone talus or cliffsides, in canyons or north-facing slopes; 800 m–2000 m. Texas along Rio Grande and canyons in Brewster, Presidio, Jeff Davis, Hudspeth and El Paso counties; New Mexico in Otero County west to Arizona and north to northern Socorro County; Arizona in eastern Pima County, north to Maricopa County and in disjunct populations northwest to Grand Canyon. Mexico along Rio Grande (Rio Bravo) and west to Santa Eulalia Mountains in Chihuahua, with a disjunct population in southern Chihuahua.

Comments.—The three individuals which serve as syntypes for *S. davidsonii* were plants collected late in the flowering season (September and October) and had cleistogamous flowers with corollas 1 cm long or less. Subsequent collections made earlier in the growing season by other botanists at the type localities exhibited fully chasmogamous flowers with corollas to 3 cm long (see discussion under corolla characters). The foliar and inflorescence characters outlined in Greenman's description were all commonly found in populations of *S. henryi*. Greenhouse-grown plants propagated by seed from New Mexico populations of *S. henryi* and from a type locality of *S. davidsonii* (Chiricahua Mts., north of Paradise, AZ) were similar morphologically and appeared to be conspecific. For the above reasons, *S. davidsonii* is treated as a synonym with *S. henryi*, the latter having priority by 33 years.

Disjunct populations of *S. henryi* in Arizona occur along Fish Creek in Maricopa County, Peoples Spring in the Arrastra Mountains in Yavapai County, and various locations along the Grand Canyon of the Colorado River. Each of these disjunct populations have plants with slight morphological differences. Most of the differences observed, such as simple leaves, larger growth habit, and pink or purple flowers, may be the result of environmental conditions; these characters are apparently phenotypically plastic and not suitable to delimit infraspecific taxa. Collections from populations growing along an environmental gradient, from mesic and shaded to xeric and exposed, showed variation in leaf shape from simple to compound, and in corolla color from red to pink to purple. Additional investigation is required to determine the basis for the observed morphological variation.

Common name.—Henry's Sage.

Representative Specimens: * = Specimens used in analyses of morphological characters. † = Specimens used in chromosome counts. **UNITED STATES. ARIZONA. Cochise Co.:** Chiricahua Mts, 2mi N of Paradise, 2 May 1935, *Maguire 11134* (NY)*; Little Dragoon Mts, NE of Benson, E of San Pedro River, 5 May 1993, *Van Devender 93-632* (ARIZ)*. **Coconino Co.:** Havasupai Cyn, 23 May 1941, *Whiting 1047* (ARIZ)*; Colorado River, Matkatamiba Cyn, 26 Oct 1990, *Scott 882* (NYBG)*; Matkatamiba Cyn, mi 148 of Colorado River, 18 May 1973, *Phillips s.n.* (ARIZ)*. **Gila Co.:** Pinal Mts, S of Globe, Jun 1995, *Walker 1971* (OKL)†. **Graham Co.:** Upper Gila River drainage, 20 Apr 1978, *McGill 2376* (ASU, NYBG, TEX)*; Bonita Creek between Midnight Cyn and San Carlos Indian Reservation, 21 Apr 1978, *McGill 2388* (ASU, RSA)*. **Greenlee Co.:** 15mi N of Clifton, 7 Jun 1935, *Maguire 11854* (NY)*; 14 mi N of Clifton, 1 Apr 1960, *Crosswhite 803* (ASU)*. **Maricopa Co.:** Fish Creek, 1 Apr 1926, *Peebles 5233* (ARIZ)*. **Mohave Co.:** along Colorado River, 1/4mi below Matkatamiba Cyn, 4 May 1970, *Holmgren 15536* (ARIZ, GH, NY); Frasiers Well, off hwy 93, between Wickenburg and Kingman, 2 Nov 1968, *Niles 906* (ARIZ)*. **Pima Co.:** Empire Mts, 31 May 1987, *Montgomery s.n.* (ARIZ)*. **Pinal Co.:** Superstition Mts, Fremont Pass, 24 Mar 1972, *McGill 433* (ASU)*. **Santa Cruz Co.:** Santa Rita Mts, 25 May 1884, *Pringle s.n.* (GH, NY); west end of Canelo Hills, above Monkey Springs, 11 Jun 1978, *Kaiser 1193* (ARIZ). **Yavapai Co.:** Southern Arastra Mts, People's Cyn, South People's Spring, 4 Jun 1979, *Fischer 6628* (ARIZ, ASU)*. **NEW MEXICO. Dona Ana Co.:** 43 air km NNE of Las Cruces on W side of San Andres Mts, 15 May 1993, *Spellenberg 11799* (BRIT, MT, NMC); East Portrillo Mts, 25 Apr 1992, *Worthington 20581* (UTEP)*; 11 air mi NW of Las Cruces, N end of Robledo Mtn, 27 Apr 1983, *Spellenberg 7007* (NMC)*. **Grant Co.:** 10mi NE of Red Rock, 21 May 1935, *Maguire 11552* (ARIZ); Little Hatchet Mts, Howell's Ridge, 14 May 1992, *Worthington 20802* (UTEP). **Hidalgo Co.:** Big Hatchet Mts, 2 air mi NNE from top Big Hatchet Peak, 19 May 1992, *Worthington 20891* (UTEP). **Lincoln Co.:** 12 mi E of Carizozo, 22 May 1987, *Barneby 18236* (NY)*; WSMR, Oscura Mts, Cottonwood Spring, 3 Jun 1993, *Anderson 6205* (TEX)*. **Luna Co.:** Florida Mts, Mahoney Park, 18 Apr 1982, *Worthington 8117* (ASU)*. **Otero Co.:** Sacramento Mts, Dog Cyn, 3 Jun 1979, *Van Devender s.n.* (UTEP, ARIZ)*; Sacramento Mts, 0.3mi W of Fresnal Cyn Tunnel, 11 May 1980, *Worthington 5898* (ARIZ, UTEP)*. **Sierra Co.:** Fra. Cristobal Range, cliffs of S side of Chalk Gap, 16 Jun 1981, *Van Devender 16191* (UTEP); Bear Den Cyn, WSMR, 28 Aug 1991, *Anderson 5085*(NMC). **Socorro Co.:** White Sands Missile Range, N end of Oscura Mts, 19 Aug 1991, *Spellenberg 10865* (NMC, UNM, NY, MO, RSA, ID, UC, TEX)*. **TEXAS. Brewster Co.:** 4mi NE of Lajitas, 18 Apr 1973, *Jump s.n.* (ARIZ). **El Paso Co.:** Franklin Mts, 6 May 1983, *Worthington 10287* (UTEP)*; Franklin Mts, 8 Apr 1978, *Worthington 2508* (UTEP)*; Hueco Pass, Hueco Mts, 27 Apr 1976, *Butterwick 2619* (TEX)*. **Hudspeth Co.:** Central Hueco Mts, along hwy 180 near Hueco Inn, 26 Apr 1975, *Everitt 75255* (ARIZ). **Jeff Davis Co.:** N of Alpine in Fern Cyn, 20 Apr 1938, *Warnock T399* (TEX). **Presidio Co.:** at base of south bluff in Bracks Cyn, 11 Jun 1941, *Hinckley 1669* (GH, NY, SRSC)*.

MEXICO. Chihuahua: Santa Eulalia Mts, Apr 1886, *Pringle 704* (MEXU, TEX)*; Canon del Rayo at northern end of the Sierra del Diablo, 25 Jul 1941, *Stewart 907* (TEX); 23 air mi ENE of Villa Ahumada in northwestern cyn of Sierra de la Alcaparra NE of Rancho El Palmar, 12 Sep 1973, *Henrickson 12853b* (TEX); SE of Lajitas, TX, 5 May 1979, *Worthington 4425* (UTEP)*.

2. **Salvia roemeriana** Scheele (**Figs. 1 D,E,F, Fig. 3**), Linnaea 22:586. 1849. Type: U.S.A. Texas: fertile soil in shady woods on the upper Guadalupe, *Lindheimer 145* (lectotype, here designated: GH!; isolectotype: MO!).

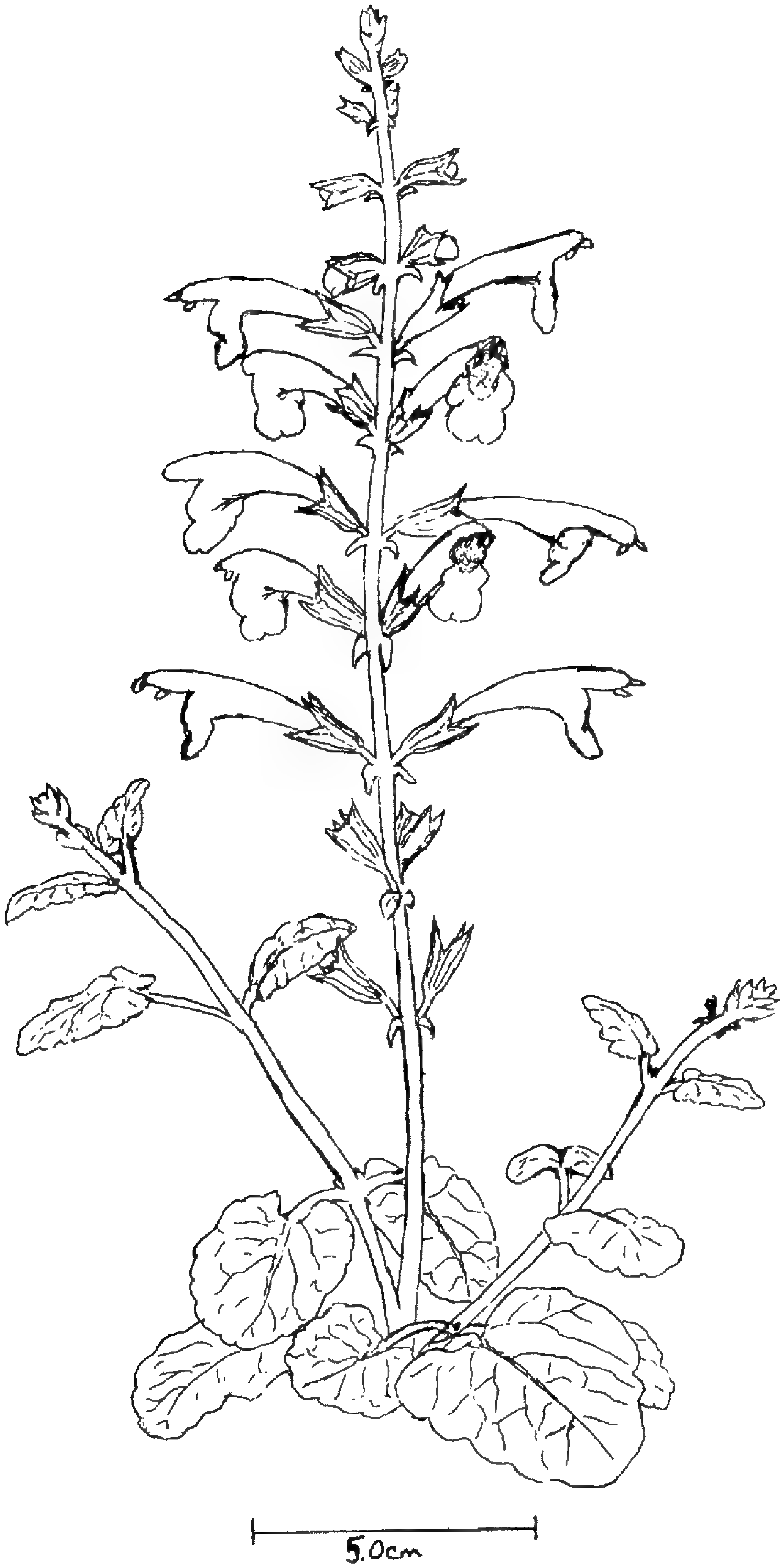

Fig. 3. Habit of *S. roemeriana* (adapted from Decaisne 1854).

Scheele described this species from a Roemer collection (In silva prope Neubraunfels leg. Roemer. Aprili). However, no Roemer collection of *S. roemeriana* is present in any of the herbaria surveyed within this project. Neither are any at the Munich herbarium (M) where many of Scheele's specimens are deposited. Roemer was in the vicinity of New Braunfels, Texas both in April of 1846 and 1847. During the April of 1846, Roemer's journal states he collected with Lindheimer in the New Braunfels area (Mueller, 1935). As is recounted by McKelvey (1955) "Lindheimer and Roemer made many botanical excursions together during 1846...At the end of the season they appear to have exchanged a set of the collections make by each during the year and Roemer, on his return to Germany, placed Lindheimer's with his own botanical specimens in the hands of Adolph Scheele who...published the descriptions in Linneae from 1848 to 1852. Not only did he publish the 'new species' of Roemer's collecting, but also those found among Lindheimer's duplicates, though he knew that Englemann and A. Gray had already undertaken to describe these collections in their Plantae Lindheimerianae, and so industriously did he continue his work that he soon completely outdistanced his American competitors and left little for them to describe." Owing to the lack of any Roemer collections of *S. roemeriana*, the authors of this paper assume that the type specimen was not a Roemer collection as suggested by Scheele, but the Lindheimer collection here designated as lectotype.

Salvia porphyrantha Decne, Rev. Hort. ser. 4, 3:301. 1854. TYPE: This species was described from specimens grown from seed at the Paris Museum. The source of the seed is unknown. *Salvia porphyrata* Hook, Bot. Mag. t.4939. 1856. (orth. var.)

Perennial to 9 dm from woody caudex. Stems erect to trailing, generally unbranched, one to several. Stem puberulent to white tomentose or densely rusty pubescent, most often pilose-setose, sparsely or rarely densely resinous dotted. Basal and cauline leaves similar, petiolate, simple or 3–5 foliate with lateral leaflets not greater than 1/3 the length of the terminal leaflet. Lateral leaflets sessile (rarely petiolate), orbicular and irregularly toothed, occasionally reduced to tooth-like appendages. Terminal leaflet 1–5 cm, cordate to reniform, crenate or less often irregularly toothed, often denticulate. Leaves often somewhat rugose, pubescence variable and generally reflecting that of the stem. Inflorescence an raceme-like, 5–15(–30) cm, verticillasters 4–10(–17), each bearing 1–6 flowers. Bracts generally distinct from cauline leaves and reduced upwards, early deciduous or persistent. Calyx puberulous and sparsely resinous dotted outside, naked inside, (8–)10–12(–15) mm long, the tube 3–6 mm long. Middle upper lobe of the calyx generally suppressed (occasionally expressed and 0.1–0.3 mm) lower lip 2-lobed, softly mucronate. Calyx green blending to red at the apex of the lobes. Calyx sinuses naked. Corolla red, puberulous, arcuate, 2.8–3.6(–4.7) cm, often reduced and cleistogamous. Upper lip of corolla weakly galeate, 6–8 mm, lower middle lobe 6–9 mm, the lower lip equal to or longer than the upper. Corolla throat 5–7 mm in height, taller than wide. Two staminodes to 5 mm in fully chasmogamous flowers. Upper anther thecae included or exserted as much as 6 mm from the galea, the lower anther thecae bent outward or rarely somewhat downward. Style bifid, exserted from galea, top branch 1mm, lower branch 2–3 mm. $2n = 28$.

Producing fully developed, chasmogamous flowers March-May. Cleistogamous flowers produced May-October.

Distribution and habitat.—Preferring limestone cliffs and talus and juniper or oak/pine woodlands; 500 m – 2000 m. Texas along Edwards Plateau and north to Bell County, west to Presidio County. Mexico along Rio Grande (Rio Bravo) from Big Bend National Park and south along Sierra Madre Oriental to southern Tamaulipas.

Comments.—Several local variants characterize *S. roemeriana*. For example, a densely rusty pubescent form of *S. roemeriana* is found in the vicinity of Melchor Muzquiz in Coahuila and a densely white pubescent form is found along the coastal plain northeast of Ciudad Victoria in Tamaulipas. Individuals of *S. roemeriana* found in the Sierra Madre Oriental south of Monterrey are considerably larger than their northern counterparts and reach a meter in height, with flowers of 4.7 cm long. Because there exists a continuous gradation of size and pubescence types among each of these local variants and the more northern members of the species, discrete morphological and geographic groupings are not apparent and subspecific rank is not warranted.

Salvia roemeriana is distinguished from *S. henryi* by a larger lower corolla lip compared to the upper lip, a corolla throat that is taller than wide, the lack of an annulus or bearded sinus in the calyx, the lack of a middle upper calyx lobe, and lateral leaflets less than 1/3 the length of the terminal leaflet.

Common name.—Cedar Sage.

Representative Specimens: * = Specimens used in analyses of morphological characters. † Specimens used in chromosome counts. **UNITED STATES. TEXAS. Andrews Co.:** 15mi W of Andrews, 10 May 1958, *Scudday 222* (SRSC). **Bandera Co.:** just NE of Can Creek, 18 Jun 1975, *Smith 684a* (TEX)*. **Bell Co.:** Tennessee Valley area, 17 Apr 1954, *York 54156* (TEX)*. **Bexar Co.:** 18mi SW of San Antonio, Helotes Creek, 15 May 1932, *Metz 256* (NYBG, RSA). **Blanco Co.:** at "The Narrows" of the Blanco River, 19 Apr 1969, *Correll 37019* (TEX)*. **Brewster Co.:** 28 mi E of Marathon, 23 Apr 1949, *Warnock 8522* (SRSC)*. **Comal Co.:** W edge of New Braunfels, 17 Apr 1966, *Correll 32508* (TEX)*; **Coryell-Bell Co.**: line: 8.8mi NE of Killeen, 23 May 1979, *Sherwood 554* (OKL). **Edwards Co.:** 1/2mi S of the dam on the west bank of Hackberry Creek, 21 Ju 1974, *Smith 253* (TEX). **Hays Co.:** College Camp, 8 April 1963, *Pete Abrigo s.n.* (TEX). **Jeff Davis Co.:** NE Davis Mts, Nations Ranch, eastern edge of Timber Mtn, 3 Jun 1987, *Larke 777* (SRSC). **Kendall Co.:** below Edge Falls, 3 May 1947, *Tharp 17T151* (TEX)*. **Kinney Co.:** Anacacho Mts., Anacacho Ranch, 19 Apr 1966, *Correll 32539* (TEX). Pecos **Co.:** Near Sheffield, Owens Ranch, 18 Apr 1953, *Souddy 48* (SRSC). **Presidio Co.:** Bofecillos Mts., Bofecillos Cyn., at Aqua Adentro and Cuevas Amarillas, 25 Mar 1994, *Worthington 23073* (UTEP)*. **Real Co.:** 5mi N of Leakey, along Frio River, 24 Jun 1946, *Correll 12865* (NY, TEX). **Terrell Co.:** 30 mi. NE of Sanderson on Sheffield road, 10 Jul 1950, *Surratt 277* (SRSC); 3mi W of Austin, 20 Oct 1996, *Walker 1962* (OKL)†. **Travis Co.:** 5mi W of Austin, 7 April 1949, *Rogers 6736* (TEX)*. **Uvalde Co.:** along Rio Frio, 22 Jun 1963, *Correll 28018* (TEX). **Val Verde Co.:** on Fawcett Ledge 20-30 mi up Devil's River, 3 Apr 1953, *Warnock 11178* (SRSC, TEX)*. **Williamson Co.:** 3mi W of Georgetown, along north fork of Gabriel River, 28 Sep 1958, *Correll 20479* (TEX).

MEXICO. Chihuahua: 23 air mi ENE of Villa Ahumada in northwestern cyn of Sierra de la Alcaparra NE of Rancho El Palmar, 12 Sep 1973, *Henrickson 12853b* (TEX); 3mi W of Santa Elena picnic Area of Big Bend NP, Fern Cyn, side cyn of Santa Elena Cyn, 2 Nov 1973, *Wendt 82* (TEX). **Coahuila:** Muzquiz, 1935, *Marsh 152* (TEX)*; Mcpo. Zaragosa, 1km W of Rancho Lagunita, 10 Apr 1976, *Riskind 1904* (TEX)*; Sierra de la Madera NW of Cuatro Cienegas, in Canada Charretera, 14 May 1992, *Mayfield 1348* (TEX); W of Buenavista, Saltillo, Canon de San Lorenzo, 9 Apr 1976, *Marroquin 3557* (MEXU)*; Mcpo. Villa Acuna, 80km SE of Big Bend NP, on SW margin of Serranias del Burro (part of the Sierra del Carmen), Rancho El Rincon, 22 Jun 1991, *Ruiz 31* (SRSC)*; 28 air mi WSW of Cuatro Cienegas, Canon Los Pozos, 5mi W of Rancho Cerro de la Madera towards Canon Desiderio, 2 May 1977, *Henrickson 15989a* (TEX)*; Mcpo. Ramos Arizpe, Sierra S. J. de los Nuncios, 2 Apr 1993, *Hinton 22769* (TEX)*. **Nuevo León:** S of Monterrey on road W of Horsetail Falls, Huesteca Cyn, 13 Nov 1989, *Starr s.n.* (TEX)*; Mcpo. Galeana, 10 km NE of Pocitos, 26 Aug 1984, *Hinton 18768* (TEX)*; Mcpo. Santiago, San Isidro, 16 Jun 1994, *Hinton 24366* (MEXU, TEX)*; SE of Casablanca-Villa de Garcia, Canada Cortinas, 20 Apr 1983, *Villarreal 2046* (MEXU)*. **Tamaulipas:** Mcpo. Hidalgo, Los Mimbres, 5 Jun 1994, *Hinton 24189* (MEXU, TEX)*; Mcpo. San Carlos, Sierra de San Carlos, Cerro del Diento, 17 km S of San Carlos, 22 May 1988, *Hernandez 2271* (TEX)*; Ejido Ricardo Garcia o La Presita, km 66 carretera Victoria-Tula, 26 Apr 1985, *Mahinda 314* (MEXU).

3. Salvia summa A. Nels.(**Figs. 1 G,H,I**), Amer. J. Bot. 18:432. 1931. Type: U.S.A. New Mexico: Carlsbad Caverns, rock crevices near springs, May 1930, *G. Convis 59* (holotype: RM! 135094; isotype: RM! 138003).

Perennial to 40 cm from woody caudex. Stems erect to trailing, generally unbranched, one to several. Stem pubescent, often densely pilose at base, resinous dotted. Basal leaves thickened, generally pinnately compound with 5–7 leaflets, terminal leaflet deltoid, 10–25 mm, lateral leaflets variable in shape, greater than 1/3 the length of the terminal. Cauline leaves grading from compound near base into simple and deltoid (rarely reniform). Leaves somewhat rugose, generally pubescent with thick vestiture of appressed hairs, particularly below, margins irregularly toothed and lobed. Inflorescence raceme-like to 20 cm, verticillasters 4–8, each bearing 1–4 flowers. Lower-most bracts often indistinguishable from uppermost leaves, the flowers thus appearing axillary in some instances. Bracts rarely deciduous. Calyx 7–8 mm long, the tube 2–4 mm, hirsute outside, particularly on veins, puberulous inside with annulus; sinuses bearded. Calyx lobes firmly mucronate, the middle upper lobe 1mm (rarely suppressed). Calyx dark green throughout. Corolla purple, often with blue dots in throat, puberulous, arcuate, 3.0–4.8 cm long, often reduced and cleistogamous. Upper lip of corolla galeate, 7–9 mm, lower middle lobe 7–10 mm. Corolla throat 5–7 mm in height. Upper anther thecae exserted from galea as much as 2mm, lower anther thecae bent downward into the throat of the corolla. Style bifid, exserted from the galea, top branch 1mm, lower branch 1–3 mm. $2n = 28$.

Producing fully developed, chasmogamous flowers April-May. Cleistogamous flowers produced May-October.

Distribution and habitat.—Preferring north-facing limestone cliffs, also in canyons along water courses; 1500 m–2000 m. Known only from six mountain ranges. Texas in Culberson and El Paso Counties, New Mexico in western Eddy, Otero, southern Chaves, and eastern Dona Ana counties. Mexico in Sierra Juarez mountains southwest of Ciudad Juarez, Chihuahua.

Comments.—*Salvia summa* has the most restricted distribution of the species studied. Described from Carlsbad Caverns in New Mexico, it was thought to be endemic to the Guadalupe Mountains until recently when new locations were described from mountain ranges farther west (Worthington 1982). Within the Guadalupe Mountains, *S. summa* is the only representative of sect. *Heterosphace*, whereas in the Oscura, San Andres and Franklin mountains, *S. summa* coexists and possibly hybridizes with *S. henryi* (see discussion under Geographic distribution and interspecific sympatry). The most distinctive feature of *S. summa* is the long, purple corolla, which is unmistakable compared to other members of the group. Its habit is more diminutive than other members of the group and its leaves are thicker. The calyx also is distinctive because of its small size and thicker annulus.

Common name.—Summa Sage.

Representative Specimens: * = Specimens used in analyses of morphological characters. † – Specimens used in chromosome counts. **UNITED STATES. NEW MEXICO. Chaves Co.:** 30mi E of Elk, 18 Apr 1949, *Goodman 5005* (OKL); 9mi W of Hope, 30 May 1997, *Walker 2160* (OKL)*. **Dona Ana Co.:** 30mi NE of Las Cruces on E side of San Andres Mts, NE side of Black Mtn, 28 Apr 1990, *Spellenberg 10170* (NMC)*; Organ Mts, Rattlesnake ridge, 31 May 1980, *Worthington 6050* (NMC, UTEP)*. **Eddy Co.:** Carlsbad Caverns, May 1930, *Convis 59* (RM); North Rocky Arroyo, 20mi W of Carlsbad, 27 May 1997 *Walker 2147* (OKL)*. **TEXAS. Culberson Co.:** Guadalupe Mts, McKittrick Cyn, 21 May 1984, Freeman *s.n.* (UTEP)*; Guadalupe Mts, McKittrick Cyn 30 Apr 1961, *Warnock 18244* (SRSU)*; Guadalupe Mts, Bear Cyn, 26 May 1979, *Warnock 21601* (SRSC)*; Guadalupe Mts, above Pine Springs campground, 27 Oct 1996, *Walker 1964* (OKL)†; Guadalupe Mts, W side of mts, Goat Spring, 29 May 1997, *Walker 2157* (OKL)*; Delaware Mts, 9 Sep 1994, *Worthington 23532* (UTEP)*; Guadalupe Mts, Pine Spring, 1 May 1971, *Weston 86* (SRSC)*; 9mi N of Van Horn, 24 Apr 1961, *Correll 23808* (MO, NY, RSA, TEX)*. **El Paso Co.:** Franklin Mts, 30 May 1981, *Worthington 7135* (UTEP)*.

MEXICO. Chihuahua: Mcpo. Juarez, in the Sierra Juarez in middle of range, 3 air km SW of Cd. Juarez center, 7 May 1993, *Spellenberg 11795* (BRIT, MEXU, MT, NMC)*.

ACKNOWLEDGMENTS

We wish to thank Guadalupe Mountains National Park and Lincoln National Forest, both of which permitted the collecting of specimens integral to this project, and the curators of the several herbaria listed in the text whose loans of specimens made this study possible. Cal Lemke provided tremendous help in the germination and care of live collections. We are grateful to Roger Sanders, Barney Lipscomb, and John Nelson for their helpful comments and review of the manuscript. We also thank Richard Spellenberg for his encouragement and sharing his extensive knowledge on this group of *Salvia*. We are grateful to Mike Powell and to the Rancho Santa Ana Botanical Garden for help in procuring seeds of the plants studied, and to Olof Ryding for his help in developing methodology for pericarp sectioning.

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BOOK REVIEW

BARBARA L. BOWLING. 2000. **The Berry Grower's Companion.** (ISBN 0-88192-489-X, hbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $29.95, 308 pp, 40 color photos, 25 b/w illustrations, 17 tables, 6" × 9".

Contents.—Preface; Acknowledgments; Introduction; What are Berry Crops? The Philosophy of Perennial Crop Production.

1. General Principles
2. Berries in the Landscape
3. Stawberries
4. Brambles
5. Blueberries
6. Grapes
7. Minor Crops [currants and gooseberries, kiwi, amelanchiers, highbush cranberry]
    - Appendix: North American Nursery Sources for Berry Plants
    - Glossary
    - References and Other Resources
    - Plant Name Index
    - Subject Index

For each type of berry plant, information includes interesting notes on cultivation history, recommended cultivars by region, site selection, techniques for planting, cultivation, propagation, and harvest, and pests and pest management. The book is written in an easily readable and highly enjoyable form, with good lessons in biology as well as the practical aspects of growing your own. The original working title (shortened by the editorial process): "Berry My Heart: A Small-Fruit Specialist Tells the Truth About the Art, Science, and Philosophy of Growing Berries in the Garden."

As noted by the author, a long-time professional horticulturalist, "We no longer know exactly where our food comes from and how it is produced, and this has created a general sense of alienation between consumers and producers. The good news is that gardening remains the number one hobby in the United States, its popularity a reflection of the fundamental attraction between humans and plants." If you like to eat berries and have ever been curious about anything more than where to find them in the store, you'll surely enjoy this book. A good gift that doesn't require a technical background.—*Guy L. Nesom, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

TAXONOMY OF *STENARIA* (RUBIACEAE: HEDYOTIDEAE), A NEW GENUS INCLUDING *HEDYOTIS NIGRICANS*

Edward E. Terrell[1]

Research Collaborator
Department of Botany
Smithsonian Institution
Washington, D.C. 20560, U.S.A.

ABSTRACT

Five North American species formerly in the genus *Hedyotis* (Hedyotideae; Rubiaceae) are revised and placed in the newly recognized genus *Stenaria*, a name used by Rafinesque for a subgenus in the genus *Houstonia*. Keys, descriptions, distributions, and synonymies are provided. The principal species is *Stenaria nigricans*, a wide-ranging polymorphic species native to eastern, central, and southwestern United States and northern and central Mexico. The remaining species are *S. butterwickiae*, known only from Brewster Co., Texas; *S. mullerae* of Coahuila, Mexico, and Brewster Co., Texas; *S. rupicola* of southwestern Texas and northern Coahuila, Mexico; and *S. umbratilis*, rare and disjunct in northern Mexico south to Veracruz. Varieties are recognized within *S. mullerae*, *S. nigricans*, and *S. umbratilis*.

RESUMEN

Se revisan cinco especies de Norte América anteriormente incluidas en el género *Hedyotis* (Hedyotideae; Rubiaceae) y se incluyen en el género nuevo y reconocido *Stenaria*, un nombre usado por Rafinesque para un subgénero dentro del género *Houstonia*. Se presentan claves, descripciones, distribución, y sinónimos. La especie principal es *Stenaria nigricans*, una especie polimorfa de amplia distribución, y nativa de las zonas orientales, centrales, y sudoeste de los Estados Unidos así como de la parte norte y central de México. Las otras especies son *S. butterwickiae*, conocida únicamente de Brewster Co., Texas; *S. mullerae* de Coahuila, México y de Brewster Co., Texas; *S. rupicola* del sudoeste de Texas y norte de Coahuila, México; y *S. umbratilis*, especie rara y disyunta de la parte norte de México al sur de Veracruz. Se reconocen variedades de *S. mullerae*, *S. nigricans*, y *S. umbratilis*.

Stenaria, newly recognized at generic rank, includes the widely distributed polymorphic species, *Hedyotis nigricans*, and four other related species that occur in the southwestern United States or Mexico: *Hedyotis butterwickiae*, *H. mullerae*, *H. rupicola*, and *H. umbratilis*. This group of five species has been called the *Hedyotis nigricans* group (Terrell 1996a).

The choice of a type species for the genus *Hedyotis* has been the subject of some controversy regarding which of two Linnaean species, *H. auricularia* or *H. fruticosa*, should be selected. *Hedyotis auricularia* has oldenlandioid seeds, although they differ slightly from typical species of *Oldenlandia*. Seeds of *H. fruticosa* are quite different from those of *H. auricularia*. Conservation of the name *H. fruticosa* as type would avoid disruption in *Oldenlandia* nomenclature.

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[1] Current address: Edward E. Terrell, 14001 Wildwood Dr., Silver Spring, MD 20905, U.S.A.

Whichever name is chosen, the genus name *Hedyotis* does not apply to the *Hedyotis nigricans* group, which has seeds differing entirely from the seeds of either *H. auricularia* or *H. fruticosa*; consequently a new name is needed for the *H. nigricans* group. Rafinesque's name for a subgenus of *Houstonia*, subg. *Stenaria*, is here elevated in rank as the name for the new genus.

Seed characters are very important in the classification of the tribe Hedyotideae (Terrell et al. 1986; Terrell 1991, 1996a). The species of *Houstonia* were grouped into subgenera and sections based mainly on seed morphology and chromosome number (Terrell 1996a). Certain *Houstonia* species (e.g., *H. rubra* Cav. and *H. subviscosa* (Wright ex A. Gray) A. Gray) differ considerably in corolla size and somewhat in corolla morphology, but nonetheless have similar seed morphology and the same chromosome number, and are classified in the same section. Thus, corolla morphology by itself may be misleading as a taxonomic character. It is likely that research on other tribes of the Rubiaceae will demonstrate the importance of seed morphology; for example, *Diodia* and *Richardia* in the Spermacoceae differ greatly in seed morphology from the Hedyotideae. Robbrecht (1989) successfully utilized pyrene and seed characters in studying *Chazaliella* in the African Psychotrieae.

Hedyotis nigricans differs from *Houstonia* in having a chromosome number of x=9 or 10 (chromosome data in this group are known only for *H. nigricans*) and non-crateriform seeds, which are somewhat compressed and ellipsoid with a centric punctiform hilum (Fig. 1). In contrast, the 20 species of *Houstonia* have basic chromosome numbers of 6, 7, 8, and 11, and crateriform seeds (with a ventral depression occupied by a linear hilar ridge or having a ventral subglobose cavity without a hilar ridge); these were discussed and illustrated by Terrell (1996a). The genus *Oldenlandia* has a chromosome number of x=9, but differs entirely in having very small, numerous, 3-angled seeds. *Hedyotis nigricans* has been seen growing naturally in the same habitat or near species of *Houstonia* and *Oldenlandia* without any evidence of hybridization, nor have any hybrids been found in herbaria. *Hedyotis nigricans* var. *nigricans* is widely distributed in the United States and Mexico, and differs conspicuously from *Houstonia* and *Oldenlandia* species by having elongate capsules instead of globose ones, as well as by having seeds differing as already described.

A related group is the presently recognized *Hedyotis mucronata* group, mostly native to Baja California. These eight species have a chromosome number of x=13 and ellipsoid or dorsally strongly ridged seeds with punctiform hila.

SYSTEMATIC TREATMENT

Stenaria (Raf.) Terrell, stat. nov. TYPE SPECIES: *Stenaria nigricans* (Lam.) Terrell. *Houstonia* subg. *Stenaria* Raf., Ann. Gen. Sci. Phys. 5:226. 1820. LECTOTYPE, here designated: *Houstonia rupestris* Raf., Ann. Gen. Sci. Phys. 5:226. 1820 [=*Hedyotis nigricans* (Lam.) Fosb.]

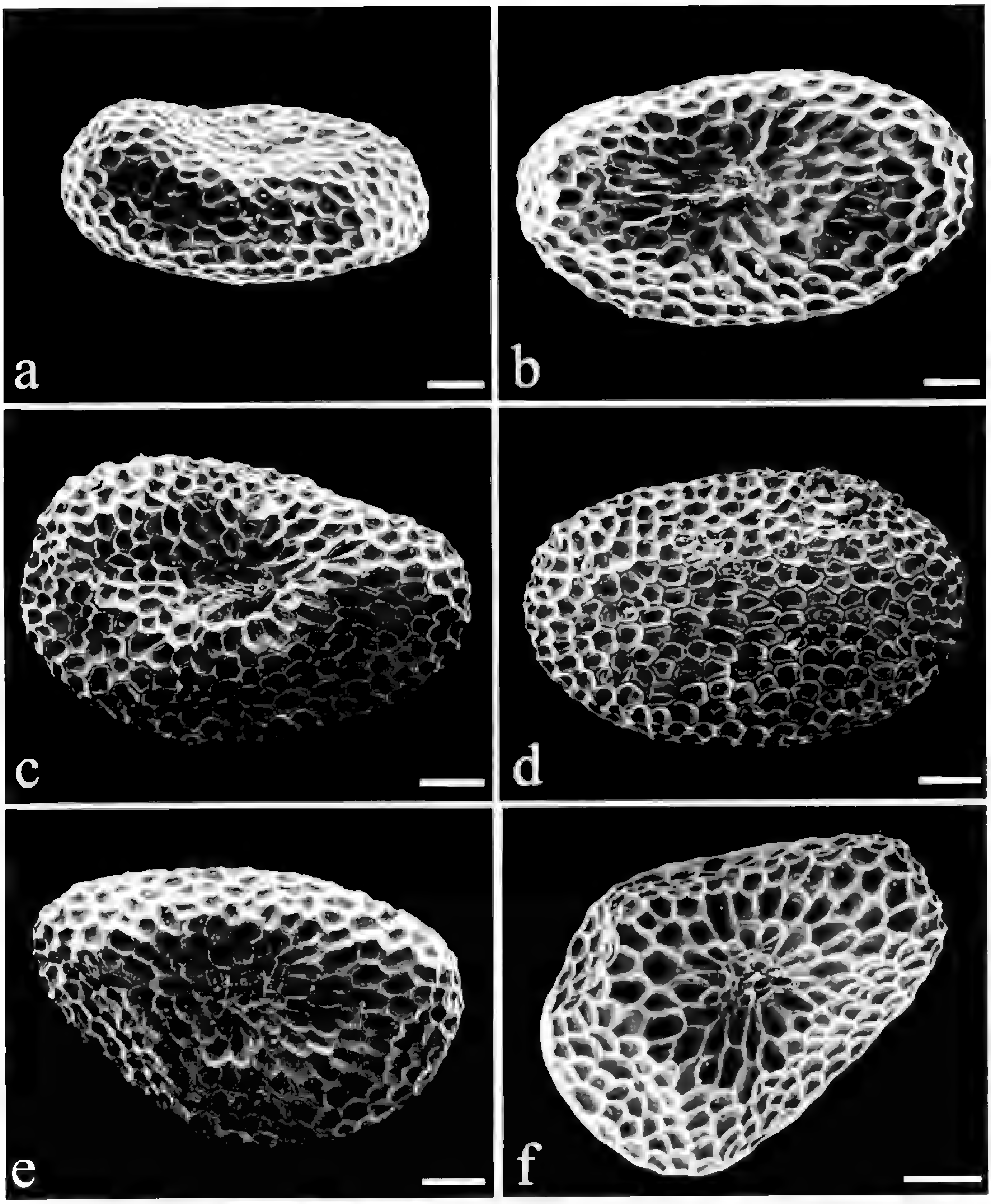

FIG. 1. Seeds of *Stenaria* species. a. *S. nigricans*, ventral view showing centric hilum, tilted 50°. b. *S. nigricans*, ventral view, not tilted. c, d. *S. mullerae*, ventral and dorsal views. e. *S. rupicola*, ventral view. f. *S. umbratilis*, ventral view. Bars=0.1 mm. *S. nigricans, Terrell 3923* (US), Manitee Co., FL; *S. mullerae, Chiang et al. 9421* (TEX), Coahuila; *S. rupicola, Tharp 43-866* (TEX), Pecos Co., TX; *S. umbratilis, Johnston et al. 12032B* (TEX), Coahuila.

Houstonia [unranked] *Angustifoliae* Small, Man. S.E. Fl. 1254. 1933. TYPE: *Houstonia angustifolia* Michx. [=*Hedyotis nigricans* (Lam.) Fosb.]

Rafinesque included his new species *Houstonia rupestris* as the first species in his new subgenus *Stenaria*. He also included four other species now in

Houstonia. Three (*H. heterophylla* Raf., *H. oblongifolia* Raf., and *H. obtusifolia* Raf.) of these are nomina dubia, and the fourth is *H. tenuifolia* Nutt. (=*H. longifolia* Gaertn. in Terrell 1996a). Steudel (Nom. Bot. ed 2, 1:776. 1840) listed *Stenaria* (as a nomen nudum) in smaller letters under *Houstonia*, consequently, he apparently intended *Stenaria* as a taxon ranked below *Houstonia* or else as a synonym of *Houstonia*.

Perennial herbs or low shrubs with or without woody tap root. Stems 2–62 cm tall, often from woody base, stout to slender, erect, spreading, or prostrate, glabrous to pubescent. Leaves 2–40 mm long, 0.3–8 mm wide, sessile or on short petioles, filiform or linear to ovate-lanceolate, elliptic, or oblanceolate, glabrous to pubescent. Stipules 0.5–3.5 mm long and wide, scarious, ovate, deltate, or lanceolate, sometimes acuminate or caudate, 0–few toothed or entire. Inflorescence of few-many cymes, dense to diffuse, flowers heterostylous or apparently homostylous in *S. umbratilis*, sessile or pedicellate. Hypanthium (calyx cup) hemispherical or cup-shaped, glabrous to hirsute. Calyx lobes 0.5–3 mm long, 0.2–1 mm wide, narrowly lanceolate to ovate-lanceolate, margins glabrous to ciliate, apices obtuse, acute, or mucronate. Corollas 2–8.5 mm long, salverform or funnelform, white, purple, pinkish, or lavender; tube 1.5–5.5 mm long, 0.4–1 mm wide at base, 0.5–2.5 mm wide at throat, densely puberulent or pubescent within; lobes 4(–5), 1–4.5 mm long, 0.5–2 mm wide, lanceolate or ovate, densely pubescent or puberulent on inner faces, apices glabrous or hairy. Pin form with stigmas subglobose, broadly elliptic,or oblong, their lobes 0.2–1.3 mm long, pubescent, elliptic or linear, exserted 0.5 to 3.5 mm beyond corolla throat; anthers 4(–5), 0.8–1.8 mm long, linear or narrowly oblong, inserted at midpoint or at distal end of corolla tube or with tips exserted at corolla throat. Thrum form with anthers 0.6–2 mm long, narrowly oblong or linear, usually blue or white, straight or curved, on slender or flattened filaments ca. 0.5–2.5 mm long, located at mouth of corolla tube or somewhat exserted; stigmas ca. 0.3–0.8 mm long, included, extended to near midpoint or to distal end of corolla tube. Mature capsules 1–4.5 mm long, 1–2.7 mm wide, 1/2–3/4(–4/5) inferior, dehiscing loculicidally, somewhat compressed, turbinate, obovoid, ellipsoid, or subglobose, glabrous to hirsutulous. Seeds several to 26 or more per capsule, 0.4–1.15 mm long, 0.3–0.6 mm wide, black or brown, often shiny, slightly to somewhat dorsilaterally compressed, non-crateriform, ellipsoid, in outline elliptical, oblong, or slipper-shaped, ventral face with punctiform centric hilum on flat, slightly convex, or slightly ridged surface, testa finely reticulate. Chromosome numbers: x=9, 10 for *S. nigricans*; other species unknown.

KEY TO SPECIES

1. Plants creeping, herbaceous, not woody or stems slightly woody toward base; Mexico, rare and disjunct. ____________ **5. S. umbratilis**
1. Plants not creeping, stems or bases woody.

2\. Plants shrublets or woody herbs, densely matted, prostrate, leaves overlapping; Coahuila, Mexico and Brewster Co., Texas. **2. S. mullerae**

2\. Plants not shrublets, woody at base or on lower stems, not densely matted, erect or spreading, leaves not or only slightly overlapping.

3\. Inflorescence very open and diffuse, leaves in inflorescence very small or lacking; Brewster Co., Texas. **1. S. butterwickiae**

3\. Inflorescence not diffuse or if somewhat diffuse then having apparent leaves in inflorescence.

4\. Stem leaves narrowly lanceolate to ovate-lanceolate or somewhat elliptic, leathery, cuspidate, margins scabrid or ciliate; capsules subglobose; southwestern Texas and northern Coahuila. **4. S. rupicola**

4\. Stem leaves various, not leathery, not cuspidate, margins not scabrid or ciliate; capsules longer than wide or subglobose only in *S. nigricans* var. *floridana*. **3. S. nigricans**

1\. **Stenaria butterwickiae** (Terrell) Terrell, comb. nov. (**Fig. 2**) *Houstonia butterwickiae* Terrell, Brittonia 31:164. 1979. *Hedyotis butterwickiae* (Terrell) Nesom, Syst. Bot. 13:434. 1988. Type: U.S.A. Texas: Brewster Co.: numerous in shallow pockets or crevices of limestone bedrock along ridgetop of Bullis Range, Bullis Gap Ranch, ca. 20 mi S of Sanderson, 2–3 mi NW of Rio Grande River, 29° 47' 30" N, 102° 32' 30" W, assoc. with *Penstemon baccharifolius, Phyllanthus ericoides, Polygala maravillasensis, Cirsium turneri*, 27 Aug 1977, *M. Butterwick, E. Lott, & S. Kennedy 3893* (holotype: US!; isotypes: GH! LL! MICH! MO! NY!). Paratype: Type locality, 16 May 1977, *M. Butterwick & E. Lott 3588* (LL!).

Perennial herb with a thick woody tap root and woody crown. Stems to 25 cm tall, often numerous, slender, wiry, glabrous, diffusely branched from upper nodes, the internodes longer than leaves, the nodes often tinged black. Basal leaves to 7 mm long, to 1 mm wide, somewhat clustered, sessile, linear, shorter, slightly wider, and thicker than cauline ones, glabrous; cauline leaves to ca. 20 mm long, 0.5–1 mm wide, sessile, rather rigid, stiffly erect, filiform or linear, acuminate at apex, glabrous or scaberulous, the midrib thick, the margin revolute. Stipules to 1 mm long and wide, scarious, whitish, subtriangular, acuminate or truncate. Inflorescence with small, few-flowered cymes, the pedicels to ca. 1 cm long, filiform, the inflorescence very diffuse, leaves lacking or greatly reduced, flowers heterostylous. Hypanthium glabrous; calyx lobes 0.8–3 mm long, ca. 1/2–3/4 as long as corolla tube, linear-lanceolate, with thick midribs, sharply acute or acuminate, stiffly erect. Corolla 2.3–4.7 mm long, funnelform, white with several dark nerves, glabrous externally; tube 1.3–3 mm long, gradually widened distally, densely puberulent within; lobes 1–1.7 mm long, 0.5–1 mm wide, ovate-lanceolate, puberulent within. Pin flowers with stigma lobes 0.3–0.5 mm long, exserted 0.5–1.5 mm beyond corolla throat, anthers 0.8-1 mm long, included, attached near midpoint or 3/4-point of corolla tube. Thrum flowers with anthers ca. 1 mm long, whitish, subsessile at sinuses of corolla lobes, stigmas included in tube. Mature capsules 1.5–2 mm long, equally wide, 1/2–3/4 inferior, dehiscing loculicidally, slightly or somewhat compressed, subglobose, glabrous, much exceeded by erect calyx lobes. Seeds ca. 10–26 per capsule, 0.4–0.7 mm

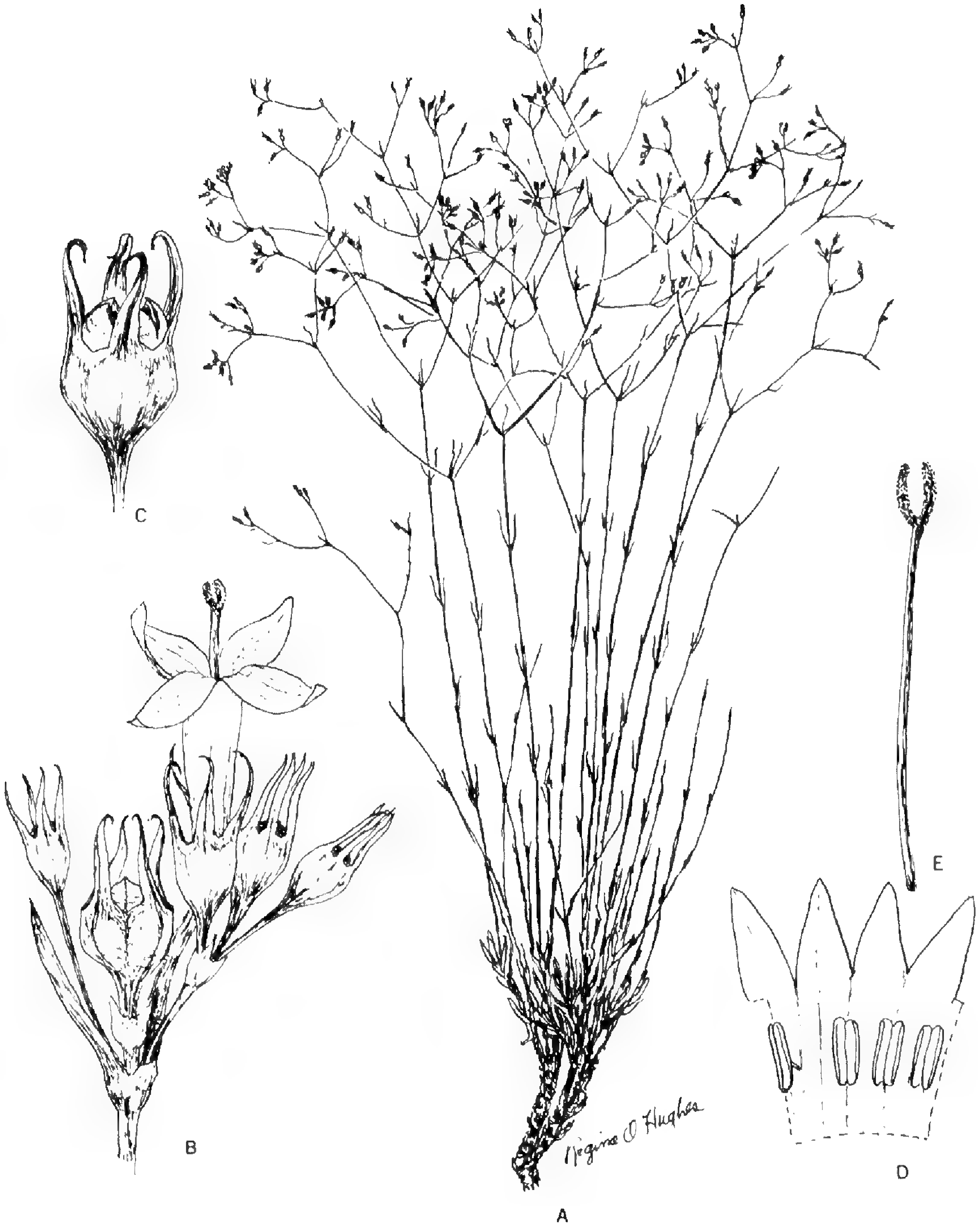

Fig. 2. *Stenaria butterwickiae*. Drawing of holotype reprinted from Brittonia 31:64. 1979. A. Habit, × .45. B. Detail of inflorescence, pin form, × 7. C. Capsule, × 5.5. D. Corolla with anthers, pin form, × 5.5. E. Style and stigma, × 5.5.

long, 0.3–0.4 mm wide, black or brown, ellipsoid, in outline elliptic or oblong, slightly or somewhat compressed, the hilum punctiform on ventral face, testa finely reticulate. Chromosome number unknown.

Phenology.—Flowering August.

Distribution.—Brewster Co., Texas. Known only from type collection.

Stenaria butterwickiae is distinctive in its very diffuse inflorescences without leaves or with leaves bract-like. The cauline leaves are small and stiffly erect. These characters are evident in Fig. 2.

2. Stenaria mullerae (Fosb.) Terrell, comb. nov. *Hedyotis mullerae* Fosb., Lloydia 4:288. 1941. *Houstonia mullerae* (Fosb.) Terrell, Brittonia 31:169. 1979. TYPE: MEXICO. COAHUILA: Mpio. de Cuatro Cienegas, Canon del Agua, Sierra de la Madera, 9 Sep 1939, *C.H. Muller 3234* (HOLOTYPE: US!, where transferred from NA; ISOTYPE: GH!).

Shrublets or perennial herbs, roots woody or with woody rhizomes to 6 mm thick. Stems to ca. 10 cm tall, often prostrate, matted, woody toward base, tetragonal, often obscured by the numerous small leaves, glabrous, internodes 1–5 mm long. Leaves 2–8(–10) mm long, 0.7–2 mm wide, sessile, thick, often gray-green, sometimes shiny, lanceolate, elliptic, narrowly elliptic, or oblanceolate, hispidulous to glabrous above, glabrous or with midrib hairs beneath, midribs often thickened and conspicuous below, margins thickened and revolute, conspicuously ciliate to scabrous, apices obtuse, acute, or apiculate. Stipules to ca. 2 mm long, adnate basally, deltate, margin often ciliate, apices 0.2–0.4(–2) mm long, acute, acuminate or apiculate. Inflorescence with flowers heterostylous, axillary, usually in groups of 3–5, subsessile or on pedicels to 1 mm long. Hypanthium hispidulous to glabrous; calyx lobes 1–2.5 mm long, lanceolate, oblanceolate, or spatulate, sometimes incurved, ciliate to glabrous, apices obtuse or acute. Corollas 2.5–6(–8) mm long funnelform, white, "sometimes tinged rose," hirtellous within distally; tube 2–4(–5) mm long, 0.7–1.2 mm wide at throat; lobes 1–3 mm long, 1–1.5 mm wide, ovate or lanceolate, densely pubescent to glabrous on inner faces, apices sometimes with hairs. Pin flowers with stigma lobes 0.2–0.4 mm long, broadly elliptic to linear, exserted on filiform styles to 2 mm beyond throat, anthers 0.8–1.4 mm long, sessile, partly exserted at throat. Thrum flowers with anthers 0.7–1.5 mm long, linear or oblong, "greenish blue," attached near or at sinuses, exserted on filaments 0.5–1 mm long, stigma included, styles to 2.5 mm long, glabrous. Mature capsules 1–2.2 mm long and wide, 1/2–4/5 inferior, compressed-subglobose, dehiscing loculicidally, apices broadly rounded or retuse. Seeds 0.6–0.8 mm long, 0.3–0.5 mm wide, black, rather shiny, somewhat compressed, in outline elliptic or angular-elliptic, hilum punctiform, on flat or slightly concave ventral surface, testa finely reticulate. Chromosome number unknown.

KEY TO VARIETIES OF *S. MULLERAE*

1. Leaves lanceolate, tapering gradually to a sharp point; stipules cuspidate with caudae 1–2 mm long. ______ 2b. var. **pooleana**
1. Leaves elliptic, narrowly elliptic, oblanceolate, or narrowly oblanceolate, obtuse, acute, or apiculate; stipules abruptly pointed, apiculate, or scarcely pointed, apical points 0.2–0.4 mm long. ______ 2a. var. **mullerae**

2a. Stenaria mullerae var. mullerae (Fig. 3).

Leaves 2–8(–10) mm long, usually gray-green, elliptic, narrowly elliptic, or oblanceolate, hispidulous to glabrous above, margins conspicuously ciliate to scabrous, apices obtuse, acute, or apiculate; stipules with apices scarcely pointed to abruptly short-pointed (more or less apiculate), apical points 0.2–0.4 mm long.

Phenology.—Flowering May to September.

Distribution.—Mexico: central (including Cuatro Cienegas Basin) and western Coahuila; rock crevices, steep slopes, ridge crests, cliff walls, usually on limestone, 1250–3000 m.

Selected representative specimens examined: **MEXICO. Coahuila:** ca. 35 km W of Cuatro Cienegas in Canyon de la Hacienda, Sierra de la Madera, near 27° 3' N, 102° 24' W, 7300 ft, *Henrickson & Wendt 11889* (ASU); ca. 31 air mi WNW of Cuatro Cienegas, Sierra de la Madera, S of Canyon Desiderio, 27° 06' N, 102° 32' W, 2700–2800 m, *Henrickson & Prigge 15275* (LL); SW end of Sierra de la Fragua, 1–2 km N of Puerto Colorado, *I.M. Johnston 8741* (GH, LL); W side of Potrero de la Mula, about 20 km NW of Ocampo, *I.M. Johnston 9245A* (GH); Sierra San Marcos, N part jutting into Cuatro Cienegas basin, 26° 47' – 26° 51' N, 102° 04' – 102° 07' W, 1250–1800 m, *M.C. Johnston et al. 10925* (LL, TEX, US); Mina El Aguirreno, N side of Sierra de la Paila, 26° 05' 30"– 06' N, 101° 36' W, 1700 -2200 m, *M.C. Johnston et al. 11692* (LL); Sierra de San Marcos, opposite Los Fresnos, *Pinkava et al. P-6011* (ASU, ENCB, LL, NY).

Stenaria mullerae is variable in leaf size and shape, leaf vestiture, and compactness. Certain collections are somewhat intergradient with *S. nigricans*, suggesting possible hybridization.

2b. Stenaria mullerae var. pooleana (B.L. Turner) Terrell, comb. et stat. nov.

Hedyotis pooleana B.L. Turner, Phytologia 79:93. 1995. TYPE: U.S.A. TEXAS. Brewster Co.: Brushy Canyon Preserve (Nature Conservancy of Texas), Dead Horse Mountains (Sierra del Caballo Muerto), ca. 0.7 mi SW of adobe house on Brushy Canyon divide (29° 27' N, 102° 58' W), 4900 ft, N to E-facing vertical limestone cliff face, with *Agave lecheguilla*, *Rhus virens*, *Quercus pungens*, 1 May 1987, *Jackie Poole 2942* (HOLOTYPE: TEX!).

Leaves usually 5–7 mm long, lanceolate, bright green, glabrous, scabrous on margins, at apex tapering gradually into a long sharp point (more or less cuspidate). Stipules with long narrow caudae 1–2 mm long, sometimes irregularly toothed.

Phenology.—Flowering May.

Distribution.—United States. Texas, Brewster County. Dead Horse Mountains (Sierra del Caballo Muerto), 29° 27' N, 102° 58' W. Known only from type collection. Also seen by the collector (but not collected) about one mile from the type locality on 27 November 1987, along the same ridge at about 4840 ft elevation within the boundary of the Big Bend National Park.

Additional collection: Type locality, 25 May 1985, *Poole 2527* (SRSC, TEX!).

Turner (1995b) in the abstract of his paper described *H. pooleana* as closely related to *H. mullerae*, but differing in having lanceolate, markedly thickened leaves with glabrous surfaces and apiculate apices. In addition, he provided

Fig. 3. *Stenaria mullerae* var. *mullerae*. Part of holotype (US).

measurements of other organs. Terrell (1996b) advocated sinking of *H. pooleana* into *H. mullerae*, based on previous study of the considerably variable *H. mullerae* in loans from ASU, ENCB, GH, NY, TEX, and US. Turner (1997) defended specific status. Recently, I have re-examined specimens and types from US and TEX (on current loan) and I now advocate varietal status for *H. pooleana*.

There are two clear differences between the two taxa: in leaf shape and stipule shape. *Hedyotis pooleana* has lanceolate leaves which taper gradually to their tips, whereas in *H. mullerae* the leaves vary from elliptic or oblanceolate to narrowly elliptic or narrowly oblanceolate, with the apices varying obtuse, acute, or apiculate. (That Turner attributed apiculate apices to *H. pooleana* appears to have been a lapse.) I accept these terms more or less as pictured by Lawrence (1951, p. 744, Fig. 307). (Also, the leaves of *H. mullerae* range from densely pubescent to glabrous). Turner did not mention stipular differences, however, these are at least as well marked as the leaf characters: var. *mullerae* has stipules with very short, abruptly narrowed apices, whereas var. *pooleana* has stipules more or less cuspidate with narrow caudae 1–2 mm long.

I believe that these differences in vegetative characters represent varietal, rather than specific differences in the variable *S. mullerae*. The two varieties are about 150 miles apart. Turner (1995b) stated that the Dead Horse Mountains (Brewster Co., Texas) are an extension of the Sierra del Carmen range "across the Rio Grande in Coahuila." Thus, it seems possible that the two varieties may have come from similar original stock, but have been isolated from each other for many millenia.

3. **Stenaria nigricans** (Lam.) Terrell, comb. nov. *Gentiana nigricans* Lam., Encycl. 2:645. 1788. *Houstonia nigricans* (Lam.) Fern., Rhodora 42:299. 1940. *Hedyotis nigricans* (Lam.) Fosb., Lloydia 4:287. 1941. TYPE: Herb. Jussieu (HOLOTYPE: P; photo, Fernald 1940).

Perennial herb with woody tap root to ca. 1.5 cm thick, foliage sometimes blackened when dried. Stems to 6.2 dm tall, often many-stemmed from broad woody base, stout to slender, erect, spreading, or decumbent, tetragonal and slightly winged, glabrous, scabridulous, papillose or densely puberulent or pubescent with gland-tipped hairs, occasionally with localized groups of densely aggregated white hairs. Leaves 7–40 mm long, 0.3–5(–8) mm wide, often fasciculate, sessile or tapering to short petioles, strongly revolute, filiform, linear, narrowly elliptic, elliptic, narrowly lanceolate, or narrowly oblanceolate, acute or obtusish, glabrous, scabridulous, densely puberulent or pubescent. Stipules to ca. 3.5 mm long and wide, scarious, deltate, ovate or lanceolate, sometimes acuminate or caudate, 0–few toothed. Inflorescence of few-many dense to loose cymes, often many-flowered (sometimes hundreds), flowers heterostylous, sometimes central or oldest flowers sessile or subsessile, other flowers on pedicels to ca. 10 mm long. Hypanthium glabrous to hirsute; calyx lobes 0.5–3(–4.4) mm long, 0.2–1 mm wide, slightly longer to slightly shorter than capsules, lanceolate or triangular-lanceolate, glabrous to hirsute, margins glabrous to ciliate, apices acute or mucronate. Corollas (2–)3.5–8.5 mm long, salverform to funnelform, quite variable in shape and size, white, light purple, pink, or lavender, buds elliptic, becoming obovate or oblanceolate and tapering to truncate or obtuse apices with or without hairs; tube (1.5–)2–4(–5.5) mm long, 0.4–1 mm wide at base, 0.5–2.5 mm wide at throat, often densely puberulent to hirsutulous within, tube length/lobe length ratio usually 1:1 to 2:1; lobes 4(–5), 1–3.5(–4.5) mm long, 0.5–2 mm wide, lanceolate or ovate, usually densely puberulent, pubescent, or hirsutulous on inner faces with white often gland-tipped hairs to ca. 0.6 mm long, apices also sometimes hairy. Pin form with stigmas bilobed, 0.3–1(–1.3) mm long, subglobose or broadly elliptic, papillose or pubescent, oblong, elliptic or linear, exserted to 3.5 mm beyond corolla throat on styles 4.5–5 mm long, anthers 4(–5), 0.8–1.8 mm long, linear or narrowly oblong, included at distal end of corolla tube or with tips exserted at corolla throat. Thrum form with 4(–5) anthers, 0.6–2.0 mm long, narrowly oblong or linear, usually blue or white, straight or curved, exserted on slender or flattened filaments ca. 0.5–2.5 mm long, attached near ends of anthers, stigmas ca. 0.3–0.8 mm long, included, linear, extended to near 2/3-point or to distal end of corolla tube on styles 1.5–2.5 mm long. Mature capsules 1.5–4.5 mm long, 1–2.7 mm wide, (1–)1.3–2 times longer than wide, (1/2–) 3/4(–4/5) inferior, somewhat compressed, turbinate, obovoid or broadly ellipsoid, quite variable in shape and size on an individual plant, glabrous or scabrous to hirsutulous, apices retuse, truncate, or broadly rounded, dehiscing widely loculicidally, then septicidally through septum, eventually forming two or four terminal segments. Seeds 0.45–1.15 mm long, 0.3–0.6 mm wide, black or dark brown, often shiny, somewhat compressed, ellipsoid, in outline elliptical, oblong, or slipper-shaped, ventral face with punctiform hilum more or less centered on flat, slightly concave, or slightly ridged surface, testa finely reticulate.

KEY TO VARIETIES OF *S. NIGRICANS*

1. Leaves more or less elliptic, 2.5–3.5(–4) times longer than wide; corollas usually 4–6 mm long; Mexico and southwest Texas 3d. var. **gypsophila**
1. Leaves usually filiform, linear, narrowly lanceolate, or oblanceolate, more than 4 times longer than wide; corollas 2–8 mm long.
    2. Capsules subglobose, 1.2–2.5 mm long, 1.2–2.2 mm wide, 1–1.3 times longer than wide; leaves 0.2–1.2 mm wide; corollas 3–5(–6) mm long; southern Florida, Bahamas. 3c. **var. floridana**
    2. Capsules longer than wide, 1.5–4.5 mm long, 1–2.7 mm wide, 1.3–2 times longer than wide; leaves 0.3–8 mm wide; corollas 2–8 mm long.
        3. Corollas 2–4(–4.5) mm long; leaves 0.7–2(–3.2) mm wide; Mexico. 3b. var. **breviflora**
        3. Corollas (2.5–)3–8 mm long; leaves 0.3–8 mm wide; wide-ranging. 3a. var. **nigricans**

3a. Stenaria nigricans var. **nigricans (Fig. 4)**. *Houstonia angustifolia* Michx., Fl. Bor.-Amer. 1:85. 1803. Non *Hedyotis angustifolia* Cham. & Schlecht., 1829. *Oldenlandia angustifolia* (Michx.) A. Gray, Pl. Wright. 2:68. 1853. *Chamisme angustifolia* (Michx.) Nieuwl., Amer. Midl. Naturalist 4:92. 1915. *Hedyotis stenophylla* Torr. & A. Gray, Fl. N. Amer. 2:41. 1841. (*Houstonia angustifolia* listed as synonym). *Hedyotis lasiantha* Nutt. ex A. Gray, Pl. Wright. 1:81. 1852, as syn. of *H. stenophylla* Torr. & A. Gray, invalid name. (Specimens labelled *H. lasiantha* in BM, K, PH). TYPE: U.S.A. FLORIDA: "submaritimis Floridae" (HOLOTYPE: P!).

Houstonia rupestris Raf., Ann. Gen. Sci. Phys. 5:226. 1820. Non *Hedyotis rupestris* Swartz, 1797. TYPE: U.S.A. KENTUCKY: rocks bordering Kentucky River, specimen lost?

Oldenlandia angustifolia (Michx.) A. Gray var. *filifolia* Chapm., Fl. S. U.S. 181. 1860. *Houstonia angustifolia* Michx. var. *filifolia* (Chapm.) A. Gray, Syn. Fl. N. Amer. 1(2):27. 1884. *Houstonia filifolia* (Chapm.) Small, Fl. S.E. U.S. 1109, 1338. 1903, as "(A. Gray) Small." *Hedyotis nigricans* var. *filifolia* (Chapm.) Shinners, Field & Lab. 17:168. 1949. TYPE: U.S.A. "S. FLORIDA," *Chapman s.n.* (LECTOTYPE: US-83375! designated by Terrell 1986).

Houstonia angustifolia var. *scabra* S. Watson, Proc. Amer. Acad. Arts 18:97. 1883. *Hedyotis nigricans* var. *scabra* (S. Watson) Fosberg, Lloydia 4:288. 1941. TYPE: MEXICO. COAHUILA: Caracol Mountains 21 miles southeast of Monclova, 19-22 Aug 1880, *Palmer 410* (LECTOTYPE, here designated, GH!; ISOTYPES, LL! NY! PH! US! VT!). Isotype at LL designated by Turner 1995a.

Houstonia angustifolia var. *rigidiuscula* A. Gray, Syn. Fl. N. Amer. 1(2):27. 1884. *Houstonia rigidiuscula* (A. Gray) Wooton & Standley, Contr. U.S. Natl. Herb. 16:175. 1913. *Hedyotis nigricans* var. *rigidiuscula* (A. Gray) Shinners, Field & Lab. 17:168. 1949. SYNTYPES: "S. and W. Texas, *Palmer, Havard, & c.* Coast of E. Florida, *Rugel.* (Mex.)." Two sheets in GH include a possible lectotype.

Houstonia salina A. Heller, Contr. Herb. Franklin and Marshall Coll. 1:96, pl. 9. 1895.

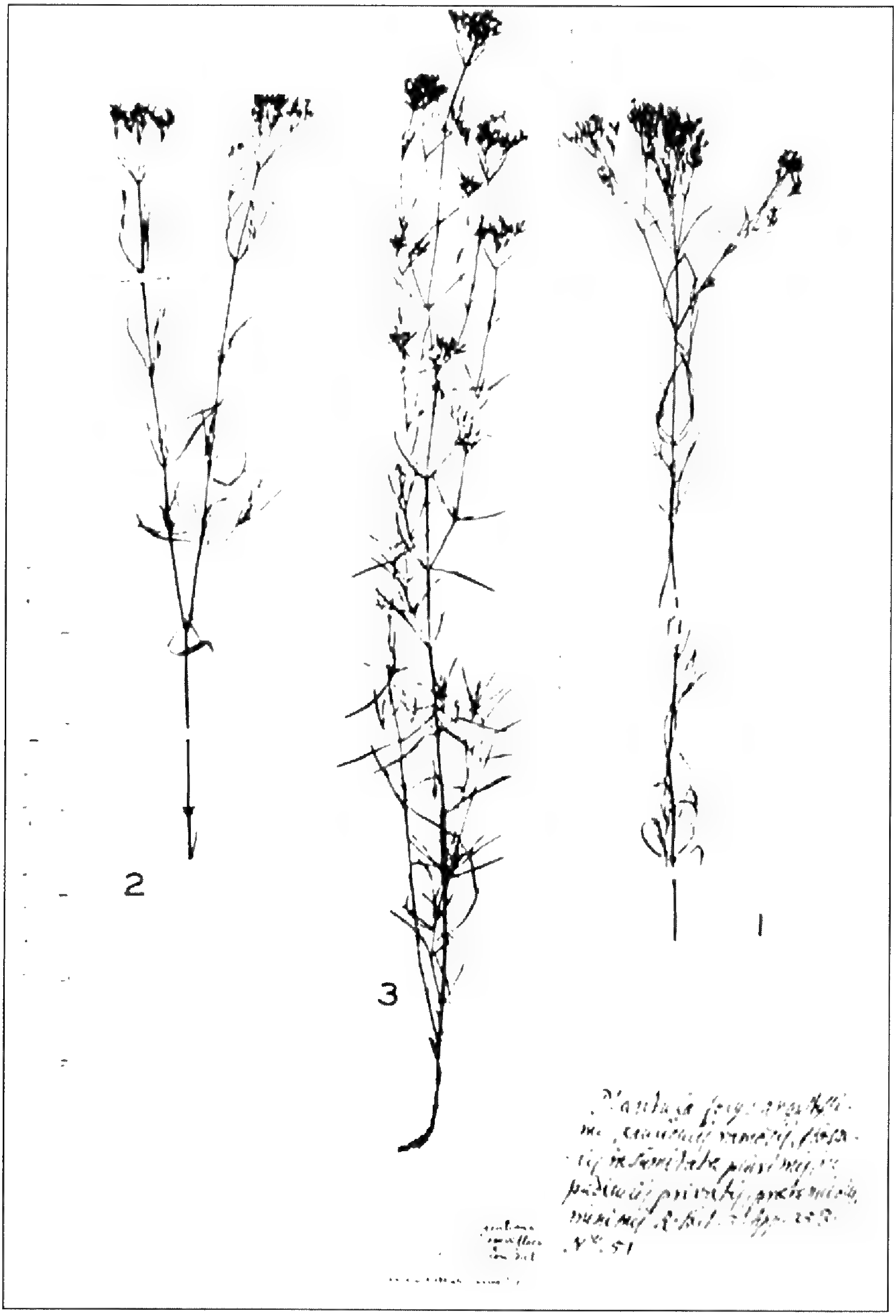

Fig. 4. Type of *Gentiana nigricans*, Paris herbarium, left and right plants. Middle plant is from Georgia, chosen by Fernald to show similarity with type. Plate 625 from Fernald 1940.

Hedyotis salina (A. A. Heller) Shinners, Field & Lab. 17:169. 1949. *Hedyotis nigricans* f. *salina* (A. Heller) W.H. Lewis, Rhodora 63:222. 1961. TYPE: U.S.A. TEXAS. Nueces Co.: shell deposit along beach, Corpus Christi, 31 May 1894, *A. A. Heller 1812* (LECTOTYPE designated by Terrell 1986, GH!; ISOTYPES, BM! ILL! K! MO! NY! PH! US-3!).

Houstonia pulvinata Small, Bull. New York Bot. Gard. 1:289. 1899. *Hedyotis nigricans* var. *pulvinata* (Small) Fosb., Castanea 19:37. 1954. *Houstonia nigricans* var. *pulvinata* (Small) Terrell, Phytologia 59:79. 1985. TYPE: U.S.A. FLORIDA. St. Johns Co.: sandy soil, St. Augustine, Jul 1876, *Mary C. Reynolds s.n.* (LECTOTYPE designated by Terrell 1986: NY!; ISOLECTOTYPE: NA!). PARALECTOTYPES, same locality and date, *A. P. Garber s.n.* (NY! US-2!).

Houstonia tenuis Small, Fl. S.E. U.S. 1109, 1338. 1903. TYPE: U.S.A. TEXAS. San Saba Co.: San Saba, Oct 1850 (?), *Thurber 67* (HOLOTYPE: NY!).

Hedyotis nigricans var. *austrotexana* B.L. Turner, Phytologia 79:15. 1995. TYPE: U.S.A. TEXAS: Karnes Co.: roadside 2 mi E of El Tejano Cafe, dry sandy clay soil, 22 June 1952, *Joe C. Johnson 833* (HOLOTYPE: LL).

Hedyotis nigricans var. *papillacea* B.L. Turner, Phytologia 79:15. 1995. TYPE: U.S.A. NEW MEXICO. Otero Co.: northern McKittrick Canyon at first crossing of Texas-New Mexico boundary, gravels and boulders of stream bottom, 8 Oct 1973, *Thomas F. Patterson 508* (HOLOTYPE: LL).

Leaves 0.3–8 mm wide, filiform, linear, narrowly lanceolate, or narrowly oblong, and more than 4 times longer than wide; corollas (2-5-)3–8 mm long; capsules 1.5–4.5 mm long, 1–2.7 mm wide, 1.3–2 times longer than wide.

Chromosome numbers.—Lewis (1959) reported $2n=18$ for var. *nigricans* from Nacogdoches Co., TX. Lewis (1962) listed $n=9$ for forma *salina* (San Patricio Co., TX), $n=9$ and 10 for var. *nigricans* (Chaves Co., NM and Brewster Co., TX) and $n=10$ for var. *rigidiuscula* (Brewster Co., TX). Lewis in Terrell et al.(1986) counted $n=10$ and $2n=20$ for var. *pulvinata* (St. Johns Co., FL). These varieties and the forma are here sunk under var. *nigricans*.

Common name.—diamond flowers.

Phenology.—Flowering usually April to December in Mexico; in U.S.A. usually April to October or all year in Florida.

Distribution.—United States. Southern Michigan (Branch Co.) and Ohio south to Florida, west to Iowa, Nebraska, eastern Colorado, and New Mexico; Mexico: Sonora, Chihuahua, Coahuila, Nuevo León, Tamaulipas, San Luis Potosí, and Hidalgo.

Selected representative specimens examined: **MEXICO. Chihuahua:** Sierra Grande, 3 km E of Rancho El Murcielago, 29° 52' N, 104° 50' W, *M.C.Johnston et al. 11293* (CAS, TEX). **Coahuila:** 8 km S of El Tule, 24 km N of Castillon, *Stewart 441* (CAS, GH, MO). **Nuevo León:** / mi W of Iturbide along hwy 60, *McGregor et al. 32* (KANU, NY, SMU, US).

UNITED STATES. ALABAMA. Dallas Co.: roadbank 9 mi W of Selma, *Webster & Wilbur 3508* (FLAS, MICH, NCSC). **ARKANSAS. Clark Co.:** Arkadelphia, *Demaree 15643* (FLAS, NY, TENN). **Garland Co.:** Hot Springs, *Harvey 12824* (IA, KANU, MICH). **COLORADO. Yuma Co.:** 0.75 mi S of Laird, *McGregor 32365* (KANU). **FLORIDA. Franklin Co.:** 6 mi NE of Alligator Point, *Kral 2800* (FLAS, FSU). **GEORGIA. Decatur Co.:** along Flint River 1 mi N of Chattahoochee, Florida, *Thorne 5931* (GA, IA, MICH, MT). **ILLINOIS. Jersey Co.:** Pere Marquette State Park, *Evers 25019* (ILLS). **INDIANA. Harrison Co.:** 1 1/2 mi NE of Davidson, *Deam 37238* (IND). **IOWA. Fremont Co.:** Hamburg, *Shimek s.n., 31 Aug 1898,* (IA). **KANSAS. Montgomery Co.:** 3 mi S of Independence, *Horr E256* (ASU, CM, FLAS, ISC, KANU, MT, NCSC, NO). **KENTUCKY. Wayne Co.:** Beaver Creek SW of Monticello, *Smith & Hodgdon 3907* (GH). **LOUISIANA. Caddo Parish**: 3 mi S of La. 526 at Forbing, *Thomas & Dorris 96086* (KANU, WNC). **MICHIGAN. Branch Co.:** loc. not given, *Mrs. J.M. Mulligan s.n., Jun 1889* (US). **MISSOURI. Franklin Co.:** 3 mi S of Grays Summit, *Steyermark 601* (MO). **NEBRASKA. Cass Co.:** Weeping Water, *Sheldon s.n., 17 Aug 1898* (WVA). **NEW MEXICO. Lincoln Co.:** 15 mi E of El Capitan, 8500 ft, *Hitchcock et al. 4239* (ISC, NO). **OHIO. Ottawa Co.:** Rattlesnake Island, *Moseley s.n., 29 Jul 1895* (CM, F, MICH, MO). **OKLAHOMA. McClain Co.:** 3 mi E of Blanchard, (Pl. Exs. Grayanae 686), *Demaree s.n., 30 Jun 1936* (DUKE, GA, IA, ISC, KANU, MICH, MT, NCSC, NO, PAC, TRT, WIS, WVA). **TEXAS. Kerr Co.:** Kerrville, *Heller 1661* (ARIZ, IA, MICH).

The preceding citation of specimens lists one specimen from most states of the United States where the typical variety occurs. Only a few Mexican specimens were cited because of lack of detailed notes on morphology. Turner (1995a) provided a map of the Texas distribution.

Previous to 1940 the name *Houstonia angustifolia* Michx. was usually applied to the species later known as *Hedyotis nigricans*. Fernald (1940, plate 625) presented an illustration of the type of *Gentiana nigricans* Lamarck from the Paris herbarium (shown here as Fig. 4). Fernald's plate shows two plants of the type collection along with a plant from Georgia collected by Boykin near the type region of *Houstonia angustifolia*. The three plants are very similar, so much so that Fernald commented "That they are the same no one is likely to question." The plants of the type collection are tall, rather strict, linear-leaved, and generally similar to other plants from the southeastern United States.

Stenaria nigricans is a polymorphic species. Plants from Adams County in southern Ohio are short and decumbent; plants from the southeastern U.S.A. often are tall and have very narrow leaves; plants from Kansas and Nebraska are often very stout and large, with thick, broad, woody bases and heavy taproots. Plants may also differ conspicuously from one population to another in size of corollas. This is only a small example of the variation, much of which seems to occur at random. I have not studied *S. nigricans* in detail, and leave it to future workers to study the species in depth.

Certain varieties are here placed in synonymy. Variety *scabra* S. Watson is only a hairier-than-average extreme connected with the typical plants by a continuum. Variety *rigidiuscula* A. Gray is a confused and ambiguous name whose protologue seems to refer to more or less typical plants of *S. nigricans*; the specimens cited as syntypes came from Texas and Florida and are rather diverse. Turner (1995a) came to a similar conclusion about this variety.

Houstonia salina and *H. tenuis* were discussed previously by Terrell (1986). I concluded that they did not merit varietal status. Turner (1995a) agreed with this conclusion.

Terrell (1986) compared var. *pulvinata* with var. *nigricans*, and maintained the former as a variety. Further consideration, however, leads me to conclude that its differences overlap so strongly with those of var. *nigricans* that it should be in synonymy.

Turner's (1995a) var. *austrotexana* and var. *papillacea* appear to differ from var. *nigricans* in rather minor ways, considering the great amount of variation in *S. nigricans*; e.g., var. *austrotexana*: "Resembling var. *nigricans* but the more mature calyces markedly papillose throughout." Variety *papillacea* is also papillose and appears to be delimited by the Texas border. I examined specimens of both varieties lent to me from TEX and specimens available in BRIT, but I could not accept their being sufficiently distinct to recognize as varieties (Terrell 1996b). Turner (1997) again upheld these varieties. *Stenaria nigricans* is an exceedingly variable entity, and I find it somewhat premature to recognize varieties on minor vestiture characters in Texas without studying the species in Oklahoma and throughout its range.

3b. Stenaria nigricans var. **breviflora** Terrell, var. nov. TYPE: MEXICO. NUEVO LEÓN: Sierra Madre near Monterrey, *C.G. Pringle 13878* (HOLOTYPE: US!; ISOTYPES: CAS! F! GH! MEXU! MICH! MO! MSC! SMU! VT!).

Folia saepe 0.7–2(–3.2) mm lata, linearia vel filiformia; corollae 2–4(-4.5) mm longae; capsulae 1.8–3(–3.8) mm longae. 1.3–2.2 mm latae, 1–1.5(2) plo longiores quam latiores.

Leaves usually 0.7–2(–3.2) mm wide, linear or filiform; corollas 2–4(–4.5) mm long; capsules usually 1.8–3(–3.8) mm long, 1.3–2.2 mm wide, 1–1.5(–2) times longer than wide, often glabrous.

Distribution.—Mexico: Nuevo León, vicinity of Monterrey, and in adjacent Coahuila. I have 30 records of this variety from 15 herbaria. The habitats are variously: limestone (travertine) and talc-like soil on gravelly hill; rocky limestone valley; sandy loam; dry pine-oak forest; crevices of limestone rock; gypsum plug (of Portrero Chico); bottom of arroyo.

Selected representative specimens examined: **MEXICO. Coahuila:** Ojo Caliente, 33 mi SW of Monterrey, *Warnock & Barkley 14744M* (ENCB, F, GH, MO, NY, TEX). **Nuevo León:** 5 km S of Sabinas Hidalgo on road to Monterrey, *Frye & Frye 2408* (GH, NY, US); 16 mi SW of Villa Santa Catarina, *Hernandez C. et al. 16M516* (TEX); Diente Canyon, Monterrey, *Muller & Muller 111* (F, GH, MEXU, TEX); toll road up Sierra Anahuac, 4.5 mi SE of Monterrey, *Oliver 202*, (SMU, TEX, US); 25 km NW of Monterrey, Portrero Chico, *Powell & Turner 2335* (TEX); between Linares and Galeana, 2500 ft, *Sharp 45653* (GH, TENN, US).

The main distinguishing character of this variety is the consistently short corollas. Also, the leaves are short and linear or filiform.

3c. Stenaria nigricans var. **floridana** (Standl.) Terrell, comb. nov. *Houstonia floridana* Standl., N. Amer. Fl. 32(1):36. 1918. *Hedyotis purpurea* var. *floridana* (Standl.) Fosb., Castanea 19:36. 1954. *Houstonia nigricans* var. *floridana* (Standl.) Terrell, Phytologia 59:79. 1985. *Hedyotis nigricans* var. *floridana* (Standl.) Wunderlin, Sida 11:400. 1986. TYPE: U.S.A. FLORIDA. Dade Co.: Cocoanut Grove, Biscayne Bay, Jul 1895, *A.H. Curtiss 5484* (HOLOTYPE: US!; ISOTYPES: FLAS! ISC! NY! US! VT!).

Stems usually 1–3.5 dm tall, sprawling, spreading, or erect, wiry and diffusely branched. Leaves filiform or linear, 0.2–1.2 mm wide. Corollas 3–5(–6) mm long, glabrate to densely pubescent within. Mature capsules subglobose, 1.2–2.5 mm long, 1.2–2.2 mm wide, 1–1.3 times longer than wide. Chromosome numbers:

Lewis (1962) reported n=9 for this variety (listed as var. *filifolia*) from Dade Co., Florida. Lewis in Terrell et al. 1986 reported n=9 and $2n$=18 for another collection from Dade Co., Florida.

Distribution.—Southern Florida: over limestone at a number of locations in Dade County, and at Big Pine Key in Monroe County; Bahamas: Grand Bahama Island, Great Abaco Island.

Selected representative specimens examined: **BAHAMAS. Grand Bahama Island:** Intersection of Settlers Way and Balao Road, Freeport, *Correll 440470* (NY); Buckingham-Leicester Co. line, Government Road, *Lewis 7182* (FSU, FTG, MO, NY). **Great Abaco Island:** halfway between Marsh Harbour and Marsh Harbour Airport, *Wunderlin et al. 8564* (USF).

UNITED STATES. FLORIDA. Dade Co.: Long Pine Key, *Brass* 32997 (USF); jct. Krome Ave., Moody Drive, 2 mi N of Homestead, S36, T56S, R38E, *Burch et al. 285* (FLAS); Pine Island, 25 mi S of Miami, E of Naranja and Homestead, *Elder* 289 (DUKE); 5 mi S of Florida City on US1, *C. & J. Janish 418* (CAS); 6 mi E of Royal Palm Park, *O'Neill 7584* (ARIZ, CAS, CM, MICH, MT, NO, US); Sykes Hammock, everglade keys, *Small, Mosier, & Small 6755* (CAS, DUKE, FLAS, MICH, US, WVA). **Monroe Co.:** Big Pine Key, *Brumbach 9392* (FSU); N of upper E-W road, Big Pine Key, *Killip 40896* (NO); 4 mi N of US1, Big Pine Key, *McDaniel 5813* (FSU).

Terrell (1986) discussed var. *floridana* and var. *filifolia* in detail, and concluded that the latter variety was a synonym of var. *nigricans*, as its description referred to plants unlike var. *floridana*.

Variety *floridana* is distinguished by having subglobose capsules. Because of these capsules Fosberg named it as *Hedyotis purpurea* [=*Houstonia purpurea*] var. *floridana*, but it has non-crateriform seeds like those of var. *nigricans* and does not belong in *Houstonia*.

3d. Stenaria nigricans var. **gypsophila** (B.L. Turner) Terrell, comb. nov. *Hedyotis nigricans* var. *gypsophila* B.L. Turner, Phytologia 79:15. 1995. TYPE: MEXICO. NUEVO LEÓN. Santa Rita, 2370 m, sparse pine woods, gypsum hillsides, 11 Jun 1981, *Hinton et al. 18278* (HOLOTYPE: TEX).

This new variety was described by Turner as follows: "Resembling var. *nigricans* but the plants low and much-branched from the base, the leaves elliptic-ovate and mostly 2.5–3.5(–4) times as long as wide (vs. linear-lanceolate to linear-oblanceolate, mostly 4–20 times as long as wide) and the mature calyces usually markedly hispid with broad-based hairs (vs. glabrous or merely minutely setose)."

My description incorporates items from Turner's description.

Stems woody at base, 0.4–2.5 dm tall. Leaves 4–17 mm long, 1–4(–6) mm wide, 2.5–3.5(–4) times longer than wide, elliptic or narrowly elliptic. Corollas usually 4–6 mm long. Capsules usually 2.5–3.2 mm long, 1.5–2.2 mm wide. Seeds 0.45–0.75 mm long, 0.3–0.6 mm wide.

Chromosome number.—Lewis (1962) listed n=9 under the name *H. nigricans* var. *angulata* (=*S. rupicola*), but the specimen was actually *S. nigricans* var. *gypsophila*.

Distribution.—Mexico: Northern and southeastern Chihuahua and northern Coahuila south southeast to Nuevo León, northeast Zacatecas, southwest

Tamaulipas, and San Luis Potosí. It has been much collected from the Saltillo and Galeana areas. The altitudes range from ca. 1500 to 3195 m. United States: Texas: Culberson, Hudspeth, and Jeff Davis counties. The specimens resemble Mexican collections, and this extends var. *gypsophila* northward into the United States. The range of habitats of the Mexican specimens includes the following: pine and oak forests; pinyon-juniper; pine-douglas fir; steep limestone slope; east-facing ravine; rocky slope; bank of dry arroyo; steep igneous slope; and gypsum flats in pine-pinyon.

The most conspicuous character is the elliptic leaves on rather small plants. As noted (Terrell 1996b) I was aware of this taxon prior to its description by Turner. Like Turner, I can not find any other characteristics significantly different from var. *nigricans* (hairy mature calyces occur in var. *nigricans*). I consider the taxon as misnamed, as I recorded only one collection out of 49 Mexican collections from 19 herbaria that mentioned a gypsum substrate. It may be noted that the type specimen came from a gypsum habitat.

Plants superficially somewhat resemble those of some variants of *Houstonia longifolia*, which occurs in the eastern and central U.S.A. (Terrell 1996a). Variety *gypsophila* may also be confused with the Mexican species *Houstonia wrightii*. The latter species may occasionally occur at higher elevations near var. *gypsophila*, and a very few collections have had both species on one sheet. The following comparison may provide a means of distinguishing them: capsules of var. *gypsophila* are somewhat compressed, longer than wide, and eventually dehisce widely into four similar segments; seeds are ellipsoid with the hilum more or less centered on the ventral side and punctiform; buds often have hairy apices. *Houstonia wrightii* capsules are subglobose, not or only slightly compressed, wider than long; seeds have a linear hilar ridge in a ventral depression; bud apices are glabrous (Terrell 1996a).

Selected representative specimens examined: **MEXICO. Chihuahua:** Sierra de la Parra, across Rio Grande from Sierra Vieja, 1450–2158 m, 30° 00–02' N, 104° 52–53' W, *M.C.Johnston et al. 11314B* (TEX, US). **Coahuila:** 22 km ESE of La Cuesta del Plomo on Muzquiz-Boquillas hwy near intersection of hwy from V. Acuña, 1000 m, 28° 38' N, 102° 18' W, *Chiang et al. 7550R* (CAS, TEX, US); about 35 mi E of Saltillo, 5–6 mi E of Los Lirios, 2300–2400 m, *McVaugh 12338* (MICH); mpio. Villa Ocampo, Canyon de la Vaca, Sierra Santa Fe del Pino, *Passini & Robert 5193* (ENCB); Sierra Guadelupe, S of La Cuchilla, 2300 -2600 m, *Pennell 17388* (F, PH, US). **Nuevo León:** Cañon del Voladero, Galeana, 2200 m, *Hinton 18744* (ASU, US); Cerro Potosí, near microwave tower, 9000 ft, *McGregor et al. 351* (TEX, US); mpio. Berrumbadero, Cañon de las Capulines above San Enrique Hacienda, San Jose de Raices, *Mueller 2413* (F, GH, MICH, MO). **San Luis Potosí:** 21.6 mi SE of San Luis Potosí, hwy 86 to Rio Verde, 7500 ft, *Oliver 190* (MO, SMU). **Tamaulipas:** 3 mi N of Miquihuana, *Stanford et al. 2399* (DS, US). **Zacatecas:** Sierra del Astillero, 24°34' N, 101° 04' W, *M.C. Johnston et al. 11551* (CAS, TEX, US).

UNITED STATES. TEXAS. Culberson Co.: south fork of McKittrick Canyon, Guadeloupe Mts., *Correll & Hanson 29822* (FSU, TEX); Victoria Canyon, E margin of Sierra Diablo, 1330–1700 m, 31° 20–21' 30" N, 104° 53–55' W, *M.C.Johnston et al. 10695* (TEX). **Hudspeth Co.:** Victoria Canyon, 1 mi from McAdoo Ranch, Diablo Mts., *Muller 8219* (MICH). **Jeff Davis Co.:** Davis Mts., Madera Canyon, *Webster 4501* (MICH).

4. **Stenaria rupicola** (Greenman) Terrell, comb. nov. (**Fig. 5**).*Houstonia rupicola* Greenman, Proc. Amer. Acad. Arts 32:286. 1897, non *Hedyotis rupicola* Sonder in Harvey & Sonder, Fl. Cap. 3:12. 1865. *Hedyotis stenophylla* Torr. & A. Gray var. *parviflora* A. Gray, Pl. Wright. 1:81. 1852, non *Hedyotis parviflora* Walpers, Ann. Bot. Syst. 2:772. 1852, nec *Houstonia parviflora* Holzinger ex Greenman, Proc. Amer. Acad. Arts 32:284. 1897. *Hedyotis angulata* Fosb. in Shinners, Field & Lab. 17:166, nom. nov. for var. *parviflora* 1949. *Hedyotis nigricans* var. *angulata* (Fosb.) W.H. Lewis, Amer. J. Bot. 49:865. 1962, nom. superfl. *Hedyotis nigricans* var. *parviflora* (A. Gray) W.H. Lewis, Ann. Missouri Bot. Gard. 55:32. 1968. TYPE: U.S.A TEXAS: Expedition from W. Texas to El Paso, N.M., May-Oct 1849, *C. Wright 238* (LECTOTYPE designated by Lewis (1968): GH!; ISOTYPES: GH! NY! PH! US!).

The protologue states "Crevices of rocks on the San Pedro River; July." The lectotype has atypical plants; the isotype at US has plants that are more typical. The San Pedro River is now the Devils River and is near Del Rio, Texas.

Small perennial herbs with woody taproots becoming 1 cm thick. Stems 2–15(–22) cm tall, sometimes many, quadrangulate, stiffly erect or ascending from thick (to 1 cm), woody, branched base, glabrous (sometimes shiny), scabrous, or pubescent on angles. Leaves 2–8(–12) mm long, 0.8–2(–2.5) mm wide, usually 3–6 times longer than wide, numerous, sessile, narrowly lanceolate to ovate-lanceolate or elliptic, thick, leathery, rigidly ascending or spreading, often shiny, cuspidate, glabrate, margin scabrid or ciliolate, midrib conspicuous beneath. Stipules 0.5–3 mm long, usually with linear or awl-shaped cauda, margins entire or toothed or ciliolate, teeth sometimes branched. Flowers heterostylous, in terminal, few-flowered cymes, pedicels to ca. 3 mm long. Hypanthium glabrous to pubescent or ciliate; calyx lobes 0.7–2.3 mm long, less than 0.5 mm wide, ovate-lanceolate or lanceolate, acute to subcaudate, rigidly erect, with thick dorsal rib, slightly to somewhat surpassing the mature capsules. Corollas 3.5–6 mm long, funnelform, white, buds obovate, often with apical hairs; tubes 2–3.8 mm long, ca. 0.8–1 mm wide at throat, puberulent or pubescent within; lobes 1–2.5 mm long, 0.7–1 mm wide, lanceolate or ovate, densely pubescent on inner faces, sometimes with hairs on apex. Pin flowers (predominating in herbarium specimens) with stigma lobes 0.3–0.8 mm long, oblong, stigmas exserted 1–2 mm beyond corolla throat, styles minutely puberulent, anthers located just below corolla sinuses. Thrum flowers with anthers 0.8–1.2 mm long, oblong or appearing subglobose, straight or curved, on filaments 0.5–1 mm, exserted to 1 mm beyond throat, stigmas located near midpoint of corolla tube. Mature capsules 1–2 mm long and wide, slightly longer than wide or subequal, 1/2–3/4 inferior, subglobose or slightly compressed, glabrous to pubescent. Seeds several–14 per capsule, 0.3–0.7 mm long, 0.25–0.5 mm wide, black or dark brown, shiny, ellipsoid, slightly to somewhat compressed, sometimes twisted or angular, ventral face with punctiform hilum, testa finely reticulate. Chromosome number unknown. Lewis (1962) listed $n=9$ for *Oliver 197* (MO, SMU, TEX) from Nuevo Leon as *H. nigricans* var. *angulata* (= *S. rupicola*); however, this collection

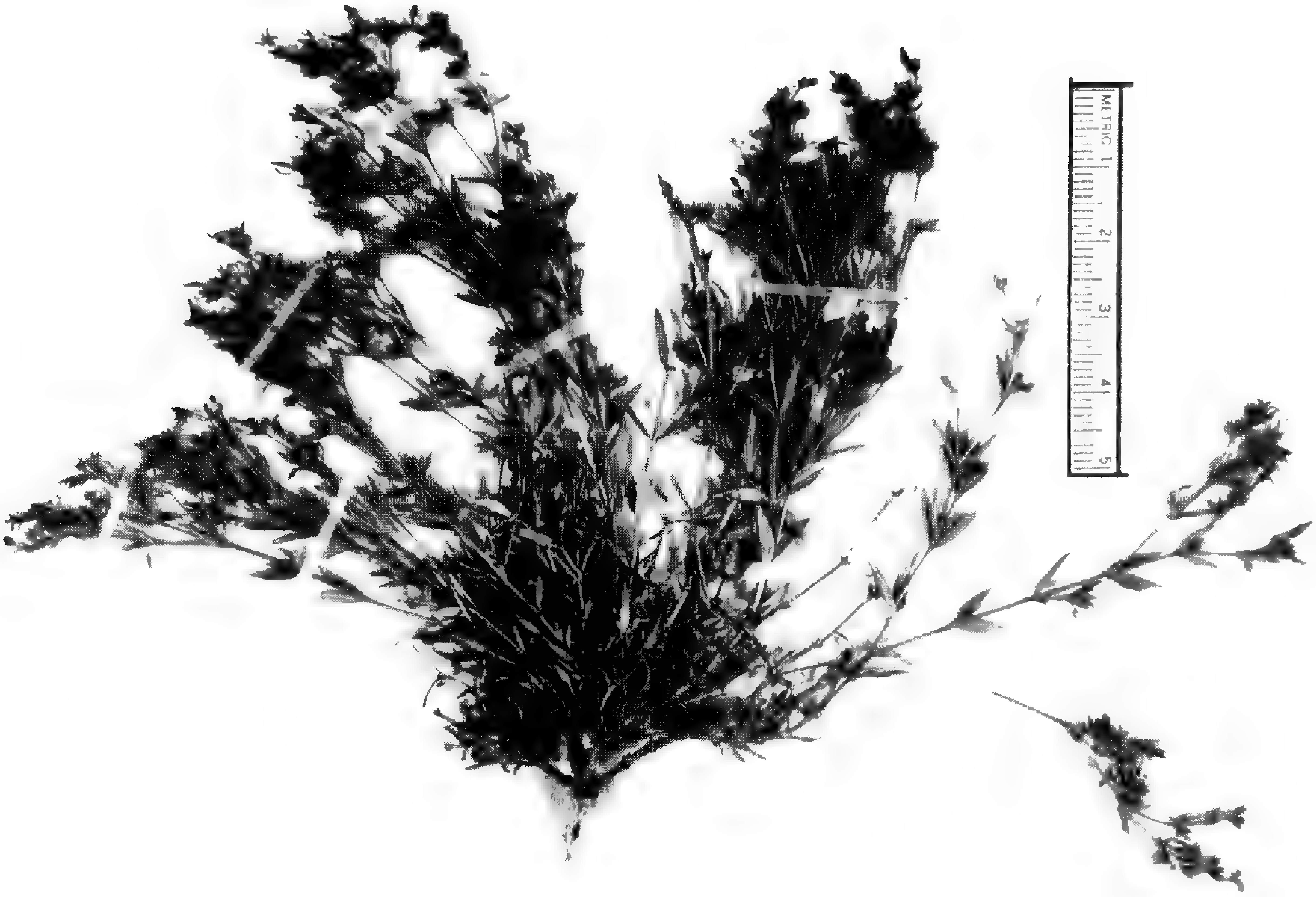

Fig. 5. *Stenaria rupicola*. *C.R. Orcutt 753* (US), Sanderson, Texas, 26 Jun 1924.

is not *S. rupicola* but *S. nigricans* var. *gypsophila*. *Stenaria rupicola* occurs no farther east than Coahuila.

Phenology.—Flowering May–November.

Distribution.—Rock crevices, talus slopes, gravelly soil, often over limestone, 500–2000 m (1500–6000 ft). United States: Southwestern Texas (Brewster, Crockett, Pecos, Presidio, Terrell, and Val Verde counties); also Culberson (atypical); Mexico: northern Coahuila in the Muzquiz area and northwest toward Boquillas del Carmen.

Selected representative specimens examined: **MEXICO. Coahuila:** 1 mi N of "La Laguna," Canyon del Mulato, Serranias del Burro, about 65 mi NW of Sabinas, 3500 ft, *Gould 10584* (ENCB, MICH); S. Paila (Valley Seco), G. Cepeda, *Hinton et al. 16540* (GH, NY, US); 140.3 km NW of Muzquiz on Hwy 53 towards Boquilla del Carmen, *Peterson & Annable 10595* (US); camp below Pichache de Centinela about 15 mi, 4600 ft, *Warnock 11538* (MICH, SMU).

UNITED STATES. TEXAS. Brewster Co.: 7 mi E of headquarters, Black Gap Wildlife Refuge, Maravillas Canyon, *D.S. & H.B.Correll 35355* (LL). **Crockett Co.:** Salviastrum Mesa, 32 airline mi NW of Ozona, *Cory 44377* (TEX). **Pecos Co.:** 40 mi S of Ft. Stockton on Sanderson Road, *Hinckley 4837* (US); main canyon on NE side of Sierra Madera, 25 mi S of Ft. Stockton, 1300 m, *McVaugh 10646* (MICH). **Presidio Co.:** Capote Canyon, 9 mi NE of Candelaria, *Ohlendorf 471* (LL). **Terrell Co.:** 1 mi E of Sanderson, 2885 ft, *Warnock 11885* (LL).

This species has been treated by me in the past as *Hedyotis angulata*, however, under *Stenaria* the earlier epithet, rupicola, may be used. It is quite distinct in leaf characters. Some collections are somewhat atypical, possibly due to introgression from *S. nigricans*. The species intergrades with *S. nigricans* and possibly with *S. mullerae*.

5. Stenaria umbratilis (B.L. Robinson) Terrell, comb. nov. *Houstonia umbratilis* B.L. Robinson, Proc. Amer. Acad. Arts 45:401. 1910. *Hedyotis umbratilis* (B.L. Robinson) W.H. Lewis, Rhodora 63:222. 1961. TYPE: MEXICO. NUEVO LEÓN: cliffs of mountains near Monterrey, 25 Apr 1906, *C.G. Pringle 13877* (HOLOTYPE: GH!; ISOTYPES: CAS! MEXU-2! MICH! MO! MSC! SMU! US! VT!).

Perennial herb. Stems prostrate, creeping, slender, glabrous or pubescent at nodes, rooting at some nodes. Leaves 2–5.5 mm long, 1–3 mm wide, subsessile or with petioles to ca. 1.5 mm long, 1-nerved, ovate or broadly elliptic, glabrous or pubescent above, glabrous and slightly paler below, acute or obtuse. Stipules minute, glabrous or sparsely pubescent, margins with one or more teeth or glands. Inflorescence with flowers solitary, axillary or terminal, on more or less straight pedicels to 3 mm long (var. *brevipedicellata*) or on slender deflected pedicels 3.5 to ca. 16 mm long, subtended by one or two bracts or leaves, flowers apparently homostylous. Hypanthium glabrous; calyx lobes 0.8–1.5(–2) mm long, 0.5–0.7 mm wide, erect, ovate-lanceolate, acutish or obtuse. Corollas 4.7–9 mm long, funnelform, white; tube 3–5 mm long, 0.5–1 mm wide at base, 1–3 mm wide at throat; lobes 1.5–4.2 mm long, 1.0–2.2 mm wide, ovate, spreading, puberulent or glabrate within. Anthers 0.6–1 mm long, 0.2–0.3 mm wide, narrowly oblong or oblong, filaments 0.5–2 mm long, somewhat exserted. Stigma lobes ca. 0.5 mm long, included in corolla tube. Mature capsules 1–2 mm long and wide, 1/2–3/4 inferior, subglobose, thin-walled, dehiscing widely loculicidally. Seeds 0.5–0.8 mm long, 0.3–0.6 mm wide, black, shiny, somewhat compressed, ovoid or ellipsoid, hilum centric, punctiform, testa finely reticulate. Chromosome number unknown.

The creeping habit of this species differs markedly from that of the other species of *Stenaria*; however, the ellipsoid seeds led me to place it with the other species of this genus. The typical variety has long pedicels that are deflected at an angle, whereas var. *brevipedicellata* consistently has short, more or less straight pedicels. The presently known distribution indicates separate ranges. The seeds of the two varieties are similar.

KEY TO VARIETIES OF *S. UMBRATILIS*

1. Stems often densely leafy because of the very short internodes; leaves somewhat leathery, revolute; flowers on more or less straight pedicels ca. 1–3 mm long. ____ 5b. var. **brevipedicellata**

1. Stems not densely leafy, internodes longer; leaves thin; flowers on long (3.5–16 mm), deflected pedicels. ____ 5a. var. **umbratilis**

5a. Stenaria umbratilis var. **umbratilis (Fig. 6).**

Leaves thin; flowers on long, deflected pedicels.

Phenology.—Flowering April, May.

Distribution.—Mexico: Nuevo León (near Monterrey), Veracruz (mpios. of Atzalan and Jalacingo). Rare and disjunct.

Additional specimens examined: **MEXICO. Veracruz:** orilla de arroyo, 800 m, Guatemimolo, mpio. de Atzalan, 13 Apr 1970, *F. Ventura A. 902* (US); orilla de arroyo, 1265 m, Agua Puente, mpio. de Jalacingo, 17 May 1972, *F. Ventura A. 5380* (US).

These collections have terminal or pseudoterminal flowers on rather long pedicels. In April, 1972, I searched unsuccessfully for this species in Diente Canyon, a few miles south of Monterrey. This canyon may have been the type locality. Seepage areas in this canyon are said to be drier than in Pringle's time.

5b. Stenaria umbratilis var. **brevipedicellata** Terrell, var. nov. **(Fig. 7).** TYPE: MEXICO. COAHUILA: steep-sided limestone mountains, calcareous gravel, Cañon de la Gavia south of Rancho de la Gavia, 1250–2200 m, 26° 18' 30"–20' N, 101° 15'–18' W, 2–3 Aug 1973, *M.C. Johnston, T.L. Wendt, F. Chiang, D. Riskind 12032B* (HOLOTYPE: US!; ISOTYPE: LL!).

Pedicelli 1–3 mm longi.

Leaves somewhat leathery, thickish; capsules on pedicels 1–3 mm long.

Distribution.—Mexico: Coahuila.

Additional collections: **MEXICO. Coahuila.** Mina El Aguirreño, N side of Sierra de la Paila, crevice plant, very steep slopes of limestone sierra, calcareous gravel, 1700–2200 m, 26° 05' 30"– 26° 06' N, 101° 36' W, 5 July 1973, *M.C. Johnston, T.L. Wendt, and F. Chiang C. 11681G* (LL); Mpio. Villa Acuña: Rancho El Rincón, on SW margin of Serranias del Burro (part of Sierra del Carmen), 1400–2100 m, 28° 40' N, 102° 15' W, ca. 80 km SE of Big Bend National Park, Texas, 28 May 1993, *Sandra Aguilar Ruiz 320 with Diana L. Doan-Crider* (TEX).

This variety has axillary flowers on short pedicels, compared with the long deflected pedicels of var. *umbratilis*.

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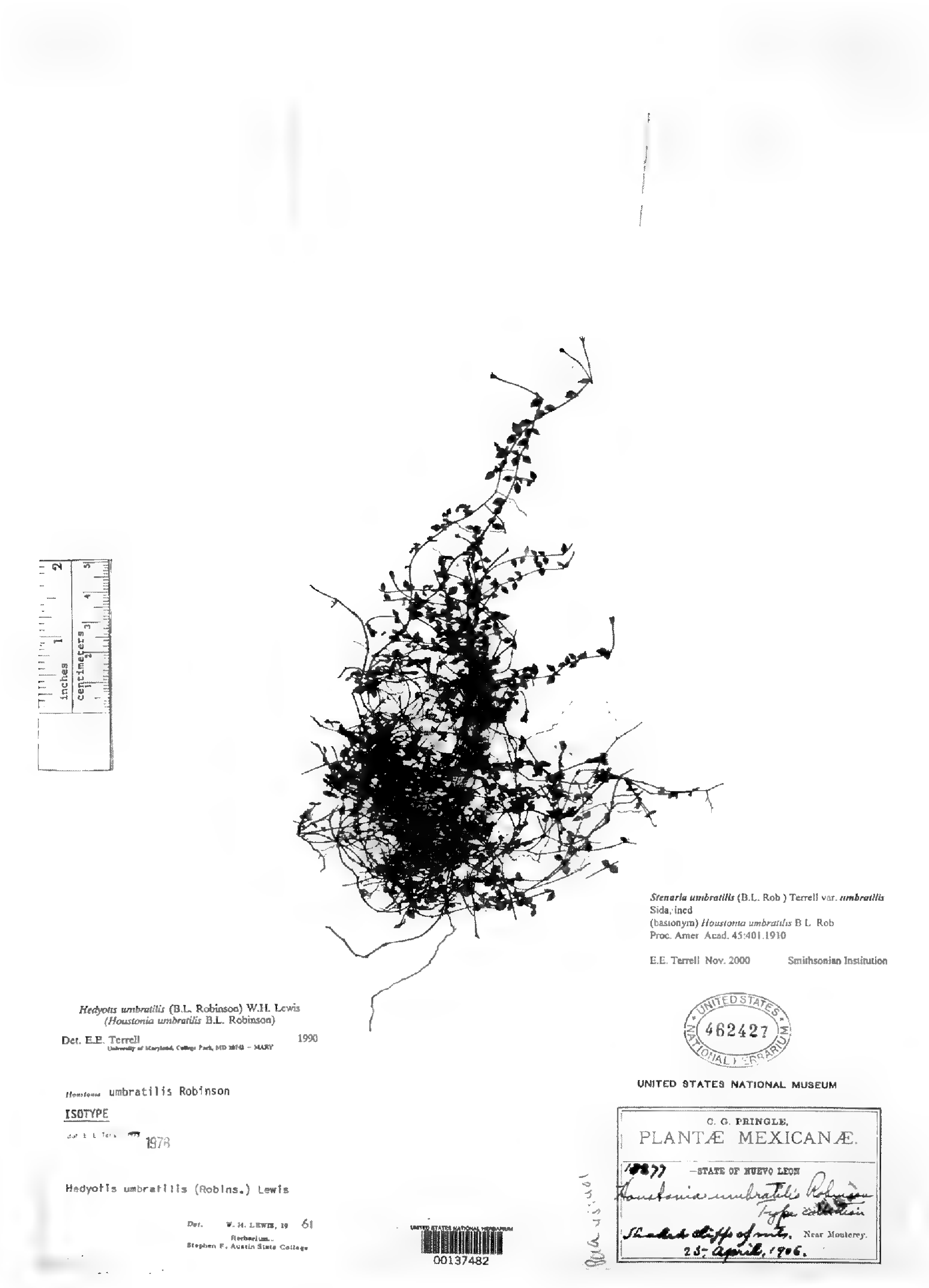
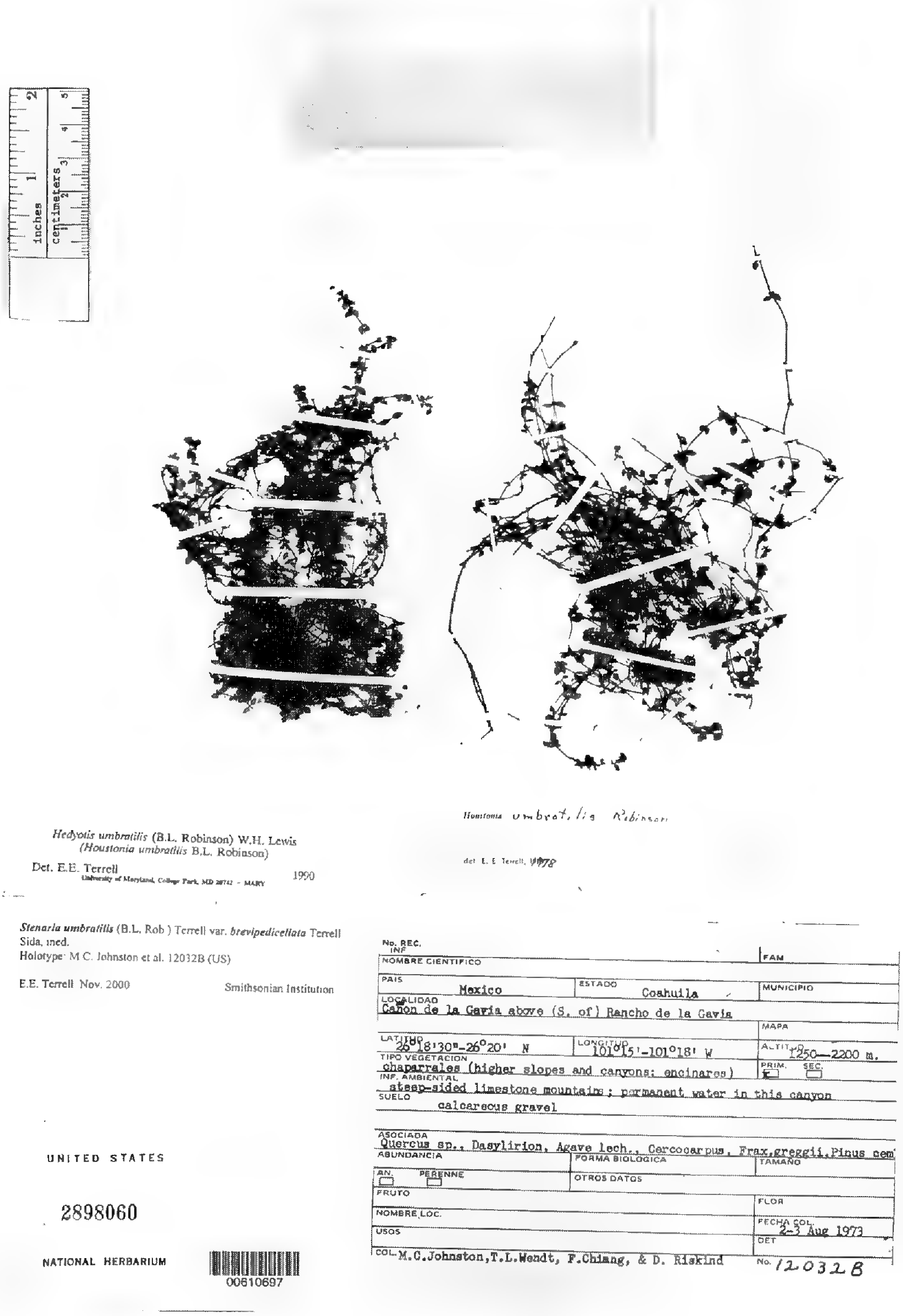


FIG. 6. *Stenaria umbratilis* var. *umbratilis*. Isotype, *C.G. Pringle 13877* (US 462427).



Houstonia umbratilis Robinson

det. E. E. Terrell, 1978

Hedyotis umbratilis (B.L. Robinson) W.H. Lewis
(*Houstonia umbratilis* B.L. Robinson)
Det. E.E. Terrell 1990
University of Maryland, College Park, MD 20742 - MARY

Stenaria umbratilis (B.L. Rob.) Terrell var. *brevipedicellata* Terrell
Sida, ined.
Holotype: M.C. Johnston et al. 12032B (US)

E.E. Terrell Nov. 2000 Smithsonian Institution

No. REC. INF
NOMBRE CIENTIFICO
FAM
PAIS Mexico
ESTADO Coahuila
MUNICIPIO
LOCALIDAD Cañon de la Gavia above (S. of) Rancho de la Gavia
MAPA
LATITUD 26°18'30"-26°20' N
LONGITUD 101°15'-101°18' W
ALTITUD 1250—2200 m.
TIPO VEGETACION chaparrales (higher slopes and canyons: encinares)
PRIM. ☒ SEC. ☐
INF. AMBIENTAL steep-sided limestone mountains; permanent water in this canyon
SUELO calcareous gravel
ASOCIADA Quercus sp., Dasylirion, Agave lech., Cercocarpus, Frax.greggii, Pinus cem
ABUNDANCIA
FORMA BIOLOGICA
TAMAÑO
AN. ☐ PERENNE ☐
OTROS DATOS
FRUTO
FLOR
NOMBRE LOC.
FECHA COL. 2-3 Aug 1973
USOS
DET
COL. M.C.Johnston, T.L.Wendt, F.Chiang, & D. Riskind
No. 12032B

UNITED STATES
2898060
NATIONAL HERBARIUM
00610697

Fig. 7. *Stenaria umbratilis* var. *brevipedicellata*. Holotype, *M.C. Johnston et al. 12032B*.

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NOTES ON VARIATION IN *PSEUDOGNAPHALIUM OBTUSIFOLIUM* (ASTERACEAE: GNAPHALIEAE)

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, TX 76102-4060, U.S.A.

ABSTRACT

Pseudognaphalium (*Gnaphalium*) *obtusifolium* sensu stricto is variable over its geographic range in the glandularity of stems and upper leaf surfaces, but the variation is difficult to characterize geographically. Variety *praecox*, described from localities on the Atlantic and Gulf coastal plains on the basis of early-season flowering and an elongate capitulescence, can only be arbitrarily separated from the species and does not deserve formal recognition. Variety *micradenium*, which has been treated at varietal rank within both *Gnaphalium obtusifolium* and the closely related *Gnaphalium helleri*, is distinct in morphology from both and apparently reproductively isolated. It is given equivalent taxonomic rank as ***Pseudognaphalium micradenium*** (Weatherby) Nesom, comb. et stat. nov.

RESUMEN

Pseudognaphalium (*Gnaphalium*) *obtusifolium* sensu stricto es variable a lo largo de su distribución geográfica en la glandulosidad de sus tallos y haces foliares, pero la variación es difícil de caracterizar geográficamente. La variedad *praecox*, descrita de localidades del Atlántico y llanuras costeras del Golfo en base a su floración temprana y una capitulescencia alargada, sólo puede ser separada de la especie arbitrariamente y no tiene reconocimiento formal. La variedad *micradenium*, que ha sido tratada a nivel varietal tanto en *Gnaphalium obtusifolium* como en *Gnaphalium helleri*, es distinta morfológicamente de ambas y al parecer aislada reproductivamente. Se le da el rango taxonómico equivalente como ***Pseudognaphalium micradenium*** (Weatherby) Nesom, comb. et stat. nov.

Before its transfer to *Pseudognaphalium*, as *P.* (*Gnaphalium*) *obtusifolium* (L.) Hilliard & Burtt, *Gnaphalium obtusifolium* has, at times, been treated with up to five varieties: var. *obtusifolium*, var. *praecox*, var. *helleri*, var. *micradenium*, and var. *saxicola* (e.g., Fernald 1950; Cronquist 1980; Gleason & Cronquist 1991). Aspects of variation affecting the taxonomy of the first four of these are considered in the present paper. The status of the morphologically reduced and apparently narrowly endemic *Gnaphalium saxicola* Fassett is currently under study by D.S. Feller at the University of Wisconsin. The current study is based on examination of more than 750 specimens of *P. obtusifolium* sensu lato from BRIT, GH, NCU, TEX-LL, and US.

1. Variation in vestiture in typical *Pseudognaphalium obtusifolium*

The type, distribution, and density of glandular hairs on the stems and leaves is significant in the identification of many species of *Pseudognaphalium*. Vestiture is variable within *P. obtusifolium* and published descriptions have been inconsistent.

Blake (1918, p. 72) noted that "If the wool of a specimen of [typical] *G. obtusifolium* be removed, stipitate glands precisely similar in shape and position to those of the variety [var. *helleri*] are found." Fernald described the stems and branches as "closely white-lanate" (1936, p. 232) and "covered with a close white felt-like pubescence" (1950, p. 1464) without mentioning glands. Cronquist (1980, p. 177) observed that the stems are "thinly white-woolly, commonly becoming subglabrous (or even a little glandular) near the base;" in the key to species he noted that the stems are "scarcely glandular except sometimes near the base." Observations here are similar to Cronquist's—glands are uncommon under the closely lanate stem vestiture, and when glands do occur, they are near the base of the plant. Minute, sessile cauline glands rarely may be present beneath the cauline tomentum. Plants with glandular stems do not show other features to suggest that presence of cauline glands reflects hybrid influence of other species.

Fernald (1936, p. 232) observed that the leaves of *Gnaphalium obtusifolium* "are commonly, though not always, glandular or glandular-papillate above ..." Cronquist (1980, p. 177) described the leaves as "from glabrous to slightly glandular or slightly woolly above." Observations here confirm the variability of vestiture on upper leaf surfaces. Glandular upper surfaces are found on plants from Illinois, Minnesota, Maryland, Mississippi, Oklahoma, Arkansas, and Texas (and probably other states). The glands have short, filiform stipes more like those of [var.] *micradenium* than [var.] *helleri* (see key below), but the stipes may be so short that the glands are nearly sessile. The persistent, thickened bases of the uniseriate, filiform hairs of the tomentum may be gland-like in appearance but they are different from the biseriate, glandular hairs.

The high ratio of pistillate florets to bisexual florets in *Pseudognaphalium obtusifolium* and the small amount of pollen produced by the bisexual florets suggest that self-pollination may be the prevalent mode of fruit production (e.g., Noyes 2000); if so, formation of local morphological races would be expected. This seems to be the case in central Texas, at the very southwestern corner of the range of the species, where plants from counties on the Edwards Plateau and slightly eastward have stipitate-glandular leaves, while plants elsewhere in the state have leaves eglandular and completely glabrous to sparsely arachnoid on the upper surface. Similarly glandular leaves are produced in other parts of the range, however, and it would be inconsistent to recognize this Texas enclave with formal taxonomy. Texas plants of *P. obtusifolium*, including those with glandular and eglandular leaves, produce the lowest numbers of bisexual flowers per capitula of any sampled over the whole species range.

2. Status of *Gnaphalium obtusifolium* var. *praecox*

Gnaphalium obtusifolium var. *praecox* Fernald (= *Pseudognaphalium obtusifolium* var. *praecox* (Fernald) Kartesz) was described from coastal plain localities in Virginia, South Carolina, Georgia, and Alabama on the basis of early-season flowering and an atypically elongate capitulescence (Fernald 1936). Its presence was later noted in New Jersey (Fernald 1950), Maryland (Brown & Brown 1984), and North Carolina (Kartesz 1999). In other regional treatments, Ahles (1968) treated var. *praecox* as a synonym of typical *Gnaphalium obtusifolium*, while Cronquist (1980) and Gleason and Cronquist (1991) did not even mention it. The taxon as an accepted entity apparently has persisted only in a few floristic accounts, e.g., Massey (1961), Brown and Brown (1984), Kartesz (1999).

Plants of var. *praecox* cited in the protologue by Fernald (1936) flowered 17 July, 23 July, 5 August, and 11 August. Other specimens (GH, US) collected by Fernald in southwestern Virginia and identified by him as var. *praecox* were flowering in August and September. Based on records from more than 600 collections of *P. obtusifolium* at BRIT, GH, NCU, TEX-LL, and US, plants at anthesis in the southeastern United States have been collected primarily from the first week of August through mid-October, with a few early bloomers in the last two weeks of July and a few late bloomers in the first two-thirds of November. Flowering times in Canada and more northern parts of the U.S. apparently begin slightly later and end slightly earlier, as most collections have been made from mid-August through September and early October. These observations extend the beginning of normal flowering of the species in the southeastern U.S., compared to the range of flowering times observed by Fernald in 1936 on the basis of GH collections. While the collections of var. *praecox* cited by Fernald are seasonally early, they are not outside the range of normal flowering for typical plants of the species and it does not seem unusual that on the Atlantic and Gulf coastal plains, with warmer temperatures and generally earlier phenologies, flowering in *P. obtusifolium* should begin earlier than elsewhere in the range.

The capitulescence of *Pseudognaphalium obtusifolium* normally is distinctly corymboid (flat-topped), this configuration usually attained before the capitula reach full anthesis. In plants described by Fernald as var. *praecox*, floriferous branches developing from relatively lower nodes and not elongating to the full capitulescence height produce a capitulescence that is "elongate-cylindric to thyrsoid." In *P. obtusifolium*, a cylindric capitulescence in full anthesis is rare, and most of the plants identified by Fernald as var. *praecox* did not produce the distinctly cylindric capitulescence shown in the type specimens (see protologue photograph). It is not uncommon to encounter a primarily corymboid capitulescence at anthesis with lower branches in various stages of earlier development or with lower branches at anthesis considerably shorter than the upper branches. Nor do such variants appear to be strongly correlated with early flowering.

Fernald (1936, p. 233) noted that "search for technical characters [to distinguish var. *praecox*] in flowers and achenes has failed to reveal them," and this is confirmed here. Plants segregated by Fernald as var. *praecox* tend to flower in the earlier part of the phenological range of the species and their capitulescence differs in a minor and overlapping way from plants of typical *P. obtusifolium*, but no other differences separate these taxa. This evidence indicates that var. *praecox* has no status as an evolutionary entity and its taxonomic recognition is not justified.

3. Status of *Gnaphalium obtusifolium* var. *micradenium*

Var. *micradenium* was originally described at varietal rank by Weatherby (1923) as "apparently the northern and more inland representative of [*Gnaphalium obtusifolium*] var. *helleri* (Britton) Blake, which seems to be confined to the coastal plain." It was accepted at varietal rank by Fernald (1950, as *G. obtusifolium* var. *micradenium*), Mahler (1975, as *G. helleri* var. *micradenium*), and other floristic accounts. Ahles (1968), however, placed var. *micradenium* as a synonym of *G. obtusifolium* (vs. *G. helleri*), while Cronquist (1980) and Gleason and Cronquist (1991, implicitly) treated var. *micradenium* as a synonym of *G. helleri*.

Weatherby's (1923) initial contrast of var. *micradenium* and var. *helleri*, emphasizing glandularity and leaf morphology, remains relatively accurate. Difference in gland morphology and the number of florets per capitulum further sharpen the distinction. Although var. *micradenium* and var. *helleri* have largely allopatric ranges (generally as mapped by Mahler 1975), a region of sympatry exists in Georgia, South Carolina, North Carolina, and southeastern Virginia. Intermediates have not been encountered, suggesting that they are reproductively isolated. The two taxa were intermixed and collected together in Northampton Co., Virginia—var. *micradenium* (*Fernald and Long 5770*, GH), var. *helleri* (*Fernald and Long 5550* and *5551*, GH)—as noted by the label data on the collections. Evidence at hand indicates that each is reasonably treated as a distinct species, as reflected in the new combination and summarized in the morphological contrasts in the key below.

Pseudognaphalium micradenium (Weatherby) Nesom, comb. et stat. nov. *Gnaphalium obtusifolium* var. *micradenium* Weatherby, Rhodora 25:22. 1923. *Gnaphalium helleri* var. *micradenium* (Weatherby) Mahler, Sida 6:32. 1975. *Pseudognaphalium helleri* var. *micradenium* (Weatherby) Kartesz, Synth. N. Amer. Fl. (ed. 1). 1999. TYPE: UNITED STATES. MASSACHUSETTS. Barnstable Co.: dry, sandy openings among scrub oak, Barnstable, 7 Oct 1917, *M.L. Fernald 15870* (HOLOTYPE: GH!).

1. Stems persistently white-tomentose-felted, sometimes lightly so, usually eglandular, uncommonly glandular near the base; pistillate florets 38–96, bisexual florets 4–8 (–11); plants only slightly if at all fragrant. _______________ **Pseudognaphalium obtusifolium**
1. Stems quickly losing most tomentum, greenish, persistently and densely stipitate-glandular; pistillate florets 47–107, bisexual florets 7–20; plants distinctly fragrant.
   2. Stems glandular-puberulent, the stipitate glands 0.1–0.2 mm high, relatively even in height on any portion of the stem, with a filiform stalk of even width and

narrower than the gland width; pistillate florets 47–78, bisexual florets (7–)11–20; leaves linear to linear-lanceolate or linear oblanceolate, 1.5–5.5 cm long, 1.5-10 mm wide, 6–10 times longer than wide. __________ **Pseudognaphalium micradenium**

2. Stems glandular-villous, the stipitate glands (0.1–)0.3–1 mm high, prominently variable in height on any portion of the stem, with a stalk broadened toward the base and ca equal the gland width; pistillate florets 83–107, bisexual florets 9–15; leaves mostly oblong-lanceolate, 2.5–7 cm long, 4–20 mm wide, 4–8 times longer than wide. ______________________________ **Pseudognaphalium helleri**

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BOOK REVIEW

DAPHNE GAIL FAUTIN, DOUGLAS J. FUTUYMA, and FRANCES C. JAMES (eds). 2000. **Annual Review of Ecology and Systematics. Volume 31, 2000**. (ISBN 0-8243-1431-X, hbk; ISSN 0066-4162). Annual Reviews Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, U.S.A. (Orders: www.AnnualReviews.org, 800-523-8635, 650-493-4400, 650-424-0910 fax). $140.00, 630 pp, 6" × 9".

Readers of *Sida* will find many subjects of interest in this Annual Review of the 'mutually supportive' disciplines of Ecology and Systematics. Volume 31 for the year 2000 has 22 articles followed by a Subject Index, Cumulative Index of Contributing Authors, and Cumulative Index of Chapter Titles (Vols. 27–31).

Contents.—Preface: A Millennial View of Ecology and Systematics, and ARES at Age 30

1. General Principles
1. The Kinship Theory of Genomic Imprinting
2. Cenozoic Mammalian Herbivores from the Americas: Reconstructing Ancient Diets and Terrestrial Communities
3. Conservation Issues in New Zealand
4. The Evolution of Predator-Prey Interactions: Theory and Evidence
5. The Ecology and Physiology of Viviparous and Recalcitrant Seeds
6. Inbreeding Depression in Conservation Biology
7. African Cichlid Fishes: Model Systems for Evolutionary Biology
8. Shrub Invasions of North American Semiarid Grasslands
9. The Grasses: A Case Study in Macroevolution
10. The Ecology of Tropical Asian Rivers and Streams in Relation to Biodiversity Conservation
11. Harvester Ants (*Pogonomyrmex* spp.): Their Community and Ecosystem Influences
12. Origins, Evolution, and Diversification of Zooplankton
13. Evolutionary Physiology
14. Mechanisms of Maintenance of Species Diversity
15. Temporal Variation in Fitness Components and Population Dynamics of Large Herbivores
16. Impacts of Airborne Pollutants on Soil Fauna
17. Ecological Resilience – in Theory and Application
18. Quasi-Replication and the Contract of Error: Lessons from Sex Ratios, Heritabilities and Fluctuating Asymmetry
19. Invasion of Coastal Marine Communities in North America: Apparent Patterns, Processes, and Biases
20. Diversification of Rainforest Faunas: An Integrated Molecular Approach
21. The Evolutionary Ecology of Tolerance to Consumer Damage

—*Guy L. Nesom, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

BIOLOGICAL STATUS OF *ARGYTHAMNIA LAEVIS* (EUPHORBIACEAE)

B.L. Turner

Section of Integrative Biology
University of Texas
Austin, TX, 78713, U.S.A.

Argythamnia laevis (A. Gray) Muell., a taxon of Trans-Pecos Texas and closely adjacent southeastern New Mexico, was first described in 1859 as *Aphora laevis* A. Gray ex Torrey. It was distinguished from its closest congener, *Argythamnia humilis* (Engelm. & A. Gray) Muell., by its glabrous condition. Other than its striking glabrosity, including reproductive organs, *A. laevis* is seemingly identical to *A. humilis*. Shinners (1956) reduced *A. laevis* to varietal rank under the latter with the observation: "Rather rare in the Trans-Pecos (specimens seen from Jeff Davis and Reeves counties); var. *humilis* is common and widespread on prairies of central and western Texas." The treatment of Shinners has been followed by most subsequent workers (eg., Johnston & Warnock 1962; Correll & Johnston 1970).

I became interested in the biological status of *A. laevis* (= *Ditaxis laevis* [A. Gray ex Torrey] Heller) in my preparation of a taxonomic account of *Ditaxis* for Trans-Pecos Texas. Johnston and Warnock (1962) provided a systematic account of the varieties concerned. In this they mapped the two as essentially sympatric but not intergrading or co-occurring in a given population, this suggesting either specific status for *A. laevis*, or perhaps mere recognition of the latter as a form. Discovery of the two taxa within a single population should prove helpful in resolving this issue. To this end I began to look intensively at any given population of *A. humilis* in hopes of finding forms referable to *A. laevis*. Among five or more populations from the trans-Pecos and peripheral areas, only two such populations were found, as indicated below and shown in Figure 1.

TEXAS. Andrews Co.: northeast shoreline and along roadside of Shafter Lake, 12 May 2000, *B. L. & Matt Turner 20-263A* (TEX). **Gaines Co.:** 3.8 mi S of Seminole along Farm Rd 181, 12 May 2000, *B. L. & Matt Turner 20-246* (TEX).

In the two mixed populations, pubescent forms (var. *humilis*) were clearly much more common than the glabrous forms (var. *laevis*). Further, I never encountered pure populations of the glabrous form. Because of this I conclude that "var. *laevis*" is but a sporadically occurring form of *A. humilis*, undeserving of varietal rank as this is conceived by Turner and Nesom (2000) and perhaps others. Better proof might be obtained through sowing field-gathered seeds of "var. *laevis*" so as to show that both pubescent and glabrous forms might arise from the seedlings concerned, the glabrous condition apparently due to the expression

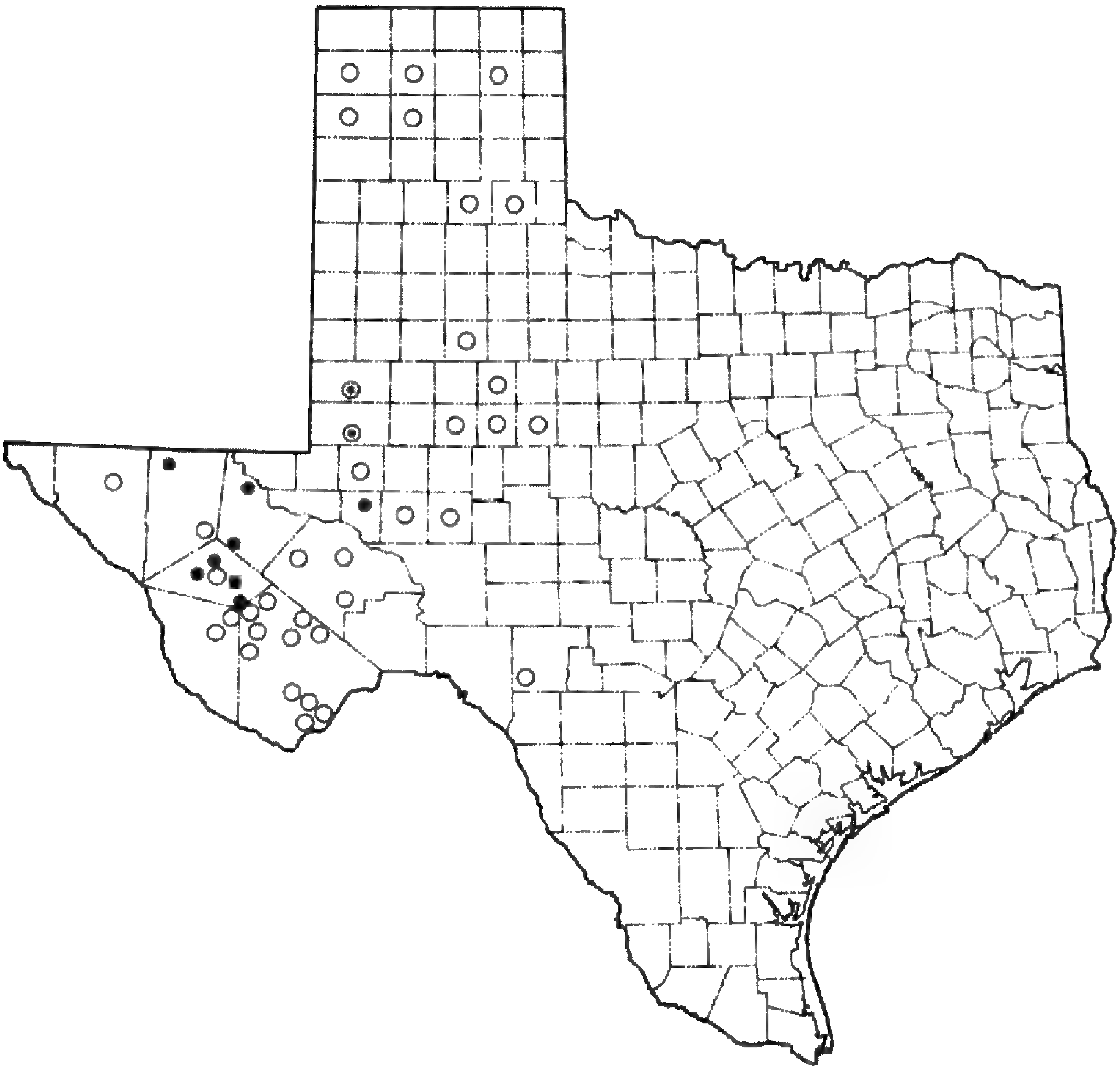

Fig. 1. Distribution of *Ditaxis humilis* in western Texas: Pubescent forms (○), glabrous forms (●), mixed populations (⊙).

of only one or a few genes, but the field observations provided here seemed sufficient to establish that likelihood.

Because of the nomenclatural history and striking appearance of the taxon concerned I deem it appropriate to reduce *Argythamnia laevis* to the category of forma, as follows:

Ditaxis humilis forma **laevis** (A. Gray ex Torrey) B.L. Turner, forma nova. Basionym: *Aphora laevis* A. Gray ex Torrey, Bot. Mexican Bound Surv. 196. 1859.

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VALIDATION OF THE NAME *OROBANCHE LUDOVICIANA* SUBSP. *MULTIFLORA* (OROBANCHACEAE)

Heather L. White and Walter C. Holmes

Department of Biology
Baylor University
Waco, TX 76798-7388, U.S.A.

The combination *Orobanche ludoviciana* Nutt. subsp. *multiflora* Collins first appeared in Collins (1973), a doctoral dissertation, and was never published. Nonetheless, the name has gained some measure of acceptance by botanists nationally (Kartesz & Meacham 1999) and in Texas (Jones et al. 1997; Diggs et al. 1999). Thus, because the combination has not been validly published, the following is proposed.

Orobanche ludoviciana Nutt. subsp. **multiflora** (Nutt.) Collins ex H.L. White & W.C. Holmes, stat. nov. BASIONYM: *Orobanche multiflora* Nutt., Proc. Acad. Philadelphia 4:22. 1848. *Orobanche ludoviciana* Nutt. var. *multiflora* (Nutt.) Beck, Bibl. Bot. 4, 19:81. 1890. *Myzorrhiza multiflora* (Nutt.) Rydb., Bull. Torrey Bot. Club. 33:151. 1906. TYPE: U.S.A. NEW MEXICO. Sandy ground along the Río Grande, 1845, *Gambel s.n.* (Not located at BM, GH, or PH). Since no duplicates of the type have been located, we select a neotype herewith. TYPE: U.S.A. TEXAS. Jim Wells Co.: 20.5 mi S of George West, off U.S. [Hwy] 281, near county boundary line, 19 Apr 1944, *Lundell & Lundell 12809* (NEOTYPE, here designated: LL).

Phelypaea erianthera Engelm. in A. Gray, Proc. Amer. Acad. Arts 7:372. 1867, as "*Phelipaea*." TYPE: COLORADO: Huerfano Valley, *Parry 147* (GH, MO).

Orobanche multiflora Nutt. var. *arenosa* (Suksdf.) Munz, Bull Torrey Bot. Club 57:623. 1931. TYPE: WASHINGTON. Klickitat Co.: Bingin, *Suksdorf 2781* (C, G).

Orobanche multiflora Nutt. var. *pringlei* Munz, Bull. Torrey Bot. Club 57:623. 1931. TYPE: MEXICO. CHIHUAHUA: Chichuahua, 3 Jun 1885, *Pringle 31* (G).

The description of *Orobanche multiflora* was published twice, originally in the Proceedings of the Academy of Natural Sciences of Philadelphia and later in the Journal of the Academy of Natural Sciences of Philadelphia, ser. 2, 1:179. 1848. Reveal and Spevak (1976) give the date of publication of the Proceedings as between 21 March and 4 April, 1848, while publication date of the Journal is given as between 1 August and 8 August 1848. *Orobanche multiflora* is best recognized as a subspecies of *O. ludoviciana* because of the excessive intergradation of the two taxa. The following brief discussion is largely taken from Collins (1973), which we have confirmed by examination of herbarium specimens from NY and TEX. They are distinguishable as subspecies except in the area of sympatry in Texas and Oklahoma where the two subspecies appear to interbreed. Corollas of subsp. *multiflora* are mostly 20–30 mm long, while those of subsp. *ludoviciana* vary from 15–20 mm long. The corolla lobes of subsp. *mul-*

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tiflora tend to be broader and either obtuse or acute. Those of subsp. *ludoviciana* are narrower and either obtuse or acute. The anthers of subsp. *multiflora* are woolly and usually inserted and the style is persistent on the capsule while anthers of subsp. *ludoviciana* are glabrous and frequently exserted and the style is not persistent on the capsule. Hosts for the two subspecies are also variable; subsp. *multiflora* parasitizes local Compositae except for *Artemisia*, whereas subsp. *ludoviciana* parasitizes principally *Artemisia* and *Grindelia*.

We wish to thank the curator and staff at TEX for the loan of *Orobanche* specimens. The hospitality and information provided by NY during a visit by the senior author is much appreciated. John Pruski of US provided literature and also reviewed a preliminary version of the manuscript, while Dan Nicolson, also of US, gave advice on the citation of synonymy. Robert Baldridge of the Department of Biology, Baylor University, also reviewed and commented on portions of the manuscript.

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AN ANOMALOUS POPULATION OF *ASTER* (ASTERACEAE: ASTEREAE) SENSU LATO IN MICHIGAN

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, TX 76102-4060, U.S.A.

ABSTRACT

Plants from a single population on the Keweenaw Peninsula in Houghton County, Michigan, have been reported as hybrids between *Doellingeria* (*Aster*) *umbellata* and *Oclemena* (*Aster*) *nemoralis*, but the few features of putative intermediacy between these two species are equivocal. In contrast, morphological features of their roots, leaves, capitulescence, florets, and cypselae are consistent with those of *Oclemena*—in the interpretation here, morphological evidence for the genomic contribution of *Doellingeria* is very limited, and the Keweenaw plants more likely arose from within *Oclemena*. They are suggested to represent either an atypical form of *O.* ×*blakei* (a recurring and persistent hybrid between *O. nemoralis* and *O.* (*Aster*) *acuminata*) or a relict population differentiated earlier in the evolutionary history of the genus and appropriately recognized as a separate species. Current evidence is insufficient to convincingly support a single hypothesis of origin.

RESUMEN

Plantas de una sola población en la Península de Keweenaw en el Condado de Houghton, Michigan, se han citado co híbridos entre *Doellingeria* (*Aster*) *umbellata* y *Oclemena* (*Aster*) *nemoralis*, pero las pocas características presumiblemente intermedias entre estas dos especies son equívocas. En contraste, las características morfológicas de sus raíces, hojas, capitulescencia, flósculos y cipselas coinciden con los de *Oclemena*—en la interpretación que hacemos aquí, las evidencias morfológicas de una contribución de *Doellingeria* es muy limitada, y las plantas de Keweenaw probablemente surgieron de *Oclemena*. Se sugiere que representan ya sea una forma atípica de *O.* ×*blakei* (un híbrido recurrente y persistente entre *O. nemoralis* y *O.* (*Aster*) *acuminata*) o una población relicta diferenciada tempranamente en la historia evolutiva del género y reconocida apropiadamente como una especie independiente. Las evidencias actuales son insuficientes para apoyar una hipótesis única de su origen.

The recent report (Gerdes 1998) of a population of hybrids between *Doellingeria* (*Aster*) *umbellata* (P. Mill.) Nees and *Oclemena* (*Aster*) *nemoralis* (Ait.) Greene from the Keweenaw Peninsula of Lake Superior in northwestern Michigan is remarkable. Such an intergeneric hybrid would provide corroborative evidence that these two genera (*Doellingeria* Nees and *Oclemena* Greene) segregated from *Aster* are closely related. Naturally occurring intergeneric hybrids in the Astereae have previously been reported only between closely related genera—in some cases these hybrids may be better interpreted as between congeneric species (Nesom 1994b).

A hypothesis of close relationship between *Doellingeria* and *Oclemena* (Nesom 1994a) is based on morphological similarities. In contrast, molecular evidence (Semple et al. 1996; Xiang & Semple 1996) suggests that *Oclemena* may

SIDA 19(3): 625 – 632. 2001

be closely related to *Ionactis* Greene. A hypothesis of close relationship between *Doellingeria* and *Oclemena* also is suggested in the disparity of interpretation regarding the position of *Aster reticulatus* Ell., a southeastern USA endemic placed by Semple et al. (1991, 1996) in *Doellingeria* but by Nesom (1993, 1994a, 2000) in *Oclemena*. Hybridization between species of *Doellingeria* and *Oclemena* has not been previously reported, although *D. umbellata* and *O. nemoralis* are sympatric over most of the range of the latter and both species occur in wetland habitats.

Gerdes noted that the putatively hybrid population was distinctive in the field and appeared to be intermediate between nearby populations of *Doellingeria umbellata* and *Oclemena nemoralis*. While the putative hybrids clearly do not fit the typical morphology of either species, the only indication of intermediacy in the published observations is in the statement (p. 18) that the "overall height and leaf size and shape are intermediate between the assumed parents." In the illustration and description, and in the voucher specimens, other possible indications of intermediacy between *D. umbellata* and *O. nemoralis* are equivocal.

Plants studied

The population described by Gerdes (*Gerdes 2210*) includes about 20 plants in a tamarack swamp situated between populations of *Doellingeria umbellata* ("common 60 m north of the hybrid site in a mixed wetland complex"—*Gerdes 2211*) and *Oclemena nemoralis* (ca. "60 m southeast of the hybrid site in a swale"—*Gerdes 2209*). Two plants of the putative hybrids and one plant each of *D. umbellata* and *O. nemoralis* from the Houghton County site were available for study (MICH), as well as many other specimens from taxa of *Oclemena* and *Doellingeria* (BRIT, GH, NCU). The two plants of *2210* are virtually identical in micromorphological detail, perhaps representing a single clone, and Gerdes did not note the occurrence of significant variation among the putative hybrids. The plant of *O. nemoralis* is morphologically typical of the species—this collection represents the westernmost known population of the species (see Voss 1996; Gerdes 1998). The collection of *D. umbellata* may be arbitrarily identified as var. *umbellata*; hairier plants of the species (*D. umbellata* var. *pubens* (A. Gray) Britt.) also occur on the Keweenaw Peninsula (as mapped by Semple et al. 1991).

Houghton County specimens examined:

1) Doellingeria umbellata (P. Mill.) Nees—MICHIGAN. Houghton Co.: Grand Traverse Bay ridge and swale complex, ca. 7 mi ESE of Lake Linden, travel E of Rice Lake ca. 0.6 mi and walk N of gravel road into swale, edge of sandy road and *Sphagnum*/ericaceous swale; *Aster nemoralis* also in swale; rays creamy white; 18 Sep 1997, *L.B. Gerdes 2211* (MICH).

2) *Oclemena nemoralis* (Ait.) Greene—MICHIGAN. Houghton Co.: Grand Traverse Bay ridge and swale complex, ca. 7 mi ESE of Lake Linden, and E of Rice Lake. Swale, primarily a *Sphagnum*/ericaceous bog (poor fen); plants scattered and numerous with *Carex michauxiana*, *Carex oligosperma*, *Andromeda glaucophylla*, etc.; rays dark pink; 18 Sep 1997, *L.B. Gerdes 2209* (MICH).

3) The putative hybrid—MICHIGAN. Houghton Co.: Grand Traverse Bay ridge and swale complex, ca. 7 mi ESE of Lake Linden and E of Rice Lake. Tamarack swamp adjacent to a *Sphagnum*/ericaceous swale; ca. 20 plants with *Aronia prunifolia*, *Chamaedaphne calyculata*, *Alnus rugosa*, *Calamagrostis canadensis*, and *Carex oligosperma*, *Aster nemoralis* and *Aster umbellatus* nearby; rays light pink; 18 Sep 1997, *L.B. Gerdes 2210* (MICH—2 sheets).

Evidence for the *Doellingeria* genome

Consideration of the illustration and published description of *Gerdes 2210* and examination of the voucher specimens indicate that features of putative intermediacy between *Oclemena nemoralis* and *Doellingeria umbellata* are relatively few.

Height.—Plants of *2210* are 6–7 dm tall, generally between the range of height for *O. nemoralis* (2–7 dm) and *D. umbellata* (3–20 dm) but also at the top of the range for *O. nemoralis* as well as *O. acuminata*.

Leaves.—Leaves of *2210* are narrowly elliptic, 4.5–5.5 cm long and 7–10 mm wide, with entire, barely revolute margins. Leaves of *D. umbellata* are elliptic to narrowly elliptic, mostly 6–12 cm long, 10–25 mm wide, and flat-margined; those of *O. nemoralis* are very narrowly oblong to linear-lanceolate, mostly 2–5 cm long, 2–12 mm wide, with entire, strongly revolute margins. Leaves of *2210* are intermediate in size between *D. umbellata* and *O. nemoralis* but they are more similar in shape to those of *D. umbellata*. The abaxial surfaces of *2210* are minutely sessile-glandular and could be regarded as intermediate between the glandular (larger glands) surfaces of *O. nemoralis* and eglandular surfaces of *D. umbellata*; the glandularity of *2210*, however, also appears to be indistinguishable from that of plants hybrid between *O. nemoralis* and *O. acuminata* (see below).

Ray florets.—Rays of *2210* are pink, intermediate between the purple of *O. nemoralis* and white of *D. umbellata*; pink rays also are characteristic of hybrids between *O. nemoralis* (purple-rayed) and *O. acuminata* (white-rayed). The length of the rays intermediate between *O. nemoralis* and *D. umbellata* but within the range of variation for *O. nemoralis*.

Cypselar vestiture.—Cypselae of *2210* are densely strigose-hispid, more similar to the sparsely to densely strigose cypselae of *D. umbellata* than the typically glabrous ones of *O. nemoralis* (thus this aspect of vestiture is technically not intermediate). Otherwise, the densely sessile-glandular cypselar surfaces of *2210* are similar to those of *O. nemoralis* but not to the eglandular surfaces of *D. umbellata.*

Morphological evidence that *Doellingeria umbellata* is represented in the genome of the plants of *Gerdes 2210* is limited, represented by the features of equivocal interpretation noted above. In contrast, various features of the roots, leaves, capitulescence, florets, and fruits refer *Gerdes 2210* to *Oclemena*. The comparisons in Table 1 summarize morphological distinctions between *Oclemena nemoralis* and *Doellingeria umbellata*—these also are essentially the contrasts that distinguish the two genera (see Nesom 1994a). In each contrast, the morphology of *2210* is similar to that of *Oclemena.*

If the assessment here of *Gerdes 2210* is correct in excluding *Doellingeria* from its close ancestry, two alternative hypotheses would place the evolutionary origin of this anomalous population from within *Oclemena*. First, it may represent a hybrid between *O. nemoralis* and *O. acuminata* (Ait.) Greene, or second, it may represent a lineage of *Oclemena* differentiated early in the evolutionary history of the genus and now persisting only as a relict at the Houghton County site.

Identification as *Oclemena* ×*blakei*

The plants of *Gerdes 2210* are nearly identical in overall aspect to some individuals of *Oclemena* ×*blakei* (Porter) Nesom, a fertile, recurrent, and persistent hybrid between *O. nemoralis* and *O. acuminata*—compare Fig. 1 of Gerdes (1998) to Figs. 3 and 11 of Pike (1970). Populations of *O.* ×*blakei* are scattered through the area of sympatry of the parents where ecological conditions allow their close contact (Brouillet & Simon 1981). "Extensive colonies of [O.] ×*blakei* are often found at the edges of bogs, the shores of ponds, and swampy borders of woods, etc., the kinds of areas that are intermediate in wetness between the boreal forest habitat of [O.] *acuminata* and the open bogs of [O.] *nemoralis*" (Pike 1970, p. 401).

If the plants of *Gerdes 2210* are scored on the morphological hybrid index developed by Pike (1970; also see Hill & Rogers 1973; Brouillet & Simon 1981), the value is 9 (Table 2), which is within the range characteristic of *O.* ×*blakei*, intermediate between *O. nemoralis* and *O. acuminata*. *Oclemena* ×*blakei* is known to produce fertile seeds (Hill & Rogers 1973), but it was not possible to make unequivocal observations of fertility for *Gerdes 2210*. Pollen grains on the stigmatic surfaces were regular in size, but the anthers had opened before the collection and an estimate of pollen fertility could not certainly exclude pollen from other species. None of the cypselae of *Gerdes 2210* were completely mature when collected; dissected cypselae examined from each plant had produced an elongated but otherwise undeveloped embryo. *Oclemena* ×*blakei* and its parental species are known to have a chromosome number of $2n = 18$ (Hill & Rogers 1970). Scoring of *2210* on this hybrid index does not indicate that it

Table 1. Morphological contrasts between *Oclemena nemoralis* and *Doellingeria umbellata* and the plants of *Gerdes 2210*.

	Oclemena nemoralis	**Gerdes 2210**	**Doellingeria umbellate**
Root System	slender, elongate rhizomes, without a cluster of thick, fibrous roots	slender, elongate rhizomes, without a cluster of thick, fibrous roots	dense cluster of thick fibrous roots at the sub-caudex or crown, also with eleongate-rhizomes
Leaves	glandular abaxially	glandular abaxially	eglandular
Peduncles	long, flexuous	long, flexuous	short, stiff
Ray Corollas	pink to purple, 11–18 mm long, strongly coiling	pink to purple, 10–12 mm long, strongly coiling	white, 5–9 mm long, not coiling
Disc Corollas	narrowly tubular-funnelform, slightly widened above the tube; lobes cut ca. 1/3 of limb, erect to spreading	narrowly tubular funnelform, slightly widened above the tube; lobes cut ca. 1/3 of limb, erect to spreading	broadly funnelform, abruptly widening above the tube; lobes cut nearly to base of limb, reflexing-coiling
Cypselae	sessile-glandular, otherwise glabrous, fusiform to narrowly columnar, ca. 1/2–2/3 the phyllary length at maturity	sessile-glandular, strigose-hispid, fusiform to narrowly columnar, ca. 1/2–2/3 the phyllary length at maturity	eglandular, strigose, obovoid, nearly equal the phyllary length at maturity
Pappus	inner and outer series of +- even length	inner and outer series of +- even length	outer series of short (<1 mm) setae

Table 2. Morphological hybrid index for *Gerdes 2210*

Character	**State**	**Value**
No. of leaves	35–100	0
Internode length (mm)	9–11	1
Ratio leaf length/width	5–4	2
Leaf margin—revoluteness	+-flat	2
Leaf margin—scabrosity	intermdt	1
Leaf margin—toothing	entire	0
No. of bracts per peduncle	2–4	1
No. of heads per capitulescence	2+	1
Ray color	pink	0
Zebra hairs on stem	occur	1

Hybrid index value = 9

actually is a hybrid between *O. nemoralis* and *O. acuminata* but does show that its features can be interpreted as intermediate in the same way as those of known hybrids can be.

Two conditions complicate the identification of *Gerdes 2210* as *Oclemena ×blakei*: **(1)** *O. ×blakei* previously has been found only within the area of sympatry of the parents, and one of the parental species, *O. acuminata*, does not occur in the Keweenaw region; and **(2)** plants of *Gerdes 2210* have entire leaves and hispid cypselae, features not generally characteristic of *O. ×blakei*.

(1) *Oclemena ×blakei* has been known to occur only much further east—the closest known locality to the Keweenaw site is in southeastern Ontario, about 850 kilometers eastward (maps in Brouillet & Simon 1981, Semple et al. 1966). The closest known locality for *O. acuminata* is the same region of Ontario. *Oclemena nemoralis* grows immediately adjacent to the *2210* population, but it is unlikely that *O. acuminata* has occurred naturally in Michigan since post-glaciation revegetation (Brouillet & Simon 1981). Long-distance dispersal would the most likely explanation for the far-disjunct occurrence of *O. ×blakei* on the Keweenaw Peninsula—at least it is a simpler hypothesis than a postulate of the former occurrence and extirpation of *O. acuminata* far west of its present geographic range. "Long-distance dispersal and chance establishment in suitable bogs ... are probably responsible for [the] establishment [of *O. nemoralis*] in the eastern Lake Superior area ... and the species could still be expanding its range westward ..." (Brouillet & Simon 1981, pp. 539–540). The discovery of *O. ×blakei* at the westernmost locality of *O. nemoralis* might also suggest that the former is similarly expanding its range.

In the region of parental sympatry, *O. ×blakei* often occurs with only one of the parents or even with neither of the parents in close proximity (Pike 1970), apparently persisting through its rhizomatous habit and ranging more widely through fertile cypselae. When found with only one of its putative parents, *O. ×blakei* is more often associated with *O. nemoralis* (Pike 1970; Brouillet & Simon 1981), perhaps because of their greater similarity in habitat.

(2) The parentage of *O. acuminata* in the hybrid *O. ×blakei* is usually reflected by at least some degree of foliar toothing. Entire leaves occur rarely in *O. ×blakei*, but F1 individuals may sometimes be closer in morphology to the entire-leaved *O. nemoralis* than to the toothed-leaved *O. acuminata* (Pike 1970; Hill & Rogers 1973). Evidence for introgression between *O. ×blakei* and its parents was observed in nature by Pike (1970) and experimentally duplicated by Hill and Rogers (1973), but the overall morphology of *Gerdes 2210* is more similar to an F1, except for the entire leaves. Leaves of *2210* are elliptic—those of *O. ×blakei* vary in shape from oblanceolate (broadest above the middle) to elliptic.

The cypselae of *Gerdes 2210* bear a mixture of sessile glands and numerous, slender, spreading-ascending, sharp-pointed hairs and are closely similar in vestiture to those of *Oclemena reticulata* (Ell.) Nesom, a species of the coastal plain of Alabama, Florida, Georgia, and South Carolina, far-removed in geography and habitat from the other species of the genus. This cypselar vestiture is unlike that of *O.* ×*blakei* from elsewhere in its range or that of its parental species, which is glandular but usually otherwise glabrous; cypselae of *O. acuminata* rarely may be sparsely strigose (e.g., Pendleton Co., W. Va., *Musselman 3894*—NCU), and Semple et al. (1996) describe the cypselae of *O. nemoralis* as "sparsely strigose." The differences in non-glandular cypselar vestiture and the leaf margins are morphological differences separating *Gerdes 2210* from *O.* ×*blakei*, but the close correspondence in other morphological features suggests that an identification as *O.* ×*blakei* is a reasonable hypothesis for the Keweenaw Peninsula plants.

Identification as a separate species

In view of tentative evidence against a hypothesis of hybridity between *Oclemena nemoralis* and *O. acuminata* (considering the anomalous achene vestiture, unusual leaf morphology, and the unlikelihood of the establishment of *2210* through long-distance dispersal) for the origin of *2210*, a hypothesis that this population represents an independent evolutionary branch of *Oclemena* becomes plausible. If this were the true origin, recognition of *2210* at specific rank would be appropriate. Current evidence, however, does not convincingly support or eliminate either of the proposed hypotheses alternative to the originally proposed intergeneric hybridization. All three competing hypotheses will be further investigated after an upcoming field season, when it will be possible to make observations on pollen and fruit fertility and collect fresh material for molecular analysis.

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BIBLIOGRAPHICAL NOTES ON THE PUBLICATION OF WOOLWARD'S MONOGRAPH ON THE GENUS *MASDEVALLIA* (ORCHIDACEAE)

Guido J. Braem

Schlechter Institute
Naunheimer Str. 17
D-35633 Lahnau, GERMANY
and
Research Associate
California Academy of Sciences

ABSTRACT

The history of publication of Florence H. Woolward's monograph on the genus *Masdevallia* is discussed. Publication dates are given for all parts of the work.

KEYWORDS: *Orchidaceae, Masdevallia,* History of Botany, Botanical Art, Woolward

RESUMEN

Se discute la historia de la publicación de la monografía de Florence H. Woolward del género *Masdevallia*. Se dan fechas de publicación de todas las partes del trabajo.

Miss Florence Helen Woolward (1854–1930) was employed or commissioned by the Marquess of Lothian to work and paint in his collection at Newbattle Abbey. Contrary to general belief, Miss Woolward was trained neither in Botany nor as an artist, as can be deduced from her own words in the introductory chapter to the book "... although being neither a trained artist nor botanist". It stands, however, without doubt, that Florence Woolward was one of the best botanical artists known. The original drawings for the *Masdevallia* monograph are kept at the Natural History Museum in London.

In *The Gardeners´ Chronicle* for October 25, 1890, the following announcement was published:

> "The Genus *Masdevallia.*—The first part of the Marquess of Lothian´s *Monograph* of species growing in his collection at Newbattle, is announced as nearly ready. The work will contain hand-coloured lithographs and engravings of every available species. The descriptions and plates are by Miss Woolward, with notes by Consul Lehmann. The work will be issued in parts of imperial quarto size, at the price of £ 1 10s. each part, the issue being limited to 250."

ON THE DATES OF PUBLICATION OF THE GENUS *MASDEVALLIA*

As so often, the correct dates of publication cannot be obtained from the primary source, as the original wrappers merely state the year of publication. Experience has shown that such indications are not necessarily correct. Therefore, secondary literature must be consulted. Unfortunately, not all authors bother to investigate the bibliography in detail, and very often the entire *Masdevallia* work of Woolward is erroneously considered to have been published in 1896.

Study of the secondary literature, however, reveals that the Woolward monograph was obviously issued in 9 parts. Parts one (1) through eight (8) consisted of 10 plates each, accompanied by the pertinent texts. With part five (5), a preliminary index was published (Rendle 1894). Obviously this preliminary index would have been discarded at the time the work was completed and bound into its final form. Part nine (9) consisted of seven plates, their text, and some additional texts such as he title page, the index, and the "List of species now excluded from the genus *Masdevallia*."

Stafleu and Cowan (1988) based their publication dates on the notices of reception published in the *Journal of Botany* (*J. Bot.*) There seem, however, to be discrepancies between those data and the information found in *The Gardeners´ Chronicle*, probably resulting from the fact that *The Gardeners´ Chronicle* was published on a weekly basis and is therefore obviously more exact. Both the Woolward monograph and *The Gardeners' Chronicle* were published in London, and it may be assumed that each installment of the Woolward monograph reached the *Chronicle* without delay.

Based on the data retrieved from notes of reception and from reviews in *The Gardeners' Chronicle*, the following dates of publication have been determined (Table 1, 2). The full citation as taken from an original copy is:

The genus Masdevallia. Issued by the Marques of Lothian, K.T., chiefly from plants in his collection at Newbattle Abbey; plates and descriptions by Miss Florence H. Woolward; with additional notes by F.C. Lehmann (German Consul in the Republic of Colombia)- With 87 plates, and 61 woodcuts from photographs. Index and Map.

The book is generally referred to as "Woolward, The genus *Masdevallia*."

TABLE 1. Probable publication dates for Woolward, The genus *Masdevallia*.

Part	Publication dates	Data from *The Gardeners' Chronicle*	Notices in *Journal of Botany*
1	1890 (December)	Note of reception: 27 December 1890 Review: 10 January 1891	Note: 30 January 1891 Review: March 1891
2	1891 (August)	Note of reception: 29 August 1891	September 1891
3	1892 (August)	Note of reception: 3 September 1892 Review: 10 September 1892	November 1892
4	1893 (July)	5 August 1893. Reference in note on *Masdevallia fragrans* and *Masdevallia aristata* – "The recently issued part IV ..."	August 1893
5	1894 (February)	Review: 24 February 1894	No. 32, 1894
6	1895 (February)	Review: 2 March 1895	?
7	1895 (October)	Review: 9 November 1895	October 1895
8	1896 (October)	Review: 24 October 1896 "We heartily congratulate Miss Woolward on the completion of her work ..."	October 1896
9	1896 (October)	Review: 24 October 1896 (see above)	October 1896

TABLE 2. Publication dates of plates arranged alphabetically according to plant names.

	Plant Name	Part	Publication date
01.	*Masdevallia abbreviata* Reichenbach fil.	4	July 1893
02.	*Masdevallia amabilis* Reichenbach fil.	1	December 1890
03.	*Masdevallia aristata* Rodrigues	4	July 1893
04.	*Masdevallia arminii* Reichenbach fil.	3	August 1892
05.	*Masdevallia attenuata* Reichenbach fil.	9	October 1896
06.	*Masdevallia auropurpurea* Reichenbach fil.	8	October 1896
07.	*Masdevallia barlaeana* Reichenbach fil.	8	October 1896
08.	*Masdevallia bella* Reichenbach fil.	1	December 1890
09.	*Masdevallia caloptera* Reichenbach fil.	7	October 1895
10.	*Masdevallia calura* Reichenbach fil.	8	October 1896
11.	*Masdevallia campyloglossa* Reichenbach fil.	8	October 1896
12.	*Masdevallia carderi* Reichenbach fil.	3	August 1892
13.	*Masdevallia caudata* Lindley	3	August 1892
14.	*Masdevallia chestertoni* Reichenbach fil.	1	December 1890
15.	*Masdevallia chimaera* Reichenbach fil.	5	February 1894
16.	*Masdevallia chimaera* var. *backhousiana* Veitch	5	February 1894
17.	*Masdevallia chimaera* var. *roezlii* Veitch	5	February 1894
18.	*Masdevallia civilis* Reichenbach fil.	2	August 1891
19.	*Masdevallia coccinea* Linden	3	August 1892
20.	*Masdevallia coriacea* Lindley	3	August 1892
21.	*Masdevallia corniculata* Reichenbach fil.	2	August 1891
22.	*Masdevallia cucullata* Lindley	2	August 1891
23.	*Masdevallia cupularis* Reichenbach fil.	8	October 1896
24.	*Masdevallia curtipes* Rodrigues	5	February 1894
25.	*Masdevallia davisii* Reichenbach fil.	3	August 1892
26.	*Masdevallia demissa* Reichenbach fil.	5	February 1894
27.	*Masdevallia elephanticeps* Reichenbach fil.	6	February 1895
28.	*Masdevallia ephippium* Reichenbach fil.	1	December 1890
29.	*Masdevallia erythrochaete* Reichenbach fil.	8	October 1896
30.	*Masdevallia estradae* Reichenbach fil.	3	August 1892
31.	*Masdevallia floribunda* Lindley	4	July 1893
32.	*Masdevallia fractiflexa* Woolward	6	February 1895
33.	*Masdevallia fragrans* Woolward	4	July 1893
34.	*Masdevallia fulvescens* Rolfe	9	October 1896
35.	*Masdevallia gemmata* Reichenbach fil.	7	October 1895
36.	*Masdevallia guttulata* Reichenbach fil.	4	July 1893
37.	*Masdevallia hieroglyphica* Reichenbach fil.	6	February 1895
38.	*Masdevallia houtteana* Reichenbach fil.	5	February 1894
39.	*Masdevallia infracta* Lindley	2	August 1891
40.	*Masdevallia ionocharis* Reichenbach fil.	4	July 1893
41.	*Masdevallia laucheana* Kraenzlin ex Woolward	8	October 1896
42.	*Masdevallia leontoglossa* Reichenbach fil.	2	August 1891
43.	*Masdevallia macrura* Reichenbach fil.	1	December 1890
44.	*Masdevallia maculata* Klotzsch	2	August 1891
45.	*Masdevallia marginella* Reichenbach fil.	9	October 1896
46.	*Masdevallia melanopus* Reichenbach fil.	4	July 1893

	Plant Name	Part	Publication date
47.	*Masdevallia militaris* Reichenbach fil.	4	July 1893
48.	*Masdevallia mooreana* Reichenbach fil.	6	February 1895
49.	*Masdevallia muscosa* Reichenbach fil.	6	February 1895
50.	*Masdevallia nidifica* Reichenbach fil.	5	February 1894
51.	*Masdevallia nycterina* Reichenbach fil.	9	October 1896
52.	*Masdevallia o´brieniana* Rolfe	7	October 1895
53.	*Masdevallia ophioglossa* Reichenbach fil.	6	February 1895
54.	*Masdevallia ortgiesiana* Hort. ex Woolward	8	October 1896
55.	*Masdevallia pachyantha* Reichenbach fil.	6	February 1895
56.	*Masdevallia pachyura* Reichenbach fil.	7	October 1895
57.	*Masdevallia peristeria* Reichenbach fil.	1	December 1890
58.	*Masdevallia picturata* Reichenbach fil.	2	August 1891
59.	*Masdevallia platyglossa* Reichenbach fil.	8	October 1896
60.	*Masdevallia polysticta* Reichenbach fil.	3	August 1892
61.	*Masdevallia porcelliceps* Reichenbach fil.	7	October 1895
62.	*Masdevallia pusilla* Rolfe	9	October 1896
63.	*Masdevallia racemosa* Lindley	4	July 1893
64.	*Masdevallia radiosa* Reichenbach fil.	7	October 1895
65.	*Masdevallia reichenbachiana* Endres	2	August 1891
66.	*Masdevallia rolfeana* Kraenzlin	5	February 1894
67.	*Masdevallia rosea* Lindley	1	December 1890
68.	*Masdevallia schlimii* Linden	2	August 1891
69	*Masdevallia schroederiana* Woolward	9	October 1896
70.	*Masdevallia simula* Reichenbach fil.	1	December 1890
71.	*Masdevallia striatella* Reichenbach fil.	6	February 1895
72.	*Masdevallia torta* Reichenbach fil.	1	December 1890
73.	*Masdevallia tovarensis* Reichenbach fil.	2	August 1891
74.	*Masdevallia triangularis* Lindley	3	August 1892
75.	*Masdevallia triaristella* Reichenbach fil.	7	October 1895
76.	*Masdevallia triglochin* Reichenbach fil.	9	October 1896
77.	*Masdevallia trinema* Reichenbach fil.	7	October 1895
78.	*Masdevallia troglodytes* Morren	7	October 1895
79.	*Masdevallia uniflora* Ruiz & Pavon	5	February 1894
80.	*Masdevallia veitchiana* Reichenbach fil.	1	December 1890
81.	*Masdevallia velifera* Reichenbach fil.	7	October 1895
82.	*Masdevallia ventricularis* Reichenbach fil.	6	February 1895
83.	*Masdevallia vespertilio* Reichenbach fil.	8	October 1896
84.	*Masdevallia wageneriana* Lindley	3	August 1892
85.	*Masdevallia wendlandiana* Reichenbach fil.	6	February 1895
86.	*Masdevallia xanthina* Reichenbach fil.	4	July 1893
87.	*Masdevallia yauaperyensis* Rodrigues	5	February 1894

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BOOK REVIEW

KEN E. ROGERS. 2000. **The Magnificent Mesquite.** (ISBN 0-292-77105-3, hbk.). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. (Orders: http://www.utexas.edu/utpress, 512-471-4032). $24.95, 167 pp, 18 color photos, 2 line drawings, 5 maps, 12 tables, 5 1/2" × 9".

Contents.—

- Introduction
- Mesquite: What Is It?
- Predators of Mesquite
- Mesquite in Texas and the Southwestern United States
- The Uses of Mesquite
- The Mesquite in Verse
- Worldwide Aspects of *Prosopis*
- Texas Ebony-Mesquite's Astonishing Cousin
- Mesquite's Future
- Appendix 1. The Genus *Prosopis* and Its Species
- Appendix 2. Sources of Information
- References and Further Reading
- Index

This book summarizes the biology, ecology, uses, and management of mesquite—an overview of interest to scientists and laymen alike. This broad interest reflects, at least in part, a shift in public perception of these plants, which used to be regarded merely as pests but now are finding wide acceptance for their utility and aesthetic qualities. A table near the end—"Future Areas of New and Increased Mesquite Utilization"—notes the following uses: fine veneers, flooring, ornamentals, desert reclamation, feedstock for chemicals and pharmaceuticals, wood extractives conversion into wood plastics, biomass for energy feedstock, pods for human and livestock consumption, packaged firewood, and lumber. The presentation ranges from a recipe for jelly and instructions on constructing a mesquite wood floor to technical information on predator control, life cycle details, and the physical, mechanical, and chemical properties of the wood. The book is beautifully bound (in handbook size, like "The Pecan Tree" in the same UT Press series) and the contents are nicely organized. Reading is easy and the whole thing can be traversed in detail in a couple of hours.

This reader falls into the general audience but is skewed toward the technical side in expectation, which perhaps underlies a serious disappointment in the mesquite book. The term 'mesquite' is used to refer to the common and conspicuous mesquite of the southwestern USA (*Prosopis glandulosa*) as well as to all species of the genus (*Prosopis* spp.). Page after page, it is difficult if not impossible to tell whether a single species or the whole genus is being referred to. I surely won't be the only one frustrated by this and hope that the author will provide amendments in the next edition of the 'compleat mesquite.'—*Guy L. Nesom, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

GNAPHALIUM EXILIFOLIUM (ASTERACEAE: GNAPHALIEAE) IN COLORADO AND SOUTH DAKOTA

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, TX 76102-4060, U.S.A.

Stricter definition of the genus *Gnaphalium* L. (e.g., Anderberg 1991) leaves the genus in North America north of Mexico with three species: *G. exilifolium* A. Nels., *G. palustre* Nutt., and *G. uliginosum* L. The lectotype species of *Gnaphalium* sensu stricto is *G. uliginosum*—discussion of this choice rather than *Pseudognaphalium (Gnaphalium) luteo-album* (L.) Hilliard and Burtt is given in Jeffrey (1979), Hilliard and Burtt (1981), and McNeill et al. (1987). The remainder of the species of *Gnaphalium* sensu lato in the United States and Canada are divided among the segregate genera *Pseudognaphalium* Kirpichn., *Euchiton* Cass., *Gamochaeta* Wedd., and *Omalotheca* Cass.

Gnaphalium exilifolium has been treated as conspecific with *G. uliginosum* in various floristic accounts of the western United States (e.g., Great Plains Flora Association 1986; Weber & Whittman 1994) but regarded as a separate species in others (e.g., Harrington 1954; Welsh et al. 1993; Cronquist 1994). Examination of collections of these plants at ARIZ, ASU, BRIT, GH, NCU, NMC, TEX, and US have provided perspective on the distinction of *G. exilifolium*. The three species of *Gnaphalium* sensu stricto that occur in the United States can be identified by the contrasts in the key below.

1. Leaves spatulate to oblanceolate oblong, 3 8(–10) mm wide; bracts of capitulescence oblanceolate to obovate, longest 4–12 mm × 1.5–4 mm, shorter than or equalling to slightly surpassing the glomerules; inner phyllaries narrowly oblong with blunt apex. ______ **Gnaphalium palustre**
1. Leaves linear to narrowly oblanceolate, 0.5 3 mm wide; bracts of capitulescence linear to oblanceolate or obovate, longest 5–25 mm × 0.5–2 mm, distinctly longer than the glomerules; inner phyllaries triangular with acute apex.
    2. Leaves oblanceolate, less commonly linear, the largest 1–5 cm; capitulescence terminal and capitate, rarely with axilllary glomerules below; bracts subtending capitulescence linear to oblanceolate or obovate, 1–2 mm wide, the longest mostly 5–15 mm. ______ **Gnaphalium uliginosum**
    2. Leaves linear, the largest 0.4–5 cm; capitulescence commonly spike-like, with numerous sessile axillary glomerules; bracts subtending capitulescence linear, 0.5–1 mm wide, the longest mostly 10–25 mm. ______ **Gnaphalium exilifolium**

The account of the United States, Canada, and Greenland flora by Kartesz (1999) records *Gnaphalium exilifolium* in New Mexico, Arizona, Utah, and Wyoming,

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and the species also occurs in northern Chihuahua, Mexico (Nesom unpublished). Records also exist for its occurrence in Colorado and South Dakota—as clarified below. Although recent accounts of the flora of Colorado (Weber & Whittman 1994, 1996a, 1996b) and South Dakota (Dorn 1977; Van Bruggen 1985) have not included *G. exilifolium* as an accepted species, collections of it (as defined above) have been made from both states.

COLORADO. Montrose Co.: Cimarron, 2200 m, 8–10 Sep 1917, *Eggleston 14200* (GH).

Recognition of the presence *G. exilifolium* in Colorado results from a more focused species concept rather than from its rarity. *Gnaphalium uliginosum*, with which it has been confused, also occurs in Colorado. The distinction between the two taxa was correctly made by Harrington (1954, p. 624), although he supplied the caveat that "all our plants [of *G. exilifolium*] may actually be a part of *G. uliginosum* L." Collections at GH of *G. exilifolium* from Colorado also are from the following counties: Clear Creek, Delta, Lake, Larimer, Mineral, Park, and Summit.

SOUTH DAKOTA. [Lawrence Co.:] Black Hills National Forest, Yellow Creek, near Kirk, banks of Ice Pond, 27 Aug 1910, *Murdoch 4337* (GH).

McIntosh (1931) identified *G. exilifolium* as occurring in the Black Hills of South Dakota, although other botanists have apparently identified the same plants as *G. uliginosum*. The latter was specifically noted to occur in Custer and Lawrence counties, South Dakota (Great Plains Flora Association 1976). The cited Murdoch collection unequivocally confirms the occurrence of *G. exilifolium* in South Dakota; the possibility of the existence of *G. uliginosum* there has not been eliminated. Neither species is documented for South Dakota in the Forest Service repository at RM.

The nomenclature details for *Gnaphalium exilifolium* are as follows.

Gnaphalium exilifolium A. Nels. [nom. nov. for *G. angustifolium*], Bull. Torrey Bot. Club 29:406. 1902. *Gnaphalium angustifolium* A. Nels., Bull. Torrey Bot. Club 26:357. 1899 (non Lam. 1788).

Gnaphalium grayii A. Nels. & Macbr. [nom. nov. for *G. strictum*], Bot. Gaz. 61:46. 1916.

Gnaphalium strictum A. Gray, Pacif. R.R. Rep. 4:110. 1858 (non Moench 1794; non Roxb. 1814).

ACKNOWLEDGMENTS

I am grateful to the staff of the cited herbaria for loans and accommodation during recent visits, to Mark Gabel for comments on the manuscript, and to Ron Hartman for checking the RM collections.

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BOOK REVIEW

KEITH RUSHFORTH. 1999. **A photographic guide to the trees of Britain and Europe**. Photographs assembled by FLPA (Frank Lane Picture Agency). (ISBN 0 00 2220013 9, pbk.). Harper Collins Publishers, 77-85 Fulham Palace Road, London W6 8JB, U.K. (Orders: www.trafalgarsquarebooks.com, www.**fire**and**water**.com, 800-423-4525). £16.99 British pounds, as listed on the cover; $14.99 on website listing. [= ca. $24.00 US dollars, or ca. $21.00], 825 + color photos, 3 3/4" × 7 1/2".

"The coverage includes the whole of Europe where plants make trees. This ranges from the Mediterranean north to beyond the Arctic circle, and from the Urals to the Atlantic coast and islands. ... The coverage includes both native and introduced (or exotic) trees." "Nearly 1,200 tree species (plus a number of prominent cultivars) are featured in the book, with over 825 illustrated and 750 described in detail." The author notes that "specialist collections such as those of major arboreta or tree collections ... will contain a number of trees not featured here," but a large number of hybrids and selections are described under the "Varieties" heading in the commentaries.

A relatively short, up-front and to-the-point portion introduces principles of classification and nomenclature and gives an overview of how species are defined. A workable "Key to the Colour Plates" gives a range of illustrated choices (e.g., leaves pinnate and buds alternate, pp. 320–39; leaves digitate and buds opposite, pp. 310-11) to lead one into the section of photos where a tree in question might be found. There also is a similar 'sort mechanism' (using color photos) to fruit types. The pictures are small but excellent, with a good mix of habit and leaf, flower, and bark details. Species in the photo section are arranged by morphological category, but the written descriptions and commentaries are arranged alphabetically by genus and species. Larger genera are introduced by an informal key that separates species into groups. Each species has some or all of these categories of commentary: Description, Range, Habitat, Varieties, Synonyms, Similar species. Comments on variation in chromosome number are a consistent feature. As might be expected in a treatment of this scope, some of the observations on cultivation and appearance, etc., appear to be more first-hand than others.

This is an excellent book, surely one of great utility for English tree-lovers, and because so many of these species are likely to be found in cooler climes of North America, Yanks also will appreciate it. It is a relatively small-sized book (9.5 × 19 cm; advertised as "The only photographic field guide you can use in the wild") but thick with 1336 pages! The pages are thin but seem to be durable; same for the binding, and it comes in a plastic cover. The advertised price seems remarkably low, apparently designed to get copies into wide distribution. It is one of a Collins Wildlife Trust series that includes guides to birds, butterflies, insects, wildflowers, and mushrooms of the same region.
—*Guy L. Nesom, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

DOCUMENTED CHROMOSOME NUMBERS 2001:1. CHROMOSOME NUMBER OF *LUPINUS HAVARDII* (FABACEAE)

B.L. Turner

Plant Resources Center
University of Texas
Austin, TX, 78713, U.S.A.

A.M. Powell

Department of Biology
Sul Ross State University
Alpine, TX, 79832, U.S.A.

Chromosome numbers for the American taxa of the large genus *Lupinus* are mostly diploid (2n=24) or tetraploid (2n=48). However, two species of biennial (or winter annuals) native to central Texas and closely adjacent Mexico, *L. subcarnosus* Hook. and *L. texensis* Hook., were found by Turner (1957) to be uniformly diploid with 2n=36. Subsequently, Turner (1994) noted that the closely related winter annual, *L. havardii* S. Wats. of Trans-Pecos, Texas and closely adjacent Mexico, appeared to belong to this complex, but chromosome counts for the species were unknown. To remedy this, bud material for *L. havardii* was obtained by the senior author in the early spring of 2001, these subsequently counted by the junior author.

Meiotic counts were obtained from natural populations of *L. havardii* using the methods of Turner (1957). Voucher specimens are on file at SRSC and TEX, these obtained at the following localities:

Presidio Co.: 2.1 road mi N of Shafter along Hwy 169, 23 Feb 2001, *Turner 21-2*.
Presidio Co.: 7 road mi E of Presidio along Hwy 170, 23 Feb 2001, *Turner 21-4*.
Presidio Co.: 14 road mi E of Presidio along Hwy 170, 23 Feb 2001, *Turner 21-7*.

All counts were determined to be 2n=36 (18 bivalents), except for collections *21-2* and *21-7*, both of which showed circa counts of n=18 bivalents. Turner (1994) noted that the chromosome count of *L. havardii* was "likely to be 2n=18 pairs since the taxon *L. havardii* seems closely related to *L. texanus*," Which is verified by the present paper.

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Turner, B.L. 1994. Species of *Lupinus* (Fabaceae) occurring in northeastern Mexico (Nuevo Leon and closely adjacent states). Phytologia 76:290–302.

Book Review

Gil Nelson. 2000. **The Ferns of Florida**. (ISBN 1-56164-193-6, hbk; 1-56164-197-9, pbk). Pineapple Press, P.O. Box 3899, Sarasota, FL 34230, U.S.A.; (Orders: www.pineapplepress.com). $27.95 hbk, $19.95 pbk, 256 pp, 204 color photos, 6" × 9".

A treatment of Florida ferns is useful and welcome—among U.S. states and territories, only Hawaii and Puerto Rico have greater numbers of fern species. Nelson records 164 spontaneously occurring taxa (153 species, 9 hybrids) within the state's borders; 123 of the taxa are considered native. 42 taxa are endangered; 6 are threatened; 3 are commercially exploited.

The Introduction provides "a brief history of fern study in Florida, a note about the importance of fern conservation, a discussion of fern classification, a treatment of botanical nomenclature and descriptive vocabulary, an explanation of the fern life cycle, a brief discussion of fern hybridization, and a glossary." At the end of the book are these:

- Appendix 1. Checklist of Florida Pteridophytes Included in the Current Volume.
- Appendix 2. Florida Pteridophytes According to Wunderlin (1998)
- Appendix 3. Pteridophytes Included on Florida's Regulated Plant Index
- Appendix 4. Where to Find Ferns in Florida.
- Bibliography and Index

The fern taxa are arranged alphabetically by family, genus, and species, as claimed most appropriate for a field guide. For each species, there is a short technical description, detailed notes on habitat, distribution within the state (including a small map of the state, divided into four regions), early Florida collections, unsuccessful searches for rare species, presumed extirpation, features for field recognition and distinction from similar species, hybrids, nativity, spread of non-natives, derivation of the epithet, references to pertinent literature, and formal categories of rarity from listings by the Florida Department of Agriculture. A selection of keys provides distinction for the families treated, genera of Dryopteridaceae, genera of Polypodiaceae, genera of Pteridaceae, species of *Asplenium*, species of Thelypteridaceae, and there is a tabular comparison of species of *Marsilea*.

The 240 color photos (all taken by the author) are clustered together in the center of the book, and scattered line drawings and black and white photos are helpful. Pointed comments on habitat, distribution, and morphological features also support the book's usefulness as a field guide. The author's field experience and first-hand knowledge of the ferns are clear features of the discussions.

Dimensions to be wished for in the Nelson volume would be keys for all genera with more than a single species — this would not be out of place for a field guide, especially as the keys convey the author's personal knowledge. Also, ease of reference would be gained (regained) by uniting the illustrations with the species commentaries, although it obviously decreases the cost of production to cluster the numerous color illustrations.

Nelson's treatment, in company of the volume reviewed next (Wunderlin and Hansen 2000), is the contemporary step in the direction set by *Ferns of Florida* (Small 1931) and *Ferns of Florida* (Long and Lakela 1976). If we can assume that the native ferns of the state are now accounted for, the main developments in Florida over the next decade will be the discovery of additional non-native species and the documentation of the extirpation of native species as fast-paced habitat destruction continues. —*Guy L. Nesom, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

THE VASCULAR FLORA OF AMITE COUNTY, MISSISSIPPI

Mac H. Alford[1]

Department of Botany
Duke University
Box 90338
Durham, NC 27708-0338, U.S.A.
mha8@cornell.edu

ABSTRACT

A survey to document the vascular plants of Amite County, Mississippi, was conducted from 1997 to 2000. Occupying 732 square miles, the county lies along an edaphic and physiographic transition zone from loess in the west to sandy loam and gravel in the east. Species composition changes with the gradient, and the county serves as a westernmost limit to several southeastern plants (e.g., *Gelsemium rankinii* Small, *Illicium floridanum* J.Ellis). Amite County also harbors a residual element of north south Pleistocene migrations in the loess hills (e.g., *Adiantum pedatum* L., *Pachysandra procumbens* Michx., *Cynoglossum virginianum* L.). A total of 923 species were recorded, with new records for the state (*Solidago auriculata* Shuttlew. ex S.F.Blake, *Clinopodium gracile* (Benth.) Kuntze, *Alstroemeria psittacina* Lehm., *Ipomoea indica* (Burm.f.) Merr., *Photinia serratifolia* (Desf.) Kalkman) and a confirmation of recently published records of *Physalis carpenteri* Riddell and *Dryopteris ludoviciana* (Kunze) Small in Mississippi.

RÉSUMÉ

Un arpentage pour documenter les plantes vasculaires du Comté d'Amite, Mississippi, a été conduit de 1997 à 2000. Occupant 1874 kilomètres carrés, le comté s'étend le long d'une zone de transition édaphique et physiographique du loess à l'ouest au terreau sablonneux et au gravier à l'est. La composition d'espèces se modifie selon le gradient du terrain, et le comté sert de limite occidentale à plusieurs plantes du sud-est (e.g., *Gelsemium rankinii* Small, *Illicium floridanum* J.Ellis). Le Comté d'Amite contient aussi un élément résiduel des migrations pléistocènes nord-sud parmi les collines de loess (e.g., *Adiantum pedatum* L., *Pachysandra procumbens* Michx., *Cynoglossum virginianum* L.). Un total de 923 espèces est enregistré, avec de nouvelles documentations pour l'état (*Solidago auriculata* Shuttlew. ex S.F.Blake, *Clinopodium gracile* (Benth.) Kuntze, *Alstroemeria psittacina* Lehm., *Ipomoea indica* (Burm.f.) Merr., *Photinia serratifolia* (Desf.) Kalkman) et la confirmation des documentations récemment publiées de *Physalis carpenteri* Riddell et *Dryopteris ludoviciana* (Kunze) Small en Mississippi.

INTRODUCTION

Relative to most of the eastern United States, the vascular flora of Mississippi is poorly known (Duncan 1953; Pullen 1966; Bryson & Carter 1992; Bryson et al. 1996; Sorrie & Leonard 1999). This problem was remedied to some extent by the Flora of Mississippi project funded by the National Science Foundation and executed by Samuel B. Jones, Jr. (University of Southern Mississippi, later GA), Thomas M. Pullen (MISS), and Ray Watson (MISSA). Despite a number of vital

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[1] Present address: L.H. Bailey Hortorium, Cornell University, 462 Mann Library, Ithaca, New York 14853 U.S.A., mha8@cornell.edu.

publications (e.g., Evans 1978; Jones 1974a, 1974b, 1975, 1976; Pullen 1966; Pullen et al. 1968; Temple & Pullen 1968), however, the project was never completed and has only recently been reinvigorated (e.g., Bryson & Carter 1992).

One of the major components of a statewide flora is information assembled from smaller-scale floras and the herbarium specimens they yield. Most of Mississippi's vascular floristic work has been concentrated in the northeast and southeast, near the major universities and in the longleaf pine belt, respectively. In fact, of all Mississippi vascular floras, only one (McCook 1982) is a survey in the southwestern part of the state. The adjacent area to the south in the Florida parishes of Louisiana can claim a much better record, but surprisingly the first flora of that region was not completed until 1972 (Allen 1972).

The area chosen for this floristic study is Amite County, Mississippi. This choice is significant, considering the following reasons. First, Amite County is one of the counties that borders Louisiana in the southwest and as such is likely to produce new records merely by its periphery for the state of Mississippi. Second, Amite County occupies an interesting edaphic and physiographic location, serving as the transition zone from heavy loessal deposits in the west to the Citronelle-derived sandy loam and gravel of the east. The vegetation is influenced by this gradient, and one can expect to find a variety of species, from those of mixed mesophytic areas in loessal deposits to those of coastal plain piney woods in the southeastern part of the county. Third, rare plants and plant communities can be observed and reported to the Mississippi Natural Heritage Program as a foundation for conservation work in the area.

THE PHYSICAL ENVIRONMENT

Amite County, Mississippi, is located in southwestern Mississippi (Fig. 1). Amite County borders East Feliciana Parish, St. Helena Parish, and Tangipahoa Parish, Louisiana, on the south at 31.00°N; Wilkinson County, Mississippi, on the west at approximately 91.06°W; Pike County, Mississippi, on the east at approximately 90.55°W; and Franklin County and Lincoln County, Mississippi, on the north at approximately 31.35°N. The county is generally rectangular but is irregular in the northwestern corner where the boundary follows a historical path of Foster Creek and of the Homochitto River.

Amite County is about 30 miles east to west by about 24 miles north to south, encompassing 732 square miles (1874 km^2 or 466,560 acres) (Milbrandt 1976). The population in 1990 was 13,328 people (Clark 1997), with the only incorporated towns being Liberty, Gloster, Centreville, and Crosby.

Climate.—Weather data supplied by the National Climatic Data Center (NOAA) for 1962–1997 are summarized in Table 1. Amite County is mild and humid with major weather influence from the Gulf of Mexico. The temperature ranges from an average maximum of 91.6°F (33.1°C) in July to an average minimum of 33.4°F (0.8°C) in January. The frost-free growing season lasts on

TABLE 1. Climatic data for Amite County, Mississippi. Based on data from the National Climatic Data Center, National Oceanic and Atmospheric Administration, for Liberty Station, 1962–1997.

	TEMPERATURE (°F)					
MONTH	**mean**	**mean maximum**	**mean minimum**	**mean # of days with max ≥90°**	**mean # of days with min ≤32°**	**rainfall (inches)**
January	45.2	56.9	33.4	0	15.1	5.85
February	48.9	61.5	36.3	0	11.4	5.44
March	57.0	69.9	44.1	0	4.9	6.42
April	64.7	77.6	51.8	0.2	0.5	5.15
May	71.5	84.0	58.9	3.9	0	5.17
June	77.9	90.1	65.6	17.0	0	5.13
July	80.3	91.6	68.9	23.2	0	5.29
August	79.7	91.5	67.8	22.6	0	4.48
September	75.4	87.6	63.2	11.9	0	4.60
October	64.9	79.3	50.4	2.0	0.5	3.06
November	56.2	69.3	43.0	0	6.3	4.67
December	48.5	60.7	36.3	0	13.9	6.21
ANNUAL	64.2	76.7	51.6	81.3	51.6	61.47

average from March 22 until November 3, or about 227 days. For the years available, the temperature never dropped below 3°F (-16°C), and the average number of days per year with even a minimum temperature of 32°F (0°C) is 52. Average annual rainfall is 61.5 inches (154 cm), with the driest months in autumn and the wettest in winter and early spring. See Milbrandt (1976) for additional climate information.

Disturbance.—Forestry, agriculture, and fire are the major causes of vegetation disturbance. Although many fires are set as part of forestry management practices, numerous fires are presumably natural. For the years 1959–1998, an average of 2078 acres of land burned each year in Amite County with a range of 402 to 6137 acres per year (Mississippi Forestry Commission, pers. comm.). Tornadoes are also a major natural cause of disturbance. From 1984 to 2000, there were 12 tornadoes, damaging an average area of 1144 acres each (Mississippi Forestry Commission, pers. comm.). More data on the effects of forestry and agriculture can be found under the section entitled *Present Vegetation Types and Land Use.*

Topography.—Amite County lies within the generalized gulf coastal plain physiographic province (Fenneman 1938) and consists of rolling hills cut by several shallow valleys. The northwestern corner of the county deviates from this pattern somewhat by its dissection, and probably belongs to Fenneman's (1938) loess hills physiographic belt. Elevation in the county ranges from 136 feet above sea level along the Homochitto River to 500 feet in the northeastern part of the county. Large bluffs and ravines are only locally common, concentrated in the Homochitto River basin and along the forks of the Amite River. Amite County is mapped on the USGS topographic maps Auburn, Berwick, Bewelcome, Busy Corner, Centreville, Crosby, Gillsburg, Gloster, Homochitto, Lake Tangipahoa, Liberty, Peoria, Smithdale, Street, and Terrys Creek 7.5' series.

Numerous rivers and streams traverse the county (Fig. 1). The heavily dissected area in the northwestern part of the county belongs to the Homochitto River drainage, which flows into the Mississippi River. Small parts of the Buffalo River drainage, which also flow into the Mississippi River, drain the county just west of Gloster. Most of the rest of the county lies within the Amite River drainage, which includes the West Fork Amite River, East Fork Amite River, Comite River, and Beaver Creek. This is the first drainage east of the Mississippi River that does not flow into the Mississippi River; it empties into Lake Maurepas of Louisiana. The Tickfaw River drains a part of the southeastern corner of the county, and the Tangipahoa River drains a very small part of the northeastern corner of the county.

Geology. Most of Amite County rests upon reddish sedimentary deposits of sand, silt, clay, and gravel called the Upland Complex of the Citronelle Formation (Bicker 1969; Spearing 1995). These sediments were probably deposited in the Pliocene or Pleistocene (~2 to 17 million years ago) as a broad alluvial fan of many streams (Doering 1935, 1956; Spearing 1995). Mineral composition (Spearing 1995), along with freshwater mussel (Stern 1976) and stonefly (Alford 1998) distributions, suggest an Appalachian origin to these sediments.

The very northwestern corner of the county rests upon Miocene deposits that are, like much of the Citronelle deposits, obscured by a layer of loess. The Miocene deposits consist of green and bluish-green clay, sandy clay, gray siltstone, and sand and are locally fossiliferous (Bicker 1969). Thought to be windblown deposits from glacial till (Krinitzsky & Turnbull 1967), the loess—unlike most coastal plain soils—is rich in calcium and magnesium, has higher pH, and is able to retain a larger percentage of water (Caplenor 1968; Krinitzsky & Turnbull 1967). Loess deposits that are less than 8 ft (2.5 m) deep, however, like those in Amite County, are often leached of their calcium (Krinitzsky & Turnbull 1967). Areas with significant loessal soil are easily recognized from the adjacent coastal plain because they do not support the longleaf pine vegetation so characteristic of much of the eastern gulf coastal plain.

Larger deposits of loess are farther west in neighboring Wilkinson County, Mississippi, where they reach 100 feet deep (Krinitzsky & Turnbull 1967). From this narrow band called the "Tunica Hills," a gradually thinner layer of loess is deposited eastward, resulting in a gradient from thick loess rolling hills in the west to a thin layer of loess in the east called brown loam (Milbrandt 1976; Milbrandt & Hale 1968; Leggett et al. 1968). Although the loess bluffs and thick loess (>2.5 m deep) region has been recognized as a distinct physiographic belt

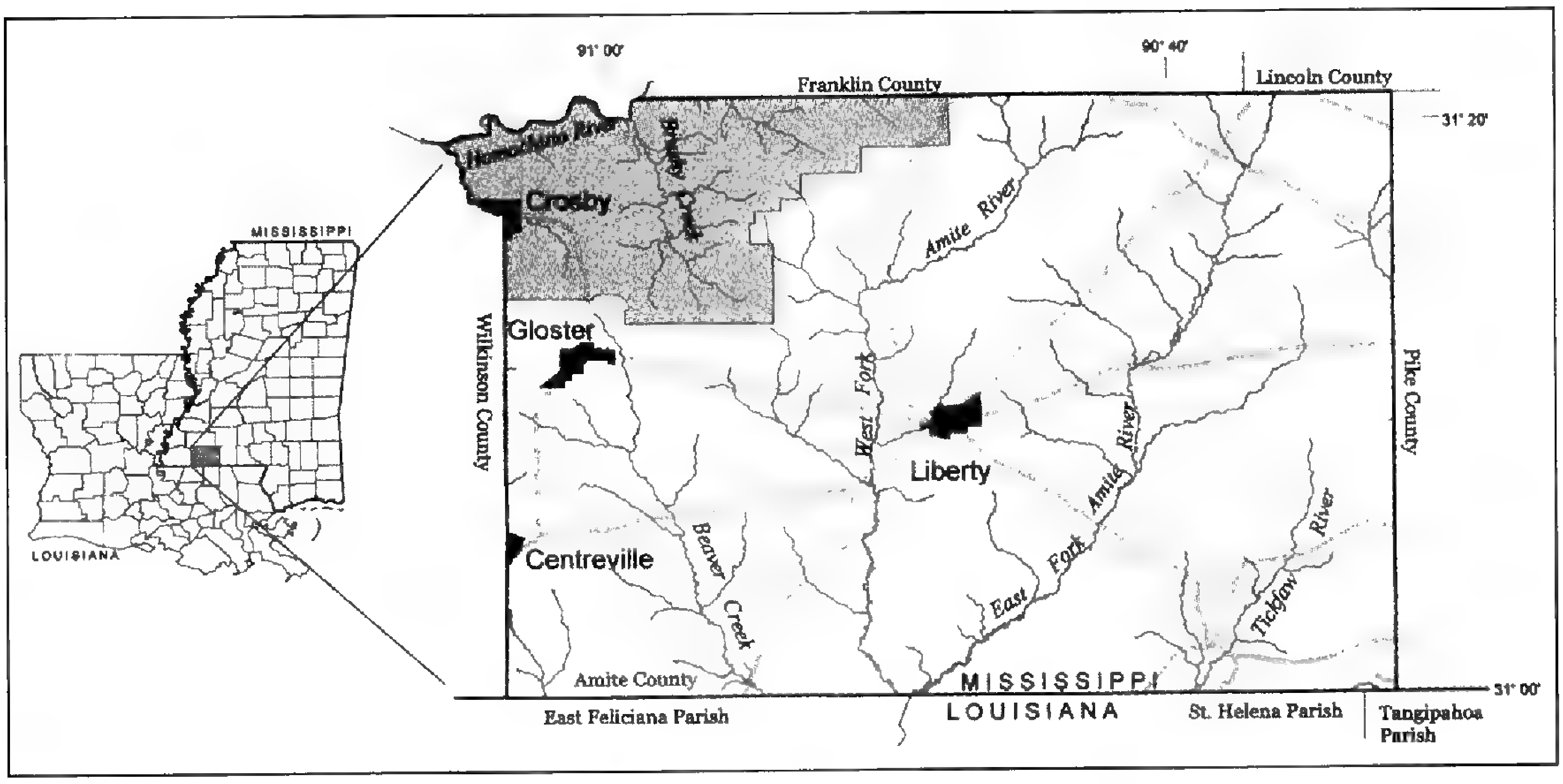

Fig. 1. Map of Amite County, Mississippi. Major highways are in pink, rivers in blue, incorporated areas (towns) in gray, and the Homochitto National Forest in green.

in the coastal plain province (Fenneman 1938; Holmes & Foster 1908; Lowe 1913), the thin loess region has generally been lumped into the "longleaf pine belt" or "southern pine hills" belt.

Soils.—As just discussed under *Geology*, an important component of the soils of Amite County is loess (brown loam). The loess is thickest in the west and thins to an almost undetectable layer in the southeast (Fig. 2).

According to Milbrandt (1976), there are seven major soil associations in Amite County (Fig. 2). Two associations, Gillsburg-Ariel-Peoria and Collings-Bude, are floodplain soils that are nearly level and poorly drained. The major upland associations, Providence-Bude and Providence-Ruston, consist primarily of small slopes with moderately well-drained soils based on loam (loess or loess-derived). One other major upland soil association is found along margins of major river dissection. This Saffell-Smithdale-Providence association, which is hilly and often consists of much gravel and silt, is of particular botanical interest, as will be noted later. In the southeastern corner of the county, the soil is less influenced by loess, tends to be better drained, and often has a reddish (instead of brown) color. It is named the Ora-Smithdale-Providence association. In the northwestern corner, the soil is influenced by loess but is highly dissected and often has a clayey subsoil. This clayey subsoil frequently outcrops where loess has been eroded at high hills in the Homochitto River basin. These areas are where one is most likely to find longleaf pine and associated species in the region.

THE BIOLOGICAL ENVIRONMENT

Presettlement Vegetation and Early History.—In 1720, only about 700 European settlers lived in Mississippi, mostly confined to the areas around present-day

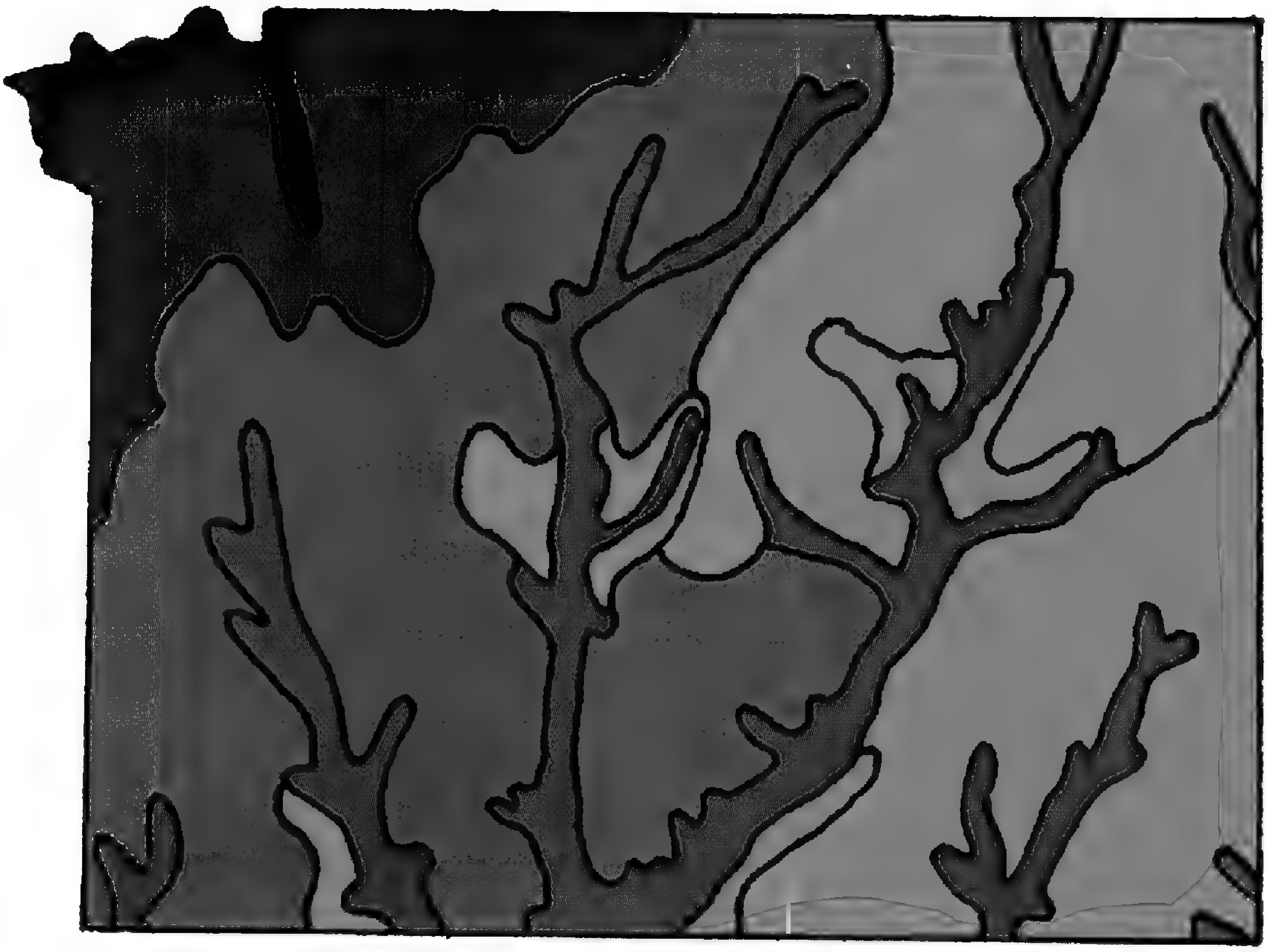

Fig. 2. Soil map of Amite County, Mississippi (adapted from Milbrandt, 1976). The Gillsburg-Ariel-Peoria association (flood plain) is in light green, Collings-Bude (flood plain) in dark green, Ora-Smithdale-Providence (upland coastal plain) in yellow, Providence-Bude in orange, Providence-Ruston (shallow loess) in blue, Saffell-Smithdale-Providence (often gravelly) in red, and Smithdale-Susquehanna (loam over clayey subsoil) in magenta.

Natchez and Vicksburg (Gillis 1963). A massacre by the Natchez Indians in 1729 eliminated most Europeans from the state, and settlement did not begin again until 1763 when Great Britain acquired the land from France. Settlement increased quickly during the Revolutionary War, when the land was under Spanish control. The Spanish census of the region in 1792 showed 4690 people living in Mississippi, most still confined to areas near the Mississippi River (Gillis 1963). However, in areas close to Amite County, there were already 112 families along Buffalo Creek and 136 families along the Homochitto River (Gillis 1963).

Amite County was officially separated from Wilkinson County in 1809 while Mississippi was still a territory (Clark 1997). The population continued to grow at an astonishing rate: the census of 1820 showed 6859 people in Amite County, 2833 of whom were slaves (Darby & Dwight 1836, U.S. Census 1820). In only four years (1816–1820), the population of neighboring Pike County grew from 330 families [~1500? people] (Gillis 1963) to 5402 people (Darby & Dwight 1836; U.S. Census 1820), also attesting to the rapid influx of people into the area. Furthermore, by 1840, 9511 people lived in Amite County (U.S. Census 1840). Additional history of the county and surrounding area can be found in Casey and Otken (1948), Casey et al. (1950), and Casey (1957).

Because Mississippi—like most of the United States outside of the original thirteen colonies and Texas—was surveyed in a standardized rectangular format (cf. Pattison 1957), the presettlement (or at least early) vegetation can be inferred from surveying records. "Marked trees" or "bearing trees" at each quarter-section can be evaluated statistically for bias and used as a statistical sample of the woody vegetation. Many areas were surveyed long before settlement, but other areas—like that in question here—were settled at approximately the same time as the surveys. Amite County was surveyed in 1847 and 1848. Because the Land Ordinance of 1785 gave priority to previous surveys in these regions (Pattison 1957), any areas already settled and surveyed by the time of the rectangular survey are readily noted on a political map as irregularly shaped sections. Therefore, one can safely assume that most early settlement (and disturbance of vegetation) in Amite County was along major rivers and streams, as the irregular so-called "Spanish Land Grants" occur in these areas.

A statistical analysis of the land survey records for determining presettlement vegetation has shown much promise (Bourdo 1956). However, the surveying of Amite County was accomplished by three different people with varying degrees of botanical expertise and note-taking, and the data are not statistically useful. As a coarse-grained tool, though, the data are interesting. For instance, in the southwestern part of the county (Township 1 North, Range 2 East), 37% of corners were described as "oak, gum, beech" forest, 35% included "pine" in the description, and only 7% were described as "timber all gone." Most vegetation descriptions were permutations of oak (*Quercus* spp.), gum (*Liquidambar styraciflua* and/or *Nyssa sylvatica* and *N. biflora*), beech (*Fagus grandifolia*), pine (*Pinus* spp.), holly (*Ilex opaca*), bay (probably *Magnolia grandiflora* or *M. virginiana*), and hickory (*Carya* spp.). In the eastern part of the county (Township 1 North, Range 4 East), however, the survey repeats again and again "poor pine land," probably of *Pinus palustris*, with only a few references to oak and hickory.

A neighboring area has been studied in this fashion (Delcourt & Delcourt 1974). Delcourt and Delcourt (1974) show that much of West Feliciana Parish, Louisiana, was dominated by a presettlement forest of *Fagus grandifolia*, *Magnolia grandiflora*, and *Ilex opaca*. However, West Feliciana Parish is a special case, because it almost entirely falls into the loess hills belt of the coastal plain province (Fenneman 1938). And, not surprising, in the northeast corner of West Feliciana Parish, not far from the border of Amite County, Mississippi, Delcourt and Delcourt (1974) record a forest composition change to *Quercus alba*, *Pinus* sp. or spp., and *Fagus grandifolia*. Whether or not this presettlement forest was or was like the climax forest of the area is beyond the scope of this paper but has been much discussed (Blaisdell et al. 1974; Delcourt & Delcourt 1974, 1977, Hodgkins 1958; Kurz 1944; Monk 1965, 1968; Nesom & Treiber 1977; Pessin 1933; Quarterman & Keever 1962; Wells 1942).

The best available information on the presettlement vegetation of Amite

County is probably from notes of botanically-trained individuals who traveled through the region before heavy settlement. Darby and Dwight (1836), while describing neighboring Wilkinson County as "one of the most productive cotton districts in the U.S.," describe Amite County with "some good land ... along and near the streams, [although] the great body of the county is ... covered with fine timber [presumably *Pinus palustris*]." Darby (1817) describes the vegetation of the thick loess, which would include Wilkinson County and perhaps some of Amite County, as "thickly timbered" and lists 33 species—all hardwoods—as the primary timber, including seven species of oak and four of hickory. Darby (1817) also lists some prominent vines and understory shrubs, most notably *Vitis* spp. and "brakes of the arundo gigantea (great cane)" [*Arundinaria gigantea*]. As one moves east, Darby (1817) describes the land in Amite County becoming of three qualities: "alluvion near the streams, that species of slopes called Hammock, and the open pine hills." The eastern half of Amite County and eastward then become forests of longleaf pine with an admixture of *Quercus falcata*, *Q. alba*, and *Liquidambar styraciflua* (Darby 1817). Darby's three categories correspond directly with the present vegetation types given later: bottomland hardwood forest, ravines / upland hardwood and mixed forest, and longleaf pine / loblolly-shortleaf pine forests for alluvion, hammock, and open pine hills, respectively.

Visits to the area by William Bartram in 1787 also confirm this general pattern (Harper 1958). Although Bartram did not travel through Amite County, he gives a personal account of the loess hills vegetation, noting that pine was "viewed here as a curiosity" and that eleven species of hardwoods were the "magnificent" trees of the forest here, while farther east pines were the dominant trees.

For the years 1807–1809, Cuming describes western Wilkinson County as "hilly, ... [with] the soil rich, though thinly inhabited"; other areas in Wilkinson County he describes as "comparatively well cultivated" (Thwaites 1904). He also writes of a trip through forest just south of the Mississippi border in Louisiana "abounding with that beautiful and majestick [sic] evergreen, the magnolia or American laurel" (Thwaites 1904), affirming the interpretation of land survey records by Delcourt and Delcourt (1974).

Studies this century (Holmes & Foster 1908, Lowe 1913) continued to record a vegetation pattern similar to that of Darby (1817): hardwood in extreme western Wilkinson County, followed by a mixed pine-hardwood forest, followed by longleaf pine forest from eastern Amite County eastward. Holmes and Foster (1908) report that Wilkinson County was 63% cleared, Amite County was 25% cleared, and Pike County (still including Walthall County) was 30% cleared. These figures do not imply that the uncleared land was primary forest, as the authors also speak of large tracts of secondary woods (Holmes & Foster 1908). Secondary woods, Holmes and Foster (1908) assert, became dominated by *Pinus taeda* rather than *Pinus palustris*.

Recent Botanical Effort.—Amite County has been visited a number of times this century by botanists. The earliest collections from the county were by Andrew Allison (1903–1907) and Thomas Bailey (1915–1916), which were subsequently noted in E.N. Lowe's "Plants of Mississippi: A List of Flowering Plants and Ferns" (1921). Despite its antiquated nomenclature and several inaccuracies, Lowe's compilation was the only statewide checklist of plants for Mississippi until the publication of Kartesz (1999). A. J. Eames visited the county in 1942, but only one specimen has been seen (*Phoradendron leucarpum*, Eames *s.n.* [BH!]).

The 1960s and 1970s showed the greatest amount of floristic work in Amite County. Louis Temple (MISS and later Mississippi College), Clair Brown (LSU), and especially Samuel B. Jones, Jr. (University of Southern Mississippi and later GA) and Jones's accompanying wife, students, and friends made numerous collections, turning up rarities for the area such as *Chromolaena ivifolia* and *Hydrangea arborescens*. Jones and associates collected over 250 specimens from the county. Collections since that time have mostly been limited to small student collections. One exception is the late John Allen Smith, a local school teacher who was contracted by the Mississippi Natural Heritage Program to find rare plants in the Homochitto National Forest. He located several populations of *Antennaria solitaria*, *Mikania cordifolia*, *Pachysandra procumbens*, and *Stewartia malacodendron* in the county.

Present Vegetation Types and Land Use.—The vegetation of Amite County is now mostly (if not exclusively) secondary. This is not surprising considering the early settlement coupled with an economy based primarily upon timber, beef cattle, and dairy cattle. Despite this somber note, one may be surprised that 78% of the county is forested and 22% is open land (Mississippi Forestry Commission 1998), an irony primarily due to the resurgence of the timber industry through tree farming.

Today, dairy production is restricted mostly to the southeastern corner of the county, an area once dominated by longleaf pine. Beef farms remain scattered throughout the county. Dairy and beef cattle production are the two major reasons for open land in the county, with smaller areas attributed to crops such as corn, soybeans, and ryegrass. Timber harvesting, too, continues throughout the county but in this age of tree farming leaves open areas only for short periods between harvest and replanting operations. In the year 1998, the merchantable timber (growing stock) in Amite County was estimated to be 309.0 million cubic feet of pine and 206.1 million cubic feet of hardwood (Mississippi Forestry Commission 1998). Only three counties in Mississippi have a greater volume of merchantable pine timber. During that same year, 68,314 MBF (thousand board feet, Doyle Rule) of pine were harvested, 5033 MBF of hardwood were harvested, 103,946 cords of pine pulpwood were harvested, and 68,689 cords of hardwood pulpwood were harvested (Mississippi Forestry Commission 1998).

Forestry management practices differ throughout the county. The northwestern corner of the county, for instance, is part of the Homochitto National Forest, and as such enjoys relatively longer timber rotation times, mandatory streamside protection zones, several older-growth areas, and even longleaf pine management and replacement. The rest of the county is owned privately, and timber production and management is determined more by economics and by soil properties. In the western part of the county, where the loess deposits are relatively thick, harvested areas require much attention (e.g., burning, discing, chemical treatments) because of rapid post-harvest non-timber growth (E. Alford, Mississippi Forestry Commission, pers. comm.). Open areas are quickly exploited by trees such as *Liquidambar styraciflua* and *Acer rubrum* var. *rubrum* and other plants such as *Rubus* spp., *Lactuca* spp., and *Eupatorium* spp. The eastern part of the county, where the soil is less loessal, is not quickly exploited by vigorous undergrowth, and thus timber practices like seed-tree regeneration are more common (E. Alford, Mississippi Forestry Commission, pers. comm.).

Pine forests comprise 45% of forested lands in the county. Mixed forest (19%) and hardwood forest (36%) also make up a sizable portion of forested land in the county (Mississippi Forestry Commission 1998). Of the pine forests, the primary type is loblolly or loblolly-shortleaf, and most hardwood forests belong to bottomland forests, with fewer acres in uplands and ravines, swamps, and other areas.

For purposes of explaining general vegetation patterns and to give the reader a background template upon which to interpret the vascular plant checklist, the vegetation of Amite County is divided into twelve categories. Naturally, this is a simplification and overlooks variation in a great continuum. A short description and common species of each type will be given (in alphabetical order, so as not to imply a rigorous statistical measurement of abundance). Species primarily restricted to certain types are noted, as are rare species. In general, these vegetation types correspond to those of Allen (1972), modified by the author and treatments by Braun (1950), the United States Forest Service (1995), Christensen (2000), Clewell (1985), and Delcourt and Delcourt (2000).

1. Longleaf Pine Forest (Fig. 3).—Longleaf pine forest is uncommon in the county, occurring only in scattered localities in the southeast and in the northwestern corner on high ridges of the Homochitto River basin. Typically, these forests are upland, open, and regularly burned. The dominant tree species, of course, is *Pinus palustris*, which is usually accompanied to some extent by *P. echinata* or *P. taeda*. Depending on the burning regime, other associates may include *Callicarpa americana*, *Carya tomentosa*, *Cornus florida*, *Crataegus* spp., *Diospyros virginiana*, *Ilex vomitoria*, *Malus angustifolia*, *Morella cerifera*, *Quercus/ falcata*, *Q. marilandica*, *Q. stellata*, *Rhus copallina*, *Vaccinium arboreum*, and *V. stamineum*. The understory is dominated by composites, grasses, and legumes, primarily *Andropogon virginicus*, *Aristida* spp., *Desmodium* spp., *Lespedeza*

Fig. 3. Photographs of major vegetation types in Amite County, Mississippi—I. Upper: longleaf pine forest. Middle: loblolly-shortleaf pine forest. Lower: Homochitto ravine. Note the *Magnolia grandiflora, Fagus grandifolia, Arundinaria gigantea*, and the predominance of hardwoods.

repens, *Schizachyrium scoparium*, *Symphyotrichum dumosum*, *S. patens*, and *Tephrosia spicata*. Some species in the county are found primarily in these forests, such as *Aletris aurea*, *Asclepias viridiflora*, *A. viridis*, *Drosera brevifolia*, *Ionactis linariifolius*, *Liatris elegans*, *L. pycnostachya*, *Phlox pilosa*, *Polygala incarnata*, *Pycnanthemum albescens*, *Quercus incana*, *Rhynchosia reniformis*, *Symphyotrichum adnatum*, and *Tragia smallii*. An example of this vegetation type is on private property about six miles south-southeast of Liberty, T2N R4E Sec 28 NW/4. An example from the Homochitto National Forest is at the intersection of West Homochitto Road and Royal Chapel Road, T4N R2E Sec 19 E/2. All longleaf pine forest is on upland sites, and thus, there are no flatwoods (sensu Clewell 1985) in the county.

2. Loblolly–Shortleaf Pine Forest (Fig. 3).—This is the most abundant vegetation type in the county. Under this category are included old field pine succession, mature upland non-longleaf pine forest, and pine plantation. These forests are dominated by *Pinus taeda*. If burning is frequent or the soil is gravelly or sandy, *Pinus echinata* becomes a clear co-dominant species. Understory or suppressed species include *Acer rubrum* var. *rubrum*, *Diospyros virginiana*, *Ilex vomitoria*, *Liquidambar styraciflua*, *Quercus falcata*, *Prunus serotina*, *Rhus copallina*, and *Vaccinium arboreum*. The ground layer is typically species-poor in unburned or plantation pine, inhabited by *Callicarpa americana*, *Clitoria mariana*, *Desmodium* spp., *Dichondra carolinensis*, *Lonicera japonica*, *Lygodium japonicum*, *Mimosa microphylla*, *Oxalis* spp., *Panicum* spp., *Rubus* spp., *Toxicodendron radicans*, and *Vitis rotundifolia*. Some pine plantations may consist of only *Pinus taeda* and *Lygodium japonicum*. With burning arrives *Hypoxis hirsuta*, *Lespedeza* spp., and *Tephrosia virginiana*. Mature, open loblolly-shortleaf pine forest is home to *Andropogon ternarius*, *A. virginicus*, *Aristida* spp., *Asclepias tuberosa*, *Cirsium carolinianum*, *Coreopsis* spp., *Eragrostis* spp., *Gentiana villosa*, *Helianthemum carolinianum*, *Hypericum drummondii*, *Ipomoea pandurata*, *Liatris squarrulosa*, *Oxalis dillenii*, *Polygala mariana*, *P. nana*, *Rhus glabra*, *Rosa carolina*, *Ruellia caroliniensis*, abundant *Schizachyrium scoparium*, *Sabatia* spp., *Scleria* spp., *Scutellaria integrifolia*, *Seymeria cassioides*, *Solidago odora*, *Stylosanthes biflora*, *Vernonia texana*, and *Viola pedata*. Wet ditches and old roads through these forests further add species such as *Carex glaucescens*, *Cyperus* spp., *Hypericum mutilum*, *Ludwigia* spp., *Rhynchospora inexpansa*, and *Xyris laxifolia* var. *iridifolia*. Rarer species in these forests include *Galactia erecta*, *Gaylussacia dumosa*, *Ludwigia hirtella*, *Oenothera linifolia*, *Orbexilum pedunculatum*, *Rhynchosia tomentosa*, *Scutellaria incana*, and *Trichostema setaceum*. An example of this type of vegetation is at the northern corner of the intersection of Mary Wall Bridge Road and River Road, T1N R5E Sec 19 W/2.

3. Upland Hardwood and Mixed Forest.—This vegetation type is also known as oak-pine or oak-pine-hickory forest. This type is quite similar to loblolly-shortleaf pine vegetation, only that the dominant and co-dominant hardwoods more conspicuously join the pines, especially *Carya pallida*, *C. tomentosa*, *Cornus florida*, *Fraxinus americana*, *Hamamelis virginiana*, *Ilex decidua*, *I. longipes*, *Ostrya virginiana*, *Prunus serotina*, *Quercus alba*, *Q. falcata*, *Q. hemisphaerica*, *Q. nigra*, *Q. velutina*, *Ulmus alata*, *Vaccinium elliottii*, and *Viburnum scabrellum*. The herbaceous layer tends to be less developed, and species like *Chasmanthium sessiliflorum*, *Matelea gonocarpos*, *Mitchella repens*, *Polystichum acrostichoides*, and *Smilax pumila* join the list. Uncommon species found in this vegetation type are *Chamaelirium luteum*, *Lilium michauxii*, *Malaxis unifolia*, *Polygonatum biflorum*, *Smilax pulverulenta*, and *Tipularia discolor*. An example of this type of vegetation is found near the pipeline crossing on Dickey Mills Road, T3N R6E Sec 31 S/2.

4. Ravines.—These areas are also known as hammocks and bluffs. The typical ravine is rich in both woody and herbaceous species. Common trees and large shrubs include *Carpinus caroliniana*, *Carya* spp., *Cornus florida*, *Fagus grandifolia*, *Frangula caroliniana*, *Hamamelis virginiana*, *Hydrangea quercifolia*, *Ilex opaca*, *Liriodendron tulipifera*, *Magnolia acuminata*, *Ostrya virginiana*, *Oxydendrum arboreum*, *Quercus alba*, *Q. michauxii*, *Q. pagoda*, *Q. velutina*, and *Viburnum rufidulum*. Common herbaceous species include *Carex* spp., *Chasmanthium sessiliflorum*, *Melica mutica*, *Oxalis violacea*, *Podophyllum peltatum*, *Phlox divaricata*, *Sanicula smallii*, *Spigelia marilandica*, and *Viola walteri*. Less common species that are found primarily in this type of vegetation are *Antennaria solitaria*, *Aristolochia serpentaria*, *Carya cordiformis*, *Dioscorea quaternata*, *Ilex ambigua*, *Matelea carolinensis*, *Phegopteris hexagonoptera*, *Schisandra glabra*, *Solidago auriculata*, *Spiranthes ovalis*, *Stewartia malacodendron*, and *Uvularia perfoliata*. Ravines are often the areas preserved by private landowners, and whether or not these rarer species are restricted to these areas because of their vegetation-edaphic properties or as a result of less disturbance is unknown.

Ravines fall into two major subtypes: **A.** *Homochitto Ravines* (Fig. 3).—These ravines are located in the Homochitto National Forest and surrounding areas. They generally have a thick loess layer over Miocene deposits, and the hills are highly dissected. These ravines have the conspicuous addition of *Acer barbatum*, *Magnolia macrophylla*, *Quercus shumardii*, and *Symplocos tinctoria* (as a mid- to upper-slope tall shrub) and much more abundant *Magnolia acuminata* and *Pinus taeda*. In the understory, ferns reach their peak with large areas dominated by *Phegopteris hexagonoptera*, *Polystichum acrostichoides*, and *Thelypteris kunthii*. Also added are *Antennaria solitaria*, *Botrychium virginianum*, abundant *Carex flaccosperma*, *Cynoglossum virginianum*, *Laportea canadensis*, *Mikania cordifolia*, *Piptochaetium avenaceum*, *Smilax pumila*, *Urtica chamaedryoides*, and *Woodsia obtusa*. Because of the dissection of land in parts of the Homochitto National Forest, there can often be a continuum between this type, upland hardwood and mixed forest, and pine forest, depending on the size of the ridges. An example of this type of vegetation can be found in the Homochitto National Forest off New Hope Road in T3N R2E Sec 12.

B. *Gravel or Saffell outcrops.*—Gravel outcrops occur primarily as ridges along the margins of the Amite River and associated large drainages. The soil here is very gravelly and sandy, and species like *Carya glabra*, *Frangula caroliniana*, *Styrax grandifolius*, and *Tilia americana* var. *caroliniana* become more common. One adds many species seldom found elsewhere in the county, including *Agrimonia microcarpa*, *A. rostellata*, *Cocculus carolinus*, *Desmodium glutinosum*, *D. nudiflorum*, *D. rotundifolium*, *Fleischmannia incarnata*, *Lithospermum tuberosum*, *Phryma leptostachya*, *Physalis heterophylla*, *Potentilla simplex*, *Quercus coccinea*, *Silene stellata*, *Smallanthus uvedalius*, *Symphyotrichum drummondii* var. *texanum*, and *Tragia cordata*. *Pleopeltis polypodioides* var. *michauxiana* can be found here growing both epiphytically and on outcrops of conglomerate rock and sandstone. *Pachysandra procumbens* is also found here in one locality. An example of this vegetation type can be found at the Ethel S. Vance Natural Area just west of Liberty on MS Hwy 24, T2N R4E Sec 6 SE/4.

5. Bottomland Hardwood Forest (Fig. 4).—Bottomland forest, too, is very rich in both woody and herbaceous species. There is much variability in this type, and one subtype is provided for the most conspicuous outlier. There is also some intergradation with spring-seeps and swamps, ponds and lakes, and streamsides, each of which is considered a separate category. Typically, bottomland hardwood forest is dominated by *Asimina triloba*, *Carpinus caroliniana*, *Fagus grandifolia*, *Halesia diptera*, *Ilex opaca*, *Liquidambar styraciflua*, *Liriodendron tulipifera*, *Magnolia grandiflora*, *Quercus laurifolia*, *Q. nigra*, *Q. michauxii*, *Q. pagoda*, and *Symplocos tinctoria*. Lianas include *Berchemia scandens*, *Decumaria barbara*, and *Smilax* spp. Herbaceous vegetation can commonly be non-existent in deeper forest, but at edges, small openings, small drains, and woods roads appear *Carex intumescens*, *C. joorii*, *C. lurida*, *Chasmanthium laxum*, *Cuphea carthagenensis*, *Elephantopus carolinianus*, *Gratiola* spp., *Hexastylis arifolia*, *Hydrocotyle* spp., *Hymenocallis caroliniana*, *Impatiens capensis*, *Leersia virginica*, *Lycopus virginicus*, *Macrothelypteris torresiana*, *Packera glabella*, *Polygonum* spp., *Ranunculus abortivus*, *R. pusillus*, *Rhynchospora caduca*, *R. glomerata*, *Samolus valerandi* ssp. *parviflorus*, *Saururus cernuus*, *Selaginella apoda*, *Thelypteris kunthii*, *Verbesina walteri*, and *Viola primulifolia*. Uncommon species found primarily in bottomlands are *Circaea lutetiana* ssp. *canadensis*, *Claytonia virginica*, *Listera australis*, *Solidago discoidea*, and *Trillium foetidissimum*. In the Homochitto drainage, *Acer rubrum* var. *drummondii*, *Geum canadense*, *Lindera benzoin*, and *Ulmus americana* join the list. Bottomland forest is commonly invaded by exotics, especially *Ligustrum sinense* and *Lygodium japonicum*. An example of the generalized type can be found at the Ethel S. Vance Natural Area just west of Liberty on MS 24 at the West Fork Amite River, T2N R4E Sec 6 S/2.

Fig. 4. Photographs of major vegetation types in Amite County, Mississippi—II. Upper: bottomland hardwood forest. Middle: swamp, here dominated by *Nyssa biflora* and *Cephalanthus occidentalis*. Lower: abandoned farm pond, with *Hydrocotyle* and *Saururus* evident.

There is one major distinctive subtype of bottomland forest. *Magnolia-Beech-Spruce Pine-Illicium Thickets.*—The locals call this type of vegetation "stink-bush thickets." These are forests of *Fagus grandifolia*, *Magnolia grandiflora*, and *Pinus glabra* with a dense understory of *Illicium floridanum*. Often there are no herbaceous plants, and the *Illicium floridanum* can become impenetrable. Occasional species in these areas are *Athyrium filix-femina*, *Epidendrum conopseum*, *Epifagus virginiana*, *Polystichum acrostichoides*, *Stewartia malacodendron*, *Symplocos tinctoria*, and the rare *Trichomanes petersii*. An example of this type can be found along the East Fork Amite River just south of South Greensburg Road, T1N R4E Sec 27.

6. Spring-Seeps and Swamps (Fig. 4).—Spring-seeps and swamps fall into the broader category of forested wetlands. Woody species typically include *Cephalanthus occidentalis*, *Fraxinus pennsylvanica*, *Ilex opaca*, *I. verticillata*, *Itea virginica*, *Magnolia virginiana*, *Nyssa biflora*, *Photinia pyrifolia*, *Quercus* spp., *Sabal minor*, *Smilax laurifolia*, and *Viburnum nudum*. The herbaceous layer consists of *Carex albolutescens*, *C. intumescens*, *C. leptalea*, *C. lonchocarpa*, *C. lurida*, *Gratiola floridana*, *Hydrocotyle* spp., *Osmunda cinnamomea*, *O. regalis* var. *spectabilis*, *Panicum gymnocarpon*, *P. rigidulum*, *Pilea pumila*, *Polygonum* spp., *Proserpinaca palustris*, *Sparganium americanum*, *Triadenum walteri*, *Viola primulifolia*, and *Woodwardia areolata*. Uncommon species found primarily in these areas include *Arnoglossum plantagineum*, *Dryopteris ludoviciana*, *Leucothoe racemosa*, *Melanthium virginicum*, *Platanthera flava*, *Smilax walteri*, *Spiranthes cernua*, *Stachys tenuifolia*, and *Woodwardia virginica*. In occasional ox-bows, *Taxodium distichum* will form monotypic stands. *Asclepias perennis*, *Carex decomposita*, and *Leersia lenticularis* are uncommon species that occur in these areas. A typical swamp can be found at the Ethel S. Vance Natural Area just west of Liberty on MS 24 downhill from the above-mentioned Saffell outcrop, T2N R4E Sec 6 S/2. Several typical spring-seeps can be found on school lands near Royal Chapel, T4N R2E Sec 18 NE/4. A mature baldcypress swamp can be found in the Homochitto National Forest, Brushy Creek at Robertson Road, T4N R2E Sec 2 SW/4.

7. Cultivated and Fallow Fields.—Land that is under cultivation or has been under cultivation recently (including home gardens) falls into this category. The common species are typical weedy herbs, including *Amaranthus spinosus*, *Brassica rapa*, *Cyperus rotundus*, *Eclipta prostrata*, *Geranium carolinianum*, *Jacquemontia tamnifolia*, *Lolium perenne*, *Physalis angulata*, *Raphanus raphanistrum*, *Senna obtusifolia*, *Sesbania herbacea*, *Solanum carolinense*, *Soliva pterosperma*, *Trifolium repens*, *Urochloa platyphylla*, *Vicia sativa* ssp. *nigra*, and *V. tetrasperma*. Rarely one finds *Melothria pendula*, *Muscari neglectum*, or *Narcissus jonquilla*. An example of this vegetation type can be found in the areas surrounding Pumpkin Patch Creek at MS 569N, T4N R6E Sec 7 S/2.

8. Pastures and Old Successional Fields.—These areas are the conspicuous autumn flower shows. Common species include *Agalinis fasciculata*, *Ambrosia artemisiifolia*, *Andropogon* spp., *Buchnera americana*, *Chrysopsis mariana*, *Croton capitatus*, *Eremochloa ophiuroides*, *Eupatorium* spp., *Helenium amarum*, *H. flexuosum*, *Hordeum pusillum*, *Lactuca* spp., *Lespedeza* spp., *Paspalum* spp., *Pityopsis graminifolia*, *Polypremum procumbens*, *Ranunculus* spp., *Rumex* spp., *Sisyrinchium* spp., *Solidago canadensis*, and *S. gigantea*. In moist pastures, *Cyperus* spp. and *Juncus* spp. become common. Fencerows and edges of this type are home to *Albizia julibrissin*, *Diospyros virginiana*, *Prunus serotina*, and *Triadica sebifera*. An example of this vegetation type can be found along Cut Through Road, T3N R5E Sec 28 N/2.

9. Roadsides.—Roadsides support a diverse array of species, although the habitat and species are generally called "ruderal." Common species include *Antennaria plantaginifolia*, *Boltonia diffusa*, *Campsis radicans*, *Chamaecrista fasciculata*, *Cicuta maculata* (in ditches or wetter sites), *Erigeron strigosus*, *Helianthus angustifolius*, *Ipomoea cordatotriloba*, *Linum medium*, *Oenothera* spp., *Panicum* spp., *Paspalum dilatatum*, *P. urvillei*, *Plantago aristata*, *Pueraria montana*, *Pyrrhopappus carolinianus*, *Robinia pseudo-acacia*, *Rudbeckia hirta*, *Sorghum halepense*, *Tradescantia ohiensis*, *Tridens flavus*, *Trifolium* spp., *Verbena brasiliensis*, *Vernicia fordii*, and *Vicia villosa*. Uncommon species in this vegetation type are *Ailanthus altissima* (apparently only beginning its spread in southern Mississippi), *Lysimachia lanceolata*, and *Penstemon laxiflorus*, as well as several waifs collected previously but not seen during this study (e.g., *Crotalaria spectabilis*, *Geranium dissectum*).

10. Ponds, Lakes, and Beaver Impoundments (Fig. 4).—This vegetation type encompasses all areas that are in or on the margin of stationary water, primarily ponds, lakes, and beaver impoundments. There is some overlap with the vegetation type "Spring-Seeps and Swamps," and one should reference that section as well. Common woody plants include *Cephalanthus occidentalis*, *Nyssa biflora*, *Smilax walteri*, and *Taxodium distichum*. The herbaceous layer includes *Bidens* spp., *Brasenia schreberi*, *Eleocharis obtusa*, *Eryngium prostratum*, *Juncus repens*, abundant *Ludwigia* spp., *Nuphar lutea*, *Panicum hians*, *Rhexia mariana*, *Saccharum* spp., *Sagittaria latifolia*, *Sparganium americanum*, *Thelypteris palustris* var. *pubescens*, *Typha latifolia*, and *Utricularia biflora*. Uncommon species in this type include *Carex louisianica*, *Gelsemium rankinii*, *Hydrolea uniflora*, *Potamogeton diversifolius*, and *P. pulcher*. An example of this vegetation type (more precisely, an open beaver impounded pond) can be found at the Ethel S. Vance Natural Area just west of Liberty on MS 24, T2N R4E Sec 7 N/2.

11. Riversides.—Riversides represent a special case of bottomland hardwood forest. The soil often has much more sand and gravel, and the flora is strikingly distinct. Moving upstream, as the rivers become smaller streams, the vegetation type, however, begins to grade with bottomland hardwood forest. Riversides are typically dominated by the woody plants *Acer negundo*, *Betula nigra*, *Platanus occidentalis*, and *Salix nigra*. The herbaceous layer includes *Apios americana*, *Carex lupulina*, *Chasmanthium latifolium*, *Cleome hassleriana*, *Commelina diffusa*, *C. virginica*, *Digitaria ciliaris*, *Hygrophila lacustris*, *Justicia ovata* var. *lanceolata*, *Lobelia cardinalis*, *Mikania scandens*, and *Vernonia gigantea*. Uncommon plants found in this vegetation type are *Leersia oryzoides* and *Melochia corchorifolia*. An example of this vegetation type can be found on private property along the West Fork Amite River south of Powell Road, T1N R4E Sec 31.

12. Cemeteries, Yards, and Ruderal Areas in Towns.—This last category incorporates all "ruderal" areas except roadsides, which do share a number of elements. Many species of trees are planted and grow natively in yards, so concentration here will focus on herbaceous species. The most common species are *Cerastium glomeratum*, *Duchesnea indica*, *Galium aparine*, *Glechoma hederacea*, *Houstonia* spp., *Krigia* spp., *Lamium amplexicaule*, *Lepidium virginicum*, *Modiola caroliniana*, *Nothoscordum bivalve*, *Nuttallanthus canadensis*, *Oxalis rubra*, *Paspalum notatum*, *Poa annua*, *Salvia lyrata*, *Sporobolus indicus*, *Stellaria media*, *Trifolium* spp., *Triodanis* spp., *Valerianella radiata*, *Veronica* spp., and *Youngia japonica*. Uncommon species in these habitats include *Cyrtomium falcatum* (sparingly naturalized), *Hedera helix* (expanding only around old home sites), *Lepuropetalon spathulatum* (cemeteries), *Ophioglossum* spp. (cemeteries), *Phyllanthus urinaria* (sidewalk cracks in town), *Plantago heterophylla* (cemeteries), and *Portulaca oleracea* (sidewalk cracks in town). An example of both a yard and ruderal area in town is Old Jackson Road at Pecan Street in Liberty, T2N R4E Sec 4. An example of a cemetery is the Stewart-Wall Cemetery near the intersection of Mary Wall Bridge Road and Mt. Vernon Road, T1N R4E Sec 24.

ANNOTATED CHECKLIST

The following checklist is the compilation of all native, naturalized, or especially long-persisting vascular plant species occurring in Amite County, Mississippi. Families are arranged in alphabetical order under the divisions of Lycopodiophyta, Polypodiophyta, Coniferophyta, Magnoliophyta: Liliopsida (monocots), and Magnoliophyta: Magnoliopsida (dicots). Family delimitation in the Lycopodiophyta, Polypodiophyta, and Coniferophyta follows the system of Kartesz (1999). Delimitation of monocot families follows the system of Dahlgren et al. (1985), which primarily means that the Liliaceae s.l. are split into various smaller families. Delimitation of dicot families generally follows the system of Kartesz (1999) with modifications to avoid polyphyletic or unnatural taxa, especially regarding the older concepts of Saxifragaceae and Loganiaceae. More specifically, *Viburnum* and *Sambucus* are considered part of Adoxaceae (Donoghue 1983; Donoghue et al. 1992), *Lepurapetalon* part of a broadly defined Celastraceae (Soltis & Soltis 1997), *Itea* part of Iteaceae (Soltis & Soltis 1997), *Penthorum* part of Penthoraceae (Haskins & Hayden 1987; Soltis & Soltis 1997), *Gelsemium* part of Gelsemiaceae, and *Polypremum* part of Buddlejaceae, despite much uncertainty regarding its position (Struwe et al. 1994; Backlund et al. 2000). Labiatae and Verbenaceae are retained and used as set forth in Kartesz (1999), although their circumscriptions are likely to change in the future. Genera and species are in alphabetical order in each family. Species entry data are arranged in the following manner:

[♦ = new state record] [† = species taxonomy or nomenclature differing from Kartesz, 1999] [* = non-native] *Species* Authority [following Brummitt & Powell 1992], *Collection Number*. Frequency. Vegetational associations. Note(s).

Species nomenclature (scientific names plus authorities), in general, follows Kartesz (1999). If there is a departure from his system, a cross and a reference citation or note accompanies the entry. The only major departure from his nomenclature is my retention of *Panicum* in the large sense. Because the taxonomy of *Panicum* s.l. is controversial and obviously still rudimentary, I follow the last treatment of the genus for Mississippi (Lelong 1986). Only four hybrids are part of the list: *Eupatorium* × *pinnatifidum*, *Gladiolus* × *gandavensis*, *Rhexia nashii* × *R. virginica*, and *Quercus* × *comptoniae*. Each of these is common enough that explorers of the region should be aware of their presence. If the species is not native, then the citation is accompanied by an asterisk. References for this criterion are Radford et al. (1968), Clewell (1985), Correll & Johnston (1970), Weakley (in prep.), and the Mississippi Natural Heritage Program (pers. comm.).

Specimens have been deposited at DUKE, and duplicates of most species have been deposited at IBE. Additional duplicates have been variously distributed to BEO, BH, LSU, MICH, MISS, NCU, US, the Mississippi Museum of Natural Science (mmns), and the personal herbarium of Charles T. Bryson (ctb) (herbarium abbreviations following Holmgren et al. 1990). Collection numbers with an *A* refer to Mac H. Alford (also used when other collectors assisted), with an *EA* refer to E. Earl Alford, Amite County Forester, Mississippi Forestry Commission, and with a *WA&M* refer to Robert L. Wilbur (DUKE), Mac H. Alford, and Gerry Moore (BKL).

Frequency, a measure of how common and widespread a species is, will follow the pattern outlined in Table 2. For maximal information retrieval, the plant association data is clearly, though sometimes verbosely, described. If the descriptions given are terse, the vegetation types of the previous section are fully adequate to describe the habitat(s) of occurrence.

Any species occurring in Amite County that was not directly planted or vegetatively produced in close proximity to a cultivated individual is considered a part of the flora. For example, *Camellia japonica*, though widely reproducing

TABLE 2. Abundance scale for vascular plants in the checklist of Amite County, Mississippi.

Abundant	Frequent, dominant, or codominant in one or more habitats; widespread.
Common	Relatively frequent; either widespread with scattered localities or frequent in a subset of habitats.
Locally Common	*Either* widely distributed but completely restricted to a certain habitat *or* locally distributed with many individuals.
Infrequent	Uncommon in the county, often small populations *and/or* restricted to certain habitats.
Rare	One or two small populations known from the county.

vegetatively under the growth of planted individuals, is not found outside a close perimeter of planted individuals and was never found in an area where its origin was ambiguous; it is not included. On the other hand, *Cyrtomium falcatum*, though remaining in close vicinity to planted (or persisting) individuals, often produces spore-derived individuals around old, moist concrete foundations and brick walls; it is included. Other species such as *Photinia serratifolia* and *Euonymus fortunei* show few (if any) signs of reproduction, but persist so long, even after abandonment of property, that they are included, as a botanist is likely to encounter them with little inherent evidence to suggest a cultivated origin.

Methods.—Field collections were made from 1997–2000. Because the county is divided according to the rectangular system of surveying, one section of each township is designated for public schools. These public lands served as evenly distributed points for collection. Because they are maintained by the Mississippi Forestry Commission for various management purposes, a diversity of plant communities and edaphic conditions were available. Public land was also accessible in the Homochitto National Forest, a significant portion of the land area in the northwest corner of the county (Fig. 1). Only one sizeable park occurs in the county, the Ethel S. Vance Natural Area near Liberty. This park, too, was extensively surveyed. Private lands and roadsides were also searched, but usually less extensively and in a more random manner, although a combination of topographic maps and the soil map were used to pinpoint potential interesting areas.

Field identification was undertaken primarily with Clewell (1985), Radford et al. (1968), and Correll and Johnston (1970). Upon return to DUKE, monographs and other references, especially Allen (1992), Bailey (1949), Chapman (1897), FNA (1997), Godfrey (1988), Godfrey and Wooten (1979, 1981), Small (1933), Steyermark (1963), and Weakley (in prep.), were consulted, and specimens were compared to those in the herbarium for accuracy.

Previous collections were consulted at GA, IBE/MISSA, LSU, MICH, and MISS. Several monographic and floristic studies had Amite County marked as occurrences on dot-maps or in specimen citation lists. If these specimens were not seen, the reference is given.

LYCOPODIOPHYTA

SELAGINELLACEAE

Selaginella apoda (L.) Spring, *A1945*. Infrequent. Bottomland forest.

POLYPODIOPHYTA

ASPLENIACEAE

Asplenium platyneuron (L.) B.S.P., *A1049*. Common. Saffell outcrops, upland hardwood forest, and pine forest.

BLECHNACEAE

Woodwardia areolata (L.) T.Moore, *A1296*. Locally common. Spring-seeps, swamps, and wooded areas near impoundments.

Woodwardia virginica (L.) Sm., *A1719*. Rare. Spring-seep in the Homochitto National Forest.

DENNSTAEDTIACEAE

Pteridium aquilinum var. *pseudocaudatum* (Clute) A.Heller, *A1695*. Common. Roadsides and pine forest.

DRYOPTERIDACEAE

Athyrium filix-femina ssp. *asplenoides* (Michx.) Hultén, *A1050*. Abundant. Mesic forest and forest roads.

**Cyrtomium falcatum* (L.f.) C. Presl, *A1784*. Rare. Moist and shady brick and concrete walls.

Cystopteris protrusa (Weath.) Blasdell, *A1086*. Rare. Sandy bottomland hardwood forest along the Homochitto River.

Dryopteris ludoviciana (Kunze) Small, *A2029*. Rare. Swamp along the East Fork Amite River.

Onoclea sensibilis L., *A1341*. Locally common. Roadside ditches, mesic forest, and swamp margins.

Polystichum acrostichoides (Michx.) Schott, *WA&M 70921*. Abundant. Mesic forest, rich ravines, Saffell outcrops, and upland hardwood forest.

Woodsia obtusa (Spreng.) Torr. ssp. *obtusa*, *A2114*. Rare. Sandy bottomland forest and associated loessal hills of the Homochitto River basin.

HYMENOPHYLLACEAE

Trichomanes petersii A.Gray, *A2028*. Rare. Bases of *Fagus grandifolia* trunks near springs of the East Fork Amite River.

LYGODIACEAE

**Lygodium japonicum* (Thunb. ex Murray) Sw., *WA&M 71082*. Abundant. Roadsides, pine forest, mesic hardwood forest, and swamp margins.

OPHIOGLOSSACEAE

Botrychium biternatum (Savigny) Underw., *A352*. Common. Forest.

Botrychium virginianum (L.) Sw., *A1007*. Infrequent. Upland mixed forest, primarily in the Homochitto River basin.

Ophioglossum crotalophoroides Walter. Rare. Sandy lawns and cemeteries. Referenced in Evans (1978); specimen not seen.

Ophioglossum nudicaule L.f. Rare. Lawns, pastures, and cemeteries. Referenced in Evans (1978); specimen not seen.

OSMUNDACEAE

Osmunda cinnamomea L., *A524*. Infrequent. Spring-seeps and moist ravines.

Osmunda regalis var. *spectabilis* (Willd.) A. Gray, *A531*. Locally Common. Spring-seeps, swamps, and wooded areas near impoundments.

POLYPODIACEAE

Pleopeltis polypodioides ssp. *michauxiana* (Weath.) E.G. Andrews & Windham, *A1526*. Locally common. Epiphyte primarily on *Quercus stellata*, *Quercus michauxii*, *Carya illinoinensis*, and *Juniperus virginiana* and infrequently growing terrestrially on exposed outcrops of Saffell sandstone.

PTERIDACEAE

Adiantum pedatum L., *A2257*. Rare. Saffell outcrop along the East Fork Amite River.

THELYPTERIDACEAE

**Macrothelypteris torresiana* (Gaudich.) Ching, *A1085*. Common. Mesic forest and forest roads.

Phegopteris hexagonoptera (Michx.) Fée, *A1289*. Infrequent. Hardwood ravines, primarily in the Homochitto River basin.

Thelypteris hispidula var. *versicolor* (R.P. St.John) Lellinger, *A1008*. Infrequent. Sandy bottom land hardwood forest.

Thelypteris kunthii (Desv.) C.V.Morton, *A1339*. Common. Mesic forest and forest roads.

Thelypteris palustris var. *pubescens* (G. Lawson)

Fernald, *A1342*. Infrequent. Swamp margins and perennially wet ditches.

CONIFEROPHYTA

CUPRESSACEAE

Juniperus virginiana L. var. *virginiana*, *A1357*. Infrequent. Fencerows and old home sites.

Taxodium distichum (L.) L.C. Rich., *A1347*. Infrequent. Ox-bow sloughs, swamps, and floodplain swales.

PINACEAE

Pinus echinata Mill., *A1167*. Common. Pine forest and old fields.

**Pinus elliottii* Engelm. var. *elliottii*, *EA 43*. Infrequent. Planted in plantations, especially in the 1950s and 1960s, and also in yards and towns.

Pinus glabra Walter, *A793*. Infrequent. Bottomland forest.

Pinus palustris Mill., *A1192*. Infrequent. Pine forest of the eastern half of the county and high ridges of the Homochitto River basin.

Pinus taeda L., *EA 204*. Abundant. Almost everywhere except cultivated fields and in permanent water. Commonly cultivated in plantations.

MAGNOLIOPHYTA: LILIOPSIDA

AGAVACEAE

Manfreda virginica (L.) Salisb. ex Rose, *L.C.Temple 9821* (MISS!). Infrequent. Pine forest and roadsides.

†*Yucca flaccida* Haw. [*Y. filamentosa* L. in part], *WA&M 70997*. Infrequent. Pine forest, particularly in the Homochitto River basin. Species taxonomy follows Trelease (1902).

ALISMATACEAE

Sagittaria latifolia Willd., *A1459*. Infrequent. Swamps, pond margins, and springs.

ALLIACEAE

**Allium ampeloprasum* L., *A778*. Rare. Perennially wet roadside ditches in full sun.

Allium canadense L. var. *canadense*, *A817*. Common. Roadsides and fields.

Nothoscordum bivalve (L.) Britton, *A264*. Abundant. Fields, roadsides, yards, and cemeteries.

**Nothoscordum gracile* (Aiton) Stearn, *A2423*. Rare. Gravelly ruderal areas in Liberty.

ALSTROEMERIACEAE

◆ **Alstroemeria psittacina* Lehm., *A1919*. Rare. Yard in Liberty.

AMARYLLIDACEAE

Hymenocallis caroliniana (L.) Herbert, *EA 266*. Infrequent. Bottomland hardwood forest.

**Narcissus jonquilla* L., *A374*. Infrequent. Persisting at old home sites and naturalizing into row crop fields.

ARACEAE

Arisaema dracontium (L.) Schott, *A1004*. Infrequent. Mesic hardwood forest.

Arisaema triphyllum (L.) Schott [including *A. quinatum* (Buckl.) Schott], *A506*. Common. Mesic forest, ravines, and occasionally pine forest.

Orontium aquaticum L., *A533*. Infrequent. Springs and sloughs.

ARECACEAE (see PALMAE)

BROMELIACEAE

Tillandsia usneoides (L.) L., *A1391*. Infrequent. Epiphyte on various trees and shrubs in mesic and lowland forest, and on *Quercus* spp. in upland forest or in yards.

COMMELINACEAE

**Commelina diffusa* Burm.f., *A1362*. Infrequent. Sandy margins of rivers.

Commelina virginica L., *A1361*. Infrequent. Sandy margins of rivers.

Tradescantia hirsutiflora Bush, *A741*. Rare. Mixed pine-hardwood upland forest and roadside ditches in the Homochitto River basin.

Tradescantia ohiensis Raf., *A1889*. Locally common. Roadside ditches and yards.

CONVALLARIACEAE

Polygonatum biflorum (Walter) Elliott, *A2065*. Infrequent. Upland hardwood forest and ravines.

CYPERACEAE

**Bulbostylis barbata* (Rottb.) C.B. Clarke, *A2315*. Rare. Cemetery in the southeastern corner of the county.

Bulbostylis capillaris (L.) Kunth ex C.B.Clarke, *A2325*. Locally common. Sandy pine forest and sandbars in the Homochitto River basin.

Carex abscondita Mack., *A1012*. Infrequent. Mature mixed forest.

Carex albicans var. *australis* (L.H. Bailey) Rettig [=*C. physorhyncha* Steud.], *A366*. Infrequent. Hardwood ravines and cemeteries.

Carex albolutescens Schwein., *A906*. Infrequent. Cypress swamps and spring-seeps.

Carex atlantica L.H.Bailey [including *C. atlantica* ssp. *capillacea* (L.H. Bailey) Reznicek], *A909*. Common. Spring-seeps and mesic ravines.

Carex basiantha Steud., *A1013*. Infrequent. Upland hardwood forest, ravines, and bottomland hardwood forest.

Carex blanda Dewey, *A1998*. Infrequent. Ravines and upland hardwood forest.

Carex bromoides var. *bromoides* Schkuhr ex Willd., *A2005*. Rare. Baldcypress swamp along the West Fork Amite River.

Carex caroliniana Schwein., *A1032*. Rare. Hardwood ravine.

Carex cherokeensis Schwein., *A634*. Infrequent. Thick loess and outcrops of clayey subsoil, primarily in the Homochitto River basin.

Carex complanata Torr. & Hook., *A733*. Common. Sandy bottomland, floodplains, clearcuts, and pine forest.

Carex corrugata Fernald [=*C. amphibola* var. *turgida* Fernald], *WA&M 71147*. Rare. Outcrops of clayey subsoil in longleaf pine forest of the Homochitto River basin.

Carex crebriflora Wiegand, *A407*. Common. Roadsides, upland and bottomland hardwood forest, and ravines.

Carex debilis Michx., *A847*. Abundant. Upland mixed forest, longleaf pine forest, outcrops of clayey subsoil in the Homochitto River basin, bottomland and associated midslopes, crevices of *Nyssa biflora* bark.

Carex decomposita Muhl., *A1071*. Rare. Cypress swamp in crevices and bark of *Taxodium distichum*.

Carex digitalis var. *asymmetrica* Fernald, *A861*. Common. Ravines, upland hardwood forest, bottomland hardwood forest, and roadside ditches.

Carex festucacea Schkuhr ex Willd., *A735*. Infrequent. Saffell outcrops and upland hardwood forest.

Carex flaccosperma Dewey, *A696*. Abundant. Bottomland forest, outcrops of clayey subsoil in the Homochitto River basin, and roadside ditches.

Carex frankii Kunth, *A1054*. Common. Bottomland openings, moist ditches in pine forest, upland loess, and oxbow lakes.

Carex glaucescens Elliott, *A1779*. Infrequent. Moist areas associated with pine forest.

Carex intumescens Rudge, *A732*. Locally common. Swamps, mesic hardwood ravines, and bottomland oak flats.

Carex joorii L.H.Bailey, *A1611*. Locally common. Bottomland hardwood forest and swamps.

Carex leptalea Wahlenb., *A736*. Locally common. Spring-seeps and associated swamps.

Carex lonchocarpa Willd., *A2032*. Infrequent. Stream banks and swamps, primarily in the southeastern part of the county.

Carex longii Mack., *WA&M 71218*. Common. Bottomland forest and mesic ravines.

Carex louisianica L.H.Bailey, *A121*. Rare. Old beaver-impounded pond.

Carex lupulina Muhl. ex Willd., *A1445*. Locally common. Riverbanks, swamp margins, and bottomland openings.

Carex lurida Wahlenb., *A1286*. Locally common. Spring-seeps, bottomland forest, and swamps.

Carex muehlenbergii Schkuhr ex Willd. var. *muehlenbergii*, *A1148*. Rare. Saffell outcrops.

Carex nigromarginata Schwein., *A249*. Rare. Mixed forest around rotting stumps.

Carex rosea Schkuhr ex Willd., *A1011*. Infrequent. Saffell outcrops and hardwood ravines.

Carex striatula Michx., *A1033*. Infrequent. Hardwood ravines and bottomland forest.

Carex texensis (Torr.) L.H. Bailey [=*C. retroflexa* var. *texensis* (Torr.) Fernald], *A747*. Common. Gravelly upland openings, yards, and alongside buildings.

Carex tribuloides Wahlenb., *A1047*. Common. Bottomland hardwood forest and Saffell outcrops.

Carex vulpinoidea Michx., *WA&M 71055*. Infrequent. Saffell outcrops and pine cutover.

Cyperus compressus L., *A2421*. Rare. Ruderal in Liberty.

Cyperus echinatus (L.) Wood, *WA&M 70959*. Infrequent. Pine forest.

Cyperus erythrorhizos Muhl., *A2355*. Infrequent. Sandy river margins.

**Cyperus esculentus* L., *A2332*. Infrequent. Sandy river margins and cultivated fields.

Cyperus haspan L., *A1020.* Infrequent. Roadside ditches and pond margins.

**Cyperus iria* L., *WA&M 71065.* Infrequent. Roadside ditches.

Cyperus polystachyos Rottb., *A2359.* Infrequent. Sandy river margins.

Cyperus pseudovegetus Steud., *A1021.* Common. Moist ditches.

Cyperus retrorsus Chapm., *EA 123.* Common. Old fields, pine forest, yards, and roadsides.

**Cyperus rotundus* L., *A556.* Locally common. Cultivated fields.

Cyperus strigosus L., *A1710.* Common. Bottomland edges, ditches, and riversides.

Cyperus virens Michx., *WA&M 71174.* Common. Pond margins and ditches in pine forest.

Eleocharis baldwinii (Torr.) Chapm., *A1929.* Infrequent. Pond margins.

Eleocharis microcarpa Torr., *A1187.* Rare. Wet ditches in pine forest.

Eleocharis obtusa (Willd.) Schult., *A1346.* Common. Pond margins, swamps, and roadside ditches.

Eleocharis tuberculosa (Michx.) Roem. & Schult., *A1762.* Infrequent. Ditches in longleaf pine forest of the Homochitto River basin.

Fimbristylis autumnalis (L.) Roem. & Schult., *A2243.* Infrequent. Bald-cypress swamp of the Homochitto River and pond margins.

Fimbristylis decipiens Kral, *A2422.* Rare. Ruderal in Liberty.

Fimbristylis dichotoma (L.) Vahl, *A2401.* Infrequent. Ditches in pine forest of the Homochitto River basin.

†**Fimbristylis miliacea* (L.) Vahl [as commonly used in the U.S.; or *F. littoralis* Gaud.], *A1519.* Common. Moist areas in pine forest and sandy river margins. See Strong & Kral (1999) for a discussion of the nomenclatural difficulties associated with this taxon.

Fimbristylis tomentosa Vahl, *A1520.* Infrequent. Moist areas in pine forest and roadside ditches.

Isolepis carinata Hook. & Arn. ex Torr. [=*Scirpus koilolepis* (Steud.) Gleason], *A734.* Locally common. Moist open areas.

**Kyllinga brevifolia* Rottb., *A2420.* Infrequent. Ruderal areas in towns.

**Kyllinga odorata* Vahl, *A1783.* Infrequent. Yards.

Kyllinga pumila Michx., *A2360.* Infrequent. Sandy river margins.

Rhynchospora caduca Elliott, *A1514.* Abundant. Bottomland fields, swamp margins, springseeps, and roadside ditches.

Rhynchospora chalarocephala Fernald & Gale, *S.Jones et al. 19951* (MISS!). Rare. Swamps.

Rhynchospora corniculata (Lam.) A. Gray, *A2035.* Infrequent. Perennially wet ditches and swamp margins.

Rhynchospora globularis (Chapm.) Small, *WA&M 71210.* Infrequent. Upland clearcuts in the southeastern part of the county.

Rhynchospora glomerata (L.) Vahl, *WA&M 71226.* Common. Bottomland fields and roadside ditches.

Rhynchospora inexpansa (Michx.) Vahl, *WA&M 71200.* Infrequent. Moist upland openings, such as old ditches in pine forest.

Rhynchospora mixta Britton, *A617.* Infrequent. Margins of dry, upland longleaf or mixed oak-pine forest.

Rhynchospora recognita (Gale) Kral [=*R. globularis* var. *recognita* Gale], *A997.* Common. Roadsides, fields, pine forest, and outcrops of clayey subsoil in the Homochitto River basin.

Scirpus cyperinus (L.) Kunth, *A1317.* Common. Roadside ditches, pond margins, swamp margins, and beaver impoundments.

Scleria ciliata Michx., *A444.* Infrequent. Longleaf pine forest.

Scleria oligantha Michx., *A905.* Common. Upland and bottomland hardwood forest, swamps, outcrops of clayey subsoil, and pine forest.

Scleria pauciflora Muhl. ex Willd. var. *pauciflora*, *A886.* Infrequent. Cemeteries.

Scleria triglomerata Michx., *WA&M 71134.* Infrequent. Pine forest.

DIOSCOREACEAE

Dioscorea quaternata Walter ex J.F. Gmel., *A1669.* Infrequent. Mesic hardwood forest and rich ravines.

Dioscorea villosa L., *A2107.* Infrequent. Saffell outcrops.

GRAMINEAE

Agrostis hyemalis (Walter) B.S.P., *A1930.* Common. Pine forest, roadsides, and fields.

Agrostis perennans (Walter) Tuck., *A1596.* Infrequent. Swamp margins, moist roadsides, and Saffell outcrops.

Alopecurus carolinianus Walter, *A2446.* Infrequent. Pond margins and cattle pasture.

Andropogon glomeratus var. *pumilus* Vasey ex Dewey, *A1691*. Common. Clearcuts and old fields.

Andropogon gyrans Ashe var. *gyrans*, *Ray 5471* (MISSA; specimen not seen). Cited in Campbell (1983). Now reportedly extirpated from MS (Kartesz 1999).

Andropogon ternarius Michx. var. *ternarius*, *A1650*. Infrequent. Pine forest.

Andropogon virginicus L. var. *virginicus*, *A1627*. Abundant. Old fields, pine forest, clearcuts, and roadsides.

Aristida dichotoma Michx. var. *dichotoma*, *A1788*. Infrequent. Pine forest.

Aristida longespica Poir. var. *longespica*, *A1787*. Common. Pine forest.

Aristida oligantha Michx., *A2801*. Infrequent. Pine forest and roadsides.

Aristida purpurascens Poir. var. *purpurascens*, *A1804*. Abundant. Pine forest.

**Arthraxon hispidus* (Thunb.) Makino, *A2328*. Rare. Sandy margins of the Homochitto River.

Arundinaria gigantea (Walter) Muhl. ssp. *gigantea*, *A978*. Common. Bottomland forest, ravines, and upland hardwood and mixed forest.

**Avena sativa* L., *A855*. Infrequent. Old fields.

Axonopus fissifolius (Raddi) Kuhlm., *A2446*. Infrequent. Fields and yards.

**Briza minor* L., *EA 242*. Common. Yards, old fields, and disturbed areas in town.

**Bromus catharticus* Vahl, *A722*. Infrequent. Disturbed areas, clearcuts, and roadsides.

**Bromus commutatus* Schrad., *A856*. Abundant. Pastures, fields, and roadsides.

Chasmanthium latifolium (Michx.) H.O.Yates, *A1366*. Locally common. Riversides and roadside ditches.

Chasmanthium laxum (L.) H.O. Yates, *A1337*. Infrequent. Forest of all sorts.

Chasmanthium sessiliflorum (Poir.) H.O. Yates, *A1680*. Abundant. Upland hardwood and mixed forest, ravines, and less commonly pine forest.

**Cynodon dactylon* (L.) Pers., *A854*. Abundant. Pastures, old fields, yards, roadsides, and riversides.

**Dactylis glomerata* L., *A1173*. Infrequent. Roadsides and disturbed gravelly areas.

Danthonia sericea Nutt., *A667*. Common. Roadsides.

**Digitaria ciliaris* (Retz.) Koeler, *A1441*. Common. Riversides and bottomland edges.

Digitaria ischaemum (Schreb.) Muhl. var. *ischaemum*, *A1599*. Common. Yards and roadsides.

**Echinochloa colona* (L.) Link, *A1405*. Common. Old fields, pastures, and pine forest.

Echinochloa muricata var. *microstachya* Wiegand, *A2335*. Rare. Sandbars of the Homochitto River.

**Eleusine indica* (L.) Gaertn., *A2424*. Infrequent. Ruderal areas in towns.

Elymus virginicus L., *A916*. Abundant. Bottomland open areas, roadside ditches, and riversides.

Eragrostis capillaris (L.) Nees, *A2805*. Infrequent. Pine forest and roadsides.

Eragrostis elliottii S.Watson, *A1625*. Common. Pine forest, roadsides, and ditches.

Eragrostis hirsuta (Michx.) Nees, *A2331*. Infrequent. Sandy river margins and associated pine forest.

Eragrostis hypnoides (Lam.) B.S.P., *A2829*. Infrequent. Pond margins.

Eragrostis refracta (Muhl.) Scribn., *A2284*. Common. Pine forest and rarely old fields.

Eragrostis spectabilis (Pursh) Steud., *A1546*. Abundant. Pine forest, old fields, and roadsides.

**Eremochloa ophiuroides* (Munro) Hack., *A1524*. Common. Yards, fields, roadsides, and cemeteries.

Hordeum pusillum Nutt., *A726*. Common. Old fields and pastures.

Leersia lenticularis Michx., *A1307*. Rare. Baldcypress swamp margins.

Leersia oryzoides (L.) Sw., *A1794*. Infrequent. Riversides.

Leersia virginica Willd., *A1727*. Common. Moist bottomland forest, swamps, and spring seeps.

Lolium arundinaceum (Schreb.) Darbysh. [=*Festuca arundinacea* Schreb.], *A2013*. Infrequent. Roadsides and farms, particularly in the northeastern part of the county.

**Lolium perenne* L., *A583*. Abundant. Fields and roadsides.

Melica mutica Walter, *A674*. Locally common. Saffell outcrops, gravelly forest, and bottomland roadsides.

Muhlenbergia schreberi J.F.Gmel., *A2834*. Infrequent. Roadside ditches and bottomland fields.

Oplismenus hirtellus ssp. *setarius* (Lam.) Mez ex Ekman [=*O. setarius* (Lam.) Roem. & Schult.], *A1464*. Infrequent. Bottomland forest, swamps, spring-seeps, and shaded yards.

Panicum: Taxonomy follows Lelong (1986). Recognition of *Dichanthelium* without *Phanopyrum* will require the transfer of numerous intermediates to other genera, or recognition of *Dichanthelium* with *Phanopyrum* will require transfer of *Dichanthelium* to *Phanopyrum* (the older name) or conservation (cf. Zuloaga et al. [1993] and phylogenetic reanalysis [Alford, unpubl. data]).

†*Panicum aciculare* Desv. ex Poir. [=*Dichanthelium aciculare* (Desv. ex Poir.) Gould & C.A.Clark, in part], *A1426*. Abundant. Pine forest and cemeteries.

†*Panicum acuminatum* Sw. var. *acuminatum* (sensu Lelong) [=*P. lanuginosum* Elliott, *Dichanthelium acuminatum* (Sw.) Gould & C.A.Clark, in part], *A1756*. Abundant. Pine forest, clearcuts, and roadsides.

†*Panicum acuminatum* var. *fasciculatum* (Torr.) Lelong [=*Dichanthelium acuminatum* var. *fasciculatum* (Torr.) Freckmann], *A1979*. Infrequent. Clearcuts.

†*Panicum acuminatum* var. *lindheimeri* (Nash) Lelong [=*Dichanthelium acuminatum* var. *lindheimeri* (Nash) Gould & C.A.Clark], *WA&M 71220*. Infrequent. Clearcuts.

†*Panicum acuminatum* var. *unciphyllum* (Trin.) Lelong [=*Dichanthelium meridionale* (Ashe) Freckmann], *WA&M 70869*. Common. Clearcuts, pine forest, sandy bottomland, and gravelly areas.

Panicum anceps Michx. [including *P. anceps* var. *rhizomatum* (Hitchc. & Chase) Fernald], *A1198*. Common. Roadside ditches and pine forest.

†*Panicum angustifolium* Elliott [=*Dichanthelium aciculare* (Desv. ex Poir.) Gould & C.A.Clarke, in part], *A2022*. Infrequent. Burned pine forest.

†*Panicum boscii* Poir. [=*Dichanthelium boscii* (Poir.) Gould & C.A.Clarke], *A1985*. Common. Upland hardwood and mixed forest and ravines.

†*Panicum commutatum* Schult. var. *commutatum* [=*Dichanthelium commutatum* (Schult.) Gould, in part], *WA&M 71057*. Infrequent. Pine forest.

†*Panicum dichotomum* var. *ramulosum* (Torr.) Lelong [=*Dichanthelium dichotomum* L. var. *dichotomum*, in part], *A1610*. Common. Bottomland hardwood forest and low-water swamps.

†*Panicum gymnocarpon* Elliott [=*Phanopyrum gymnocarpon* (Elliott) Nash], *A1822*. Locally common. Old river beds and swamp margins.

†*Panicum hians* Elliott [=*Steinchisma hians* (Elliott) Nash], *A2061*. Locally common. Swamp margins and pond margins.

†*Panicum laxiflorum* Lam. [=*Dichanthelium laxiflorum* (Lam.) Gould, *P. xalapense* Kunth], *A1064*. Common. Upland pine forest, bottomland edge, and cemeteries.

†*Panicum polyanthes* Schult. [=*Dicanthelium sphaerocarpon* var. *isophyllum* (Scribn.) Gould & C.A. Clark], *A969*. Infrequent. Mixed forest.

†*Panicum ravenelii* Scribn. & Merr. [=*Dichanthelium ravenelii* (Scribn. & Merr.) Gould], *A450*. Rare. Outcrops of clayey subsoil in longleaf pine forest of the Homochitto River basin.

Panicum rigidulum Bosc ex Nees, *A1598*. Locally common. Bottomland forest edges, spring-seeps, swamp margins, and roadside ditches.

†*Panicum scoparium* Lam. [=*Dichanthelium scoparium* (Lam.) Gould], *A1600*. Common. Pine forest and roadsides.

†*Panicum sphaerocarpon* Elliott [=*Dichanthelium sphaerocarpon* (Elliott) Gould, in part], *A812*. Locally common. Pine forest and clearcuts.

†*Panicum strigosum* Muhl. ex Elliott var. *strigosum* [=*Dichanthelium strigosum* (Muhl. ex Elliott) Freckmann var. *strigosum*], *A1428*. Rare. Loblolly and shortleaf pine forest.

†*Panicum tenue* Muhl. [=*Dichanthelium dichotomum* var. *tenue* (Muhl.) Gould & C.A. Clark], *A449*. Rare. Outcrops of clayey subsoil in longleaf pine forest of the Homochitto River basin.

Panicum verrucosum Muhl., *A1597*. Common. Roadside ditches and pond margins.

Panicum virgatum L. var. *virgatum*, *A1545*. Common. Old fields and roadsides.

Paspalum boscianum Flüggé, *A1614*. Infrequent. Roadside ditches.

**Paspalum dilatatum* Poir., *A962*. Abundant. Pastures, old fields, roadsides, and yards.

Paspalum floridanum Michx., *A1748*. Infrequent. Pine forest and roadsides.

Paspalum laeve Michx., *A1655*. Infrequent. Pine forest in the southeastern part of the county.

**Paspalum notatum* var. *saurae* Parodi, *A939*. Abundant. Pastures, old fields, disturbed areas in town, and yards.

Paspalum plicatulum Michx., *WA&M 71132*. Rare. Pine forest of the Homochitto River basin.

Paspalum setaceum Michx., *A957*. Infrequent. Pine forest of the Homochitto River basin.

**Paspalum urvillei* Steud., *A938*. Common. Roadsides and old fields.

**Phalaris angusta* Nees ex Trin., *A860*. Rare. Roadside ditches.

Phalaris caroliniana Walter, *A584*. Infrequent. Roadsides and old fields.

**Phyllostachys aurea* Carrière ex Rivière & C.Rivière, *A1224*. Infrequent. Bottomlands in the southwestern part of the county and persisting around old homes.

Piptochaetium avenaceum (L.) Parodi [=*Stipa avenacea* L.], *A1897*. Rare. Steep ravine of the Homochitto River basin.

**Poa annua* L., *A210*. Locally common. Yards, disturbed areas in town, and fields.

Poa autumnalis Muhl. ex Elliott, *A275*. Common. Bottomland forest, upland hardwood and mixed forest, Saffell outcrops, and yards.

Saccharum baldwinii Spreng. [=*Erianthus strictus* Elliott], *A1475*. Infrequent. Bottomland edges and riversides.

Saccharum brevibarbe var. *contortum* (Elliott) R.D.Webster [=*S. contortum* (Elliott) Nutt., *Erianthus contortus* Baldwin ex Elliott], *A1648*. Common. Bottomland openings, clear-cuts, and roadsides.

Saccharum giganteum (Walter) Pers. [=*Erianthus giganteus* (Walter) P.Beauv.], *A1664*. Infrequent. Pond margins and ditches in pine forest.

Sacciolepis striata (L.) Nash, *A2358*. Rare. Sandy margin of the West Fork Amite River.

Schizachyrium scoparium (Michx.) Nash, *A1626*. Abundant. Pine forest, clearcuts, and roadsides.

**Setaria glauca* (L.) P.Beauv., *A1404*. Common. Pastures, old fields, and moist roadsides.

Setaria parviflora (Poir.) Kerguélen [=*S. geniculata* P.Beauv.], *A1647*. Rare. Xeric roadsides.

Sorghastrum elliottii (C.Mohr) Nash, *A2389*. Infrequent. Pine forest.

**Sorghum halepense* (L.) Pers., *A1117*. Common. Roadsides.

Sphenopholis filiformis (Chapm.) Hitchc., *A2550*. Rare. Cemetery in the eastern half of the county.

Sphenopholis obtusata (Michx.) Scribn., *A587*. Infrequent. Roadsides, pastures, and disturbed areas in town.

**Sporobolus indicus* (L.) R.Br., *A1732*. Common. Fields, pastures, yards, and disturbed areas in town.

Sporobolus junceus (P.Beauv.) Kunth, *A1645*. Infrequent. Pine forest in the eastern part of the county.

**Stenotaphrum secundatum* (Walter) Kuntze, *EA 265*. Common. Lawns and fields.

Tridens flavus (L.) Hitchc., *A1484*. Common. Roadsides and fields.

Tripsacum dactyloides (L.) L., *A1227*. Infrequent. Roadside ditches, riverbanks, and pine forest.

**Triticum aestivum* L., *A835*. Infrequent. Fields and food plots.

Urochloa platyphylla (Munro ex C. Wright) R.D. Webster [=*Brachiaria platyphylla* (Munro ex C.Wright) Nash], *A1215*. Infrequent. Cultivated fields.

**Vulpia myuros* (L.) C.C.Gmel., *A721*. Common. Disturbed areas and roadsides.

Vulpia octoflora (Walter) Rydb. var. *octoflora*, *A664*. Infrequent. Roadsides.

HEMEROCALLIDACEAE

**Hemerocallis fulva* (L.) L., *A814*. Infrequent. Roadsides and old home sites.

HYACINTHACEAE

**Muscari neglectum* Guss. ex Ten., *A376*. Rare. Fallow soybean fields.

HYDROCHARITACEAE

Vallisneria americana Michx., *A337*. Locally common. In channel and margins of both forks of the Amite River and its tributaries, occasionally in spring-fed streams.

HYPOXIDACEAE

Hypoxis hirsuta (L.) Coville, *A2021*. Infrequent. Pine forest, primarily those that are occasionally burned, in the Homochitto River basin and in the southeastern corner of the county, rarely along sandy stream margins of the Homochitto River basin.

IRIDACEAE

**Gladiolus × gandavensis* Van Houtte, *A689*. Infrequent. Roadside ditches.

**Gladiolus communis* ssp. *byzantinus* (Mill.) A.P.Ham., *A529*. Rare. Old house sites.

Iris brevicaulis Raf., *A790*. Rare. Edges of bottomland hardwood forest along the East Fork Amite River.

**Iris pseudacoris* L., *A537*. Infrequent. Perennially wet ditches and shallow abandoned ponds.

Sisyrinchium angustifolium Mill., *A911*. Common. Pine forest, midslope mixed forest, and ungrazed pasture land.

*†*Sisyrinchium exile* E.P. Bicknell (*S. rosulatum* E.P. Bicknell, in part), *A556*. Infrequent. Roadsides and pastures. Species taxonomy follows Shinners (1962).

Sisyrinchium mucronatum Michx., *A1880*. Rare. Pine forest in the eastern half of the county.

Sisyrinchium rosulatum E.P. Bicknell, *A631*. Common. Roadsides and pastures.

JUNCACEAE

Juncus acuminatus Michx., *A895*. Infrequent. Bottomland fields and openings.

Juncus biflorus Elliott, *A638*. Locally common. Open moist areas and roadside ditches.

Juncus brachycarpus Engelm., *WA&M 70996*. Rare. Open swamp.

Juncus bufonius L., *A1948*. Rare. Bottomland hardwood forest.

Juncus coriaceus Mack., *A1446*. Locally common. Open swamps, roadside ditches, riverbanks, moist fields, and hardwood forest.

Juncus diffusissimus Buckley, *A913*. Common. Open swampy areas, roadside ditches, and moist bottomland fields.

Juncus effusus L., *A620*. Locally common. Swamps, roadside ditches, and moist fields.

Juncus marginatus Rostk., *WA&M 71161*. Infrequent. Moist openings.

Juncus repens Michx., *A1923*. Infrequent. Pond margins and perennially wet ditches.

Juncus tenuis Willd., *A699*. Abundant. Roadside ditches, forest edges, old woods roads, clearcuts, and swamps.

Juncus validus Coville, *A1022*. Locally common. Open swamps and roadside ditches.

Luzula acuminata var. *carolinae* (S.Watson) Fernald, *A2522*. Rare. Steep gravelly bluff overlooking the East Fork Amite River.

Luzula bulbosa (Wood) Smyth and L. Smyth, *A297*. Infrequent. Roadsides in town.

Luzula echinata (Small) F.J.Herm., *A277*. Common. Saffell outcrops, mature hardwood forest, bottomland hardwood forest, and yards.

LEMNACEAE

Lemna aequinoctialis Welw., *A1351*. Infrequent. Stagnant ditches, small streams, beaver-impounded ponds, and sloughs.

Lemna valdiviana Philippi, *A2581*. Rare. Slough of the East Fork Amite River.

LILIACEAE

Chamaelirium luteum (L.) A. Gray. Infrequent. Upland hardwood forest.

Lilium michauxii Poir., *A2018*. Infrequent. Upland hardwood forest.

MELANTHIACEAE

Aletris aurea Walter, *A1095*. Infrequent. Longleaf pine forest, especially ridge outcrops of clayey subsoil in the Homochitto River basin.

Melanthium virginicum L., *A1298*. Rare. Spring-seep in the Homochitto River basin.

ORCHIDACEAE

Epidendrum conopseum W.T. Aiton, *A1369*. Infrequent. Epiphytic on *Magnolia grandiflora* along rivers, especially in the East Fork Amite River drainage.

Listera australis Lindl., *A423*. Rare. Bottomland hardwood forest along West Fork Amite River.

Malaxis unifolia Michx., *A845*. Rare. Mesic upland hardwood forest.

Platanthera ciliaris (L.) Lindl., *A41*. Rare. Moist hardwood drains between longleaf pine dominated ridges of the Homochitto River drainage.

Platanthera flava (L.) Lindl. var. *flava*, *A1328*. Infrequent. Spring-seeps and low-water swamps.

Spiranthes cernua (L.) Rich., *A60*. Rare. Spring-seep and low water swamp of the West Fork Amite River.

Spiranthes ovalis Lindl., *A1668*. Rare. Mesic hardwood ravine.

Spiranthes praecox (Walter) S.Watson, *A1941.* Infrequent. Pine forest.

Spiranthes tuberosa Raf., *A1191.* Infrequent. Cemeteries and yards.

Spiranthes vernalis Engelm. & A.Gray, *A2079.* Common. Fields, yards, roadsides, and cemeteries.

Tipularia discolor (Pursh) Nutt., *A1388.* Infrequent. Upland hardwood forest.

PALMAE

Sabal minor (Jacq.) Pers., *A1211.* Infrequent. Spring-seeps, bottomland hardwood forest, and swamp margins.

POACEAE (see **GRAMINEAE**)

POTAMOGETONACEAE

Potamogeton diversifolius Raf., *A2294.* Infrequent. Tributaries and open spring-fed waters in the Amite River drainage.

Potamogeton pulcher Tuck., *A2582.* Rare. Open slough of the East Fork Amite River.

SMILACACEAE

Smilax bona-nox L., *A889.* Common. Upland forest, secondary forest, and Saffell outcrops.

Smilax glauca Walter, *A1920.* Abundant. Pine forest and roadsides.

Smilax laurifolia L., *A1839.* Locally common. Swamps, swamp margins, and bottomland hardwood forest.

Smilax pulverulenta Michx., *A2537.* Infrequent. Upland hardwood forest.

Smilax pumila Walter, *A1638.* Locally common. Saffell outcrops and unburned longleaf pine forest in the Homochitto River basin and southeastern corner of county.

Smilax rotundifolia L., *A2044.* Abundant. Forest of all sorts.

Smilax smallii Morong, *A1829.* Abundant. Forest of all sorts.

Smilax tamnoides L., *A1162.* Abundant. Upland forest, secondary forest, bottomland forest, and Saffell outcrops.

Smilax walteri Pursh, *A1840.* Infrequent. Swamps.

SPARGANIACEAE

Sparganium americanum Nutt., *A2027.* Infrequent. Swamps, marshes, impoundments of water near forest, and perennially-wet roadside ditches.

TRILLIACEAE

Trillium foetidissimum J.D. Freeman, *A300.* Infrequent. Bottomland hardwood forest and occasionally in rich ravines.

TYPHACEAE

Typha latifolia L., *A881.* Infrequent. Roadside ditches and pond margins.

UVULARIACEAE

Uvularia perfoliata L., *A1885.* Infrequent. Mature hardwood forest and steep ravines.

XYRIDACEAE

**Xyris jupicai* Rich., *A1657.* Rare. Old farm ponds in southeastern corner of county.

Xyris laxifolia var. *iridifolia* (Chapm.) Kral [=*X. iridifolia* Chapm.], *A1297.* Infrequent. Spring-seeps, *Nyssa* swamps, and perennially wet ditches in full sun.

MAGNOLIOPHYTA: MAGNOLIOPSIDA

ACANTHACEAE

Hygrophila lacustris (Schltdl. & Cham.) Nees, *A1109.* Infrequent. Riverbank sand and gravel, often submerged.

Justicia ovata var. *lanceolata* (Chapm.) R.W.Long, *A768.* Locally common. Riverbank sand and gravel, pond margins, and swamp margins.

Ruellia caroliniensis (J.F.Gmel.) Steud. var. *caroliniensis*, *A920.* Common. Fields, open bottomland, and roadsides.

ACERACEAE

Acer barbatum Michx., *A2115.* Infrequent. Mature hardwood or mixed forest, primarily in the Homochitto River basin.

Acer negundo L, *A395.* Common. River-banks and sandy bottomland forest.

Acer rubrum L. var. *rubrum*, *A259.* Abundant. Forest of all sorts.

Acer rubrum L. var. *drummondii* (Hook. & Arn. ex Nutt.) Sarg., *A1076.* Infrequent. Swamps and bottomland, particularly along the Homochitto River.

Acer saccharinum L., *A2025.* Rare. Bottomland forest in the southeastern corner of the county.

ADOXACEAE

†*Sambucus canadensis* L. [=*S. nigra* ssp. *canadensis* Bolli], *A792.* Abundant. Mesic

roadsides, fencerows, and edges of bottom land forest. Rank is arbitrary here, and I choose to maintain the historical usage.

Viburnum nudum L., *A569*. Locally common. Swamps.

Viburnum rufidulum Raf., *A433*. Infrequent. Saffell outcrops and ravines.

†*Viburnum scabrellum* Torr. & A. Gray ex Chapm. [=*V. dentatum* var. *scabrellum* Torr. & A. Gray], *A576*. Common. Upland forest, ravines, and Saffell outcrops. Species taxonomy follows McAtee (1956).

AMARANTHACEAE

**Alternanthera philoxeroides* (Mart.) Griseb., *A795*. Infrequent. Bottomland fields and roadside ditches.

**Amaranthus spinosus* L., *A1220*. Infrequent. Pastures and cultivated fields.

ANACARDIACEAE

Rhus copallinum L., *A1739*. Abundant. Pine forest, secondary forest, fencerows, and roadsides.

Rhus glabra L., *A941*. Infrequent. Pine forest, fencerows, and roadsides.

Toxicodendron radicans (L.) Kuntze, *A1126*. Abundant. Widespread, but especially common in secondary forest and unburned pine or upland hardwood forest.

Toxicodendron pubescens Mill. [=*T. toxicarium* Gillis, =*T. quercifolium* (Michx.) Greene], *A1185*. Infrequent. Pine forest, primarily in the southeastern part of the county.

Toxicodendron vernix (L.) Kuntze, *A1105*. Rare. Swamp along the East Fork Amite River.

ANNONACEAE

Asimina triloba (L.) Dunal, *EA 54*. Infrequent. Bottomland hardwood forest and Saffell outcrops.

APIACEAE (see UMBELLIFERAE)

APOCYNACEAE

Trachelospermum difforme (Walter) A.Gray, *A717*. Infrequent. Sandy bottomland forest, upland pine forest, and upland forest edges.

**Vinca major* L., *A357*. Infrequent. Roadsides and around old homes.

AQUIFOLIACEAE

Ilex ambigua (Michx.) Torr., *A1390*. Infrequent. Mature hardwood forest of Saffell outcrops.

Ilex coriacea (Pursh) Chapm., *A1116*. Infrequent. Swamps in the East Fork Amite River drainage.

Ilex decidua Walter, *A412*. Common. Various forest and forest edges.

Ilex longipes Chapm. ex Trel., *A439*. Common. Midslope or upland mature forest.

Ilex opaca Aiton, *A538*. Common. Mature forest.

Ilex verticillata (L.) A.Gray, *A510*. Locally common. Swamps, margins of beaver-impounded ponds, and bottomland forest.

Ilex vomitoria Aiton, *A437*. Common. Upland forest, roadsides, and fencerows.

ARALIACEAE

Aralia spinosa L., *A1552*. Infrequent. Upland pine forest and roadsides.

**Hedera helix* L., *A1230*. Infrequent. Old home sites.

ARISTOLOCHIACEAE

Aristolochia serpentaria L., *A2082*. Infrequent. Saffell outcrops, ravines, bluffs, and mature hardwood forest.

Hexastylis arifolia (Michx.) Small var. *arifolia* [=*Asarum arifolium* Michx.], *A1886*. Infrequent. Mature bottomland hardwood forest.

ASCLEPIADACEAE

Asclepias amplexicaulis Sm., *WA&M 70994*. Infrequent. Pine forest.

Asclepias longifolia Michx., *A1938*. Rare. Pine forest.

Asclepias perennis Walter, *A1006*. Rare. Old dry oxbow lake with baldcypress in the Homochitto River drainage.

Asclepias tuberosa L., *A688*. Common. Pine forest and roadsides.

Asclepias variegata L., *A591*. Common. Forest of all sorts.

Asclepias verticillata L., *WA&M 70866*. Rare. Pine forest in the southeastern part of the county.

Asclepias viridiflora Raf., *A1281*. Infrequent. Longleaf pine forest and ridges of the Homochitto River basin.

Asclepias viridis Walter, *A565*. Infrequent. Longleaf pine forest and ridges of the Homochitto River basin.

Matelea carolinensis (Jacq.) Woodson, *A952*. Infrequent. Rich ravines and Saffell outcrops.

Matelea gonocarpos (Walter) Shinners, *A972*. Infrequent. Upland hardwood forest and open ravines.

ASTERACEAE (see **COMPOSITAE**)

BALSAMINACEAE

Impatiens capensis Meerb., *A650*. Infrequent. Floodplains and riverbanks.

BERBERIDACEAE

**Nandina domestica* Thunb., *A1678*. Infrequent. Commonly planted and sparingly naturalizing to all kinds of forest.

Podophyllum peltatum L., *A338*. Infrequent. Midslope hardwood forest and ravines.

BETULACEAE

Betula nigra L., *A2506*. Locally common. Riverbanks and pond margins.

Carpinus caroliniana Walter ssp. *caroliniana*, *WA&M 70905*. Abundant. Bottomland forest, ravines, and mature forest of various sorts.

Ostrya virginiana (Mill.) K. Koch, *A1994*. Common. Mature forest, bottomland forest, ravines, and Saffell outcrops.

BIGNONIACEAE

Bignonia capreolata L., *A512*. Abundant. Forest, forest edges, and dense fencerows.

Campsis radicans (L.) Seem. ex Bureau, *A852*. Abundant. Forest edges and fencerows.

Catalpa bignonioides Walter, *A796*. Infrequent. Old fields, fencerows, and persisting from cultivation at homes and ponds. Possibly non-native.

BORAGINACEAE

Cynoglossum virginianum L. var. *virginianum*, *A1001*. Rare. Upland mature forest of the Homochitto River basin.

**Heliotropium indicum* L., *EA 184*. Infrequent. Ruderal areas in towns.

Lithospermum tuberosum Rugel ex DC., *A1174*. Infrequent. Saffell outcrops.

Myosotis macrosperma Engelm., *A492*. Infrequent. Mesic semi-openings and yards.

BRASSICACEAE (see **CRUCIFERAE**)

BUDDLEJACEAE

Polypremum procumbens L., *A832*. Abundant. Pine forest, clearcut areas, road sides, and disturbed sites.

BUXACEAE

Pachysandra procumbens Michx., *A2574*. Infrequent. Mixed upland forest in the Homochitto River basin and hardwood forest of Saffell outcrops in the Amite River drainage.

CABOMBACEAE

Brasenia schreberi J.F.Gmel., *WA&M 71089*. Infrequent. Beaver impounded ponds and old impoundments of various sorts.

CALLITRICHACEAE

Callitriche heterophylla Pursh, *A2433*. Infrequent. Ponds and beaver-impoundments.

Callitriche peploides Nutt. var. *pepoides*, *A2557*. Rare. Cleared forest in the northeastern part of the county.

CAMPANULACEAE

Lobelia appendiculata A.DC., *A874*. Pine forest, upland open areas, and gravelly bottomland woods roads.

Lobelia cardinalis L. var. *cardinalis*, *A70*. Common. Bottomland openings and riverbanks.

Lobelia puberula Michx., *A1633*. Abundant. Roadsides.

Triodanis biflora (Ruiz & Pav.) Greene, *A365*. Common. Roadsides, ruderal areas in towns, and yards.

Triodanis perfoliata (L.) Nieuwl., *A500*. Infrequent. Bottomland semi-open areas and yards.

**Wahlenbergia marginata* (Thunb.) A.DC., *A718*. Roadsides and gravelly disturbed areas.

CAPPARACEAE

**Cleome hassleriana* Chodat, *WA&M 70900*. Infrequent. Riverbanks and sandbars.

CAPRIFOLIACEAE

**Lonicera japonica* Thunb., *A478*. Abundant. Secondary forest, roadsides, and fencerows.

Lonicera sempervirens L. var. *sempervirens*, *A434*. Infrequent. Forest edges.

CARYOPHYLLACEAE

Arenaria lanuginosa (Michx.) Rohrb., *A713*. Infrequent. Saffell outcrops.

**Cerastium glomeratum* Thuill., *A266*. Abundant. Roadsides, fields, ruderal areas in towns, and yards.

Sagina decumbens (Elliott) Torr. & A.Gray, *A369*. Infrequent. Old fields, yards, and ruderal areas in towns.

Silene antirrhina L., *A2553*. Infrequent. Roadsides and farms in the eastern half of the county.

Silene stellata (L.) W.T.Aiton, *A1131*. Infrequent. Saffell outcrops.

***Stellaria media* (L.) Vill., *A285*. Abundant. Old fields, roadsides, ruderal areas in towns, and yards.

CELASTRACEAE

Euonymus americanus L., *A1702*. Infrequent. Upland hardwood forest.

**Euonymus fortunei* (Turcz.) Hand.-Mazz., *A2800*. Rare. Long-persisting after cultivation.

Lepuropetalon spathulatum Muhl. ex Elliott, *A1872*. Infrequent. Cemeteries.

CHENOPODIACEAE

**Chenopodium ambrosioides* L., *A2354*. Infrequent. Sandy river margins.

CISTACEAE

Helianthemum carolinianum (Walter) Michx., *A320*. Infrequent. Pine forest and cemeteries.

Lechea mucronata Raf., *A1636*. Infrequent. Pine forest, clearcuts, and roadsides, especially in the eastern half of the county.

Lechea tenuifolia Michx., *A2010*. Infrequent. Roadsides and pine forest in the eastern half of the county.

CLUSIACEAE (see GUTTIFERAE)

COMPOSITAE

Acmella oppositifolia var. *repens* (Walter) R.K. Jansen [=*Spilanthes americana* var. *repens* (Walter) A.H.Moore], *EA 31*. Infrequent. Riversides and sandy bottomland.

Ageratina aromatica (L.) Spach, *A1715*. Infrequent. Pine forest.

Ambrosia artemisiifolia L., *EA 61*. Abundant. Old fields, clearcuts, and roadsides.

Ambrosia trifida L., *A1708*. Common. Roadside ditches.

Antennaria plantaginifolia (L.) Richardson, *A382*. Infrequent. Gravelly roadsides, roadside banks, and upland pine forest.

Antennaria solitaria Rydb., *A1894*. Rare. Steep ravines of the Homochitto River basin.

**Anthemis cotula* L., *A819*. Infrequent. Cattle farms and old fields.

Arnoglossum plantagineum Raf., *A2041*. Infrequent. Swamps and spring-seeps.

Baccharis halimifolia L., *EA 137*. Common. Pine forest.

Bidens aristosa (Michx.) Britton [including *B. polylepis* S.F.Blake], *A1586*. Common. Roadside ditches.

Bidens bipinnata L., *A2349*. Rare. Roadside.

Bidens discoidea (Torr. & A. Gray) Britton, *A2250*. Infrequent. Swamps.

Boltonia asteroides (L.) L'Hér., *A1442*. Infrequent. Roadsides and sandy river margins.

Boltonia diffusa Elliott, *A1273*. Common. Pine forest and roadsides.

Chromolaena ivifolia (L.) King & H.Robins. [=*Eupatorium ivifolium* L.], *A2808*. Infrequent. Open roadsides.

Chrysopsis mariana (L.) Elliott, *A1635*. Abundant. Upland pine forest, old fields, and roadsides.

Chrysopsis pilosa Nutt., *A1294*. Infrequent. Upland pine forest, particularly in the Homochitto River basin.

Cirsium altissimum (L.) Spreng., *A1673*. Infrequent. Upland forest edges and gravelly clearcuts.

Cirsium carolinianum (Walter) Fernald & B.G.Schub., *A1939*. Infrequent. Pine forest, especially in the Homochitto River basin and in the southeastern part of the county.

Cirsium horridulum Michx., *A794*. Abundant. Old fields, roadsides, and forest edges.

Cirsium nuttallii DC., *A1324*. Infrequent. Upland pine forest and gravelly areas.

**Cirsium vulgare* (Savi) Ten., *A830*. Infrequent. Clearcuts.

Conoclinium coelestinum (L.) DC. [=*Eupatorium coelestinum* L.], *EA 33*. Abundant. Old fields and roadsides.

Conyza canadensis (L.) Cronquist, *A1290*. Infrequent. Upland pine forest and roadsides.

†*Conyza parva* Cronquist [=*C. canadensis* var. *pusilla* (Nutt.) Cronquist], *A1728*. Common. Moist roadsides. Species taxonomy follows Cronquist (1980).

Coreopsis lanceolata L., *A441*. Common. Roadsides and upland forest edges.

Coreopsis pubescens Elliott var. *pubescens*, *A806*. Infrequent. Roadsides and upland forest edges.

**Coreopsis tinctoria* Nutt. var. *tinctoria*, *A1019*. Infrequent. Pine forest, especially of the Homochitto River basin.

Coreopsis tripteris L., *A1539*. Infrequent. Pine forest, clearcuts, and roadsides.

Eclipta prostrata (L.) L., *A1535*. Infrequent. Old fields and lawns.

Elephantopus carolinianus Raeusch., *A1454*. Locally common. Bottomland hardwood forest.

Elephantopus tomentosus L., *A1329*. Common. Upland hardwood and mixed forest.

Erigeron annuus (L.) Pers., *A936*. Infrequent. Clearcuts, old fields, and roadsides.

Erigeron philadelphicus L., *A228*. Common. Roadsides, yards, upland hardwood forest, and Saffell outcrops.

Erigeron strigosus var. *beyrichii* (Fisch. & C.A. Mey.) Torr. & A. Gray ex A. Gray, *A598*. Abundant. Roadsides and fields.

Erigeron tenuis Torr. & A. Gray, *A224*. Infrequent. Wooded yards.

Eupatorium album L., *A1283*. Infrequent. Pine forest and upland mixed forest.

Eupatorium capillifolium (Lam.) Small, *EA 132*. Abundant. Old fields, upland forest edges, and roadsides.

Eupatorium hyssopifolium L., *A2279*. Infrequent. Pine forest.

Eupatorium perfoliatum L., *A1605*. Infrequent. Old fields, forest margins, and roadsides.

Eupatorium × pinnatifidum Elliott, *EA 107*. Abundant. Clearcuts, roadsides, and pine forest.

Eupatorium rotundifolium L. var. *rotundifolium*, *A1275*. Common. Pine forest.

Eupatorium semiserratum DC., *A1661*. Common. Pine forest edges, secondary forest edges, and old fields.

Eupatorium serotinum Michx., *A1688*. Abundant. Roadsides and clearcuts.

Eurybia hemispherica (Alexander) Nesom [=*Aster hemisphaericus* Alexander, *Aster paludosus* ssp. *hemisphericus* (Alexander) Cronquist], *A1407*. Common. Roadsides and upland pine forest.

Euthamia leptocephala (Torr. & A. Gray) Greene, *A1660*. Common. Pine forest, forest edges, and old fields.

**Facelis retusa* (Lam.) Sch.Bip., *A800*. Infrequent. Roadsides and old fields.

Fleischmannia incarnata (Walter) R.M. King & H. Rob. [=*Eupatorium incarnatum* Walter], *A76*. Rare. Saffell outcrops.

Gamochaeta americana (Mill.) Wedd. [=*Gnaphalium americanum* Mill.], *A554*. Common. Fields and yards.

Gamochaeta falcata (Lam.) Cabrera [=*Gnaphalium falcatum* Lam.], *A2556*. Infrequent. Fields and roadsides.

Gamochaeta pensylvanica (Willd.) Cabrera [=*Gnaphalium pensylvanicum* Willd.], *A2393*. Common. Roadsides, clearcuts, and sandy fields.

Gamochaeta purpurea (L.) Cabrera [=*Gnaphalium purpureum* L.], *A599*. Abundant. Roadsides, clearcuts, yards, and disturbed forest margins.

Helenium amarum (Raf.) H. Rock, *A744*. Abundant. Old fields, cattle farms, roadsides, and disturbed areas in towns.

Helenium flexuosum Raf., *A1107*. Common. Old fields, upland pine forest, and roadsides.

Helianthus angustifolius L., *A1603*. Abundant. Pine forest and roadsides.

Helianthus atrorubens L., *EA 109*. Rare. Upland roadsides.

Helianthus divaricatus L., *A1197*. Common. Upland pine forest, especially in the Homochitto River basin.

Helianthus microcephalus Torr. & A. Gray, *EA 35*. Common. Old fields and roadsides.

Helianthus resinosus Small, *A1408*. Infrequent. Pine forest and roadsides, especially in the eastern half of the county.

Helianthus strumosus L., *A1266*. Infrequent. Pine forest and roadsides.

Heliopsis helianthoides var. *gracilis* (Nutt.) Gandhi & R.D. Thomas, *A1147*. Rare. Saffell outcrops.

†*Heterotheca subaxillaris* var. *latifolia* (Buckley) Gandhi & R.D. Thomas, *A1397*. Infrequent. Roadsides and gravelly areas. Infraspecific taxonomy follows Gandhi & Thomas (1989).

Hieracium gronovii L., *A1713*. Infrequent. Hardwood ravines, cemeteries, and pine forest.

Ionactis linariifolius (L.) Greene [=*Aster linariifolius* L.], *A111*. Locally common. Outcrops of clayey subsoil in longleaf pine forest of the Homochitto River basin.

Iva annua L., *A1746*. Rare. Upland pine forest of the Homochitto River basin.

Krigia cespitosa (Raf.) K.L. Chambers, *A207*. Infrequent. Fields and yards.

Krigia dandelion (L.) Nutt., *A370*. Infrequent. Yards, disturbed areas in town, and bottomland fields.

Krigia virginica (L.) Willd., *A627*. Infrequent. Edges of pine forest and outcrops of clayey subsoil in the Homochitto River basin.

Lactuca canadensis L., *A1106*. Common. Roadsides and old fields.

Lactuca floridana (L.) Gaertn., *A1394*. Common. Roadsides and gravelly areas.

Lactuca graminifolia Michx., *A1285*. Infrequent. Longleaf pine forest of the Homochitto River basin.

**Leucanthemum vulgare* Lam., *A851*. Rare. Roadsides.

Liatris elegans (Walter) Michx., *EA 5*. Rare. Outcrops of clayey subsoil in longleaf pine forest of the Homochitto River basin.

Liatris pycnostachya Michx., *A1264*. Locally common. Upland pine forest, clearcuts, and roadsides, especially in the Homochitto River basin.

Liatris squarrosa (L.) Michx., *A1249*. Locally common. Upland pine forest, clearcuts, and roadsides, especially in the Homochitto River basin.

Liatris squarrulosa Michx. [=*L. earlei* (Greene) K. Schum.], *A1631*. Common. Pine forest and roadsides, especially in the southeastern part of the county.

Mikania cordifolia (L.f.) Willd., *A1718*. Infrequent. Ravines of the Homochitto River basin and Saffell outcrops.

Mikania scandens (L.) Willd., *A1460*. Common. Bottomland openings.

Packera anonyma (Wood) W.A. Weber & Á. Löve [=*Senecio anonymus* Wood], *A590*. Locally common. Roadsides of the eastern one-third of the county.

Packera glabella (Poir.) C. Jeffrey [=*Senecio glabellus* Poir.], *A308*. Locally common. Moist fields, margins of beaver impoundments, streamsides, and bottomland hardwood forest.

Pityopsis graminifolia (Michx.) Nutt., *EA 139*. Abundant. Upland pine forest, old fields, and gravelly areas.

Pluchea camphorata (L.) DC., *A1518*. Infrequent. Bottomland hardwood forest and swamp margins.

Pluchea foetida (L.) DC., *A2267*. Infrequent. Moist ditches in pine forest.

Prenanthes altissima L., *A990*. Infrequent. Ravines of the Homochitto River basin.

Pseudognaphalium helleri (Britton) Anderb., *W. Allison 481* (MISS!). Rare.

Pseudognaphalium obtusifolium (L.) Hilliard & B.L. Burtt [=*Gnaphalium obtusifolium* L.], *EA 74*. Common. Old fields.

Pyrrhopappus carolinianus (Walter) DC., *A653*. Abundant. Roadsides and forest edges.

Rudbeckia hirta L., *A600*. Abundant. Roadsides, old fields, and upland forest edges.

Smallanthus uvedalius (L.) Mack. ex Small [=*Polymnia uvedalia* (L.) L.], *A698*. Infrequent. Upland mixed forest, Saffell outcrops, and forest edges.

◆ *Solidago auriculata* Shuttlew. ex S.F. Blake, *A1670*. Rare. Mature hardwood ravine near center of county.

Solidago caesia L., *A1606*. Common. Mesic hardwood forest.

Solidago canadensis L., *EA 113*. Abundant. Old fields, clearcuts, and roadsides.

Solidago discoidea Elliott [=*Brintonia discoidea* (Elliott) Greene], *A1706*. Infrequent. Bottom land forest and swamps.

Solidago gigantea Aiton, *A1325*. Common. Old fields.

Solidago hispida Muhl. ex Willd., *A1685*. Infrequent. Clearcuts and roadsides.

Solidago odora Aiton var. *odora*, *A1274*. Common. Pine forest and old fields.

Solidago patula Muhl. ex Willd., *A2407*. Infrequent. Swamps and spring-seeps.

Solidago rugosa Mill. [including var. *celtidifolia* (Small) Fernald], *A1683*. Abundant. Pine forest, margins of other forest, roadsides, and clearcuts.

Solidago ulmifolia Muhl. ex Willd., *A1559*. Infrequent. Saffell outcrops.

**Soliva sessilis* Ruiz & Pav. [=*S. pterosperma* (Juss.) Less.], *A857*. Infrequent. Old fields and yards.

**Sonchus asper* (L.) Hill, *A310*. Infrequent. Around buildings in towns and on farms.

Symphyotrichum adnatum (Nutt.) Nesom [=*Aster adnatus* Nutt.], *A112*. Locally common. Outcrops of clayey subsoil in longleaf pine forest of the Homochitto River basin.

Symphyotrichum concolor (L.) Nesom [=*Aster concolor* L.], *A2395*. Infrequent. Pine forest of the Homochitto River basin.

Symphyotrichum drummondii var. *texanum* (Burgess) Nesom [=*Aster drummondii* var. *texanus* (Burgess) A.G.Jones], *A682*. Infrequent. Saffell outcrops.

Symphyotrichum dumosum (L.) Nesom [=*Aster dumosus* L.],*A1744*. Abundant. Roadsides and pine forest.

Symphyotrichum lateriflorum (L.) Á. Löve & D. Löve [=*Aster lateriflorus* (L.) Britton],*A1643*. Infrequent. Open pine forest, clearcuts, roadsides, and bottomland forest edges.

Symphyotrichum patens var. *gracile* (Hook.) Nexom [=*Aster patens* var. *gracilis* Hook.], *A642*. Rare. Outcrops of clayey subsoil in longleaf pine forest of the Homochitto River basin.

Symphyotrichum patens (Aiton) Nesom var. *patens* [=*Aster patens* Aiton var. *patens*], *A1687*. Common. Roadsides, clearcuts, and pine forest.

Symphyotrichum praealtum (Poir.) Nesom [=*Aster praealtus* Poir.], *A106*. Infrequent. Old fields and pine forest.

Symphyotrichum undulatum (L.) Nesom [=*Aster undulatus* L.],*A1771*. Infrequent. Upland pine or mixed forest.

**Taraxacum officinale* Weber ex F.H. Wigg.,*A225*. Common. Old fields, yards, and disturbed areas in towns.

Verbesina virginica L.,*A1491*. Infrequent. Roadside ditches in the southeastern part of the county.

Verbesina walteri Shinners, *A1449*. Locally common. Bottomland forest and ditches.

Vernonia gigantea (Walter) Trel. ssp. *gigantea*, *EA 122*. Common. Mesic openings and forest edges.

Vernonia texana (A. Gray) Small,*A1256*. Common. Upland pine forest and roadsides.

**Xanthium strumarium* L., *A1206*. Infrequent. Sandy stream margins.

**Youngia japonica* (L.) DC.,*A273*. Infrequent. Yards and disturbed areas in towns.

CONVOLVULACEAE

Dichondra carolinensis Michx., *EA 208*. Common. Old fields and yards.

Ipomoea cordatotriloba Dennst.,*A578*. Common. Roadsides.

Ipomoea hederacea Jacq., *A2814*. Infrequent. Roadsides and fields.

◆ **Ipomoea indica* (Burm.f.) Merr., *EA 17*. Rare. Ditches in Liberty.

Ipomoea lacunosa L.,*A1538*. Infrequent. Old fields and cultivated areas.

Ipomoea pandurata (L.) G. Mey.,*A752*. Abundant. Roadsides and pine forest.

Ipomoea quamoclit L.,*EA 3*. Infrequent. Roadsides and fencerows.

Jacquemontia tamnifolia (L.) Griseb., *A1104*. Abundant. Old fields, roadsides, fencerows, and forest edges.

Stylisma humistrata (Walter) Chapm., *A1094*. Infrequent. Pine forest, especially in the Homochitto River basin.

CORNACEAE

Cornus florida L., *A1869*. Abundant. Forest of all sorts.

Nyssa biflora Walter, *A1348*. Locally common. Swamps, margins of beaver impoundments, and occasionally in typical bottomland forest.

Nyssa sylvatica Marshall, *A1396*. Common. Upland forest of various sorts, old fields, fencerows, and occasionally bottomland forest.

CRUCIFERAE

**Brassica rapa* L.,*A377*. Infrequent. Old fields and persisting in gardens.

Cardamine bulbosa (Schreb. ex Muhl.) B.S.P., *EA 217*. Infrequent. Bottomland hardwood forest, moist semi-open forest, and Saffell outcrops.

**Cardamine hirsuta* L., *A280*. Common. Fields, yards, and ruderal areas in towns.

Lepidium virginicum L., *A787*. Common. Pastures, roadsides, and ruderal areas in towns.

**Raphanus raphanistrum* L., *A309*. Common. Old fields and roadsides, especially in the eastern half of the county.

Rorippa sessiliflora (Nutt. ex Torr. & A. Gray) Hitchc., *A2500*. Infrequent. Riverside gravel in the Amite River drainage.

**Sisymbrium officinale* (L.) Scop., *A2552*. Infrequent. Roadsides and farms in the eastern half of the county.

CUCURBITACEAE

Cayaponia quinqueloba (Raf.) Shinners, *A1481*. Rare. Bottomland roadside in the southeastern part of the county.

**Cucumis melo* L.,*EA 255*. Infrequent. Bottomland fields.

Melothria pendula L., *S. Jones et al. 19957* (MISS!). Rare. Cultivated fields.

CUSCUTACEAE

Cuscuta compacta Juss. ex Choisy var. *compacta*, *A2470*. Rare. Parasitic on roadside herbs.

Cuscuta cuspidata Engelm., *A1466*. Infrequent. Parasitic on bottomland field herbs or riverbank herbs, especially in the southeastern part of the county.

Cuscuta pentagona Engelm., *A973*. Common. Parasitic on roadside and clearcut area herbs.

DROSERACEAE

Drosera brevifolia Pursh, *A448*. Rare. Outcrops of clayey subsoil in long-leaf pine forest of the Homochitto River basin.

EBENACEAE

Diospyros virginiana L., *WA&M 70894*. Abundant. Pine forest, mixed forest, roadsides, and old fields.

ERICACEAE

Gaylussacia dumosa (Andrews) Torr. & A. Gray var. *dumosa*, *A2097*. Infrequent. Pine forest in the southeastern part of the county.

Kalmia latifolia L., *A422*. Rare. Ravines in the Buffalo River drainage of the western part of the county. Apparently native, as referenced by a local biologist (R. Richardson, pers. comm.), but suspiciously close to John James Audubon Arboretum in Gloster. If not originally extending this far west, the species has definitely naturalized along certain streams.

Leucothoe racemosa (L.) A. Gray, *A2039*. Infrequent. Swamps in the south central and southeastern part of the county.

Lyonia ligustrina (L.) DC., *A2417*. Rare. Swamp in the southeastern part of the county.

Oxydendrum arboreum (L.) DC., *A754*. Common. Pine forest and upland mixed or hardwood forest.

Rhododendron canescens (Michx.) Sweet, *A387*. Locally common. Bottomland forest, especially along streams, swamp margins, and rarely in pine forest.

Vaccinium arboreum Marshall [=*Batodendron arboreum* (Marshall) Nutt.], *A546*. Common. Mature pine forest and upland mixed or hardwood forest.

Vaccinium elliottii Chapm., *A614*. Abundant. Pine forest and upland mixed forest.

Vaccinium fuscatum Aiton, *A1039*. Infrequent. Pine and mixed forest.

Vaccinium stamineum L. [=*Polycodium stamineum* (L.) Greene], *A528*. Common. Pine and upland mixed forest.

EUPHORBIACEAE

Acalypha gracilens A. Gray, *A842*. Common. Pine forest, gravelly areas, and roadsides.

Acalypha rhomboidea Raf., *A1785*. Infrequent. Ruderal areas in towns and yards.

Acalypha virginica L., *A1412*. Rare. Roadsides in the northeastern part of county.

Chamaesyce hyssopifolia (L.) Small, *A1326*. Infrequent. Old railroad tracks and ruderal areas in towns.

Chamaesyce maculata (L.) Small, *A1319*. Pine forest, roadsides, ruderal areas in towns, and yards.

Chamaesyce nutans (Lag.) Small, *A1353*. Infrequent. Roadsides and ruderal areas in towns.

Croton capitatus Michx., *A1278*. Common. Old fields, clearcut areas, cultivated areas, and roadsides.

Croton glandulosus var. *septentrionalis* Müll. Arg., *A2322*. Rare. Sandy margin of the Homochitto River.

Euphorbia corollata L., *A658*. Abundant. Roadsides, pine forest, and clearcuts.

Euphorbia cyathophora Murr, *A2365*. Infrequent. Roadsides.

Phyllanthus caroliniensis Walter ssp. *caroliniensis*, *A1444*. Infrequent. Roadsides.

**Phyllanthus urinaria* L., *A2850*. Infrequent. Ruderal areas in towns.

Tragia cordata Michx., *A1146*. Rare. Saffell outcrops.

Tragia smallii Shinners, *A2096*. Infrequent. Pine forest in the southeastern part of the county.

**Triadica sebifera* (L.) Small [=*Sapium sebiferum* (L.) Roxb.], *A1528*. Common. Riverbanks, fencerows, old fields, and secondary forest.

**Vernicia fordii* (Hemsl.) Airy Shaw [=*Aleurites fordii* Hemsl.], *A1865*. Common. Pine forest, secondary woods, and roadsides, especially in the eastern half of the county.

FABACEAE (see LEGUMINOSAE)

FAGACEAE

Castanea pumila (L.) Mill. var. *pumila* [in the broad sense, sensu Johnson (1988)], *EA 32*. Infrequent. Pine forest and Saffell outcrops.

Fagus grandifolia Ehrh., *A1942*. Abundant. Primarily in bottomland hardwood forest, ravines, and mature hardwood forest, but also in pine forest and secondary forest.

Quercus alba L., *EA 152*. Abundant. Primarily in upland hardwood or mixed forest, but also in bottomland forest.

Quercus × *comptoniae* Sarg. [=*Q. lyrata* Walter × *Q. virginiana* Mill.], *A1259*. Infrequent. Upland forest in the southwestern corner of the county.

Quercus coccinea Münchh., *A1133*. Infrequent. Saffell outcrops.

Quercus falcata Michx., *EA 247*. Abundant. Upland forest, primarily associated with pine.

Quercus hemisphaerica W.Bartram ex Willd., *A625*. Locally common. Ridges and mid-slope of ravines in the Homochitto River basin.

Quercus incana W. Bartram, *A1765*. Infrequent. Outcrops of clayey subsoil in longleaf pine forest of the Homochitto River basin.

Quercus laurifolia Michx., *A1402*. Common. Bottomland hardwood forest and swamps.

Quercus lyrata Walter, *A2366*. Infrequent. Swamps and bottomland forest.

Quercus marilandica Münchh., *A1766*. Locally common. Upland forest, primarily associated with pine; most common on ridges of the Homochitto River basin and in the eastern half of the county.

Quercus michauxii Nutt., *A1554*. Common. Bottomland hardwood forest and ravines.

Quercus muhlenburgii Engelm., *A971*. Rare. Mature hardwood forest in ravines.

Quercus nigra L., *A2373*. Abundant. Bottomland hardwood forest, upland forest of all types, roadsides, and yards.

Quercus pagoda Raf., *A2372*. Abundant. Bottomland hardwood forest and ravines.

Quercus phellos L., *A2367*. Infrequent. Upland flats, bottomland, and yards.

Quercus rubra L., *A1682*. Rare. Ravines.

Quercus shumardii Buckley, *A1005*. Infrequent. Upland hardwood or mixed forest, ravines, and Saffell outcrops.

Quercus stellata Wangenh., *EA 248*. Locally common. Upland forest, primarily associated with pine, and yards; most common in the eastern half of the county.

Quercus velutina Lam., *A977*. Common. Upland hardwood and mixed forest and Saffell outcrops.

Quercus virginiana Mill., *EA 38*. Rare. Upland roadsides in southwestern corner of county.

FUMARIACEAE

Corydalis micrantha ssp. *australis* (Chapm.) G.B. Ownbey, *A404*. Infrequent. Gravelly roadsides and rarely rich hardwood forest in the southeastern part of the county.

GELSEMIACEAE

Gelsemium rankinii Small, *EA 182*. Infrequent. Swamps.

Gelsemium sempervirens (L.) J. St.-Hil., *EA 231*. Common. Fencerows, pine forest, and forest edges.

GENTIANACEAE

Gentiana villosa L., *EA 89*. Infrequent. Pine forest.

Sabatia angularis (L.) Pursh, *Webster & Wilbur 3277* (DUKE!, MICH!). Infrequent. Pine forest and forest edges.

Sabatia brachiata Elliott, *A1175*. Infrequent. Pine forest and roadsides.

Sabatia campestris Nutt., *A1182*. Rare. Pine forest in the southeastern corner of the county.

GERANIACEAE

Geranium carolinianum L., *A282*. Common. Old fields, disturbed areas in towns, and yards.

**Geranium dissectum* L., *S. Jones & C.Jones 4120* (MISS). Rare. Roadsides.

GUTTIFERAE

Hypericum crux-andreae (L.) Crantz, *A1497*. Infrequent. Pine forest in the southeastern part of the county.

Hypericum drummondii (Grev. & Hook.) Torr. & A. Gray, *A1293*. Common. Pine forest and Saffell outcrops.

Hypericum gentianoides (L.) B.S.P., *A2324*. Infrequent. Sandy pine forest.

Hypericum gymnanthum Engelm. & A.Gray, *A823*. Rare. Pine forest and clearcuts in the southeastern part of the county.

Hypericum hypericoides (L.) Crantz, *A1248*. Common. Pine forest.

Hypericum mutilum L., *A824*. Common. Pine forest and clearcuts, particularly in the southeastern part of the county.

Hypericum nudiflorum Michx. ex Willd., *WA&M 71017*. Infrequent. Stream banks and swamps.

Triadenum walteri (J.G. Gmel.) Gleason, *A1457*. Infrequent. Swamps, spring-seeps, and bottomland hardwood forest.

HALORAGACEAE

**Myriophyllum aquaticum* (Vell.) Verdc., *A798*. Infrequent. Slow-moving streams.

Proserpinaca palustris var. *amblyogona* Fernald, *S. Jones et al. 13944* (MISS!). Infrequent. Pond margins.

Proserpinaca palustris var. *crebra* Fernald & Griscom, *WA&M 70918*. Infrequent. Moist ditches of bottomland hardwood forest.

HAMAMELIDACEAE

Hamamelis virginiana L., *A871*. Common. Upland hardwood and mixed forest.

Liquidambar styraciflua L., *A1851*. Abundant. Hardwood ravines, bottomland hardwood forest, secondary succession, and pine forest.

HIPPOCASTANACEAE

Aesculus pavia L., *A1899*. Infrequent. Mature upland hardwood forest, especially at Saffell outcrops, creekbanks, and pine forest.

HYDRANGEACEAE

Decumaria barbara L., *A785*. Infrequent. Bottomland hardwood forest.

Hydrangea arborescens L., *S. Jones et al. 13930* (MISS!). Rare. Steep ravines and bottomland hardwood forest along the East Fork Amite River.

Hydrangea quercifolia W. Bartram, *A873*. Infrequent. Ravines and Saffell outcrops.

HYDROPHYLLACEAE

Hydrolea uniflora Raf., *WA&M 71091*. Rare. Beaver-impounded ponds in the Homochitto River basin.

HYPERICACEAE (see GUTTIFERAE)

ILLICIACEAE

Illicium floridanum J. Ellis, *A1884*. Locally common. Bottomland hardwood forest, primarily in the Amite and Tickfaw River basins, but at least one population in the Homochitto River basin.

ITEACEAE

Itea virginica L., *A570*. Locally common. Spring-seeps and swamps.

JUGLANDACEAE

Carya aquatica (F.Michx.) Nutt., *A1065*. Infrequent. Sandy bottomland hardwood forest, primarily in the Homochitto River basin.

Carya cordiformis (Wangenh.) K. Koch, *A1679*. Rare. Ravines of mature hardwood forest.

Carya glabra (Mill.) Sweet, *A1900*. Common. Upland hardwood or mixed forest.

Carya illinoinensis (Wangenh.) K. Koch, *A1529*. Common. Old fields, fencerows, and house sites.

Carya pallida (Ashe) Engl. & Graebn., *A1260*. Common. Upland hardwood, mixed, or pine forest.

†*Carya tomentosa* (Poir.) Nutt. [=*C. alba* (L.) Nutt. ex Elliott], *A1432*. Abundant. Upland hardwood or mixed forest, pine forest, secondary forest, and roadsides. Nomenclature follows D. Stone (1997).

**Juglans nigra* L., *A1247*. Infrequent. Fields and yards. Probably all introductions from elsewhere in eastern North America.

LABIATAE

♦ **Clinopodium gracile* (Benth.) Kuntze, *A782*. Rare. Bottomland hardwood forest of the East Fork Amite River.

Collinsonia tuberosa Michx., *A1697*. Infrequent. Upland gravelly hardwood forest.

**Glechoma hederacea* L., *A482*. Infrequent. Shady yards, towns, and cemeteries.

Hedeoma hispida Pursh, *A729*. Infrequent. Clearcuts, disturbed fields, upland forest edges, and roadsides.

Hyptis alata (Raf.) Shinners. Rare. Referenced in Jones (1976); specimen not seen.

**Lamium amplexicaule* L., *A223*. Common. Yards, towns, roadsides, and fields.

**Lamium purpureum* L., *A265*. Infrequent. Yards and towns.

Lycopus rubellus Moench, *A1590*. Infrequent. Swamp margins and roadside ditches.

Lycopus virginicus L., *A1452*. Common. Bottomland openings, roadside ditches, spring-seeps, and riverbanks.

Monarda fistulosa var. *mollis* (L.) Benth., *A820*. Infrequent. Upland pine forest and forest edges.

Monarda punctata L. var. *punctata*, *A1413*. Infrequent. Pine forest and roadsides.

**Perilla frutescens* (L.) Britton, *A1676*. Infrequent. Disturbed areas, secondary pine forest, and secondary bottomland forest.

**Prunella vulgaris* L., *A581*. Infrequent. Yards, fencerows, towns, and occasionally along forest edges.

Pycnanthemum albescens Torr. & A. Gray, *A1284*. Infrequent. Upland pine forest, especially in the Homochitto River basin.

Pycnanthemum tenuifolium Schrad., *EA 87*. Abundant. Pine forest and roadsides.

Salvia lyrata L., *A426*. Common. Forest of various sorts and yards.

Scutellaria elliptica Muhl. ex Spreng., *A764*. Infrequent. Saffell outcrops and upland hard wood forest.

Scutellaria incana Biehler, *A1496*. Rare. Pine forest in the southeastern part of the county.

Scutellaria integrifolia L., *A574*. Abundant. Forest of various sorts, forest edges, and roadsides.

Stachys floridana Shuttlew. ex Benth., *A481*. Rare. Yards in Liberty.

Stachys tenuifolia Willd., *A1458*. Rare. Bottomland hardwood forest and spring seeps.

Teucrium canadense L., *WA&M 70906*. Rare. Sandy bank of the West Fork Amite River.

Trichostema dichotomum L., *A1602*. Common. Pine forest, sandy riverbanks, and roadside ditches.

Trichostema setaceum Houtt., *A1639*. Infrequent. Pine forest in the southeastern part of the county and in the Homochitto National Forest.

LAMIACEAE (see LABIATAE)

LAURACEAE

Lindera benzoin (L.) Blume, *EA 30*. Locally common. Sandy bottomland hardwood forest in the Homochitto River basin and infrequently in the Amite River basin.

Persea palustris (Raf.) Sarg., *EA 36*. Infrequent. Bottomland hardwood forest, mid slope mixed forest, and ravines.

Sassafras albidum (Nutt.) Nees, *A1140*. Abundant. Roadsides, fencerows, and hardwood forest.

LEGUMINOSAE

Albizia julibrissin Durazz., *A943*. Common. Roadsides, fencerows, and yards.

**Alysicarpus vaginalis* (L.) DC., *A2837*. Infrequent. Roadsides.

Apios americana Medik., *EA 165*. Infrequent. Bottomland forest edges, swamp margins, and riversides.

Baptisia alba var. *macrophylla* (Larisey) Isely [=*B. lactea* (Raf.) Thieret, =*B. leucantha* Torr. & A. Gray], *A579*. Infrequent. Old fields and pine forest.

Centrosema virginianum (L.) Benth., *A756*. Abundant. Upland forest edges and roadsides.

Cercis canadensis L., *A267*. Infrequent. Upland hardwood forest, Saffell outcrops, and commonly cultivated.

Chamaecrista fasciculata (Michx.) Greene, *A1303*. Common. Roadsides and old fields.

Chamaecrista nictitans (L.) Moench var. *nictitans*, *A1561*. Infrequent. Roadsides.

Clitoria mariana L., *A1252*. Abundant. Pine forest, forest edges, and roadsides.

Crotalaria rotundifolia Walter ex J.F. Gmel., *A549*. Rare. Pine forest.

Crotalaria sagittalis L., *A608*. Locally common. Pine forest, especially in the Homochitto River basin.

**Crotalaria spectabilis* Roth, *C.Brown 18686* (LSU!). Rare. Roadsides. Herbarium label indicates Wilkinson Co., MS, but the locality data ("north of Coles") indicate Amite Co.

Desmodium canescens (L.) DC., *A1515*. Infrequent. Roadsides.

Desmodium ciliare (Muhl. ex Willd.) DC., *A2275*. Infrequent. Pine forest.

Desmodium glutinosum (Muhl. ex Willd.) A.W. Wood, *A1142*. Infrequent. Mature hardwood forest over Saffell outcrops.

Desmodium laevigatum (Nutt.) DC., *A1721*. Infrequent. Upland forest edges.

Desmodium lineatum DC., *EA 81*. Common. Forest of various sorts, roadside ditches, and cemeteries.

Desmodium nudiflorum (L.) DC., *A1145*. Rare. Mature hardwood forest over Saffell outcrops.

Desmodium nuttallii (Schindl.) B.G. Schub., *A2308*. Rare. Burned pine forest.

Desmodium obtusum (Muhl. ex Willd.) DC., *A1693*. Common. Clearcuts, pine forest, and roadsides.

Desmodium paniculatum (L.) DC., *A1720*. Abundant. Pine forest, bottomland openings, old fields, and roadsides.

Desmodium perplexum B.G. Schub., *A1619.* Infrequent. Sandy bottomland river margins and roadside ditches.

Desmodium rotundifolium DC., *A1813.* Infrequent. Ravines of mixed forest and Saffell outcrops.

Desmodium viridiflorum (L.) DC., *A2815.* Infrequent. Upland pine forest and roadsides in the eastern half of the county.

Erythrina herbacea L., *A573.* Common. Forest edges, gravelly areas, and Saffell outcrops.

Galactia erecta (Walter) Vail, *A2102.* Rare. Pine forest in the southeastern part of the county.

Galactia volubilis (L.) Britton as interpreted by most authors [*G. regularis* (L.) B.S.P. sensu Duncan] [including *G. macreei* M.A. Curtis], *A1301.* Common. Forest edges.

Gleditsia triacanthos L., *A1246.* Infrequent. Upland roadsides and forest edges.

Glottidium vesicarium (Jacq.) R.M. Harper, *A2412.* Infrequent. Bottomland openings.

Kummerowia striata (Thunb.) Schindl. [=*Lespedeza striata* (Thunb.) Hook. & Arn.], *A1722.* Common. Upland pine forest.

**Lathyrus hirsutus* L., *A777.* Infrequent. Roadsides, old fields, and cultivated fields.

**Lespedeza cuneata* (Dum.Cours.) G. Don, *EA 40.* Common. Roadsides, old fields, and pine forest.

Lespedeza hirta (L.) Hornem. ssp. *hirta*, *A1499.* Common. Pine forest and old fields.

Lespedeza procumbens Michx., *A622.* Common. Upland forest edges, old fields, and roadsides.

Lespedeza repens (L.) W.P.C. Barton, *A550.* Abundant. Pine forest.

Lespedeza violacea (L.) Pers., *A1723.* Rare. Upland forest edges of the Homochitto River basin.

Lespedeza virginica (L.) Britton, *A1745.* Abundant. Pine forest, forest edges, and roadsides.

**Medicago arabica* (L.) Huds., *A361.* Infrequent. Ruderal areas in towns.

Medicago polymorpha L. Referenced in Pullen et al. (1968); specimen not seen.

Mimosa microphylla Dryand. [=*Schrankia microphylla* (Dryand.) J.F. Macbr.], *A593.* Common. Pine forest and roadsides.

Orbexilum pedunculatum (Mill.) Rydb., *A513.* Rare. Pine forest of the southeastern part of the county.

**Pueraria montana* (Lour.) Merr. [*Pueraria lobata* (Willd.) Ohwi], *A1371.* Infrequent. Roadsides and adjacent forest.

Rhynchosia reniformis DC., *A694.* Infrequent. Outcrops of clayey subsoil in longleaf pine forest of the Homochitto River basin.

Rhynchosia tomentosa (L.) Hook. & Arn., *A2098.* Infrequent. Pine forest.

Robinia pseudo-acacia L., *A536.* Common. Upland forest edges and roadsides.

Senna obtusifolia (L.) H.S. Irwin & Barneby, *A1236.* Locally common. Cultivated fields.

Sesbania herbacea (Mill.) McVaugh [=*S. exaltata* (Raf.) Rydb. ex A.W.Hill?], *A2351.* Infrequent. Cultivated fields.

Strophostyles helvula (L.) Elliott, *A2323.* Rare. Sandy banks of the Homochitto River.

Strophostyles umbellata (Muhl. ex Willd.) Britton, *A1493.* Common. Pine forest.

Stylosanthes biflora (L.) B.S.P., *A607.* Common. Pine forest, especially in the Homochitto River basin.

Tephrosia spicata (Walter) Torr. & A. Gray, *A646.* Common. Pine forest.

Tephrosia virginiana (L.) Pers., *A563.* Locally common. Pine forest, especially dry open ridges and frequently burned areas.

**Trifolium arvense* L., *A474.* Infrequent. Roadsides.

**Trifolium campestre* Schreb., *A585.* Common. Roadsides, yards, and fields.

Trifolium carolinianum Michx., *A1892.* Rare. Edge of mature upland hardwood forest in the Homochitto River basin.

Trifolium dubium Sibth., *A429.* Common. Roadsides and yards.

**Trifolium incarnatum* L., *A330.* Abundant. Roadsides and fields.

**Trifolium repens* L., *A552.* Abundant. Roadsides, fields, and yards.

**Trifolium resupinatum* L., *A467.* Infrequent. Roadsides and yards.

**Vicia sativa* ssp. *nigra* (L.) Ehrh. [=*V. angustifolia* L.], *A270.* Common. Old fields, cultivated fields, and roadsides.

**Vicia tetrasperma* (L.) Schreb., *A484.* Infrequent. Old fields.

**Vicia villosa* Roth ssp. *villosa*, *A472.* Common. Roadsides, old fields, and cultivated fields.

**Wisteria sinensis* (Sims) DC., *A1879.* Infrequent. Roadsides, secondary forest, and old home sites.

LENTIBULARIACEAE

†*Utricularia biflora* Lam. [=*U. gibba* L., in part], *A2063*. Infrequent. Beaver-impounded ponds and perennially-wet ditches. Species taxonomy follows Godfrey & Wooten (1981) and Weakley (in prep.).

LINACEAE

Linum medium var. *texanum* (Planch.) Fernald, *A645*. Abundant. Pine forest and roadsides.

Linum striatum Walter, *A1044*. Infrequent. Bottomland open areas and wet roadsides.

LOGANIACEAE

†*Cynoctonum mitreola* (L.) Britton [=*Mitreola petiolata* (J.F. Gmel.) Torr. & A. Gray], *A2283*. Infrequent. Bottomland openings. I do not consider the pirated *Opera Varia* (1758) of Linnaeus, and the generic name *Mitreola* taken within, validly published according to Art. 34.1 of the ICBN (St. Louis).

Spigelia marilandica (L.) L., *A561*. Infrequent. Ravines of mature hardwood forest and Saffel. outcrops.

LYTHRACEAE

**Cuphea carthagenensis* (Jacq.) J.F. Macbr., *A833*. Common. Roadsides, clearcut areas, and sandy bottomland openings.

**Lagerstroemia indica* L., *A1177*. Infrequent. Fencerows and secondary forest.

Rotala ramosior (L.) Koehne, *A2317*. Rare. Swamp margins in the Homochitto River basin.

MAGNOLIACEAE

Liriodendron tulipifera L., *A509*. Abundant. Bottomland hardwood forest, mixed forest, ravines, and Saffell outcrops.

Magnolia acuminata (L.) L., *A2105*. Infrequent. Saffell outcrops and ravines, most common in the Homochitto River basin.

Magnolia grandiflora L., *A714*. Abundant. Bottomland hardwood forest, ravines, and occasionally upland hardwood or mixed forest.

Magnolia macrophylla Michx., *A566*. Locally common. Ravines of the Homochitto River basin.

Magnolia virginiana L., *A687*. Locally common. Swamps and perennially wet roadside areas.

MALVACEAE

Modiola caroliniana (L.) G. Don, *A311*. Infrequent. Disturbed areas in towns, yards, and roadsides.

Sida rhombifolia L., *A1026*. Common. Roadsides and bottomland openings.

MELASTOMATACEAE

Rhexia mariana L. var. *mariana*, *A940*. Common. Pond margins, margins of beaver impounded ponds, and roadside ditches.

Rhexia nashii Small × *R. virginica* L., *A821*. Infrequent. Swamp margins in the Homochitto River basin.

Rhexia virginica L., *A1588*. Infrequent. Roadside ditches.

MELIACEAE

**Melia azedarach* L., *A557*. Common. Mesic pine forest, mesic secondary forest, roadsides, and old home sites, more common in the eastern half of the county.

MENISPERMACEAE

Cocculus carolinus (L.) DC., *A1134*. Infrequent. Hardwood forest and Saffell outcrops.

MOLLUGINACEAE

**Mollugo verticillata* L., *WA&M 71108*. Common. Riverbanks and sandbars.

MONOTROPACEAE

Monotropa uniflora L., *A1781*. Rare. Sandy lower slopes of ravines in the Homochitto River basin.

MORACEAE

**Broussonetia papyrifera* (L.) L'Hér. ex Vent., *EA 18*. Infrequent. Disturbed areas in towns.

Morus rubra L., *A436*. Infrequent. Upland forest, Saffell outcrops, and yards.

MYRICACEAE

Morella cerifera (L.) Small [=*Myrica cerifera* L.], *A220*. Abundant. Pine forest, roadsides, various forest edges, and occasionally along swamp margins.

NELUMBONACEAE

Nelumbo lutea Willd., *S. Jones et al. 19892* (GA!, MISS!). Rare. Pond in Liberty; apparently now extirpated.

NYCTAGINACEAE

**Mirabilis jalapa* L., *A1511*. Infrequent. Roadsides and around old homes in the southeastern part of the county.

NYMPHAEACEAE

Nuphar lutea ssp. *advena* (Aiton) Kartesz &

Gandhi [=*N. advena* (Aiton) W.T. Aiton], *A511*. Infrequent. Beaver-impounded ponds and stagnant sloughs.

**Nymphaea odorata* Aiton, *A1170*. Rare. Naturalizing in ponds from introductions from other parts of the state.

OLEACEAE

Fraxinus americana L., *A915*. Infrequent. Upland mixed forest.

Fraxinus pennsylvanica Marshall, *A1077*. Common. Bottomland hardwood forest and moist roadsides.

**Ligustrum lucidum* W.T. Aiton, *A1096*. Infrequent. Secondary pine forest, fencerows, and roadsides.

**Ligustrum sinense* Lour., *A541*. Abundant. Secondary pine forest, bottomland forest, forest edges, fencerows, and riverbanks.

Osmanthus americanus (L.) Benth. & Hook.f. ex A. Gray, *A2415*. Infrequent. Swamps in the southeastern part of the county.

ONAGRACEAE

Circaea lutetiana ssp. *canadensis* (L.) Asch. & Magnus, *A767*. Rare. Bottomland hardwood forest along the West Fork Amite River.

Gaura brachycarpa Small, *S. Jones 5345* (MISS!). Rare. Roadside in the northeastern part of the county.

Ludwigia alternifolia L., *A1344*. Common. Roadside ditches, pond margins, riverbanks, and disturbed areas.

Ludwigia decurrens Walter, *A1360*. Infrequent. Riverbanks and pond margins.

Ludwigia glandulosa Walter ssp. *glandulosa*, *A1780*. Infrequent. Pond margins.

Ludwigia hirtella Raf., *A1181*. Rare. Longleaf pine forest.

Ludwigia leptocarpa (Nutt.) H. Hara, *A1838*. Rare. Pond margins.

Ludwigia linearis Walter, *A1659*. Rare. Pond margins in the southeastern part of the county.

Ludwigia palustris (L.) Elliott, *WA&M 70920*. Locally common. Pond margins, sloughs, open swamps, and river margins.

Ludwigia peploides ssp. *glabrescens* (Kuntze) P.H. Raven, *A1097*. Infrequent. Ponds and open stream margins.

Oenothera biennis L., *A1410*. Common. Roadsides and clearcuts.

Oenothera fruticosa L. ssp. *fruticosa*, *A1975*. Pine forest and clearcuts.

Oenothera laciniata Hill, *A473*. Common. Clearcuts, roadsides, towns, and yards.

Oenothera linifolia Nutt., *A2095*. Rare. Open pine forest in the southeastern part of the county.

**Oenothera speciosa* Nutt., *A604*. Locally common. Roadsides.

OROBANCHACEAE

Epifagus virginiana (L.) W.P.C. Barton, *A97*. Infrequent. Mature hardwood forest.

OXALIDACEAE

Oxalis corniculata L., *A274*. Infrequent. Pine forest, fields, and yards.

**Oxalis debilis* var. *corymbosa* (DC.) Lourteig, *A2484*. Infrequent. Roadsides, ruderal areas in towns, and yards.

Oxalis dillenii Jacq., *A368*. Abundant. Pine forest and Saffell outcrops.

**Oxalis rubra* A. St.-Hil., *A2418*. Infrequent. Towns and yards.

Oxalis violacea L., *A390*. Infrequent. Saffell outcrops and upland hardwood forest.

PASSIFLORACEAE

Passiflora incarnata L., *A1270*. Common. Clearcuts, roadsides, fencerows, and forest edges.

Passiflora lutea L., *A1399*. Infrequent. Mesic forest edges.

PENTHORACEAE

Penthorum sedoides L., *A1365*. Infrequent. Bottomland hardwood forest.

PHYTOLACCACEAE

Phytolacca americana L., *A673*. Common. Roadsides and pasture edges.

PLANTAGINACEAE

Plantago aristata Michx., *A596*. Common. Pine forest, roadsides, old fields, and disturbed areas in towns.

Plantago heterophylla Nutt., *A1896*. Rare. Cemeteries.

Plantago virginica L., *A555*. Common. Clearcuts, fields, roadsides, and cemeteries.

PLATANACEAE

Platanus occidentalis L., *A1233*. Common. River margins, bottomland hardwood forest, and occasionally cultivated.

POLEMONIACEAE

Phlox divaricata L., *A204*. Infrequent. Saffell outcrops and hardwood ravines.

Phlox pilosa L., *A431*. Infrequent. Pine forest and roadsides.

POLYGALACEAE

Polygala incarnata L., *A758*. Rare. Outcrops of clayey subsoil in longleaf pine forest of the Homochitto National Forest.

Polygala mariana Mill., *A606*. Common. Pine forest.

Polygala nana (Michx.) DC., *A1935*. Infrequent. Outcrops of clayey subsoil in longleaf pine forest of the Homochitto National Forest and pine forest of the southeastern part of the county.

Polygala verticillata L., *A885*. Rare. Cemetery in the southwestern part of the county.

POLYGONACEAE

Brunnichia ovata (Walter) Shinners, *A1400*. Infrequent. Sandy river margins and associated forest.

**Polygonum caespitosum* var. *longisetum* (Bruyn) Steward, *A701*. Infrequent. Bottomland forest and woods roads.

Polygonum hydropiperoides Michx. [=*Persicaria hydropiperoides* (Michx.) Small], *A805*. Locally common. Swamp margins, moist bottomland fields and forest, roadsides, and woods roads.

Polygonum lapathifolium L., *A2823*. Rare. Pond margin in the eastern part of the county.

Polygonum pensylvanicum L. [=*Persi-caria pensylvanica* (L.) M.Gómez, including *P. bicornis* Raf.], *EA 66*. Infrequent. Bottomland ditches and forest edges.

Polygonum punctatum Elliott [=*Persicaria punctata* (Elliott) Small], *A1595*. Locally common. Roadside ditches, swamp margins, river margins, and bottomland forest edges.

Polygonum scandens L. [=*Fallopia scandens* (L.) Holub], *A1786*. Infrequent. Moist roadside ditches.

Polygonum setaceum Baldwin [=*Persicaria setacea* (Baldwin) Small], *A1069*. Infrequent. Swamps and spring-seeps.

Polygonum virginianum L. [=*Persicaria virginiana* (L.) Gaertn., *Antenoron virginianum* (L.) Roberty & Vautier, *Tovara virginiana* (L.) Raf.], *A1308*. Infrequent. Upland mixed forest especially in the Homochitto River basin, bottomland forest, and spring-seeps.

**Rumex crispus* L., *A1179*. Abundant. Old fields, cultivated fields, fencerows, and roadsides.

Rumex hastatulus Baldwin, *A1877*. Common. Old fields, roadsides, and yards.

**Rumex pulcher* L., *A779*. Infrequent. Old fields and cultivated fields.

PORTULACACEAE

Claytonia virginica L., *A477*. Rare. Edge of bottomland hardwood forest.

**Portulaca oleracea* L., *EA 126*. Infrequent. Sidewalk cracks in towns.

PRIMULACEAE

Anagallis minima (L.) E.H.L. Krause, *A1870*. Infrequent. Pine forest and roadsides.

Lysimachia lanceolata Walter, *A844*. Infrequent. Roadside ditches.

Samolus valerandi ssp. *parviflorus* (Raf.) Hultén [=*S. parviflorus* Raf.], *A1946*. Infrequent. Bottomland hardwood forest.

RANUNCULACEAE

**Clematis terniflora* DC., *A1354*. Infrequent. Fencerows, roadsides, and house sites.

Clematis virginiana L., *A1696*. Common. Forest edges.

Ranunculus abortivus L., *A279*. Infrequent. Moist open roadsides and yards.

Ranunculus fascicularis Muhl. ex Bigelow, *A268*. Infrequent. Pine forest, clearcuts, and road sides.

**Ranunculus parviflorus* L., *A540*. Infrequent. Old fields.

Ranunculus pusillus Poir., *A324*. Common. Moist open areas.

Ranunculus recurvatus Poir., *A652*. Infrequent. Sandy and gravelly areas, especially near bottomland.

**Ranunculus sardous* Crantz, *A222*. Abundant. Pastures, old fields, yards, and roadsides.

RHAMNACEAE

Berchemia scandens (Hill) K. Koch, *A558*. Common. Forest of various sorts and forest edges.

Ceanothus americanus L., *A659*. Infrequent. Pine forest and associated roadsides.

Frangula caroliniana (Walter) A.Gray [=*Rhamnus caroliniana* Walter], *A609*. Infrequent. Mature hardwood forest of ravines and Saffell outcrops.

ROSACEAE

Agrimonia microcarpa Wallr., *A1555*. Rare. Mature upland hardwood forest of Saffell outcrops.

Agrimonia rostellata Wallr., *A1389*. Rare. Mature upland hardwood forest of Saffell outcrops.

Amelanchier arborea (F. Michx.) Fernald, *A203*. Infrequent. Forest of various sorts.

Crataegus marshallii Eggl., *EA 246*. Common. Forest of various sorts.

Crataegus pulcherrima Ashe, *WA&M 70982*. Infrequent. Upland, unburned longleaf pine forest in the Homochitto River basin.

Crataegus spathulata Michx., *A547*. Rare. Upland unburned longleaf pine forest of the Homochitto River basin.

**Duchesnea indica* (Andrews) Focke, *A206*. Infrequent. Yards and ruderal areas.

Geum canadense Jacq., *A1057*. Rare. Sandy bottomland forest of the Homochitto River.

Malus angustifolia (Aiton) Michx., *A432*. Infrequent. Upland forest, especially in the Homochitto River basin.

Photinia pyrifolia (Lam.) K.R. Robertson & J.B. Phipps [=*Aronia arbutifolia* (L.) Pers.], *A2024*. Infrequent. Spring-seeps and swamp margins.

◆ **Photinia serratifolia* (Desf.) Kalkman, *A386*. Rare. Upland and bottomland mixed forest.

Potentilla simplex Michx., *A503*. Rare. Saffell outcrops.

Prunus angustifolia Marshall, *EA 196*. Common. Pine forest and dry roadsides.

Prunus caroliniana (Mill.) Aiton, *EA 224*. Infrequent. Saffell outcrops, upland mature hardwood forest, and bottomland hardwood forest.

Prunus mexicana S.Watson, *A205*. Common. Forest edges of various sorts and Saffell outcrops.

Prunus serotina Ehrh., *A745*. Abundant. Forest of various sorts and fencerows.

Prunus umbellata Elliott, *A211*. Infrequent. Upland and bottomland forest edges.

**Pyrus calleryana* Decne., *A383*. Rare. Old oil well site.

**Rosa bracteata* J.C.Wendl., *A776*. Rare. Roadside north of Liberty.

Rosa carolina L., *A1944*. Common. Upland pine forest and roadsides.

**Rosa laevigata* Michx., *A406*. Common. Fencerows, roadsides, and forest edges of various sorts.

**Rosa multiflora* Thunb. ex A.Murray, *A543*. Infrequent. Roadsides.

**Rosa wichuraiana* Crép., *A797*. Infrequent. Old pastures and fields, fencerows, and roadside ditches.

Rubus argutus Link, *A438*. Abundant. Pine forest, forest edges, and clearcuts.

Rubus flagellaris Willd. [including *R. enslenii* Tratt.], *A2518*. Infrequent. Pine forest and gravelly areas.

Rubus trivialis Michx., *A218*. Abundant. Old fields, pastures, and open forest of various sorts.

RUBIACEAE

Cephalanthus occidentalis L., *A1098*. Infrequent. Pond margins, riverbanks, and swamp margins.

Diodia teres Walter, *A1282*. Common. Clearcuts, ruderal areas, and pine forest.

Diodia virginiana L., *A719*. Infrequent. Clearcuts and disturbed areas.

Galium aparine L., *A263*. Infrequent. Ruderal areas and yards.

Galium circaezans Michx. Referenced in Jones (1976); specimen not seen.

Galium obtusum Bigelow ssp. *obtusum*, *A479*. Rare. Bottomlands.

Galium orizabense ssp. *laevicaule* (Weath. & S.F.Blake) Dempster, *A1226*. Common. Saffell outcrops, burned pine forest, and roadsides.

Galium pilosum var. *puncticulosum* (Michx.) Torr. & A. Gray, *A1503*. Rare. Pine forest.

Galium triflorum Michx., *A848*. Rare. Mature hardwood forest.

Galium uniflorum Michx., *A1018*. Rare. Pine forest.

Houstonia micrantha (Shinners) Terrell, *A281*. Infrequent. Yards, cemeteries, and fields.

Houstonia purpurea L. var. *purpurea*, *A613*. Infrequent. Forest drains.

Houstonia pusilla Schoepf, *A209*. Infrequent. Yards, cemeteries, and fields.

Houstonia rosea (Raf.) Terrell, *A294*. Infrequent. Yards, cemeteries, and fields.

Mitchella repens L., *A545*. Common. Forest of various sorts.

Oldenlandia boscii (DC.) Chapm., *WA&M 71205*. Infrequent. Sandy and gravelly openings.

Oldenlandia uniflora L., *A2289*. Infrequent. Bottomland fields.

**Richardia scabra* L., *A2353*. Infrequent. Sandy river banks.

**Sherardia arvensis* L., *A656*. Infrequent. Roadside ditches and yards.

RUTACEAE

**Poncirus trifoliata* (L.) Raf., *A1209*. Infrequent. Sandy margins of creeks and old home sites.

Ptelea trifoliata var. *mollis* Torr. & A. Gray, *A1201*. Rare. Upland hardwood forest in the western part of the county.

Zanthoxylum clava-herculis L., *A1200*. Infrequent. Upland forest or sandy bottomland forest.

SALICACEAE

**Populus alba* L., *A1176*. Rare. Old home sites in the eastern half of the county.

Populus deltoides Bartram ex Marshall, *A1225*. Infrequent. Forest edges or bottomland openings.

Salix nigra Marshall, *A575*. Common. Riverbanks, pond margins, and moist roadsides.

SAPOTACEAE

Sideroxylon lycioides L. [=*Bumelia lycioides* (L.) Pers.], *A2576*. Rare. Upland hardwood forest in the Homochitto River basin.

SAURURACEAE

Saururus cernuus L., *A737*. Locally common. Roadside ditches, open swamps, spring-seeps, and beaver-impounded ponds.

SCHISANDRACEAE

Schisandra glabra (Brickell) Rehder, *A994*. Infrequent. Hardwood ravines and Saffell outcrops.

SCROPHULARIACEAE

Agalinis fasciculata (Elliott) Raf., *A1553*. Abundant. Old fields.

Agalinis plukenetii (Elliott) Raf., *A1764*. Infrequent. Longleaf pine forest of the Homochitto River basin.

Agalinis tenuifolia (Vahl) Raf., *A2254*. Rare. Rocky bluffs overlooking the East Fork Amite River.

†*Aureolaria dispersa* (Small) Pennell [=*A. virginica* (L.) Pennell, in part], *A1632*. Infrequent. Pine forest in the southeastern part of the county. Species taxonomy follows Pennell (1935).

Aureolaria pectinata (Nutt.) Pennell, *EA 96*. Infrequent. Pine forest.

Buchnera americana L. [including *B. floridana* Gandoger], *A588*. Common. Fields.

Gratiola floridana Nutt., *A216*. Locally common. Spring-seeps and swamp margins.

Gratiola neglecta Torr., *A517*. Rare. Bottomland roadside in the southeastern part of the county.

Gratiola pilosa Michx., *WA&M 71195*. Infrequent. Pine forest and roadsides.

Gratiola virginiana L., *A532*. Infrequent. Bottomland forest and river margins.

**Lindernia crustacea* (L.) F.Muell., *A1355*. Infrequent. Yards.

Lindernia dubia (L.) Pennell, *A1045*. Common. Bottomland openings and river margins.

**Mazus pumilus* (Burm.f.) Steenis, *EA 227*. Infrequent. Bottomland fields and yards.

Mecardonia acuminata (Walter) Small, *A1502*. Infrequent. Pine forest.

Micranthemum umbrosum (Walter ex J.F. Gmel.) S.F. Blake, *A763*. Locally common. Pond margins, wet ditches, swamps, and bottomland hardwood forest.

Mimulus alatus Aiton, *A1330*. Swamp margins, river margins, and edges of bottomland hardwood forest.

Nuttallanthus canadensis (L.) D.A. Sutton [=*Linaria canadensis* (L.) Chaz.], *A269*. Common. Pastures, roadsides, and yards.

Pedicularis canadensis L., *A643*. Rare. Upland forest of the Homochitto River basin.

Penstemon digitalis Nutt. ex Sims, *A843*. Infrequent. Pine forest and roadsides.

Penstemon laxiflorus Pennell, *A1883*. Infrequent. Roadside banks.

Scoparia dulcis L., *A2290*. Rare. Gravelly clearcuts.

Seymeria cassioides (Walter ex J.F. Gmel.) S.F. Blake, *A1743*. Common. Pine forest.

**Verbascum thapsus* L., *A1132*. Infrequent. Saffell outcrops, gravelly areas, and roadsides.

**Veronica arvensis* L., *A286*. Common. Roadsides and yards.

Veronica peregrina L., *A1882*. Common. Roadsides and clearcuts.

**Veronica persica* Poir., *A295*. Common. Roadsides.

SIMAROUBACEAE

**Ailanthus altissima* (Mill.) Swingle, *A2109*. Infrequent. Ditches and roadsides in the western part of the county.

SOLANACEAE

Physalis angulata L., *A1237*. Common. Cultivated fields.

Physalis carpenteri Riddell, *A1051*. Infrequent. Saffell outcrops.

Physalis heterophylla Nees, *A700*. Infrequent. Saffell outcrops and sandy bottomland.

Physalis pubescens L., *A1240*. Common. Clearcuts and roadsides.

Solanum elaeagnifolium Cav., *M. Whitson 1142* (DUKE!). Rare. Gravelly upland in the Homochitto River basin.

Solanum carolinense L., *A666*. Common. Roadsides, cultivated fields, and pine forest.

**Solanum pseudocapsicum* L., *A2346*. Infrequent. Sandy bottomland forest along the forks of the Amite River.

Solanum ptychanthum Dunal, *A720*. Common. Clearcuts, open fields, and sandy roadsides.

**Solanum viarum* Dunal, *A1025*. Rare. Cattle barns. Noxious weed; all individuals observed were collected or destroyed.

STERCULIACEAE

Melochia corchorifolia L., *A1795*. Rare. Riverbanks and sandbars of the Amite River basin.

STYRACACEAE

Halesia diptera J. Ellis, *A430*. Abundant. Bottomland forest, swamp margins, ravines, and Saffell outcrops.

Styrax grandifolius Aiton, *A1100*. Infrequent. Bottomland hardwood forest, ravines, and Saffell outcrops.

SYMPLOCACEAE

Symplocos tinctoria (L.) L'Hér., *A402*. Common. Bottomland hardwood forest, upland hardwood or mixed forest, and ravines.

THEACEAE

Stewartia malacodendron L., *A559*. Infrequent. Bottomland hardwood forest, hardwood ravines, and Saffell outcrops.

TILIACEAE

Tilia americana var. *caroliniana* (Mill.) Castigl., *A2075*. Infrequent. Hardwood forest of Saffell outcrops.

ULMACEAE

Celtis laevigata Willd., *A1061*. Infrequent. Sandy bottomland of the Homochitto River basin.

Ulmus alata Michx., *A935*. Abundant. Upland hardwood forest, pine forest, and bottomland nardwood forest.

Ulmus americana L., *EA 200*. Infrequent. River margins and bottomland forest.

Ulmus rubra Muhl., *A870*. Rare. Bottomland hardwood forest.

UMBELLIFERAE

Chaerophyllum tainturieri Hook., *A332*. Common. Roadsides and fields.

Ciclospermum leptophyllum (Pers.) Sprague ex Britton & Wilson [=*Apium leptophyllum* (Pers.) Benth.], *A636*. Infrequent. Roadsides, upland forest over loose soil, and Saffell outcrops.

Cicuta maculata L., *A807*. Infrequent. Moist roadsides and open bottomland.

**Daucus carota* L., *EA 262*. Infrequent. Roadsides.

Eryngium prostratum Nutt. ex DC., *A829*. Abundant. Moist fields, roadside ditches, and open bottomland.

Eryngium yuccifolium Michx., *WA&M 71053*. Infrequent. Upland pine forest and sandy river margins.

Hydrocotyle ranunculoides L.f., *A1837*. Rare. Muddy swamp edge in the West Fork Amite River drainage.

Hydrocotyle umbellata L., *A2059*. Common. Pond margins, swamp margins, sloughs, and wet ditches.

Hydrocotyle verticillata Thunb., *A1949*. Infrequent. Bottomland hardwood forest.

Ptilimnium capillaceum (Michx.) Raf., *A757*. Common. Roadside ditches and bottomland fields.

Sanicula canadensis L. var. *canadensis*, *A859*. Common. Mixed forest and dry, upland hardwood forest.

Sanicula smallii E.P. Bicknell, *A615*. Infrequent. Mesic hardwood ravines and Saffell outcrops.

Thaspium trifoliatum (L.) A. Gray, *A351*. Infrequent. Bottomland hardwood forest and hardwood ravines.

URTICACEAE

Boehmeria cylindrica (L.) Swartz, *A1350*. Common. Bottomland forest or other mesic forest.

Laportea canadensis (L.) Wedd., *A2112*. Infrequent. Hardwood forest of the Homochitto River basin.

Pilea pumila (L.) A. Gray, *A1823*. Rare. Abandoned oxbow swales.

Urtica chamaedryoides Pursh, *A2118*. Infrequent. Hardwood forest on thick loess in the Homochitto River basin and disturbed forest in the northeastern corner of the county.

VALERIANACEAE

Valerianella radiata (L.) Dufr., *A272*. Common. Roadsides, yards, and fields.

VERBENACEAE

Callicarpa americana L., *A1029*. Abundant. Pine forest, mixed forest, and Saffell outcrops.

**Clerodendrum indicum* (L.) Kuntze, *A2282*. Rare. Roadsides.

Glandularia pulchella (Sweet) Tronc. Referenced in Pullen et al. (1968); specimen not seen.

**Lantana camara* L., *A2306*. Rare. Roadsides.

Phryma leptostachya L., *A1143*. Infrequent. Rich hardwood forest at Saffell outcrops.

**Verbena brasiliensis* Vell., *A724*. Abundant. Roadsides, upland forest edges, and old fields.

Verbena halei Small, *A470*. Infrequent. Roadsides.

**Verbena rigida* Spreng., *A597*. Locally common. Roadsides.

**Vitex agnus-castus* L., *A996*. Rare. Ruderal lot in Liberty.

VIOLACEAE

Viola affinis Leconte, *A247*. Common. Ravines, upland hardwood and mixed forest, and Saffell outcrops.

Viola bicolor Pursh [=*V. rafinesquii* Greene], *A328*. Infrequent. Yards and old fields.

Viola missouriensis Greene (sensu lato, including *V. floridana* Brainerd and possibly *V. langloisii* Greene; see Gilad 1995), *A291*. Infrequent. Old fields and yards.

Viola pedata L., *A334*. Locally common. Pine forest and roadsides in the eastern half of the county.

Viola primulifolia L., *A217*. Abundant. Moist openings, streambanks, bottomland fields, and roadside ditches.

Viola triloba Schwein., *A708*. Common. Forest of various sorts and Saffell outcrops.

Viola walteri House, *A260*. Common. Upland hardwood forest, ravines, and Saffell outcrops.

VISCACEAE

Phoradendron leucarpum (Raf.) Reveal & M.C. Johnst., *A1534*. Common. Parasitic and epiphytic upon various hardwoods, primarily *Prunus serotina* and *Quercus* spp.

VITACEAE

Ampelopsis arborea (L.) Koehne, *A1305*. Common. Open forest or forest edges of various sorts.

Parthenocissus quinquefolia (L.) Planch., *A1155*. Abundant. Pine forest, upland hardwood or mixed forest, bottomland hardwood forest, Saffell outcrops, swamps, yards, and towns.

Vitis aestivalis Michx. var. *aestivalis*, *A2081*. Abundant. Forest and forest edges of various sorts.

Vitis cinerea (Engelm.) Engelm. ex Millardet var. *cinerea*, *A888*. Common. Forest and forest edges of various sorts.

Vitis rotundifolia Michx., *A695*. Abundant. Forest and forest edges of various sorts.

DISCUSSION

The survey for vascular plants in Amite County, Mississippi yielded 923 species, which is about 31% of the total number of species found in Mississippi (Kartesz 1999). Table 3 provides a summary of the taxa found in the county. The largest plant families are Compositae (116 spp.), Gramineae (99 spp.), Cyperaceae (74 spp.), and Leguminosae (63 spp.), and the three largest genera are *Carex* (34 spp.), *Panicum* s.l. (19 spp.), and *Quercus* (18 spp. + 1 common hybrid). Introduced species make up about 16% of the flora, which is a proportion similar to neighboring areas (e.g., Clewell 1985: 16%).

The survey re-confirmed the existence of several rare species in the county

TABLE 3. Synopsis of vascular plant taxa recorded for Amite County, Mississippi.

	Species	Genera	Families
Lycopodiophyta	1	1	1
Polypodiophyta	26	20	11
Coniferophyta	7	3	2
Magnoliophyta	889	442	139
(Magnoliopsida	634	343	109)
(Liliopsida	255	99	30)
TOTAL	**923**	**466**	**153**
Indigenous	777	389	142
Introduced	146 (16%)	77	11

Largest families: Compositae (116 spp.), Gramineae (99 spp.), Cyperaceae (74 spp.), Leguminosae (63 spp.)
Largest genera: *Carex* (34 spp.), *Panicum* s.l. (19 spp.), and *Quercus* (18 spp.)

and added a few new records to the state. Rarity is measured in accordance with the Mississippi Natural Heritage Program (1994), where "G" and a number indicate worldwide status and "S" and a number indicate state status. The rarest species are given a number 1, and the more secure given 5. Rare species indicated by the Mississippi Natural Heritage Program (1995) to occur in Amite County that were again encountered in the present survey include *Antennaria solitaria* (G5/S3?), *Chromolaena ivifolium* (G5/S2?), *Epidendrum conopseum* (G3G4/S2), *Luzula acuminata* (G5/S3), *Mikania cordifolia* (G5/S3S4), *Pachysandra procumbens* (G4G5/S3), *Schisandra glabra* (G4/S3?), *Stewartia malacodendron* (G4/S3S4), *Trichomanes petersii* (G3/S1), and *Trillium foetidissimum* (G3G4/S3). *Stewartia malacodendron* and *Trillium foetidissimum*, although listed as state rare species, are actually not uncommon in the county.

In addition to previous records, the present survey recorded the existence of *Carex decomposita* (G3G4/S3?), *Dryopteris ludoviciana* (G4/S1), *Iris brevicaulis* (G4/S?), *Lobelia appendiculata* (G4G5/S2S3), *Matelea carolinensis* (G4/S2S3), *Melanthium virginicum* (G5/S2S3), *Sabatia campestris* (G5?/S2S3), and *Spiranthes ovalis* (G5/S2S3).

New records for the state are *Alstroemeria psitticina* (Alstroemeriaceae), *Clinopodium gracile* (Labiatae), *Ipomoea indica* (Convolvulaceae), *Photinia serratifolia* (Rosaceae), and *Solidago auriculata* (Compositae). *Alstroemeria psitticina* is an introduced species from Brazil (Bailey 1949). One small population was discovered within the city limits of Liberty under a tree with much leaf mulch. Neither the property owner nor his neighbors recognized the species, and none claimed to have cultivated such a species in the past. *Clinopodium gracile* is an introduced species from Japan (Burkhalter 1984). It was first noted to occur in the United States in Louisiana in 1963 (Thieret 1964) and has subsequently been collected in Florida (Burkhalter 1984) and reported for Alabama (J.V.Ward, pers. comm. to Kartesz 1999). *C. gracile* was actually discovered in the United States as early as 1934 but apparently was never reported (*Roland Harper, s.n.*, Iberia Parish, LA, 16 July 1934, BH!). It has also been known to occur in Mississippi (*John R. MacDonald 9771*, Copiah Co., MS, 19 July 1996, MO!) but has not been previously reported. *Ipomoea indica* is a pantropical weed and was found in several roadside ditches near Liberty. *Photinia serratifolia* is a shrubby species native to China (Bailey 1949) and has been frequently cultivated in the southern United States. Although I found no clear evidence of self-established lines, the species was found in areas with no evidence suggesting former cultivation either. *Solidago auriculata* is the only new record of a species native to the southeastern United States. It has a large distribution but seldom occurs with frequency.

Also collected were *Physalis carpenteri* and *Dryopteris ludoviciana*, both of which have only recently been reported to occur in Mississippi (L.M. McCook, pers. comm. to Kartesz 1999, Sorrie & Leonard 1999, respectively). At least one specimen of *Physalis carpenteri* had been collected in Mississippi before (Warren County, MISS!), was misidentified, and was later annotated correctly by Janet Sullivan, then working on her part of the *Flora of the Southeastern United States*. Unfortunately, that treatment was not subsequently published. Considering the limited range of *Physalis carpenteri* to Florida, Louisiana, and Mississippi, it will likely be added to the Mississippi Natural Heritage Program list of rare species.

The flora also yielded a number of champion trees and shrubs. Especially large trees and shrubs were noted and contributed to the Mississippi Forestry Commission champion tree program. Amite County was already known to be home to the largest individuals of *Frangula (Rhamnus) caroliniana*, *Hamamelis virginiana*, *Liriodendron tulipifera*, *Magnolia acuminata*, *Nyssa sylvatica*, *Pyrus communis*, and *Triadica (Sapium) sebifera* in Mississippi and is now known to be home to the largest *Halesia diptera*, *Ilex verticillata*, *Ilex vomitoria*, *Kalmia latifolia*, and *Morella cerifera*.

The flora of Amite County reveals the complexity of plant distributions in the southeastern United States. The flora is rich in species and vegetation types, with prominent variations resulting from physiographic, topographic, and edaphic factors. The eastern half of the county shows floristic similarity to other upland regions of the lower coastal plain. Pines are the dominant woody plants, surrounded by a herbaceous vegetation rich in composites, legumes, grasses, and sedges. Surprisingly, there is more similarity between the highlands of the Homochitto River basin and the southeastern corner of the county than with the area in between (see Fig. 2). Perhaps this is a result of the erosion of loess from Homochitto ridges and the exposure of the underlying Miocene clays. In these Homochitto areas, many coastal plain species are found which are not even found in the southeastern corner of the county, for example, *Drosera brevifolia*, *Ionactis linariifolius*, *Liatris elegans*, and *Symphyotrichum adnatus*.

With the introduction of loess to the substrate and the large Mississippi Embayment just to the west, Amite County naturally serves as the westernmost distribution point for several coastal plain species, such as *Gelsemium rankinii* and *Illicium floridanum*. This is almost true for *Packera anonyma*, *Gaylussacia dumosa*, and *Kalmia latifolia* as well, but there are rare reports of their occurrence west of the Mississippi River (MacRoberts 1989). The introduction of loess also serves to harbor the residual flora of Pleistocene migrations from the north (Delcourt & Delcourt 1975), and thus, Amite County is home to several species indicative of the mesophytic forests of mid-eastern North America, including *Adiantum pedatum*, *Cynoglossum virginianum*, *Hydrangea arborescens*, and *Pachysandra procumbens*. There is also a weaker botanical association with the West (e.g., *Cuscuta cuspidata*, *Gaura brachycarpa*, *Liatris pycnostachya*, *Sabatia campestris*, and *Vernonia texana*) and with the neotropics (e.g., *Chromolaena ivifolia* and *Mikania cordifolia*). Other phytogeographical conclusions have been discussed in greater detail in Allen et al. (1975).

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BOOK REVIEW

RICHARD P. WUNDERLIN and BRUCE F. HANSEN. 2000. **Flora of Florida, Volume I. Pteridophytes and Gymnosperms**. (ISBN 0-8130-1805-6, hbk.). University Press of Florida, 15 NW 15th Street, Gainesville, FL 32611-2079, U.S.A. (Orders: www.upf.com). $49.95, 384 pp, 8 b&w photos, 68 drawings, bibliography, index, 7" × 10".

"*Flora of Florida, Volume I*, is the first of a proposed eight-volume comprehensive reference to the more than 3,800 vascular plants, native and non-native, known to occur growing wild in the state." This provides standard botanical treatments for all families, genera, and species of the ferns and gymnosperms, including keys, descriptions, nomenclature, illustrations, and summary information on habitat and geographic distribution. Introductory chapters, good for the whole Flora of Florida series, provide overviews of the physical setting, vegetation, and botanical exploration of the state. A number of excellent biographical capsules form part of the 'biographical exploration' chapter. At the end are Literature Cited, General Index, Index to Common Names, and Index to Scientific Names.

It's obviously unusual that two separate volumes dealing primarily with the ferns and fern allies of Florida appear the same year, but the treatments are largely complementary and the authors obviously were in communication, as Gil Nelson provided some of the dust jacket PR commentary for the W&H volume: "This important addition to the botanical literature of Florida and the eastern United States will be welcomed by professional and amateur botanists and field biologists throughout the region." W&H include 152 species and 9 hybrids; there are various differences in taxonomic interpretation at the species, genus, and family levels between the two treatments, but they cover essentially the same species.

In contrast to the Nelson volume, W&H provide longer and more detailed technical descriptions, detailed and formal synonymy, keys to all genera with more than a single species, and a line drawing (habit and details, placed with the text) of one species for each genus. Think of the W&H volume as the technical companion to the Nelson volume—a serious pteridologist in the Southeast surely will want both books. Of course, it would have been good (from my point of view) to have all the information in a single volume. Gymnosperms are covered only in the W&H volume.—*Guy L. Nesom, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

NOTES ON THE INCREASING PROPORTION OF NON-NATIVE ANGIOSPERMS IN THE MISSOURI FLORA, WITH REPORTS OF THREE NEW GENERA FOR THE STATE

George Yatskievych
Missouri Department of Conservation/
Missouri Botanical Garden
P.O. Box 299
St. Louis, MO 63166, U.S.A.
george.yatskievych@mobot.org

Jay A. Raveill
Department of Biology
Central Missouri State University
Warrensburg, MO 64093, U.S.A.
jar8812@cmsu2.cmsu.edu

ABSTRACT

Three additions to the Missouri flora are reported: *Fatoua villosa* (Moraceae), *Oenanthe javanica* (Apiaceae), and *Ottelia alismoides* (Hydrocharitaceae). Each of these represents a nonindigenous genus new to the state. The number of introduced taxa of vascular plants in Missouri continues to increase more rapidly than that of native taxa, and the non-native component of the state's floristic diversity has risen from ca. 22.8 percent to 27.7 percent during the past 35 years.

RESUMEN

Se citan tres nuevas especies para la flora de Missouri: *Fatoua villosa* (Moraceae), *Oenanthe javanica* (Apiaceae), y *Ottelia alismoides* (Hydrocharitaceae). Cada una de éstas representa un género nuevo no autóctono para el estado. El número de taxones introducidos continúa incrementándose más rápidamente que el de los taxones nativos, y el componente no nativo de la diversidad florística del estado ha aumentado del 22.8 por ciento al 27.7 por ciento en los últimos 35 años.

There are many good reasons for establishing permanent programs to collect data on floristic diversity in various regions. Among these, perhaps the most surprising to non-botanists is that field and herbarium studies continue to yield major new distributional records, even in supposedly well-botanized areas. The notion that plants, unlike animals, are generally rooted in place has led to the flawed perception among some scientists, administrators, and politicians that plant distributions generally are static, and that inventory and monitoring activities reasonably may be curtailed following attainment of some qualitatively established benchmark, such as publication of a state floristic manual.

Actual facts counter this perception. For example, for many years, knowledge of the vascular flora of Missouri was considered by many botanists to be relatively complete, at least compared with that of most other states. Missouri had an exemplary floristic manual (Steyermark 1963), praised by botanists for its completeness and attention to detail. Steyermark's own extensive body of meticulously documented field work and more than 60,000 Missouri collections, along with the activities of a large number of other prolific collectors, resulted in one of the most thoroughly documented regional floras in the country.

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Missouri's landlocked midcontinental position also contributed to the notion of stability of the state's flora.

Even before the publication of *Flora of Missouri*, however, additional species records began to accumulate. In fact, Steyermark (1963) was forced to add a 3- page addendum to his book to include mention of 20 species that been confirmed to occur in Missouri after his text had been finalized for the publisher, based on specimens newly accessioned in herbaria. Over time, a remarkable number of other additions to the register of the state's flora has been reported by a large number of workers. Yatskievych (1999) summarized these for the 35-year period following publication of Steyermark's Flora as comprising 292 species, 25 infraspecific taxa, and 21 hybrids, a net increase of 11.9 percent. He further noted that the amazing rate of nearly ten new taxa discovered per year showed no sign of slowing. The new records represent a mixture of relatively localized taxa overlooked by earlier botanists, recently established populations reflecting rapidly shifting or expanding ranges of some plants, and a few novelties only recently described as new to science. Turner and Yatskievych (1992) detailed the Missouri distributions of new records recorded from 1963 to 1991 and some additional records were discussed by Yatskievych (1999).

At the species level, 37 percent of these reports were of taxa considered to be native components of the flora, with the remaining 63 percent representing non-native taxa (Yatskievych 1999). Thus, during the three and a half decades following the publication of Steyermark's (1963) Flora, the non-native component of the state's floristic diversity rose from ca. 22.8 percent to 27.7 percent. It is worth noting that although most of the non-native additions to the flora have remained relative rarities, some of them have become quite common and widespread, including such weedy species as *Alliaria petiolata* (M. Bieb.) Cavara & Grande (Brassicaceae, garlic mustard), *Dipsacus laciniatus* L. (Dipsacaceae, cut-leaved teasel), *Elaeagnus umbellata* Thunb. (Elaeagnaceae, autumn olive), *Lonicera maackii* (Rupr.) Maxim. (Caprifoliaceae, Amur honeysuckle), and *Ligustrum obtusifolium* Sieb. & Zucc. and *L. sinense* Lour. (Oleaceae, privets). Some of the worst invasive exotics troubling property owners, land managers, and conservationists today were not known to grow in Missouri in 1963.

With this in mind, we present data to justify the inclusion of three recently found species in the flora of Missouri. The taxa are notable in that they represent new generic records for the state as well, and in one case, to our knowledge, the species previously has not been recorded for the North American flora. We believe that each of these species has the potential to become more widespread in Missouri and possibly to become invasive in some native plant communities in the state.

Fatoua villosa (Thunb.) Nakai (Moraceae, mulberry weed).—This monoecious annual is native to eastern Asia, where it often occurs in disturbed habitats. It was first reported for North America from Louisiana by Thieret (1964), who indicated that it may have been present in the New Orleans area for 15 or more years prior to his report. Since that time, it has become widespread in the southeastern and midwestern states west to Texas and has appeared sporadically in Utah, California and Washington, as well as Hawaii, Puerto Rico, and the Bahamas. For reviews of the literature on its geographic spread, see Vincent (1993) and Kartesz and Meacham (1999). Reports of occurrences in Indiana (Wunderlin 1997; Kartesz & Meacham 1999) require confirmation.

Fatoua villosa is a nondescript herb with alternate, petiolate, stipulate, ovate to triangular leaves having trunctate to cordate bases, crenate margins, and attenuate tips. The vegetative portions strongly resemble seedlings or root sprouts of mulberries (*Morus* spp.), hence the common name "mulberry weed." The dense, flattened, brownish purple cymes containing both staminate and pistillate flowers somewhat resemble a reduced version of a *Dorstenia* (Moraceae) inflorescence. The flowers mature at different times, so the tiny projectile seeds are dispersed over at least a two month period (pers. obs. in Missouri). Wunderlin (1997) provided a description and keys to separate *Fatoua* from other genera of North American Moraceae.

Mulberry weed is most commonly found in greenhouses, flower beds, and similar highly disturbed sites. Much of its interstate spread may be in the form of seeds residing as contaminants in nursery stock and soil or mulch. The strong superficial similarities between the herbage to that of *Morus* suggests that plants of *Fatoua* may be overlooked by some collectors and that the species' range might be greater than has been documented thus far.

In Missouri, *Fatoua villosa* was first brought to the authors' attention by Dr. Michael Vincent of Miami University, who had studied the species' distribution in Ohio (Vincent 1993), and who noted plants in flower beds at the Missouri Botanical Garden while attending a symposium in October, 1993. Subsequent herbarium studies disclosed that the species was present as early as 1990 as a greenhouse weed at the Botanical Garden. By 1994, the plant had become a troublesome pest in planted areas around the property and the horticulture staff began an aggressive campaign to weed it out. Despite the efforts of staff and volunteers since then, the plants have merely decreased in numbers and size and not been eliminated, presumably because of a soil seed bank. Indeed, by 1996 the species had spread to the Garden's Shaw Nature Reserve, in Franklin County, where it became established in tended woodland areas. Other weedy occurrences noted in flower beds at various locations in and around St. Louis City and County presumably resulted from independent introductions into the state. However, based on a survey of herbarium specimens, the species was present as early as 1972 as a greenhouse weed in Cape Girardeau. In recent years, localized infestations have been documented from additional counties, and the species eventually may be found in most metropolitan areas around the state. Its invasive potential remains to be determined, but it is worth noting that it has been collected along disturbed margins of at least one mesic upland forest site in St. Louis County.

Specimens examined: U.S.A. **Missouri. Boone Co.:** Columbia, 608 E. Cherry Street, common weed along edge of perennial evergreen shrubbery at NW corner of Federal Building, 24 Aug 1995, *McKenzie 1629* (MO, UMO). **Butler Co.:** Poplar Bluff, 252 S Barron Road, weed in flower bed of residence, present for at least 2 years, 17 Sep 1994, *Hudson s.n.* (MO); Poplar Bluff, near steps leading from E parking lot of Kneibert Clinic to parking lot, at edge of lawn, 26 Aug 1996, *Hudson 956* (MO). **Cape Girardeau Co.:** Cape Girardeau; Brooks Gardens, 1110 N Cape Rock Drive, weed in greenhouse, 24 Sep 1972, *Brooks s.n.* (MO, SEMO). **Cole Co.:** Jefferson City, Missouri Department of Conservation Headquarters, in mulched plantings of courtyard within office complex, 7 Aug 2000, *Smith 3605* (MO). **Franklin Co.:** Gray Summit, Shaw Arboretum, Whitmire Wildflower Garden in shaded bed near gazebo at S end of small pond, scattered weeds in planting, 14 Sep 1996, *Yatskievych & Yatskievych 96-82* (MO). **St. Louis Co.:** St. Louis City, Missouri Botanical Garden, weed in greenhouse, 19 Sep 1990, *Miller, Merello, & Schmidt 5608* (MO); Missouri Botanical Garden, weed in flower bed in front of Climatron, 9 Oct 1993, *Vincent 6443* (MO, MU); Missouri Botanical Garden, along edge of main walk from Ridgway Center to Climatron, uncommon weed in bed, presumably introduced as a seed contaminant in *Zinnia* planting, 9 Oct 1993, *Yatskievych & Yatskievych 93-371* (MO); Missouri Botanical Garden, weed on W side of Schoenberg Administration Building, 30 Aug 1995, *Lievens, Yatskievych, & Yatskievych 5770* (MO); Clayton; SW corner of Forsyth Blvd. and Bemiston Rd., scattered weeds in planting along bank building, 7 Sep 1996, *Yatskievych & Yatskievych 96-80* (MO); Manchester, 957 Barcroft Woods Ct., uncommon along disturbed margin of mesic upland forest adjacent to back yard, 25 Oct 2000, *Yatskievych & Yatskievych 00-99* (MO).

Oenanthe javanica (Blume) DC. (Apiaceae, water celery).—American horticulturalists continue to search abroad for hardy new plants to promote for use in gardens in the United States. This is especially true in water gardening, where there is a strong trend to utilize “specimen plants” exhibiting unusual growth forms. The water dropwort genus, *Oenanthe*, contains perhaps 40 species of mostly Old World perennials, a few of which have made their way into plant commerce (Mabberley 1997). Most of the species contain a number of toxic compounds (mostly polyacetylenes), and the vernacular “dropwort” generally has been used to denote plants responsible for animal or human poisoning. Thus, some species have been cultivated on a small scale for medicinal, pharmaceutical, or biochemical investigations.

The most commonly cultivated species of *Oenanthe* have been recorded as localized escapes: *O. aquatica* (L.) Poir. (water fennel), from Franklin County, Ohio (Cooperrider 1995); and *O. pimpinelloides* L., from Humboldt County, California (Constance 1993). To these, we now add *O. javanica*, from Johnson County, Missouri, apparently the first report of this species’ establishment outside of cultivation in North America.

Oenanthe javanica is a native of southeastern Asia and the Indo-Malaysian region. As North American botanists may be unfamiliar with the species, the following description has been adapted from the treatment in the forthcoming dicot volume of Steyermark’s Flora of Missouri (Yatskievych, in prep.):

Plants perennial, glabrous, with fibrous roots, lacking tubers. Stems 30–150 cm or more long, spreading with ascending branches and tips, somewhat inflated, rooting at the lower nodes. Leaves alternate and sometimes also basal, short- to long-petiolate, the petioles somewhat inflated. Leaf blades 3–20 cm long, ovate to triangular-ovate in outline, pinnately 1–2(–3) times compound, the leaflets 10–50 mm long, narrowly lanceolate to broadly ovate, rounded, narrowed, or tapered (sometimes unequally so) at the base, finely to more commonly coarsely toothed along the margins, occasionally with 1 or 2 basal lobes. Inflorescence an umbel, opposite the leaves and occasionally also terminal, mostly long-pedunculate. Involucre absent or less commonly of 1 or 2 bracts, these shorter than the rays, spreading to ascending at flowering, linear, with sharply pointed tips. Rays (4–)6–20, 0.5–3.0 cm long, strongly angled and with entire or minutely toothed, pale angles or narrow wings. Involucel of 7–13 bractlets, these shorter than to more commonly longer than the pedicels, linear, sometimes with thin, white, papery margins, tapered to sharply pointed tips. Flowers 5 to numerous in each umbellet, all perfect, epigynous, the pedicels 1–5 mm long. Sepals 5, minute triangular teeth. Petals 5, obovate, appearing shallowly notched apically but narrowed abruptly to a slender pointed extension at the tip, white. Ovary inferior, 2-carpellate, glabrous. Fruit a schizocarp, sometimes shed while still green, 2–3 mm long, oblong in outline, somewhat flattened laterally, glabrous, the 2 mericarps each with 5 ribs, these blunt, and broad, tan or light yellow to straw-colored, all or mostly obscuring the reddish brown surfaces between them.

This species was first collected in Missouri in 1996 by Lisa Wilson, a student in the plant taxonomy class at Central Missouri State University, but initially went unrecognized as a new record. Confirmation of its identity required collection of fruiting material during the 2000 field season. All collections originated from Race Horse Lake, a 0.73 ha (1.8 acre) artificial lake in the Pertle Springs Biological Study Area, owned by Central Missouri State University and located in Warrensburg, Johnson County. The population, which apparently originated near a bridge on the southern side of the lake, has been monitored since 1997 and has spread to occupy the entire shoreline of the lake. There are no records of its intentional cultivation at the site and the circumstances of its establishment there are not known. The species occurs as an emergent aquatic, with common associates including *Polygonum hydropiperoides*, *P. sagittatum*, *Schoenoplectus atrovirens*, *Boehmeria cylindrica*, and *Bidens cernua*. Its potential for becoming a serious weed is apparent in a 20 × 50 m, seasonally-inundated area along the southern side of the lake, where it forms a near monoculture. However, it is a minor vegetational component where steep slopes limit the littoral zone to a narrow strip. *Oenanthe javanica* has not spread to other ponds and lakes in the drainage, but is found in pockets of soil in the concrete spillway that drains Race Horse Lake and leads directly to the adjacent 6 ha (15 acre) Cena Lake. Future spread will be monitored and a plan to eliminate the population of

Oenanthe is being formulated by the CMSU Facilities and Grounds personnel in consultation with the Biology Department faculty.

Water celery is unusual in the genus *Oenanthe* in its edible herbage, and the species has a long history of cultivation in southeastern Asia and Malesia as a vegetable and potherb. Its adoption into North American horticulture apparently has been relatively recent, and the species was not included in Hortus Third (Liberty Hyde Bailey Hortorium staff 1976). Its popularity has risen in the last few years and cultivars have begun appearing on the market, such as 'Flamingo' with pinkish foliage. One indication of its popularity is that a recent search of the World Wide Web yielded about 65 sites including mention of the genus *Oenanthe*, principally online nursery catalogs. Some of these nursery catalogs include comments on the potential aggressiveness and vegetative spread of the species in some garden situations. That it can be dispersed by seed is evidenced from our conversations with horticulture staff at two botanical gardens in Indiana and Missouri, where plants grew spontaneously as contaminants in plantings of other aquatic species.

It should be noted that there is no modern monograph of *Oenanthe*. Several taxa originally treated as separate species have been reduced to infraspecific status by more recent workers, (e.g., Murata 1973). If one accepts the taxonomic validity of multiple varieties in this morphologically plastic taxon, then Missouri materials (and horticultural materials in the United States in general) should be referred to var. *javanica*, as currently circumscribed. Additionally, in working to determine the Missouri materials, we were surpised at the similarities between *O. javanica* and the North American native, *O. sarmentosa* C. Presl ex DC. (Pacific water dropwort), which occurs in wetlands mostly near the coast from Alaska to California. This species has been brought into cultivation locally within its native range, but apparently has not been marketed outside the Pacific Northwest. Regrettably, the only treatment thus far to attempt to contrast the two species is that of Hiroe (1979), whose key separated them on the basis of subtle differences in involucre and involucel size and shape, which are variable in both taxa. Future monographers may determine that *O. javanica* and *O. sarmentosa* should be combined into a single species with a disjunct distribution around the Pacific Rim.

Specimens examined: U.S.A. **Missouri. Johnson Co.:** Warrensburg, Pertle Springs, Race Horse Lake, 6 Oct 1996, *Wilson 113* (MO); same locality, 17 Aug 2000, *Raveill 3175* (MO, NEMO, SEMO, UMO, WARM); same locality, 26 Aug 2000, *Raveill 3176* (MO, NEMO, SEMO, UMO, WARM).

Ottelia alismoides (L.) Pers. (Hydrocharitaceae, duck lettuce).—The pantropical genus *Ottelia* comprises 21 mostly Old World species of aquatic annuals and perennials (Cook et al. 1984; Cook & Urmi-König 1984). One species, *O. alismoides*, which is native from Asia to Australia, has become widely established as an aquatic weed in parts of Africa, Europe, and North America. In the

United States, where the U.S. Department of Agriculture has listed the species as a federal noxious weed, it was first reported from southwestern Louisiana (Holmes 1978), where it was collected in 1939 (Haynes, 2000) and apparently remains well-naturalized in lakes and reservoirs in five parishes (Thomas & Allen 1993). Hatch et al. (1990) reported it from adjacent southeastern Texas without citation of localities or vouchers. A population in Butte County, California, in a ditch associated with rice fields was exterminated even before it could be reported in the literature (Turner 1980). The report from Missouri is the first example of a population occurring at a significantly inland location.

Ottelia alismoides is a short-stemmed, robust, submerged aquatic with large, long-petiolate, mostly ovate-cordate leaves resembling those of a plantain (*Plantago*) or water plantain (*Alisma*). The long-pedunculate, 1-flowered, emergent inflorescences are enclosed basally in a spathe with several undulate wings or ribs. The usually perfect flowers have 3 showy (2–3 cm long) white to pale pink petals. For more complete descriptions of this species and keys to its determination, see Godfrey and Wooten (1979), Cook and Urmi-König (1984), and Haynes (2000).

In July 2000, a population of *Ottelia* was located in southeastern Missouri by herpetologist Jeff Briggler, who, with other biologists from the Missouri Department of Conservation, was conducting reptile and amphibian surveys in two adjacent artificial wetlands at the Big Cane Conservation Area, in Butler County. These sites had been excavated in 1998 to create marsh habitat for the state-endangered western chicken turtle (*Deirochelys reticularia miaria*). There is no evidence that propagules of *Ottelia* were transported to the site accidentally on the equipment used for the excavations, so the plants are presumed to have been introduced into the area by migratory waterfowl. The shallow depressions in sandy soil presently contain a young successional wetland plant community, including individuals and patches of such associates as *Alisma triviale*, *Azolla mexicana*, *Echinodorus cordifolius*, *Eleocharis* spp., *Heteranthera* spp., *Ludwigia peploides*, *Myriophyllum pinnatum*, *Potamogeton foliosus*, *Sagittaria calycina*, and *Sphenoclea zeylanica*. Plants of *Ottelia* originally were noted flowering in the northernmost of the two areas, but a subsequent visit by local botanist Stanton Hudson (who is completing a floristic survey of Butler County) disclosed a few plants in the more southern area as well. Other sites in the vicinity have not been searched yet for the presence of duck lettuce. The Missouri Department of Conservation is preparing to attempt the eradication of plants at the known sites and to survey for the occurrence of duck lettuce in adjacent areas. In addition to the possibility that *O. alismoides* may spread to natural wetlands in the southern portion of the state, the potential exists for this species to invade rice fields in Missouri's Bootheel.

Specimens examined: U.S.A. **Missouri. Butler Co.:** Big Cane Conservation Area, ca. 3 mi S of Neelyville, ca. 1/3 mi NNW of parking lot on County Rd 278, in water of shallow man-made marshes, 27 Jul 2000, *Briggler, Pelton, Johnson & Urich s.n.* (MO, UMO); same locality, 12 Sep 2000, *Hudson 1287* (MO).

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BOOK REVIEW

JEAN ANDREWS. 1998. **The Pepper Lady's Pocket Pepper Primer.** (ISBN 0-292-70467-4, hbk.; 0-292-70483-6, pbk.). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. (Orders: http://www.utexas.edu/utpress, 512-471-4032). $17.95, 184 pp, 94 full color photographs, b/w illustrated glossary, 5" × 8".

"*This little book is intended to clarify some of the lingering confusion surrounding the pungent pods indigenous to Columbus' New World*," says the author. The book may be diminutive but like the tiny Chilpequin, *Capsicum annum* var. *glabriusculum*, it packs a lot in its small size! This time, author/artist Jean Andrews shows us her equally adept skill as photographer in this slick and colorful handbook.

This is an excellent quick reference identification guide (as the title suggests-a 'pocket primer'). Chapters can be found on nomenclature, how to recognize domesticated species, what makes a pepper hot, discussions on color, aroma, flavor and nutritional value, how to select and store peppers, how to roast and rehydrate, and how to cultivate them.

Forty-five peppers are identified and discussed in the chapter simply titled: *The Peppers*. Each are listed alphabetical by common type/group name with scientific names given beside the common name. Each are described and a brilliant color photo (sometimes more than one) accompanies each description. The peppers are photographed to scale to show relative size to other peppers in the book. Additional information is consistent with uniform categories: SIZE, COLOR, FRUIT SHAPE, FLESH, PUNGENCY, SUBSTITUTES, OTHER NAMES, SOURCES, USES, AND REMARKS.

There is an extensive Illustrated Glossary showing simple line drawings of fruit shape at peduncle (stem) attachments, fruit shape at blossom end or apex, and fruit cross-section. An explanation of fruit group/types and a Pungency Rating/Heat Scale are also provided. Sources for locating both dried and fresh peppers, prepared products and seeds are included. In the back is a list of Seed Sources containing a few addresses and, of course, an index. Plus, Jean adds some personal remarks based on her years of study on the pungent spice of *Capsicum*.

So if you are looking for a slick handbook on peppers, look no further. Once again *Nuestra Señora de los Chiles* strikes again with a fine new creation. This book is designed for pepper lovers of all types, professional or not. *Brava, Señora Andrews!—Linny Heagy, Linny/Designer, Illustrator, Arlington, TX, U.S.A., a0005835@airmail.net.*

GLOCHIDION PUBERUM (EUPHORBIACEAE) NATURALIZED IN SOUTHERN ALABAMA

Miriam L. Fearn
Department of Earth Sciences
University of South Alabama
Mobile, AL 36688-0002, U.S.A.

Lowell E. Urbatsch
Biological Sciences Department
Louisiana State University
Baton Rouge, LA 70803-1705, U.S.A.

During the month of July 2000, a colony of about ten unusual, small trees was observed growing in a wooded area near Halls Mill Creek in Mobile, Alabama. They have subsequently been identified as *Glochidion puberum* (L.) Hutch., a member of Euphorbiaceae (Fig. 1). The largest tree was approximately 4.5 m tall with a diameter of nearly 7.5 cm at its base while the smallest was a seedling less than 5 dm tall. Simple, alternate, distichous leaves characterized these plants. Numerous, axillary clusters of small, yellowish flowers and young fruit were evident on the larger individuals. On subsequent visits to the site mature fruits were observed.

The Alabama occurrence appears to be the first known record of this species naturalized in the United States. Specimen data from Harvard University Herbaria (HUH) indicate that this taxon is widespread in southeastern China where its occurrence is documented by specimens for the following provinces: Anhui, Fujian, Guangdong, Guangxi, Guizhou, Hainan, Hong Kong, Hubei, Hunan, Jiangsu, Sichuan, Taiwan, Yunnan, Zhejiang (Anthony Brach, pers. comm.). This species is known to be cultivated in Florida. University of Florida Herbarium (FLAS) specimen data indicate its cultivation on the University of Florida campus in Gainesville, Alachua County. According to label data, a single tree reported near St. Augustine in St. Johns County, Florida was obtained from the University of Florida.

The source of this material in Alabama is unknown. To our knowledge, *G. puberum* is not cultivated in the region; area plant nursery personnel and state agriculture extension staff were not familiar with this species. No record of it for Alabama was found in the Freeman Herbarium, Auburn University. This plant has few attractive features and, therefore, is probably not sought for ornamental use. Certain species of *Glochidion* are available in the nursery trade in tropical regions of the world where they are used for hedge plantings and reforestation (Alstonville Tree Farm 2000). *Glochidion puberum* reportedly has many ethno-botanical medicinal uses in China in the treatment of abscess, amenorrhea, arteritis, snake bite, dysentery, enteritis, flu, laryngitis, malaria, sores, and trauma (Duke 1997). A Chinese name for the plant is "Suan p'an tzu"

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or "abacus plant" because the seeds resemble small abacus beads (Kam-biu Liu, pers. comm.).

The area in Alabama where the plant was discovered is beside a roadway through a degraded wetland on the south side of Halls Mill Creek. The *Glochidion* plants are growing aproximately five meters from the edge of the asphalt road and about two meters from the wetland itself. They are on better-drained soil about halfway up the roadside embankment, one meter above poorly drained, acidic, wetland soils and standing water. Overstory vegetation consists primarily of scattered *Pinus taeda* L. near the road and a few *Acer rubrum* L. near the creek itself. In close proximity to the *G. puberum* colony are other non-natives such as *Sapium sebiferum* (L.) Roxb., *Ligustrum sinense* Lour., and *Lonicera japonica* Thunb. Nearby native plants include *Cyrilla racemiflora* L. and *Myrica cerifera* L. The site is relatively shady due to the surrounding *Pinus* and relatively tall *Sapium*.

Glochidion puberum are large shrubs or trees. According to label data, one individual on the University of Florida campus was multi-trunked, 10 meters tall. Based on the material from Alabama the bark is brown with closely spaced fine longitudinal furrows; milky sap or exudate absent; twigs tan, densely pubescent; hairs uniseriate, spreading or tangled. Leaves simple, alternate, distichous, deciduous, 5–7 cm long, 2–3 cm wide, abaxially pubescent; blades narrowly elliptic, somewhat coriaceous; apex acute; bases rounded, asymmetric; margin entire; venation pinnate, secondary veins ca. 9 pairs, evenly spaced, prominent, arcuate, yellowish; petiole ca. 4 mm long, rusty-brown, densely pubescent; stipules laterally placed, free of one another, scale-like, acute 1–2 mm long. Inflorescences axillary, 10–20 flowers per cluster; pedicels ca. 2 mm long. Flowers at least some unisexual with staminate and pistillate flowers on the same plant, actinomorphic; ca. 5 mm in diameter; perianth consisting of 6 sepals, distinct, persistent in fruit; petals absent; stamens ca. 8; filaments joined, free of the perianth; ovary superior; carpels 4–5, bilocular; styles bi-lobed. Fruit capsular, pale green to yellow, ca. 14 mm in diameter. Seeds reddish-orange, ca. 4 mm long (Fig. 1).

Glochidion is mainly a tropical genus of more than 200 Asian, Australasian, and Polynesian species (Webster 1994). The native range of *G. puberum*, in China and its occurrence in the Gainesville, Florida area suggest that the taxon possesses some frost tolerance and may otherwise be pre-adapted to conditions in the southeastern U.S.

Voucher specimens: **ALABAMA: Mobile Co.**: naturalized in a wooded area near roadside on west side of Demetropolis Road immediately south of Halls Mill Creek Bridge, small tree approximately 7.5 cm in diameter at the base and 3.5–4 m tall growing with others, 30° 36.35' N, 88° 9.42' W; 12 Jul 2000, *Fearn s.n.* (LSU). Additional specimens have been distributed to AUA, DAV, HUH, and L.

FIG. 1. Branch of *Glochidion puberum* showing twig, leaf, and floral features. Insets show nearly mature fruit and seed.

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RADIATE AND ERADIATE INDIVIDUALS IN *GRINDELIA NUDA* (ASTERACEAE)

R.T. Harms

Department of Linguistics
University of Texas at Austin
Austin, TX 78712-1196, U.S.A.

Grindelia nuda Wood var. *nuda* is a common rayless taxon of central Texas. However, a population exhibiting both radiate and eradiate heads exists in NW Hays County in central Texas. I first noted this when plants cultivated from seeds collected from rayed plants produced both rayed and rayless individuals (Figs. 1 and 3; scales represent mm). Subsequent inspection of the locale, along a quarter mile of county road, revealed roughly a dozen specimens of each type. The two types typically did not grow together. Additionally, one individual from my planting was essentially "subradiate," with rays varying in length from 1–4 mm (Fig. 2), in contrast to rays of 10–14 mm on regular radiate plants.

Voucher specimens (verified by B. L. Turner): **TEXAS. Hays Co.:** NW part of county on roadside immediately above Deadman's Hole, 27 Oct 2000, *Harms 11* (rayless) & *Harms 12* (rayed) (TEX).

Since the presence or absence of rays is emphasized in recent keys for Texas *Grindelia* (e.g., Diggs et al. *Shinners & Mahler's illustrated flora of North Central Texas*, 1999), a revision for the key seems in order, perhaps utilizing achene morphology as a distinguishing feature following G. Nesom, *Phytologia* 68:304, 1990:

> Besides the presence of ray flowers, at least the Great Plains forms of *G. squarrosa* differ from *G. nuda* in the production of dimorphic achenes: the ray and outer disc achenes of *G. squarrosa* are smooth and compressed but slightly 3–4 angled, while the inner disc achenes are longer than the outer, strongly compressed and 2 angled, and have numerous superficial, longitudinal nerves; the achenes of *G. nuda* are monomorphic, all smooth or developing shallow furrows late in their maturation.

ACKNOWLEDGMENTS

I am grateful to Tom Wendt and B.L. Turner for their assistance in preparing this report.

FIG. 1. Radiate *Grindelia nuda.*

FIG. 2. "Subradiate" *Grindelia nuda.*

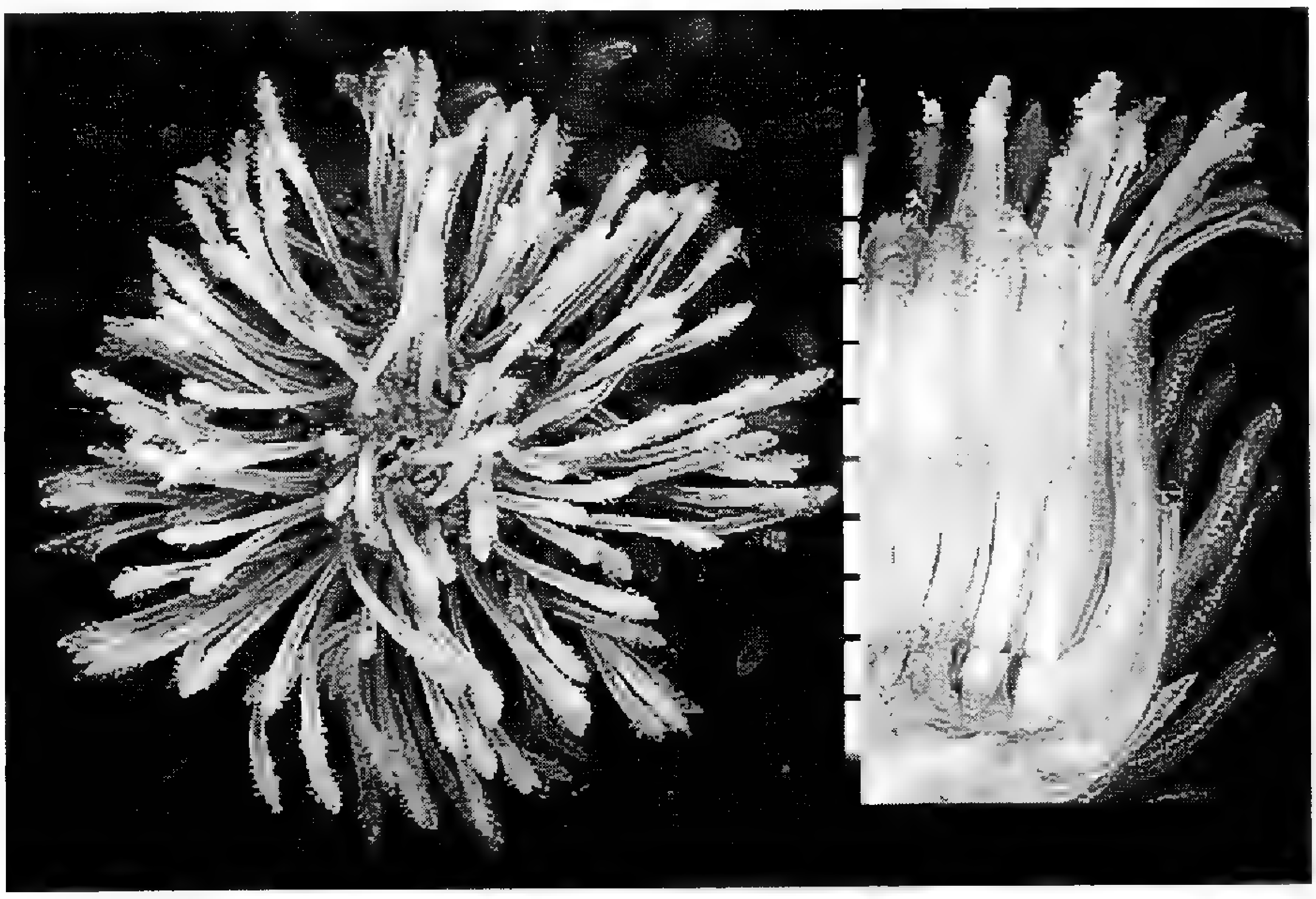

Fig. 3. Eradiate *Grindelia nuda*.

BOOK REVIEW

EDWARD F. ANDERSON. 2001. **The Cactus Family.** (ISBN 0-88192-498-9, hbk.). Timber Press, 133 S.W. Second Ave., Suite 450, Portland, OR 97204, USA. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $99.95, 776 pp, 1008 color photos, 6 b/w photos, 3 drawings, 8 maps, hardcover, 8" × 11".

This is another fine publication from Timber Press, this time by author Edward F. Anderson, who has spent over 45 years researching cacti and is currently in residence at the Desert Botanical Garden, Phoenix, Arizona. The author brings a number of talents to the table, an ethnobotanical interest, a conservationist ethic, and exceptional photography. *The Cactus Family* is an encyclopedic reference to the genera of the Cactaceae family and is nothing short of landmark.

The book begins with five chapters covering introductory information on the science of cacti. Chapter one covers the distinctive features of cacti, such as growth forms, stems, roots, flowers, as well as chemistry, physiology, and distribution. Chapter two discusses the ethnobotany of cacti. This chapter thoroughly covers peyote, the San Pedro cactus, Saguaro, cacti for food and medicine, ceremonial and religious uses, as sources of dyes, and its role in horticulture. This chapter is highlighted by color photographs of indigenous people preparing cacti for a number of uses. Chapter three is devoted to the conservation of cacti, specifically *in situ* and *ex situ* conservation and the legal protection of cacti. Chapter four is contributed by Roger Brown and covers the cultivation of cacti. Light, containers, potting media, water, fertilizer, air circulation, pests, and propagation are all covered in this chapter. Chapter five covers the classification of cacti, the problems with it, its history, and an overview of the cactus classification of the International Cactaceae Systematics Group. These chapters set up the bulk of the book, the encyclopedic reference for the family.

Covered in the treatment are 125 genera and 1810 species. For each taxon, its latin and common names are given, along with a description of the plant and a color photograph where available. There are 1000 color photos in all making this an invaluable resource for cactus lovers and investigators. An appendix of maps and botanic gardens and herbaria with significant collections of cacti, a glossary, literature cited, and indices of scientific and common names close the book.

There is no other book that comprehensively discusses the botany, conservation, cultivation and ethnobotany of cacti than *The Cactus Family.* This culmination of a lifetime of research this beautifully illustrated and exceptionally written treatment of the Cactaceae family that will be useful to the systematist, ethnobotanist, or conservationist among us.—*Kevin D. Janni, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A., kjanni@brit.org.*

CUPRESSUS ARIZONICA (CUPRESSACEAE) NEW TO THE DAVIS MOUNTAINS OF WEST TEXAS

John P. Karges
The Nature Conservancy
P.O. Box 2078
Fort Davis, TX 79734, U.S.A.
jkarges@tnc.org

James C. Zech
Department of Biology
Sul Ross State University
Alpine, TX 79832, U.S.A.
jzech@sulross.edu.

The Arizona Cypress, *Cupressus arizonica* Greene (Cupressaceae) has previously been reported to occur natively as a well-publicized population at a single Texas location in the Chisos Mountains (Vines 1960; Correll & Johnston 1979; Powell 1988; Simpson 1988; Cox & Leslie 1997; Powell 1998). This species is considered to be widely distributed throughout northern Mexico and the southwestern United States, including southern Arizona, southwestern New Mexico, and southern California (Vines 1960; Correll & Johnston 1979; Powell 1988; Cox & Leslie 1997; Powell 1998). In Mexico, Arizona Cypress is known from the Sierra Madre Occidental into extreme northeastern Sonora and Chihuahua in the west and southward on the east to southern Coahuila to the Sierra de Parras (Peattie 1950), and into Zacatecas. It is well known in the Maderas del Carmen Mountains in northern Coahuila, approximately 40 miles southeast of the Chisos (Wood et al. 1999) in montane conifer forests. In Texas, *C. arizonica* has been thought to be restricted to a similar forest type occurring in Boot Canyon (e.g., *Warnock & Hinckley 7138*, SRSC) within the Chisos Mountains of Big Bend National Park in Brewster County (Vines 1960; Correll & Johnston 1979; Powell 1988; Simpson 1988; Cox & Leslie 1997; Powell 1998). This limited distribution has puzzled phytogeographers (Simpson 1988) as to why *C. arizonica* occurs in the Chisos Mountains but not in other high Trans-Pecos Mountain ranges (e.g., Davis and Guadalupe).

Cupressus arizonica has been recently collected from The Nature Conservancy's Davis Mountains Preserve in the Davis Mountains of Jeff Davis County. The location is a steep, forested canyon at an elevation between 2072 and 2103 m. It was found just below Bridge Spring (Mt. Livermore, 7.5 min, USGS topographic quad). The canyon floor is mesic with permanently saturated soils from the spring. This drainage is an eastern headwater tributary of Madera Creek and Canyon which drains the north slopes of Mount Livermore, the highest summit of the Davis Mountains. The canyon is north trending, shaded and steep enough to maintain a cool, mesic microclimate compared to the much more xeric south and west facing drainages nearby. The primary community type is pinyon-oak-juniper forest with gray oak (*Quercus griseus*), alligator juniper

(*Juniperus deppeana*), Texas madrone (*Arbutus xalapensis*), some Gambel's oak (*Q. gambeli*), silverleaf oak (*Q. hypoleucoides*), southwestern chokecherry (*Prunus serotina*), and three species of pine, Mexican pinyon (*Pinus cembroides*), ponderosa (*P. ponderosa*), and southwestern white pine (*P. strobiformis*). Our collection, from an isolated tree, indicates a more widespread distribution (possibly dating back to Pleistocene) as suggested by Cox and Leslie (1997), as well as a more continuous distribution of *C. arizonica* with both Texan and Mexican populations to the south and New Mexico, Arizona, and California populations to the north and west. This newest specimen agrees in habitat with previous collections. Isolated, forested, canyon bottoms at high elevations, associated with springs, are habitat characteristics which appear common for this species (Elmore 1976; Correll & Johnston 1979; Powell 1988; Cox & Leslie 1997; Powell 1998; Watson & Eckenwalder 1993). *Cupressus arizonica* has been extensively planted as ornamentals and wind-breaks throughout the Trans-Pecos (Powell 1988, 1998), and may be considered the most widely planted tree in west Texas (Simpson 1988). While introduction through ornamental stock remains possible, the height, overall size, and habitat of the tree is comparable to those within the Chisos. This may indicate that the Davis Mountain collection is a post-Pleistocene relictual fragment of a more extensive Texas population resulting from the extension of this species' natural distribution. Our on-going investigations in the Davis Mountains and other insular West Texas mountain ranges will continue to elucidate the pattern of distribution and differentiation among species of Cupressaceae including *Cupressus* and *Juniperus*.

Voucher specimen: **TEXAS. Jeff Davis Co.:** Bridge Gap Spring, ca. 75 ft downstream from spring box, ca. 40 ft tall, 20 Jun 1998, *J.P. Karges & L.K. Hedges 2480* (SRSC).

ACKNOWLEDGMENTS

The authors thank the Nature Conservancy of Texas; Linda K. Hedges for field assistance; A. Michael Powell for specimen preparation; Sharon Yarborough of SRSC; and the reviewers for helpful comments.

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Book Review

Michael J. Balick, Michael H. Nee, and Daniel E. Atha. 2000. **Checklist of the Vascular Plants of Belize with Common Names & Uses.** (ISBN 0-89327-440-2, pbk.). Memoirs of the New York Botanical Garden, Volume 85. New York Botanical Garden Press, Bronx, New York 10457-5126, U.S.A. $42.34, 246 pp, 6" × 9".

This is the first floristic checklist devoted to the second smallest country (less than 200,000) in Central America, Belize. The first product to come from the collaboration between the New York Botanical Garden and various Belizean institutions, known as the Belize Ethnobotany Project (Sheldon et al 1997). Another volume, *The Ethnobotanical Diversity of Belize*, is in preparation. In this volume 3408 species in 1219 genera and 209 families are recognized with 1.2% endemism for this subtropical environment.

The design follows that of other *Memoirs* of the Garden with a preface, abstract, introduction (covering: geography, climate, vegetation, floristic composition, and endemism), a section covering classification and family sequence, and sections divided as such: Psilophyta, Lycopodiophyta, Polypodiophyta, Pinophyta, Cycadophyta, Magnoliophyta: Magnoliopsida, and Magnoliophyta: Liliopsida. These sections are followed by a bibliography and general index. For each plant covered in the checklist the authors provide the scientific names, synonyms, uses, references, common names, notes (e.g. taxonomic problems), habit, vouchers, types, and cultivation notes. The authors recognize nineteen categories for plant uses covering beverages, construction, dyes, fibers, edible products, animal forage, fuel, fumitory, gums, latex, medicines, oils, ornamentals, poisons, resin, ritual, spices, and tannins. A major strength of this volume is its erudite foundation in the historical botany of Belize, acknowledging the contributions of major collectors (indigenous and Western) over time and its framework for designing the Belize Ethnobotany Project and future research.

This is a must-have resource for those researching the conservation biology, biogeography, ecology, economic botany and ethnobotany of Meso-America. I would recommend it to students and professionals alike for its close attention to botanical and biogeographical detail and emphasis on local culture and uses. All libraries with a Latin American biodiversity focus should have a copy, as well as all institutions supporting tropical botany programs.

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Sheldon, J.W., M.J. Balick, and S.A. Laird. 1997. Medicinal Plants: Can Utilization & Conservation Coexist? Advances in Economic Botany vol. 12, New York Botanical Garden Press, Bronx, New York.

—*Kevin D. Janni, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A., kjanni@brit.org.*

DIPSACUS FULLONUM (DIPSACACEAE) AND *VERBESINA WALTERI* (ASTERACEAE), NEW TO TEXAS

Jason R. Singhurst

Wildlife Diversity Program
Texas Parks and Wildlife Department
Austin, TX 78704, U.S.A.
jason.singhurst@tpwd.state.tx.us

Walter C. Holmes

Department of Biology
Baylor University
Waco, TX 76798-7388, U.S.A.
walter_holmes @baylor.edu

ABSTRACT

Dipsacus fullonum L. (Dipsacaceae) and *Verbesina walteri* Shinners (Asteraceae) are reported as new to Texas.

RESUMEN

Se citan *Dipsacus fullonum* L. (Dipsacaceae) y *Verbesina walteri* Shinners (Asteraceae) nuevas para Texas.

Continued fieldwork and herbarium study conducted by the authors have resulted in the following records of two species here reported as new to Texas. Neither species is included in the standard references treating the vascular plants of the state (Correll & Johnson 1970; Hatch et al. 1990; Johnston 1990; Jones et al. 1997), nor is the first mentioned species, which is from the area treated in *Shinners & Mahler's Illustrated Flora of North Central Texas* (Diggs et al. 1999), included in that work.

Dipsacus fullonum L. (Dipsacaceae)

TEXAS. Collin Co.: 3.0 mi W of Anna at jct. of U.S. Hwy 75 and FR 455, 30 Jun 2000, *Singhurst 9379* (BAYLU, TEX).

Dipsacus fullonum, commonly called Fuller's teasel, is an erect, coarse, prickly biennial about 0.5–2(–3) m tall. The flowers are violet and borne in oblong-ovoid capitula 2–4 cm tall that are subtended by numerous linear to linear-lanceolate prickly involucral bracts 3–10 cm or more long. Gray (1895) mentions that *Dipsacus fullonum* has "awn-like tips of the rigid chaff [paleae] hooked at the end, which makes the teasel useful for carding woolen [sic] cloth; cultivated in central N.Y. for this purpose ..." Bobrov (1957), however, states that "because of the flexibility of the paleae, this plant [*D. fullonum*] is not used for napping in the woolen industry." In commenting on the complicated nomenclature of the species, Bobrov (1957) notes that *D. fullonum* is a Linnean name that cannot be abolished because it is the type species of the genus, consequently the plant, "which is of no use to the textile industry, retains the [common] name Fuller's

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teasel." It is probable that the plant referred to by Gray (1895) as *D. fullonum* is actually *D. sativas* (L.) Honckeny.

The species is native to the Old World from Atlantic and central Europe to Asia Minor and Iran (Bobrov 1957). It has been reported from all of the contiguous states of the United States except Delaware, Florida, Georgia, Louisiana, Maine, Minnesota, North Dakota, and South Carolina (USDA, NRCS 1999). The plant normally occurs in waste places, rights-of-way, margins of cultivated fields, and similar areas. At the collection locality cited above, two "clumps" of the species were found in the immediate area. One consisted of about 20 stems originating from the same basal area while the other had the same growth form and approximately 35 stems. The occurrence of only two plants suggests that the species has only recently colonized the area.

Dipsacus fullonum is the second species of this Old World family to be introduced to Texas, the other being *Scabiosa atropurpurea* L., which is a garden escape becoming an invasive weed in north central Texas (Diggs et al. 1999). The following key distinguishes the two genera.

Plants prickly; heads 2–4 cm long; involucral bracts 3–10 cm long; corollas 4 lobed _____ **Dipsacus**
1. Plants not prickly; heads to about 1 cm long; involucral bracts to 1 cm long; corollas 5-lobed _____ **Scabiosa**

Verbesina walteri Shinners (Asteraceae)

TEXAS. Jasper Co.: Floodplain of Walnut Run Creek near U.S. Hwy 96 ca. 2 mi S of jct. with U.S. Hwy. 190 in Jasper, 23 Sep 2000, *Holmes 10984 & Singhurst* (BAYLU, TEX). **Newton Co.:** Big Cow Creek at jct. with U.S. Hwy 190, W of Newton, 23 Sep 2000, *Holmes 11029 & Singhurst* (BAYLU, TEX); Big Cow Creek at jct. with FR 363, E of Bleakwood, 23 Sep 2000, *Holmes 11053 & Singhurst* (BAYLU).

Verbesina walteri is described by Cronquist (1980) as being "much like *V. alternifolia*, but the heads discoid, with white flowers." *Verbesina alternifolia* has both ray and disc flowers that are yellow. Cronquist gives the distribution as South Carolina to Georgia and Louisiana, with outliers in the Piedmont Plateau of North Carolina and the Ouachita Mountains of Arkansas. In their treatment of the family for Louisiana, Gandhi and Thomas (1989) considered the species to be widespread and abundant east of the Mississippi River but uncommon in the remainder of the state. The known Texas distribution is basically contiguous with the western distribution of the species in Beauregard, Vernon, and Sabine parishes, Louisiana, presented by Thomas and Allen (1996). At each of the locations mentioned in the list of exsiccatae, the species occurred in the flat floodplains in two or more "clumps" about 25–100 m or more distant from each other. Plants numbered from few (2–5) to 25 or more in each clump.

ACKNOWLEDGMENT

We are grateful to John Pruski (US) for review of the manuscript.

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BOOK REVIEW

FRANKLIN W. MARTIN, RUTH M. RUBERTE, and LAURA S. MEITZNER. 1998. **Edible Leaves of the Tropics. Third Edition.** (ISBN 0-9653360-1-8, pbk.). ECHO, 17430 Durrance Road, North Fort Myers, FL 33917, U.S.A. $14.95, 194 pp, b&w plates, 6" × 9".

This third edition of *Edible Leaves of the Tropics* puts back in print this classic that has been unavailable for 15 years. Published by the Educational Concerns for Hunger Organization, Inc. or ECHO, this text is a primary resource used by the staff in answering questions of development workers in the tropics and subtropics. This edition updates the 1981 edition with new information from scientific publications and the insights of the ECHO staff and at the same time retains much of the information and style from Martins original.

Leaves are a high quality food in the tropics and "developing" nations, not only because of their nutritional value but also the little effort required in their production. This text describes tropical plants with edible leaves, discussing their origin, growth, habit, cultivation guidelines, nutritional value, preparation, multiple uses, and cautions. The book is divided into ten chapters, followed by a list of seed sources and resources, a bibliography, an appendix on tropical plants with edible leaves (over 1500 species), and an index to genera and common names. Chapters one through ten cover 89 pages and discuss the place of green leaves in the diet, the principal green leaf herbs of the tropics, common weeds with edible leaves, temperate zone green leaves, lettuce, poisonous leaves, and culture and care of green-leafed vegetables. Following chapter ten are 56 pages of "Illustrations." However there are no illustrations, but black and white photographs of plants, the quality of which ranges from poor to good. There is more than one photo where sterile specimens are pictured and one that is hardly visible. The appendix on tropical plants with edible leaves is this books strong point and defines it as a "source" book. This appendix, twenty-six pages in length, covers over 1500 species, their latin name, source (Congo, Tropical Africa, India, etc.), and type (shrub, herb, vine). It would be useful for the common names to be included in this table for future editions.

Edible Leaves of the Tropics is a useful book for anyone interested in tropical botany, gardening, and the nutrition of tropical diets. Not necessarily appropriate for classes, this is primarily a source book and should yield a considerably diverse readership that will continue to justify its existence. It is well written and researched and available for a modest price. I would recommend this book for anyone interested in finding an inventory of edible tropical plants for either their own research or consumption.—*Kevin D. Janni, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A., kjanni@brit.org.*

CAREX ABSCONDITA (CYPERACEAE: *CAREYANAE*) IN LOUISIANA

David J. Rosen

U.S. Army Corps of Engineers
Galveston District, P.O. Box 1229
Galveston, TX 77553, U.S.A.

During fieldwork southeast of Baton Rouge, Louisiana, I collected a *Carex*, Sect. *Careyanae* in alluvial mixed woods overlooking the Amite River. A tentative identification of *Carex abscondita* Mackenzie was made. A duplicate specimen (*Rosen 1032*) was sent to Stanley Jones (BRCH), who confirmed that the sedge was indeed *C. abscondita*, and provided information on his own collection of *C. abscondita* from Louisiana (*Jones 13392*). In a subsequent review of Thomas and Allen's *Atlas of the vascular flora of Louisiana* (1993), *C. abscondita* was listed under excluded species. This paper confirms the occurrence of *C. abscondita* in Louisiana's flora based on field collections and herbarium specimens.

In a revision of *Carex*, Sect. *Laxiflorae*, Bryson (1980) cites collections of *C. abscondita* from Orleans (GH), St. Tammany (US), and Washington (TENN, VDB) parishes. According to Jones (1999), the correct section is Sect. *Careyanae*. Queries to several herbaria (LSU, MCN, MICH, and NO) revealed additional collections of *C. abscondita* from Louisiana. *Carex abscondita* is a sciophyte of mesic to wet alluvial woodlands, often overlooked due to its well-concealed inflorescences hidden among the leaf bases. This could explain the scarcity of collections from Louisiana. Sufficient collections reported herewith lessen the gap in distribution (Fig. 1) from the specimens cited by Bryson (1980) for eastern Louisiana, to Texas where *C. abscondita* is also a recent addition (Naczi & Bryson 1990; Jones et al. 1997). Additional fieldwork and herbarium searches are needed to complete the distribution of *C. abscondita* in Louisiana.

Specimen citations: **LOUISIANA. Calcasieu Parish:** Woods adjacent to Camp WI-Ta-Wenton in Sect. 2, T8S, R7W, 1 Apr 1998, *Neyland 1726* (MCN). **Catahoula Parish:** Catahoula Ranger District of the Kisatchie National Forest, Georgetown vicinity, about 6 mi W, floodplain of Indian Creek, 20 Apr 1996, *Hyatt 6960* (LSU). **Claiborne Parish:** Corney fire tower vicinity, near Corney Lake on LA Hwy. 9, common, mainly in floodplains along streams, 17 Apr 1998, *Hyatt 8003* (MICH). **East Baton Rouge Parish:** Behind residence at 19452 Indian Ridge Avenue in SE Baton Rouge, frequent in sloping woodland above Amite River, 13 Apr 2000, *Rosen 1032* (BRCH, NO). **Grant Parish:** Packton, 1.0 mi S of US Hwy. 167 in Sect. 4, T9N, R2W, in floodplain woods on sandy soil, locally dominant on forest floor, 19 May 1995, *Hyatt 6434* (MICH); Catahoula Ranger District of the Kisatchie National Forest; Iatt Creek near what is called and reported to be a Spanish Mound at the end of the road into the Spanish Mound, 18 Apr 1996, *Hyatt 6958* (LSU). **Natchitoches Parish:** Winn Ranger District of the Kisatchie National Forest; Ashland vicinity, about 3 air mi SW, mature floodplain deciduous forest; common along medium to large streams, 14 May 1996, *Hyatt 7066* (LSU). **Rapides Parish:** Evangeline

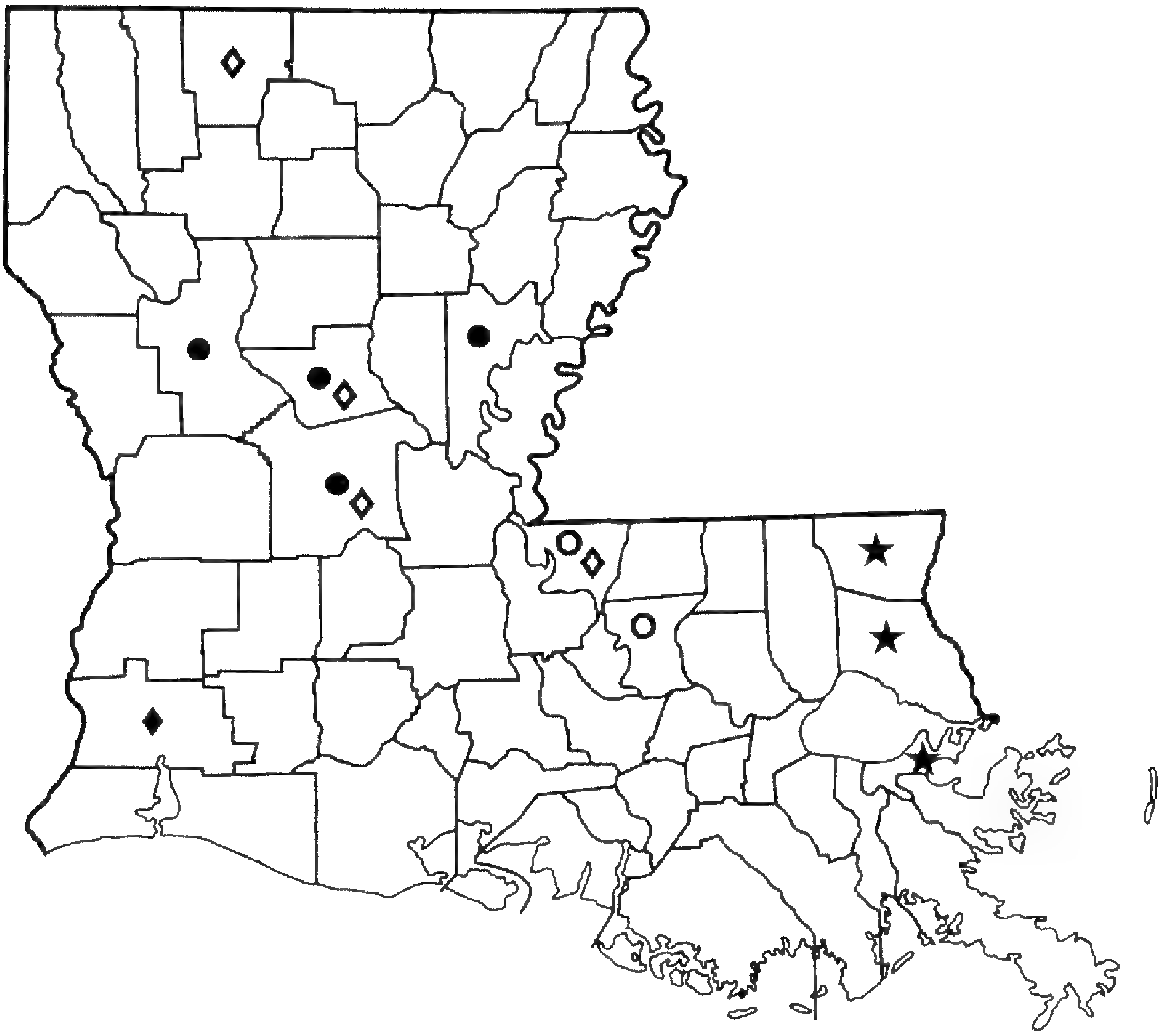

Fig. 1. Distribution by Parish of *Carex abscondita* in Louisiana. Specimens from Bryson (1980) noted by stars (★), LSU by closed circles (●), MCN by closed diamonds (◆), MICH by open diamonds (◇), and NO by open circles (○).

Ranger District of the Kisatchie National Forest; Alexandria Vicinity; about 8 mi WSW; Timber Compartments 14/78's north edge, S bank of Bayou Beouf vicinity, 07 May 1996, *Hyatt 7052* (LSU); Brushy Creek Riparian site, Sect. 11, T2N, R3W, common, local in floodplains and adjoining slopes, 23 May 1998, *Hyatt 7912* (MICH); Kisatchie National Forest; 0.7 mi SW on forest rd. 188 from its jct. with forest rd. 155; then 0.7 mi SW on a logging rd. to Camp Pond Creek bottomland, NW of Williana; bottomland forest with a few pines, lower slopes, occasional, 22 April 1998, *Jones 13392* (SAT). **West Feliciana Parish:** Ravines in woods near St. Francisville, 14 Apr 1936, *Penfound s.n.* (NO); Along W side of Rt. 61, just S of St. Francis Hotel, 0.2 mi S of jct. of Rts. 61 & 10, common, 23 May 1994, *Naczi 3988* (MICH); W side of US Rt. 61, S of Wakefield near fire tower, Sect. 2, T1S, R2W, 20 April 1998, *Hill 30011* (MICH).

ACKNOWLEDGMENTS

Thanks to Stanley D. Jones (BRCH), Roland P. Roberts (LSU), Ray Neyland (MCN), Tony Reznicek (MICH), and Anne S. Bradburn (NO) for their assistance. I am also extremely grateful to Robert F.C. Naczi and Charles T. Bryson for their illuminating review of this manuscript.

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BOOK REVIEW

PAUL MARTIN, DAVID YETMAN, MARK FISHBEIN, PHIL JENKINS, THOMAS VAN DEVENDER, and REBECCA WILSON (eds.). 1998. **Gentry's Rio Mayo Plants: The Tropical Deciduous Forest & Environs of Northwest Mexico.** (ISBN 0-8165-1726-6 hbk.). University of Arizona Press, 330 S. Toole Ave., Suite 200, Tucson, AZ, 85701-1814. (Orders: www.uapress.arizona.edu, 520-621-1441, 520-621-8899 fax). $75.00, 558 pp, 2 maps, photos, index, 7" × 10".

The interface of Neotropical and Sonoran Desert ecozones has been a region of great interest to botanists and biologists. Howard Scott Gentry was drawn to it over 60 years ago, specifically the Río Mayo region of northwestern Mexico and in 1942 he published the first version of this text. This new version of the classic text updates and amends major portions of the original and more than doubles the original list of taxa. This was undertaken with the help and support of Gentry until his death in 1993. Gentry also authored a number of books on *Agave's* in continental North America, Sonora, and Baja, California during his lifetime. The list of almost 3,000 taxa is accompanied by a new historical background, a review of geography and vegetation, changes to land and rivers as a result of agricultural development and lumbering, and an emphasis on local knowledge and use of plants.

The book is divided into four parts, covering: the Río Mayo at the end of the twentieth century, a list of Río Mayo localities, excerpts from the original, and an annotated list of Río Mayo vascular plants. Part one offers an overview of the region and a contemporary overlook of the regional vegetation. Part two is a list of localities and an explanation of the list. Part three covers geography (rivers, mountains, climate, etc) and vegetation (forests, plant habitats, successions in disturbed areas). Part four is the annotated plant list (345 pages) preceded by an explanation of the format.

For each plant – names, local distributions, habitat, descriptive information, and indigenous uses are provided. There are no English common names included in this list, but some plants have the local Río Mayo name. I have two comments concerning this editorial decision: 1. the local names are not consistent enough to justify their existence and 2. *why leave out the English common names?!?* Recognized as medicinals in several parts of Latin America, the taxa *Sonchus asper* (L.) Hill and *Sonchus oleraceus* L. are listed without a Rio Mayo name, I found this surprising. Three to five local participants could probably accomplish this by spending a few afternoons in a local herbarium recording local names. The common names in English *plus* Rio Mayo names would offer an interesting linguistic perspective and possibly open the book up to a wider audience. Indeed, Latin names are of a lesser salience to most lay readers. The *Plants in Use* section in part three should be pleasing to those interested in the regional economic botany. Included in this section are lists of cultivated plants and wild plants, the latter including an annotated checklist of useful fruits, seeds, roots and herbage, and construction, fuel, and miscellaneous uses.

These sections are followed by Gentry's bibliography, literature cited, and an index. There are two maps included, one being a large removable b/w map from the back cover. This is a pleasing feature of the book, emphasizing its overall utility and usefulness. However, the press page accompanying the review copy we received here at BRIT advertises a removable *color* map. This same advertisement appears on the press web site: www.uapress.arizona.edu/books/bid1204.htm. A color map would be a great addition, whether designed to emphasize biodiversity or biogeography, and also help justify the price.

Overall, this is a beautiful book. It is well designed, academically and aesthetically. Moreover, this is a major contribution to our botanical and biogeographical literature. The authors should be commended for their efforts. Everyone interested in the botany, biogeography, conservation, and ethnobotany of northwest Mexico should find this book useful.—*Kevin D. Janni, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A., kjanni@brit.org.*

PHYLLOSTACHYS BAMBUSOIDES (POACEAE: BAMBUSEAE) PREVIOUSLY UNREPORTED FROM LOUISIANA

David J. Rosen
U.S. Army Corps of Engineers
Galveston District, P.O. Box 1229
Galveston, TX 77553, U.S.A.

Stanley D. Jones
Botanical Research Center
P.O. Box 6717
Bryan, TX 77805-6717, U.S.A.

Joseph K. Wipff
Pure Seed Testing, Inc.
P.O. Box 449
Hubbard, OR 97032, U.S.A.

ABSTRACT

Phyllostachys bambusoides, native of China, is reported from the floodplain of Thompson Creek, West Feliciana Parish, Louisiana. A key to Louisiana *Phyllostachys* and a description of the genus and species are included.

RESUMEN

Phyllostachys bambusoides, nativo de China, se cita del llano inundado de Thompson Creek, West Feliciana Parish, Louisiana. Se incluye una clave para los *Phyllostachys* de Louisiana y una descripción de *P. bambusoides*.

Phyllostachys bambusoides Sieb. & Zucc., a native of China (McClure 1957), has been found growing outside cultivation in West Feliciana Parish. Hitchcock (1950) describes *P. bambusoides* as an exotic introduced through cultivation and persisting in areas with mild winter temperatures, but listed no distribution. *Phyllostachys bambusoides* has previously been reported to occur in cultivation for Texas (Jones et al. 1997), but has not been reported from Louisiana (Allen 1992; Thomas & Allen 1993).

Phyllostachys Sieb. & Zucc.

Perennial with extensive rhizomes. *Culms* straight and stiffly erect; thick hallow, glabrous, and D-shaped in cross section; culms branching freely from the middle and upper nodes, with usually 2 unequal branches at each node, sometimes a third smaller one. *Culm sheaths* deciduous and subcoriaceous. *Leaves* 1–7 per branchlet; sheaths ciliate along one side; ligules a short ciliolate membrane; blades flat, tessellate, lanceolate, abruptly acuminate, base round and connected to a short flattened pseudopetiole. *Pseudospikelets* numerous, often with small rigid bracts at their bases, spikelet concealed by inflated external, coriaceous bract; bract bearing reduced leaf blade, glabrous but with ciliate margin. *Spikelet* florets 1–2; glumes 2(1), lanceolate; lemmas similar to glumes; palea bilobed at apex.

"The characteristics most generally useful in the identification of bamboo species (once the genus is known) are found in the culm sheaths that clothe the young shoot. These characteristics reveal themselves most vividly while the sheaths are in a fresh state. As they dry, their delicate, often very distinctive colors fade to light or dark straw, though any spots of dark pigment usually persist. The tissues shrink and sometimes become more or less warped, and some of the delicate parts, such as the auricles and the ligule, become brittle and easily broken when dry." (McClure 1957). When collecting culm sheaths, carefully remove several samples along the length of the culm. *Phyllostachys bambusoides* is easily distinguished from *P. aurea* using the following key modified from McClure (1957). This key must be used in the spring when the young shoots are actively growing and the culm sheaths are still present.

A KEY TO *PHYLLOSTACHYS* IN LOUISIANA

Auricles and well developed oral setae present on the upper culm sheaths (the lowermost culm sheaths usually without auricles); culms 6-22 m tall; base of culm 5-15 cm in diameter. ____ **Phyllostachys bambusoides** Sieb. & Zucc.

Auricles and oral setae absent on the upper culm sheaths (rudiments do not appear); culms 3-10 m tall; base of culm 1-5 cm in diameter. ____ **Phyllostachys aurea** E. Carr. ex A. Riv. & C. Riv.

Phyllostachys aurea E. Carr. ex A. Riv. & C. Riv.

Culms 3–10 m, straight and stiffly erect; base of culms 1–5 cm in diameter; thick hollow, glabrous, D-shaped in cross section; green, visibly to strongly glaucous soon after sheath fall, becoming green to yellowish green when mature; culms branching freely from the middle and upper nodes, usually with 2 unequal branches at each node, sometimes a third branch also present. *Culm sheaths* deciduous, subocoriaceous, pale olive green to pale rosy buff, with burgundy or pale-green veins, rather sparsely strewn with small brown spots, not glaucous, glabrous except for a line of minute white hairs along the base. Auricles and oral setae absent. Ligules short, apex slightly convex or rarely slightly concave and ciliate on the margin in the lower several sheaths; slightly longer and long ciliate to fimbriate on the margin in mid-culms sheaths. *Culm sheath blades* subulate to lanceolate, more or less crinkled below, becoming long, narrowly strap-shaped and pendulous above. *Leaves* leaf sheaths 2.5–3.5 cm long, ciliate along one side, with auricles and oral setae well-developed (occasionally absent), conspicuous in spring when leaves are young; ligules a short ciliolate membrane; leaf blades flat, tessellate, 4–12 cm long, 5–16 mm wide, lanceolate, abruptly acuminate, base round to a short flattened pseudopetiole, pseudopetiole 2–4 mm long, glabrous or glabrescent, margins scabrous; 1–7 leaves per branchlet. *Pseudospikelets* numerous, ascending and overlapping, 35–50 cm long, often with small rigid bracts at their bases, spikelet concealed by inflated external, coriaceous, bract ca. 22 mm long, bearing reduced leaf blade, glabrous, ciliate margins. Spikelets 1-several in each pseudospikelet. *Spikelet* florets 1–2; glumes 2(–1), lanceolate; lemmas similar to glumes, ca. 19 mm long, glabrous with a stiff awn tip, palea ca. 15 mm long, glabrous, bilobed at apex, not keeled. Native to southern China.

Phyllostachys bambusoides Sieb.& Zucc.

Culms 6–22 m, straight and stiffly erect; base of culms 5–15 cm in diameter; thick hollow, glabrous, D-shaped in cross section; not glaucous at culm sheath fall, green, golden yellow or golden yellow with a variable amount of green striping; culms branching freely from the middle and upper nodes, usually with 2 unequal branches at each node, sometimes a third branch also present. *Culm sheaths* deciduous, subocoriaceous, greenish to ruddy buff, more or less densely spotted throughout with dark brown spots; the lowest several culm sheaths usually without auricles and oral setae, but the rest bearing two (rarely one) auricles; auricles conspicuous, narrow to broadly ovate or falcate (more or less staghorn in shape), conspicuously fringed with several greenish crinkled bristles (oral setae). Ligules well-developed, the apex more or less strongly convex with ciliolate margins in smaller culms to truncate and ciliate with coarse bristles in older culms. *Culm sheath blades* short, lanceolate, reflexed, and crinkled in lower sheaths to strap shaped and recurved in the upper ones; green or colored with burgundy, green and cream stripes to 9 cm long. *Leaves* 1–7 leaves per branchlet. Leaf sheaths 5.2–25 mm long, ciliate along one side, auricles, when present, conspicuous, with oral setae well developed (occasionally absent), oral setae conspicuous in spring when leaves are young; ligules convex, a short ciliolate membrane; glabrous, ciliate along one margin; leaf blades flat, tessellate, 10–15 cm long, 15–20 mm wide, lanceolate, abruptly acuminate, base round to a short flattened pseudopetiole; adaxially glabrous, abaxially glaucous, densely spinulous scabrous on the basal portion of midvein, scabrous along one margin of blade. Pseudopetiole 3–5 mm long. *Pseudospikelets* numerous, 1-several per node on leafy or leafless branchlets; ascending and overlapping, 40–80 cm long, often with small rigid bracts at their bases, spikelet concealed by inflated external, coriaceous, bract 10–40 mm long, bearing reduced leaf blade. Spikelets 2–5 in each pseudospikelet. *Spikelet* florets 1–2; glumes 2, lanceolate ca. 17 mm long; lemmas similar to glumes, 18–22 mm long, densely pubescent, ciliate margins, palea 17–20 mm long, bilobed at apex, keeled, 3-veins between the keel, 3–5 veins along margin, keels pubescent. Native to Japan and mainland China, extending westwards to the Himalayan Mountains.

In Louisiana, *Phyllostachys bambusoides* was observed growing aggressively in sandy, alluvial soils, out of cultivation, among riparian hardwoods, and covering an area of ca. 0.5 ha. A random sampling (n=9) of culm DBH yielded a mean of 6.6 cm ranging to 12.25 cm with an estimated mean culm height of 9 m.

Voucher specimens: **LOUISIANA. West Feliciana Parish:** W of the town of Jackson, N of Hwy. 10 on the west bank of Thompson Creek, in deep alluvial sands with *Platanus occidentalis*, *Betula nigra*, *Quercus phellos*, *Salix nigra*, and *Smilax rotundifolia*, 30 Apr 2000, *Rosen 1098, det. J.K. Wipff* (BRCH, jkw-pers. herb., NLU, SAT, and NO).

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A *SCUTELLARIA* (LAMIACEAE) NEW TO NORTH CAROLINA AND A KEY TO THE SMALL-FLOWERED CAROLINA CONGENERS

Alexander Krings
Herbarium, Department of Botany
North Carolina State University
Raleigh, NC 27695-7612, U.S.A.
Alexander_Krings@ncsu.edu

Joseph C. Neal
Department of Horticultural Science
North Carolina State University
Raleigh, NC 27695-7609, U.S.A.
Joe_Neal@ncsu.edu

Native to South America, *Scutellaria racemosa* Pers. (South American skullcap) has been collected sporadically in the southeastern United States but has not been reported for North Carolina by Radford et al. (1968) or Kral (1981). Listed as an obligate wetland species by Reed (1988), *S. racemosa* has primarily been found in coastal plain communities and was previously only known from Texas, Louisiana, Alabama, Florida, Georgia, and South Carolina (Godfrey & Wooten 1981; Kral 1981; Allen 1983; Jones & Coile 1988; Tobe et al. 1998; Wunderlin & Hansen 2000). During field work, Joe Neal discovered a population of an unknown weed on the grounds of a nursery in Chatham County, in the lower Piedmont of North Carolina. Live plants, collected from the site on 4 Dec 1998, were grown out in a greenhouse at North Carolina State University and identified as *Scutellaria racemosa* based on fertile material. Representative material of this collection was prepared for deposit at NCSC in Dec 2000. A subsequent site visit, also in Dec 2000, yielded additional voucher material (see voucher specimens below). Based on observations by Neal, the population has been established since at least 1996. Plants were found spreading at the edges of nursery ground cloths and greenhouses, as well as around a nearby pond. Soils appear to be persistently moist to wet, due to regular irrigation. A search of nearby forests revealed that the population has started encroaching in natural areas only within reach of the irrigation system. Voucher specimens are deposited at BHO, NCSC, and USCH.

Voucher specimens: U.S.A. **North Carolina. Chatham Co.:** Specimen from potted plant collected 4 Dec 1998 from 2925 NC Hwy 751 and grown in North Carolina State University greenhouse by Joseph Neal, 1 Dec 2000, *Krings & Neal 365* (NCSC); 2925 NC Hwy 751, field collection from nursery, specifically from fertilized pots of shrubs kept in enclosed greenhouse space and receiving regular irrigation, 6 Dec 2000, *Krings & Neal 366* (BHO, NCSC, USCH).

Scutellaria racemosa Pers. (Fig. 1) can be distinguished from its southeastern congenerics by the hastate leaves (Fig. 2, C). In the Carolinas, it is one of only four species exhibiting corollas 7 mm long or less (see key below). Worldwide, it is apparently one of only two skullcaps displaying consistently hastate leaves

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(Paton 1990). The other species, *S. hastifolia* L., is native to W Europe and exhibits an erect habit, flowers greater than 2 cm long, and brown nutlets with a prominent median band. *Scutellaria racemosa* on the other hand, exhibits a trailing to weakly ascending habit, flowers typically 4 mm or less long, and brown nutlets lacking a median band (Fig. 1; description).

KEY TO SMALL-FLOWERED *SCUTELLARIA* (COROLLAS ≤ 7 MM LONG) IN THE CAROLINAS

1. Larger leaves hastate, 1.3–3.2 cm long; corollas white to lavender or purple, 2–4 mm long. ______ **S. racemosa** Pers.
1. Larger leaves not hastate, 0.6–12 cm long; corollas white to lavender or violet, 3–7 mm long
    2. Petioles > 4 mm long; leaves 3–12 cm long, the apices typically acuminate; flowers in axillary racemes, the bracts much reduced. ______ **S. laterifolia** L.
    2. Petioles < 3 mm long; leaves ≤ 3 cm long, the apices acute to blunt; flowers solitary in the axils, or somewhat racemose, the bracts resembling stem leaves and only somewhat reduced
        3. Principal leaves ovate, rounded to slightly cordate, ≥ 2.5 cm long. ______ **S. nervosa** Pursh
        3. Principal leaves ovate to lance-ovate, rounded to slightly cordate or not, ≤ 2 cm long or less ______ **S. parvula** Michx.

SYNONYMY AND SPECIES DESCRIPTION

Scutellaria racemosa Pers., Syn. Pl. 2:136. 1807. (**Fig. 1**). TYPE: collected near Montevideo, Paraguay *Commerson s.n.* (HOLOTYPE: P).

Scutellaria bonariensis Willd. ex Benth., Linnaea 11:345. 1837.
Scutellaria hastata Larrañaga, Escritos de Don Damaso Antonio Larrañaga 2:87. 1923.
Scutellaria heterophylla Willd. ex Benth., Linnaea 11:345. 1837.
Scutellaria rojasii Briq., Bull. de l'Herbier Boissier, sér. 2, 7: 600. 1907.
Scutellaria rumicifolia Kunth, Nov. Gen. Sp. 2:324. 1817.

Colonial, low herbaceous perennials with slender rhizomes; stems 4-angulate, glabrous to puberulent, trailing to weakly ascending (to 1 ft.), typically several from base; leaves opposite, 3–5 veined from base, glabrous or minutely puberulent on both surfaces, the uppermost typically narrowly- lanceolate or deltate and toothed or lobed basally, 1–4 mm broad, 5–12 mm long, the lower narrowly to broadly hastate, 5–20 mm broad, 13–32 mm long, apices retuse or, less frequently, rounded; flowers solitary, axillary, pedicels 2–4 mm long, puberulent; calyces campanulate, puberulent to glabrate with age, green to purplish, with a protuberance on the distal surface (scutellum), 1.8–2 mm long, enlarging to 3 mm long following anthesis and splitting horizontally; corolla white to lavender or purple, 2–4 mm long, 2-lipped, the upper concave, hoodlike, the lower spreading, purple or pink spotted; stamens 4; nutlets brown, obovoid, lacking median band, ca. 0.5 mm in diam.

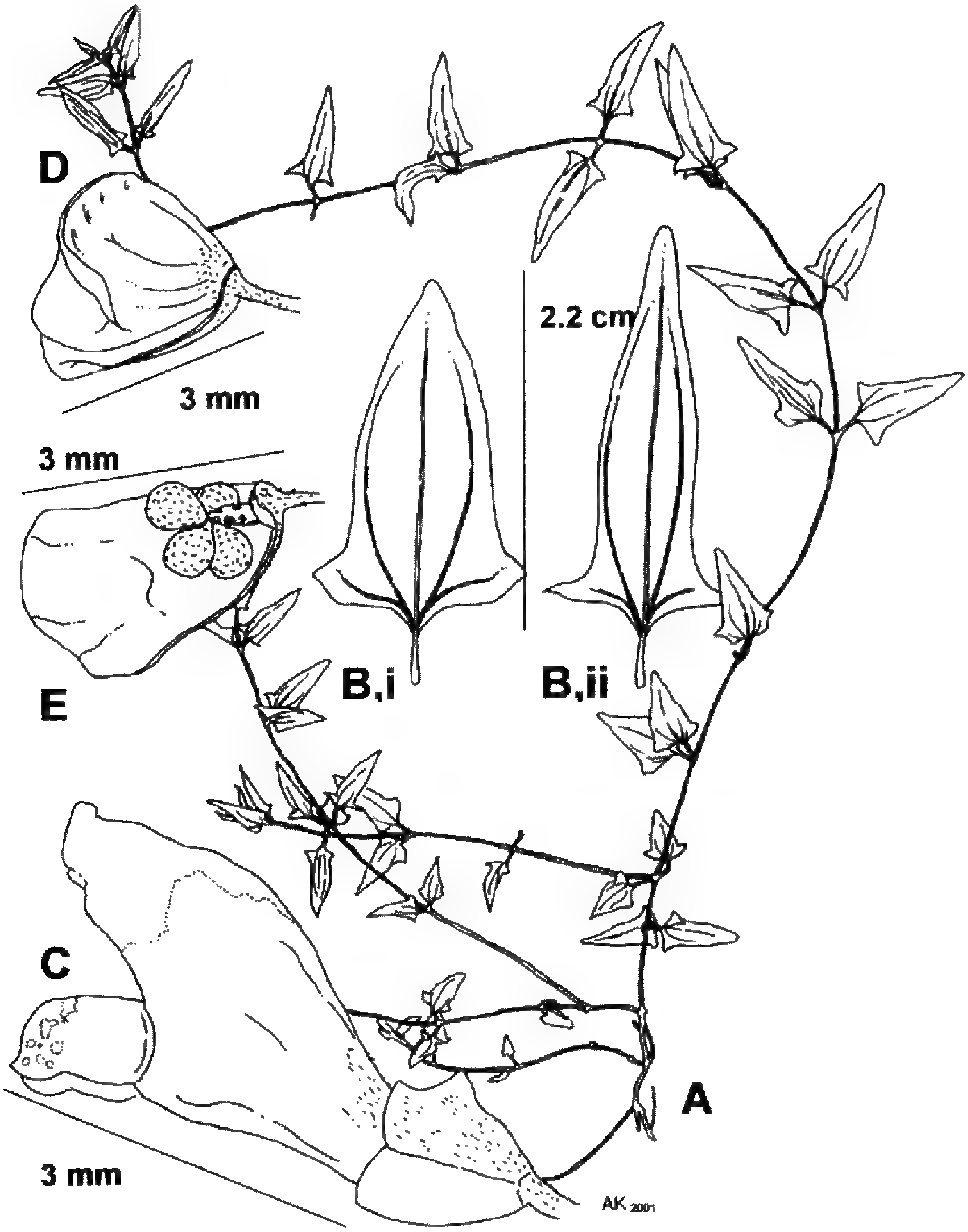

Fig. 1. *Scutellaria racemosa* Pers. (Lamiaceae): **A.** Habit; **B.** i–ii. Leaf variation; **C.** Flower; **D.** Calyx; **E.** Dehisced calyx and seeds. A–B based on *Krings 371* (NCSC). C based on *Radford 46268* (FLAS). D–E based on *Godfrey 73437* (FLAS).

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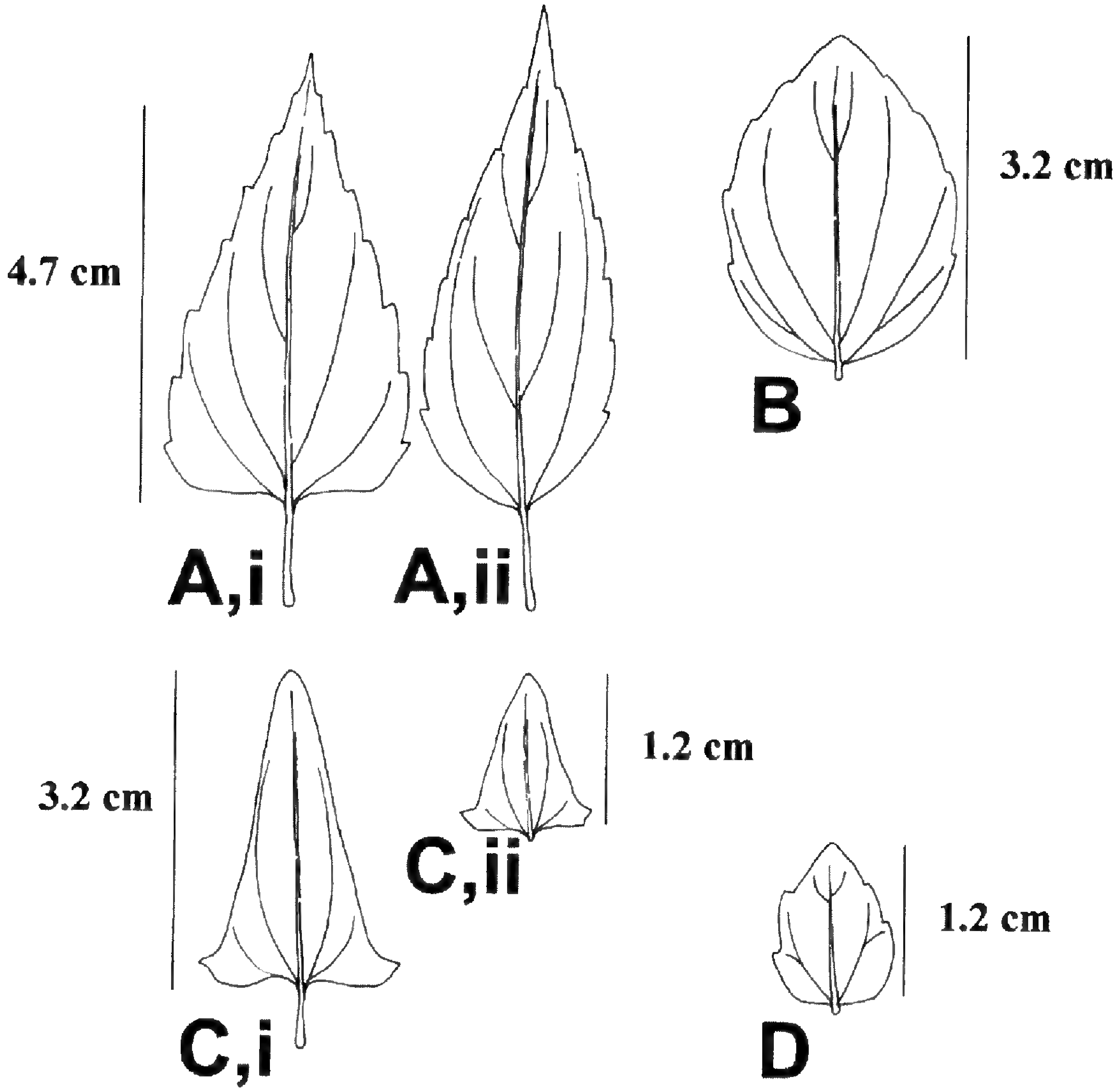

FIG. 2. Comparative leaf morphology of the four Carolina species of *Scutellaria* exhibiting corollas ≤ 7 mm long. A. i: *Scutellaria laterifolia* L., *M.E. Wharton 3331* (NCSC); ii: *Scutellaria laterifolia* L., *W.H. Duncan 23451* (NCSC). B. *Scutellaria nervosa* Pursh., *E.A. Bartholomew W1941-1016* (NCSC). C. i: *Scutellaria racemosa* Pers., *Krings & Neal 366* (NCSC); ii: *Scutellaria racemosa* Pers., *Palacios-Cuezzo 497* (NCSC). D. *Scutellaria parvula* Michx., *Kral 55372* (NCSC).

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BOOK REVIEW

ROBERT H. ROBICHAUX and DAVID A. YETMAN (eds.). 2000. **The Tropical Deciduous Forest of Alamos: Biodiversity of a Threatened Ecosystem in Mexico.** (ISBN 0-8165-1922-6, hbk.) The University of Arizona Press. 355 S. Euclid Ave, Suite 103, Tucson, AZ 85719. (Orders: www.uapress.arizona.edu, 520-621-1441, 520-621-8899 fax). $50.00, 260 pp, 19 halftones, 5 line illustrations, 4 maps, 6 1/8" × 9 1/4".

Tropical forests follow a phytogeographic and ecological continuum of wet to dry. In wet climates there are typically taller trees with medium-large leaves and in dry climates trees are usually shorter with smaller leaves. The tropical deciduous forest of Alamos Mexico is somewhere in the middle of this gradient. Most people, those of us in academia not withstanding, do not picture this part of North America as being tropical, but nonetheless, "there are more than 100 species of tropical trees in 36 families, 48 species of orchids, 6 species of parrots, mountain lions, jaguars, and according to local legend, a big cat called the *onza*": Pg3. *The Tropical Deciduous Forest of Alamos: Biodiversity of a Threatened Ecosystem in Mexico* is a collection of articles covering aspects of botany, ecology, ethnobotany, and even the diversity and distribution of reptiles, amphibians, mammals, and birds in the region. This volume is a satisfying continuation of *Gentry's Rio Mayo Plants* (Martin et al 1998: *Reviewed in this issue: pg 730)* also published by the University of Arizona Press.

The book comes in seven chapters, followed by an index. The introductory chapter discusses the ecosystem and biodiversity of the region and the human use of these resources. In this chapter, the authors not only give highway and road directions to the area (only a day's drive south of the Mexico-U.S. border) but also offer a few recommendations on soliciting plant knowledge from the local people. (*Dispenseme. Como se llama este planta?*). Chapter two compares the structure and functioning of the tropical deciduous forest of Alamos with the other areas of western Mexico. Chapter three analyzes the vegetation and flora of the tropical deciduous forest, specifically the Rio Cuchujaqui. Included in this chapter is an annotated checklist of the river area that illustrates well the diversity of tree species in the region. In chapter four, the authors examine the tree species of the forest that are used by the Mayo people of Mexico. The Mayo are linguistic brethren of the Yaqui of western Sonora. The Mayo and others have developed several varieties of domesticated plants that flourish in the area. Two appendices close chapter four, one covering ethnobotanically useful trees and columnar cacti of the Mayo region and the other provides a list of the trees in the Mayo region by scientific, Mayo, and Spanish names. Chapter five discusses further the crop diversity among the indigenous farming cultures and includes an appendix of indigenous names for native wild and domesticated crops of the northern Sierra Madre Occidental. Chapter six examines the diversity and distributions of amphibians, reptiles, and mammals in the region. And chapter seven provides a comprehensive analysis of the birds of the Alamos area, including their ecological distributions and seasonal behaviors.

Compared with the majority of books devoted to biodiversity conservation, this volume has a refreshingly human (i.e. *ethno*) aspect to it. The people of the region are dependent on several plant species from the forest and including this aspect makes the need for conservation even more compelling. The editors of this volume and the contributors of each chapter have done a fine job in broadly outlining this region and elucidating the need for biocultural conservation. I enthusiastically recommend this book to anyone interested in the botany, ecology, ethnobotany, and conservation of this region in northwest Sonora.—*Kevin D. Janni, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A., kjanni@brit.org.*

LESPEDEZA CUNEATA (FABACEAE), A FIRST RECORD OF ITS OCCURRENCE IN MEXICO

Eduardo Estrada C. and Carmen Yen M.

Facultad de Ciencias Forestales
Universidad Autónoma de Nuevo León
P. 41, 67700, Linares, Nuevo León, MÉXICO

ABSTRACT

Lespedeza cuneata (Dum.Cours.) G. Don, a native species from eastern Asia and introduced in the U.S.A., is reported for first time to Mexico. Recent botanical field collections between Cuauhtémoc and La Junta, in Chihuahua, Mexico have extended its distribution about 800 km southwestern from its previously known range, in eastern Texas.

RESÚMEN

Lespedeza cuneata (Dum.Cours) G. Don, una especie nativa del este de Asia e introducida en los E.U.A se cita por primera vez para México. Colecciones recientes de material botánico entre Cuauhtémoc y La Junta, en el estado norteño de Chihuahua, México, permiten extender su rango de distribución cerca de 800 km al sur de su rango de distribución conocido, en el este de Texas.

The genus *Lespedeza* is present in Australia, eastern Asia and eastern North America (Clewell 1966; Turner 1959; Correll & Johnston 1979). Three species of *Lespedeza, L. striata* (Thunb.) H. & A., *L. stipulacea* Maxim. and *L. cuneata* (Dum.cours.) G. Don, have been introduced in eastern U.S.A. to prevent soil erosion, for green manure and for forage for cattle and wildlife. (Clewell 1966). *Lespedeza cuneata* is one of many plants used for soil and water conservation; it provides good ground cover on soils that are not adequate for other plants, and it helps build the soil by replenishing the nitrogen supply (Guernsey 1970). In Mexico there are only isolated records for this genus: *L. virginica* (L.) Britton and *L. texana* Britton are reported for Coahuila (Clewell 1966), and Estrada and Marroquín (1992) reported *L. repens* for central part of Nuevo León. There are no records of *Lespedeza* species for Sonora (Shreve & Wiggins 1964), Arizona (Kearney & Pebbles 1960), and Chihuahua (Estrada & Martínez 2000). Figure 1 shows its historical and recent range distribution in U.S. A. and Mexico.

Lespedeza cuneata (Dum.Cours.) G. Don

Perennial herb, 25–45 cm tall; stems several from the base, erect and, ascending, branched above, longitudinally ribbed, appressed pubescent, the trichomes 0.2–0.4 mm long, white, most abundant in ribs; stipules persistent, linear lanceolate, 2.5–5 mm long, striate, sparsely pubescent; leaves abundant, crowded, trifoliolate, petioles 2–3.5 mm long; leaflets cuneate 7–10(–18) mm long, 2–3 mm wide, apex retuse, truncate or mucronate, glabrous above, sparse pubescent below, lateral veins ascendant, branched, anastomosed; inflorescences axillary, shorter than the foliage, solitary or in pairs; pedicels 1 mm long; bractlets 2, ovate, apex attenuate, 1.2–1.9 mm long; calyx narrowly campanulate, 4–4(–5) mm long, 1–3 mm wide, 5-dentate, the throat 1.3—1.5 mm long, the teeth 2.7–3 mm long, lanceolate, the two upper notched less deeply than three lower ones; corollas white, papilionate; banner obovate or spatulate, 6–7.3 mm long, the base thiny, auriculate and unguiculate, with a purple throat, the wings narrowly oblong, inequilateral, 6–6.2 mm long, 1.3 mm wide, the keel incurved, 6–7 mm long, 1–3 mm wide, apex retuse; stamens 10, diadelphous; ovary ovate; style linear filiform; fruit in lower branches originated from cleistogamous flowers, rounded, 2 mm in diameter, reticulate, the style tightly recurved, sparse pubescent; fruits of chasmogamous flowers undeveloped.

Specimens examinated: **Chihuahua**: km 135 carretera Cuauhtémoc–La Junta, a la altura de Páramo de Morelos, Mpio. Guerrero, vegetación de pastizal mediano abierto de *Bouteloua gracilis*, *Brickellia* spp., *Mimosa aculeaticarpa*, 1950 m.s.n.m., 25.Jul. 1994, *C. Yen, E. Estrada* 2693 (ANSM, CFNL, TEX).

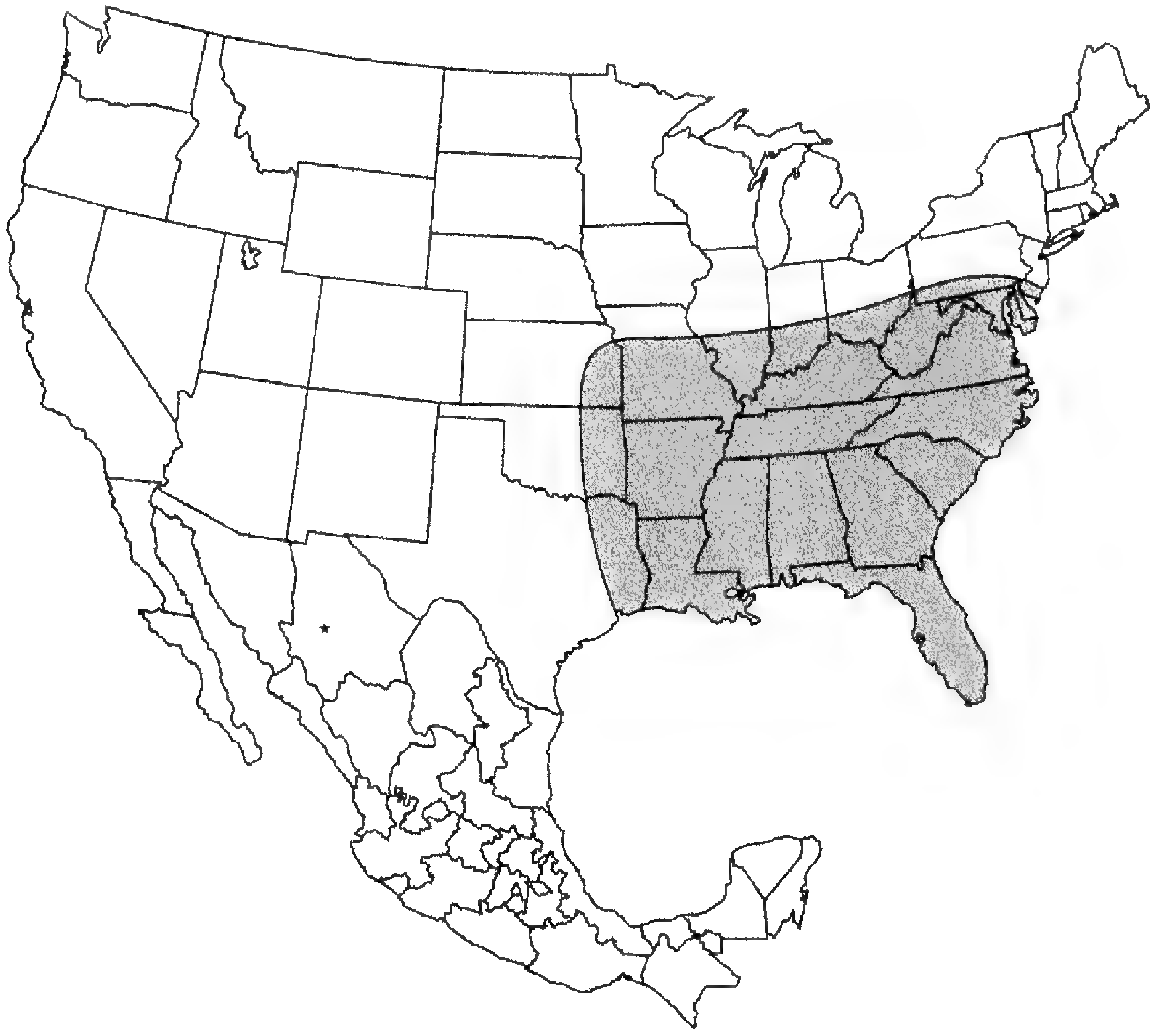

Fig. 1 Map showing distribution of *Lespedeza cuneata* (Dumont) G. Don, in U.S.A. and Mexico (State of Chihuahua).

The presence of *Lespedeza cuneata* is sporadic, and patchy along roadsides, it does not appear to invade adjacent abandoned croplands. This species has not been internationally introduced in Chihuahua (people of the area, personal comments). As far as we observed, its distribution comprises small patches in an area of 26 km in this area. (from km 120 to km 146 Cuauhtémoc-La Junta highway).

ACKNOWLEDGMENTS

We thank B.L. Turner for plant verification, John L. Anderson, James Henrickson, and Barney Lipscomb for helpful suggestions, Mariela Pando for English revision, and Miguel González B. for the map.

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BOOK REVIEW

ROBERT H. MACARTHUR and EDWARD O. WILSON. 2001. **The Theory of Island Biogeography.** (ISBN 0-691-08836-5, pbk.). Princeton University Press, 41 William Street, Princeton, NJ 08540, U.S.A. (Orders: www.pupress.princetion.edu, 609-258-5714, 609-258-1335 fax). $19.95, 203 pp, 60 figures, 5" × 8".

This newest edition in the Princeton series of *Landmarks in Biology* brings us an essential text that when published in 1967 made an indelible mark on the field of ecology. While the parameters of the assembly of discrete biotic communities is a focus, the innovation here was the authors breaking away from the mold to explore other phenomena like demography and competition. In the 30 years since initial publication, *The Theory of Island Biogeography's* impact has resonated primarily in the disciplines of conservation biology and biogeography. This is an introductory text in the truest sense. In hindsight, Wilson notes in the preface: "the flaws in this book lie in its oversimplification and incompleteness, which are endemic to most early efforts at theory and synthesis. Large number of experiments supported our hypothesis others did not. Also, we were satisfied to account for the effect of area on equilibrium species numbers as an outcome of varying population size and fluctuation. Thus, small islands supporting small populations are more prone to lose species than large ones, and the effect is exacerbated when the amplitude of population fluctuation is increased. Later, others were quick to point out that population size is far from the whole story. The area effect owes a lot to physical geography." (p. ix) Nonetheless, this edition offers students the foundations of island biogeography.

There are eight chapters covering the following topics: the importance of islands, area and number of species, explanations of the area-diversity pattern, invisibility and the variable niche, biotic exchange, and evolutionary changes following colonization. The book begins with the area-diversity curve and throughout an extensive theory of the equilibrium of species is developed. The authors then go on to consider the influence of life-table parameters of individual organisms on the immigration and extinction rates of populations and generalize about the evolutionary strategies species must adopt in order to be good colonizers. The role of stepping stones in dispersal and exchange of species and the consequences of island biogeography theory on evolutionary theory are discussed in closing the book. The book is sufficiently detailed in the mathematical formulas that describe and support their theory and also contains a very useful glossary of terms and general subject index.

In summary, I would recommend this book for island biogeography, conservation biology, or history of science classes. It serves as a snapshot of the early theoretical development of biogeography by which students can gain an appreciation for the disciplines evolution in light of the far more detailed work that has preceded it. The text is concise, affordable and the product of two men whose contributions to biology have been immeasurable.—*Kevin D. Janni, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A., kjanni@brit.org.*

RUPERT C. BARNEBY
(October 6, 1911–December 5, 2000)
A MEMOIR

Richard Spellenberg

Department of Biology
New Mexico State University
Las Cruces, NM 88003-8001, U.S.A.

"Dear Rich: Thanks so much for your letter of July 13, for the good news in it, and for the little loco from near St. George, Utah, which brought a special joy (your no. 3182). I feel sure that you have run it correctly to *A. musimonum*—it's simply not possible to squeeze a flower so short, a calyx so distinctly campanulate, into *A. amphioxys*. ... What gives me a particular boot about your plants is this: in 1942 I collected on limestone in Mokiak Pass s of St. George an astragalus at the time only in young flower which seemed to me almost certainly *A. musimonum*. ... This collection (my no. 4321) was cited provisionally in the protolog ... , but later I was never able to locate the material for comparison. ... [Y]ou can imagine the satisfaction that your collection brings to me, the loss of my own having stuck in my mind like a splinter in the foot, healed over but still and always a cryptic nag" (Aug. 2, 1973). I received an essay, essentially, about a single collection we had made in Mokiak Pass on a circuitous return from a collecting trip with two graduate students to Death Valley. The collection was not particularly significant, but still one that elicited a letter so gratifying to a young botanist, a letter that simultaneously provided a confirmation on identification of a little-known species from a world's expert on this immense genus and provided images of Rupert Barneby and Dwight Ripley three decades earlier, during a great world war, isolated in southwestern Utah sniffing out locoweeds and other marvelous flora in a very open West. As do others, I treasure my letters and memories from Rupert, always so positive with regard to the material at hand, so encouraging, and so expressive. The specimens were "run," of course, in his at-that-time recently published "Atlas of North American *Astragalus*" (1964).

Rupert Barneby was born on October 6, 1911, at Trewyn, Monmouthshire, a 17th century house in England nearly on the Wales border. He died at 89 years old at 5:10 PM, Tuesday, December 5, 2000, at the Jewish Home for the Aged in New York, where he resided subsequent to a mild stroke a few months earlier. Until the stroke, he was in his office nearly every day, continuing to work with his botany, at the last "primarily identifying the gazillions of specimens sent to him for det." (Jackie Kallunki). The world has lost a tremendous botanical taxonomist and grand human being.

Early in his childhood Rupert was fascinated with plants and insects and fossils, and two aunts gave books to him that encouraged his interest. At 14 Rupert excelled in producing a herbarium collection in a local naturalist's club competition. Some of his identifications where challenged. Rupert knew he was right, and came to the realization that he had an independent intellect. Not only from books does one gain knowledge, but real learning could come from observing the natural world. In public school, at Harrow, at age 14, he met Dwight Ripley, two years older, who had a knowledge of plant scientific names. This deeply impressed Rupert, and from there a life-long friendship grew. Officials were scandalized, Rupert enjoyed telling, by the close relationship that developed, not so because of a schoolboy romance, but because Mr. Ripley was American. After boarding school Rupert went to Grenoble University in France, and to Cambridge (Trinity College), where he finished a B.A. in History and Modern Languages before he was 21. Mr. Ripley attended Oxford. While at university they went on joint plant-hunting trips to Spain, the Mediterranean, and northern Africa, bringing back plants to grow in the rock garden at the Ripley estate at Sussex, a garden that ultimately grew to contain 1138 species. As was the case for other great biologists of the past few centuries, Rupert's father resisted his study of botany; it was unsuitable for a young man. Suitable occupations were the army, navy, or church, or as they encouraged, a career in diplomacy. Rupert relates, "I was unsuitable for the army or navy and I hated the church. That's really why I came to America." Rupert was disinherited; Mr. Ripley's personal fortune paid the bills.

The relationship between Rupert Barneby and Dwight Ripley was expressed largely in the development and appreciation of their garden. In 1939 they published together a catalogue of the plants growing at their house, The Spinney, in Waldron, Sussex, England. *Carlina barnebiana* Burtt & P. H. Davis, a thistle from Crete, dates from this period of their explorations. Overnight guests at the Ripley/Barneby house might very well find a bud vase on their headboard placed by Rupert, with a small bouquet of plants in their families of interest, taken from the garden. After 50 years of sharing their enthusiasm for botany and the beauty of plants, Rupert lost his life-long friend; Mr. Ripley died of complications arising from alcoholism.

Rupert arrived in the United States in 1937, first living in Hollywood, later moving to New York. He established permanent residency in 1941. He and Ripley continued their plant hunting in the American West. In addition to collecting living plants for their rock garden, Rupert also prepared herbarium specimens, many of them representing undescribed taxa from that still poorly known region. Among his several newly made friends in western botany, Alice Eastwood and John Thomas Howell encouraged Rupert to publish his first new species in 1941, from Yucca Flat in Nevada, *Cymopterus ripleyi*. The article appeared in Leaflets of Western Botany, a journal that they supported financially for many years. In the same issue Eastwood described *Castilleja barnebyana* in honor of her friend who had deposited many collections at CAS. From that beginning he, often with others, named more than 1160 plant taxa new to science (*Mimosa* 217; *Astragalus* 118; *Cassia* 112; *Senna* 98; *Dalea* 61; *Chamaecrista* 50; etc. [NYBG database]) in 147 publications. In all western states, plant taxonomists and conservationists deal with Barneby names daily. In New Mexico, for example, he authored 26 plant taxa (23 *Astragalus*), and made new combinations in names for 44 more (K. Allred, NMCR database). A search of Index Kewensis on CD-ROM in 1997 listed 2045 taxa with Rupert as publishing author. Many of the drawings in his publications are by his own hand.

Rupert arrived at the New York Botanical Garden in the early 1950's as a visiting scholar to consult the herbarium. He soon became an honorary curator in Western botany. In 1959 he was given an official position to help Howard Irwin proceed with his studies of *Cassia*. In 1989 he was named curator of systematic botany, the first and only paying job he ever held. He consulted for Brittonia, particularly to vet Latin descriptions for new taxa, and to critically read manuscripts. His special interests were xerophytic floras, taxonomy of the Leguminosae, Neotropical Menispermaceae. His extensive knowledge of the Fabaceae resulted in thousands of specimens being sent to him for determination. These gifts have pushed the legume collection at NYBG beyond 270,000 specimens.

Rupert's ability to discern differences and recall detail, and to deal with cards and sheets of notes in extensive files while working on a typewriter, was matched by his truly astounding ability to synthesize. "Rupert Barneby was a great student of plants in the style of George Bentham and the other encyclopedic workers of the nineteenth century, who would tirelessly analyze all we knew about enormous groups of plants and reduce that knowledge to lucid prose, working day after day, month after month, and year after year" (Peter Raven, as cited in The New York Times). So true; chatting over tea on one of my visits to NYBG I learned that he spent the best part of six months dealing with the variation and synonomy of *Lupinus argenteus* Pursh for the Intermountain Flora (Fabales, Vol. 3,B, 1989). His ability to organize and synthesize massive amounts of detail, unrelentingly moving great projects toward completion, have given us magnificent taxonomic syntheses of *Oxtytropis* (1952), *Astragalus* (1964), *Cassia* (1977, 1978,) and *Cassiinae* (1982), *Dalea* and allied genera (1977), Mimosaceae (1996, 1998). Of his 147 botanical publications, 111 are in the Fabaceae. In all, they comprise more than 6,600 printed pages.

I am grateful to Stan Welsh for the following passage, from his Jan. 16, 2001, presentation at NYBG at Rupert's memorial service. It reflects upon Rupert's love of the West, of the field, of plants; on his humor, on his valued involvement with colleagues, and his view of himself relative to the "real" world. Writes Stan, "Field work was part of Rupert's Psyche. He spent a huge amount of time collecting plants, becoming acquainted with them in nature. And, he had an almost mystical quality of being able to ferret out novelties over vast expanses of the American West. His field experiences were sometimes interrupted by real stupidities, as when he was accosted by police in Arkansas in 1963. 'A suspected murderer was known to be in flight, in a Jeep, and naturally anyone in an out of state Jeep [Rupert's favorite field vehicle] was it. It was a nasty experience being forced out of the car at gun point by a porcine state cop of the lowest (almost Hollywood) style—huge belly, flabby cheeks, cigar-butt clamped into a tiny red mouth—and then have all my possessions pawed over. Only botanists believe in anything so other-worldly as a botanist, and I do sort of sympathize with the Law faced by Linnaeus; one cannot fairly expect comprehension or sympathy.' The quote is from a letter to Isely (16 July 1965), and was in response to Duane's having been held in jail for some hours by Colorado police, him looking suspiciously like a bank robber. Botanists are a suspicious bunch."

Rupert understood and used Latin well, consulting for Brittionia and, upon request, helping those less skilled in the idiom to prepare proper descriptions and diagnoses. He could also be relied upon to provide opinions on the use of Latin in botany. For example, in New Mexico a number of us were preparing a review of plant species of conservation concern in the state, and we encountered a specific epithet spelled in two ways in the literature. Solution: ask Rupert — and we received: "Dear Rich: there's so much wrong with the epithet *mesaverdae* that it would be best put on an index expurgatorius, but as we don't have a method for this it is best left exactly as originally written. Latinized Mesa Verde would be *mensa viridis*, giving a genitive *mensae-viridis*: simply putting a Latin genitive ending on one or both parts of the Spanish place name is not at all that same thing. If any tinkering were to [be] attempted it would be best to think of mesaverde as one word and make a genitive *mesaverdei*. In any case *mesae-verdae* is even more grotesque than the original monstrosity, which I would recommend you leave unaltered, as a warning to those who assume that they have mastered Chopin yet are at page one of Czerny's exercises" (14 March, 1988). I am so glad I asked.

The botanical community showed its appreciation for Rupert's magnificent contributions again and again by bestowing upon him prestigious awards. Rupert always struck me as a modest and unassuming individual, appreciative of the work of others, truly interested in their progress. Awards were not his cup of tea. In response during an interview regarding his receipt of the Millenium Botany Award at the International Botanical Congress in 1999, given for his lifetime of contribution to botany, he said, "I'm conscious of the prestige of the medallion, but hideously aware that it's an award for survival rather than for merit. It's part of the dismal cult of personality that started in Hollywood and now has infected the entire planet." Among other prestigious awards are the Distinguished Service Award, NYBG, 1965; the Henry Allan Gleason Award, an annual award from NYBG for an outstanding recent publication in plant taxonomy, ecology, or geography, in1980; the Asa Gray Award, American Society of Plant Taxonomists, for his contribution to systematic botany, in 1989; and the Engler Silver Medal, International Association of Plant Taxonomists highest honor for publications, for his monographic work in *Mimosa*, in 1993. He also was awarded an honorary doctor degree in 1979 from The City University of New York. In 1991, NYBG established the Rupert C. Barneby Fund for Research in Legume Systematics, a fund that continues to support research in this large, important family.

Rupert was an unofficial mentor and valued colleague to many. Duane Isely spent a sabbatical period with him at NYBG. Many, among them, Jim Grimes, Melissa Luckow, and André de Carvalho, recently have credited him as an inspiration in their lives. Ghillean Prance shares that "he will be remembered by thousands of colleagues for his uncommon generosity in sharing his inexhaustible knowledge and precise editorial skills." Stan Welsh writes to me, "... [he] was a master of words, works, and wonders. ... I miss him already." Cronquist wrote (Brittonia 33:263. 1981), "Rupert is a gentleman and our resident classical scholar. If we need to know something about Latin, or Greek, or the niceties of English construction, we turn to him. He is kind, considerate, and learned. No polemicist, he can come up with the piquant *mot juste* when he chooses. We love him." The last speaks for so many. He had a delightful sense of humor, and loved a twist of the word. I often used a heading on my letters that involved a pun, "From the Herbarium, where. ..." In response I received a letter from Rupert, "From the New York Botanical Garden, where Brittonia waives the rules."

Volume 33 of Brittonia was dedicated to Rupert C. Barneby on the occasion of this 70th birthday, "in recognition of his devotion and intellectual commitment to plant systematics and his extraordinary depth and breadth of scholarship." In issue number three of that volume (33:263-274. 1981) is a series of letters from friends and colleagues from several nations. Each letter lauds his intellect, his accomplishments, and to a one, each expresses deep appreciation for the warmth of this extraordinary person. Joseph Kirkbride, who received his doctoral training at NYBG, brings back memories for many in one paragraph of his letter, "In his office, he had prepared a pot of tea and opened a package of biscuits. The tea was Jackson of Piccadilly, and the blend was 'Earl Grey's,' his favorite blend and brand of tea. That first 'tea time' was a marvelous experience. He put me at ease and kept the conversation going as he introduced himself. It is a landmark in my life." In a modern e-mail message to Pat Holmgren, Stan Welsh writes, "My trips to the garden were always highlighted by the morning and afternoon teas in his office." In my own trips to the Northeast, for professional reasons or otherwise, I would always make a special effort to arrive at Rupert's office to spend some time visiting with him over a cup of tea, each time a very special moment, the memories of which I now value so much.

In the same vein, in a communication from Noel Holmgren (Dec. 8, 2000), I learn that he also considers Rupert an important mentor in his development. He expressed what so many of us have felt in our interactions with Rupert. "There was no formal structure to the lessons, they were just part of relaxed, enjoyable conversation. He loved the same plants that I was becoming acquainted with. Each species of plant had a special character, be it the place it grew, its appearance, or its relationships to other species. He always gave the feeling that there was a spirit residing in each plant. You, Rich, have had these enlightening conversations with Rupert and so have so many others. So many, many others. I know this after years of being right across the hall from his office. In some ways his hearing loss was sometimes my gain. I could listen to his tea-time conversations with people, whenever I chose. His wonderful and suddenly explosive laughter. I'll really miss him." As will I, and so many others who Rupert so generously touched in his long and productive life.

Author's note.—A number of individuals responded enthusiastically and helpfully when I asked for information regarding Rupert Barneby's great life. Clearly he was extremely important to, and well-liked by, them. I know there are dozens of others who have had exchanges with Rupert that they would have been happy to share. I am particularly grateful to Pat Holmgren, who forwarded numerous very valuable sources of facts and perspectives on his private and professional life. Particularly helpful were New York Times, 10 Dec 2000, NYBG Herbarium Sheet #254, 15 Oct 1997, an NYBG press release, Dec 8, 2000, and Rupert Barneby's vitae.

Rupert Barneby, photo by Noel Holmgren, who writes (31 Jan 2001), "The photograph of Rupert was taken on May 30th, 1978. It was the last full day in the field with Rupert that year before he flew back to New York. I had been trying to get a candid photo of him daily for the preceding 10 days and I could never pull it off. I thought he would feel self conscious if he were aware of what I was trying to do, so finally, out of frustration I asked him to pose. I couldn't believe how natural and photogenic he was. The backdrop is on the San Rafael Swell in Emery County, Utah, south of Interstate Highway 70."

BOOK REVIEWS

RICHARD S. FELGER. 2000. **Flora of the Gran Desierto and Río Colorado Delta**. (ISBN 0-8165-2044-5, hbk.). University of Arizona Press, 355 S. Euclid Ave., Suite 103, Tucson, AZ 85719, U.S.A. (Orders: www.uapress.arizona.edu, 520-621-1441, 520-621-8899 fax). $75.00, 700 pp, 440 illustrations, 8 1/2" × 11".

Contents.—Acknowledgments, Abbreviations. **Part I.** The Environment and Human Interactions (including Paleoclimate, Present Climate, Major Habitats, History and Human Influences, Growth Forms, and Bortanical History). **Part II.** The Flora (the systematic portion, of 521 pages). Gazeteer (by Bill Broyles and Richard Felger). **Appendices** (including **A.** Growth Forms and Distribution of Plants in Northwestern Sonora; **B.** Distribution of Plants in Sykes Crater; **C.** Commonly Cultivated Trees and Shrubs in Northwestern Sonora; **D.** Non-native Plants in Northwestern Sonora; **E.** Systematic Arrangement and Relative Abundance of the Grasses in Northwestern Sonora; **F.** Geographic Distributions of Grasses in Northwestern Sonora) Literature Cited Index.

"Excuses, corrections, and additions" to the book are maintained on the University of Arizona Herbarium (ARIZ) website <http://eebweb.arizona.edu/HERB/ tools/gran_des.html>.

The flora area is in the northwest corner of the Mexican state of Sonora, an area of approximately 15,000 square km (5790 square mi, about 5% the size of the adjacent state of Arizona) and one of the most arid regions of North America. "It is a substantial portion of the extremely arid center, or heart, of the Sonoran Desert. Within this region there are expansive dune fields, maritime strands, a small river, a once-great river and its delta, tidal wetlands, desert plains, steep granitic mountains, desert oases, and an enormous black and red volcanic field featuring its own mountain, lava flows, cinder cones, and formidable craters. Also included is the Quitobaquito oasis, along the international border but mostly on the Arizona side." Average annual precipitation varies from 40 to 195 mm, depending on locality, and variability is extreme months or years may pass without significant rainfall, or much of the year's precipitation may occur during a few hours. "Average [average!] maximum daily temperature exceeds 38°C (100°F) during June, July, and August, and temperatures exceeding 38°C are common from late April to early October."

Within this cooker of an area, Felger documents the occurrence of 575 species of vascular plants (by my count from Appendix A), including 88 non-native species (a number of these are North American natives).

Comprising the bulk of the book are
* **original keys**;
* **short but useful technical descriptions** of species and infraspecific taxa, based "only on plants and populations from northwestern Sonora and immediately adjacent areas unless otherwise stated" and emphasizing "characters that seem important to understanding the variation and adaptations of plants in this arid environment;"
* **comments on habitat and distribution**, nativity, weediness, palatability, uses, and comparative notes on how to distinguish species from similar ones—this commentary often expansively developed, providing a vehicle for Felger's correspondingly expansive personal knowledge of these plants;
* **collection citations for each species**—the great majority of these Felger's own collections; and
* **illustrations**—apparently each species illustrated by a line drawing, often with details, these gathered from a variety of sources, with some originals.

Ira Wiggins's 1964 "Flora of the Sonoran Desert" (which covers the Gran Desierto region) is cited only twice—once in the 'Botanical History' section (p. 38) in connection with mention of early collections made by Wiggins and once (p. 39) in connection with synonyms in FGDRCD not appearing in the Wiggins flora. This latter work, however, has more to go before outliving its usefulness, although, as one would expect after the last 35 years, the nomenclature is outdated in many areas and various species have been described de novo or discovered as range extensions. Felger's apparent disconnect from the earlier treatment probably reflects a true discontinuity, because the Flora of the Gran Desierto is truly an original, with trace of debt only to be inferred. And not only is FGDRCD packed with information, it is nicely organized and easy to read, good reading. Good price. For biologists and conservationists with an interest in American desert floras or simply in the flora of western North America, this book is a must-have.—*Guy L. Nesom, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

KAREN L. WILSON and DAVID A. MORRISON (eds). 2000. **Monocots: Systematics and Evolution.** (ISBN 0 643 06437 0, hbk.). CSIRO Publishing, P.O. Box 1139 (150 Oxford Street), Collingwood VIC 3066, Australia. $175.00, i–xiv, 1–738 pp, b/w photos, figures, 8 1/4" × 11 1/4".

Monocots: Systematics and Evolution is a proceedings volume resulting from the Second International Conference on the Comparative Biology of the Monocotyledons, held in Sydney, Australia, during the week beginning 28 September 1998. A total of 280 individuals from 31 countries participated in the conference, whose aim was to "increase our scientific understanding of the relationships, classification and functional biology of the monocots...." According to the preface, the 72 papers included in this volume "are based on presentations given at the conference, but many have been updated or extended to take into account new information." Given the rate at which much of the field of systematics is currently progressing, such updating is an important consideration. In addition, all the papers were peer-reviewed. A look at the authors is a good indication of the quality of the conference and volume—they include many of the most recognized and respected authorities worldwide on monocots, and systematics in general, working today. Such well-known names as Barrett, Bernhardt, Briggs, Chase, Conran, Fay, Goldblatt, Faden, Merrow, Rudall, Soltis, and Tomlinson (to mention a few) are seen scattered throughout the volume. The papers have been organized into three major sections (General Comparative Biology of the Monocots, Systematics of the Lilioids, Systematics of the Commmelinoids), with each of these divided into a number of subsections. For example, the section on Comparative Biology has papers in the following subsections: Phylogeny, Biogeography & Fossils, Development & Organization, Chemotaxonomy & Cytology, Micromorphology, Anatomy & Embryology, and Reproductive Biology.

If size (weight) is any indication of amount and quality of content, then this hefty six pound book is certainly worthwhile. Indeed, the overall quality of the numerous papers is quite high, and the volume is extremely useful for anyone wishing to see a wide-angle snapshot of the current understanding of monocot biology. In particular, the conference organizers and proceedings editors should be congratulated on putting together a conference/proceedings that includes information from a wide variety of disciplines and subspecialties (e.g., anatomy, biogeography, cytology, developmental biology, molecular systematics, paleontology, reproductive biology). While molecular information is currently providing some of the most profound and interesting insights in the field today, other disciplines are also making major contributions, as shown so well in this volume.

This said, I personally (with a taxonomist's bias) found several of the articles focusing on molecular systematics particularly interesting. For example, the first paper of the volume, "Higher-level systematics of the Monocotyledons: An assessment of current knowledge and a new classification" (by M.W. Chase et al.), clearly shows how molecular systematics has developed and matured. It is a well-presented and exciting look at current understanding of the relationships of the various monocot groups based on a combined analysis of DNA sequence data from three genes. The consensus tree presented shows Acoraceae as the sister group to the rest of the monocots, followed by Alismatales (including Araceae and Tofieldiaceae) as the next diverging order, followed by Pandanales, Dioscoreales, Liliales, and finally Asparagales-commelinoids. Such an understanding of monocot relationships would only have been dreamed about several decades ago. Another particularly interesting paper was "Phylogenetic studies of Asparagales based on four plastid DNA regions" (by M.F. Fay et al.). In this case, a combined analysis of four plastid DNA regions was used to examine relationships among members of the Asparagales. This paper likewise is well-presented, has a visually easily understandable tree, and provides a fascinating look at this large and important order. While many of the most important insights have been published previously, this is none-the-less an important updating of the molecular systematics of the order. Understanding that the Amaryllidaceae, Asparagaceae, Iridaceae, and Orchidaceae (for example) all belong in the same order would have been unthinkable just a generation ago. Here we see a detailed presentation and explanation of their relationships. While some of the details may change as further molecular work is done, studies such as these are important steps towards an ever more sophisticated understanding of monocot phylogeny. Valuable contributions from the other sections including titles such as "Stem vasculature in climbing monocotyledons: A comparative approach," "Mating strategies in monocotyledons," "Ins and outs of orchid phylogeny," or "Fire response and conservation biology of Western Australian species of Restionaceae" could be reviewed here in detail. However, suffice it to say that overall this is a volume of diverse and exceptionally high quality papers.

If anything negative can be said, it would be that as expected from a proceedings volume, and from the size of the monocots (ca. 25% of the world's flowering plant species), the papers do not provide even coverage of all monocots groups. By necessity, it reflects the participants' interests and expertise, and many groups have not been included (in particular, the grasses have been excluded but are covered in a well done companion volume). However, there is quite broad coverage, ranging from such well known groups as Asparagales, Dioscoreales, Liliales, Orchidaceae, Commelinaceae, and Cyperaceae, to lesser known but none-the-less interesting groups such as the Restionaceae.

In summary, this is a valuable addition to our knowledge of monocot biology, and provides an excellent overview of the current state of understanding. It will undoubtedly be one of the most useful and broadly cited references on monocot systematics and evolution for many years to come. Further, the papers presented here are an exciting and accurate reflection of the diverse and dynamic nature of systematics and evolution at the beginning of the 21st century.—*George M. Diggs, Jr., Dept. of Biology, Austin College, Sherman, TX 75090, and Botanical Research Institute of Texas, Fort Worth, TX 76102, U.S.A. gdiggs@austinc.edu.*

ADA GRAHAM and FRANK GRAHAM, JR. 1995. **Kate Furbish and the Flora of Maine.** (ISBN 0-88448-175-1, hbk, ISBN 0-88448-176-X, pbk). Tilbury House Publishers, 132 Water Street, Gardiner, MA 04345, U.S.A. (Orders: 800-582-1899). $55.00 (hbk), $30.00 (pbk). 162 pp, 43 full color illustrations, 100 b/w illustrations, 6 b/w photographs, and a b/w map of Maine, 8" × 10".

This is the story of a spirit driven with a fire to collect and paint the unique and diverse flora that was Maine. In a lifetime spanning nearly a century (1834-1931) Catherine (Kate) Furbish would 'paint' a reputation as field botanist and botanical illustrator by creating more than 1,300 botanical watercolors and sketches. Self-taught in both fields of art and science, Kate had a no-nonsense approach to her painting. She was a serious naturalist with a botanist's eye. "*I do not claim Artistic merit, but merely a truthful representation of what I saw in the plants, free from all decorative effects.*"

Born the only girl amongst five brothers, she held a strong reserve inherited from her father. Her work is not fussed over or decorative, but true botanical illustrations and yet the artistry does come through. Her illustration of Bloodroot, *Sanguinaria canadensis*, created between 1870-1880 when she was at her most productive, is masterful in both composition and form. At 36 years old, unmarried and still living with her parents, she was a woman of post Civil War Victorian conventionality holding within an unrelenting personal quest; a body of scientific and artistic work that was about to spring forth like no other period of her life. Photographs taken of her at the time show a clear, direct gaze revealing a curious nature not unlike earlier pioneer botanists.

Kate was not daunted by arduous 'solo' field exploration and sometimes hazardous conditions. One of these expeditions in 1880 would lead her to discover the Furbish's Lousewort, *Pedicularis furbishiae*, a wild snapdragon found nowhere in the world except along a 130-mile stretch of the Saint John River in Northern Maine. Its discovery has helped her name endure. She was also not deterred by gender prejudices and lack of proper academic degree. In a letter to a colleague she expresses her frustration with another botanist: "*I think he is one of those men, who if I was young and the bloom was on the peach, would feel more interested in helping me. I tried to show my appreciation by sending him my best work [a painting of trilliums] but I'm not going to wail over it all. For my part I help everyone whom I can and put my self out to do it too.*"

She was admired and respected by noted botanists of the day including her one time prodigy, Merritt Lyndon Fernald who was to become a noted field botanist and systematist at the Harvard Herbarium and editor of the New England Botanical Club's journal *Rhodora*. In his *Second Edition of the Portland Catalogue for Maine Plants* he speaks of the variety of *Aster cordifolius* that she had discovered in Aroostook County. "*Dedicated to Maine's distinguished artist-botanist, the "posy-lady" of the Madawaska Acadians, who through her undaunted pluck and faithful brush, has done more than any other to make known the wonderful flora of the "Garden of Maine.*"

It was not until the 19th century that botanical interest began to shift to the Northeastern United States and Asa Gray was one of the driving forces. He helped foster the popular interest in identification and collection of wild plants. Thus, Kate's favorite and often referenced books were Asa Gray's *How Plants Grow and Manual of the Botany of the Northern United States*. Unlike the rule of thumb that in biology diversity of species diminished from the equator toward the poles, Maine held many varied flora just waiting to be discovered by adventurous botanists like Kate. Maine was also varied in habitats: offshore islands and coastlines ranging from beaches to salt marshes to rocky headlands, sandy plains, dense forests, river valleys, mountaintops, thousands of lakes and ponds, old fields, and cold sphagnum bogs. Maine also lay in a transition zone. A portion of its flora is made up of Southern plants in their northern most limits, and Northern Canadian plants in their southern most limits. Maine was ripe for exploration!

At 49 years old, in the span of one decade Kate collected more than 1000 species of plants and of these illustrated 850. (In 1983 the complete checklist of vascular plants in Maine totals 2,137 known species.) "*It has been accomplished by means of hard work and persistent effort, and without regard to fatigue*," wrote Furbish. "*I have wandered alone for the most part, on the highways and in the hedges, on foot, in hay ricks, in country mailstages (often with a revolver on the seat), in improvised rafts, (equipped with hammer, saw, nails, knife, rubber-boots, vasculum, etc.), in rowboats, on logs, crawling on hands and knees on the surface of bogs, and backing out, when I dare not walk, in order to procure a coveted treasure. Called 'crazy,' a 'fool'...this is the way my work has been done, the Flowers being my only society and the Manuals, the only literature for months together. Happy, happy hours!*"

I like the way the authors have moved Kate's 'time-line' of paintings along with the 'time-line' of the botanical history of Maine. In regards to the design and layout of the book, the illustrations are interspersed throughout the text in a very pertinent and pleasing manner. It is evident that much thought has been given to the layout and design of this fine biography.—*Linny Heagy, Linny/ Designer, Illustrator, Arlington, TX, U.S.A., a0005835@airmail.net.*

DANIEL W. GADE. 1999. **Nature and Culture in the Andes.** (ISBN 0-299-16124-2, pbk.). University of Wisconsin Press, 2537 Daniels St., Madison, WI, 53718, U.S.A. $18.95, 298 pp, 46 figures, 6" × 9".

The thrust of this volume is what the author refers to as the *nature/culture gestalt*. And throughout this work he proves that this is more than just an attempt at neologism; it is, in fact, a reality of the Andean region. The nature/culture gestalt is "a mutually interactive skein of human and nonhuman components, rather than opposing polarities or separate entities": Pg. 5. The Western penchant of categorization tends to separate these two seemingly unrelated phenomena, whereby the interrelatedness is lost and questions are only partially answered. Cultural geographer and professor emeritus at the University of Vermont, Daniel W. Gade delivers a groundbreaking volume for the annals of Andean history, ecology, and ethnobiology. *Nature and Culture in the Andes* is a book with a holistic vision that attempts to broaden the perspective achieved solely by objective scientific methods of inquiry.

The ten chapters include an introduction and conclusion laced with a self-reflexive commentary on the author's observations of Andean culture throughout his years of fieldwork. The main chapters themselves are free of the author's self-reflexive voice, but are framed within the concepts that are a result of his own self-reflection. In the introductory chapter, references are made to everyone from Goethe to Nietzsche and the author provides an autobiographical discussion that frames his insights and perspectives on the geographically and culturally diverse region of Andean South America. The second chapter, "Andean Definitions and the Meaning of *lo Andino*," covers the various meanings behind the term *the Andes*, geographically and culturally, and seeks to revise these definitions with his own. As the author states, "Over the past 400 years the definition of *the Andes* has shifted twice; from a nonregion to a region, and from a physical entity to a cultural area": Pg. 41.

The third chapter, "Deforestation and Reforestation of the Central Andean Highlands," is a chapter that stands out for several reasons. The common perspective of the Andes is one of a vast treeless region. Contrary to popular belief, the treeless Andes are actually a result of the economic demand for wood and subsequent deforestation. The author also discusses the role of anthropogenic fire and its role in environmental management. Fire was also used along the Pacific Northwest regions of North America (Boyd 1999); however, European colonists there frowned on its use, and the result being what many today perceive as the forest primeval, when in actuality the current tree population is relatively new. In the Andes, the author shows that fire management was *encouraged* by European settlers, the result being the treeless Andes as we know it. Various species of *Eucalyptus* were introduced to the region and replaced to some extent the species lost. The author goes on to offer 42 plant species, primarily at the genus level, that once covered the Andean highlands of Bolivia, Ecuador, and Peru. Tree removal was also a result of opening up more land for agriculture. As a result of population pressure, more and more trees were removed and this eventually led to environmental deterioration. However, without more land settled life would be limited in most regions.

The fourth chapter, "Malaria and Settlement Retrogression in Mizque, Bolivia," discusses the disease ecology of malaria in various elevations in the Andes and the pathogens introduced by European settlement. The author's case study provides a context for discussion whereby one of the largest and most virulent malaria histories in the region of western South America is brought to light through migration, population density, and racial/ethnic change. Chapter five, "The Andes as a Dairyless

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Civilization: *Llamas and Alpacas as Unmilked Animals*," continues in the spirit of debunking the traditional anthropological assumption that milk bearing animals are always milked. Chapter six, "Epilepsy, Magic, and the Tapir in Andean America," discusses the relationship of controlling epileptic seizures by wearing the nail of tapir around ones neck. Chapter seven, "Valleys of Mystery on the Peruvian Jungle Margin and the Inca Coca Connection," discusses how the popular assumption that the Incas did not cultivate coca has not properly been challenged. Chapter eight, "Guayaquil as Rat City," discusses the inundation of brown and black rats in this port city in Ecuador. Arriving as a result of overseas travelers, rats have played an undeniable role in the health and demographic patterns of Guayaquil. In the early 1900's the bubonic plague wreaked havoc upon Guayaquil, and was due in no small part to the co-existence of rats and humans and was squelched by a major public sanitation campaign. However, rats remain in the urban Guayaquil scavenging on trash left by humans. Going beyond mere causation is a metaphorical significance, "...rats symbolize the port function and external connections... rats also reflect Guayaquil's failure as a civic entity...(and) also represent local poverty": Pg. 183. Chapter nine, "Carl Sauer and the Andean Nexus in New World Diversity," covers the life work of Carl Sauer's studies in New World plant domestication and biodiversity.

Due not only to its diversity, but also its theoretical scope, this book would be a valuable part of any course in Andean Ethnobiology. Covering several overlapping ethnobiological concerns in botany, ecology, geography, and public health, this text seeks to fuse together nature and culture in a series of erudite arguments. Moreover, this is lively and interesting reading that dismisses ideas long held about the pre-Columbian Andean environment and human/environment relationships and seeks to replace them with ideas that could only be the result of rigorous research and a long career in the field. Perfect for graduate level classes in anthropology or geography, *Nature and Culture in the Andes* is bold, scholarly, and inexpensive. I would highly recommend this book to departments focusing in Latin American and Andean studies. Daniel Gade succeeds in defending his *nature/culture gestalt* theory in central South America and sets a level of scholarship to be modeled by current and future students of Ethnobiology.—*Kevin D. Janni, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060 U.S.A., kjanni@brit.org.*

REFERENCE

Boyd, R. (ed.) 1999. Indians, fire, & the land in the Pacific Northwest. Oregon State University Press. Corvallis, Oregon.

Estelle Levetin and Karen McMahon. 1999. **Plants and Society. Second Edition.** (ISBN 0-697-34552-1, pbk.). WCB/McGraw-Hill, Dubuque, IA, U.S.A. (Orders: www.mhhe.com). $55.60, 477 pp, b&w photos, 8 1/2" × 11".

Plants and Society is not unlike other high school/graduate level texts that have come out in the last two years and have attempted to present botany as an important aspect to human life, rather than an esoteric scientific discipline with little applicability. However, other texts have focused heavily on the cultural aspects of plant use, where this text uses historical examples to punctuate its scientific discussions.

The book comes in twenty-five chapters grouped in seven units. This first nine chapters cover the basic botany found in introductory courses, the rest of the book either looks at the applied aspects of botany or the historical impact of the relationship between people and plants. Unit one, "the botanical connection to our lives," covers flowering plants, fungi, an overview of the plant sciences and a general discussion of phytochemistry. Unit two is made up of eight chapters of introductory botany covering: the plant cell, body, and physiology, the plant life cycle (flowers, fruits, and seeds), genetics, systematics and evolution, and the diversity of plant life. This portion of the book looks like most any other general botany textbook, with the exception of the boxes sprinkled throughout with examples of applied and/or historical aspects of the given chapters subject matter.

Beginning with unit three the text focuses more on the relationship of plants and society. Unit three is six chapters covering plants as a source of food. Human nutrition and the origins of agriculture set up the following four chapters covering the grasses, legumes, starchy staples, and the case of worldwide hunger. Unit four discusses the commercial products derived from plants in three chapters. These chapters are devoted to stimulating beverages, herbs and spices, and materials (cloth, paper, wood). Unit five is also three chapters long and covers the role of plants in human health, specifically: medicinal plants, psychoactive plants, and poisonous and allergy plants. Unit six is a discussion of fungi in the natural environment, as beverages and food, and fungi that affect human health. Unit seven closes the book with a chapter on ecology that focuses on plants and the environment.

Each chapter follows the typical textbook design with key words in bold font, tables and boxes with case studies and/or examples, concept quizzes throughout the body of the chapter, a chapter summary, review questions and a list of further reading. Following the main chapters are an appendix on the metric system, an appendix on plant classification, a glossary, and an index.

I have a few design criticisms for this otherwise well-put-together text. First, the unit on fungi (chapters 22-24) would more appropriately follow chapter nine, the diversity of plant life. Secondly, units four and five could have been condensed to together. The chapter devoted to psychoactive plants is superfluous and the same subject matter could have been incorporated into the chapters on herbs and spices, medicinal plants, and poisonous plants. I have two substantive criticisms for the text. Chapter eight, "Plant Systematics and Evolution," is essentially a discussion on the rationality of scientific and common names, a discussion of binomial nomenclature, and a discussion of Darwin's voyage on the H.M.S. Beagle. In this chapter there is one paragraph that mentions cladistics and its attempt to identify evolutionary relationships among organisms. With the title this chapter carries I would like to see a more in-depth discussion of phylogeny and its implications for analyzing evolutionary relationships. My second substantive criticism is that this book is essentially about plants with reference to human relationships, nutrition, and civilization. In other words, there isn't as much balance between plants and society as the title indicates. I am quite satisfied with the first half of the book and its introductory discussion of botany. At unit three the book takes a closer look at plants and people, but is still mostly about plants. Perhaps if each chapter had an individual case study of an ethnic group and their relationship with plants would correct this.

In summary, while this book is not as balanced as it could be it is nevertheless appropriate for high school level units on plants and civilization and could be supplemented with other texts for undergraduate courses in ethnobotany. A better balance between plants and society could make this book considerably more versatile and open to a wider audience. *Plants and Society* is representative of the current trend in curriculum design that is shifting the focus of traditional botany courses by making the subject matter more practical and relevant to daily life and succeeds in doing so.—*Kevin D. Janni, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060 U.S.A., kjanni@brit.org.*

BERYL B. SIMPSON and MOLLY C. OGORZALY. **Economic Botany. Plants in our World, Third Edition.** 2001. (ISBN 0-07-290938-2, hbk.). McGraw-Hill Higher Education, McGraw-Hill Companies, Inc., 1221 Avenue of the Americas, New York, NY 10020, U.S.A. (Orders: www.mhhe.com). $70.50, 544 pp, illustrated, 8 1/2" × 11".

The distinction between economic botany and ethnobotany is often blurry. For many people, economic botany is an inventory plants used for project x and ethnobotany is trudging through Amazonia in search of the cure to a modern disease. Neither of these perspectives is particularly accurate. While included in this text are a number of ethnobotanical examples, this book, as its title indicates, is devoted to economic botany. (And economic botany is inherently human-based and/or influenced.) This third edition of *Economic Botany* outlines the breadth of this discipline and its impact on our lives, past and present.

The book is made up of 19 chapters that have been significantly updated since the publication of the second edition. Chapters one and two from the first two editions have been condensed and rewritten into the third editions chapter one, "Plants and Their Manipulation by People." This chapter discusses plants, vegetative structures, reproductive structures, traditional methods of plant manipulation, variation and selection in flowering plants, the nature of plant species, the naming of plants, and determining the relationships among plants. Chapter two reviews current ideas on the adoption of agriculture, as well as the origins of particular crops.

The bulk of the book is made up of chapters three through 17 that focus on important angiosperm and gymnosperm crop species. The first five of these chapters group food plants by the parts of the plants (ie – fruits, leaves, stems) harvested for food. Chapters eight through 16 cover products that are primarily extracted from plant parts. Substances such as volatile oils, alkaloids, latexes, are grouped according to their use: spices and perfumes, textile fibers, and bioactive compounds. For each group of plant products discussed, the natural occurrences, chemistries, and functions within the plants in which they occur are outlined. Chapter three discusses fruits and nuts of temperate regions, focusing on apples and their relatives and other fruits. Chapter four covers fruits and nuts from warm regions, like citrus fruits, tomatoes, peppers and eggplants, to name a few. Cereal grains and forage grasses are covered in chapter five, which reviews the major grain crops and grass plants and forage grasses. Chapters six is devoted to legumes: pulses, tamarind, and carob. Chapter seven covers foods from leaves, stems, and roots and is one of the larger chapters in the book. Discussed in chapter seven are the structure and function of stems, leaves, and roots, biennial and annual crops, vegetables from bulbs, starchy root crops, and sweets from stems and roots.

Chapter eight covers the chemistry and ecology of spices, herbs, and perfumes. Chapter nine discusses the composition of seed oils like polyunsaturated, unsaturated, and moderately saturated oils and vegetable fats. Chapter 10 discusses hydrogels, elastic latexes, and resins. Chapter 11 focuses on medicinal plants, and in this edition include updated information on the most commonly used herbal remedies. The chapter covers the history of medicinal plants, the chemistry of plant derived medicines, and dietary supplements. Chapter 12 is devoted to psychoactive drugs and poisons and includes information about the chemistry and pharmacology of psychoactive drugs, and a history of drug use and abuse. Chapters 13 and 14 cover stimulating and alcoholic beverages. Chapter 15 covers fibers, dyes, and tannins, followed by chapter 16 covering wood, cork, and bamboo. Chapter 17 covers ornamental plants, specifically, nursery crops, florist crops, and houseplants. Chapter 18 on Algae is expanded from the previous editions to include new information on bioactive algae that produce newly discovered toxins and research on the medical potential of algal compounds. The final chapter discusses the uses of plants in the future and is also revised. The book closes with a list of additional readings, a glossary (new to this edition), and an index.

In this updated edition the authors have made an effort to make the book more accessible in several ways. First, the material has been condensed into 500 pages that appear in two-column format to save page space. Color photos have been excluded, but there exist a number of new photos that are up to date and more globally inclusive. Another new design feature are the boxes that highlight interesting case-study material about the plants included in different chapters. The concentration in this edition is on species of major economic importance in the Western world, rather than trying to be encyclopedic. The authors have attempted to give a balanced treatment of plants including aspects of history, morphology, chemistry, and modern usage. At first glance this is a very textbook-like edition, however there are no summaries or review questions at the end of each chapter, suggesting that the target audience for this edition are graduate students.

In summary, this updated and revised edition of Simpson and Ogorzaly's original *Economic Botany* is an excellent text that should be the foundation for graduate level economic botany classes. The updated material on medicinal plants, ethnobotany, genetics and biotechnology, and sustainability and conservation ethics make the book relevant and practical to students and instructors of economic botany. I would highly recommend this book to anyone wanting a thorough global view of economic botany for a class or personal use.—*Kevin D. Janni, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060 U.S.A., kjanni@brit.org.*

BOOKS RECEIVED

Book reviews will be published in upcoming issues of Sida.

Systematics/Monographs/Floras/Guides

B. NORDENSTAM, G. EL-GHAZALY, and M. KASSAS (eds.). 2000. **Plant Systematics for the 21st Century.** (ISBN 1-85578-135-2, hbk.). Portland Press Ltd, 59 Portland Place, London W1B 1QW, UK. (Orders in North America: Princeton University Press, 41 William Street, Princeton, NJ 08540, 609-883-1759, 609-883-7413 fax). $120.00, 366 pp, figures.

ROBERT W. KIGER and DUNCAN M. PORTER. 2001. **Categorical Glossary for the Flora of North America Project.** (ISBN 0-913196-70-3, pbk.). Hunt Institute for Botanical Documentation, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213-3890). $5.00 (shipping $4.00), 165 pp.

MARCO LAMBERTINI (Translated by JOHN VENERELLA). 2000. **A Naturalist's Guide to the Tropics.** (ISBN 0-226-46828-3, pbk.). The University of Chicago Press, 11030 S. Langley, Chicago, IL 60628, www.press.uchicago.edu, 800-621-2736). $25.00, 312 pp, illustrated, color.

S.H.J.V. RAPANARIVO, J.J. LAVRANOS, A.J.M. LEEUWENBERG, and W. RÖÖSLI. 1999. **Pachypodium (Apocynaceae). Taxonomy, Ecology and Cultivation.** (ISBN 90-5410-485-6, hbk.). A.A. Balkema Publishers, Old Post Road, Brookfield, VT 05036-9704, www.balkema.nl, balkema@balkema.nl, 802-276-3837 fax, 31-10-4135947). $48.00, 128 pp, 90 color photos.

N.M. NAYAR and T.A. MORE. 1998. **Cucurbits.** (ISBN 1-57808-003-7, hbk.). Science Publishers, Inc., P.O. Box 699, May Street, Enfield, NH 03748, 603-632-7377, 603-632-5611 fax). $75.00, 340 pp.

EDWARD A. COPE. 2001. **Muenscher's Keys to Woody Plants: An Expanded Guide to Native and Cultivated Species.** (ISBN 0-8014-8702-1, pbk.). Cornell University Press, Sage House, 512 E. State Street, Ithaca, NY 14850). $22.95, 377 pp.

PAT HALLIDAY. 2001. **The Illustrated Rhododendron: Their Classification Portrayed Through the Artwork of Curtis's Botanical Magazine.** (ISBN 0-88192-510-1, hbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $69.95, 268 pp., illustrations, color.

ROBERT H. MOHLENBROCK. 2001. **The Illustrated Flora of Illinois. Grasses. Panicum to Danthonia, Second Edition.** (ISBN 0-8093-2360-5, hbk.). Southern Illinois University Press, P.O. Box 3697, Carbondale, IL 62902-3697, danseit@siu.edu, 618-459-6633, 618-453-1221 fax). $50.00, 455 pp, 306 line drawings, maps.

ROBERT H. MOHLENBROCK. 2001. **The Illustrated Flora of Illinois. Sedges. Cyperus to Scleria, Second Edition.** (ISBN 0-8093-2358-3, hbk.). Southern Illinois University Press, P.O. Box 3697, Carbondale, IL 62902-3697, danseit@siu.edu, 618-459-6633, 618-453-1221 fax). $59.95, 223 pp, 128 line drawings, maps.

ROBERT H. MOHLENBROCK. 2001. **The Illustrated Flora of Illinois. Pokeweeds, Four-O-Clocks, Carpetweeds, Cacti, Purslanes, Goosefoots, Pigweeds, and Pinks.** (ISBN 0-8093-2380-x, hbk.). Southern Illinois University Press, P.O. Box 3697, Carbondale, IL 62902-3697, danseit@siu.edu, 618-459-6633, 618-453-1221 fax). $39.95, 277 pp, 139 line drawings, maps.

DONALD WATTS. 2000. **Elsevier's Dictionary of Plant Names and Their Origin.** (ISBN 0-444-50356-0, hbk.). Elsevier Science, P.O. Box 211, 1000 AE Amsterdam, The NETHERLANDS) (North American orders: Elsevier Science Inc., P.O. Box 945, Madison Square Station, New York, NY 10160-0757, www.elsevier.com, 31-20-485-2603, 20-485-3533 fax). $209.00, euro 181.51, NLG 400, 1032 pp.

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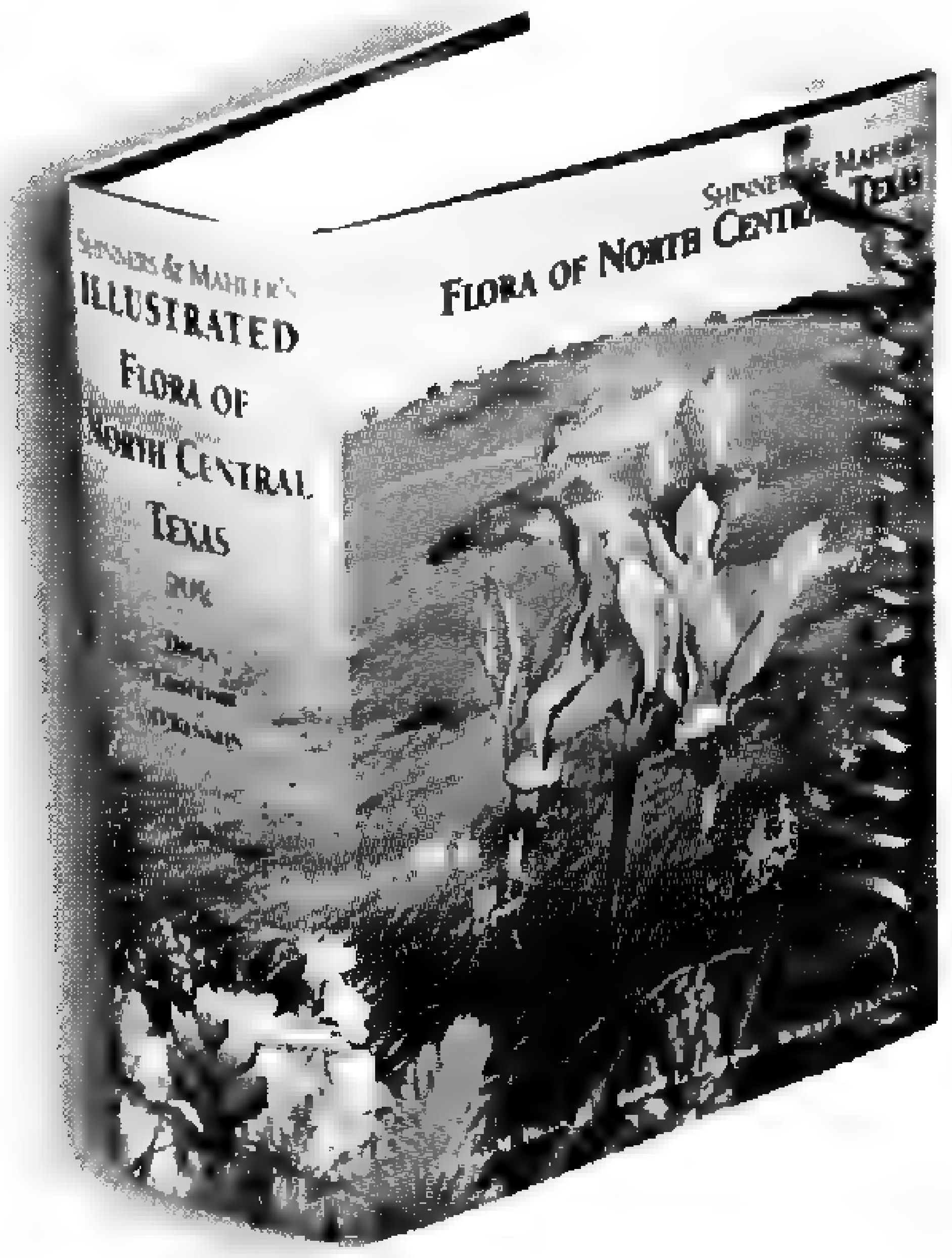

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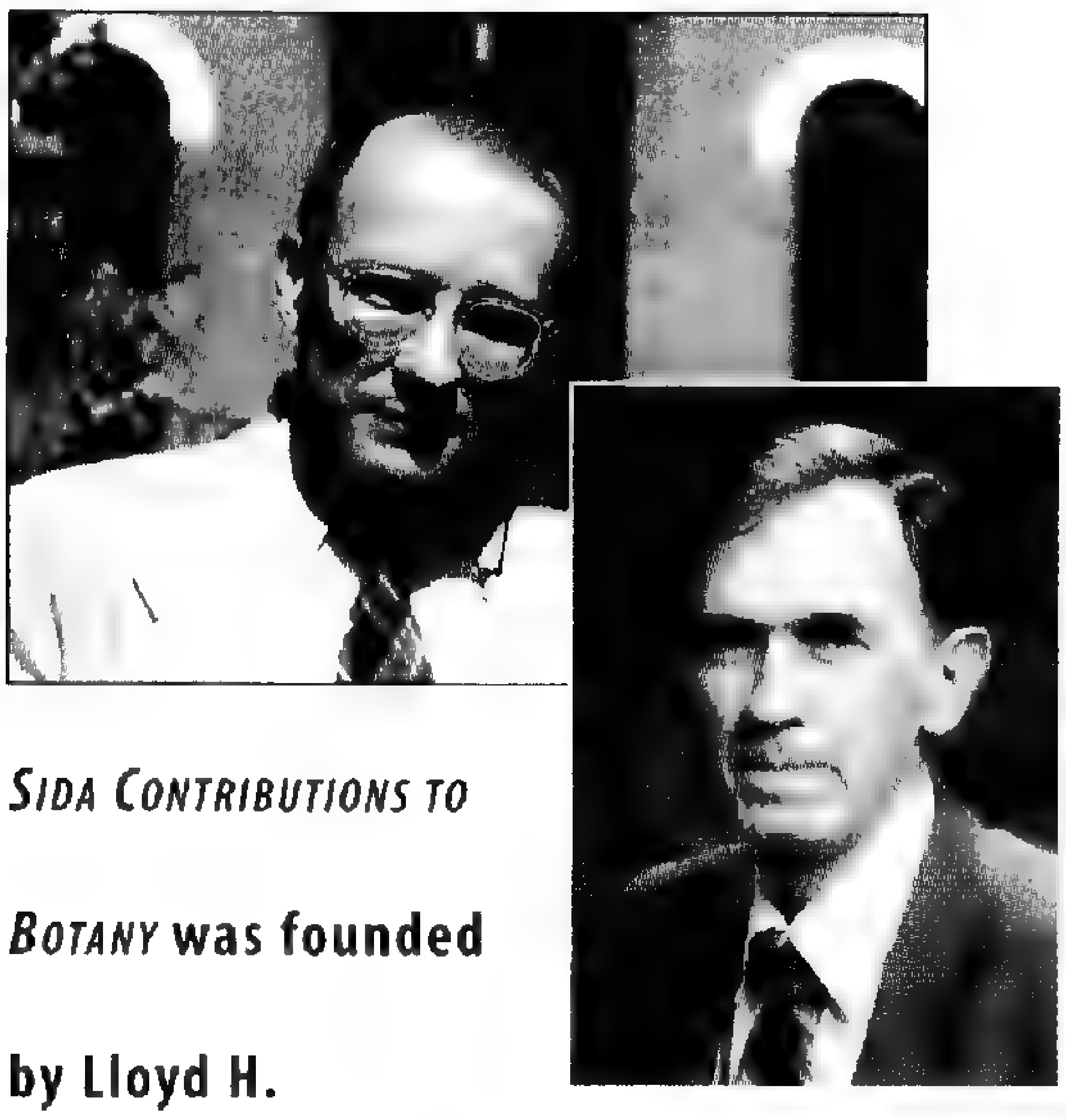

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Barney L. Lipscomb, Editor

Botanical Research Institute of Texas

509 Pecan Street

Fort Worth, Texas 76102-4060, USA

817 332-4441 / 817 332-4112 FAX

Electronic mail: sida@brit.org

Home page at the URL: http://www.brit.org/sida/

John W. Thieret, Associate Editor

Dept. of Biological Sciences

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Universidad de León

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TWO NEW SPECIES OF *LIATRIS* SERIES *PUNCTATAE* (ASTERACEAE: EUPATORIEAE) CENTERED IN NORTH CENTRAL TEXAS

G.L. Nesom and R.J. O'Kennon

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, TX 76102-4060, U.S.A.

ABSTRACT

Liatris aestivalis, sp. nov., is recognized from Texas and Oklahoma as a species separate from *L. mucronata* DC. and *L. punctata* Hook., although it has been synonymized with both of the latter as *L. angustifolia* (Bush) Gaiser. The type of *L. angustifolia* is a plant best identified as *L. mucronata*, perhaps showing some influence of hybridization with *L. aestivalis*. *Liatris aestivalis* produces subglobose corms and has mostly been identified as *L. mucronata* but differs from it in foliar and capitular features as well as phenology. The new species is known from 16 counties primarily along a north-south band from central counties of Texas into south-central Oklahoma; it is sympatric with *L. mucronata* and the two sometimes grow in close association, but they are completely separated to barely overlapping in flowering period. Putative intermediates are identified from several counties in the region of their distributional overlap. **Liatris glandulosa**, sp. nov., has been collected from five localities in Dallas County but is known to be extant at only a single site there; it also has been collected in three other Texas counties southward. It is similar to *L. aestivalis* in its subglobose corms and narrowly triangular, weakly graduate phyllaries but differs from all species of the genus in its vestiture of stipitate-glandular hairs. *Liatris glandulosa* also is early-flowering, nearly completely separated in phenology from *L. mucronata*, which grows in close sympatry at the Dallas County site. A description, illustration, distribution map, and key contrast with *L. mucronata* are provided here for each of the new species.

RESUMEN

Liatris aestivalis, sp. nov., se reconoce de Texas y Oklahoma como una especie separada de *L. mucronata* DC. y *L. punctata* Hook., aunque ha sido sinonimizada con estas dos últimas como *L. angustifolia* (Bush) Gaiser. El tipo de *L. angustifolia* es una planta que debe identificarse como *L. mucronata*, quizás muestre algo de influencia de hibridación con *L. aestivalis*. *Liatris aestivalis* produce bulbos subglobosos y ha sido identificada la mayoría de las veces como *L. mucronata* pero difiere de ella por las características foliares y del capítulo así como en la fenología. La nueva especie se conoce de 16 condados situados a lo largo de una banda norte-sur desde los condados centrales de Texas hasta el sur-centro de Oklahoma; es simpátrica con *L. mucronata* y ambas viven a menudo en íntima asociación, pero están completamente separadas o sólo ligeramente solapadas en el periodo de floración. Se han identificado intermedios putativos en varios condados de la región donde su distribución se solapa. ***Liatris glandulosa***, sp. nov., ha sido colectada de cinco localidades en el condado de Dallas pero se sabe que sólo permanece allí en una única localidad; también ha sido colectada en otros tres condados de Texas hacia el sur. Es similar a *L. aestivalis* por sus bulbos subglobosos, filarios débilmente atenuados y estrechamente triangulares pero difiere de todas las especies del género por su indumento de pelos estipitado-glandulares. *Liatris glandulosa* también florece antes, casi completamente separada en su fenología de *L. mucronata*, que crece en fuerte simpatría en la localidad del condado de Dallas. Se ofrecen aquí una descripción, una ilustración, mapa de distribución, y una clave que contrasta *L. mucronata* con las nuevas especies.

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Field evidence and review of herbarium collections have revealed the presence of two previously undescribed species of *Liatris*, both of which are geographically centered in north central Texas. For the first, field observations led to re-evaluation of species definitions in the field and herbarium. For the second, review of earlier herbarium collections led to recognition of a distinctive species and field confirmation that it is still extant.

Contemporary botanists in north central Texas have observed the occurrence of early-flowering plants similar to *Liatris mucronata* DC. but distinct from it. Gaiser (1946, 1950) recognized these 'non-*mucronata*' plants as *L. angustifolia* (Bush) Gaiser, but her morphological and geographic definition of the taxon was diffuse. In contrast, *L. angustifolia* was treated by Shinners (1951), Menhusen (1963), and in the Flora of Texas (Correll & Johnston 1970) as a synonym of *L. mucronata* and in a survey of the Oklahoma flora (Waterfall 1969) as a synonym of *L. punctata* var. *nebraskensis* Gaiser. The name *L. angustifolia* has been sporadically applied by original identification and annotation to a few of the collections cited in the present manuscript, but the name never gained currency as representative of a valid species. In other recent floras and checklists of Texas and Oklahoma (Hatch et al. 1990; Johnston 1990; Taylor & Taylor 1994; Jones et al. 1997; Diggs et al. 1999), these plants are identified as *L. mucronata* and *L. angustifolia* has not been included even as a synonym. Kartesz (1999) treated *L. angustifolia* as a synonym of *L. densispicata* (Bush) Gaiser 'var. *interrupta* Gaiser' (the correct disposition of 'var. *interrupta*' is as *L. mucronata* var. *interrupta* Gaiser).

With the benefit of field observations of phenologically distinct entities around Fort Worth and other north central Texas localities, we sorted collections of *Liatris mucronata* sensu lato from BAYLU, SMU/BRIT, TEX/LL, MO, OKL, and OKLA—arriving at a reasonable definition of two morphological groups, with a third group of possible intermediates. We examined types of taxa that held the possibility of representing the generally unrecognized (or diffusely recognized) entity from north central Texas and found that a name has not been correctly applied to it. In this report we provide a name for the species as well as means of identification and documentation of its geographical extent.

Liatris aestivalis Nesom & O'Kennon, sp. nov. (**Figs. 1, 2, 6**). TYPE: U.S.A. TEXAS. TARRANT CO.: W side of city of Fort Worth, undeveloped area (advertised for sale) with rock outcrops near corner of Green Oaks Drive and Genoa Road, NE corner of Ridgmar Mall area, shallow soil over Glen Rose (Cretaceous) limestone; major associates *Yucca pallida, Silphium albiflorum, Hedyotis nigricans, Ceanothus herbaceus, Sorghastrum nutans, Schizachyrium scoparium, Polygala alba, Salvia texana, Stenosiphon linifolius, Grindelia lanceolata* var. *texana, Phyllanthus polygonoides, Paronychia virginica, Oenothera macrocarpa, Vernonia lindheimeri, Scutellaria wrightii, Dalea hallii*, with *Liatris mucronata* common but generally in deeper soil, still in early bud; *Liatris aestivalis* abundant on flats and exposed slopes with little competition, plants in early to mid-flower, 8 Jul 2001, *Guy L. Nesom FW15, Robert J. O'Kennon, and George M. Diggs* (HOLOTYPE: BRIT; ISOTYPES: BAYLU, COLO, F, FLAS, GA, GH,

ISC, KANU, KSC, MIN, MO, NCU, NLU, NY, OKL, RM, SBSC, TAES, TENN, TEX, UARK, UC, UNM, US—to be distributed).

Differt a *L. mucronata* DC. foliis inferis longioribus, phyllariis angustioribus paucioribus leniter 2–3-seriatis, et florescentia praecici.

Plants 20–65 cm tall (avg. ca. 30 cm), with 1–2(–5) erect stems arising from a globose or subglobose corm 13–30 mm in diameter; stems, leaves, and phyllaries densely punctate with imbedded, clear-resinous glands, otherwise mostly glabrous. *Leaves* crowded, spreading-ascending, 0.6–2.5 mm wide, the lower 7–15 cm long, shortened upward, usually ca. 1/3 as long at midstem and half as wide, usually reduced to short, spreading bracts in the lowermost part of the capitulescence, margins smooth to minutely papillate or sparsely short-ciliate, the narrower not punctate, the broader inconspicuously punctate, otherwise glabrous. *Capitulescence* 4–15 cm long, ca. 13–30 mm wide, capitula densely arranged, upper cauline leaves sometimes continuing upward as capitular bracts not wider than the capitulescence. *Capitula* turbinate-cylindric, 9–12 long, 3.5–5 wide; phyllaries 6–11 per head, in 2–3 series weakly graduate in length, the outermost ca. 1/2–2/3 the length of the inner, inner 11–12 mm long, oblong-lanceolate to lanceolate-triangular, acute to acute-attenuate at the apex, not abruptly mucronate or cuspidate but sometimes with a long, narrow tip, commonly becoming dark purple in anthesis, glabrous or the outer sparsely ciliate. *Florets* 3–4(–5) per head; corollas pink-purple, sessile-glandular, 6–10 mm long, tube 4–7 mm long, glabrate within, lobes lanceolate, 1.5–3 mm long; filaments sparsely puberulent-pilose. *Cypselae* 4.5–6 mm long, oblong-oblanceolate in outline, compressed to distinctly 3-angled, with 9–11 longitudinal nerves, densely hairy on nerves and interstices with duplex hairs (0.2–)0.4–0.6 mm long, sometimes minutely sessile-glandular; pappus of plumose bristles 5.5–8 mm long, ca. equal the corolla length. Chromosome number unknown.

Etymology.—The epithet alludes to the summer flowering of the species, a distinctive feature compared to *L. mucronata.*

Additional collections examined: U.S.A. **OKLAHOMA**. **Atoka Co.:** 3.0 mi N of Caddo, rocky hillside, 11 Jul 1967, *Johnson 172* (OKL). **Bryan Co.:** 2 mi W, 1.5 mi N of Matoy, pine-oak woods, 23 Jul 1962, *C. & J. Taylor 916* (OKL). **Johnston Co.:** 2.5 mi W and 1 mi N of Mannsville, on Baum Limestone outcrop, Jun 1960, *Taylor s.n.* (OKL). **Love Co.:** 6.5 mi NE of jct OK 77 on OK 32 (ca. 8 mi E of Marietta), limestone outcrop, eroded sandy slope, post oak-juniper woods, 270 m elev., 14 Aug 1979, *Wagner and Solomon 4070* (MO-2 sheets). **Marshall Co.:** 1 mi SE of Madill, prairie, 21 Jul 1959, *Goodman 6921* (OKL, SMU). **Murray Co.:** open prairie near Sulphur, 5 Aug 1939, *Broadbent 598* (OKL); Platt National Park, Cold Spring, near Sulphur, 20 Jun 1935 [early flower], *Merrill 703* (MO); Platt National Park, Flower Park, near Sulphur, 30 Sep 1935 [past flower], *Merrill 1535* (MO). **TEXAS**. **Anderson Co.:** ca. 350 m S of jct Co. Road 425 on Co. Road 2202, N 31.73987, W 95.73025, limestone outcrop, 2 Jun 1999, *Holmes 10140* (BAYLU)—*L. mucronata* collected at the same site on 25 Oct 1997, *Singhurst 6132a* (BAYLU). **Cooke Co.:** near Tyler Bluff, W edge of county, blackland prairies, 2 Jul 1946, *Correll and Correll 12961* (SMU); NE side of St. Jo, Co. Road 414—Brushy Mound Road, W of FM 2382, calcareous soil, 7 Aug 1995, *Lusk s.n.* (BRIT); Don Vogel Ranch (Elm Fork of the Trinity River), Co. Road 302, 2 mi E of Montague Co. line, 13 Aug 1995, *Lusk s.n.* (BRIT); **Cooke Co.:** County Road 343 0.5 mi S of FM 1630, Freemound

Community, growing in close proximity to *L. mucronata* (also see 22 Jul collection of putative intermediate *L. mucronata* × *L. aestivalis* made from nearby locality), 14 Jul 2001, *Lusk s.n.* (BRIT); 3 mi S of Era on FM 51, ranch of J. David Thomas, M.D., 16 Jul 2001, *Lusk s.n.* (BRIT); Marysville Community, 1.1 mi S of Co. Road 408 on E side of Co. Road 417 (0.7 mi S of N. Fish Creek bridge), 2 Aug 2001, *Lusk s.n.* (BRIT). **Coryell Co.:** 5 mi W of Gatesville, prairie, 23 Aug 1945, *Muller 8732* (LL, MIN, SMU). **Denton Co.:** 15.5 mi W of Denton, gravelly (limestone) shoulder above stream, 9 Oct 1949 [end of fruiting], *Shinners 11892* (SMU); between Sanger and Denton on I-35, along service road, 0.7 mi N of FM 3163 (Milam Road), *L. mucronata* growing nearby, (locality found by Jeff Quayle), 17 Jul 2001, *Lusk s.n.* (BRIT). **Hays Co.:** 2 mi SE of Wimberly, across road from entrance to Hidden Valley Ranch, common locally on shallow limestone slopes, 30 Aug 1948 [very end of flowering], *Johnson 383* (TEX). **Montague Co.:** Hugh Garnett Ranch, ca. 4 mi SW of Dye Mound on FM 3206, 7 Aug 1995, *Lusk s.n.* (BRIT); Don Vogel's Hardy Ranch, FM 1630 at FM 677, in Hardy community, SE corner of the county, *L. squarrosa* growing nearby, 14 Jul 2001, *Lusk s.n.* (BRIT); Don Vogel's Littlefield Ranch, Littlefield Road at Gladys Community, E of FM 677, growing with *L. squarrosa*, 14 Jul 2001, *Lusk s.n.* (BRIT); Jane D. Lucas Ranch, FM Road 677, 5 mi S of jct with US Hwy 82 in center of Saint Jo, 14 Jul 2001, *Lusk s.n.* (BRIT); Garnett property, ca. 4 mi S of Dye Mound on Dye Mound Road, ca. 8 air mi SW of Saint Jo, sandy soil over limestone, *L. aestivalis* in early flower and common on rocky slopes, *L. mucronata* abundant but none yet in flower, 10 Jul 2001, *Nesom FW16* with Garnett, Lusk, Miller, O'Kennon, and Quayle (BRIT, TEX); Nored Road, between Farm Road 455 and Dye Mound Road, ca. 11 air mi SSW of Saint Jo, hillside along road, exposed limestone and shallow sandy soil, *L. aestivalis* abundant, in early flower, 10 Jul 2001, *Nesom FW39* with Garnett, Lusk, Miller, O'Kennon, and Quayle (BRIT); site of old Dye Community, Farm Road 3206 at jct with Dye Mound Road, ca. 7 mi SW of Saint Jo on FR 3206; steep, eroding limestone slopes, *L. aestivalis* in early flower and abundant on open slopes, *L. mucronata* common, not yet in flower, 10 Jul 2001, *Nesom FW44* with Garnett, Lusk, Miller, O'Kennon, and Quayle (BRIT, TEX); Clear Creek Loop (road), between Farm Road 3206 and 677, ca. 0.6 mi SSE of jct with Farm Road 3206, ca. 5 air mi S of Saint Jo, open roadside with exposed limestone outcrop and shallow soil, nearly clay-sand, steep slopes by side, *L. aestivalis* relatively common, barely into flower, 10 Jul 2001, *Nesom FW46* with Garnett, Lusk, Miller, O'Kennon, and Quayle (BRIT, KSC); Clear Creek Loop (road), between Farm Road 3206 and 677, ca. 1 mi SW of jct with Farm Road 677, ca. 2.5 air mi S of Saint Jo, open roadside with exposed limestone outcrop and shallow soil, *L. aestivalis* relatively common, barely into flower, 10 Jul 2001, *Nesom FW47* with Garnett, Lusk, Miller, O'Kennon, and Quayle (BRIT, TEX). **Parker Co.:** Ranch House Road 200 meters north of Vista Road near Lake Weatherford, deep sand, *L. mucronata* also in immediate area but not in flower, 6 Aug 2001, *O'Kennon 15007* and Jeff Quayle (BRIT, TEX). **Tarrant Co.:** [no other locality data], 1 Aug 1926, *Killian 6577* (LL); WSW part of city of Fort Worth, between Cumberland St. and Vickery Blvd, just N of Vickery, E of Ridglea Hills Elementary School, publicly owned land (Ridglea Hills Park), open area of limestone slopes, with scattered small trees, *L. mucronata* on upper slopes and not yet in flower, 12 Jul 2001, *Nesom FW48* and O'Kennon (BRIT, TEX); SW part of city of Fort Worth, N side of Winscott/Vickery Blvd., 0.7 mi NE of jct with Hwy 377, just N of jct Hwy 377 and IH 20, open relatively flat limestone outcrop on N side of road, alongside road at edge of public land (Z. Boaz South Park), 12 Jul 2001, *Nesom FW51* and O'Kennon (BRIT, KSC); SW part of city of Fort Worth, Lakeview Road just W of Benbrook Lake, 0.3–0.4 mi E of jct with Hwy 377, open limestone outcrop, gentle slope, this habitat relatively continous for ca. 0.3 mi eastward along Lakeview Road, *L. mucronata* abundant, long before flowering, 12 Jul 2001, *Nesom FW53* and O'Kennon (BRIT); W portion of City of Fort Worth, Westridge Drive ca. 2 blocks N of jct with Vickery Blvd., undeveloped lot with open, steep slopes of Glen Rose limestone outcrop and shallow silty soil, 22 Jul 2001, *Nesom FW55* (BAYLU, BRIT, KSC, TEX); Tandy Hills Municipal Park, ca. 2 air mi E of downtown Fort Worth, N of Hwy 30, limestone slopes with shallow to deeper soil on flats and slope bottoms, *L. mucronata* abundant on lower slopes in deeper soil but not yet in flower, 22 Jul 2001, *Nesom FW56* and O'Kennon (BRIT, KSC, OKL, TEX, US); Ft. Worth, 26 Jul 1929, *Whitehouse s.n.* (TEX). **Travis Co.:** rocky hillsides and summits around Austin, 1 Aug 1926, *Tharp s.n.* (SMU). **Wise Co.:** dry gravelly prairies on steep sandstone slopes, on E side of co. road E of Big Sandy Creek, ca. 4 air mi NE of Alvord and ca. 3.8 air mi ESE of Park Springs, Post Oak Ridge, LBJ Natl. Grassland, 850–930 ft, Antlers Sand Formation, 1 Aug 1989, *Orzell and Bridges 11265* (TEX); just N and W of Bald Knob Cemetery, ca. 1 air mi S of LBJ Natl. Grassland field headquarters, ca. 3.3 air mi ENE of Alvord and 10 air mi NNW of Decatur, Bald Knob Hill, LBJ Natl. Grassland, shallow soil limestone prairies/outcrops, 1100–1180 ft, 1 Aug 1989, *Orzell and Bridges 11287* (BRIT, TEX).

Gaiser (1946, p. 370) noted that "confusing intermediates" apparently are formed between *Liatris* "*angustifolia*" and *L. mucronata*, especially as "the centre of the range for both of these species lies in central Texas." A group of plants putatively intermediate between *L. aestivalis* and *L. mucronata* is recognized here: most of these plants have foliar features similar to *L. mucronata* and a large number of phyllaries ((11–)13–18) strongly graduate in length, like those of *L. mucronata*; the flowering period of these populations ranges from July through mid-October (the flowering dates of these collections are not included in Table 1). In contrast, these plants have relatively long phyllaries, at the upper range for *L. mucronata*, the inner with longer, more attenuate apices than typical for *L. mucronata*, more similar to those of *L. aestivalis*. The geographic coherence of the putative 'intermediates' (as cited below) suggests that they may have a similar evolutionary origin. As a tentative identification, these collections have been annotated as "*L. mucronata* possibly > *L. aestivalis*," although their distribution ranges somewhat outside of the known range of *L. aestivalis* (compare Figs. 5 and 6). The type of *L. angustifolia* (provenance uncertain, see comments below) is similar to plants of this group.

Nesom FW57 (intermediate, from Tandy Hills in Fort Worth) was flowering at the same time as typical *Liatris aestivalis* (*Nesom FW56*) at the same site but considerably before *L. mucronata* (*Nesom FW58*). At this locality, *L. mucronata* and the putative intermediate (easily distinguished in the field) grew in relatively deeper soil and were both more abundant than the typical *L. aestivalis*, which occurred only on a relatively small area of limestone outcrop. Only three major phenotypes were evident among the Tandy Hill plants—those putatively intermediate were obvious but evidence of introgression was not. *Lusk s.n.* (Cooke Co., Tex.) also was flowering at the same time as *L. aestivalis* at the same site (*Lusk s.n.*, above) but well before *L. mucronata* (not collected).

POSSIBLE INTERMEDIATES BETWEEN *L. AESTIVALIS* and *L. MUCRONATA*: **OKLAHOMA. Love Co.:** 8 mi E of Marietta, roadside cut W of Hickory Creek, 1 Aug 1958, *Goodman 6713* (OKL). **TEXAS. Bosque Co.:** Hwy 174, 3.6 mi SW of Walnut Springs, 25 Sep 1950, *Cory 58025* (SMU); **Clay Co.:** 5.2 mi E of Henrietta, Hwy 82, 6 Oct 1945, *Whitehouse 10848* (SMU). **Cooke Co.:** Cla Hamilton Freemound Ranch, 1.8 mi S of FM 1630, 0.8 mi E of gate on County Road 343, these plants apparently intermediate between *L. mucronata* (typical plants nearby) and *L. aestivalis*, 22 Jul 2001, *Lusk s.n.* (BRIT); J. & M. Tepera Ranch, Co. Rd. 414, 0.1 mi W of Brushy Mound Cemetery on S side, NE of Saint Jo, 28 Jul 2001, *Lusk s.n.* (BRIT). **Dallas Co.:** S side of Tenison Park, 9 Sep 1950, *Cory 57909* (SMU); Dallas, 10 Jul 1925, *Hynes s.n.* (TEX); off Northwest Highway, E of Vickery, 7 Sep 1940, *Longnecker 79* (SMU). **Fannin Co.:** ca. 3 mi SE of Bonham, among grasses in open, scrub oak-cedar hills of Bonham State Park, 16 Sep

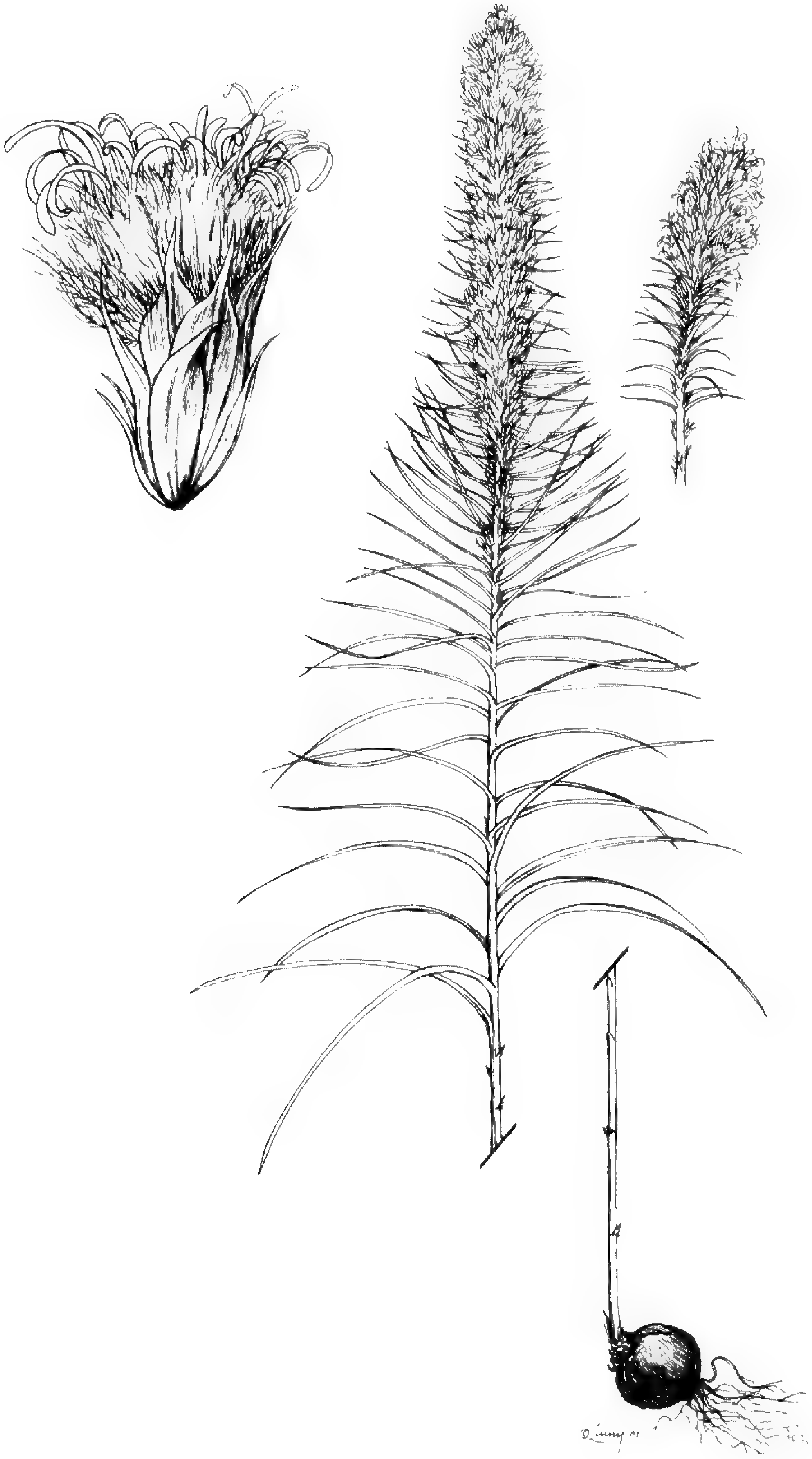


FIG. 1. Habit and details of *Liatris aestivalis* (from the type collection).

FIG. 2. Habit and details of *Liatris aestivalis*.

1960, *Correll 23498* (LL). **Grayson Co.:** 6 mi SE of center of Sherman, remnant prairie vegetation, Chamberlain's Ridge substation, 23 Sep 1993, *Nee 43947* (MO). **Hood Co.:** Hwy 171, 2.8 mi NW of Cresson, 30 Sep 1950, *Cory 58481* (SMU). **Montague Co.:** 10 mi E of St. Joe, 3 Oct 1975, *Lipscomb 554* (SMU). **Navarro Co.:** 15.7 mi SE of Corsicana on Hwy 75, 2 Oct 1949, *Shinners 11809* (SMU). **Tarrant Co.:** 3 mi W of Ft. Worth, 23 Sep 1936, *McCart s.n.* (SMU); Tandy Hills Municipal Park, ca. 2 air mi E of downtown Fort Worth, N side of Hwy 30, limestone slopes with shallow to deeper soil on flats and slope bottoms, 22 Jul 2001, *Nesom FW57* with O'Kennon (BRIT, KSC, OKL, TEX, US); dry, stony ground, 2 Sep 1929, *Ruth 78* (SMU); SE of Fort Worth near Village Creek, 4 Oct 1946, *Whitehouse 17295* (SMU).

Taxa of Series Punctatae

The taxa involved in the present study are members of sect. *Liatris* series *Punctatae* Gaiser (1946), which is characterized by relatively few-flowered capitula, phyllaries with non-petaloid tips, and a plumose pappus. Of the five species recognized by Gaiser in series *Punctatae*, *L. punctata* Hook. and *L. densispicata* (Bush) Gaiser are distinct in their elongate rootstock-like corms (vs. globose to subglobose corms). *Liatris densispicata* was regarded by Gaiser as endemic to Minnesota; it has more recently been treated as a synonym of *L. punctata* (Ownbey & Morley 1991). *Liatris bracteata* Gaiser is a Texas endemic distinct in its large, many-flowered (10–14 florets) capitula on relatively long peduncles. *Liatris mucronata*, *L. aestivalis*, and the second new species (described below) are similar in their relatively few-flowered capitula and globose to subglobose corms.

Infraspecific variants have been described in both *Liatris mucronata* and *L. punctata*, but in most of Texas and Oklahoma *L. mucronata* is closely similar to *L. punctata*, except for the difference in corm morphology. They intergrade in parts of their range, as noted by Gaiser (1946) and Menhusen (1963). Fig. 5 (present manuscript) maps *L. mucronata* as well as *L. punctata* and indicates that they have a nearly contiguous range in Texas. Plants with intermediate morphology are relatively common along the zone where their ranges meet. In Texas, the morphological difference between *L. aestivalis* and *L. mucronata* is easier to ascertain than than of *L. punctata* and *L. mucronata*, since the critical features of distinction are not underground parts. Within series *Punctatae*, we focus on comparisons of *L. aestivalis* with *L. mucronata* because of their similarity in corm morphology and their recent conceptual confusion.

Distinction of Liatris aestivalis

The original circumscription of *Liatris* (*Lacinaria*) *angustifolia* by Bush is not adequate to distinguish it from *L. mucronata* and the specimens of *L. angustifolia* cited by him include collections of *L. mucronata*. In Gaiser's morphological description of *L. angustifolia*, she fairly clearly was observing the core of the same taxon recognized here as *L. aestivalis*, but she also cited various out-of-range Texas collections (here regarded as *L. mucronata*), apparently including plants with atypically long but otherwise *mucronata*-type phyllaries.

Also among Gaiser's citations for *Liatris angustifolia* are collections from southern Missouri, eastern Kansas, and Nebraska. Our examination of collections from these states, as well as northern Arkansas, confirms their similarity to *L. aestivalis*, but this 'northern segment' is distinct in a number of features (mostly 'gigas' compared to *L. aestivalis*) and geographically disjunct. While evidence for the distinction of *L. mucronata* and *L. aestivalis* in Texas and Oklahoma is clear, variation patterns in the overall range of both *L. mucronata* and *L. punctata* need to be restudied.

Morphological differences between *Liatris aestivalis* and *L. mucronata* are conspicuous in features of the capitula. The long lower cauline leaves, abruptly reduced upward, also provide a useful feature of differentiation. Plants of *L. aestivalis* also are generally shorter, thinner-stemmed, and have smaller corms producing a smaller number of stems, but these differences are hard to quantify on the basis of herbarium specimens, as collectors avoid the larger difficult-to-press plants.

The flowering period of *L. aestivalis* is earlier than that of *L. mucronata* (Table 1). At most localities, the two apparently are complete separate in flowering period—if overlap occurs, it is only for a short time around the end of August. In fact, the flowering period of a given population appears to be a fairly reliable indicator of its identity (*L. aestivalis* vs. *L. mucronata*). As identified here, *L. aestivalis* also has a relatively discrete geographic distribution (Fig. 6), although it is imbedded within that of *L. mucronata*. Details of morphological and phenological differences between the two taxa are given in the following couplet.

1. Lower cauline leaves usually 2–3.5 times longer than the midcauline and 1.5–2 times wider; phyllaries 6–11 per head, in 2–3 series weakly graduate in length, the outermost ca. 1/2–2/3 the length of the inner, inner 11–12 mm long, oblong-lanceolate to lanceolate-triangular, acute to acute-attenuate at the apex, not mucronate or cuspidate but sometimes with a long, narrow tip, lateral veins usually evident above the middle and continuing to nearly the apex; florets 3–4(–5) per head; flowering mostly mid-July through mid-August ______ **Liatris aestivalis**
1. Lower cauline leaves similar to the midcauline in length and width; phyllaries 11–15(–18) per head, in (4–)5–6 series strongly graduate in length, the outermost 1/3–1/5 the length of the inner, inner 7 9 mm long (12 mm in putative intermediates), mostly oblong-obovate and obtuse to abruptly truncate-rounded at the apex, tipped by a thick, often spinulose mucro or cusp, lateral veins usually not evident above the middle or at least on the distal third; florets (3–)4–5(–6) per head; flowering mostly mid-September through mid-October ______ **Liatris mucronata**

Habitat and plant associates

Populations of *Liatris aestivalis* in Tarrant County apparently are restricted to sites with shallow soil over outcrops of Glen Rose Limestone, on slopes or on flatter areas at the slope bases. The exposed limestone at other *L. aestivalis* sites in Texas and Oklahoma is closely similar in origin and characteristics to the Glen Rose formation. The species apparently is true to such sites, except for the

Parker County plants (*O'Kennon 15007*), which grow in deep sand. The latter, however, are otherwise inseparable from typical *L. aestivalis*, which also grew in a typical habitat about 50 feet away. Corms of the new species tend to be shallow (1–5 cm below the surface, or even partly exposed) in relatively loose soil, but some occur in rockier substrate.

Associated plant species at these limestone outcrops in Tarrant County are remarkably predictable: *Artemisia ludoviciana* var. *mexicana*, *Ceanothus herbaceus*, *Chamaesyce fendleri*, *Dalea hallii*, *Dyssodiopsis tagetoides*, *Echinacea angustifolia*, *Eryngium leavenworthii*, *Grindelia lanceolata* var. *texana*, *Hedyotis nigricans*, *Heliotropium tenellum*, *Marshallia caespitosa*, *Opuntia humifusa*, *Paronychia virginica*, *Penstemon cobaea*, *Phyllanthus polygonoides*, *Polygala alba*, *Salvia texana*, *Schizachyrium scoparium*, *Scutellaria wrightii*, *Silphium albiflorum*, *Sorghastrum nutans*, *Stenosiphon linifolius*, *Styllingia texana*, *Thelesperma filifolium*, *Vernonia lindheimeri*, and *Yucca pallida*. In Tarrant County, *Yucca pallida* is a conspicuous and reliable predictor of the presence of *L. aestivalis*, although the *Liatris* is even more simply located by looking for exposed slopes with the white limestone. In Montague County, *Yucca arkansana* replaces *Y. pallida* as a conspicuous associate of *L. aestivalis* and other local variations in species composition are evident.

Liatris mucronata also occurs at most sites where we have found *L. aestivalis*, providing evidence that the two taxa are distinct. While there is overlap in microhabitat, *L. mucronata* occurs in deeper soil, compared to the rocky, shallow soil to which *L. aestivalis* is restricted. Presumably, the combination of phenological separation and distinction in microhabitat provides genetic isolation between the two taxa. The broader ecological range of *Liatris mucronata* corresponds with a geographic range wider than that of *L. aestivalis* (compare Figs. 5 and 6).

Chromosome numbers for taxa of series *Punctatae* have been reported by Gaiser (1950) and Menhusen (1963). Counts for *L. mucronata* (two populations—Comal and Nueces cos., Tex.) were diploid ($2n = 20$). Counts for "*L. angustifolia*" from eight localities were diploid; a single population of this taxon, from Wichita Co., Tex., was reported by Gaiser to have plants at diploid and tetraploid levels. It is not clear that sampling by Gaiser included plants identified here as *L. aestivalis*, and Menhusen did not include Texas plants in her study.

Types examined

Lacinaria angustifolia Bush, Amer. Midl. Naturalist 12:315. 1931. *Liatris angustifolia* (Bush) Gaiser, Rhodora 48:368. 1946. TYPE: TEXAS. "Cultivated specimen in green house from seed from Texas plants, TYPE, type locality unknown, sheet No. 211347" (as cited by Bush 1931, p. 315); the specimens label has "Cult. Green House fr. Texas," (HOLOTYPE: MIN!). Date of greenhouse collection not indicated

Gaiser (1946, p. 369) gave the type locality of *Lacinaria angustifolia* with more precision—"Tarrant Co.: dry soil, Fort Worth, Sept. 5, 1912, *A. Ruth 78* (M, 211347)," but in this she apparently took label data from some other specimen giving the collection number as "*Ruth 78*," perhaps even confusing it with the type of *Lacinaria ruthii* (see below). Ruth, however, used the number "78" on labels of *Liatris* of various collections from different localities and different dates, although all of them apparently were made from Tarrant County or nearby localities. Bush received specimens from Albert Ruth for use in his study, but if Ruth collected the seeds from which the type of *L. angustifolia* was grown, it is curious that Bush was not able to provide more precise collection data.

This plant is similar to those cited above as perhaps indicating gene flow between *Liatris aestivalis* and *L. mucronata*. As in *L. mucronata*, it has leaves nearly equal in length and width from base to midstem, and the 15 phyllaries are strongly graduate in length, forming a distinctly cylindric involucre, and with densely ciliate margins. The phyllaries, however, are more elongate than typical for *L. mucronata* and the apices vary from obtuse-mucronate to ovate-lanceolate. We have annotated this collection as "*Liatris mucronata* perhaps with genetic influence of *L. aestivalis*."

Lacinaria leptostachya Bush, Amer. Midl. Naturalist 12:314. 1931. TYPE: TEXAS. TARRANT CO.: on poor, rocky, sterile ground, 10 Jun 1923, *A. Ruth 24* (HOLOTYPE: ISC!).

This was treated by Gaiser (1946) as a synonym of *Liatris mucronata*, and that identity is confirmed here. The collection is a single plant with six flowering stems from a globose corm. The capitulescence is narrow (hence the epithet) and the capitula have mostly three florets each, but the capitula have ca. 15 phyllaries and the shape and apex are similar to those of *L. mucronata*. Phyllaries are conspicuously tomentose on the lamina and have finely long-ciliate margins. The collection date is anomalous and probably is incorrect—the spikes are in full flower or slightly past (no unopened florets remaining)—a flowering date anytime in June is considerably earlier than any known collection of *L. mucronata* and most collections of *L. aestivalis* (see Table 1).

Lacinaria ruthii Bush, Amer. Midl. Naturalist 12:316. 1931 (non *Lacinaria ruthii* Alexander 1933 = *Liatris squarrulosa* Michx.). TYPE: TEXAS. TARRANT CO.: Polytechnic, 5 Sep 1912, *A. Ruth 78* (HOLOTYPE: MIN!).

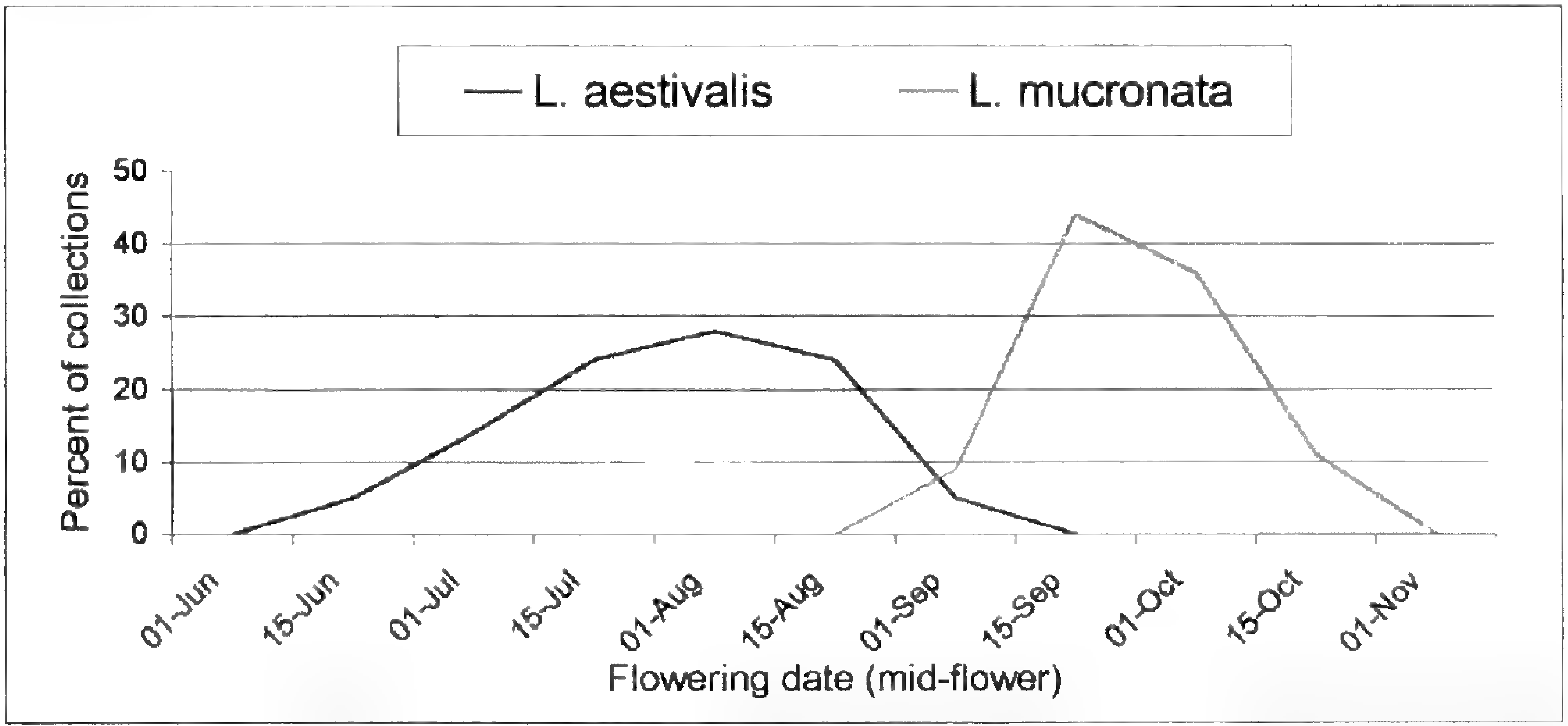
This was regarded by Gaiser (1946, p. 370) to be among intermediates between *L. angustifolia* and *L. mucronata*, but the type specimen belongs with nearly typical *L. mucronata*. Flowering in early September is early for *L. mucronata*, late for *L. aestivalis*, but all morphological features of this plant are *L. mucronata*: phyllaries 18 in number, strongly graduate in length, with an abruptly rounded, cuspidate apex, lightly tomentose on the surface, with ciliate margins; florets 4 per head.

A STIPITATE-GLANDULAR SPECIES OF *LIATRIS*

In examination of collections identified as *Liatris mucronata*, a small set of plants with stipitate-glandular vestiture was separated. These collections were

TABLE 1. Flowering phenology of plants of *Liatris aestivalis* and *L. mucronata* in Texas and southern Oklahoma. Lower tabular data show number of collections scored at mid-flower for each date (*L. aestivalis*: 21 total collections; *L. mucronata*: 136 total collections; for each collection scored, an estimate was made of when the plant/plants was/were in mid-flower). Upper tabular data show percentage of the total number of collections scored at mid-flower. Graph show species compared by the percentage of the total number of collections scored at mid-flower. At most sites where the two species co-occur, overlap in flowering apparently occurs rarely or not at all.

	01-Jun	15-Jun	01-Jul	15-Jul	01-Aug	15-Aug	01-Sep	15-Sep	01-Oct	15-Oct	01-Nov
L. aestivalis	0	5	14	24	28	24	5	0			
L. mucronata						0	9	44	36	11	0



	01-Jun	15-Jun	01-Jul	15-Jul	01-Aug	15-Aug	01-Sep	15-Sep	01-Oct	15-Oct	01-Nov
L. aestivalis	0	1	3	5	6	5	1	0			
L. mucronata						0	12	60	49	15	0

made in the 1930s and early 1940s from within Dallas County, before dense residential, commercial, and transportation development covered most of the natural habitat. A collection of this entity was made in 1936 by L.O. Gaiser, who also obtained chromosome counts from five plants of the population, and the SMU sheets were examined by Cory and Shinners, but none of these researchers apparently found taxonomic significance in the distinctive features of these plants. In the present perspective, however, the vestiture of these plants is unique in the genus, and other features set it apart from *L. mucronata*. The discovery of a large, multi-segmented population in a nature preserve, growing sympatrically with *L. mucronata* but obviously distinct from it in morphology and phenology, allows us unhesitatingly to describe it at specific rank.

Liatris glandulosa Nesom & O'Kennon, sp. nov. (**Figs. 3, 4, 6**). TYPE: U.S.A. TEXAS. Dallas Co.: City of Garland, Dallas metro area, ca. 16 air mi NW of downtown Dallas, Spring Creek Forest Preserve, between Interstate Hwy 190 and Arapaho Road, vicinity of Holford Road, natural habitats on open relatively flat, limestone outcrops (Austin Chalk formation) and also on quarry fill, 21 Jul 2001, *Guy L. Nesom FW62 with Robert J. O'Kennon and Thomas M. Frey* (HOLOTYPE: BRIT; ISOTYPES: GH, KSC, MO, NY, OKL, TEX, US—to be distributed).

Differt a *L. mucronata* DC. vestimento stipitato-glanduloso, foliis latioribus laxioribus, phyllariis paucioribus leniter 3–4-seriatis, et florescentia praecici.

Plants 3–6 cm tall with 1–2(–4) erect stems arising from a subglobose to depressed-globose corm 2–4 cm in diameter; stems, leaves, and phyllaries densely punctate with imbedded, clear-resinous glands, stems and leaves also densely stipitate-glandular with trichomes 0.1–0.2(–0.3) mm high, the whole plant sticky to the touch, very sparsely arachnoid, especially along the margins. *Leaves* crowded, spreading-ascending or the lower slightly deflexed, rigid to lax, the lower 6–11 cm long, 1.5–4(–4.5) mm wide, usually 1/2–1/3 as long at midstem and ca. 1/2 as wide, usually reduced to short, spreading bracts in the lower part of the capitulescence. *Capitulescence* 8–18(–28) cm long, mostly 1.5–2.5 cm wide, of densely arranged capitula. *Capitula* turbinate-cylindric, 8–12 mm long, 3–5 mm wide; phyllaries 7–10(–12) per head, in 3–4 series weakly graduate in length, the outermost 1/2–2/3 the length of the inner, inner 9–11(–12) mm long, oblong-lanceolate to lanceolate-triangular, broadly to narrowly acute or acuminate at the apex, sometimes with an indurate mucro, green, rarely becoming purplish, very densely glandular with a mixture of sessile-sunken glands and slightly elevated ones, margins narrowly hyaline below the apex. *Florets* 3–4(–5) per head; corollas pink-purple, punctate-glandular, 7–8 mm long, tube 4–5 mm long, glabrous to glabrate within, lobes linear-lanceolate, ca. 3 mm long; filaments puberulent-pilose. *Cypselae* 5–6 mm long, oblong-oblanceolate in outline, brown to nearly black, compressed to 3-angled, with 8–10 nerves, densely hairy on nerves and interstices with duplex hairs 0.2–0.6 mm long; pappus of plumose bristles 6–7.5 mm long, ca. equal the corolla length. Chromosome number, $2n = 20$ (Gaiser 1950).

Etymology.—The epithet alludes to the stipitate-glandular vestiture of the species, a distinctive feature compared to *L. mucronata* and all other species of the genus.

Additional collections examined: **TEXAS. Bosque Co.:** ca. 4 mi S of Clifton along Hwy 6, 1 Sep 1946, *Pudig and York 46334* (LL, MO); gravel road E of Tx Hwy 6 and ca. 2.5 NW of Clifton, N of Meridian Creek, dry, gravelly limestone hill, 800 ft, Comanche Peak limestone, community dominated by *Juniperus ashei-Quercus buckleyi*, 6 Aug 1989, *Orzell and Bridges 11401* (TEX). **Dallas Co.:** 11 mi W of Dallas on US Hwy 80, chalky limestone (Austin Chalk) at fault on road to Ft. Worth, voucher for chromosome count of $n = 10$, 27 Aug 1936, *Gaiser 122* (OKL); N of University Park, prairie, 2 Aug 1940, *Longnecker 6* (LL, SMU-2 sheets); [city of Dallas], off Hillcrest Road [in current vicinity of Southern Methodist University], on limestone outcrop, 21 Aug 1942, *Lundell 11561* (LL, SMU); Duncanville, Dallas metro area SW of downtown Dallas, junction of Clark Road and Camp Wisdom Road, ca. 2 acre lot on NE corner, currently advertised for sale, shallow, gravelly limestone soil, common species *Carduus nutans*, *Cirsium undulatum*, *Centaurea solstitialis*, *Mentzelia oligosperma*, *Diplotaxis muralis*, *Solidago altissima*, *Hedyotis nigricans*, ca. 10 plants of *Liatris glandulosa* in mid flower, 25 Jul 2001, *Nesom FW75* and O'Kennon (BAYLU, BRIT, COLO, GH, ISC, KSC, MIN, MO, NCU, NLU, NY, OKL, RM, TEX, TAES, UC, US); Coomb's Branch, 19 Aug [without year], *Reverchon s.n.* (MO). **McLennan Co.:** W of Hillcrest Hospital, limestone soil on creek bank, 9 Aug 1947, *Smith 1007* (TEX). **Travis Co.:** "pocket" in rocks on Bee Creek, 6 Sep 1901 [past flr, frting heads shattering], *Ferguson 451* (TEX).

We found plants of *Liatris glandulosa* in two Dallas County sites where collections had not been previously made. The Duncanville site is about 6 miles south

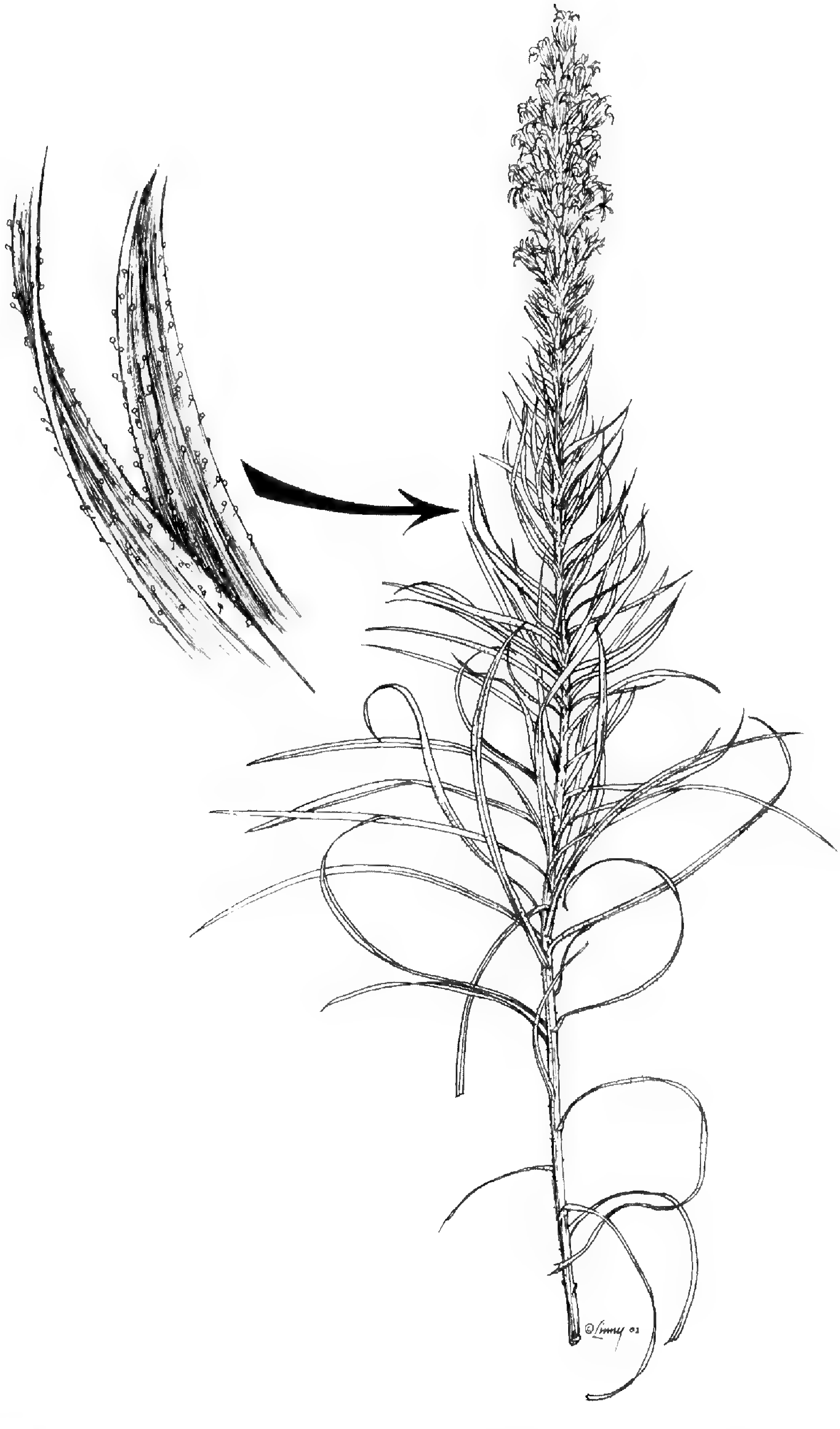


Fig. 3. Habit and details of *Liatris glandulosa* (from the type collection).

Fig. 4. Habit of *Liatris glandulosa*.

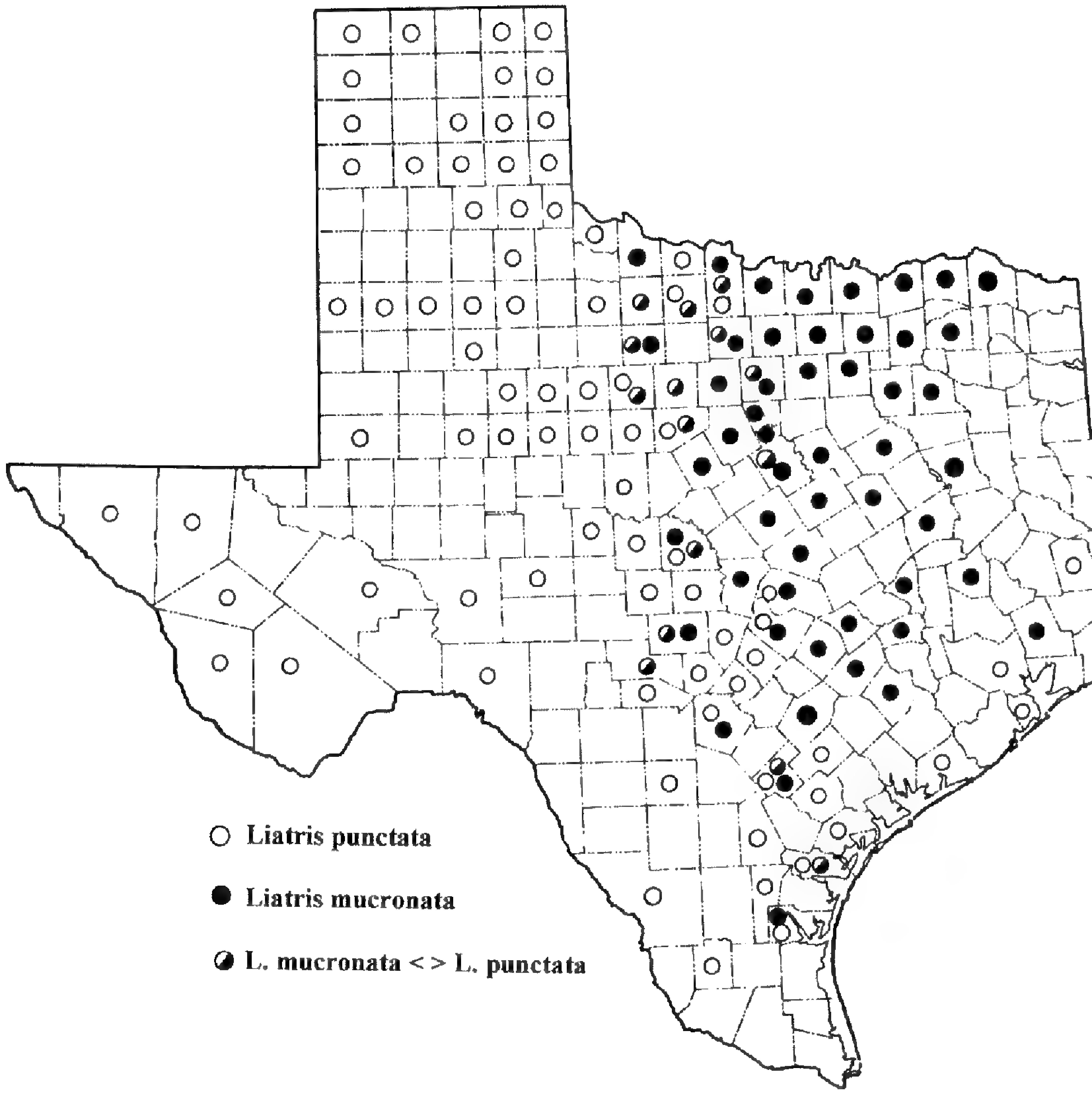


Fig. 5. Distribution of *Liatris mucronata* and *L. punctata* in Texas, including putative intermediates between these two taxa. Distinctions between varieties in *L. punctata* (var. *nebraskensis* Gaiser and var. *mexicana* Gaiser) and between varieties in *L. mucronata* (var. *mucronata* and var. *interrupta* Gaiser) are not made on this map.

southeast of the 1936 collection site by Gaiser (her collection *122*)—this is a flat (probably artificially so), open field of about two acres with exposed limestone in some places. Numerous invasive plant species are abundant, and a large "for-sale" sign signals the close approach of 'development' of this lot and extirpation of the *Liatris* population. We collected most of these plants, taking corms for cultivation.

The Spring Creek site is a nature preserve that now protects the only known population of *Liatris glandulosa* in Dallas County. Here, the species grows in apparently natural habitats, and it also occurs in abundance in a 'reconstituted' substrate of mixed crushed limestone, gravel, and asphalt that filled a quarry and gravel pit site now located in a central portion of the preserve. This portion of the quarry was active until around 1988 (when acquired by Dallas County),

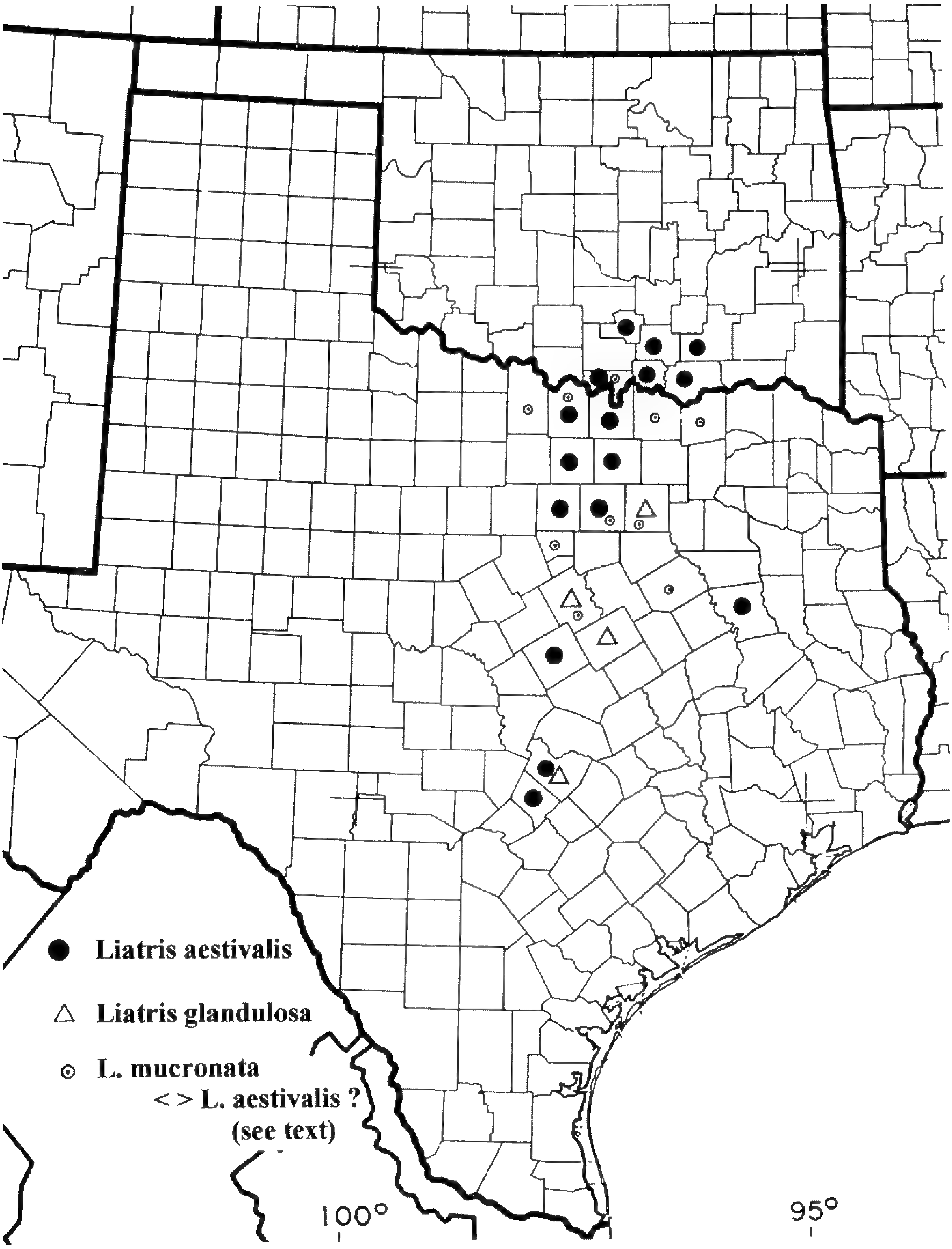


Fig. 6. Distribution of *L. aestivalis* and *L. glandulosa*. Localities for putative intermediates between *L. aestivalis* and *L. mucronata* also are shown.

so the revegetation (including *Liatris* recolonization) apparently has occurred within the last 12 years, lending optimism that *L. glandulosa* may be successfully sustained at Spring Creek and propagated elsewhere.

In the previously quarried area at Spring Creek (E side of Holford Road), with the plants of *Liatris glandulosa*, these species were common: *Yucca arkansana, Asclepias asperula, Hedeoma reverchonii, Heliotropium tenellum, Hedyotis nigricans, Paronychia virginica, Dalea multiflora, Pedomelum linearifolium, Eryngium leavenworthii, Mentzelia oligosperma, Grindelia lanceolata* var. *lanceolata, Hymenopappus scabiosaeus, Iva angustifolia,* and *Thelesperma filifolium. Liatris mucronata* (*Nesom FW68*) also is relatively common on the quarry fill, as well as other sites on deeper soil, but it was not yet in flower on 25 July, when the *L. glandulosa* was collected. Natural habitat adjacent to the old quarry site, encroached by *Juniperus virginiana, Cercis canadensis, Rhamnus caroliniana, Rhus trilobata,* harbors *L. glandulosa* and herbaceous species in addition to those above: *Schizachyrium scoparium, Sporobolus compositus* var. *drummondii, Krameria lanceolata, Eriogonum longifolium, Echinacea angustifolia,* and *Amphiachyris* sp. On a hilltop with exposed limestone (W side of Holford Road, about 1600 feet from the quarry site noted above), *L. glandulosa* grows with a similar set of species: *Yucca arkansana, Hedyotis nigricans, Heliotropium tenellum, Hedeoma reverchonii, Paronychia virginica, Eriogonum longifolium, Phyllanthus polygonoides, Styllingia texana, Toxicodendron radicans, Krameria lanceolata, Vernonia lindheimeri, Thelesperma filifolium, Echinacea angustifolia,* and *Amphiachyris* sp.; *Liatris mucronata* also is relatively common in deeper soil in this area (to the periphery of the *L. glandulosa* plants) but was not yet in flower on 25 July.

Spring Creek Forest Preserve is close to the northern boundary of Dallas County, suggesting that similar sites may still exist in adjacent Collin County. Habitats for *Liatris glandulosa* on the southwest side of Dallas County (*Gaiser 122; Nesom FW75*) are associated with the White Rock Escarpment, which extends southward. We will search for additional populations of the 'sticky gayfeather' in this area and in more southern counties and hope that Dallas-area naturalists will also do so.

Distinction of Liatris glandulosa

Plants of *Liatris glandulosa* have previously been identified as *L. mucronata*, but no other species of *Liatris* (across the whole genus) has a vestiture of stipitate-glandular hairs. Observation of these glandular plants growing sympatrically with *L. mucronata* and flowering far in advance of it indicates that two evolutionarily independent entities are present. There apparently is slight overlap in flowering time with *L. mucronata*, and some plants have been observed that suggest that limited gene flow occurs. These two species are distinguished by the following contrasts.

1. Stems and leaves densely stipitate-glandular, sticky to the touch; leaves relatively lax, ascending to loosely spreading or the lower deflexed; phyllaries 7–10(–12) per head, in 3–4 weakly graduate series, the outermost 1/2–2/3 the length of the inner, inner mostly oblong-lanceolate to lanceolate-triangular, broadly to narrowly acute at the apex, sometimes with an indurate mucro; florets 3–4(–5) per head; flowering mostly mid-July through early September **Liatris glandulosa**
1. Stems, leaves, and phyllaries strongly to weakly punctate, otherwise essentially glabrous or sparsely ciliate along the margins, not at all sticky; leaves stiffly spreading-ascending; phyllaries 11–15(–18) per head, in (4–)5–6 series strongly graduate in length, the outermost 1/3–1/5 the length of the inner, inner mostly oblong-obovate and obtuse to abruptly truncate-rounded at the apex, tipped by a thick, often spinulose mucro or cusp; florets (3–)4–5(–6) per head; flowering mostly mid-September through mid-October **Liatris mucronata**

We hypothesize that *Liatris glandulosa* and *L. aestivalis* have a sister relationship and that these two as a pair are most closely related to the northern segment of *L. mucronata*. Compared to 'southern' *L. mucronata*, the new species are both early-flowering and grow in a similar habitat, both are relatively restricted in geographic distribution, and they produce fewer-flowered capitula with fewer, weakly graduate phyllaries. Their geographic ranges are nearly contiguous—the populations of *L. glandulosa* in southwestern Dallas County are disjunct from closest *L. aestivalis* habitats in Tarrant County by an area of deep soil (Woodbine sand and Eagle Ford clay) without rock outcrops—or they may overlap southward. In addition to the difference in vestiture, plants of *L. aestivalis* differ from *L. glandulosa* in their narrower leaves and phyllaries that usually turn purple.

Postscript.—The question arises—how did these species escape the notice of Lloyd Shinners, who lived, worked, and botanized in north central Texas? In a commentary on *Liatris mucronata*, Shinners (1951) noted that "After observing and collecting the plants for five years, I fail to recognize two species [*L. angustifolia* and *L. mucronata*] as distinguished by Dr. Gaiser ..." Shinners included *L. angustifolia* as a synonym of *L. mucronata* and observed that the latter is "very common in north central Texas in the wild, on a variety of soils (but commonest on limestone and chalk outcrops and calcareous prairies)." In this case, with all respect to the acuity of our predecessor, reality remained elusive. At least in part, he may have been led in his observations by Gaiser's diffuse morphological and geographical concept of *L. angustifolia* (narrowed here to *L. aestivalis*) and its distinction from *L. mucronata*. Shinners collected *L. mucronata* from various habitats in 12 Texas counties, but there is only a single record of his collection of the earlier-flowering *L. aestivalis*—this from a Denton County plant far past flowering. Shinners also examined the SMU collections of *L. glandulosa* and recorded (by annotation) involucre height, and V.L. Cory similarly recorded by annotation his observation that the plants were glandular, but neither botanist carried the investigation further.

We also note that, given the broader ecological range of *Liatris mucronata*, it certainly was once much more abundant than *L. aestivalis*, at least in the Fort Worth area. The most common habitat for *L. mucronata* is open, flat prairie—this habitat is easily turned to commercial and residential development and it has been. The relatively numerous cited collections of *L. aestivalis* from within the city of Fort Worth (where it is now more "common" than *L. mucronata*) reflect the persistence of scattered little plots of steep, rocky slope that have not yet been built upon. A few of these sites have been preserved within the city park system.

If the existence of *Liatris glandulosa* had been earlier recognized, it might or might not have prevented the apparent destruction of most of the species' habitat in Dallas County. The value of preservation of natural sites is emphasized by the present example, where the only known extant population of *L. glandulosa* exists in areas of a relatively small park (83 acres) preserved within the city of Garland as part of the Dallas County Park and Open Space Program. The park was created to protect the old-growth forest that occurs there—preservation of the prairie patches harboring the rare *Liatris* was not a central concern.

ACKNOWLEDGMENTS

We thank the staffs at ISC, MIN, OKL, and OKLA for loans of pertinent specimens, the staffs of BAYLU, MO, and TEX-LL for help during visits there, Craig Freeman and Caleb Morse (KANU) for sending a copy of the Menhusen dissertation, Bill Burk at the Couch Botanical Library (UNC-Chapel Hill) for help with other literature, and Mark Mayfield for comments on the manuscript. Hugh Garnett, Shirley Lusk, and Betty Miller showed us populations of *Liatris aestivalis* and *L. mucronata* in north central Texas that they have been observing over a number of years and shared original insights about these plants, including their own recognition that the name *L. mucronata* has represented more than a single species. We are grateful to Tom Frey, Landscape Architect with the Garland Parks and Recreation Department, for guiding us within the Spring Creek Forest Preserve for observation of *L. glandulosa*. Illustrations of the new species are by Linny Heagy.

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BOOK REVIEW

THOMAS M. BONNICKSEN. 2000. **America's Ancient Forests: From the Ice Age to the Age of Discovery.** (ISBN 0-471-13622-0, hbk.). John Wiley & Sons, Inc., One Wiley, Drive, Somerset, NJ 08875, U.S.A. (Orders: http://www.wiley.com/Corporate/Website/Objects/Products/0,9049,38301,00.html). $90.00, hbk., 608 pp, b/w figures, 6" × 9".

What a wonderful synthesis of information from fields as widely varied as botany, ecology geology, archaeology, anthropology, and history! Thomas Bonnicksen has produced a work that will capture the imagination of anyone interested in the grandeur and beauty of the forests of North America.

The first half of the book describes in wonderful detail how the forests of North America came to be what they were at the time of European settlement. The first two chapters set the stage with a cogent discussion of what drives ice ages, and a magnificent description of what the ice age forests must have looked like. The third chapter takes the reader on a journey through time as Bonnicksen describes the migrations and changes in species composition of forests and the expansion of prairies caused by the climatic changes occurring as the glaciers retreated. The next four chapters provide an account of the effects both beneficial and detrimental that the earliest Native Americans had on the continuing development of the North American landscape. Major themes in these chapters include: **1)** effects on the fauna and mass extinctions caused by changing climates and hunting practices; **2)** the harvesting and managing of forests for food and shelter; **3)** the domestication of native species, and discussions on how various native cultures utilized the natural resources found in forests; **4)** an extensive discussion on how the Native Americans' use of fire both intentionally and accidentally altered the landscape.

The second part of the book provides wonderful historical descriptions of the North American forests as the earliest European settlers found them. Chapter 9 gives an accounting of the forests first encountered by Spanish explorers in the southern and western United States. Chapter 10 provides well-documented historical accounts of the ecology and uses of the forests by colonists in the east. Chapter 11 looks at forests from the perspective of missionaries, who were often the first to see the extensive forests of Canada and the North Central United States. Bonnicksen makes extensive use of the written descriptions of these early pioneers who often kept beautifully detailed records of what they saw, and were often well-educated in botany and natural history. The final chapter provides a view of forests not often considered in many other texts, that of the trappers and fur traders who were often the first Europeans to lay eyes on the vast forests of the rugged western part of the continent.

I would recommend this book to anyone interested in the natural history of North America. It is packed full of wonderfully interwoven bits of information from a wide variety of disciplines, and Bonnickesen tells this complex story in a style that is immensely readable, and thoroughly enjoyable.—*Debra K. Trock, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A., dtrock@brit.org.*

LAENNECIA TURNERORUM (ASTERACEAE: ASTEREAE), A NEW SPECIES FROM TRANS-PECOS TEXAS

G.L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, TX 76102-4060, U.S.A.

ABSTRACT

Laennecia turnerorum sp. nov., from Brewster County, Texas, is similar to other species of *Laennecia* sect. *Sophiifolium* (*L. coulteri*, *L. sophiifolia*, and *L. mapimiana*) in its annual duration, hirsute-pilose vestiture, acuminate phyllary apices, elaminate ray florets, and small, strigose cypselae with a uniseriate, caducous pappus. It differs from those three species in its stems, leaves, and phyllaries sparsely (vs. densely) glandular, basal leaves persistent at flowering (vs. senescent and usually absent by flowering), reduced vestiture of the phyllaries, and non-accrescent pappus (vs. accrescent). Plants of *L. turnerorum* are spring ephemerals and grow with plants of *L. coulteri*.

RESUMEN

Laennecia turnerorum sp. nov., del condado de Brewster, Texas, es similar a otras especies de *Laennecia* sect. *Sophiifolium* (*L. coulteri*, *L. sophiifolia*, y *L. mapimiana*) en su duración anual, indumento hirsuto-piloso, ápices de los filarios acuminados, flósculos no laminados, y cipselas pequeñas, estrigosas con un vilano caduco uniseriado. Difiere de las otras tres especies en sus tallos, hojas, y filarios esparsamente (vs. densamente) glandulares, hojas basales persistentes en la floración (vs. senescentes y usualmente ausentes en la floración), indumento de los filarios reducido, y vilano no acrescente (vs. acrescente) Las plantas de *L. turnerorum* son efímeras primaverales y crecen con plantas de *L. coulteri*.

Recent collections in trans-Pecos Texas by Dr. B.L. Turner have brought to light a previously undescribed species of *Laennecia* Cass. Plants of the new species, which apparently are spring ephemerals, are currently known from about six plants of a single collection. Their small size, disciform capitula, and short duration probably account for their escape from detection by earlier botanists. Turner returned to the type locality about four weeks after the type collection was made and found that plants of the new species had died and dried essentially beyond recognition, while those of *Laennecia coulteri* (Gray) Nesom at the same site remained alive and in reproductive condition (B.L. Turner pers. comm.).

Laennecia turnerorum Nesom, sp. nov. (**Fig. 1**). TYPE: U.S.A. TEXAS. BREWSTER CO.: Turner's Valentine Section, vicinity of old 'residence,' ca 58 mi S of Alpine along Hwy 118, 29° 34' N, 103° 34' W, 3330 ft elev., intermixed with *Laennecia coulteri*, 21 Mar 2001, *B.L. Turner 21-73* (HOLOTYPE: TEX; ISOTYPE: BRIT).

Laenneciae coulteri similis duratione annua, vestimento grosso, foliis superis subamplectentibus vel auriculatis, phyllariis apicibus acuminatis, flosculorum pistillatorum corollis elaminatis, et cypselis parvis strigosis pappo uniseriato caduco; differt statura minore, caulibus foliis ac phyllariis sparsim (vs. dense) glandulosis, foliis petiolatis bipinnatis, et capitulis majoribus.

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Fig. 1. Habit of *Laennecia turnerorum* (from isotype).

Plants annual, herbaceous, from a slender taproot, producing 1–3 erect to ascending stems from the base, 16–20 cm tall; stems and leaves sparsely and minutely sessile-glandular and stipitate-glandular, also sparsely hispid-pilose with thick-based trichomes 0.2–1 mm long, not at all woolly. *Leaves* basal and cauline, basal and lowermost cauline persistent but sometimes senescent at flowering, 2–5 cm long, blade portion oblanceolate to obovate, 5–12 mm wide, 2-pinnatifid with ovate lobes or segments, lower cauline leaves with narrow, petioliform, non-clasping base, upper cauline gradually reduced in size to 1–2 cm long, becoming epetiolate and clasping. *Capitula* ca. 5–15 in a corymboid or subcorymboid capitulescence; involucres broadly campanulate, 3–4 mm high, 5–7 mm wide; phyllaries in 3–4 series, sometimes fused at the base into a disc 3–4 mm in diameter, the outermost 3–3.7 mm long, 0.8–1 mm wide, 3/4 to equally as long as the inner, completely herbaceous, without an evident midrib or midvein, coarsely hispid along the midportion and sparsely glandular, inner 3.5–4 mm long, narrower, with prominent hyaline flanges on the distal half, all with a hyaline, purplish apex. *Pistillate florets* ca. 200, in 2–4 series, corolla tube 1 mm long, whitish, lamina absent. *Bisexual florets* 15–18, corollas tubular, 2.2 mm long, yellow, with purple lobes 0.2–0.3 mm long. *Cypselae* elliptic-oblong, 0.8–1 mm long, tan, sparsely short-strigose, sparsely sessile-glandular at the apex; pappus uniseriate, of 16–18 fragile, white, caducous, non-accrescent barbellate bristles ca. 2 mm long, slightly longer than the style branches of pistillate florets, slightly shorter than the disc corollas.

Etymology and distribution.—The epithet commemorates the two Turners: Billie, who collected the plants in the course of preparing a florula of the "Valentine Section" (640 acres), and his wife Gayle, who surprised Billie with a Valentine's Day gift of the property. The area is in a large basin essentially surrounded by desert mountains. The plants of *Laennecia turnerorum* were collected in silty limestone-derived soil in a low area with desert grasses; abundant *Larrea*, scattered *Yucca*, and other shrubs occur slightly upslope. Although the immediate site has been slightly disturbed, plant species in the area apparently are native.

Within the genus, *Laennecia turnerorum* is a member of sect. *Sophiifolium* Nesom (Nesom 1990a), the plants characterized by their annual duration, hirsute-pilose vestiture, elaminate corollas in pistillate florets, and relatively small, strigose cypselae with very small, deciduous glands and a uniseriate pappus of basally caducous bristles. The other North American species of sect. *Sophiifolium* are *L. coulteri* (Gray) Nesom (southwestern USA through northern Mexico), *L. sophiifolia* (Kunth) Nesom (southwestern USA through Mexico and Guatemala, then apparently disjunct to northern South America), and *L. mapimiana* Nesom (northeastern Durango, southeastern Chihuahua; Nesom 1990b). Among these, *L. turnerorum* is most similar to *L. mapimiana* in its short duration (spring ephemeral), relatively small stature, sparsely glandular vestititure, basal leaves persistent until flowering, leaves non-clasping below, subclasping to clasping above, corymboid capitulescence, and relatively large capitula. *Laennecia turnerorum* can be identified among its most closely similar congeners by contrasts in the key below.

KEY TO NORTH AMERICAN SPECIES OF *LAENNECIA* SECT. *SOPHIIFOLIUM*

1. Leaves clasping to subclasping, oblong in outline with a broad lamina, sharply toothed, the teeth cut 1/4–1/3 to the midrib ______ **Laennecia coulteri**
1. Leaves clasping or not, oblanceolate to obovate-spatulate or oblong in outline, pinnatifid to 2-pinnatifid, the segments cut 2/3–3/4 to the midrib.
   2. Plants (15) 30 70 cm tall; leaves not clasping; capitulescence paniculiform, columnar to pyramidal; involucres 1.5–2.5 (–3.5) mm wide ______ **Laennecia sophiifolia**
   2. Plants 9–20 cm tall; at least the upper leaves clasping; capitulescence corymboid to subcorymboid; involucres 5 7 mm wide.
      3. Plants 7–10 cm tall, stems strongly decumbent; leaves 1–2 cm long, oblong to obovate-oblanceolate in outline, epetiolate or with a short, weakly differentiated petioliform portion, blades 3–6 mm wide, 1(–2)-pinnatifid; pappus of 9–12 bristles ______ **Laennecia mapimiana**
      3. Plants 16–20 cm tall, stems erect to basally ascending; leaves 2–5 cm long, spatulate in outline, petioliform portion strongly differentiated, blades 5–12 mm wide, 2-pinnatifid; pappus of 16–18 bristles ______ **Laennecia turnerorum**

Direct comparisons of *Laennecia turnerorum* to *L. coulteri* and *L. sophiifolia* are as follows.

* ***similar*** to *L. coulteri* in its subclasping upper leaves; ***different*** in its short duration, sparsely glandular vestiture, smaller stature (16–20 cm tall vs. [20–]30–110 cm), smaller (1.5–2 cm long vs. 1.5–10 cm), petiolate, bipinnatifid cauline leaves, non-clasping lower leaves, basal leaves present (vs. absent) at flowering, corymboid capitulescence (vs. columnar-paniculate to corymboid), and larger capitula (5–7 mm wide vs. 3–5 mm).

* ***similar*** to *L. sophiifolia* in its pinnatifid leaves and non-clasping lower leaves; ***different*** in its short duration, sparsely glandular vestiture, smaller stature (16–20 cm tall vs. [15–] 30–70 cm), slightly smaller (1.5–2 cm long vs. 1–4 cm) cauline leaves with shorter, broader segments, the upper leaves subclasping to clasping, basal leaves present (vs. absent) at flowering, capitulescence corymboid (vs. columnar- to pyramidal-paniculate), larger capitula (5–7 mm wide vs. 1.5–2.5[–3.5] mm), and greater number of pappus bristles (16–18 vs. 9–12[–15]).

The geographic range of *Laennecia turnerorum* and its relationship to *L. mapimiana* should be studied by search during the early spring. The latter also appears to be narrowly distributed; it is separated at its closest point by about 300 kilometers from the *L. turnerorum* locality. Both taxa are highly restricted in range compared to *L. coulteri* and *L. sophiifolia*.

The new species brings the number of species in *Laennecia* to 18 (Nesom 1990a, 1990b, 1992). Morphological and molecular data (Zardini 1981; Nesom

2000; Noyes & Rieseberg 1999) indicate that the genus is not closely related to *Conyza* Less., where most of the species have been placed previously. *Laennecia* instead apparently is related to South American groups, possibly most closely to subtribe Podocominae (Nesom 1994, 2000).

ACKNOWLEDGMENTS

I am grateful to the staff of TEX-LL for their help during a recent visit and to Ted Barkley and John Strother for their comments on the manuscript. Linny Heagy provided the illustration.

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BOOK REVIEW

AMANDA MCQUADE CRAWFORD. 1997. **Herbal Remedies for Women: Discover Nature's Wonderful Secrets just for Women.** (ISBN 0-7615-0980-1, pbk.). Prima Publishing, P.O. Box 1260BK, Rocklin, CA 95677, www.primahealth.com, 800-632-8676, 916-632-4400). $18.00, pbk., 291 pp., illustrations, 7 3/8" × 9 1/4".

There is currently much interest in herbal remedies and the proliferation of publications dealing with herbal medicine reflects the acceptance of herbal remedies as a useful alternative to "traditional" medicine as well as the general public's increasing fascination with this topic. Most herbals deal with a wide range of diseases and conditions, and may be overwhelming to the beginning student of herbal therapy. This book is designed specifically to address the particular health needs of women, and is full of information on nearly every problem from anemia to varicose veins.

Amanda McQuade Crawford has spent a lifetime studying and teaching about herbal therapies. She recognized a need to provide information specifically to women, and to the medical personnel in women's clinics, about alternative treatments for conditions and disorders that often have a profound impact on the quality of life for women.

The first portion of this book deals with some basic information about plants, plant collecting, specific actions of useful herbs, and terminology associated with the preparation of herbal remedies. The remainder of the book deals with specific problems associated with menses, reproduction, menopause, sexually transmitted diseases and "abnormal cell growth." McQuade provides easily understandable definitions of each disease or condition, followed by a discussion of symptoms, causes and conventional medical treatments. She then provides good descriptions of alternative herbal therapies including specific herbal formulas and recommendations for proper nutrition and exercise to complement the herbal treatments. She is also careful to point out what treatments are and are not appropriate during pregnancy and lactation.

The book contains several appendices including: sources for purchasing herbal products, as well as fresh and dried herbs; educational resources; organizations with information or databases on herbal practitioners or suppliers of herbal information and products; and lists of journals devoted to the dissemination of information on herbal medicine.

If you are a woman who is interested in or a user of herbal remedies or a medical practitioner who is interested in incorporating herbal therapies into traditional medical practice, this is the book for you.—*Debra K. Trock, Botanical Research Institute of Texas, 509 Pecan, Fort Worth, TX 76102-4060, U.S.A., dtrock@brit.org.*

TWO NEW SPECIES OF *IMPATIENS* (BALSAMINACEAE) FROM INDIA

Muktesh Kumar
Botany Division
Kerala Forest Research Institute
Peechi 680 653, Thrissur, Kerala, INDIA
muktesh@kfri.org

Stephen Sequiera
Botany Division
Kerala Forest Research Institute
Peechi 680 653, Thrissur, Kerala, INDIA

ABSTRACT

Two species of *Impatiens* viz., *I. sholayarensis* and *I. violacea* are described from Kerala, India.

KEY WORDS: Balsaminaceae, *Impatiens sholayarensis*, *Impatiens violacea*, Kerala, India

RESUMEN

Se describen dos especies de *Impatiens* viz., *I. sholayarensis* e *I. violacea* de Kerala, India.

INTRODUCTION

The genus *Impatiens* L. consists of about 900 species distributed in tropical Africa and South East Asia, with a few representatives in North America, Europe and East Asia (Grey-Wilson 1985). Of these, 200 species were reported from India (Biju 1999) and are mainly distributed in the Eastern Himalayas and the Western Ghats—the megacenter of endemism in India (Nayar 1996). Among these, there are 86 species of *Impatiens* reported so far from the Western Ghats region (Augustine et al. 1999).

During our studies on the epiphytic flora of the Western Ghats, two epiphytic balsams were collected with striking differences. On critical examination they were found to be new to the science and are described and illustrated here.

1. Impatiens sholayarensis M. Kumar & Sequiera, sp. nov. (**Figs. 1, 2**). TYPE: INDIA. KERALA: Thrissur Dt., Sholayar, alt. 900m, 9 Oct 1998, *Sequiera 20620* (HOLOTYPE: KFRI; ISOTYPE: MH).

Impatiente kulamavuensi similis caule moniliformi, foliis aggregatis glabris, sepalis lateralibus glabris, sepalis dorsalibus c. 35 mm longa viridi-flava labello coccineo ore unco prominenti, petala dorsali carinata glabra, petalarum lateralium lobulis spinosis, seminibus sacci- et pyriformibus ciliatis differt.

Epiphytic on trees, glabrous; stems thick, fleshy up to 4 cm long, green. *Leaves* crowded towards apex of the stem; petioles 2.5–8 cm long, channeled, light greenish, with two prominent stipitate glands near the base of the blade; lamina ovate to elliptic-lanceolate, 2.3–8 × 1.3–3.2 cm, acute at apex, shortly attenuate at the base, membranaceous, glabrous, light green above, silvery white below, margins crenulate, crenules 4–17 mm apart, crenatures short, furnished with short incurred bristles, lateral veins up to 4 pairs, indistinct. *Inflorescence* a

Fig. 1. *Impatiens sholayarensis* M. Kumar & Sequiera. A. Habit. B. Single flower. C. Sepal. D. Dorsal petal. E. Lateral petal (outside view). F. Lateral petal (inside view). G. Lower sepal. H. Pistil. I. Gynoecium. J. Seed.

FIG. 2. *Impatiens sholayarensis* M. Kumar & Sequiera.

FIG. 3. *Impatiens violacea* M. Kumar & Sequiera.

2-flowered raceme, peduncles 1.3–2 cm long, pedicels 2.5–5 cm long, filiform, greenish-white. *Flowers* greenish-yellow with crimson red; *lateral sepals* 0.8–1 × 0.2 cm, linear-ovate, slightly falcate, glabrous on both surfaces; *lower sepal* saccate, compressed, 1–3.5 × 0.5–1.1 cm, glabrous, greenish-yellow with crimson-red, mouth descended, with a prominent hook at the lower side, spur curved, tip obtuse, white; *dorsal petal* erect, 0.6–1.1 × 0.4–0.9 cm, gland dotted, glabrous; *lateral petals* united at the base, 3-lobed, 1.7–1.9 × 1–1.2 cm, upper lobes with a small spine and a pouch. *Androecium* 0.8–1 cm long; stamens 5. *Ovary* elliptic-lanceolate, 1–1.2 × 0.3 cm, slightly falcate, glabrous, stigma straight, toothed. *Capsule* elliptic-lanceolate, up to 1.2 cm long, glabrous. *Seeds* pear shaped, tip ciliate.

This species is allied to *Imaptiens kulamavuensis* Pandurangan & V.J. Nair, but differs in having moniliform stem; crowded, glabrous leaves; glabrous lateral sepals; 35 mm long, greenish yellow with crimson red lip with a prominent hook at the mouth; keeled, glabrous dorsal petal; lobules of the lateral petals with a spine & pouch and pear shaped ciliate seeds.

Distribution.—*Impatiens sholayarensis* is known only from its type locality.

Ecology and conservation status.—*Impatiens sholayarensis* occurs in the evergreen forests at an altitude of 700–800m (type collection has '900m'). In the type locality only about 20 populations exist in the wild. Due to its restricted distribution and less number of occurrences this taxon is considered as a critically endangered species. Loss of habitat and destruction of host trees and human interference are the major threats in the area.

Etymology.—The species is named after its type locality.

2. Impatiens violacea M. Kumar & Sequiera, sp. nov. (**Figs. 3, 4**). TYPE: INDIA. KERALA: Idukki Dt., Munnar, Pettimudi, Way to Edamalakudy, alt. 2000m, 25 Aug 1998, *Sequiera 20731* (HOLOTYPE: KFRI; ISOTYPE: MH).

Impatiente viridiflora similis, petiolo violaceo, folii crenaturis, brevibus, floribus violaceis, sepalis lateralibus lineari-lanceolatis glabris, sepalo inferiore violaceo rugoso, apice unco prominenti, petalis dorsalibus viridi- flavis, petalis lateralibus 3-lobatis lobulis lateralibus quibusque sacco minuto, stigmatis apice obtuso sericeo, seminibus tetragonis laevibus differt.

Epiphytic on trees, glabrous, stems thick, 1–1.5 cm in diameter, up to 10 cm high. *Leaves* crowded towards the apex of the stem; petioles up to 3.5 cm long, violet, channeled, with 2 prominent stipitate glands near the base of the blade; lamina lanceolate to ovate-lanceolate, 2–6 × 1.4–4 cm, acute at apex, truncate at base, margins crenulate-serrate, violet, crenules 4–6 mm apart, crenatures short, furnished with short incurved bristles, violet. *Inflorescence* a 1–4 flowered raceme, peduncles 1.5–2 cm long, pedicels 2–4 cm long, violet. *Flowers* violet; *lateral sepals* linear-lanceolate, glabrous, 0.8–1 × 0.2–0.3 cm, slightly keeled on upper side; *lower sepal* saccate, 1.75–2 × 0.6–1.1 cm, violet, glabrous, wrinkled, with a short prominent hook at the mouth; *dorsal petal* erect, 0.6–0.8 × 0.5–0.7 cm, greenish yellow, gland dotted, deeply hooded, hood dark green; *lateral petals* fleshy, 0.8–1 × 0.6–0.8 cm, 3-lobed, gland-dotted, with a small pouch in each

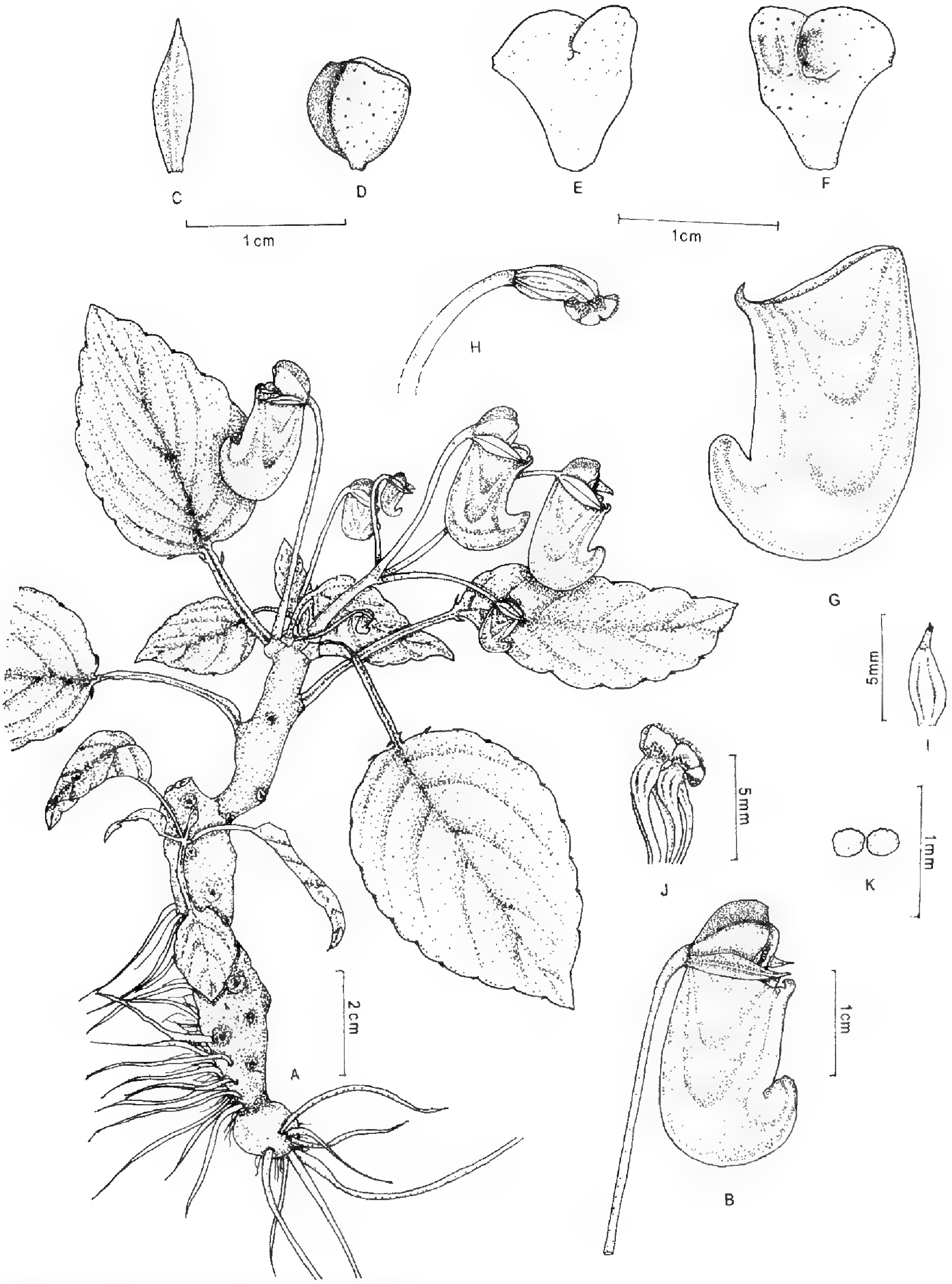

Fig. 4. *Impatiens violacea* M. Kumar & Sequiera. A. Habit. B. Single flower. C. Sepal. D. Dorsal petal. E. Lateral petal (outside). F. Lateral petal (inside). G. Lower sepal. H. Pistil. I. Gynoecium. J. Androecium. K. Seeds.

TABLE 1. Comparison between *Impatiens kulamavuensis* and *Impatiens sholayarensis*.

Impatiens kulamavuensis	Impatiens sholayarensis
Stems less than 1 cm	Stems up to 5 cm
Stoloniferous	Stem moniliform
Leaves alternate	Leaves fascicled
Leaves glanduliferous	Leaves glabrous
Lateral sepal hairy out side	Lateral sepal glabrous on both the surfaces
Lower sepal up to 15 mm long	Lower sepal up to 35 mm long
Lower sepal without hook	Lower sepal with a hook at the mouth
Lower sepal greenish-yellow	Lower sepal greenish-yellow with crimson red
Dorsal petal glabrous	Dorsal petal gland dotted
Dorsal petal not keeled	Dorsal petal keeled
Dorsal petals hairy at base	Dorsal petals glabrous
Lobules of the lateral petals without spine and pouch	Lobules of the lateral petals with a spine and pouch
Stigma curved with a silky pubescent apex	Stigma straight with toothed apex
Ovary ellipsoid	Ovary elliptic-lanceolate, slightly falcate
Seeds smooth	Seeds ciliate

TABLE 2. Comparison between *Impatiens violacea* and *Impatiens viridiflora*.

I. violacea	I. viridiflora
Petiole violet	Petiole green
Leaves green with violet tinge, nerves violet	Leaves dark green, nerves green
Crenatures short, violet	Crenatures long, green
Peduncles violet bearing 1–4 flowers	Peduncles green bearing 1–3 flowers
Pedicel violet	Pedicel green
Flowers violet	Flowers green
Sepals large, dark green, linear-lanceolate, not deflexed or reflexed, slightly keeled on upper side.	Sepals large, dark green, linear oblong, deflexed or reflexed, slightly not keeled.
Lower sepal saccate, wrinkled, violet, spur laterally compressed.	Lower sepal saccate, wrinkled, green, spur laterally compressed.
Dorsal petal 2-lobed, yellow-green	Dorsal, 2-lobed, green
Lateral petals 3-lobed, yellow with small pouch in each lateral lobules	Lateral petals 2-lobed, green without small pouch in each lateral lobules
Capsule elliptic ovate	Capsule ellipsoid

lateral lobules. *Androecium* 0.5–0.6 cm long, stamens 5 in number. *Ovary* elliptic-ovate, glabrous, 0.4–0.5 × 0.15–0.2 cm; *style* short; *stigma* with an obtuse silky pubescent tip. *Capsule* elliptic-ovate, 1–1.1 × 0.3–0.4 mm, glabrous. *Seeds* almost tetragonal, smooth.

This species is similar to *Impatiens viridiflora* Wight in its structure and shape but differs in having violet colored petiole, short crenatures; violet colored flowers, lateral sepals linear lanceolate, glabrous, lower sepal violet colored and wrinkled with a prominent hook at the apex; dorsal petal greenish yellow, lateral petals 3 lobed with small pouch in each lateral lobules; stigma with obtuse silky pubescent tip and tetragonal, smooth seeds.

Distribution.—Impatiens violacea is known from Pettimudi area of Munnar, Idukki Dt., Kerala, India.

Ecology and conservation status.—This species occurs only in the montane shola forests at an altitude of 1800–2200 m. Only 50 individuals exist in the wild habitat. Cultivated in KFRI green house for *in situ* conservation. Due to its restricted distribution and less number of individuals occurring in the wild the species is considered as critically endangered. Human interference and habitat destruction are the major threats for this balsam.

Etymology.—The species is named after its violet color of the lateral sepal.

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Book Review

Laurence Parent (photographs) and Joe Nick Patoski (text). 2001. **Texas Mountains.** (ISBN 0-292-76592-4, hbk.). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. (Orders: http://www.utexas.edu/utpress, 512-471-4032). $39.95 hbk., 156 pp., 120 color photos, 10" × 11".

As a child, this reviewer was captivated by the high rugged mountains of Colorado and Wyoming. As an adult, a trip to Big Bend National Park was so inspiring that it resulted in a major career change, many subsequent trips to the area, and a love for all aspects of the natural history of wild places. This beautiful book with photographs by Laurence Parent and text by Nick Patoski, takes the reader on an incredible journey to the breathtaking region of the Trans-Pecos in far west Texas. The combination of photographs and prose describe places that are both rugged and beautiful, and much more enticing than the over-exploited areas of the intermountain west. I looked at the details in every picture, and found myself delighted every time I came upon a particular view and could say, "Wow! I've been there."

Parent's photographs capture the mountains and the vegetation of the Trans-Pecos in all of their glory through the seasons. The vibrant reds, oranges and yellows of a desert sunset or sunrise are contrasted with the rich shades of greens of the rivers, canyons and high mountain forests. The breathtaking agoraphobic views complement photographs of rocky pinnacles, Ponderosa pine forests and the myriad of strange and unusual desert plants.

Patoski's text provides a glimpse into the lives of the rugged individuals who inhabit these beautiful and remote parts of Texas. Interviews with people who are relative newcomers to the region as well as those who have made the Trans-Pecos their home for generations, provide insight into what draws people to live and work in places that are considered by some to be desolate and remote. A love of the land is evident in all of the people Patoski came to know through this work.

If you love mountains, if you love the west, if you love wide open spaces and the concepts of self-reliance and individual freedom you will love this book.—*Debra K. Trock, Botanical Research Institute of Texas, 509 Pecan, Fort Worth, TX 76102-4060, U.S.A., dtrock@brit.org.*

ANOTHER NEW SPECIES OF *TRIPOGON* (POACEAE) FROM INDIA

C.N. Sunil

Department of Botany
S.N.M. College, Maliankara
Kerala 683 516, INDIA

A.K. Pradeep

Department of Botany
University of Calicut
Kerala 673 635, INDIA

ABSTRACT

A new species of Poaceae, *Tripogon ravianus* Sunil & Pradeep from the Western Ghats of Tamil Nadu, India is described and illustrated

RESUMEN

Se describe e ilustra una nueva especie de Poaceae, *Tripogon ravianus* Sunil & Pradeep de los Western Ghats de Tamil Nadu, India.

During previous floristic investigations on the Western Ghats of Kerala, India, two new species of *Tripogon* Roem. & Schult. were described (Pradeep & Sunil 1999). Since then, yet another remarkable undescribed species of *Tripogon* from Pykara on the Western Ghats of Tamil Nadu, South India has been discovered. It is described here as new.

Tripogon ravianus Sunil & Pradeep, sp. nov. (**Fig. 1**). TYPE: INDIA. TAMIL NADU. NILGIRI DT.: Pykara near Udagamandalam, 1990 m, 3 Dec 2000, *Sunil 2176* (HOLOTYPE: BRIT; ISOTYPES: CALI, K, L, NY).

Tripogoni anantaswaniano affinis, *T. ravianus* racemis 15–40 cm longis, spiculis 10–25 mm longis et flosculis 6–14 instructis, glumis inferioris profunde 2-lobatis, lemmatis apicaliter 4-lobata facile distinguendus.

Tufted perennial. Culms 24–70 cm tall; nodes glabrous. Leaf blades 5–35 cm long, 2–4 mm wide, the margins slightly scabridulous or scabrid especially towards the base, the upper surface pubescent with short white, papillose hairs, glabrous abaxially. Leaf-sheaths 3–9 cm long, glabrous, apex pubescent with a tuft of 2–3 mm long hairs; ligule a fine membrane. Racemes terminal, 15–40 cm long, with 15–48 spikelets; rachis smooth, glabrous. Spikelets 1–2.5 cm long, linear, secund, dark gray, 6–14-flowered, distant, up to 7 mm apart. Lower glume 2–4 mm long, 1–2 mm wide, coriaceous, broadly ovate, unequally 2-lobed, 1-veined, the inner margin of smaller lobe slightly serrulate or entire, apex of both lobes acuminate. Upper glume 5–6 mm long, 1.5–2 mm wide, lanceolate, notched at apex and awned, coriaceous, 1-veined; awn 1.5–2 mm long, scabrid, the lateral lobes ca. 1 mm long, lanceolate, acute. Lemma 3–4 mm long excluding awns, 2–3 mm wide, coriaceous, dark gray, 3-veined, 4-lobed at the apex; awns 3, scabridulous, the central awn 4–5 mm long, the lateral awns 3–3.5 mm

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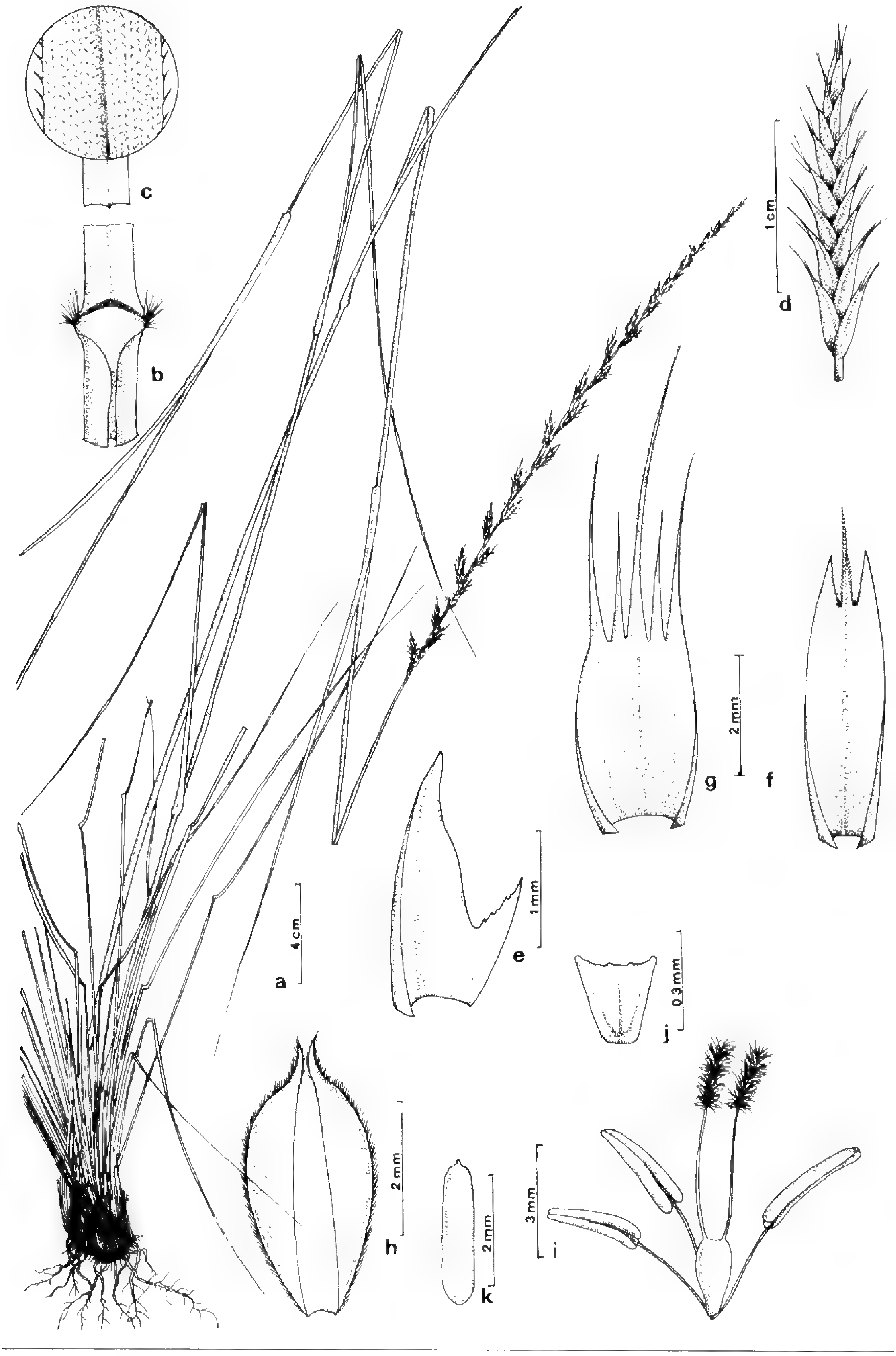

Fig. 1. *Tripogon ravianus* Sunil & Pradeep. a. Habit. b. Sheath and a portion of lamina. c. Portion of lamina enlarged. d. Spikelet. e. Lower glume. f. Upper glume. g. Lemma. h. Palea. i. Stamens and Pistil. j. Lodicule k. Caryopsis.

long; lobes between awns ca. 2 mm long, acuminate; callus tufted; hairs up to 1 mm long. Palea 2.5–3.5 mm long, 1–1.5 mm wide, obovate, hyaline, 2-keeled, the keels ciliate, apex shortly 2-lobed, the lobes acuminate. Lodicules 2, 0.5–0.75 mm long, wedge-shaped. Stamens 3; anthers 1.5–2 mm long, oblong, creamy yellow; filaments 1–1.5 mm long. Ovary 0.75–1 mm long, ca. 0.5 mm broad, obovate; styles 2, ca. 1 mm long; stigma 1–1.5 mm long, feathery, creamy white. Caryopses 1.8–2.3 mm long, 0.4–0.7 mm wide, oblong -cylindric. Chromosome number unknown.

Distribution.—*Tripogon ravianus* is endemic to Tamil Nadu and is known only from the type locality, Pykara near Udagamandalam in Nilgiri District of Tamil Nadu.

Ecology and phenology.—This species grows from 1500–2200 m elevation on road cuts and wet rocky hillsides; flowering October to late December.

Etymology.—The specific epithet honors Prof. N. Ravi, teacher of the first author and a grass specialist now with the Tropical Botanic Garden and Research Institute, Trivandrum.

Tripogon ravianus is closely allied to *T. anataswamianus* Sreek., V.J. Nair & N.C. Nair, a species endemic to Kerala (Sreekumar & Nair 1991). It can be distinguished by its 15–40 cm long racemes, 10–25 mm long spikelets with 6–14 florets, deeply 2-lobed lower glumes and apically 4-lobed lemma.

KEY TO THE SPECIES OF *TRIPOGON* IN SOUTH INDIA

1\. Culms thickened below by the persistent leaf sheaths; leaves equitant, rigid, pungent ______ **T. pungens**

1\. Culms not thickened below by the persistent leaf-sheaths; leaves not equitant, not rigid or pungent.

- 2\. Lemmas cleft at apex into 2 lobes, awned in the cleft; lobes awned or not.
  - 3\. Central awn of the lemma flexuous, capillary, several times as long as lemma ______ **T. capillatus**
  - 3\. Central awn of the lemma straight or curved, not more than twice as long as the lemma.
    - 4\. Spikelets 10–40 mm long; paleas broadly winged ______ **T. wightii**
    - 4\. Spikelets 4–17 mm long; paleas not broadly winged.
      - 5\. Culms less than 20 cm tall; central awn geniculate, strongly twisted below ______ **T. pauperculus**
      - 5\. Culms greater than 20 cm tall; central awn not geniculate or twisted.
        - 6\. Perennials with wiry roots forming tufts; leaves glabrous.
          - 7\. Leaves and culms glaucous, involute; lower glume lobed on one-side ______ **T. jacquemontii**
          - 7\. Leaves and culm not glaucous, flat; lower glume symmetrical ______ **T. vellarianus**
        - 6\. Perennials with fibrous roots, forming a close turf; leaves villous on the upper surface.
          - 8\. Spikelets 5–8-flowered; lower glume 2 mm, notched on one-side ______ **T. sivarajanii**

8. Spikelets 1–2-flowered; lower glume 0.7 mm, symmetrical ______ **T. roxburghianus**

2. Lemmas cleft at apex into 4 or 6 lobes or with a definite lobe between each lateral awn and the central; outer lobes if present awned or not.
    9. Leaves hairy; ligules inconspicuous; keels of the paleas scabrid ______ **T. bromoides**
    9. Leaves glabrous or hairy; ligules conspicuous, thin, membranous; keels of the paleas ciliate.
        10. Leaves glabrous; lemmas cleft at apex into 6 lobes ______ **T. anantaswamianus**
        10. Leaves pubescent; lemmas cleft at apex into 4 lobes.
            11. Culms 10–20 cm tall; lower glumes shallowly lobed on one-side above the middle; central lobes of the lemmas ovate-acute ______ **T. narayanae**
            11. Culms 24–70 cm tall; lower glume deeply lobed on one-side below the middle; central lobes of the lemmas lanceolate ______ **T. ravianus**

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IPOMOEA SORORIA (CONVOLVULACEAE), A NEW SPECIES FROM YUCATAN, MEXICO

Daniel F. Austin

Arizona Sonora Desert
Museum
2021 N. Kinney Road
Tucson, AZ 85743, U.S.A.

Jose Luis Tapia Muñoz

Centro de Investigacion Cientifica
de Yucatan A. C. (CICY)
Calle 43 No. 130, Colonia
Chuburná de Hidalgo, 97200 Mérida
Yucatán, MÉXICO

ABSTRACT

Ipomoea sororia, a new species in *Ipomoea* section *Leptocallis* is described from the Yucatan Peninsula of Mexico. This species, apparently endemic to a small region of low deciduous forest in the NW of the peninsula, is similar to the more widespread species *I. ternifolia* and *I. costellata*. The new species differs from those in having cordate sepal bases and three rows of largely reflexed excresences on the outer sepals.

RESUMEN

Se describe *Ipomoea sororia*, una nueva especie de *Ipomoea* sección *Leptocallis* para la Península de Yucatán, México. Esta especie, aparentemente endémica de una pequeña región de selva baja decidua, en la zona NW de la península, es similar a las especies de más amplia distribución, *I. ternifolia* e *I. costellata* de la costa pacífica. La nueva especie se diferencia por presentar los sépalos con las bases cordadas y tres hileras de crestas reflejas en los sépalos exteriores.

During preparation of the treatment of the Convolvulaceae for *Flora Mesoamericana* (Austin et al., in prep.), and collaboration on the *Flora Ilustrada de la Peninsula de Yucatán* (Austin and Tapia, in press), collections were found that match no known species. These specimens are similar to those in sect. *Leptocallis* (McDonald 1995), with which they are thought to be allied. Comparison with the keys in McDonald's paper, and with available material in CICY and MEXU make it clear that the plants do not fall within the known variability of species from Mexico and Mesoamerica. Therefore, we describe the new species.

Ipomoea sororia D.F. Austin & J.L. Tapia, sp. nov. (**Fig. 1**). TYPE: MÉXICO. YUCATÁN: Mpio. Dzemul, al S del entronque a las ruinas Xtampú. Selva baja caudicifolia con Cactáceas columnares, 9 Nov 2000, *Tapia & Carnevali 1120* (HOLOTYPE: CICY; ISOTYPES: F, FAU, K, MEXU, MO, NY, UCAM, XAL).

Ipomoea ternifoliae et *I. costellatae* primo adspectu maxime semile, sed sepalis externis seriebus tribus rugarum vel bullarum vel fere papillarum et praesertim cordatis basibus distinguitur.

Twining herbs, annuals with fibrous root-systems, stems climbing or prostrate, to ca 2 m, glabrous or glabrescent. Leaves pedately 5–7-lobed, more or less reniform to orbicular in outline, 2.5–5 cm long, 3–7 cm wide, the lobes entire, or the

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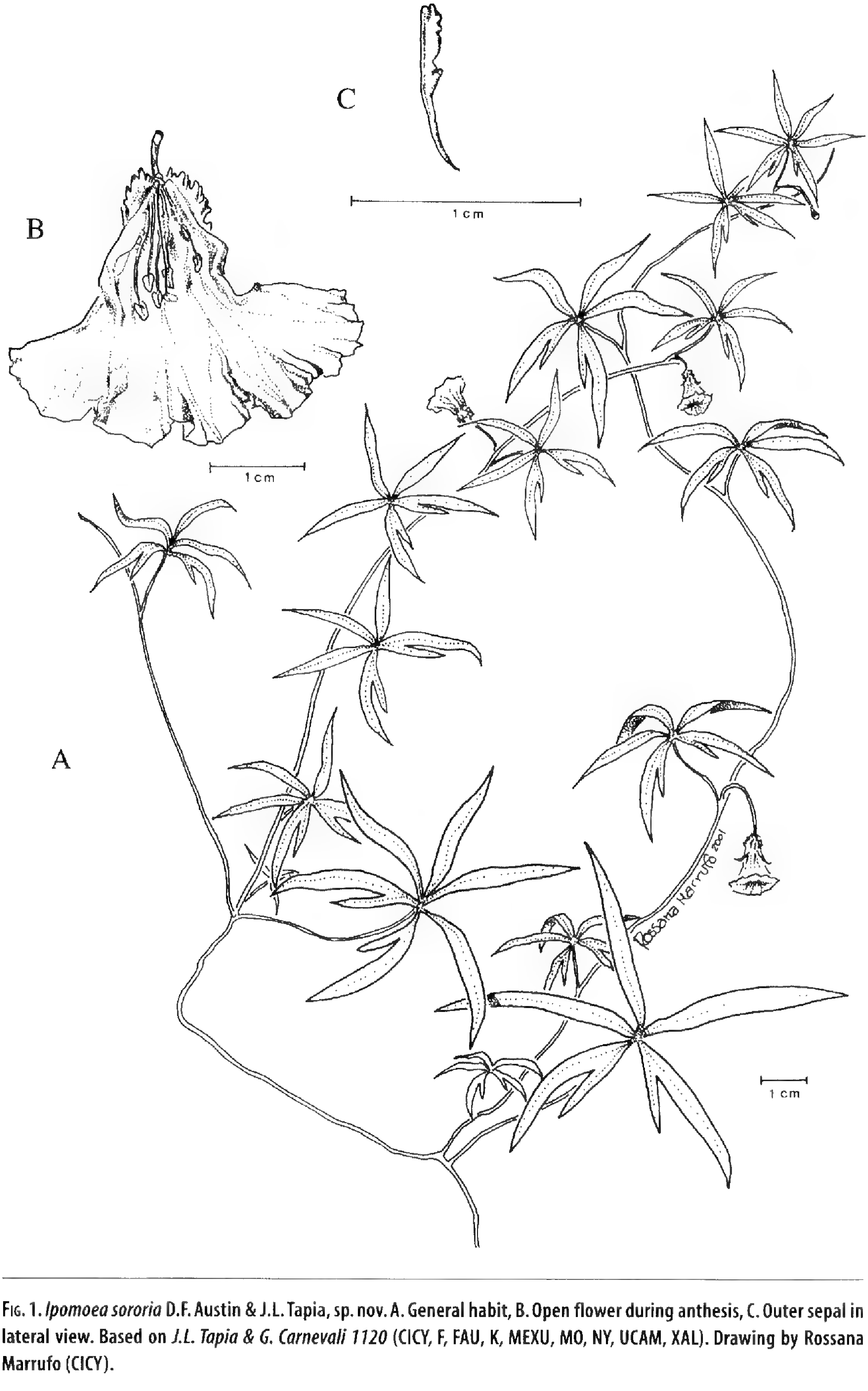

FIG. 1. *Ipomoea sororia* D.F. Austin & J.L. Tapia, sp. nov. A. General habit, B. Open flower during anthesis, C. Outer sepal in lateral view. Based on *J.L. Tapia & G. Carnevali 1120* (CICY, F, FAU, K, MEXU, MO, NY, UCAM, XAL). Drawing by Rossana Marrufo (CICY).

basal lobes with 1–3 lobes, glabrous, the base cordate, the apex broadly obtuse to rounded, the petioles 2–3 cm long. Inflorescences cymose but mostly solitary on peduncles 0.5–3.5 cm long, the pedicels 4–5 mm long, the bracteoles lanceolate, 0.75–2 mm long. Flowers 1(–2); sepals more or less equal or the outer somewhat shorter, 5–8 mm long, the outer ovate, basally cordate, with a lanceolate terminal acumen 1–2 mm long, reflexed, glabrous, mostly with 3 rows of rugae or bullae to almost papillae, the inner 6–8 mm, ovate, long acuminate, glabrous, borders hyaline, the acumen 3–4 mm long, glabrous; corolla 2–2.5 cm, funnelform, the limb white, the limb faintly 5-lobed, the throat lavender; the stamens included, unequal, 8–12 mm long, white, the filaments basally glandular-pubescent, inserted 4 mm above the base of the corolla tube, anthers erect, dithecal; the ovary lobate, 1 mm diameter, glabrous, the style white, glabrous, 6–8 mm long, the stigma in contact with stamens, capitate, bilobate, papillose surface. Fruits capsular, ovoid, 5 mm long, 4 mm wide, 4-valvate, the 2-locules well-delimited and somewhat 2-lobed, tan to brown, the valves membranaceous, glabrous; seeds not seen.

Paratypes: MÉXICO. Campeche: Mpio. Campeche, 2 km Noroeste de Chiná, 10°47’15”N, 90°31’50”W. alt. 08 msnm, Selva baja subcaducifolia secundaria, suelo negro, inundable, 23 Nov 1998, *C. Gutierrez B. 6056* (CICY, MEXU, UCAM); Mpio. Calkini, 10 km al O de Tankuche, sobre el camino a Punta Arenas. Zona transicional entre selva baja y manglar con *Hematoxyllum*, 1 Dec 1988, *Cabrera & Cabrera 15304* (MEXU).

Etymology.—The epithet is based on Latin *soror*, *-is*, meaning sister. This is intended to draw attention to the similarity between this species and *Ipomoea ternifolia*.

Distribution.—México. Campeche, Yucatan. 8–10 m. Flowering November–December. Endemic to southern Mexico.

This species is noted as growing with mangroves and *Hematoxyllum* in one site, and in others with *Bursera simaruba*, *Metopium brownei*, *Gymnopodium floribundum*, *Croton* spp., *Pterocereus gaumeri*, *Cienfugosia yucatanensis*, *Bakeridesia gaumeri*, *Myrmecophila christinae* and *Tillandsia fasciculata*. Apparently, the species is tolerant of the drier deciduous forest and inundation where this habitat approaches mangroves. Soils are recorded as litosols mixed with rendsins, shallow and with outcrops of calcareous rocks, flooded during the rainy season (*suelo negro somero muy pedregoso, suelo negro inundable*).

Ipomoea sororia is similar to not only *I. ternifolia*, but also other species in sect. *Leptocallis* (G. Don) J.A. McDonald (1995). The cordate basal portion and ornamentation on the sepals clearly distinguish *I. sororia* from *I. ternifolia*. Habitat will distinguish *I. sororia* from all related species except *I. ternifolia* and *I. costellata*, which share the lowland deciduous communities.

In McDonald's (1995) key these plants lead to couplet No. 6, where the corollas are shorter than either choice, but longer than 1 cm. Indeed, the variation within *I. plummerae* makes it similar, but *I. sororia* is prostrate, not erect. Then, these plants fall between the traits at couplet No. 7, which leads on one hand to *I. perpartita* and on the other to *I. plummerae* and *I. ternifolia*. *Ipomoea sororia* has the pedatisect segments, but the corolla tube is darker than the limb of *I. perpartita*. Moreover, the leaves are not twice dissected as in *I. perpartita*.

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TAXONOMIC REVIEW OF *CHRYSOGONUM* (ASTERACEAE: HELIANTHEAE)

G.L. Nesom
Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, TX 76102-4060, U.S.A.

ABSTRACT

Three allopatric varieties are recognized within *Chrysogonum virginianum*: the northern var. *virginianum*, with non-stoloniferous plants and mostly leafy aerial stems; the southern (Gulf coastal plain) var. *australe*, with flagellate stolons and only leafless aerial stems; and the geographically intermediate var. **brevistolon**, var. nov., with stolons of intermediate length and mostly leafy aerial stems. These three taxa are separated by other minor and overlapping differences. Intermediates apparently occur, but uncommonly, between var. *virginianum* and var. *brevistolon*. Variety *australe* is more strongly separated in geographic range and more distinct in morphology.

RESUMEN

Se reconocen tres variedades alopátricas en *Chrysogonum virginianum*: la norteña var. *virginianum*, con ejemplares no estoloníferos y la mayoría de los tallos aéreos con hojas; la sureña (llanura costera del Golfo) var. *australe*, con estolones flagelados y únicamente tallos aéreos sin hojas; y la intermedia geográficamente var. ***brevistolon***, var. nov., con estolones de longitud intermedia y con la mayoría de los tallos aéreos con hojas. Estos tres taxa se separan por otras diferencias menores que se solapan. Se encuentran intermedios aparentemente, pero raramente, entre var. *virginianum* y var. *brevistolon*. La variedad *australe* se separa más en el rango geográfico y tiene una morfología más distinta.

Chrysogonum L. is a monotypic genus represented by *C. virginianum* L. ("Green-and-gold") of the eastern United States, ranging from Mississippi, Alabama, and Florida north to Ohio and Pennsylvania. It has mainly been treated as a single species with two varieties (e.g., Ahles 1968; Stuessy 1977; Cronquist 1980). *Chrysogonum australe* Alexander ex Small was originally published as a separate species (Small 1933) but reduced in rank by Ahles (1964), without comment, to *C. virginianum* var. *australe* (Alexander ex Small) Ahles. In an unpublished treatment of the flora of "the Carolinas and Virginia," Weakley (in manuscript) recognizes *C. australe* as a separate species but provides no rationale for the taxonomic judgement.

Stuessy (1977) distinguished two varieties (var. *virginianum* vs. var. *australe*) based on plant height (15–35 cm vs. 3–14 cm), stem orientation (erect vs. often decumbent), and disposal of leaves (primarily cauline vs. nearly all basal). Stuessy mapped intermediates, not only in the area of North Carolina and South Carolina where the ranges of the two taxa (in his concept) meet, but also nearly throughout the geographic range of the whole complex. Ahles' (1968) distinction of the two taxa in North Carolina and South Carolina was based primarily

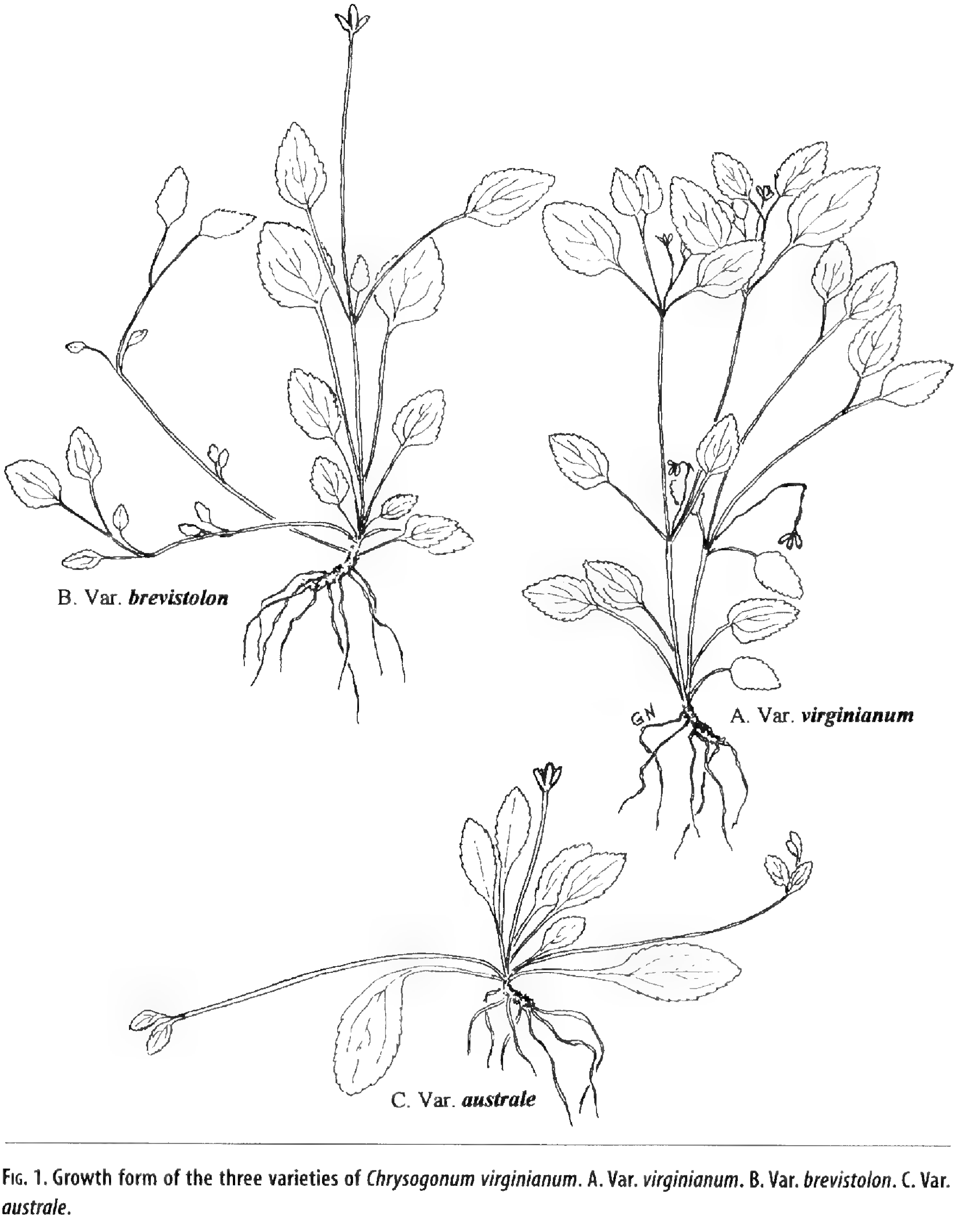

Fig. 1. Growth form of the three varieties of *Chrysogonum virginianum*. A. Var. *virginianum*. B. Var. *brevistolon*. C. Var. *australe*.

on stolon production and his concepts and mapping are closer to what is presented here.

In the present study, variation patterns within the *Chysogonum virginianum* complex are reviewed and three morpho-geographic entities are recognized (Fig. 1; Fig. 3). Their morphological distinction is based primarily on production (or not) of stolons, length of stolon internodes, whether or not the flowering stems are leafy, and height of flowering stems. Variation in other features (vestiture, leaf morphology, capitular and floral morphology, and cypsela and elaiosome morphology) is overlapping and/or parallel among the three taxa.

Data for the present study are from the field and from herbarium specimens. Map records are from BRIT, MO, NCU, OS, SMU, TEX-LL, USCH, and VDB, with some distribution points added from various references (Strausbaugh & Core 1977; Harvill et al. 1981; Fisher 1988; Brown & Brown 1984; Rhoads & Klein 1993).

TAXONOMY

Chrysogonum L., Sp. Pl. 2:920. 1753. TYPE: *Chrysogonum virginianum* L.

> *Diotostephus* Cass., Dict. Sci. Nat. 48:543. 1827. TYPE: *Diotostephus repens* Cass. (see comments below, under var. *brevistolon*).

Chrysogonum virginianum L., Sp. Pl. 2:920. 1753. TYPE: U.S.A. VIRGINIA: [No other data], *J. Clayton 298* (LECTOTYPE, Stuessy 1977 [or ISOLECTOTYPE" fide Reveal 1989 by annotation]: BM, John Clayton Herbarium image!).

Plants herbaceous, perennial, arising from a fibrous-rooted rhizome up to 5 cm long, sometimes stoloniferous, sometimes producing basal offsets. *Stems* erect to erect-ascending (flowering), mostly 10–30 (rarely to 50) cm, or prostrate (nonflowering stolons), up to 50 cm, villous. *Leaves* opposite, basal and cauline, 3(–5)-nerved from the base, elliptic-ovate to deltate-ovate, 2.5–10 cm, petiolate, crenate-dentate to subentire, minutely strigose-hirsutulous to hirsute-villous, also minutely stipitate-glandular above and beneath with hairs ca. 0.1 mm long. *Capitula* axillary, 1–2 per node, solitary on naked peduncles 2–22 cm or appearing to arise from the basal rosette; involucres cupulate-hemispheric, 7–10 cm wide; phyllaries 10 in 2 series, outer oblong-oblanceolate, distal half foliaceous and spreading, inner greenish, rigidly erect and somewhat scarious; receptacles flat to shallowly convex; paleae oblanceolate, ca. 4 mm long, scarious. *Ray florets* 5(–6), pistillate, fertile, corolla laminae yellow, broadly elliptic, 6–17 mm, apically 3-toothed; cypselae each basally adnate to a single inner phyllary, 3 paleae, and 3 sterile disc florets, this "cypsela-complex" deciduous as a unit. *Disc florets* ca. 25–50, functionally staminate, corollas yellow, 2.5–2.7 mm, tubes much shorter than the narrowly funnelform throats, lobes 5, deltate; ovaries sterile; anthers brown to black; styles filiform, the branches mostly undivided; ovaries filiform, epappose. *Cypselae* (ray) obovoid, strongly flattened radially, 3–4.5 mm × 2–2.5 mm, blackish-brown; pappus a low, irregular, 'half-cup-shaped' crown, incomplete on the adaxial face. Base chromosome number, $x = 16$.

An elaiosome is developed at the base of the cypsela-complex (formerly termed "achene-complex"). This is a fleshy, oil-bearing structure elaborated at the base of the phyllary and the two associated outer paleae (Fig. 2). All three taxa of *Chrysogonum* produce elaiosomes; variation in the degree of elaboration of the elaiosome tissue occurs but without apparent geographical pattern.

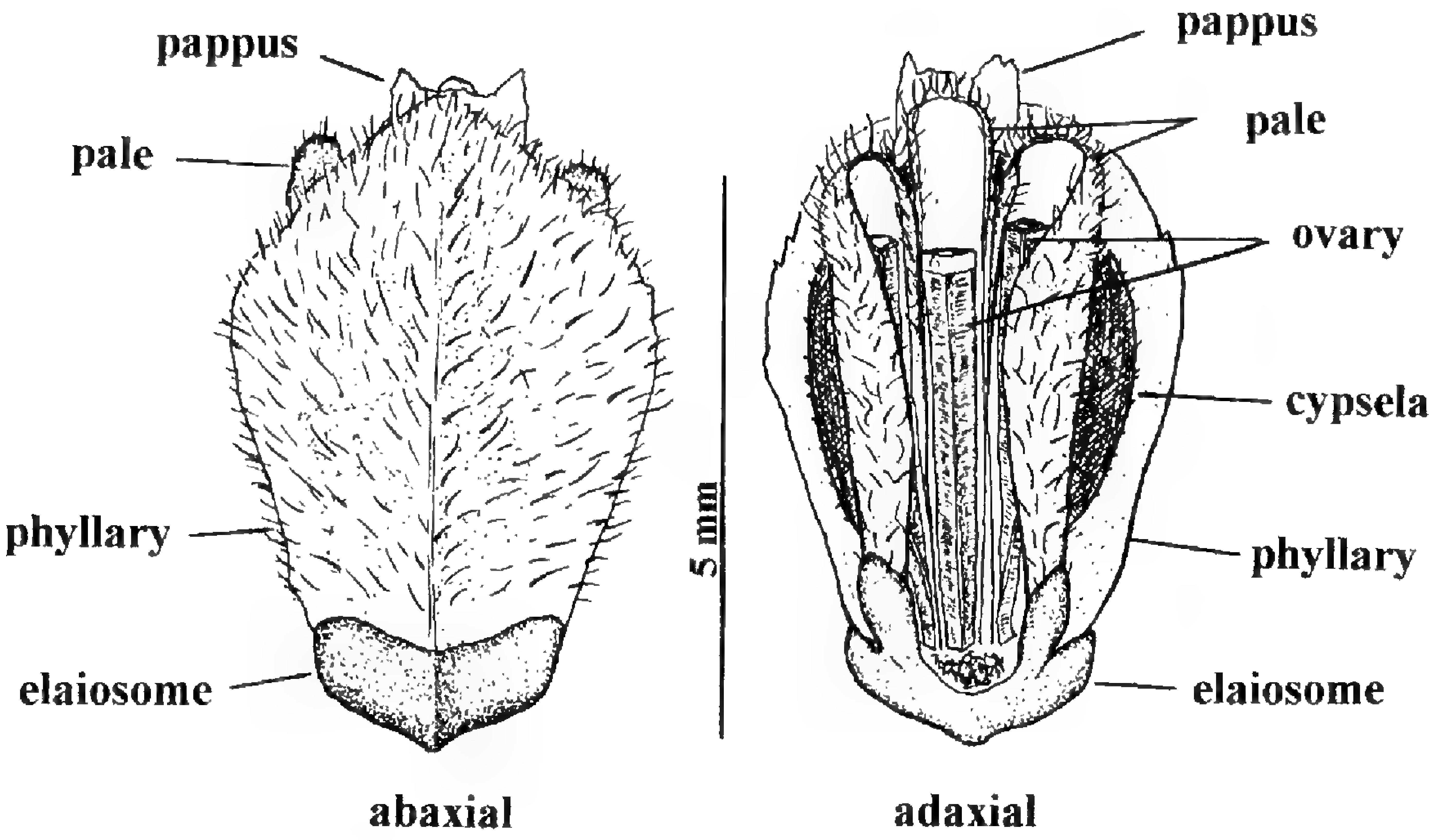

Fig. 2. Cypsela-complex and elaiosome morphology in *Chrysogonum virginianum*.

Native species of ants carry the cypsela-complexes into their nests, chew off the elaiosomes, and return the undamaged cypselae or the whole complexes to the surface (Nesom 1978).

The stolons of var. *brevistolon* and var. *australe* presumably are derived from erect leafy stems (as in var. *virginianum*) where developmental processes have re-oriented them into lateral, prostrate or decumbent branches. In var. *australe*, the stolons commonly produce leaves and rooting plantlets only at the apex; another pair of leaves less commonly is produced proximal to the stolon apex. In var. *brevistolon*, the stolons are shorter and produce leaves more frequently at rooting nodes along the length. The basal offsets that are uncommonly produced in var. *virginianum* apparently are essentially subterranean rhizomes produced from the caudex or main rhizome without the herbaceous nature that would indicate they are directly derived from erect branches.

In all three varieties of *Chrysogonum virginianum*, the first (earliest-flowering) capitula are borne on leafless, ebracteate scapes. These scapes apparently are homologous with the leafless and ebracteate peduncles of later capitula that are raised on leafy stems in var. *virginianum* and var. *brevistolon*. In this view, the permanently 'acaulescent' flowering stems of var. *australe* remain in an early development stage and can be interpreted as neotonous.

Chromosome numbers are invariantly $2n = 32$ for var. *virginianum* and var. *brevistolon*. A count has not been made for var. *australe* sensu stricto. Chromosome counts reported below as "Nesom unpublished" were made by the author in 1975 and 1976 from field-collected meiotic materials from North Carolina localities. In all observations, meiosis and tetrad formation were regular; 16 bivalents were observed in populations from Lee, Montgomery, Moore, and Orange cos. (var. *virginianum*) and Wilkes Co. (var. *brevistolon*). Eight tetravalents were regularly produced in one population from Orange Co., N.C. (UNC campus); in one population from Wake Co., N.C. (Umstead State Park), four to eight tetravalents were commonly formed.

All three taxa of *Chrysogonum* are now used as garden plants and are sold in nurseries under various horticultural names.

KEY TO THE VARIETIES OF *CHRYSOGONUM VIRGINIANUM*

1. Plants occurring individually, without stolons; earliest flowering stems leafless, later ones leafy; leafy flowering stems mostly 15–35(-50) cm high ____________ var. **virginianum**
1. Plants colonial, mat-forming by stolons; flowering stems leafless and/or leafy; leafy flowering stems (if present) mostly 15–25 cm high.
    2. Earliest flowering stems leafless, mostly 2–10 cm hign, later ones leafy, 15–25 cm high; longest stolon internodes 2–6 cm ____________ var. **brevistolon**
    2. All flowering stems leafless, 2–10 cm high; longest stolon internodes 12–60 cm ____________ var. **australe**

1a. Chrysogonum virginianum L. var. virginianum (Fig. 1)

Chrysogonum virginianum L. var. *dentatum* A. Gray, Bot. Gaz. 7:31. 1882. TYPE: U.S.A. MARYLAND. MONTGOMERY CO.: High Island in the Potomac River, 6 Jun 1881, *J.D. Smith s.n.* (HOLOTYPE: GH!).

Plants without stolons, not colonial or mat-forming. Stems (flowering) 15–35(–50) cm tall, the earliest leafless, becoming leafy. Leaves: blades deltate-ovate, basally abruptly cuneate to truncate or subcordate, minutely strigose-hirsutulous with ascending-appressed hairs 0.1–0.3 mm long. Capitula: peduncles 2–22 cm long; outer phyllaries 6–11(–15) mm long, 3–7 mm wide. Chromosome number, $2n = 32$ (Montgomery Co., Md.–Kovanda 1978; Lee Co., Montgomery Co., Moore Co., Orange Co., and Wake Co., N.C.–Nesom unpublished).

Flowering spring–early summer or longer with moisture (late Mar–Jun, –Jul and later). Moist to dry woodlands and forests, usually in partially sunny sites, especially in clearings and along edges; D.C., Ky., Md., N.Y., N.C., Ohio, Pa., S.C., Va., W.Va. The report from New York (Mitchell & Tucker 1999) is noted as an escape from cultivation.

Plants of var. *virginianum* do not produce leafy stolons, but basal offsets sometimes increase the size of the plant. Elongation of basal offsets or the primary rhizome may produce the effect of separate but interconnected plants, but such offsets/rhizomes are not commonly produced, except (apparently) in Maryland, D.C., and adjacent regions of Virginia. Plants of var. *virginianum* occur as discrete individuals but they are usually clustered, probably as a result of the pattern of cypsela-complex dispersal by ants. The flowering stems are erect; the first are leafless; they are later leafy as the lower internodes elongate.

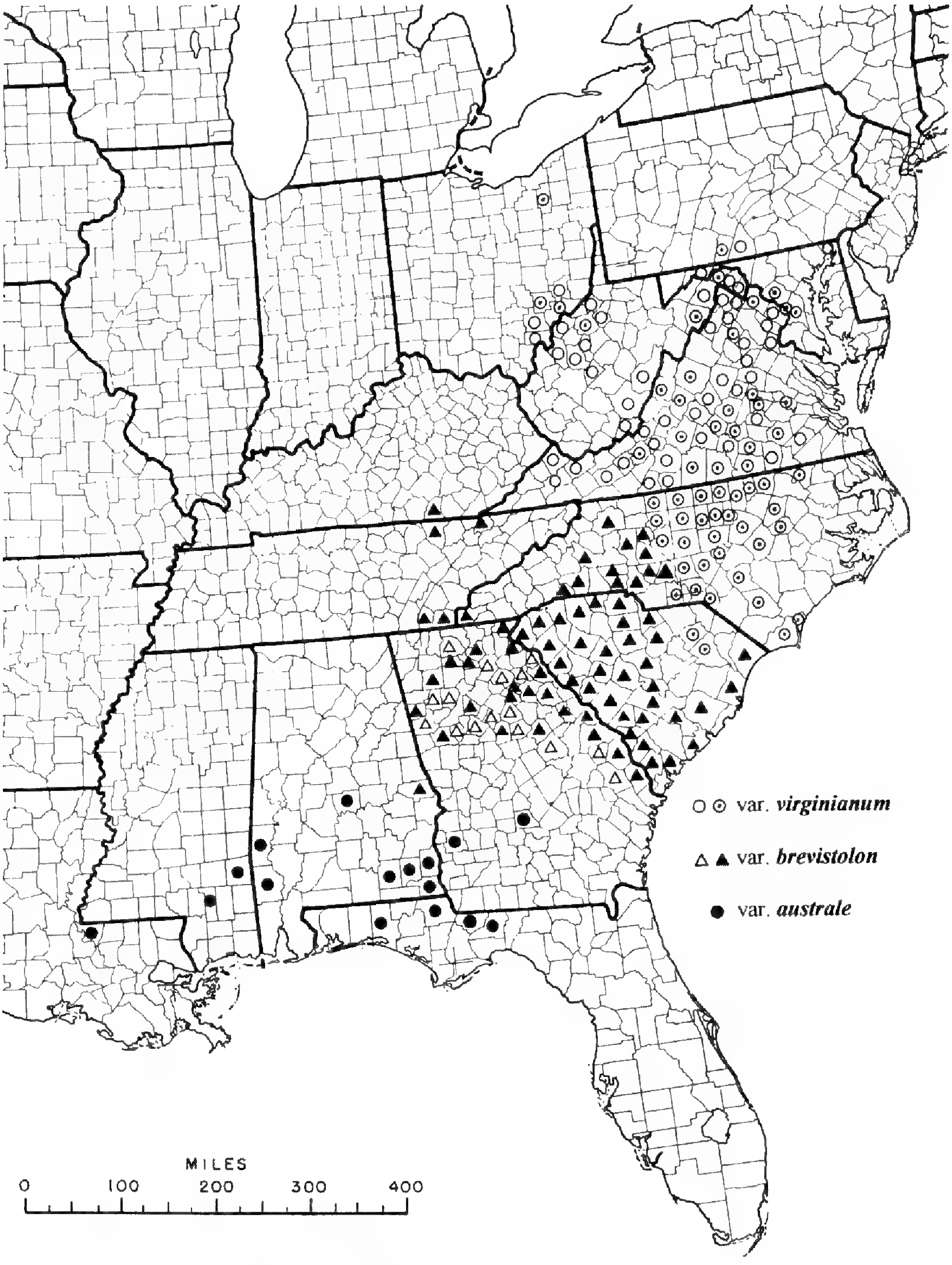

Fig. 3. Geographic distribution of the three varieties of *Chrysogonum virginianum*. Distribution points added from literature references (without vouchers seen by the author) are indicated as open (unfilled) symbols. A record for Greene County, Tenn., shown in Chester et al. (1997) is vouchered by a specimen collected from cultivation (B.E. Wofford pers. comm.) and is not included in the present account.

1b. Chrysogonum virginianum var. **brevistolon** Nesom, var. nov. (**Fig. 1**). TYPE: U.S.A. SOUTH CAROLINA. LEXINGTON CO.: Riverbanks Zoo Botanical Garden, old Saluda Mill site, shaded slope near ravine just S of tram line clearing, occasional herbs, somewhat trailing but with flowering stems generally erect, 7 May 1993, *J.B. Nelson 14,062* (HOLOTYPE: BRIT!; ISOTYPE: USCH!).

Differt a var. *virginiano* stolonibus et habitu coloniali; differt a var. *australi* stolonibus brevioribus foliaceis internodiis brevibus.

Diotostephus repens Cass., Dict. Sci. Nat. 48:544. 1827. *Chrysogonum diotostephus* DC., Prodr. 5:510. 1836 (nom. nov. illegit.). TYPE: "Nous avons fait cette description, générique et spécifique, sur un très petit ènchantillon sec, incomplet, en mauvais ètat, et dont nous ignorons l'origine" (HOLOTYPE: P?). As noted by Stuessy (1977), Cassini's description of this taxon is explicit enough that its identity as *C. virginianum* seems reasonable, and de Candolle, who saw the specimen, treated it within *Chrysogonum* (as *C. diotostephus*, see below). Its association here with var. *brevistolon* rather than var. *australe* is based on de Candolle's description of its habitat as " in siccis pinguibus Carolinae."

Plants stoloniferous, colonial and mat-forming; stolons (leafy above-ground runners) with longest internodes 2–6 cm, these often becoming lignescent, partially to fully buried and rhizome-like. Stems (flowering) mostly 2–25 cm tall, the earliest leafless, becoming leafy. Leaves: blades deltate-ovate, basally abruptly cuneate to truncate or subcordate, strigose-hirsutulous with hairs 0.5–0.3 mm long. Capitula: peduncles 2–22 cm long; outer phyllaries 6–10 mm long, 3–4 mm wide. Chromosome number, $2n = 32$ (Clarke Co., Ga.–Jones 1968; Lancaster Co., S.C.–Solbrig et al. 1972; Rutherford Co., N.C.–Morton 1981; Wilkes Co., N.C.–Nesom unpublished).

Flowering spring–early summer (Mar–May, –early Jun). Moist to dry woodlands, usually in partially sunny sites; Ala., Ga., Ky., N.C., S.C., Tenn.

Variety *brevistolon* differs from var. *virginianum* primarily by elongation and lateral re-orientation of the basally produced stems of the latter into stolons or stoloniform branches. Stolon production in var. *brevistolon* results in colonies of closely interconnected plants (often densely matted), in contrast to the individuals of var. *virginianum*. The distinction between var. *virginianum* and var. *brevistolon* usually can be determined from herbarium collections, but early-flowering plants commonly produce only a single head from a basal rosette of leaves and observation of later growth is necessary to observe stolon production. In a few instances, it is possible that intermediates and infra-population variation occur (e.g., in NCU and USCH collections from Darlington and Florence cos., S.C.), and lignescent stolons (becoming partially buried and rhizome-like) of var. *brevistolon* may be very similar to structures in var. *virginianum* that originate as basal offsets or rhizomes. Using the criteria discussed here for their distinction, however, var. *virginianum* and var. *brevistolon* have closely contiguous, non-overlapping geographic ranges.

Stolon length appears to vary in var. *brevistolon*, although the stolons are never like those of var. *australe* and intermediates between var. *brevistolon* and var. *australe* have not been observed. In earlier phases of the present study, however, no distinction was made between var. *brevistolon* and var. *australe* (as recognized here), and all were annotated as var. *australe*, based on their production of distinct stolons (in contrast to var. *virginianum*).

The erect stems of var. *brevistolon* tend to be shorter than in var. *virginianum* but are often otherwise indistinguishable. In both taxa, the erect stems become leafy, with 2–3 internodes.

In var. *virginianum*, a flower bud is produced in each leaf axil, and two capitula on naked peduncles are produced at each node (from a pair of opposite leaves). On the prostrate to decumbent stoloniform branches of var. *brevistolon*, one of the axillary flower buds commonly is suppressed and a node produces only a single capitulum, which is held erect. This mechanism for bud suppression tends to be active even on the erect branches of var. *brevistolon*, and on a plant collected without complete lower parts, observation of a single axillary shoot per node on erect stems is a reliable indication of its identity. The converse is not true, because plants of var. *brevistolon* may also produce both axillary buds at a node.

1c. Chrysogonum virginianum var. **australe** (Alexander ex Small) Ahles, J. Elisha Mitchell Sci. Soc. 80:173. 1964. (**Fig. 1**). *Chrysogonum australe* Alexander ex Small, Man. Southeast. Fl., 1415, 1509. 1933. TYPE: U.S.A. FLORIDA. JACKSON CO.: dry woods, somewhat calcareous, about a mile E of Marianna, 16 Mar 1925, *R.M. Harper s.n.* (HOLOTYPE: NY; ISOTYPES: GH!, US!).

Plants stoloniferous, mat-forming; stolons (leafy above-ground runners) with longest internodes 12–60 cm, apparently remaining herbaceous. Stems (flowering) 2–10 cm tall, leafless. Leaves: blades elliptic-ovate, gradually tapered to the petiole, villous-hirsute with spreading hairs 1–3 mm long. Capitula: peduncles 2–10 cm long; outer phyllaries 7–10 mm long, 2.5–4 mm wide. Chromosome number unknown.

Flowering spring (mid Mar–Apr, –May). Pine-oak, longleaf pine, beech-oak-magnolia woods, ravine slopes, limestone outcrops, floodplains and terraces, sand or sandy loam; Ala., Fla., Ga., La., Miss.

Variety *australe*, as recognized here, corresponds in geographic range almost exactly to the "East Gulf Coastal Plain" phytogeographic pattern outlined by Sorrie and Weakley (2001). Plants of this taxon are recognized by their leafless flowering stems and whip-like stolons with long internodes. They are so strikingly different in appearance from those of var. *virginianum* that treatment of var. *australe* as a separate species might be justified. This is further emphasized by the apparent allopatry (and corresponding genetic isolation) of var. *australe*. The existence of a broad region of morphologically and geographically intermediate populations (var. *brevistolon*), however, makes it reasonable to view var. *australe* and var. *virginianum* as extremes of a three-segmented array of variation within a single species.

Besides the features of stolons and flowering stems, var. *australe* is distinguished from the other two varieties by a tendency for the leaf blades to be basally attenuate, a tendency for stems and petioles to be more villous (with longer trichomes), and a tendency for the phyllaries to be narrower. Variability in these features of var. *australe* overlaps with that in the other two varieties.

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TAXONOMY OF THE *DICHOTOMA* GROUP OF *DICHANTHELIUM* (POACEAE)

Richard J. LeBlond

North Carolina Natural Heritage Program
P.O. Box 787
Richlands, NC 28574 0787, U.S.A.

ABSTRACT

Eleven taxa associated with the *Dichotoma* group of *Dichanthelium* are recognized, including eight species and three varieties. A summary of recent taxonomic treatment of the group is provided, along with a key to the species and varieties, plus synonymy, typification, discussion, distribution, and ecology. Six new combinations are made: *Dichanthelium annulum* (Ashe) R.J. LeBlond, *D. dichotomum* (L.) Gould var. *nitidum* (Lam.) R.J. LeBlond, *D. dichotomum* var. *ramulosum* (Torr.) R.J. LeBlond, *D. dichotomum* var. *roanokense* (Ashe) R.J. LeBlond, *D. lucidum* (Ashe) R.J. LeBlond, and *D. sphagnicola* (Nash) R.J. LeBlond.

RESUMEN

Se reconocen once taxa asociados con el grupo *Dichotoma* de *Dichanthelium*, que incluyen ocho especies y tres variedades. Se ofrece un resumen del reciente tratamiento taxonómico del grupo, junto con una clave para las especies y variedades, junto con sinonimias, tipificación, discusión, distribución y ecología. Se hacen seis combinaciones nuevas: *Dichanthelium annulum* (Ashe) R.J. LeBlond, *D. dichotomum* (L.) Gould var. *nitidum* (Lam.) R.J. LeBlond, *D. dichotomum* var. *ramulosum* (Torr.) R.J. LeBlond, *D. dichotomum* var. *roanokense* (Ashe) R.J. LeBlond, *D. lucidum* (Ashe) R.J. LeBlond, y *D. sphagnicola* (Nash) R.J. LeBlond.

INTRODUCTION

In their seminal treatment of North American *Panicum*, Hitchcock and Chase (1910) established *Dichanthelium* as a subgenus, which they further subdivided into 17 "minor groups. ... These names are not intended to be formal and should have no nomenclatural standing." *Dichotoma* is one of these "minor groups," though it should be noted that *Dichotoma* has been used to name a section that includes all North American species of *Dichanthelium* found north of Mexico (Hsu 1965; Crins 1991). *Dichanthelium* was elevated to generic rank by Gould (1974) based on morphological characters, an interpretation more recently supported by molecular data (Giussani et al. 2000).

Although most current treatments do not recognize the Hitchcock and Chase groups, the implied relationships are reflected in key groupings, infraspecific alignments, and synonymy. Hitchcock and Chase recognized 14 taxa in their *Dichotoma* group, all at the rank of species: *Panicum annulum* Ashe, *P. barbulatum* Michx., *P. boreale* Nash, *P. caerulescens* Hack. ex Hitchc., *P. clutei* Nash, *P. dichotomum* L., *P. lucidum* Ashe, *P. mattamuskeetense* Ashe, *P. microcarpon* Muhl.

ex Elliott, *P. multirameum* Scribn., *P. nitidum* Lam., *P. roanokense* Ashe, *P. sphagnicola* Nash, and *P. yadkinense* Ashe. *Panicum nudicaule* Vasey was added by synonymy in later treatments of *Dichotoma* taxa (Gould & Clark 1978; Clewell 1985; Hansen & Wunderlin 1988; Wunderlin 1998) but evidently is more closely related to tropical species or to members of Hitchcock and Chase's *Laxiflora* group. Gould and Clark (1978) treated *Dichanthelium boreale* (Nash) Freckmann (=*Panicum boreale*) as a species separate from their concept of the *Dichotoma* group, regarding it as appearing "to be close to and possibly intergrading with *D. dichotomum* var. *dichotomum* and *D. commutatum*." Gould and Clark also placed *Panicum bicknellii* Nash and *P. calliphyllum* Ashe, members of Hitchcock and Chase's *Bicknelliana* group, in synonymy with *D. boreale*.

This treatment recognizes 10 taxa—seven species and three varieties—from the original *Dichotoma* group: *Dichanthelium annulum* (Ashe) R.J. LeBlond (comb. nov.), *D. caerulescens* (Hack. ex Hitchc.) Correll, *D. dichotomum* (L.) Gould, *D. dichotomum* var. *nitidum* (Lam.) R.J. LeBlond (comb. nov.), *D. dichotomum* var. *ramulosum* (Torr.) R.J. LeBlond (comb. nov.) (=*Panicum microcarpon*), *D. dichotomum* var. *roanokense* (Ashe) R.J. LeBlond (comb. nov.), *D. lucidum* (Ashe) R.J. LeBlond (comb. nov.), *D. mattamuskeetense* (Ashe) Mohlenbr., *D. sphagnicola* (Nash) R.J. LeBlond (comb. nov.), and *D. yadkinense* (Ashe) Mohlenbr. Even though its closest relatives undoubtedly lie outside the *Dichotoma* group, *D. nudicaule* (Vasey) B.F. Hansen & Wunderlin is also treated here because of its morphological similarity to *Dichotoma* taxa (e.g., minute ciliate ligules, glabrous internodes), and because of recent treatments in synonymy. *Dichanthelium boreale* is in need of additional study and is not treated here. No attempt is made to elevate the status of *Dichotoma* above an informal grouping of taxa that appear to be very closely related (corroborated by synonymy assignments in recent treatments).

RECENT TAXONOMIC TREATMENT

Hitchcock and Chase's *Dichotoma* group species concepts were largely maintained in regional manuals until 1964. Fernald (1950) added *P. lucidum* var. *opacum* Fernald, treated *P. clutei* as *P. mattamuskeetense* var. *clutei* (Nash) Fernald, and treated *P. barbulatum* as *P. dichotomum* var. *barbulatum* (Michx.) A.W. Wood. Gleason (1952) added *P. annulum* var. *glabrescens* Gleason, treated *P. microcarpon* as *P. nitidum* var. *ramulosum* Torr., and synonymized *P. lucidum* var. *opacum* with *P. lucidum*, *P. clutei* with *P. mattamuskeetense*, *P. barbulatum* with *P. dichotomum*, and *P. caerulescens* with *P. roanokense*. In summary, Fernald recognized all 12 of the *Dichotoma* taxa attributed to the region covered by *Gray's Manual of Botany*, plus *P. lucidum* var. *opacum*, and Gleason recognized nine of the same taxa (not including *P. lucidum* var. *opacum*), plus *P. annulum* var. *glabrescens*. Among the Hitchcock and Chase *Dichotoma* taxa, only *Panicum multirameum* and *P. sphagnicola* were not known from the northeastern U.S.

Radford et al. (1964) reduced the 11 *Dichotoma* taxa known to occur in the Carolinas to a single taxon, *Panicum dichotomum* (not including *P. sphagnicola*, which was included in synonymy by Radford et al. 1968, but a specimen has not been found). This single-species concept was also used in several subsequent treatments, notably Correll and Johnson (1970), Gould and Clark (1978), Hansen and Wunderlin (1988), and Zuloaga et al. (1993). Gould and Clark additionally included all 11 species of Hitchcock and Chase's *Ensifolia* group within their concept of *D. dichotomum*, thereby reducing Hitchcock and Chase's concept of 25 species (not including *boreale* but including *nudicaule*) to a single species comprising five varietal taxa. The 13 *Dichotoma* taxa plus *nudicaule* were treated as a single taxon, *D. dichotomum* var. *dichotomum*, with the 11 *Ensifolia* species reduced to four varieties: D. *dichotomum* var. *ensifolium* (Baldwin) Gould & C.A. Clark, var. *tenue* (Muhl.) Gould & C.A. Clark, var. *glabrifolium* (Nash) Gould & C.A. Clark, and var. *breve* (Hitchc. & Chase) Gould & C.A. Clark. *Ensifolia* taxa were separated from *Dichotoma* taxa at the species level in later treatments (Godfrey & Wooten 1979; Lelong 1984, 1986; Hansen & Wunderlin 1988; Gleason & Cronquist 1991; Zuloaga et al. 1993; Wunderlin 1998). Clewell (1985), however, exceeded even Gould and Clark's reduction by lumping all *Dichotoma* and *Ensifolia* taxa into a single taxon, *Dichanthelium dichotomum*.

Lelong (1984) argued that some taxa in Hitchcock and Chase's *Dichotoma* group deserved a better fate than "being buried in synonymy," and resurrected six former species as varieties of *Panicum dichotomum*: var. *lucidum* (Ashe) Lelong (including *P. sphagnicola* and *P. lucidum* var. *opacum*), var. *mattamuskeetense* (Ashe) Lelong (including *P. annulum* and *P. clutei*), var. *nitidum* (Lam.) A.W. Wood, var. *ramulosum* (Torr.) Lelong, var. *roanokense* (Ashe) Lelong (including *P. caerulescens*), and var. *yadkinense* (Ashe) Lelong. Neither *Panicum boreale* nor its synonyms, *P. bicknellii* and *P. calliphyllum*, are included in synonymy under Lelong's concept of *Dichotoma* taxonomy. Lelong (1986) included *P. barbulatum* in synonymy with *P. dichotomum* var. *dichotomum*, and recognized *Panicum nudicaule* at the rank of species. The only other Hitchcock and Chase *Dichotoma* entity is *Panicum multirameum*, known from Mexico to Venezuela and Jamaica. It is treated in the present study as a synonym of *D. dichotomum* var. *nitidum*.

DISTRIBUTION AND ECOLOGY

All 10 *Dichotoma* group taxa treated here, plus *Dichanthelium nudicaule*, are centered in the eastern U.S., and five are endemic: *Dichanthelium annulum, D. lucidum, D. mattamuskeetense, D. nudicaule*, and *D. sphagnicola*. Distribution of species and populations in the U.S. is concentrated in the Atlantic and Gulf Coast states from New Jersey south to Florida and west to Texas, and extending as far inland as Illinois, Missouri, and Oklahoma. *Dichanthelium dichotomum* var. *dichotomum* is the only taxon reaching Canada (New Brunswick and

Ontario). Three taxa range southward to the Bahamas and West Indies: *D. caerulescens*, *D. dichotomum* var. *nitidum*, and *D. dichotomum* var. *roanokense* (the last not in the Bahamas). Two reach Mexico: *D. dichotomum* var. *nitidum* and *D. yadkinense*, with *D. dichotomum* var. *nitidum* reaching Central America and South America (Venezuela).

Within the U.S., three are endemic to the Atlantic and/or Gulf coastal plains: *D. mattamuskeetense*, *D. nudicaule*, and *D. sphagnicola*. *Dichanthelium caerulescens* and *D. dichotomum* var. *roanokense* are restricted to the coastal plain in the U.S. portion of their ranges. *Dichanthelium dichotomum* var. *nitidum* and *D. lucidum* are primarily found on the coastal plain in the U.S., but range inland: *nitidum* to the Appalachians, and *lucidum* to the Great Lakes. *Dichanthelium dichotomum* var. *dichotomum*, *D. dichotomum* var. *ramulosum*, and *D. yadkinense* are widespread from the Atlantic and Gulf coasts to the Midwest, though *D. yadkinense* appears to be less frequent. Only *Dichanthelium annulum* is primarily an inland species, nearly restricted to the Appalachian Province with very few coastal plain occurrences.

Literature sources for range data in the descriptions are Hitchcock and Chase (1910, 1915), Fernald (1950), Hitchcock (1951), Correll and Correll (1982), Lelong (1986), Zuloaga et al. (1993), Homoya et al. (1995), Angelo and Boufford (1998), and Schuyler (2000). All reported U.S. states of occurrence are listed, including District of Columbia (DC).

The majority of *Dichotoma* group taxa are adapted to wet habitats, including swamps, marshes, and wet pine savannas and flatwoods. *Dichanthelium dichotomum* var. *ramulosum* and *D. dichotomum* var. *nitidum*, primarily plants of wet habitats, can occasionally be found in dry situations (with var. *nitidum* known only from dry habitats south of the U.S.). *Dichanthelium dichotomum* var. *dichotomum* is primarily a plant of wet-mesic to dry woodlands. *Dichanthelium annulum* is a plant of dry rocky or sandy open woods and calcareous grasslands (barrens) and is thus distinguished by habitat and range as well as by morphology from other *Dichotoma* taxa. All of the *Dichotoma* taxa (plus *D. nudicaule*) primarily or exclusively found on the Atlantic and/or Gulf coastal plains are restricted to wetland habitats.

SYSTEMATICS

Dichanthelium is a frustratingly complex genus. Familiarity with living populations is helpful in understanding taxonomic concepts, but lack of *in situ* familiarity with taxa outside of one's area of work can lead to parochial treatments. Many *Dichanthelium* taxa are clinal, distinct in one part of their range and indistinct in another, adding to the difficulty of a range-wide approach. Intermediates can be found even among apparently more stable taxa. Despite these difficulties, most *Dichotoma* specimens, and especially living plants, are readily assignable to a taxon and most taxa display fidelity to a limited range of habitats.

The following key and discussions are proposed as a foundation for a range-wide treatment of *Dichotoma* group taxa. They result from field and herbarium study beginning in 1985, and the accumulated efforts of other students of the genus. Field familiarity includes much of the Atlantic and Gulf coastal plains from Massachusetts to Mississippi, and Andros Island in the Bahamas. Since 1990 I have been a fulltime field botanist in the coastal plain of North Carolina, where nine of the 10 *Dichotoma* taxa are found. The treatment is based primarily on a study of the extensive collections at US, NCU and DUKE, specimens in my own collection, and living populations. As much as possible, it relies on features of the spikelet to distinguish taxa, particularly spikelet and first glume length, pubescence, and fertile lemma length and width. Taxa with consistent diagnostic characters throughout their range are treated as full species, even if sometimes appearing intermediate toward other taxa in some features (e.g., *D. mattamuskeetense, D. sphagnicola*).

KEY TO *DICHANTHELIUM DICHOTOMA* GROUP TAXA AND *D. NUDICAULE*

1\. Nodes, at least lower, bearded.
  2\. Culm internodes (at least middle and upper) and peduncle sparsely to moderately spreading short-hairy, sometimes also glandular; vernal cauline blades velvety-pubescent on both surfaces, often densely so; spikelets (1.5–)1.8–2.1 mm long; plants of dry rocky or sandy soil and barrens **1. D. annulum**
  2\. Culm internodes glabrous; at least middle and upper cauline blades glabrous (if pubescent, then spikelets 2.0–2.8 mm long in *D. mattamuskeetense*, or fertile lemma densely papillose in *D. lucidum*); spikelets 1.4–2.8 mm long; plants mostly of wet soils and mesic to dry woodlands.
    3\. Spikelets glabrous.
      4\. Spikelets 1.8–2.3 mm long; first glume 0.6–1.1 mm long; fertile lemma 0.8–1.0 mm wide; widest vernal blades 3–8(–10) mm wide **3. D. dichotomum** var. **dichotomum**
      4\. Spikelets 1.4–1.9 mm long; first glume 0.3–0.6(–0.7) mm long; fertile lemma 0.6–0.8 mm wide; widest vernal blades 7–15 mm wide **5. D. dichotomum** var. **ramulosum**
    3\. Spikelets pubescent (rarely in *D. dichotomum* var. *ramulosum*).
      5\. Spikelets (2.0–)2.2–2.8 mm long; first glume 0.5–1.3 mm long; fertile lemma 1.8–2.3 mm long; lowest vernal cauline blades pubescent at least abaxially **8. D. mattamuskeetense**
      5\. Spikelets 1.4–2.2 mm long; first glume 0.3–0.9 mm long; fertile lemma 1.4–1.7 mm long; lowest vernal cauline blades glabrous.
        6\. Spikelets 1.7–2.2 mm long; first glume 0.6–0.9 mm long; fertile lemma 0.7–1.0 mm wide **4. D. dichotomum** var. **nitidum**
        6\. Spikelets 1.4–1.9 mm long; first glume 0.3–0.6(–0.8) mm long; fertile lemma 0.6–0.8 mm wide **5. D. dichotomum** var. **ramulosum**
1\. Nodes beardless, though sometimes short-pubescent.
  7\. Cauline leaves mostly basally disposed, strongly ascending, much larger than the 2–3 remote middle and upper cauline leaves of fertile culms; spikelets 2.4–2.9 mm long; culms branch from basal and lower nodes, but are not known to produce autumnal inflorescences **9. D. nudicaule**

7. Cauline leaves well-distributed along culm, more than three, gradually reduced upwards and often spreading; spikelets 1.4–2.6 mm long; culms branch either from all nodes, or from middle and/or upper nodes, producing autumnal inflorescences.
    8. Widest vernal cauline blades 7–15 mm wide; upper sheaths often glutinous-warty; spikelets 2.1–2.6 mm long, some or most acute to beaked, second glume and sterile lemma extending 0.3–0.5 mm beyond fertile lemma in at least some spikelets ____ **11. D. yadkinense**
    8. Widest vernal cauline blades 3–10 mm wide; upper sheaths not glutinous-warty; spikelets 1.4–2.7 mm long, blunt to subacute, second glume and sterile lemma equal to or shorter than fertile lemma, or extending less than 0.3 mm beyond it.
        9. Spikelets 1.4–1.8 mm long; first glume 0.3–0.8 mm long; fertile lemma 1.3–1.5 mm long, smooth; mature vernal panicles usually short-exerted with ascending branches; fresh foliage bluish-glaucous ____ **2. D. caerulescens**
        9. Spikelets (1.5–)1.7–2.7 mm long, if as short as 1.5 mm, then with densely papillose fertile lemma (*D. lucidum*); first glume 0.6–1.4 mm long; fertile lemma 1.5–2.2 mm long, smooth or densely papillose; mature vernal panicles exerted with spreading branches; fresh foliage not bluish-glaucous.
            10. Culms weak, soon sprawling over other vegetation; spikelets either pubescent or fertile lemma and palea minutely but densely papillose at 20×.
                11. Spikelets 2.2–2.7 mm long, pubescent; first glume 1.0–1.4 mm long; fertile lemma and palea smooth or with a few weak papillae at 20× ____ **10. D. sphagnicola**
                11. Spikelets (1.5–)1.7–2.3 mm long, glabrous (rarely pubescent); first glume 0.7–1.1 mm long; fertile lemma and palea densely papillose at 20× ____ **7. D. lucidum**
            10. Culms stiffer, erect to ascending; spikelets glabrous, fertile lemma with no or few papillae.
                12. Vernal cauline blades stiffly erect; plants of wet pine savannas and open swamps ____ **D. dichotomum** var. **roanokense**
                12. Vernal cauline blades spreading to deflexed, flexuous; plants of wet-mesic to dry woods and thickets ____ **3. D. dichotomum** var. **dichotomum**

1. Dichanthelium annulum (Ashe) R.J. LeBlond, comb. nov. *Panicum annulum* Ashe, J. Elisha Mitchell Sci. Soc. 15:58. 1898. *Panicum bogueanum* Ashe, J. Elisha Mitchell Sci. Soc. 16:85. 1900, nom. illegit. TYPE: U.S.A. DISTRICT OF COLUMBIA: Dry rocky woods, Woodley Park, 1882, *Ward* s.n. (LECTOTYPE: US!; SYNTYPE: US!).

Panicum annulum var. *glabrescens* Gleason is referable to *D. mattamuskeetense* (Ashe) Mohlenbr.

This poorly known species has been infrequently collected and is presumably rare over its range. It has been treated in synonymy with *D. dichotomum* var. *dichotomum*, specifically with what is here treated as *D. mattamuskeetense*, because of plants from southeastern Massachusetts. *Dichanthelium annulum* is a plant of dry rocky or sandy soil of open woods and calcareous grasslands (barrens), while *D. mattamuskeetense* inhabits wet sandy or peaty acidic soils of wet pine savannas and meadows, and wet borders of pocosins and thickets. As indicated in the key, the middle and upper internodes and peduncle of *D.*

annulum are sparsely to moderately spreading pubescent with hairs 0.1–0.3 mm long. All internodes of *D. mattamuskeetense* are glabrous. Additionally, the internodes of *D. annulum* are typically dull, while those of *D. mattamuskeetense* are shiny. Spikelets of *D. annulum* are (1.5–)1.8–2.1 mm long with first glumes 0.6–0.9 mm long. In *D. mattamuskeetense*, spikelets are 2.0–2.8 mm long with first glumes 0.5–1.3 mm long. Fertile lemmas are (1.2–)1.4–1.8 mm long and 0.8–1.0 mm wide in *D. annulum* and 1.8–2.3 mm long and (0.8–)1.0–1.3 mm wide in *D. mattamuskeetense*. Plants from southeastern Massachusetts with all blades pubescent on both surfaces, glabrous internodes, spikelets 2.2–2.5 mm long, and occurring on moist ground, were treated by Gleason (1952) as *P. annulum* var. *glabrescens* Gleason. These plants may be the source of Fernald's (1950) declaration that *P. annulum* is "perhaps better merged with [*mattamuskeetense*]." Glabrous internodes, spikelet length, and habitat are a much better fit for *D. mattamuskeetense*, as is range. Based on these conditions and character states, *P. annulum* var. *glabrescens* is here synonymized with *D. mattamuskeetense*.

Dichanthelium annulum is one of the more distinctive entities within the *Dichotoma* group. Its combination of short-hairy upper internodes and velvety-pubescent leaves (upper as well as lower) distinguish it from all other taxa in the Hitchcock and Chase *Dichotoma* group. I have not found a treatment that specifically describes the internode pubescence character, but Ashe (1898) described the culms as "below pilose, above generally glabrous," which is opposite of the condition expressed in the two types at US, which are cited in Ashe's paper. Culm internodes and the panicle axis are often glandular in *D. annulum*, with resinous nodules frequently in the grooves between upper internode longitudinal ridges, and with pellucid spots often present on the peduncle and panicle axis (both types at US express these characters). While glutinous-warty spots are encountered on sheaths in the *Dichotoma* group (notably *D. yadkinense* and *D. dichotomum* var. *nitidum*), and occasionally pellucid spots in the panicle axis and branches of *D. dichotomum* var. *nitidum*, further study may show that these glandular expressions provide additional distinguishing characters.

Distribution and habitat.—Distribution of *Dichanthelium annulum* is primarily in the Appalachian Province with very few occurrences on the coastal plain, from New Jersey to Georgia, west to Mississippi, and in Tennessee, southeast Missouri, and southern Indiana (AL, DC, DE, GA, IN, MD, MO, MS, NC, NJ, PA, TN, VA). Recent collections have been made in Lee Co., VA, on July 22, 1996 (*J.C. Ludwig 2872 & G. Fleming*, pers. herb. R.J. LeBlond), and in Harrison Co., IN, on May 19, 1991 (Homoya et al. 1995). A specimen at US (*Hanes & Hanes s.n.*, 3 Jul 1934) that may be the source of Michigan's inclusion in the Hitchcock (1951) range has sparsely bearded nodes, glabrous internodes, and leaves that are membranous, subcordate, and pubescent. This entity may be more closely related to *D. commutatum* (J.A. Schultes) Gould. A specimen at US (*Neill 5021*) that may be the source of Florida's inclusion in the Hitchcock (1951) range has pubescent leaves and pubescent spikelets 1.8–2.0 mm long, but a glabrous and shiny culm. It is not typical and may be more closely related to *D. dichotomum* var. *nitidum*. No other specimens of *D. annulum* have been seen from Michigan or Florida and these states are not here included in the distribution. *Dichanthelium annulum* is a plant of dry rocky or sandy soil of open woods and calcareous grasslands (barrens).

2. Dichanthelium caerulescens (Hack. ex Hitchc.) Correll, J. Arnold Arbor. 60:154. 1979. *Panicum caerulescens* Hack. ex Hitchc., U.S. Natl. Herb. Contr. 12:219. 1909. TYPE: U.S.A. FLORIDA. DADE CO.: "In glade among *Spartina*, etc.," 3 Apr 1906, *Hitchcock 706* (HOLOTYPE: US!).

This species has the smallest spikelets and fertile lemmas among the *Dichotoma* taxa with beardless nodes and non-papillose fertile lemmas. Combined with the usually narrow and short-exerted vernal panicles, bluish-glaucous fresh foliage, and usually erect vernal blades, these characters readily distinguish *Dichanthelium caerulescens* from other *Dichotoma* taxa. It is most similar in habit to *D. dichotomum* var. *roanokense*, which has spikelets 1.8-2.2 mm long (1.4-1.8 mm in *D. caerulescens*) and fertile lemmas 1.6-1.8 mm long (1.3-1.5 mm in *D. caerulescens*). The culms of *D. dichotomum* var. *roanokense* on average are 5-10 dm tall while those for *D. caerulescens* are 3-7.5 dm tall and not as stout. *Dichanthelium caerulescens* also prefers less acidic soils than *D. dichotomum* var. *roanokense*.

Distribution and habitat.—The documented range of *Dichanthelium caerulescens* is discontinuous and restricted to near the coastal edge in New Jersey, Virginia, and North Carolina, and from both coasts of Florida through southern Alabama and Mississippi to Louisiana. It also occurs in the Bahamas, western Cuba, and Puerto Rico. *Dichanthelium caerulescens* inhabits marshes, swamps, wet pinelands, maritime grasslands, and damp sandy soil near the coast. It is most frequently found in habitats where an alkaline or calcareous influence is evident and appears to be one of the least collected members of the *Dichotoma* group.

3. Dichanthelium dichotomum (L.) Gould var. **dichotomum**, Brittonia 26:59. 1974. *Panicum dichotomum* L., Sp. Pl. 58. 1753. *Chasea dichotoma* (L.) Nieuwl., Amer. Midl. Naturalist 2:64. 1911. TYPE: U.S.A. VIRGINIA: "Habitat in Virginia," *Clayton 458* (LECTOTYPE: BM; ISOLECTOTYPE: US!, fragment).

Panicum barbulatum Michx. 1803, Fl. Bor. Amer. 1:49. 1803. *Panicum dichotomum* var. *barbulatum* (Michx.) A.W. Wood, Class-Book Bot., ed. 3:786. *Panicum pubescens* Lam. var. *barbulatum* (Michx.) Britton, Cat. Pl. New Jersey 280. 1889. *Panicum nitidum* var. *barbulatum* (Michx.) Chapm., Fl. South. U.S., ed. 3:586. 1897. TYPE: CANADA: "Hab. in Canada P. capillari affine. Ad ripas amnis: *Rivierre* a Jacques Cartier dicti legi," *Michaux s.n.* (LECTOTYPE: P-MICH; ISOLECTOTYPE: US!, fragment).

Panicum angustifolium Leconte ex Torr., Cat. Pl. New York 91. 1818, non Elliott 1816. TYPE:

unknown. "A vernal specimen in the Torrey Herbarium penciled 'angustifolius (nitid. var.)' but without data may be the type" (Hitchcock & Chase 1910).

Panicum tremulum Spreng., Neue Entd. 2:103. 1821. TYPE: U.S.A.: without data, *Muhlenberg Herb. s.n.* (LECTOTYPE: B, destroyed; ISOLECTOTYPE: US, fragment).

Panicum dichotomum L. var. *divaricatum* Vasey, U.S.D.A. Div. Agrost. Bull. 8:30. 1889. TYPE: U.S.A. MISSISSIPPI: SCOTT CO.: Lake, *Tracy 127* (LECTOTYPE: US!).

Panicum dichotomum L. var. *viride* Vasey, U.S.D.A. Div. Agrost. Bull. 8:30. 1889. *Panicum nitidum* Lam. var. *viride* (Vasey) Britton, Trans. New York Acad. Sci. 9:14. 1889. *Panicum ramulosum* Michx. var. *viride* (Vasey) Porter, Bull. Torrey Bot. Club 20:194. 1893. TYPE: U.S.A. DISTRICT OF COLUMBIA.: Woodley Park, 1881, *Ward s.n.* (LECTOTYPE: US!).

Panicum nitidum Lam. var. *pauciflorum* Britton, Trans. New York Acad. Sci. 9:14. 1889. TYPE: U.S.A.: NEW JERSEY: MORRIS CO.: Shady moist grounds, July [without year], *Britton s.n.* (HOLOTYPE: NY).

Panicum dichotomum L. var. *commune* S. Watson & J.M. Coulter in A. Gray, Manual, ed. 6. 633. 1890. TYPE: unknown.

Panicum gravius Hitchc. & Chase, Rhodora 8:205. 1906. TYPE: U.S.A. DELAWARE: NEWCASTLE CO.: "in sandy, rather dry woods, on the old Commons farm, between Centerville and Mt. Cuba," 30 Jul 1906, *Chase 3620* (HOLOTYPE: US!). Placed in synonymy with *Panicum barbulatum* Michx. by Hitchcock and Chase (1910).

Recognition of the several species and varieties in this treatment reduces but by no means eliminates the apparent genetic diversity in *Dichanthelium dichotomum* var. *dichotomum*. Robust plants with bearded nodes, leaves to 10 mm wide, and top-heavy autumnal inflorescences are referable to *Panicum barbulatum* (*P. dichotomum* var. *barbulatum*), but intermediates abound. Plants frequently are found with bearded nodes, but with the smaller leaves and culms typical of the glabrous node form.

Distribution and habitat.—*Dichanthelium dichotomum* var. *dichotomum* ranges from southern Canada (N.B., Ont.) south to the Gulf Coast, occurring throughout the eastern U.S. (AL, AR, CT, DC, DE, FL, GA, IL, IN, KY, LA, MA, MD, ME, MI, MO, MS, NC, NH, NJ, NY, OH, OK, PA, RI, SC, TN, TX, VA, VT, WV). Gould (1980) included this in synonymy in his treatment of *D. dichotomum* var. *dichotomum* sensu lato in Mexico, but var. *dichotomum* sensu stricto needs confirmation. *Dichanthelium dichotomum* var. *dichotomum* is the most widespread and frequent taxon within the *Dichotoma* group in the U.S., occurring in all states from which other members of the group have been documented. It is found primarily in wet-mesic to dry woods, thickets, and woodland openings.

4. Dichanthelium dichotomum (L.) Gould var. **nitidum** (Lam.) R.J. LeBlond, comb. nov. *Panicum nitidum* Lam., Tabl. Encycl. 1:172. 1791. *Panicum dichotomum* L. var. *nitidum* (Lam.) A.W. Wood, Class-Book Bot., ed. 3:786. *Dichanthelium nitidum* (Lam.) Mohlenbr., Erigenia 6:26. 1985. TYPE: U.S.A. "E. CAROLINA:" *Fraser s.n.* (HOLOTYPE: P-LAM; ISOTYPE: US!, fragment and photo).

Panicum nodiflorum Lam., Encycl. 4:744. 1798. *Panicum dichotomum* var. *nodiflorum* (Lam.) Griseb., Cat. Pl. Cuba 234. 1866. TYPE: U.S.A. "CAROLINE:" *Fraser s.n.* (HOLOTYPE: P-LAM; ISOTYPE: US, fragment and photo).

Panicum multirameum Scribn., U.S.D.A. Div. Agrost. Circ. 19:2. 1900. TYPE: MEXICO: VERACRUZ: near Jalapa, 1889, *Pringle 7882* (LECTOTYPE: US!; ISOLECTOTYPE: MO).

Panicum subbarbulatum Scribn. & Merr., U.S.D.A. Div. Agrost. Circ. 29:9. 1901. TYPE: U.S.A.: *Elliott Herb. s.n.* (HOLOTYPE: CHARL!; ISOTYPE: US!, fragment).

Panicum multirameum, recognized by Hitchcock and Chase (1910, 1915), is an entity from Mexico, Guatemala, and Jamaica. Hitchcock and Chase (1910) describe it as "allied to *P. nitidum*," and a handwritten note (by J.R. Swallen, per P. Peterson, pers. comm.) on the outside of the Mexico-CA *Panicum nitidum* folder at US reads: "There are no consistent characters to distinguish *P. multirameum* from *P. nitidum*. Neither the habit of the autumnal phase nor the viscid-spotted sheaths are constant characters. The type of *P. multirameum* is from dry hills, which would account for its aspect. 5/15/50." I concur with this conclusion after review of the *P. multirameum* specimens at US, although an apparent difference in habitat may warrant further study.

Distribution and habitat.—In the U.S., *Dichanthelium dichotomum* var. *nitidum* is found in the coastal plain from Pennsylvania and New Jersey south to Florida and west to east Texas; also in southeastern Missouri (DE, FL, GA, LA, MO, MS, NC, NJ, PA, SC, TX, VA). There are a few scattered mountain and piedmont records from Virginia to Georgia. It is also known from the Bahamas and West Indies, and from Mexico to Venezuela. *Dichanthelium dichotomum* var. *nitidum* occurs on moist sandy or peaty soil of wet pine savannas and pocosin ecotones, in wet meadows near the coast, and reportedly from swamps and marshes. The *Panicum multirameum* specimens are from dry hills and gravely banks.

5. **Dichanthelium dichotomum** (L.) Gould var. **ramulosum** (Torr.) R.J. LeBlond, comb. nov. *Panicum nitidum* Lam. var. *ramulosum* Torr., Fl. N. Middle United States 146. 1824. *Panicum dichotomum* L. var. *ramulosum* (Torr.) Lelong, Brittonia 36:265. 1984. TYPE: U.S.A. NEW JERSEY: near Quaker Bridge, Jun 1818, *Torrey s.n.* (HOLOTYPE: NY).

Panicum microcarpon Muhl. ex Elliott, Sketch Bot. S. Carolina 1:127. 1816. *Dichanthelium microcarpon* (Muhl. ex Elliott) Mohlenbr., Erigenia 6:26. 1985. TYPE: U.S.A. GEORGIA: *Baldwin s.n.* (LECTOTYPE: CHARL!). Two fragments at US! labeled as isolectotypes of *P. microcarpon* are assignable to *P. polyanthes* Schult. and are examples of the nomenclatural problem discussed by Hitchcock and Chase (1910) for this name.

The infrequent occurrences of pubescent spikelets or first glumes to 0.8 mm in length in *Dichanthelium dichotomum* var. *ramulosum* suggest intergradation with another taxon, possibly *D. dichotomum* var. *nitidum*. The width of the fertile lemma appears to be a more reliable character than the width of the spikelet as a whole (the latter used by Fernald 1950), especially in herbarium specimens.

Distribution and habitat.—*Dichanthelium dichotomum* var. *ramulosum* is found from Massachusetts west to Michigan and south to Florida and Texas (AL, AR, CT, DC, DE, FL, GA, IL, IN, KY, LA, MA, MD, MI, MO, MS, NC, NJ, NY, OH, OK, PA, RI, SC, TN, TX, VA, WV). Gould (1980) included this in synonymy (as *Panicum microcarpon*) in his treatment of *D. dichotomum* var. *dichotomum* in Mexico, but its occurrence there needs confirmation. *Dichanthelium dichotomum* var. *ramulosum* inhabits floodplain forests, swamps, openings, and borders of streams and ponds, and is occasionally found in dry upland woods.

6. Dichanthelium dichotomum (L.) Gould var. **roanokense** (Ashe) R.J. LeBlond, comb. nov. *Panicum roanokense* Ashe, J. Elisha Mitchell Sci. Soc. 15:44. 1898. *Panicum dichotomum* L. var. *roanokense* (Ashe) Lelong, Brittonia 36:265. TYPE: U.S.A. NORTH CAROLINA: DARE CO.: Roanoke Island, Jun 1898, *Ashe s.n.* (PARATYPE: US!, NCU!). The specimen at NCU is labeled "*Panicum roanokense* Type" in Ashe's handwriting and was collected by him, but lacks a date and locale.

Panicum curtivaginum Ashe, J. Elisha Mitchell Sci. Soc. 16:85. 1900. TYPE: U.S.A. MISSISSIPPI: JACKSON CO.: Petit Bois Island, 8 May 1898, *Tracy 4584* (ISOLECTOTYPE: US!). The lectotype, suspected to be at NCU (Hansen & Wunderlin 1988), could not be located.

Dichanthelium dichotomum var. *roanokense* is quite distinctive in the field with its stiff and erect vernal blades, but I can find no other character to consistently separate it from *D. dichotomum* var. *dichotomum*. Other treatments (Hitchcock & Chase 1910; Small 1933; Hitchcock 1951; Fernald 1950; Gleason 1952) variously have used node annulus length, grayish olive-green blade color, spikelet turgidity, glume nerves, and glume basal coloring to separate var. *roanokense* from other *D. dichotomum* taxa, especially var. *dichotomum*. Fernald described the node annulus (the disk-like cartilaginous structure separating the internodes) as two-thirds or more as long as wide in var. *roanokense*, compared with "rarely" one-third as long as wide in var. *dichotomum*. Plants otherwise matching var. *roanokense* but with an annulus less than one-third as long as wide are common. Plants matching var. *roanokense* with olive-green blades are frequent, but plants with green and purplish-tinged blades are also encountered. Spikelets tend to be more turgid than in var. *dichotomum*, and glume and sterile lemma nerves tend to be more pronounced, but there is too much variability in both taxa for this to be of use. Purplish-based glumes are frequent, but also occur in var. *dichotomum*. *Dichanthelium dichotomum* var. *roanokense* is perhaps transitional between var. *D. dichotomum* var. *dichotomum* and *D. caerulescens*.

Distribution and habitat.—The primary range for *Dichanthelium dichotomum* var. *roanokense* in the U.S. is near the coast from Delaware and Virginia south to Florida and west to Texas (AL, DE, FL, GA, LA, MS, NC, SC, TX, VA). It also occurs in Jamaica. Gould (1980) included this in synonymy in his treatment of *D. dichotomum* var. *dichotomum* in Mexico, but its occurrence there needs confirmation. This taxon is found in wet pine savannas, swamp openings, and wet peaty meadows.

7. Dichanthelium lucidum (Ashe) R.J. LeBlond, comb. nov. *Panicum lucidum* Ashe, J. Elisha Mitchell Sci. Soc. 15:47. 1898. *Panicum dichotomum* L. var. *lucidum* (Ashe) Lelong, Brittonia 36:265. 1984. TYPE: U.S.A. NORTH CAROLINA: DARE CO.: swamps bordering Lake Mattamuskeet, Jun 1898, *Ashe s.n.* (LECTOTYPE: US!).

Panicum lucidum Ashe var. *opacum* Fernald, Rhodora 39:386. 1937. TYPE: U.S.A. VIRGINIA: PRINCE GEORGE CO.: boggy depression north of Gary Church, 25 Aug 1936, *Fernald and Long 6484* (HOLOTYPE: GH; ISOTYPES: MO, NY, PH, US!).

Panicum taxodiorum Ashe is referable to *Dichanthelium longiligulatum* (Nash) Freckmann (LECTOTYPE: NCU!).

The densely papillose fertile lemma and palea readily separate *Dichanthelium lucidum* from all other *Dichotoma* taxa. Fertile lemmas in other taxa in the group can have a few scattered papillae or longitudinally elongate reticulations, but are otherwise smooth. The papillae in *D. lucidum* cover the entire surface and are most easily seen at 20× or greater, with the pebbled texture discernable at 10×. Fernald (1950) described the fertile lemma as "obviously cellular-reticulate," but the papillate structure is evident when the edge of the fertile lemma is viewed at 20×. *Dichanthelium lucidum* is recognized in the field by its habit of sprawling over other vegetation (also see discussion under *D. sphagnicola*). Fernald (1937) described *Panicum lucidum* var. *opacum* from "an extensive boggy depression" in southeastern Virginia, distinguishing it from the typical variety by opaque strigose-pilose leaves (vs. lustrous and glabrous), and spikelets 1.5–1.8 mm long (vs. 1.9–2.1 mm). The isotype at US has leaves pilose to glabrous, but the vestiture cannot be described as strigose. However, this character state may be present *in situ*, and may be lost over time in herbarium specimens. The lustrous (satiny) leaf surface character is often absent (at least when dried) among specimens with glabrous leaves and larger spikelets. Gleason (1952) stated that "(i)ntermediates exist with glabrous leaves and small spikelets, or with puberulent leaves and typical spikelets." Glabrous plants with spikelets as short as 1.7–1.8 mm are frequent from the Carolinas to the Gulf Coast.

Distribution and habitat.—*Dichanthelium lucidum* is found primarily along the coast from Massachusetts south to Florida and west to Texas and Arkansas; it also occurs near the Great Lakes in Michigan and Indiana (AL, AR, CT, DC, DE, FL, GA, IN, LA, MA, MD, MI, MS, NC, NJ, NY, PA, SC, TN, TX, VA). This species inhabits wet meadows, sphagnous swamps, bogs, wet woods, and sphagnous streamheads (known as streamhead pocosins in the Carolina Sandhills and baygalls in the Gulf Coast).

8. Dichanthelium mattamuskeetense (Ashe) Mohlenbr., Erigenia 6:26. 1985. *Panicum mattamuskeetense* Ashe, Journ. Elisha Mitchell Sci. Soc. 15:45. 1898. *Panicum dichotomum* L. var. *mattamuskeetense* (Ashe) Lelong, Brittonia 36:265. TYPE: U.S.A. NORTH CAROLINA: HYDE CO.: Lake Mattamuskeet, 10 Jun–6 Jul 1898, *Ashe s.n.* (LECTOTYPE: US!; ISOLECTOTYPE: NY).

Panicum clutei Nash, Bull. Torrey Bot. Club 26:569. 1899. *Panicum mattamuskeetense* Ashe var. *clutei* (Nash) Fernald, Rhodora 39:386. 1937. *Panicum dichotomum* var. *clutei* (Nash) C.F. Reed, Phytologia 67:452. TYPE: U.S.A. NEW JERSEY: BURLINGTON CO.: Tuckerton to Atsion, 3–6 Jul 1899, *Clute s.n.* (HOLOTYPE: NY!).

Panicum flexuosum Muhl. ex Scribn. & Merr., U.S. Dept. Agric. Div. Agrost. Circ. 27:3. 1900, nom. illegit., non Retz. 1791. (ISOTYPE: US!, fragment).

Panicum annulum Ashe var. *glabrescens* Gleason, Phytologia 4:21–22. 1952. TYPE: U.S.A. MASSACHUSETTS: BARNSTABLE CO.: Along roads leading from cranberry bogs east of Slough Road, Harwich, 18 Aug 1918, *Fernald & Long 16044* (HOLOTYPE: NY!). At US! is a specimen labeled as an isotype of *P. annulum* var. *glabrescens* from Barnstable Co., Massachusetts, "Along cart road from cranberry bogs east of Slough Road, Harwich," 9 Jul 1918, *Fernald 16043*, but there is no indication in the protologue or on the specimen sheet itself that Gleason designated this as a type.

One of the most distinctive of the *Dichotoma* taxa, *D. mattamuskeetense* is larger not only in spikelet and fertile lemma length, but tends to have the tallest and thickest culms, and the herbage tends to be a darker and more frequent purple-maroon. Plants with only the lowest nodes, sheaths, and blades pubescent, and with smaller spikelets, have been treated as *Panicum clutei* (Hitchcock & Chase 1910; Hitchcock 1951) or *P. mattamuskeetense* var. *clutei* (Fernald 1950). Hitchcock and Chase (1910) describe *P. clutei* as "but doubtfully distinguished from *P. mattamuskeetense*," and there is considerable variability relative to plant pubescence and spikelet size throughout the range. Plants with glabrous middle and upper portions and with larger spikelets (2.4–2.8 mm long) are frequent in the southern portion of the range, and more pubescent plants with smaller spikelets (2.2–2.5 mm long) are known from southern New England. Also see discussion under *Dichanthelium annulum*.

Distribution and habitat.—Dichanthelium mattamuskeetense is found in the Atlantic coastal plain from southeastern Massachusetts south to northeastern South Carolina (DC, DE, MA, MD, NC, NJ, NY, RI, SC, VA). In the northern part of its range (Massachusetts to New Jersey), it is frequently found in the margins of cranberry bogs and in margins and openings of red maple–Atlantic white cedar swamps. Farther south it is found in damp to wet sandy or peaty soil of wet pine savannas and meadows, and wet borders of pocosin shrub swamps and thickets.

9. Dichanthelium nudicaule (Vasey) B.F. Hansen & Wunderlin, Novon 11:367. 2001. *Panicum nudicaule* Vasey, U.S.D.A. Div. Bot. Bull. 8:31. 1889. TYPE: U.S.A. FLORIDA: swamps, Santa Rosa Co.: May 1886, *Curtiss 3583* (LECTOTYPE: US!; ISOLECTOTYPES: NY, TAES, US!).

Panicum nudicaule was "tentatively" placed in a single-taxon group, *Nudicaulia*, by Hitchcock and Chase (1910) based on "the narrow, enveloping base of the blades, and the nearly naked culms." They allowed that the "technical characters" suggest placement in the *Dichotoma* group, and *D. nudicaule* has been synonymized with *D. dichotomum* by recent authors (Gould & Clark 1978; Clewell 1985; Hansen & Wunderlin 1988; Wunderlin 1998). The blades gradually narrow proximally and frequently the base is no wider than the summit of the sheath, although envelopment of the culm by the basal portion of the blade is not a consistent character. Blade bases are frequently conduplicate (a continuation of the sheath folding), but are as likely to be free of the culm as to enclose it. (In their 1910 description of *P. nudicaule*, Hitchcock and Chase modified this *Nudicaulia* group character by describing the blade as "somewhat enveloping the culm at base.") The elongate lower culm blades are numerous and crowded and the middle and upper blades of fertile culms are few, distant, and markedly smaller. This leaf arrangement is due to short lower culm internodes and elongate upper culm internodes. Lower sheaths tend to be much shorter than the blades while middle and upper sheaths are often much longer than the blades.

Other important morphological characterstics of *Dichanthelium nudicaule* suggest its closest relatives lie outside the *Dichotoma* group. It is peculiar among U.S. *Dichanthelium* taxa for not producing autumnal inflorescences; at least none has ever been seen or collected, not even during visits to 48 *D. nudicaule* sites from 1995–1999 by B.A. Sorrie and myself. However, *D. nudicaule* branches from the base and lower nodes, with the axillary branches persistent and the lower portions of previous-year culms at least sub-persistent. These character states suggest an affinity with *Dichanthelium* taxa found in the tropics and South America. Floral dimorphism in *Dichanthelium* taxa is often absent in tropical America, and "[m]ain and axillary culms are persistent in Mesoamerican and South American species" while "only the rosette usually persists" in North American species (Zuloaga et al. 1993). Basal branching and numerous elongate basal leaves also suggest an affinity with such taxa as *D. laxiflorum* and *D. strigosum*, both of which occur in North America and Mesoamerica.

Distribution and habitat.—*Dichanthelium nudicaule* is known only from northwestern Florida, southern Alabama, and southern Mississippi, where it occurs in saturated areas of pitcher plant bogs (especially at the bases of seepage slopes) and boggy ecotones between wet savannas and cypress streamheads.

Representative specimens: **ALABAMA. Baldwin Co.:** Gateswood, 1 May 1903, *S.M. Tracy 8432* (GH); Lilian Swamp, on tree stump along west bank of south fork of Caney Bayou, directly south of confluence with north fork, 18 Sep 1980, *M. Lelong N532* (USA). **Mobile Co.:** pitcher plant bog along Rte 59, 0.5 mi N of Fowl River, 24 Apr 1972, *M. Lelong 6492* ((NCU, USA, VDB). **FLORIDA. Bay Co.:** mucky sand of grass savanna between Sand Creek Rd and Mule Creek, ca. 8.5 air mi ESE of Callaway, 9 May 1995, *L.C. Anderson 15473* (FSU). **Santa Rosa Co.:** Blackwater River swamp, May 1886, *A.H. Curtiss 3583B* (JS, holotype). **Walton Co.:** Eglin Air Force Base, New Home Bogs, 17 May 1996, *B.A. Sorrie 8812* (GA, NCU). **MISSISSIPPI. Greene Co.:** sphagnum bog ca. 2 mi S of State Line, 5 Jun 1980, *K.L. Fordon 1903 and J. Burris* (IBE). **Harrison Co.:** DeSoto National Forest, pitcher plant bogs, Tuxachanie Trail, 4 May 1974, *K.E. Rogers 9537-A* (NCU). **Stone Co.:** University of Mississippi Forest Lands, seepage bog at headwaters of Little Railroad Creek, 16 May 1997, *B.A. Sorrie 9226* (GH, NCU).

10. Dichanthelium sphagnicola (Nash) R.J. LeBlond, comb. nov. *Panicum sphagnicola* Nash, Bull. Torrey Bot. Club 22:422. 1895. TYPE: U.S.A. FLORIDA: COLUMBIA CO.: sphagnum bog, Lake City, 29–31 Aug 1895, *Nash 2500* (LECTOTYPE: NY; ISOLECTOTYPES: NY, US!)

Soon reclining, *Dichanthelium sphagnicola* is similar in aspect to *D. lucidum*, but it has longer spikelets and first glumes that are typically pubescent and has smooth fertile lemmas. A few specimens from Florida have glabrous to glabrate spikelets and weakly papillose fertile lemmas, suggesting intergradation with *D. lucidum*. However, even these are readily separated from *D. lucidum* based on spikelet and glume lengths and the nearly smooth fertile lemmas. Hitchcock and Chase (1910) describe the autumnal habit of *D. lucidum* as "much more slender, more leafy, and bright green and shining" compared with *D. sphagnicola*.

Distribution and habitat.—*Dichanthelium sphagnicola* is restricted to southeast Georgia and northern to south-central Florida. Although included in synonymy with *Panicum dichotomum* by Radford et al. (1968), no specimen has yet been seen from North or South Carolina. It is found along edges of cypress swamps, in sphagnous bogs, and similar moist, shady places (Hitchcock & Chase 1910).

Representative specimens: **FLORIDA. Columbia Co.:** Lake City, 29/31 Aug 1895, *G.V. Nash 2500* (lectotype, US). **Levy Co.:** fertile black flat woods near ponds, Bronson, 6 Sep 1898, *R. Combs 838* (US). **Volusia Co.:** sandy bank along road about 10 mi SW of Daytona Beach, 24 Oct 1940, *W.A. Silveus 6/26* (US). **GEORGIA. Chatham Co.:** river swamp near Chatham Tower, 14 May 1940, *D.E. Eyles 5628* (US).

11. Dichanthelium yadkinense (Ashe) Mohlenbr., Erigenia 6:27. 1985. *Panicum yadkinense* Ashe, J. Elisha Mitchell Sci. Soc. 16:85. 1900 (nom. nov.). *Panicum maculatum* Ashe, J. Elisha Mitchell Sci. Soc. 15:44. 1898, nom. illegit., not Aublet 1775. *Panicum dichotomum* L. var. *yadkinense* (Ashe) Lelong, Brittonia 36:266. TYPE: U.S.A. NORTH CAROLINA: WAKE CO.: Raleigh, May 1895, *Ashe s.n.* (LECTOTYPE: US!).

The combination of beardless nodes, large vernal blades (to 15 mm wide), and acute spikelets 2.1–2.6 mm long are definitive. When present, the large yellowish glandular "warts" on the (usually upper) sheaths are also helpful. However, they are often absent and occasionally occur on other *Dichotoma* group taxa (notably *D. dichotomum* var. *nitidum*). Within an inflorescence, some spikelets may be blunt apically, but many or most will be acute, with the second glume and sterile lemma surpassing the fertile lemma by as much as 0.5 mm. These characters, combined with no observed intergradation with other *Dichotoma* taxa, have led to recognition here at species rank. However, care must be taken not to confuse *D. yadkinense* with the superficially similar *D. cryptanthum* (Ashe) R.J. LeBlond ined., which has a similar appearance and acute spikelets of similar length, but with a membranous ligule (vs. hairy) and a scabrous peduncle and panicle axis (vs. smooth in *D. yadkinense*).

Distribution and habitat.—*Dichanthelium yadkinense* is reported from New Jersey to Michigan and south to Georgia and Texas (AL, DC, DE, GA, IL, IN, KY, LA, MD, MI, NC, NJ, OH, PA, SC, TN, TX, VA, WV). It also occurs in Mexico (Hitchcock & Chase 1915). This species appears to be scattered throughout most of its range, though there are 22 counties of occurrence in North Carolina. *Dichanthelium yadkinense* is found in floodplain forests, thickets, bottomlands, and swamps, often on alluvial deposits.

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BOOK REVIEW

EDWARD A. COPE. 2001. **Muenscher's Keys to Woody Plants: An Expanded Guide to Native and Cultivated Species.** (ISBN 0-8014-8702-1, pbk.). Cornell University Press, Sage House, 512 E. State Street, Ithaca, NY 14850). $22.95, 377 pp., 6 1/8" × 9 1/4".

Especially for many of us who work in increasingly urbanized floras, the need to identify non-native woody species is ever-present. I would have used this volume many times and in many contexts over the last decades, had it been available. The keys are simple but efficacious and well-polished and, clearly, most of the woody species to be encountered in temperate eastern North America are included. The geographic coverage is "that area east of the Mississippi River to the Atlantic Ocean, north to the Arctic and south to include northern Mississippi, Alabama, and Georgia, and all of South Carolina except for five southeastern counties. ..." Even with this, all but five of the tree species on my tentative list of those native, naturalized, and cultivated in Fort Worth (Texas) are in Cope's treatment.

Cope's revision and expansion of the last edition of Muenscher's Keys (1950) treats 335 genera (174 native; 161 cultivated or naturalized) and 1171 species (589 native; 582 cultivated, including 198 naturalized). Some of the additions are "southern native species," but "about 80 percent of [the] additions are cultivated species. ... Of these, 198 species are naturalized from horticultural or ... inadvertent introductions of non-native species, although about half are only occasionally or rarely naturalized." "Additions of native woody plant species are mostly accounted for by a more precise and somewhat expanded southern boundary of the geographical range covered, [a] tendency to include more of the locally endemic species, and the inclusion of woody grasses or herbs that appear to be woody, such as *Polygonum cuspidatum*." Examples of others included but on the border between 'woody' and 'herbaceous' are *Chamaecrista fasciculata*, *Chimaphila* spp., *Hypericum* spp., *Puereria lobata*, *Rubus* spp., *Epigaea repens*, *Cocculus carolinus*, *Clematis* spp., *Schisandra* spp., *Gelsemium* spp., *Vinca* spp., etc.

Past the introductory material, the book is divided into the following sections:

Keys to Genera—Inclusive [all native, naturalized, and cultivated genera that might be found outside of a botanical garden or arboretum]
Keys to Genera—Abridged [native and naturalized genera]
Keys to Species [genera arranged alphabetically for easy access]
Systematic List of Species Included in the Keys [genera arranged by family, following the Cronquist system]
Glossary [technical terminology kept to a mininum], and **Index.**

Each of the two 'Keys to Genera' is divided into seven smaller keys:

Plants with needlelike, scalelike, or awl-shaped leaves
Plants with opposite or whorled simple leaves
Plants with opposite or whorled compound leaves
Plants with alternate simple leaves
Plants with alternate compound leaves
Plants lacking leaves, with the leaf scars opposite or whorled
Plants lacking leaves, with the leaf scars alternate

If the genus in question has several species with deciduous leaves, two 'keys to species' are often provided—a summer key and a winter key. "The summer keys are based primarily on leaves and fruits; the winter keys are based primarily on bud and twig characters, supplemented by those of bark, general habits, and fruits." Floral features are not used in the keys.

Highly recommended.—*Guy L. Nesom, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

THE GENUS *HESPEROYUCCA* (AGAVACEAE) IN THE WESTERN UNITED STATES AND MEXICO: NEW NOMENCLATURAL COMBINATIONS

Karen H. Clary[1]

Department of Integrative Biology
Plant Resources Center, Bio Labs 311
University of Texas, Austin, TX 78712, U.S.A.

ABSTRACT

The genus *Hesperoyucca* (Agavaceae), consisting of three species, is recognized as distinct from *Yucca* based on distinct morphological, phenological and pollinator characteristics, biogeographic considerations and recent DNA analyses. *Hesperoyucca whipplei* is recognized and new combinations for two species are made: *H. newberryi* and *H. peninsularis*. A key that distinguishes *Yucca* from *Hesperoyucca* and the three species of *Hesperoyucca* is included.

RESUMEN

Se reconoce a *Hesperoyucca* (Agavaceae) como género distinto de *Yucca* en base a caracteres morfológicos, fenológicos y del polinizador, a consideraciones biogeográficas y análisis recientes de ADN. *Hesperoyucca* consta de tres especies. Se reconoce *Hesperoyucca whipplei* y se proponen dos combinaciones nuevas para las otras dos especies, *H. newberryi* y *H. peninsularis*. Se presenta una clave para distinguir *Yucca* de *Hesperoyucca* y para identificar las tres especies de *Hesperoyucca*.

Key Words: *Hesperoyucca*, *Yucca whipplei*, Agavaceae, DNA

Within *Yucca* L., as traditionally circumscribed, is a group of species, herein recognized as *Hesperoyucca* (Engelm.) Baker, that has morphological, phenological, and pollinator characteristics markedly different from all others. These characteristics include a loculicidal capsule, a capitate stigma, and glabrous, swollen filaments that are attached to the lower part of the tepals and that draw away from the ovary when the tepals open. These filaments bear bulbous anthers with tufted pubescence that bend toward the stigma and dehisce laterally (Fig. 1). Their pollen is produced in a glutinous mass. The sole pollinator of *Hesperoyucca* is *Tegeticula maculata* Riley, a species of yucca moth (Riley 1892; Trelease 1893, 1902; Powell & Mackey 1966; Davis 1967; Segraves & Pellmyr 2001). The other approximately 47 species of *Yucca* are visited by the remaining species of yucca moth (Pellmyr 1999). In *Yucca*, the pollen is not agglutinated, but produced as single grains, nor are the filaments tufted. Furthermore, the stigmas are not capitate, but divided into three lobes that spread outward. The pubescent filaments are appressed to the ovary and angle outward and when the tepals open.

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[1] Current address: 4701 Canyonwood Drive, Austin, TX 78735-6602, U.S.A. kjclary@flash.net

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Recent analyses of DNA markers, including the internal transcribed spacer region (ITS) of nuclear ribosomal DNA and chloroplast DNA (cpDNA) (Hanson 1993; Bogler 1994; Bogler & Simpson 1995, 1996; Clary 1997) support the recognition of these unique species as members of a separate genus, *Hesperoyucca* (Engelm.) Baker. In the phylogenetic parsimony and maximum likelihood trees from DNA analyses, these species form a branch that is sister to *Hesperaloë* (Agavaceae) and not *Yucca* (Fig. 2). *Hesperaloë* Engelm. includes a group of five species found in the Sonoran and Chihuahuan Deserts allied taxonomically as close relatives to both *Agave* L. and *Yucca* (Correll & Johnston 1979; Gentry 1972; Starr 1997).

The group in question, *Hesperoyucca*, corresponds to Engelmann's (1871) *Yucca* group *Hesperoyucca*, which ranges from California and Arizona to Baja California Norte and Sonora in México. In this paper, *Hesperoyucca* is recognized at the genus level, requiring two new species combinations. A taxonomic treatment of the genus will be published in Flora of North America.

While taxonomists working with *Yucca* have recognized the members of the *Hesperoyucca* group as distinctive from the other *Yucca* species, they have not agreed on infrageneric and infraspecific circumscription. The taxa within *Hesperoyucca* have been classified primarily by growth form (single or multiple rosettes), leaf morphology and whether the plants are monocarpic or polycarpic. Most of the disagreement centers on the significance of morphological variation in *Y. whipplei* Torr. populations in Arizona and California (Trelease 1893, 1902; Haines 1941; McKelvey 1947; Webber 1953; Hochstätter 2000).

Within *Yucca whipplei*, Trelease (1893) recognized two varieties, Haines (1941) and Munz (1968) each recognized five subspecies and Webber (1953) recognized four varieties. Others argue that growth form is a highly variable character and question the recognition of varieties or subspecies at all (McKelvey 1947; McKinney & Hickman 1993).

McKelvey (1947) described *Yucca newberryi* from Arizona *and Y. peninsularis* from the Vizcaíno Desert region in Baja California Norte. Webber (1953:33) believed leaf, inflorescence and capsule features used by McKelvey to separate *Y. newberryi* from *Y. whipplei* were weak and within the normal variation of *Y. whipplei*. Hochstätter (2000) included *Y. newberryi* as a subspecies of *Y. whipplei*.

Supported by distinctive morphological characteristics, unique species ranges and ITS DNA analyses (Clary 1997), three species of *Hesperoyucca* are here recognized: *H. whipplei*, *H. peninsularis* (McKelvey) Clary, and *H. newberryi* (McKelvey) Clary. A key to the species follows.

The ITS DNA analysis of *Yucca*, *Hesperoyucca*, *Agave* and *Hesperaloë* (Clary 1997) included single individuals from four *Hesperoyucca* populations: *H. whipplei* from Sierra Viejo, Sonora, México (Bogler & Simpson 1996), and from San Diego County, California; *H. peninsularis* from Cataviña, Baja California

Norte, México; and *H. newberryi* from Mohave County, Arizona. The results show each of these samples to be genetically distinct from the others (Clary 1997). The other taxa attributed to *H. whipplei* [*Y. whipplei* subsp. *caespitosa* (M.E.Jones) A.L.Haines, *Y. whipplei* subsp. *percursa* A.L.Haines, *H. whipplei* subsp. *intermedia* A.L.Haines, *Y. whipplei* subsp. *typica* A.L.Haines, and *Y. whipplei* subsp. *parishii* (M.E.Jones) A.L.Haines] were not sampled.

Results of the phylogenetic (parsimony and maximum likelihood) analysis show a tree (Fig. 2) with the *Hesperoyucca* clade split into two branches. One branch contains *H. newberryi*, basal to the lineage, while the other branch contains *H. peninsularis*, which is sister to a branch that contains both *H. whipplei* populations. These data support specific status for *H. peninsularis* and *H. newberryi*, but not the two *H. whipplei* populations since they share unique mutations (Clary 1997).

Recognition of infraspecific taxa within *Hesperoyucca whipplei* is beyond the scope of this paper. Although the taxonomic treatments of *H. whipplei* within the above-cited earlier works give distinctive morphological characters that separate taxa within *H. whipplei*, the treatments, with the exception of McKelvey's (1947), lack sufficient records of specimens seen to evaluate the hypotheses about the proposed nature of variation within *Y. whipplei*. Further systematic study of informative morphological characters and DNA of all taxa of *Hesperoyucca* is warranted to elucidate its entire phylogeny and determine the genetic relationships that underlie the taxonomy of this group.

KEY TO *YUCCA* AND THE THREE RECOGNIZED SPECIES OF *HESPEROYUCCA*

1. Capsules septicidal, the seeds dispersing laterally through openings at the locule tips, or the fruit indehiscent, fleshy or spongy; seeds ultimately dispersed by animals; stigmas 3-lobed, white, the lobes papillose on the inner surface; filaments usually shorter than the pistil, pubescent, distally clavate and eventually turned at a pronounced or negligible angle to the proximal portion; anthers sagittate or hastate; inflorescence bracts on erect, persistent; leaf blades narrowed at junction with spoonlike base, widening above that point before tapering to the tip ____________ **Yucca s.l.**
1. Capsules loculicidal, the seeds dispersing laterally through fringed or rudimentary false placental septa; seeds initially wind dispersed; stigmas capitate, bright green, densely long papillate; filaments usually longer than pistil, finely papillate, and more or less swollen the entire length, stoutest at or near the middle, erect or spreading outwardly from point of attachment at anthesis, bearing tufts of papillae at the apex; anthers cordate; inflorescence bracts becoming reflexed above the base, easily detached; leaf blades widest just above basal spoon and tapering to tip _____ **Hesperoyucca**
   2. Mature leaf blades usually long and slender, to 0.7–2.0(–2.5) cm wide above the base, to 45–60(–100+) cm long, flexible, or if rigid, then distinctly thickened.
      3. Mature capsules with conspicuous placental wings; plants with single or multiple rosettes; western southern California and adjacent northern Baja California and Sonora ____________ **H. whipplei**
      3. Mature capsules with rudimentary placental wings; rosettes solitary; Mojave County, Arizona and vicinity ____________ **H. newberryi**

2. Mature leaf-blades rather short and broad, to (2.5–)3.2–4.0 cm wide, straight and rigid, or falcate, tapering from above basal spoon to the tip; plants forming clustered rosettes; Vizcaíno region, Baja California Norte, México ________ **H. peninsularis**

Hesperoyucca (Engelm.) Baker, Bull. Misc. Inform. Kew 1892(61):8. 1892. *Yucca* subgen. *Hesperoyucca* (Engelm.) Baker. Gard. Chron. n.s. 6:196. 1876. Based on *Yucca* (without rank) *Hesperoyucca* Engelm. in S. Wats. et al., Botany [fortieth parallel]: 497. 1871 as group 2: HESPERO-YUCCA. *Yucca* Sect. *Hesperoyucca* (Engelm.) in McKelvey, Yuccas Southw. U.S. 2:14. 1947. TYPE: *Yucca whipplei* Torr. in Ives.

There is disagreement regarding authorship of the genus *Hesperoyucca*. Engelmann (1871) divided *Yucca* into two major groups: EU-YUCCA and HESPERO-YUCCA, the former with three subgroups: Sarcocarpa, Clistocarpa and Chaenocarpa. His group *Hesperoyucca* contained only *Yucca whipplei*. Engelmann (1873) provided a similar summary classification, but within his Euyucca, changed the names to Sarcoyucca, Clistoyucca, Chaenoyucca (note change from "-carpa" to "-yucca"). In 1875 Engelmann retained four equal groups under *Yucca*: Sarcoyucca, Clistoyucca, Chaenoyucca and Hesperoyucca. But at no time did Engelmann indicate ranks for his groups within *Yucca*. Baker (1876) gave the rank subgenus to Engelmann's *Hesperoyucca* recognizing within it a single species, *Yucca whipplei*. Greuter et al. (1993) and Greenhouse and Strother (in press) accept this as legitimizing Engelmann's *Hesperoyucca* as a subgenus. In 1892, Baker noted that *Y. whipplei*, "had better be kept as a genus distinct from *Yucca*, under Engelmann's name *Hesperoyucca*" but he still listed the species as *Yucca whippleii* (sic.) Torrey. Greuter et al. (1993) accept this as having erected the genus *Hesperoyucca*. (Engelm.) Baker in 1892. Greenhouse and Strother (in press) following ICBN Art. 34.1 (Greuter et al. 2000), do not accept this as creating a new genus as Baker listed the species as *Yucca whipplei* and thus did not accept the new combination. Trelease (1893:208) accepted Baker's (1892) suggestion of the genus rank for *Hesperoyucca*, formally recognizing *Hesperoyucca* at the same rank as, and separate from *Yucca*, and distinguishing *Hesperoyucca* from the "true Yuccas." The combination *Hesperoyucca whipplei* appears in the list of illustrations, in the Explanation of Plates (Trelease 1893:215) and as the generic name of variety *graminifolia* (Trelease 1893:215, tt. 17 & 23). This is considered by Greenhouse and Strother (in press) to be the first legitimate use of the name of the genus *Hesperoyucca*. However, Baker's (1892) mere suggestion in print of generic rank for *Hesperoyucca* is accepted by Names in Current Use (Grueter et al. 1993) and by Flora North America (FNA) to be the first valid use of *Hesperoyucca* as a genus, not Trelease's (1893) taxonomic description.

Distribution.—U.S.A. California, Arizona. México. Baja California Norte, Sonora.

Hesperoyucca whipplei (Torr.) Baker ex Trel., Ann. Rep. Missouri Bot. Gard. 4:208. 1893. (**Fig. 1**). Basionym: *Yucca whipplei* Torr. in J.C. Ives. Rep. Colorado R. 4 (Bot.):29. 1861. TYPE: U.S.A. CALIFORNIA. SAN DIEGO CO.: San Pasqual, *A. Schott s.n.* (LECTOTYPE: NY!). The

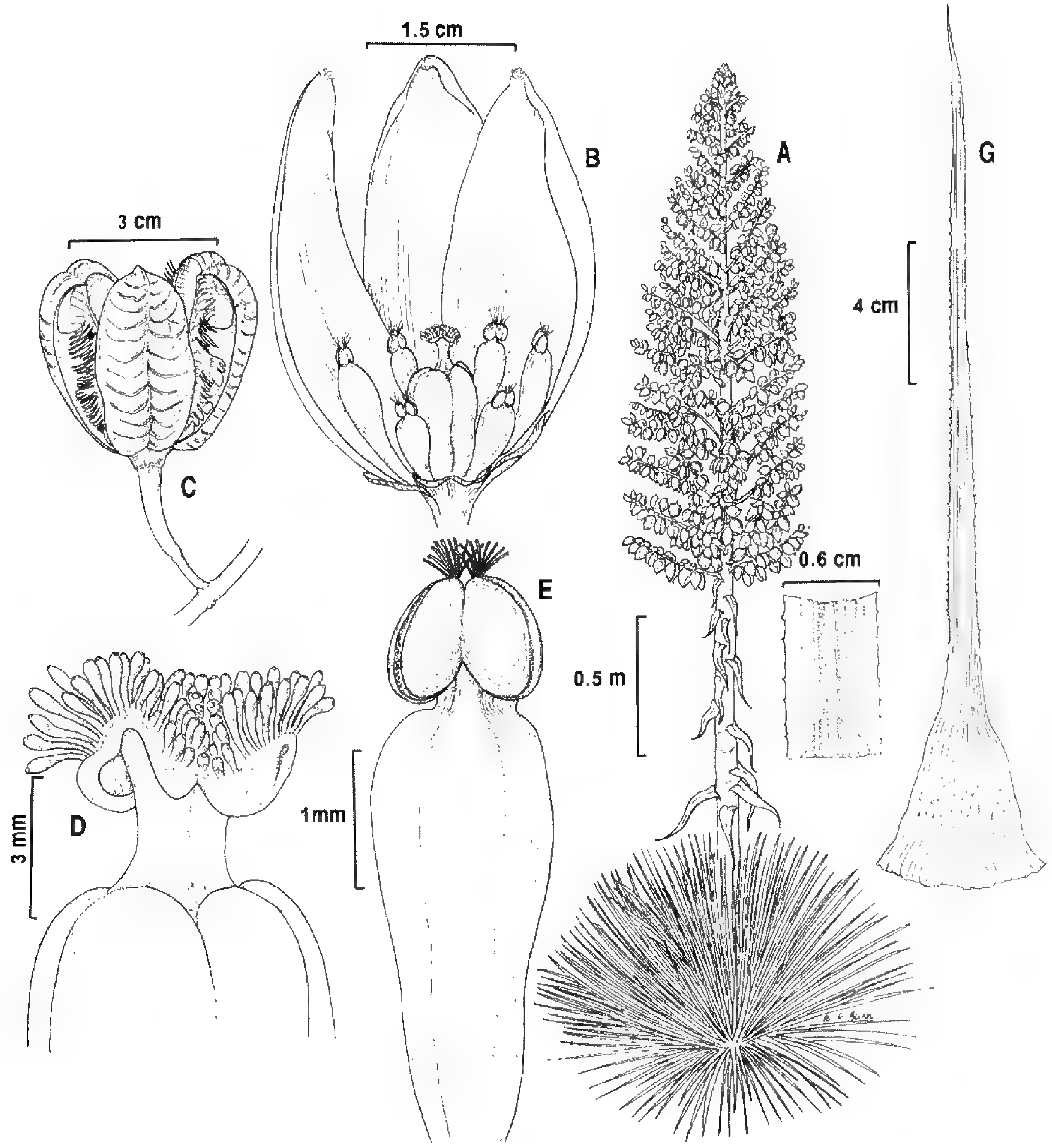

Fig. 1. Illustration of *Hesperoyucca whipplei*: A. Growth habit, showing basal leaf rosette and inflorescence [from photo voucher 148731 (MO)]; B. Flower, showing tepals, filaments and central ovary [from Nichols B-4-21-92 (TEX), and photo by Constance & Morrison 2269, 1150192 (MO)]; C. Capsule, showing fringed placenta septa margins and loculicidal dehiscence [135741 (MO)]; D. Capitate stigma, showing papillae on stigma surface [from Nichols B-4-21-92 (TEX) and photo by Constance & Morrison 2269, 1150192 (MO)]; E. Stamens showing cordate anthers and tufted pubescence [from Nichols B-4-21-92 (TEX)]; F–G. Leaf blade (F) detail showing minutely serrated leaf margin and (G) with expanded basal spoon [from photo by Constance & Morrison 2269, 1150192 (MO)].

citation in *Yucca* is often given as: *Yucca whipplei* Torr. in Emory, Rep. U.S. & Mex. Bound. 2:222. 1859. Torrey noted "if it prove to be a distinct species it may be called *Y. whipplei*." Greenhouse and Strother (in press) consider Torrey's name as provisional and not validly published as of 1859, but validly published in Ives' "Report upon the Colorado River of the west" (Torrey 1861). Baker (1892) suggested that the species should be recognized within *Hesperoyucca*. Trelease (1893) formally recognized *Hesperoyucca* as a genus, and *Hesperoyucca whipplei* as a

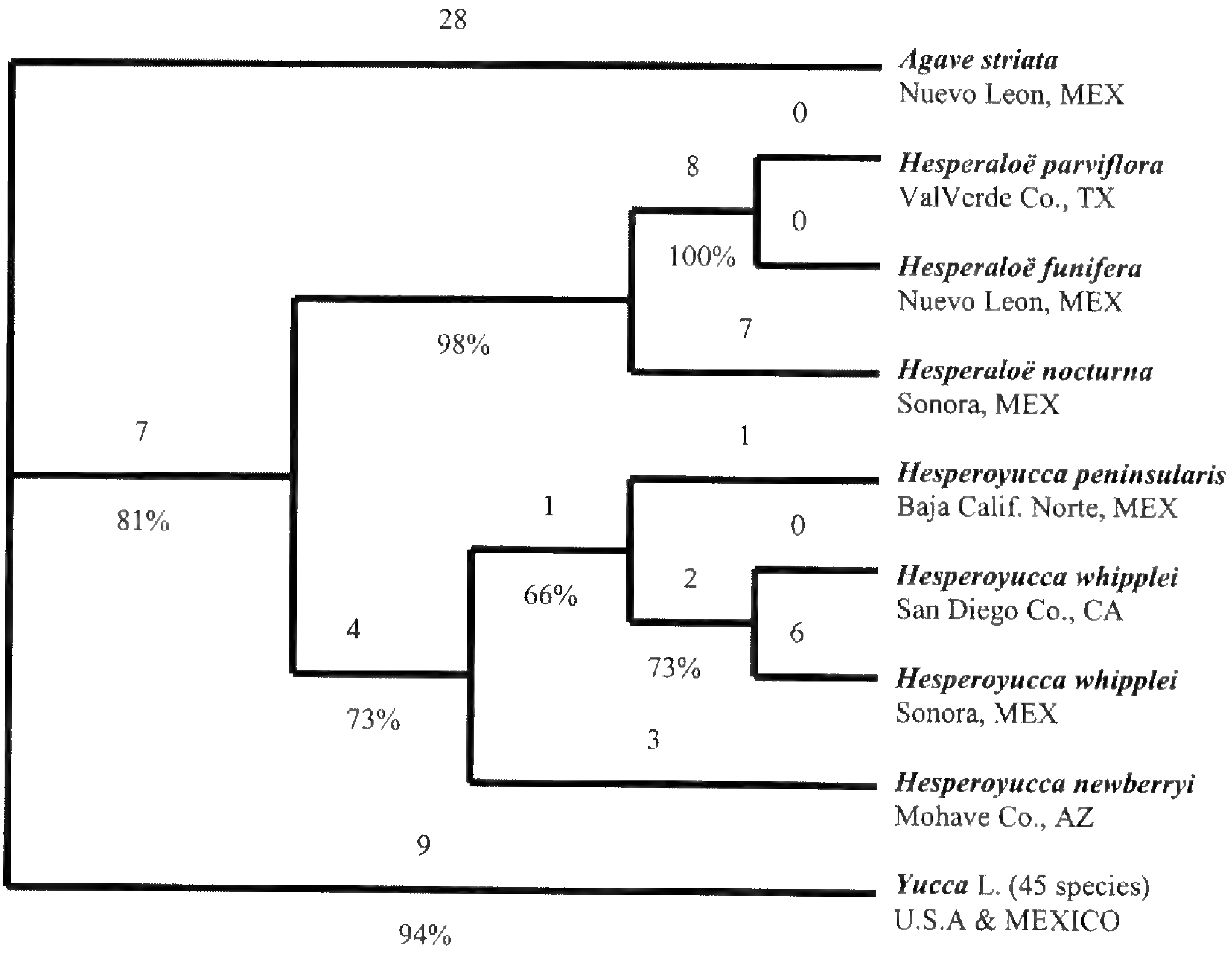

Fig. 2. ITS 1 & 2 strict consensus tree of the 10,777 most parsimonious 467 step trees found by PAUP (CI=0.89, HI=0.527, RI=0.846). Step changes are written above branches, with bootstrap percentages > 50 % written below (Clary 1997). Samples of *Agave striata, Hesperaloë parviflora, Hesperaloë funifera, Hesperoyucca whipplei* (Sonora, Mexico) are from Bogler (1994, 1996); samples of *Hesperaloë nocturna, Hesperoyucca peninsularis, Hesperoyucca whipplei* (San Diego, California), *Hesperoyucca newberryi* and *Yucca* L. are from Clary (1997).

species. The combination listed above, can be shortened to *Hesperoyucca whipplei* (Torr.) Trel. following ICBN Art. 46.4 (Greuter et al. 2000). Torrey's (1859) paper cited a single specimen, "a yucca found by Mr. Schott on rocks near San Pasqual, southern California." Torrey (1861) in the Ives Report cited three collections, "Mouth of Diamond River, 3 April, growing in tufts, on rocks," another by Dr. Bigelow in Cajon Pass (California) in the Whipple expedition and by Mr. Schott near San Pasqual. The latter is here designated as lectotype.

Hesperoyucca whipplei var. *graminifolia* Trel., Ann. Rep. Missouri Bot. Gard. 4:215. 1893, based on: *Yucca graminifolia* A.W. Wood, Proc. Acad. Nat. Sci. Philadelphia 20:167. 1868, *non* Zucc. 1837. TYPE: U.S.A. CALIFORNIA. LOS ANGELES CO.: Mountains 12 mi E of Los Angeles, 3 Mar 1866, *A. Wood s.n.* McKelvey (1947:32) notes a specimen at GH. Greenhouse and Strother (in press) note that Wood's initial combination was superfluous due to the existence of *Y. graminifolia* Zucc. The name was legitimized by Trelease's reference in 1893.

Yucca whipplei var. *parishii* M.E. Jones, Contr. W. Bot. 15:59. 1929. *Yucca whipplei* subsp. *parishii* (M.E. Jones) A.L. Haines, Madroño 6:44. 1941. TYPE: No specimens were cited by Jones (1929). Jones (p. 59) described this taxon as "the common form at low elevations on the Pacific slope, seldom if ever found on the desert side." Haines (1941) gave the location of the type (California: San Bernardino Co.: above Cajon Pass, *M.E. Jones s.n.*) but selected no lectotype. Jones collected several specimens from the Cajon Pass (POM, photocopy!), but none have been designated as a type. With further study, a type may be designated for this taxon.

Yucca whipplei var. *caespitosa* M.E. Jones, Contr. W. Bot. 15:59. 1929. *Yucca whipplei* subsp. *caespitosa* (M.E.Jones) A.L. Haines, Madroño 6:43. 1941. TYPE: U.S.A. CALIFORNIA. SAN BERNARDINO CO.: Cactus Flat in Cushenbury Canyon, 12 May 1926, *Jones s.n.* (HOLOTYPE: POM!; ISOTYPE: CAS).

Yucca whipplei subsp. *intermedia* A.L. Haines, Madroño 6:43. 1941. *Yucca whipplei* var. *intermedia* (A.L. Haines) J.M.Webber. Yuccas Southw. 34. 1953. TYPE: U.S.A. CALIFORNIA. LOS ANGELES CO.: Malibu Lake, Santa Monica Mountains, 1 Jun 1940, *Haines s.n.* [HOLOTYPE: LA (photocopy!)].

Yucca whipplei subsp. *percursa* A.L.Haines. Madroño 6:43:1941. *Yucca whipplei* var. *percursa* (A.L. Haines) J.M. Webber. Yuccas Southw. 35. 1953. TYPE: U.S.A. CALIFORNIA. SANTA BARBARA CO.: Cachuma Mountain in San Rafael Mountains, *Haines s.n.* (not found). A search at LA has found no authentic material. A neotype may be designated after further study.

Distribution.—U.S.A. California: San Diego, Orange, Riverside, San Bernardino, Los Angeles, Ventura, Santa Barbara, Kern, San Luis Obispo, Tulare, Monterey, San Benito counties; México. Baja California Norte: Municipio Ensenada, Mexicali; Sonora.

Hesperoyucca newberryi (McKelvey) Clary, comb. nov. BASIONYM: *Yucca newberryi* McKelvey, Yuccas Southw. U.S. 2:49. 1947. *Yucca whipplei* subsp. *newberryi* (McKelvey) Hochstätter, Succulenta (Netherlands) 79:39. 2000. TYPE: U.S.A. ARIZONA. MOHAVE CO.: Below rim of S wall of Colorado River, at New Water Point, 29 Apr 1934, *McKelvey 4087* (HOLOTYPE: A!).

Distribution.—U.S.A. Arizona: Mohave County.

Hesperoyucca peninsularis (McKelvey) Clary, comb. nov. BASIONYM: *Yucca peninsularis* McKelvey, Yuccas Southw. U.S. 2:52. 1947. TYPE: MÉXICO. BAJA CALIFORNIA NORTE: Canyon 10 mi E of El Rosario, 8 Feb 1935, *I.L. Wiggins 7559* (HOLOTYPE: DS!).

Yucca whipplei subsp. *eremica* Epling & A.L.Haines, Brittonia 9:172. 1957. TYPE: Epling and Haines designated a type collection from Baja California Norte, from 13 mi SE of Rosario in cirio-cardon community, 15 Apr 1957, *A.L. Haines 5759* (not found). A search at LA has found no authentic material. A neotype will be designated after further study.

Distribution.—México. Baja California Norte.

Matuda and Piña-Lujan (1980) consider *Yucca whipplei* subsp. *eremica* Epling & A.L.Haines to be a synonym of *Y. peninsularis*. The original collections of each species are from the same area, 10 E of, and 13 miles SE of El Rosario. Comparisons of habit and leaf morphology in the original descriptions (McKelvey 1947; Epling & Haines 1957; Matuda & Piña-Lujan 1980) and of both live and vouchered specimens at TEX indicate that both belong to the same species.

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Book Review

Paul Minnis (editor). 2000. **Ethnobotany, a Reader.** (ISBN 0-8061-3180-2, pbk.). University of Oklahoma Press, 4100 28th Avenue N.W., Norman, OK 73069-8218, U.S.A. (Orders: www.ou.edu/oupress, 405-325-2291, 405-364-5978 fax). $18.95, 384 pp, 22 b&w illustrations, 42 line drawings, 10 maps, 53 tables, 6 1/8" × 9 1/4".

Table of Contents:

This is an edition that most, if not all, ethnobotany students will enjoy. Its broad scope gives a holistic flavor to ethnobotany—so commonly perceived as trekking through the Amazonian jungles for the cure to cancer. Moreover, there is a refreshingly applied approach to most of these articles, demonstrating how ethnobotany can answer greater questions concerning human-plant interactions. I would highly recommend this book to anyone interested in learning more about ethnobotany. It would work well in undergraduate or graduate courses in ethnobiology.—*Kevin D. Janni, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A., kjanni@brit.org.*

NEW COMBINATIONS IN *CHIONOLAENA* (ASTERACEAE: GNAPHALIEAE)

G.L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, TX 76102-4060, U.S.A.

ABSTRACT

Five nomenclatural combinations complete the transfer of Mexican and Central American species from *Gnaphaliothamnus* to *Chionolaena*: **Chionolaena costaricensis**, **Chionolaena cryptocephala**, **Chionolaena durangensis**, **Chionolaena macdonaldii**, and **Chionolaena salicifolia**. In this view, *Chionolaena* is a genus spread across northeastern and northern South America, Central America, and south-central to southwestern Mexico.

RESUMEN

Cinco combinaciones nomenclaturales completan la transferencia de especies mexicanas y Centroamericanas de *Gnaphaliothamnus* a *Chionolaena*: **Chionolaena costaricensis**, **Chionolaena cryptocephala**, **Chionolaena durangensis**, **Chionolaena macdonaldii**, y **Chionolaena salicifolia**. Desde este punto de vista, *Chionolaena* es un género distribuido por el noreste y norte de Sur América, América Central, y del sur-centro al suroeste de México.

Ten species of Mexico and Central America were treated within *Gnaphaliothamnus* Kirpiczn. (Nesom 1990a, 1990b, 1994), but a case has been made for regarding these species as members of *Chionolaena* DC. (Anderberg & Freire 1989; Anderberg 1991; Freire 1993), which otherwise includes species from northeastern and northern South America. Emphasizing similarities in habit and microcharacters among all of these species, as well as their apparent geographical continuity, the view that all arose from an immediate common ancestor is reasonable and all will be recognized as members of *Chionolaena* in an upcoming treatment of Mexican Gnaphalieae (Nesom in prep.).

In this view, *Chionolaena* is a genus spread across South America, Central America, and south-central and southwestern Mexico. The Mexican and Central American species are characterized by a low, woody habit, revolute leaf margins, mostly heterogamous heads, phyllaries with white-opaque, spreading tips, reddish corollas, fertile achenes ellipsoid to obovoid 1.2–2 mm long with minute, somewhat elongated, duplex hairs, and central florets functionally staminate, with apically swollen pappus bristles and narrowly lanceolate style branches with collecting hairs along their whole length. They occur primarily in areas of high elevation. Distinctive vegetative glandularity and features of achenial vestiture of the Mexican and Central American species of *Chionolaena*, however, indicate that they probably constitute a phyletically coherent northern

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segment of the genus, rather than being cladistically interspersed among the South American species, as postulated by Freire (1993) (see Nesom 1994 for further commentary).

Five of the Mexican and Central American species have valid names within the genus *Chionolaena*, as summarized here.

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Chionolaena concinna (A. Gray) Anderb. & Freire, Ann. Missouri Bot. Gard. 80:415. 1993. *Gnaphalium concinnum* A. Gray, Proc. Amer. Acad. Arts 15:34. 1879. *Gnaphaliothamnus concinnus* (A. Gray) Nesom, Phytologia 68:374. 1990. *Chionolaena mexicana* Freire [nom. nov.], Ann. Missouri Bot. Garden 80:427. 1993.

Chionolaena eleagnoides Klatt, Leopoldina 23:88. 1887. *Gnaphaliothamnus eleagnoides* (Klatt) Nesom, Phytologia 68:376. 1990.

Chionolaena lavandulifolia (Kunth) Benth. & Hook. f. ex B.D. Jackson, Index Kew. 1:516. 1893. *Helichrysum lavandulifolium* Kunth, Nov. Gen. & Sp. 4[folio]:68. 1818 [as *Elychrysum lavandulaefolium*]. *Gnaphaliothamnus lavandulifolius* (Kunth) Nesom, Phytologia 68:377. 1990.

Chionolaena sartorii Klatt, Leopoldina 23:89. 1887. *Gnaphaliothamnus sartorii* (Klatt) Nesom, Phytologia 68:379. 1990.

Another five species are brought into *Chionolaena* with combinations provided here. The first four were not accounted for in the revision of *Chionolaena* by Freire (1993); the taxonomic disposition of the fifth (*C. salicifolia*) is discussed.

Chionolaena costaricensis (Nesom) Nesom, comb. nov. *Gnaphaliothamnus costaricensis* Nesom, Phytologia 68:374. 1990.

Chionolaena cryptocephala (Nesom) Nesom, comb. nov. *Gnaphaliothamnus cryptocephalus* Nesom, Phytologia 68:375. 1990.

Chionolaena durangensis (Nesom) Nesom, comb. nov. *Gnaphaliothamnus durangensis* Nesom, Phytologia 69:1. 1990.

Chionolaena macdonaldii (Nesom) Nesom, comb. nov. *Gnaphaliothamnus macdonaldii* Nesom, Phytologia 68:378. 1990.

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Gnaphalium rhodanthum Schultz-Bip. in Seemann, Bot. Voy. Herald, 310. 1856. *Gnaphaliothamnus rhodanthus* (Schultz-Bip.) Kirpiczn., Trudy Bot. Inst. Akad. Nauk SSSR, Ser. 1, Fl. Sist. Vyss. Rast. 9:33. 1950. [the type of *Gnaphaliothamnus*]

Gnaphalium seemannii Schultz-Bip. in Seemann, Bot. Voy. Herald, 309. 1856. *Chionolaena seemannii* (Schultz-Bip.) Freire, Ann. Missouri Bot. Gard. 80:432. 1993.

Chionolaena corymbosa Hemsley, Diagn. Pl. Nov. 2:32: 1879.

TABLE 1. Pappus features of Mexican and Central American *Chionolaena*.

SPECIES	pappus bristles: basal coherence	pappus bristles basal persistence	pappus bristles apical cell shape
C. aecidiocephala	separate	persistent	clavate
C. concinna	separate to slightly connate	persistent	clavate
C. costaricensis	separate	caducous	clavate
C. cryptocephala	separate	caducous	linear to weakly clavate
C. durangensis	slightly connate	persistent	clavate
C. eleagnoides	slightly connate	persistent	clavate
C. lavandulifolia	separate	persistent	linear to weakly clavate
C. macdonaldii	(not seen)	(not seen)	clavate
C. salicifolia	slightly connate	caducous	linear to weakly clavate
C. sartorii	(not seen)	(not seen)	(not seen)

Freire (1993) noted that the genus *Gnaphaliothamnus*, restricted in her concept to a single species, *Gnaphaliothamnus salicifolius*, is the sister group to *Chionolaena*, differing from all other species of *Chionolaena* in its "free pappus bristles" [vs. pappus bristles "fused at base into a ring"] "with linear apical cells" [vs. "clavate" apical cells]. In contrast, she incorporated the same single species into *Chionolaena*, using one of its synonyms for the nomenclatural combination (*Chionolaena seemannii* = *Gnaphaliothamnus rhodanthus* = *Gnaphaliothamnus salicifolius* ≡ *Chionolaena salicifolia* (see Nesom 1994 for further commentary on this synonymy).

My own observations regarding the pappus features that distinguish *Gnaphaliothamnus* sensu stricto (in Freire's view) further indicate that its separation at generic rank from similar Mexican and Central American species is artificial. Table 1 compares pappus features of these species—*C. salicifolia* does not stand apart. *Chionolaena salicifolia* was hypothesized to be most closely similar and related to *C. eleagnoides* by Nesom (1994).

ACKNOWLEDGMENTS

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SYSTEMATICS OF THE *CAREX JAMESII* COMPLEX (CYPERACEAE: SECT. *PHYLLOSTACHYAE*)

Robert F. C. Naczi

Claude E. Phillips Herbarium
Dept. of Agriculture & Natural Resources
Delaware State University
Dover, DE 19901-2277, U.S.A.
rnaczi@dsc.edu

Bruce A. Ford

Department of Botany
University of Manitoba
Winnipeg, Manitoba
R3T 2N2, CANADA
bford@cc.umanitoba.ca

ABSTRACT

Analyses of morphologic, geographic, and ecologic data indicate three species comprise the *Carex jamesii* complex: *C. jamesii*, *C. juniperorum*, and *C. timida*, sp. nov. *Carex jamesii* has shoot bases lacking red-purple, relatively tall culms, relatively long staminate portions of spikes, and relatively long perigynium beaks. It is common and widespread in mesic deciduous forests in much of the eastern U.S.A. and in southwestern Ontario. *Carex juniperorum* has red-purple shoot bases, short culms, short staminate portions of spikes, and short perigynium beaks. It is rare and has a disjunct distribution in mesic deciduous and deciduous-juniper forests and forest edges in the eastern U.S.A. and southeastern Ontario. *Carex timida* has red-purple shoot bases, tall culms, short staminate portions of spikes, and short perigynium beaks. It is rare and has a disjunct distribution in mesic deciduous forests of the eastern U.S.A. Phylogenetic analysis of morphologic data indicates the complex is monophyletic and *C. juniperorum* is the sister species of *C. timida*. The correct name and authorship of the section to which the *C. jamesii* complex belongs is determined to be *Carex* section *Phyllostachyae* Tuck. ex Kük. Synonymies, typifications, descriptions, and citations of representative specimens are provided for each species, along with an identification key.

RESUMEN

Los análisis de datos morfológicos, geográficos, y ecológicos indican que el complejo *Carex jamesii* comprende tres especies: *C. jamesii*, *C. juniperorum*, y *C. timida*, sp. nov. *Carex jamesii* tiene las bases de los renuevos que no son rojo-púrpura, cúlmenes relativamente altos, parte estaminada de las espigas relativamente largas, y picos del utrículo relativamente largos. Es común y está distribuido en los bosques deciduos mesófilos en gran parte del este de U.S.A. y en el suroeste de Ontario. *Carex juniperorum* tiene las bases de los renuevos rojo-púrpura, cúlmenes cortos, parte estaminada de las espigas corta, y picos del utrículo cortos. Es raro y tiene una distribución disyunta en los bosques deciduos mesófilos y enebrales, y bordes de bosques en el este de U.S.A. y sureste de Ontario. *Carex timida* tiene las bases de los renuevos rojo-púrpura, cúlmenes altos, parte estaminada de las espigas corta, y picos del utrículo cortos. Es raro y tiene una distribución disyunta en los bosques deciduos mesófilos del este de U.S.A. El análisis filogenético de datos morfológicos indica que el complejo es monofilético y que *C. juniperorum* es la especie hermana de *C. timida*. El nombre correcto y autoría de la sección a la que pertenece el complejo *C. jamesii* se determina que es *Carex* sección *Phyllostachyae* Tuck. ex Kük. Se ofrecen sinonimias, tipificaciones, descripciones, y citaciones de especímenes representativos de cada especie, junto con una clave de identificación.

INTRODUCTION

Carex section *Phyllostachyae* Tuck. ex Kük. is a morphologically distinctive group of sedges endemic to North American forests and forest openings. The large and often leaf-like pistillate scales are the most striking feature of these plants. Additional traits common to the members of this group are densely caespitose habit; winged culms and peduncles, both of which are dilated at their apices; androgynous spikes, with lateral ones usually arising from the plant base; and beaked perigynia with entire orifices. Various workers (e.g. Crins 1990; Starr & Ford 1995; Naczi et al. 1998) have used the unusual morphologic features of *Carex* sect. *Phyllostachyae* to suggest the section is monophyletic, a hypothesis recently supported by molecular data (Starr et al. 1999). Recently, several authors have focused on various aspects of the systematics of *Carex* sect. *Phyllostachyae*, including phylogeny (Crins 1990; Starr et al. 1997, 1999), taxonomy (Catling et al. 1993; Naczi & Ford 1998; Naczi et al. 1998), genetic diversity (Ford et al. 1998a, 1998b, 1998c), chromosome numbers and arrangements (Naczi 1999), and anatomy and micromorphology (Starr & Ford 2001).

Ten species belong to *Carex* section *Phyllostachyae*: *C. backii* Boott; *C. basiantha* Steud.; *C. jamesii* Schwein.; *C. juniperorum* Catling, Reznicek, & Crins; *C. latebracteata* Waterf.; *C. saximontana* Mack.; *C. superata* Naczi, Reznicek, & B.A. Ford; *C. willdenowii* Willd.; *C.* sp. nov. Saarela & B.A. Ford; and one species described as new in this paper. The greatest species diversity occurs in the southeastern United States, where as many as five of these species are sympatric in portions of Alabama, Arkansas, and Tennessee.

One of the clades we have identified within *Carex* section *Phyllostachyae* is the *C. jamesii* complex (Naczi & Ford 1998; Starr et al. 1999). We hypothesize that this clade contains three species, *C. jamesii*, *C. juniperorum*, and an undescribed species here named *C. timida*. In this paper, we test this hypothesis by examining the systematics of the *C. jamesii* complex. This is the first of two papers exploring the systematics and genetic diversity among taxa in the *C. jamesii* complex.

MATERIALS AND METHODS

We studied the morphology, geography, and ecology of the *C. jamesii* complex in the field on numerous trips during 1986–2001. The field work included observations at sites throughout most of the geographic range of this complex. These sites were in Ontario, Canada, and 13 states of the eastern United States: Alabama, Arkansas, Illinois, Kentucky, Maryland, Michigan, Mississippi, Missouri, Ohio, Oklahoma, Tennessee, Virginia, West Virginia.

For this project, we studied over 1,950 specimens from the following 27 herbaria: BEREA, BLH, DHL, DOV, EKY, IBE, KNK, KY, MICH, MO, MT, MU, MUR, NA, NY, OS, PENN, PH, TENN, US, VDB, VPI, WIN, WIS, WKU, ctb, bas. Abbreviations of herbaria are those of Holmgren et al. (1990) except for Charles T. Bryson herbarium (ctb) and Bruce A. Sorrie herbarium (bas).

Morphology

For the study of morphology, we selected 74 specimens as a representative subset to measure for univariate and multivariate statistical analyses. We chose mature, complete, and ample specimens that exhibited the full range of morphologic variation of the *C. jamesii* complex and that originated from throughout the geographic range of the complex. We measured 16 continuous and two discrete characters on each of these specimens (Table 1). Each specimen we measured is denoted by a superscript asterisk in the specimen citations below.

To detect groups among the specimens and identify the characters that best diagnose these groups, we used principal components analysis (PCA). Before conducting the analysis, we standardized all measurements so each variable would have a mean of 0 and a standard deviation of 1. For the PCA, we included only continuous characters. To avoid weighting characters, we excluded characters that are probably genetically redundant. To detect such characters, we checked the Pearson correlation coefficient for all pairs of characters, and regarded values of the correlation coefficient ≥ 0.7 as indicating possibly genetically redundant characters. Exclusion of seven genetically redundant characters and two discrete characters resulted in the remaining nine characters being included in the PCA (Table 1).

We assessed the degree to which the groups detected in the PCA differed among themselves, character by character, by analyzing each of the measured variables with one-way analysis of variance (ANOVA) with the Tukey Honestly Significantly Different test for multiple comparisons of means. Because the variances of several variables are heterogeneous (as determined by the Bartlett chi-square test for homogeneity of group variances), we transformed these data with the common logarithm before conducting the ANOVA. We performed all statistical analyses with SYSTAT version 5.1 (Wilkinson 1989) on an Apple® computer.

In order to apply the available names to the groups revealed through PCA and ANOVA, we studied type specimens. Isotypes of *C. steudelii* Kunth were unsuitable for measuring because of their immaturity. We ascertained the application of this name by comparison of its isotypes with the specimens of the PCA and ANOVA groups. We applied all other names by inclusion of type specimens in the PCA and ANOVA.

Geography

To determine the geographic range of each of the groups identified in the morphologic studies, we used herbarium specimen collection data to plot their distributions on outline maps. Each point on these maps is based on at least one herbarium specimen.

Ecology

For each population encountered in the field, we noted vascular plant associates. Closely associated vascular plant species are those that grew within 10 m of a plant of the *C. jamesii* complex at more than one-third of all sites investigated for this study. We also surveyed all localities for additional members of

TABLE 1. Morphologic characters, with their abbreviations, measured on herbarium specimens of the *Carex jamesii* complex. The 9 characters marked with asterisks are those included in the principal components analysis.

Continuous Characters

1. Height of tallest culm, including terminal spike (CLMHT)*
2. Height of shoot bearing tallest culm (SHTHT)*
3. Width of widest leaf blade (WLFW)
4. Length of longest (per specimen) staminate portion of terminal spike (MSPL)
5. Length of peduncle of longest (per specimen) staminate portion of terminal spike (MPDCLL)*
6. Length of proximalmost staminate scale of terminal spike (MSCL)*
7. Length of longest (per specimen) scale subtending proximalmost perigynium of terminal spike (LFSCL)*
8. Width of hyaline margin of scale subtending distalmost perigynium of terminal spike (MARGW)*
9. Length of perigynium (PERIGL)*
10. Width of perigynium (PERIGW)*
11. Length of perigynium beak (PERIGBKL)
12. Length of achene (ACHNL)
13. Width of achene (ACHNW)
14. Height of culm/height of shoot (RCLM)
15. Length of proximalmost staminate scale/length of longest (per specimen) staminate portion of terminal spike (RSC)*
16. Length of perigynium beak/length of perigynium (RBK)

Discrete characters

17. Number of leaves and bracts on shoot bearing tallest culm (LFNO)
18. Number of perigynia in terminal spike (PERIGNO)

the complex. We consider species of the complex found within 30 m of each other to be examples of syntopy.

Phylogeny

We compared members of the *C. jamesii* complex with each other and with other species in section *Phyllostachyae* in an attempt to discover morphologic characters useful for phylogenetic analysis. We polarized character states using members of sect. *Phyllostachyae* that constitute the "wide-scaled clade." Four species comprise this clade: *C. backii*, *C. latebracteata*, *C. saximontana*, and an undescribed species similar to *C. saximontana* (*C.* sp. nov. Saarela & B.A. Ford). Previous analyses of morphologic and molecular data indicate this wide-scaled clade is sister to the clade that includes the *C. jamesii* complex (Starr & Ford 2001).

To conduct the phylogenetic analysis, we used PAUP* version 4.0b (Swofford 2000) on an Apple® computer. For this analysis, all characters were weighted equally. The most parsimonious tree was computed using an exhaustive search. We assessed the robustness of clades using decay and bootstrap analyses (10,000 replicates for the bootstrap analysis).

RESULTS

Morphology

A scatter plot of the scores of principal components 1 and 2 depicts three distinct groups (Fig. 1). Component 1 provides separation of *C. jamesii* from *C. juniperorum*, while *C. timida* is separated on component 2. No subgroupings within these three groups are evident. Together, the first two components explain 71% of the variance within the data set, with component 1 accounting for 44% and component 2 accounting for 27%. The third principal component accounts for only 9.6% of the total variance and affords no separation of groups. All of the variables employed in the PCA have relatively high loadings (absolute values > 0.5) on at least one of the first two components (Table 2). The variables with the highest loadings on component 1 are CLMHT, LFSCL, and PERIGL, in descending order (abbreviations as in Table 1). On component 2, RSC, MSCL, and MARGW had the highest loadings. A plot of the two variables with the highest loadings for each component, CLMHT vs. RSC, separates the three groups (Fig. 2), but not as well as in the PCA plot.

Like the PCA, the ANOVA supports the existence of three groups in the *C. jamesii* complex. Though the measurements of many characters possess considerable variability and the ranges of the measurements overlap for many characters, at least two of the three groups have significantly different means for all 18 measured variables (Table 3). For eight of these characters, all three means are significantly different from each other. The variables that are the best for distinguishing the members of the *C. jamesii* complex, based on high *F* values, are RCLM, RSC, and MSCL, in descending order.

Each of the three species identified in the PCA and ANOVA is distinguished by several characters. Specimens with relatively high values for MSPL, MPDCLL, LFSCL, PERIGL, PERIGBKL, and RBK are referable to *Carex jamesii*, since its holotype falls within this group (Fig. 1). Plants with low values for CLMHT, MSCLL, MARGW, PERIGBKL, RCLM, and high values for LFNO and PERIGNO are *C. juniperorum*. A measured isotype of *C. juniperorum* is a member of this second group. The third group, with low values for MSPL, high for MSCL, and high for RSC, is *C. timida*. The specimen designated as holotype of *C. timida* is clearly in this third group.

Several qualitative characters also distinguish members of the *C. jamesii* complex. Plants of *C. juniperorum* and *C. timida* have red-purple tinging on their dark brown shoot bases, whereas plants of *C. jamesii* lack red-purple coloration. The cells of the cataphylls of specimens of *C. juniperorum* and *C. timida* are bulging (Fig. 3). However, in *C. jamesii*, the cataphylls have cell surfaces that are collapsed or flush with their anticlinal walls, at least in dried specimens. In living plants, *C. timida* is distinctive in the color of its foliage. Its leaves are lighter

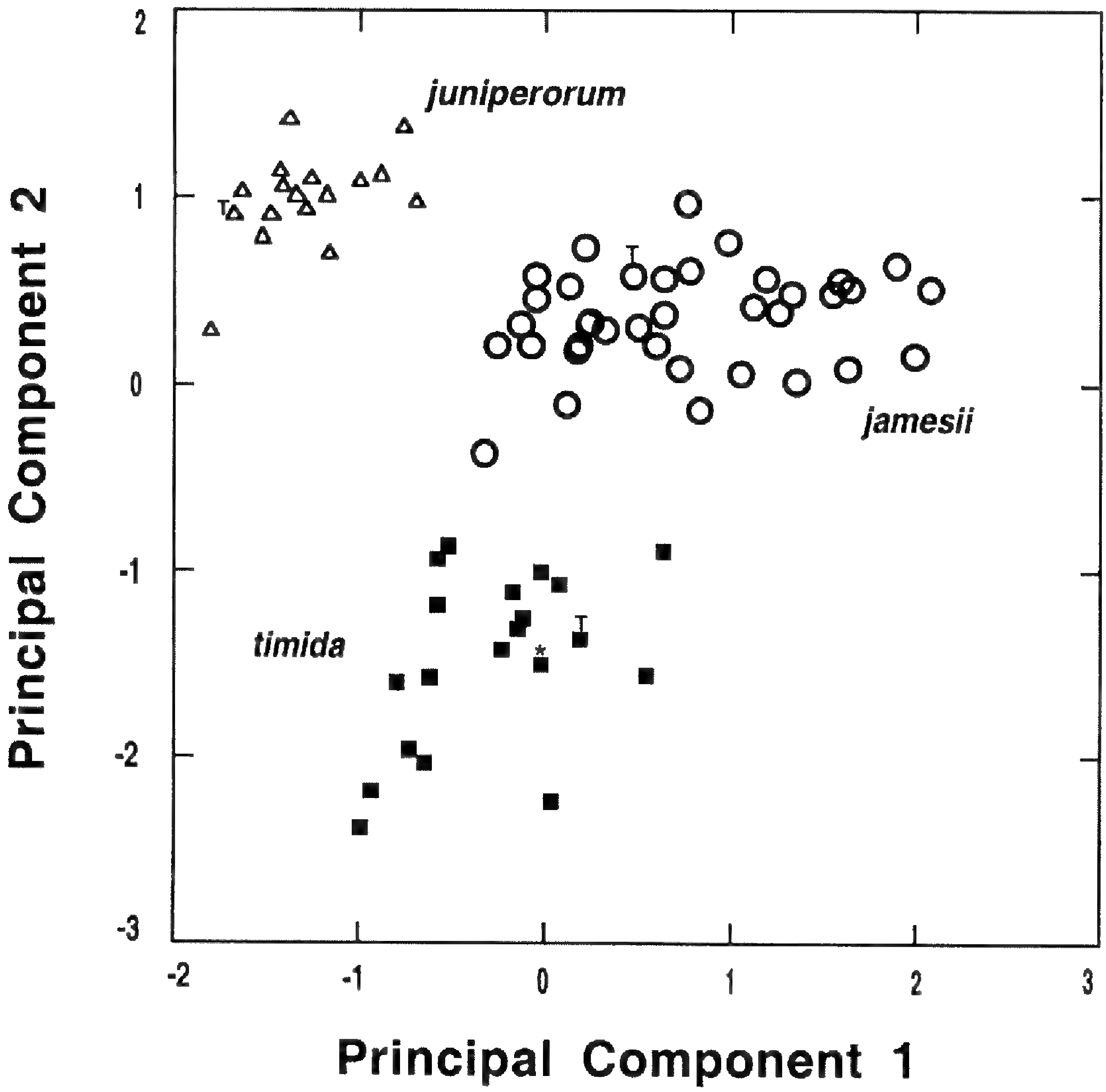

FIG. 1. Scatter plot of the scores of principal component 2 vs. principal component 1 from PCA of the measurements of members of the *Carex jamesii* complex. Circles represent specimens of *C. jamesii*, triangles represent *C. juniperorum*, and squares represent *C. timida*. The symbols adjacent to "T" represent type specimens. The asterisked square represents a specimen from the population that clusters with *C. juniperorum* in the study of genetic diversity of the *C. jamesii* complex (Ford & Naczi 2001).

green than those of *C. jamesii* and *C. juniperorum*. Also in living plants, the culms and leaves of *C. timida* are quite lax and spreading. Consequently, when perigynia are mature (and relatively heavy), most of the spikes are concealed by the foliage. The living culms of *C. jamesii* are more rigid, erect, and evident than those of *C. timida*. In *C. juniperorum*, the culms are erect and concealed by the greatly overtopping foliage (illustrated in Catling et al. 1993). The wider leaf blades of *C. juniperorum* have hyaline margins, whereas those of *C. jamesii* and *C. timida* are green. The proximalmost staminate scale in each spike has connate margins in *C. juniperorum* and *C. timida*, but the margins are free in *C. jamesii* (Fig 4). In addition, the staminate scales are papillate in *C. timida*, but nonpapillate in *C. jamesii* and *C. juniperorum* (Fig 5). In *C. timida*, some of the

Table 2. Loadings for the first two principal components from PCA of specimens of the *Carex jamesii* complex. Character abbreviations correspond to those in Table 1.

Character	Component 1	Component 2
CLMHT	0.89	-0.21
SHTHT	0.76	0.087
MPDCLL	0.72	0.089
MSCL	0.23	-0.90
LFSCL	0.83	0.11
MARGW	0.58	-0.68
PERIGL	0.82	0.16
PERIGW	0.57	0.44
RSC	-0.20	-0.93

papillae are elongate and acute. Often these elongate papillae occur in pairs and resemble arthropod cerci.

Judging from the amount of scatter of points on the PCA plot (Fig. 1), the morphologic variability of *C. jamesii* and of *C. timida* is similar. Each of these species has substantially more variation than *C. juniperorum*. A specimen from the population of *C. timida* that clusters with *C. juniperorum* based on allozymes (Ford & Naczi 2001) is nested firmly within the *C. timida* group on the PCA plot (Fig. 1).

Geography

Carex jamesii ranges widely, from northern New York and southern Ontario west to southeasternmost Minnesota and south to western South Carolina, northern Alabama, northern Mississippi, southern Arkansas, and southeasternmost Oklahoma (Fig. 6). It is very common in much of this region, but is rather rare east of Ohio, Kentucky, Tennessee, and Alabama.

Carex juniperorum occurs in three disjunct areas: southeastern Ontario, southwestern Virginia, and southern Ohio and adjacent northeastern Kentucky (Fig. 7). Except for the populations in southeastern Ontario, all populations of *C. juniperorum* are sympatric with *C. jamesii*. The southern Ohio and northeastern Kentucky populations of *C. juniperorum* are sympatric with *C. timida*. *Carex juniperorum* is local and quite rare, with populations known from only six counties.

Carex timida occurs disjunctly in three areas: the Ozark Mountains of southern Missouri and northern Arkansas, the Ouachita Mountains of southwestern Arkansas and southeastern Oklahoma, and southwestern Ohio and Indiana south to northern Alabama (Fig. 7). Throughout its range, *C. timida* is sympatric with *C. jamesii*. *Carex timida* is local and rare, with populations known from only 20 counties.

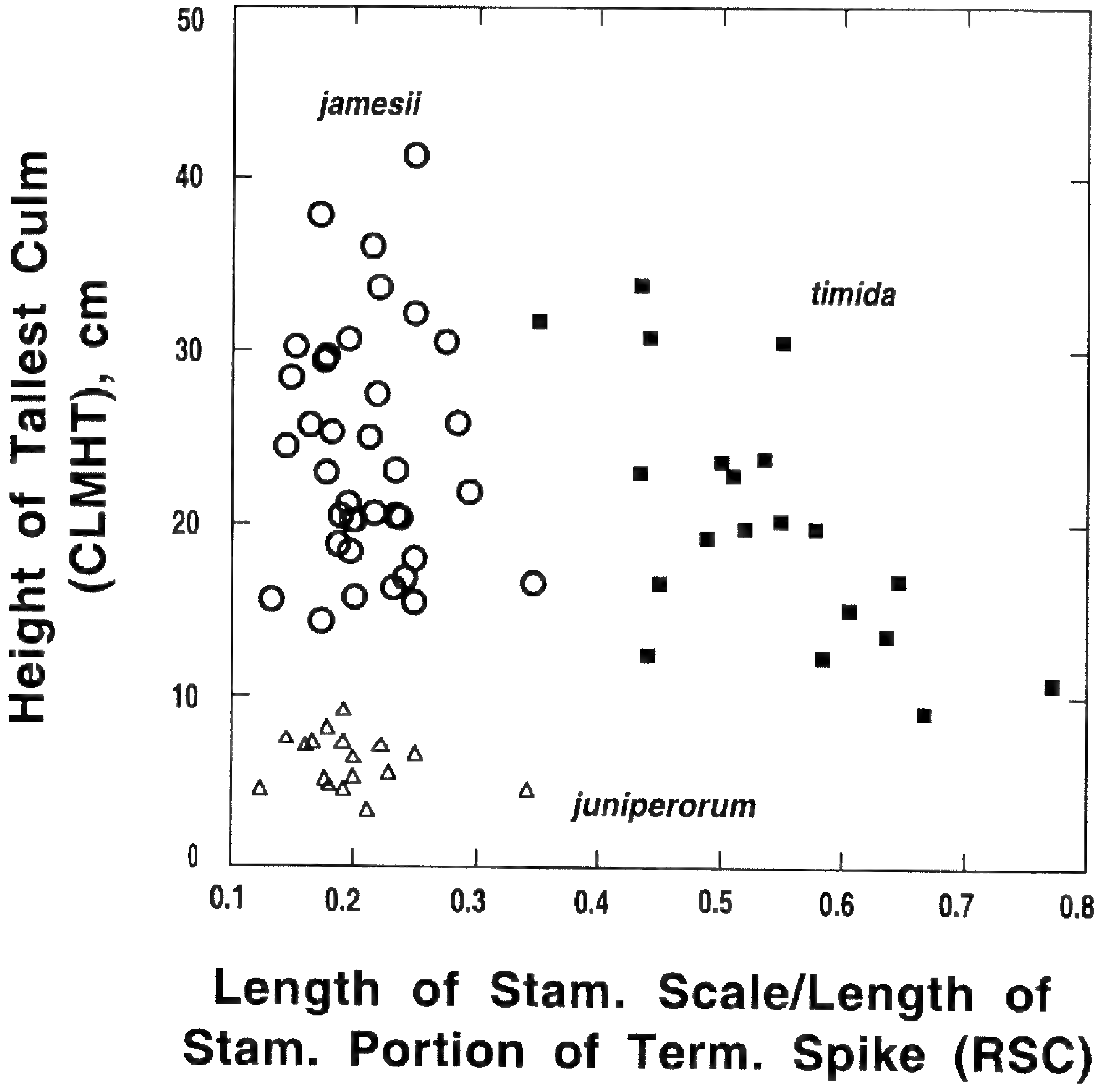

Fig. 2. Scatter plot of measurements of the variable having the highest loading on principal component 1 (height of tallest culm) vs. on component 2 [ratio of length of proximalmost staminate scale/length of longest (per specimen) staminate portion of terminal spike] for the members of the *Carex jamesii* complex. Circles represent specimens of *C. jamesii*, triangles represent *C. juniperorum*, and squares represent *C. timida*.

Ecology

Carex jamesii plants inhabit mesic deciduous woodlands. They often grow along streams, usually in uplands, though they occasionally grow on floodplains. Substrates for *C. jamesii* are loams that appear to be calcareous and nutrient-rich, judging from the diverse associated flora, including known calciphiles. Some close associates of *C. jamesii* are *Acer saccharum* Marshall, *C. albursina* E. Sheld., *C. amphibola* Steud., *C. blanda* Dewey, *C. laxiculmis* Schwein. var. *copulata* (L.H. Bailey) Fernald, *C. oligocarpa* Willd., *C. rosea* Willd., *Cercis canadensis* L., *Diplazium pycnocarpon* (Spreng.) M. Broun, *Hydrastis canadensis* L., *Jeffersonia diphylla* (L.) Pers., *Lindera benzoin* (L.) Blume, *Osmorhiza longistylis* (Torr.) DC., *Podophyllum peltatum* L., *Polystichum acrostichoides* (Michx.) Schott, and

TABLE 3. Means ± 1 SD and ranges for morphologic characters measured for *Carex jamesii* complex. Character abbreviations correspond to those in Table 1. All measurements are in millimeters, except characters 14–16 (ratios) and characters 17–18 (counts). *N* = sample size. Within a row, means with different superscripts differ significantly (ANOVA, $P < 0.03$).

Character	*C. jamesii* ($N = 37$)	*C. juniperorum* ($N = 17$)	*C. timida* ($N = 20$)	ANOVA *F*
1. CLMHT	$239^{a} \pm 68.7$ (142–413)	$61^{b} \pm 16$ (32–91)	$202^{a} \pm 73$ (90–338)	120
2. SHTHT	$385^{a} \pm 91.6$ (248–626)	$271^{b} \pm 90.2$ (145–449)	$314^{b} \pm 74.7$ (219–453)	13.2
3. WLFW	$2.7^{a} \pm 0.40$ (1.8–3.5)	$3.3^{b} \pm 0.61$ (2.2–4.2)	$3.0^{ab} \pm 0.73$ (1.7–4.3)	7.0
4. MSPL	$8.2^{a} \pm 2.2$ (4.9–13.5)	$6.0^{b} \pm 1.5$ (3.6–8.4)	$4.7^{c} \pm 0.83$ (3.4–6.2)	33
5. MPDCLL	$1.9^{a} \pm 0.7$ (0.8–3.8)	$0.7^{b} \pm 0.4$ (0.1–1.4)	$1.1^{c} \pm 0.4$ (0.4–1.9)	30
6. MSCL	$1.7^{a} \pm 0.21$ (1.1–2.1)	$1.1^{b} \pm 0.22$ (0.9–1.6)	$2.5^{c} \pm 0.33$ (1.9–3.3)	140
7. LFSCL	$59^{a} \pm 22$ (31–119)	$24^{b} \pm 6.9$ (16–36)	$35^{c} \pm 19$ (17–81)	38
8. MARGW	$0.5^{a} \pm 0.1$ (0.3–0.7)	$0.1^{b} \pm 0.06$ (0.05–0.3)	$0.6^{c} \pm 0.09$ (0.4–0.7)	100
9. PERIGL	$6.1^{a} \pm 0.75$ (4.8–7.6)	$4.6^{b} \pm 0.38$ (3.9–5.4)	$5.0^{b} \pm 0.46$ (4.0–6.0)	44
10. PERIGW	$2.1^{a} \pm 0.16$ (1.8–2.5)	$1.9^{b} \pm 0.14$ (1.7–2.1)	$1.9^{b} \pm 0.15$ (1.6–2.1)	19
11. PERIGBKL	$2.9^{a} \pm 0.51$ (1.9–3.9)	$1.6^{b} \pm 0.24$ (1.2–2.2)	$2.0^{c} \pm 0.27$ (1.4–2.5)	77
12. ACHNL	$2.4^{a} \pm 0.24$ (1.9–2.8)	$2.2^{b} \pm 0.14$ (2.0–2.5)	$2.3^{ab} \pm 0.12$ (2.1–2.5)	5.2
13. ACHNW	$2.0^{a} \pm 0.15$ (1.8–2.4)	$1.9^{b} \pm 0.13$ (1.6–2.1)	$1.8^{b} \pm 0.14$ (1.6–2.1)	19
14. RCLM	$0.62^{a} \pm 0.095$ (0.45–0.86)	$0.23^{b} \pm 0.050$ (0.15–0.32)	$0.63^{a} \pm 0.12$ (0.39–0.83)	190
15. RSC	$0.21^{a} \pm 0.045$ (0.13–0.35)	$0.20^{a} \pm 0.048$ (0.13–0.34)	$0.54^{b} \pm 0.10$ (0.35–0.77)	160
16. RBK	$0.47^{a} \pm 0.038$ (0.39–0.53)	$0.35^{b} \pm 0.029$ (0.30–0.43)	$0.39^{c} \pm 0.029$ (0.34–0.44)	85
17. LFNO	$4^{a} \pm 0.6$ (3–6)	$8^{b} \pm 1$ (6–11)	$6^{c} \pm 1$ (4–8)	70
18. PERIGNO	$3^{a} \pm 0.7$ (1–4)	$6^{b} \pm 1$ (4–8)	$3^{a} \pm 0.5$ (2–4)	90

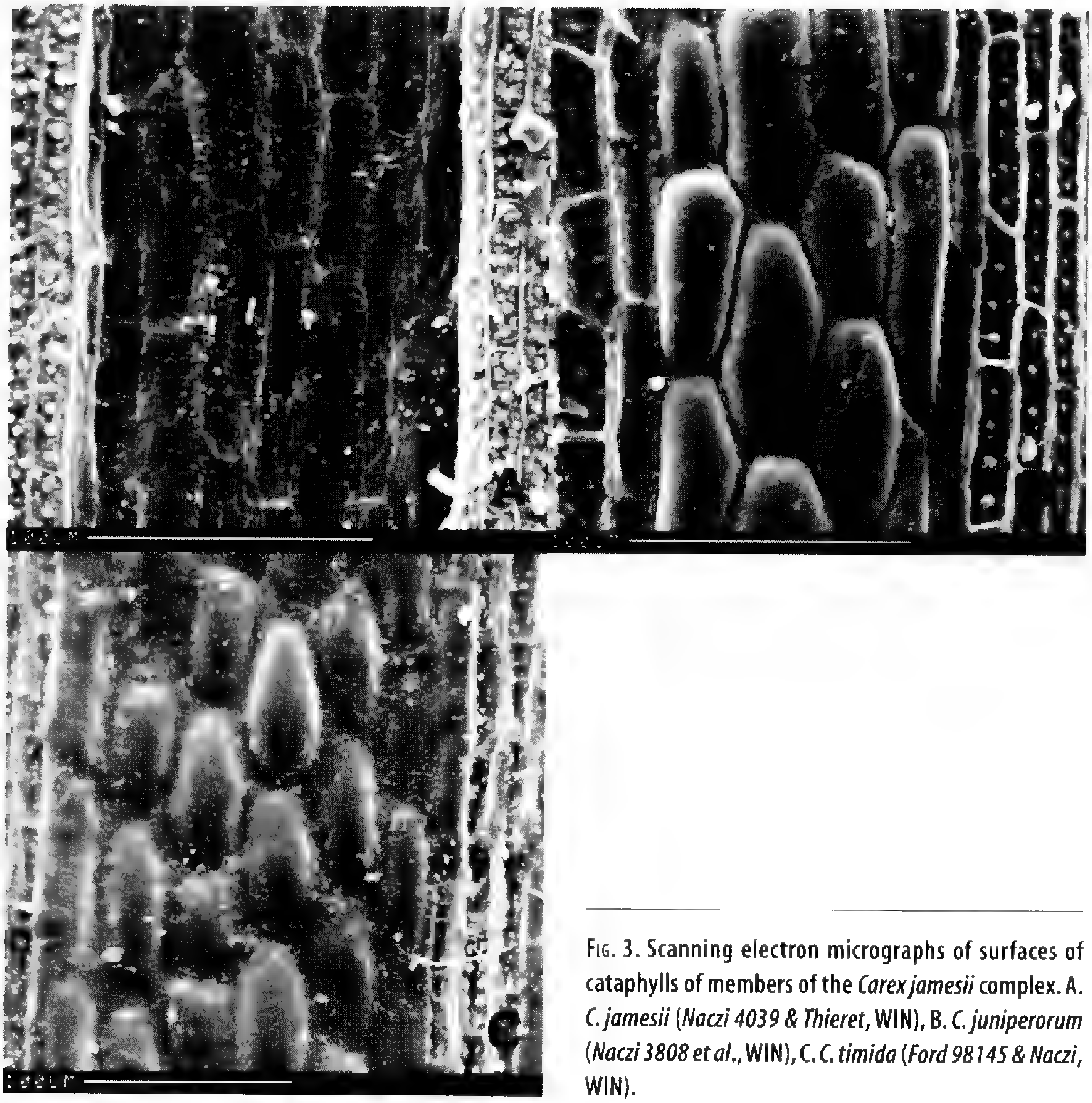

Fig. 3. Scanning electron micrographs of surfaces of cataphylls of members of the *Carex jamesii* complex. A. *C. jamesii* (*Naczi 4039 & Thieret*, WIN), B. *C. juniperorum* (*Naczi 3808 et al.*, WIN), C. *C. timida* (*Ford 98145 & Naczi*, WIN).

Sanguinaria canadensis L. *Carex jamesii* rarely grows with *C. timida* (Table 4, and see below).

Plants of *Carex juniperorum* grow in mesic woodlands and edges of woodland openings, usually with a mixture of deciduous trees and junipers (*Juniperus virginiana* L.). Especially in Ontario, *C. juniperorum* occurs in juniper-dominated woodlands with few deciduous trees, particularly surrounding alvar openings (Catling et al. 1993). In the southern part of its range, *C. juniperorum* can be found in woodlands that are devoid of juniper. The optimal habitat, judging from the fact that specimens that are the most robust and produce the most perigynia grow in such places, appears to be mature, relatively open forests dominated by oaks and hickories, with few and scattered junipers. Usually, plants of *C. juniperorum* occur far from streams, particularly since they often grow on gentle slopes near hilltops. Its habitats are moist, at least during the early part of the growing season, often through groundwater seepage. Its

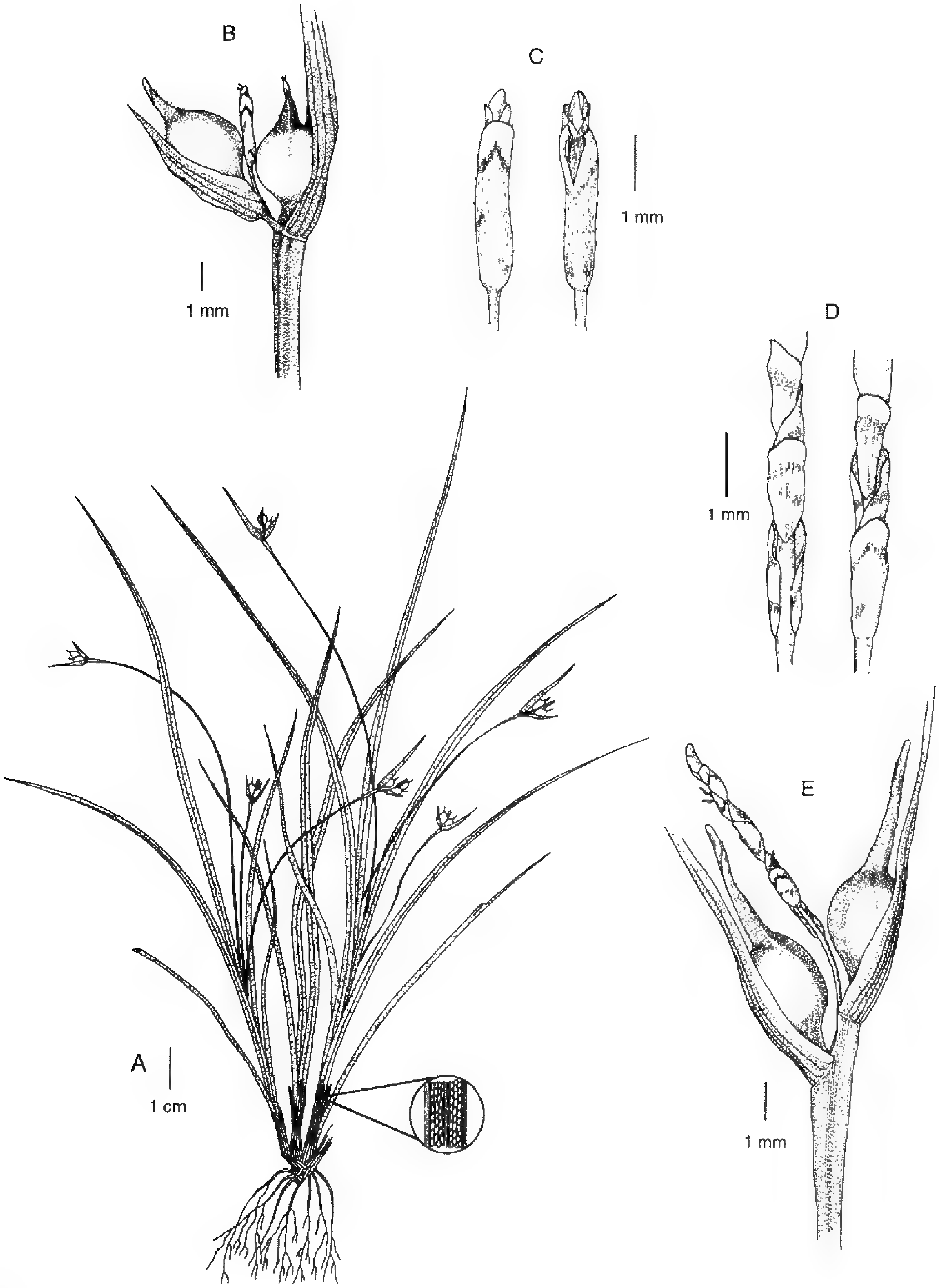

FIG. 4. *Carex timida* (A–C) and *C. jamesii* (D–E). *Carex timida*: A. Habit, with enlargement of portion of cataphyll, B. Terminal spike, C. Staminate portion of terminal spike, with proximalmost scale in abaxial view (left) and in adaxial view (right). *Carex jamesii*: D. Proximal region of staminate portion of terminal spike, with proximalmost scale in adaxial view (left) and in abaxial view (right). E. Terminal spike.

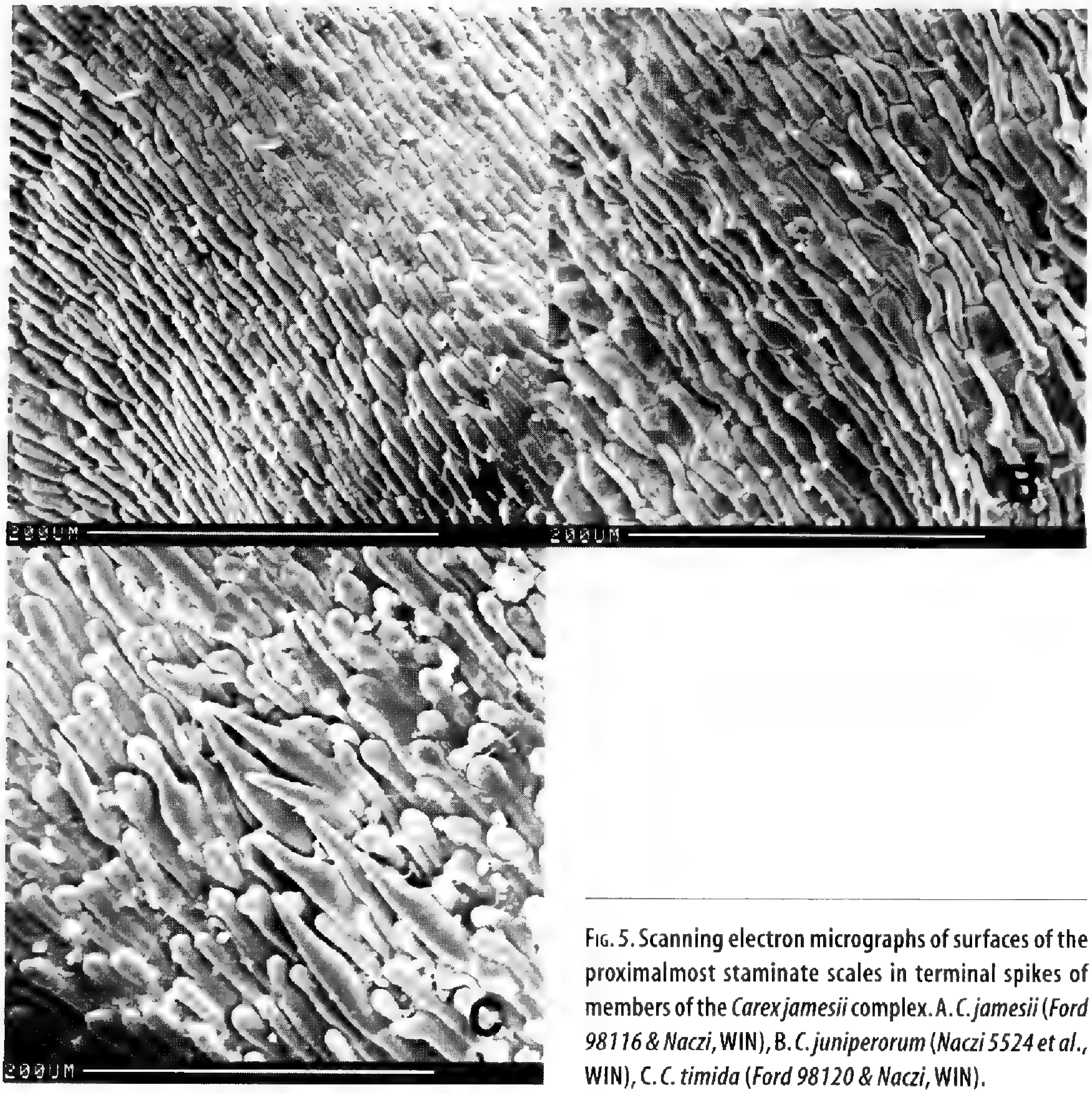

Fig. 5. Scanning electron micrographs of surfaces of the proximalmost staminate scales in terminal spikes of members of the *Carex jamesii* complex. A. *C. jamesii* (*Ford 98116 & Naczi*, WIN), B. *C. juniperorum* (*Naczi 5524 et al.*, WIN), C. *C. timida* (*Ford 98120 & Naczi*, WIN).

substrates are clays that are calcareous and circumneutral (Catling et al. 1993) and usually are not rocky. Vascular plants closely associated with *C. juniperorum* include *Calystegia spithamea* (L.) Pursh, *Carex laxiflora* Lam., *C. oligocarpa*, *C. umbellata* Willd., *Cercis canadensis*, *Houstonia canadensis* Roem. & Schult., *Juniperus virginiana*, *Lithospermum canescens* (Michx.) Lehm., *Lobelia spicata* Lam., *Rhus aromatica* Aiton, and *Viburnum prunifolium* L. We have never observed *C. juniperorum* growing with any other member of the *C. jamesii* complex. Though rare and local, *C. juniperorum* is often common where it does occur.

The usual habitat of *Carex timida* is in relatively open (sometimes closed) mesic deciduous and deciduous-juniper woodlands. Populations often occur high on slopes and on hilltops, far from streams. The substrates are loams and clay-loams that are apparently calcareous. The substrates are often rocky, with limestone at or near the surface at several sites. Among the closely associated vascular plant species are *Acer saccharum*, *Aristolochia serpentaria* L., *Carex*

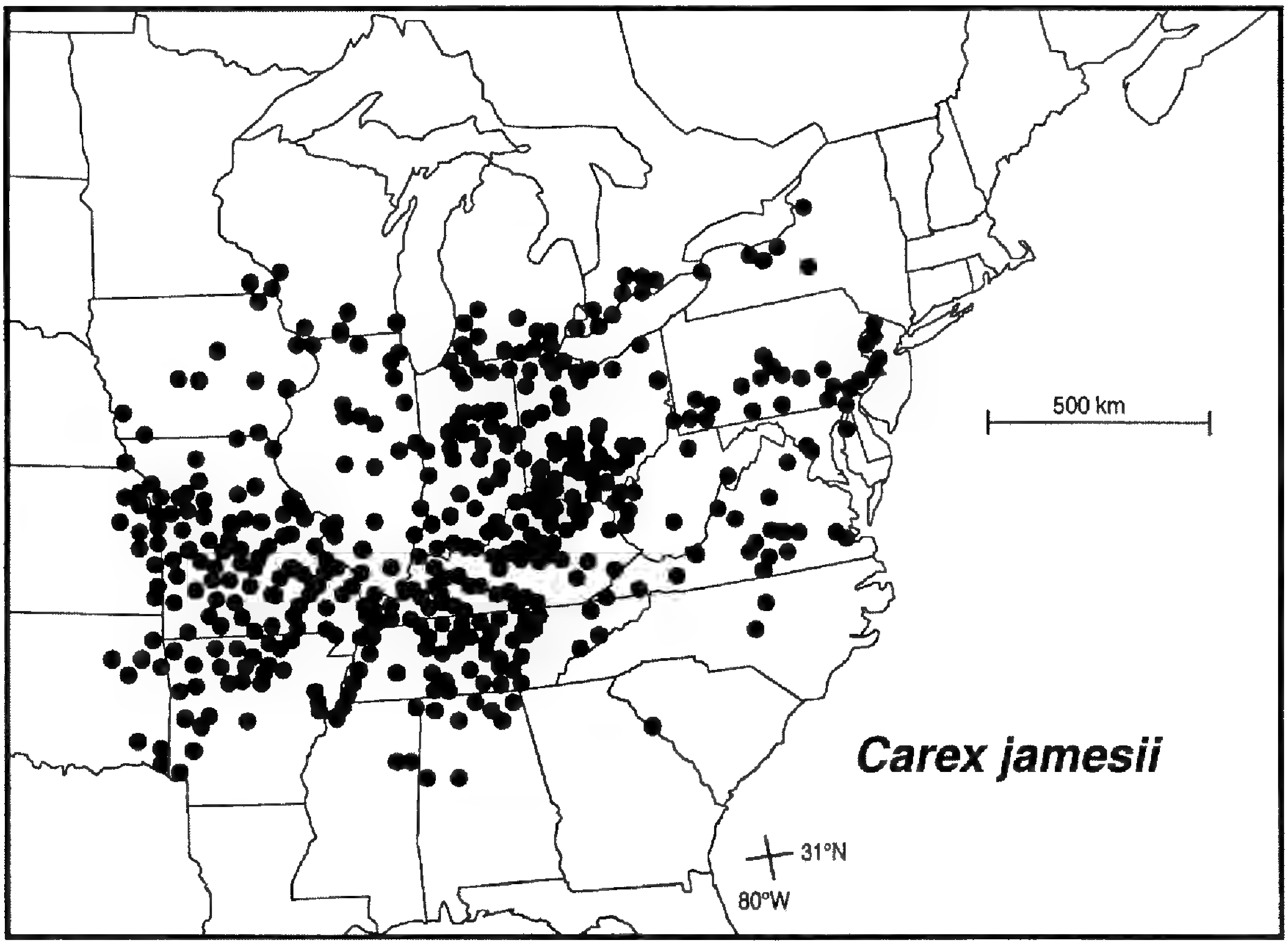

FIG. 6. Geographic distribution of *Carex jamesii*.

blanda, *C. cephalophora* Willd., *Carya* spp., *Cercis canadensis*, *Juniperus virginiana*, *Quercus* spp., and *Ulmus* spp. Of the nine sites for *C. timida* we have studied in the field, four of them also hosted *C. jamesii* (Table 4). When *C. timida* and *C. jamesii* are syntopic, *C. timida* usually grows higher on slopes in slightly drier microsites than *C. jamesii*.

Phylogeny

We discovered 13 morphologic characters useful in the phylogenetic analysis of the *C. jamesii* complex (Table 5). Nine of the characters are reproductive and four are vegetative. Each of these characters has two states (Tables 5, 6). The analysis resulted in one most parsimonious tree that is 18 steps long (Fig. 8). The values for the consistency index and the retention index, excluding uninformative characters, are 0.67 and 0.64, respectively. Of the 13 characters employed in the phylogenetic analysis, 8 are nonhomoplasious, 2 are subject to parallelism between the *C. jamesii* complex and the outgroup (characters #4 and 7), and 3 are subject to reversal (#8, 10, and 12).

Five synapomorphies, three of which are nonhomoplasious, diagnose the *C. jamesii* complex and support its status as a monophyletic group (character numbers as in Table 5 in parentheses following the synapomorphy): relatively

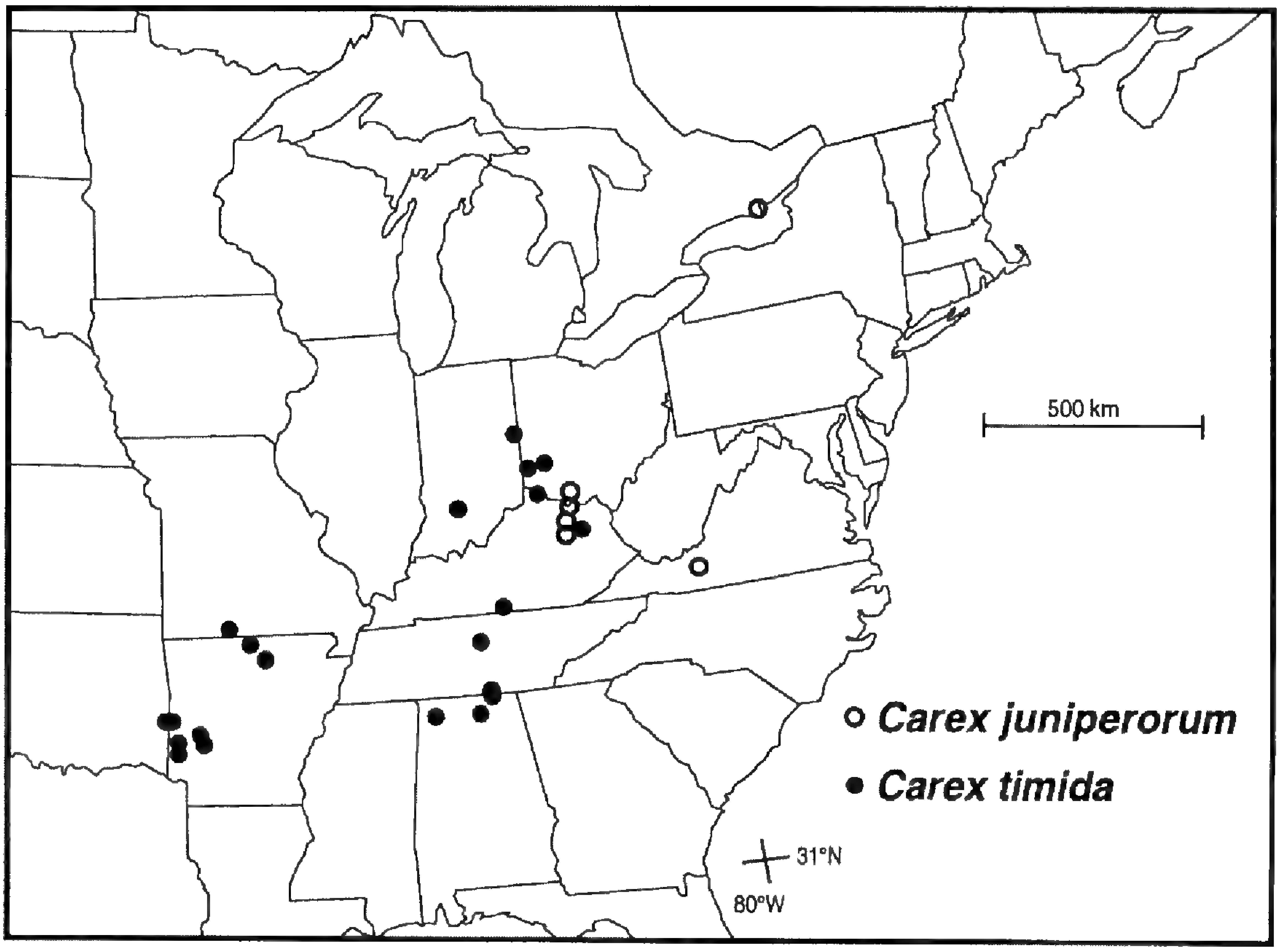

Fig. 7. Geographic distribution of *Carex juniperorum* and *C. timida*.

narrow staminate portions of the terminal spikes (6); relatively short proximalmost staminate scales (8), reversed in *C. timida*; truncate staminate scales (9); pistillate scales with hyaline margins relatively wide (12), reversed in *C. juniperorum*; and perigynia abruptly contracted to beaks (13). Two nonhomoplasious synapomorphies support the sister-group status of *C. juniperorum* and *C. timida*: shoot bases tinged with red-purple (1) and cataphyll cells bulging, Fig. 3 (3). Each of the three species in the *C. jamesii* complex is diagnosed by at least two autapomorphies. *Carex jamesii* has relatively long staminate portions of the spikes (5) and staminate scales with free margins, a reversal (10). *Carex juniperorum* is diagnosed by culms quite short relative to shoots (2), wider leaf blades with hyaline margins (4), a relatively high number of perigynia in the terminal spikes (7), and pistillate scales with the hyaline margins very narrow, a reversal (12). *Carex timida* has relatively long proximalmost staminate scales, a reversal (8), and staminate scales bearing papillae, some of which are elongate and acute (11). The clade of *C. jamesii* + *C. juniperorum* + *C. timida* has a decay value of 2 and has 78% bootstrap support, while the *C. juniperorum* + *C. timida* clade has a decay value of 1 and is supported in 51% of the bootstrap replicates.

TABLE 4. Examples of syntopy of *Carex jamesii* and *C. timida*. Numbers listed are Naczi's collection numbers for voucher specimens. Full specimen citations are provided in the taxonomic treatment.

Locality	*C. jamesii*	*C. timida*
Arkansas: Howard Co.	1925	1918, 1921
Kentucky: Campbell Co.	5649	5650
Kentucky: Monroe Co.	7236	7232
Ohio: Montgomery Co.	7363	7357

TABLE 5. Characters, character states, and character state polarizations discovered for use in the phylogenetic analysis of the *Carex jamesii* complex. The plesiomorphic state is indicated by "(0)" and the apomorphic state by "(1)." Abbreviations for characters included in the statistical analyses are as in Table 1.

1. Shoot bases, color: lacking red-purple (0), tinged with red-purple (1).
2. Culm, height of tallest per specimen/shoot bearing tallest culm, height (RCLM): $\geqslant$ 0.39 (0), $\leqslant$ 0.32 (1).
3. Cataphylls, appearance of periclinal walls of epidermal cells, in dried specimens (Fig. 3): sunken or flush with anticlinal walls (0), bulging (1).
4. Leaves, color of margins of wider blades: green (0), hyaline (1). The apomorphic state is due to complete sclerification of the margins (Starr & Ford 2001). *Carex latebracteata* and *C. saximontana* have hyaline leaf blade margins, but *C. backii* and *C.* sp. nov. lack them. Hyaline margins are scored as apomorphic since specimens in the likely sister groups to sect. *Phyllostachyae*, sects. *Filifoliae* and *Firmiculmes* (Starr et al. 1999), have green margins.
5. Staminate portion of terminal spikes, length of longest per specimen (MSPL): $\leqslant$ 8 mm (0), $\geqslant$ 6 mm (1).
6. Staminate portion of terminal spikes, width: $\geqslant$ 0.8 mm (0), $\leqslant$ 0.8 mm (1). *Carex latebracteata* has the staminate portions of terminal spikes greater than 1 mm, but sometimes, *C. backii*, *C. saximontana*, and *C.* sp. nov. have them as narrow as 0.5 mm. However, most specimens of *C. backii*, *C. saximontana*, and *C.* sp. nov. have the staminate portions at least 0.8 mm wide. Thus, the plesiomorphic state is scored as staminate portions $\geqslant$ 0.8 mm wide.
7. Perigynia in terminal spike, number (PERIGNO): $\leqslant$ 5 (0), $\geqslant$ 5 (1). *Carex latebracteata* usually has 7 or more perigynia in the terminal spike, which is likely a parallelism with the occurrence of this apomorphy in the *C. jamesii* complex since *C. backii*, *C. saximontana*, and *C.* sp. nov. usually have 5 or fewer perigynia per spike.
8. Proximalmost staminate scale in terminal spikes, length (MSCL): $\geqslant$ 2.0 mm (0), $\leqslant$ 2.0 mm (1).
9. Staminate scales, shape: ovate (0), truncate (1).
10. Proximalmost staminate scale in terminal spikes, degree of fusion of margins: margins free (0), margins connate in basal 30–80% (0). *Carex latebracteata* has staminate scales with free margins, but *C. backii*, *C. saximontana*, and *C.* sp. nov. have scales with connate margins. Free margins are scored as plesiomorphic because specimens in the likely sister groups to sect. *Phyllostachyae*, sects. *Filifoliae* and *Firmiculmes* (Starr et al. 1999), have scales with free margins.
11. Staminate scales, appearance of periclinal walls of epidermal cells (Fig. 5): nonpapillate (0), papillate, with some papillae elongate and acute (1).
12. Pistillate scale margins, width of hyaline portion of scale subtending distalmost perigynium of terminal spike (MARGW): $\leqslant$ 0.3 mm (0), $\geqslant$ 0.3 mm (1).
13. Perigynia, abruptness of taper from bodies to beaks: gradually tapered (0), abruptly contracted (1).

TABLE 6. Character state assignments for members of the *Carex jamesii* complex. Characters and their states are as in Table 4. *Carex backii*, *C. latebracteata*, *C. saximontana*, and *C.* n.sp. constitute the outgroup.

	Character Number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
C. jamesii	0	0	0	0	1	1	0	1	1	0	0	1	1
C. juniperorum	1	1	1	1	0	1	1	1	1	1	0	0	1
C. timida	1	0	1	0	0	1	0	0	1	1	1	1	1
C. backii	0	0	0	0	0	0	0	0	0	1	0	0	0
C. latebracteata	0	0	0	1	0	0	1	0	0	0	0	0	0
C. saximontana	0	0	0	1	0	0	0	0	0	1	0	0	0
C. sp. nov.	0	0	0	0	0	0	0	0	0	1	0	0	0

DISCUSSION

The results of the PCA and ANOVA support the recognition of three distinct species in the *Carex jamesii* complex. The best diagnostic features are CLMHT, MSCL, RCLM, and RSC. Morphologically, the most divergent member of the *C. jamesii* complex is *C. juniperorum*. On both the PCA and bivariate plots, *C. juniperorum* is the most distinct of the three species (Figs. 1, 2). Of the 16 measured characters with statistically significantly different means that are extremes, 10 of them belong to *C. juniperorum* (Table 3). Measurements for 8 of these 10 characters represent low extremes. For measurements of only one character (MSPL) is *C. juniperorum* intermediate between *C. jamesii* and *C. timida*. *Carex juniperorum* is the only species with very short culms (CLMHT), very short peduncles on the staminate portions of spikes (MPDCLL), very short staminate scales (MSCL), very short pistillate scales (LFSCL), very narrow hyaline margins on its distal pistillate scales (MARGW), very short perigynium beaks (PERIGBKL), culms greatly overtopped by the leaves (RCLM), very short perigynium beaks relative to the length of the perigynia (RBK), a high number of leaves and bracts on reproductive shoots (LFNO), and a high number of perigynia in the terminal spikes (PERIGNO). *Carex juniperorum* is also the only species with hyaline margins on the wider leaves.

Carex jamesii is distinctive mostly in its high values for measured features. Of the 16 measured characters with statistically different means that are extremes, 10 of them belong to *C. jamesii* (Table 3). Measurements for 9 of these 10 characters represent high extremes. For measurements of only two characters (MSCL, MARGW) is *C. jamesii* intermediate between *C. juniperorum* and *C. timida*. *Carex jamesii* is the only species with very tall shoots (SHTHT), very long staminate portions of terminal spikes (MSPL), very long peduncles on the staminate portions of spikes (MPDCLL), very long pistillate scales (LFSCL), very long perigynia (PERIGL), very wide perigynia (PERIGW), very long perigynium

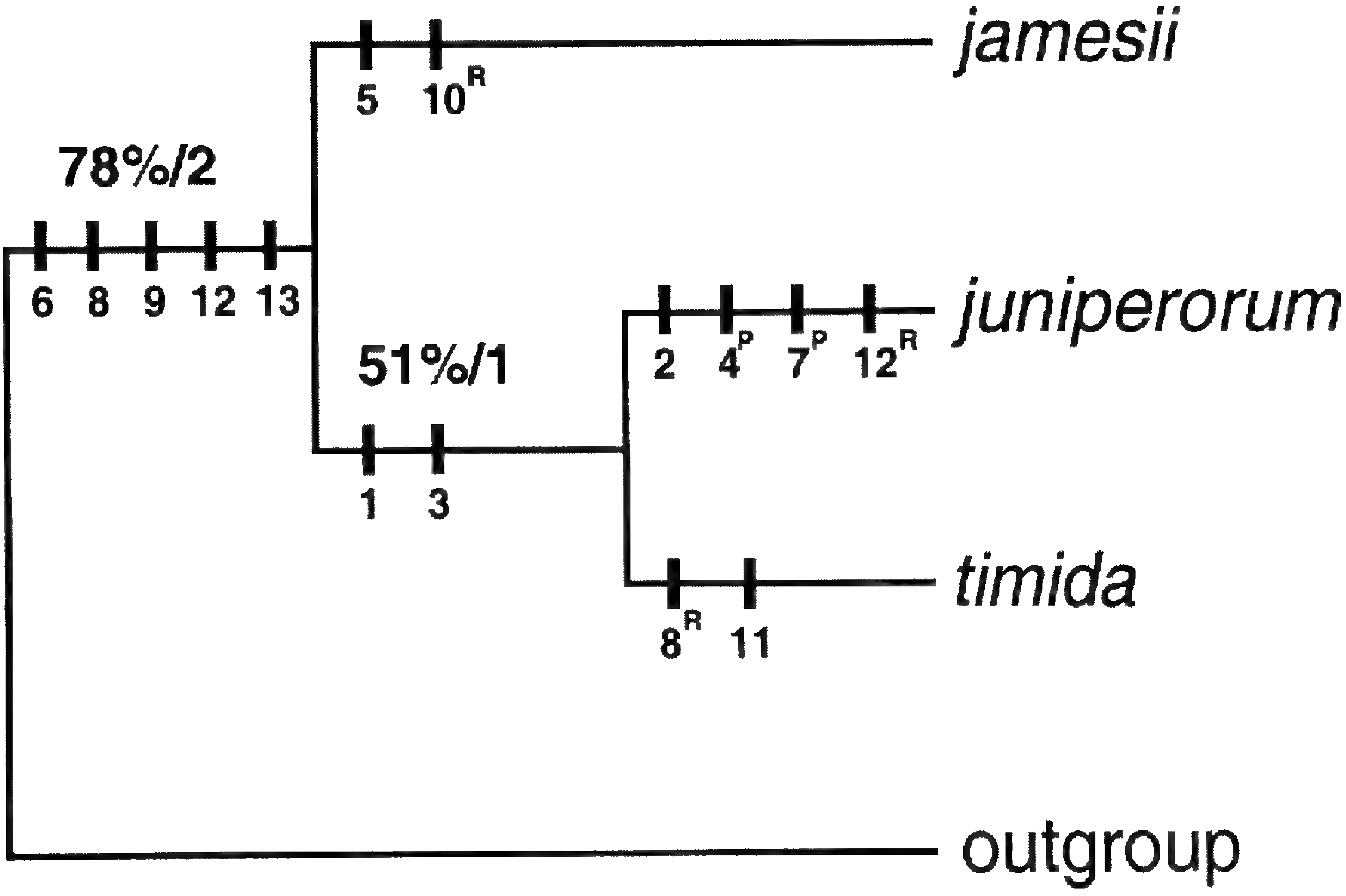

FIG. 8. The single most parsimonious tree resulting from the phylogenetic analysis of morphologic data of the *Carex jamesii* complex. The outgroup is composed of the "wide-scaled clade" of sect. *Phyllostachyae* (see Materials and Methods). The character state changes are represented by vertical bars (character numbers as in Table 5), with nonhomoplasious apomorphies indicated by unadorned character numbers, parallelisms with the outgroup indicated by superscript "P" on the character numbers, and reversals indicated by superscript "R." Bootstrap values and decay indices (following the slashes) are given above the branches.

beaks (PERIGBKL), very wide achenes (ACHNW), very long perigynium beaks relative to the length of the perigynia (RBK), and a low number of leaves and bracts on reproductive shoots (LFNO). Brown shoot bases, cataphylls with collapsed or flush cell surfaces, and staminate scales with free margins also distinguish *C. jamesii*.

The status of *C. timida* as a distinct species is less obvious than for *C. jamesii* and *C. juniperorum*. In five quantitative features (MPDCLL, LFSCL, PERIGBKL, RBK, LFNO), *C. timida* is intermediate between *C. jamesii* and *C. juniperorum*. Of the 16 measured characters with statistically different means that are extremes, only 4 of them belong to *C. timida*. *Carex timida* is unique in having very short staminate portions of terminal spikes (MSPL), very long staminate scales (MSCL), very wide margins on the distalmost pistillate scale (MARGW), and proximalmost staminate scales that occupy a very high proportion of the length of the staminate portion of spikes (RSC). Qualitative features unique to *C. timida* include its lax culms and leaves, its relatively light green foliage, and its papillate staminate scales. While the features that distinguish *C. timida* are less obvious than those of the other species in the complex, it does have several unique quantitative and qualitative morphologic features supporting its status as a species. We have chosen the epithet "timida" to highlight one of this species' morphologic qualities (lax culms usually hidden among the foliage and thus difficult to detect), but also because the true identity of *C. timida* had been undetected for so long.

The PCA and bivariate plots indicate that *C. jamesii* and *C. timida* are more phenetically similar to each other than either is to *C. juniperorum* (Figs. 1, 2). Yet, the phylogenetic analysis indicates that *C. juniperorum* and *C. timida* are sister species. The retained plesiomorphies of *C. jamesii* and *C. timida*, in combination with the apparently greater amount of anagenesis of *C. juniperorum* (as determined by it having twice as many autapomorphies as *C. jamesii* and *C. timida*), account for this discrepancy between phenetic and phylogenetic relationships. Genetic analysis of the *C. jamesii* complex also supports the sister-group status of *C. juniperorum* and *C. timida* (Ford & Naczi 2001).

The bootstrap and decay values indicate relatively weak support for the branches in the phylogenetic tree (Fig. 8). The consistency index (0.67) is relatively low, too, due to homoplasy. Given the relatively few morphologic characters available for phylogeny reconstruction in these reduced plants, the relatively weak support and moderate level of homoplasy are not unexpected. Despite relatively weak support for the tree generally, the monophyly of the *C. jamesii* complex is well-supported (5 character state changes, bootstrap value of 78%, and decay value of 2).

The presence of a greater amount of morphologic variability in *C. jamesii* and *C. timida* than in *C. juniperorum* is congruent with the results of genetic analysis of the *C. jamesii* complex (Ford & Naczi 2001). The reduced level of variation of *C. juniperorum* might be the result of morphologic features that limit gene flow (Ford & Naczi 2001). *Carex juniperorum* does have several characteristics that would seem to limit outcrossing and seed dispersal, such as very short culms, proximal pistillate scales that completely conceal the perigynia, and very short stigmas. It is surprising that *C. timida* would have a level of morphologic variation similar to the much more common and wider-ranging *C. jamesii*. Still, the geographic range of *C. timida* is large, and perhaps its relatively high morphologic variability results from diverse selection pressures and ecologic influences across its range.

One point of disagreement between the results of morphologic and genetic studies is in the relationships of plants from a population in Queen Wilhelmina State Park, Polk County, Arkansas. Ford & Naczi (2001) found these plants to group with *C. juniperorum*. Based on morphology, a specimen from this population is clearly *C. timida* (Fig. 1).

Each member of the *C. jamesii* complex has a unique geographic distribution. The limits of the range of *C. jamesii* are greater in all directions than the range limits of the other two species, except the northeastern extreme. In this area, *C. juniperorum* ranges farther north than *C. jamesii*. *Carex juniperorum* is broadly sympatric with *C. jamesii*, though its range is disjunct. The range of *C. timida* is completely encompassed in the range of *C. jamesii*. *Carex timida* differs geographically from *C. jamesii* in being limited to three disjunct regions, while *C. jamesii* is relatively continuous across its range. The pattern of disjunction of *C. timida* is similar to several other vascular plant species. These species occur in the Ozark Mountains, the Ouachita Mountains, and in areas east of the Mississippi Embayment, but not intervening regions. Taxa sharing this pattern of disjunction include *C. ouachitana* Kral, Manhart, & Bryson (Naczi & Bryson 1990; McNeilus 1992), *C. willdenowii* Willd. (Naczi et al. 1998), *Castanea ozarkensis* Ashe (Johnson 1988; Nixon 1997), *Cotinus obovatus* Raf. (Little 1977), *Leptopus phyllanthoides* (Nutt.) G.L. Webster (Clark 1967; Smith 1988), *Magnolia tipetala* L. (Little 1977; Meyer 1997), *Monarda virgata* Raf. (Scora 1967; Smith 1988), and *Trillium pusillum* Michx. var. *ozarkanum* (Palmer & Steyerm.) Steyerm. (Cabe & Werth 1995). In a study of fish lineages with similar distribution patterns, Strange & Burr (1997) found different mechanisms may account for the disjunctions, including fragmentation of formerly widespread ranges by Pleistocene glaciations, dispersal events, and events that predated Pleistocene glaciations.

As with morphologic and geographic data, ecologic features distinguish the members of the *C. jamesii* complex. Ecologically, *C. juniperorum* is the most divergent member of the *C. jamesii* complex. It grows in the most open habitats with substrates having the highest clay content. It apparently does not occur with *C. jamesii* or *C. timida*, probably because of the distinctiveness of its habitat. *Carex jamesii* occurs in relatively moist sites in closed forest. *Carex timida* usually grows in slightly drier sites in more open forests, though it often grows near *C. jamesii*. The syntopic occurrences of *C. jamesii* and *C. timida* are significant because the two species probably overlap in flowering period and appear to have the opportunity to interbreed when syntopic. Our morphologic and genetic analyses revealed no evidence of hybrids. The fact that plants of such closely related species co-occur and maintain their distinctions is additional evidence of their status as separate species.

Carex jamesii is the most common member of the complex. In many parts of its range, it is one of the most common sedges of mesic deciduous forests. In contrast, *C. juniperorum* and *C. timida* are truly rare. Their rarity is reflected in the relative recency of their earliest collections. Whereas *C. jamesii* was collected at least as early as 1824 (the year of its description), the first known collection of *C. juniperorum* was in 1940 (originally identified as *C. jamesii*) and of *C. timida* in 1921 (again, originally identified as *C. jamesii*). Though additional collecting undoubtedly will reveal additional populations of these species, we recommend a range-wide review of their conservation status, with consideration for protection.

Though the eastern North American flora is relatively well-studied, it does continue to harbor undescribed species. As with *C. jamesii* in this study, morphologically distinctive species described early from northeastern North America have been a rich source of previously unsuspected diversity (Naczi et al. 1998). These species are often so distinctive and easy to identify that they are thought to be without taxonomic complexity until critically examined. Our expectation is that future studies of such species will yield more novelties, in sedges as well as in other plant groups.

TAXONOMIC TREATMENT

Sectional Nomenclature

Much confusion has surrounded determination of the correct name and authorship of the section to which the *Carex jamesii* complex belongs. Most modern authors (e.g. Mackenzie 1935; Fernald 1950; Gleason & Cronquist 1991) have used *Phyllostachyae* Tuck., but recent authors have followed Catling et al. (1993) in using *Phyllostachys* (J. Carey) L.H. Bailey.

Tuckerman (1843) was the first to apply an infrageneric name to the *C. jamesii* complex and its closest relatives. He used "*Phyllostachyae*" for three species, *C. backii*, *C. jamesii* (as *C. steudelii*), and *C. willdenowii*. Though Tuckerman attributed the name to Gray, Gray apparently did not publish *Phyllostachyae* himself. Tuckerman did not provide a description for *Phyllostachyae*, nor did he make its rank explicit. Christ (1885) used the name *Phyllostachyae* explicitly as a section for two European species, but again did not provide a description. It was not until 1909 that Kükenthal validly published the name *Phyllostachyae* at the sectional level.

Carey (1848) was the first to use the infrageneric name "*Phyllostachys*," for the same three species as Tuckerman, and attributed the name to Torrey and Gray. The attribution of the name to Torrey and Gray is probably because of their suggestion that *C. willdenowii* may belong to a genus separate from *Carex*, one "...to which the name *Phyllostachys* would be appropriate" (Torrey 1836: 404). While Carey described the infrageneric group he called *Phyllostachys*, he was not explicit about its rank. Apparently, Bailey (1885) was the first to explicitly assign the rank of section to the name *Phyllostachys*. He also listed the members of the section, designated its type, and divided the section into two "subordinate groups" (rank not explicit). Bailey placed six species in sect. *Phyllostachys*: *C. backii*, *C. geyeri* Boott, *C. jamesii* (as *C. steudelii*), *C. multicaulis* L.H. Bailey, *C. phyllostachys* C.A. Meyer, and *C. willdenowii*. He clearly designated *C. phyllostachys* the type of the section by stating, "...all but the type species exclusively American." Furthermore, he regarded *C. backii*, *C. jamesii*, and *C. willdenowii* as different enough from typical members of *Phyllostachys* to assign them to the "subordinate group" *Bractoideae*.

We regard *C. phyllostachys* as belonging to a section separate from *C. jamesii* and its closest relatives. *Carex phyllostachys* lacks the apical dilation of culms that characterizes the *C. jamesii* complex and its allies. In addition, *C. phyllostachys* has multinerved and vetricose perigynia, unlike the unnerved (but 2-ribbed), nonventricose perigynia in the *C. jamesii* complex and allies. Because Bailey used *C. phyllostachys* to typify sect. *Phyllostachys*, "*Phyllostachys*" cannot be used for the section that includes the *C. jamesii* complex. Instead, the correct name and authorship of the section that includes the *C. jamesii* complex is *Carex* sect. *Phyllostachyae* Tuck. ex Kük.

Carex section **Phyllostachyae** Tuck. ex Kük., Pflanzenr. IV. 20 (Heft 38):642. 1909. LECTOTYPE, here designated: *Carex jamesii* Schwein.

Dapedostachys Börner, Abh. Naturwiss. Vereine Bremen 21:265. 1913. TYPE: *Carex steudelii* Kunth. Non *Carex* section *Phyllostachys* (Torrey & A. Gray ex J. Carey) L.H. Bailey, Bot. Gaz. 10:208. 1885. TYPE: *Carex phyllostachys* C.A. Meyer.

Identification Key to Members of the *Carex jamesii* Complex

Mature, complete, and ample specimens are necessary for correct identification of the members of the *Carex jamesii* complex.

1. Tallest culm 9.0–41 cm high, 39–86% of plant height; terminal spike with 1–4 perigynia; wider leaves with green margins; hyaline margins of distal pistillate scales 0.3–0.7 mm wide; perigynium beak 34–53% of perigynium length.
    2. Longest (per plant) staminate portion of terminal spike 3.4–5.6(–6.2) mm long; proximalmost staminate scale in terminal spike (1.9–)2.1–3.3 mm long, (35–)44–77% of length of staminate portion of terminal spike; perigynium beaks 1.4–2.3(–2.5) mm long, 34–44% of perigynium length; shoot bases tinged with red-purple **Carex timida**
    2. Longest (per plant) staminate portion of terminal spike (4.9–)5.8–13.5 mm long; proximalmost staminate scale in terminal spike 1.1–1.8(–2.1) mm long, 13–26(–35)% of length of staminate portion of terminal spike; perigynium beaks (1.9–)2.3–3.9 mm long, 39–53% of perigynium length; shoot bases lacking red-purple **Carex jamesii**
1. Tallest culm 3.2–9.1 cm high, 15–32% of plant height; terminal spike with 4–8 perigynia; wider leaves with hyaline margins 0.05–0.2 mm wide; hyaline margins of distal pistillate scales 0.05–0.3 mm wide; perigynium beak 30–38(–43)% of perigynium length **Carex juniperorum**

Species Accounts

Carex jamesii Schwein., Ann. Lyceum Nat. Hist. New York 1:67. 1824. TYPE: U.S.A. INDIANA. [no additional locality data provided], [no date provided], *James s.n.* (HOLOTYPE: PH*; PROBABLE ISOTYPE: NY).

Carex steudelii Kunth, Enum. Pl. 2:480. 1837. *Dapedostachys steudelii* (Kunth) Börner ex Fedde & C. Schuster, Just's Bot. Jahresber. 41. II:9. 1918. TYPE: U.S.A. OHIO. [County unspecified, but in southwestern Ohio in the region drained by the Miami River (R.L. Stuckey, pers. comm.)]: Miami, 1835, *Frank s.n.* (HOLOTYPE: B, n.v., presumably destroyed; ISOTYPES: MO, NY). For historical background on this collection, see Stuckey (1974).

Perennial herb, densely caespitose. *Rhizomes* very short, 0.1–0.4 mm long between shoots or branches of the rhizomes, covered with cataphylls, with internodes 0.1–0.2 mm long and 1.2–1.9 mm thick. *Shoot bases* surrounded by cataphylls, dark brown or ferruginous to stramineous, lacking red-purple coloration. *Reproductive shoots* 12–63 cm tall, spreading; culms 5.7–41 cm tall, the tallest 14–41 cm high, slightly to moderately overtopped by the leaves, (0.45–) 0.52–0.72(–0.86) of shoot height, 0.4–0.7 mm wide at midheight, smooth proximally and denticulate in distal half, acutely trigonous and three-winged, dilated just basal to terminal spike, 0.7–1.5 mm wide just basal to terminal spike. *Cataphylls* glabrous, multicostate, with cells with their outer walls sunken or flush with their anticlinal walls. *Leaves* 3–5(–6), blades 1.1–59 cm long, 1.2–3.1 (–3.5) mm wide, the widest (1.8–)2.3–3.1(–3.5) mm wide, deep green, flat to barely plicate, glabrous, adaxial surface smooth or sparsely antrorsely scaberulous in distal portion, abaxial surface smooth; margins green, smooth or antrorsely scaberulous in distal portion; leaf sheaths 1.8–9.8 cm long, tight, glabrous; adaxial face of sheaths with hyaline band, hyaline band with apex subtruncate; ligules subtruncate to depressed-lingulate, 0.6–1.4 mm long. *Vegetative shoots* 13–57 cm tall; leaves like those of reproductive shoots; pseudoculms 3.3–9.9 cm tall, 1.1–2.6 mm wide at mid-height, 0.09–0.30 of shoot height. *Infructescence* a single terminal spike and (0–)1–3 lateral spikes. *Spikes* androgynous, simple, with staminate scales and perigynia spirally and densely imbricate. Terminal spike atop widely spreading to nodding culm, 6.4–15.7 mm long, 4.8–9.3 mm wide; staminate portion 2.4–10.3(–13.5) mm long, the longest (4.9–)6.0–10.3 (–13.5) mm long, 0.4–0.7(–0.8) mm wide, 5–12-flowered, on peduncle 0.8–3.8 mm long; pistillate portion overlapping and usually exceed by staminate portion but sometimes slightly exceeding staminate portion, 6.4–11.3 mm long, 4.8–9.3 mm wide, (1–)2–3(–4)-flowered. Lateral spikes on widely spreading to nodding peduncles arising from base of culm; peduncles 2.7–14 cm long, capillary, flat, narrowly two-winged, dilated just basal to spike; spikes similar to terminal spikes except staminate portion 2.0–9.5 mm long. Proximalmost *staminate scale* of each terminal spike 1.1–1.9(–2.1) mm long, 0.13–0.26(–0.35) of length of staminate portion of terminal spike, 0.7–1.4 mm wide, short-cylindric, truncate or subtruncate (very broadly ovate), longitudinally 1-veined in basal 0.7, with longitudinal and narrow green band centered on vein, transversely brown-banded distal to apex of green band; margins free, overlapping base of adjacent distal staminate scale but not sheathing it, hyaline. Distalmost *pistillate scale* of each spike 3.8–21 mm long, 1.6–2.4 mm wide, ovate to lanceolate, acute and awnless but occasionally with awn to 5.9 mm long or longer scales leaf-like, center green and 4–9-veined, margins hyaline, whitish or whitish with brown band paralleling margin, hyaline margins (0.3–)0.4–0.7 mm wide. Proximalmost pistillate scale of each spike with morphology dependent on spike position; in terminal spikes, proximalmost scale leaf-like; in lateral spikes, proximalmost scale ovate and awned or awnless. Proximalmost pistillate scale of terminal spikes 12–119 mm long, the longest 31–119 mm long; basal portions 1.6–2.9 mm wide, partially or completely concealing perigynia, green with hyaline margins, green portion 5–12-nerved, hyaline margins 0.05–0.3 mm wide; distal portions green, long-acuminate, with antrorsely scaberulous margins. Other pistillate scales, if present between proximalmost and distalmost scales, morphologically intermediate between distalmost and proximalmost scales. *Filaments* laminar, 0.20–0.30 mm wide, usually slightly wider than anthers. *Anthers* 3, 0.8–1.2 mm long. *Styles* jointed with summits of achenes, portions distal to achenes withering with age. *Stigmas* 3, 1.7–2.1 mm long, withering with age. *Perigynia* (4.8–) 5.4–6.8(–7.6) mm long, 1.8–2.3(–2.5) mm wide, (2.3–)2.5–3.3(–3.6) times as long as wide, (2.1–)2.4–3.0 times as long as achenes, ascending to spreading, subrotund to very broadly trigonous in cross-section, 2-ribbed, nerveless, glabrous, pale green to tan, narrowly ovoid to narrowly ellipsoid with obovoid body and compressed-deltoid beak; body tapered from widest point to subacute base, abruptly contracted to beak; beak (1.9–)2.3–3.4(–3.9) mm long, (0.39–)0.43–0.53 of perigynium length, straight, scaberulous on angles, apex entire. *Achenes* 1.9–2.8 mm long, 1.8–2.4 mm wide, 0.9–1.4 times as long as wide, tightly enveloped by perigynia, subrotund to very broadly trigonous in cross section, brown with 3 longitudinal paler brown lines that intersect at style base, subglobose, basally abruptly contracted to light tan stipe, beakless; stipes 0.3–0.4 mm long, 0.8–1.1 mm wide (Fig. 3A, 4, 5A).

Representative Specimens. Specimens marked with asterisks are those measured for statistical analyses. **CANADA. ONTARIO. Essex Co.:** Pelee Island, Fish Point, 25 Jun 1981, *Reznicek 6338* (MICH, MO, VPI, ctb). **Kent Co.:** Orford Township, Clear Creek, 22 May 1991, *Oldham 12554* (MICH*). **Middlesex Co.:** 9 km ESE of Glencoe P.O., N side of Thames River, 29 May 1987, *Reznicek 7899* (MICH, MO, ctb*). **Welland Co.:** 2.5 mi W of Port Colborne, near Rathfon Point, 1 Jul 1958, *Calder 23864* (MICH*, MT, US). **U.S.A. ALABAMA. Madison Co.:** Huntsville, Monte Sano State Park, 8 May 1986, *Naczi 1020* (DOV). **Marshall Co.:** near Grant, near bottom of Fletcher's Hollow, 13 May 1939, *Harper 3728* (MICH*, US). **Tuscaloosa Co.:** along Warrior River, ca. 0.25 mi above Lock 14, 10 May 1935, *Harper 3366* (MO, PH, US). **ARKANSAS. Benton Co.:** N of Bella Vista, 17 May 1986, *Castaner 9209* (MO, ctb). **Carroll Co.:** US highway 412 and Osage Creek, 24 May 1992, *Hyatt 4386.08* (MICH, ctb*). **Cross Co.:** W of Birdeye, 20 May 1990, *Naczi 2449* (DOV, ctb). **Franklin Co.:** ca. 1 mi N of Cecil, 12 May 1989, *Naczi 2151* (DOV, ctb). **Howard Co.:** ca. 8 mi W of Umpire, N of route 4, along W side of Cossatot River, 17 May 1988, *Naczi 1925* (MICH*). **Marion Co.:** Hand Valley at Ranchette (White River) Access Area, 1 May 1992, *Hyatt 4821.45* (MICH*). **Montgomery Co.:** ca. 6 mi NW of Mount Ida, 20 May 1994, *Naczi 3935 & Ford* (DOV). **Scott Co.:** ca. 2 mi N of Y City, 10 May 1989, *Naczi 2128* (DOV, ctb). **Stone Co.:** ca. 3 mi ENE of Fifty Six, 21 May 1986, *Naczi 1206* (DOV). **DISTRICT OF COLUMBIA.** Washington and vicinity, 15 May 1896, *Steele s.n.* (MU*). **ILLINOIS. Cook Co.:** Elk Grove, 28 May 1948, *Chase 9491* (NY). **Jackson Co.:** 5 mi SW of Murphysboro, 11 Apr 1976, *Solomon 1453* (MO). **Jo Daviess Co.:** 7.5 mi NW of Stockton, Apple River Canyon, 16 Jun 1937, *Hermann 8842* (NY). **Peoria Co.:** N of Princeville, 16 Jun 1897, *Chase 36* (MO, PH, US). **Pulaski Co.:** 2.1 mi SW of Olmsted, along E side of route 37, 26 May 1990, *Naczi 2488* (DOV*, ctb) **Saline Co.:** ca. 7 mi ESE of Harrisburg, 20 May 1992, *Hyatt 4356* (MICH*). **Winnebago Co.:** W of Rockford, 4 Jun 1954, *Fell 54303* (US). **INDIANA. Carroll Co.:** 5 mi E of Brookston, 8 Jun 1924, *Deam 40663* (NY). **Henry Co.:** 3 mi E of Mt. Summit, 24 May 1938, *Kriebel 5284* (NA). **Wabash Co.:** ca.

6 mi SW of Wabash, Asher Wood Nature Preserve, 21 May 1991, *Rothrock 2271* (ctb*). **IOWA. Hardin Co.:** Near Eldora, along Iowa River, 3 Jun 1950, *Thorne 9619* (MT, US). **Johnson Co.:** McBride State Park, 25 May 1954, *Thorne 14072* (DHL, MT, NY). **Mills Co.:** Wilson Timber, T73N, R41W, section 24, 29 May 1992, *Wilson 5175* (MICH*). **Story Co.:** Ames, 16 May 1938, *Weber 616* (MO, OS). **KANSAS. Linn Co.:** La Cygne Lake Park, along road to campground, 28 May 1994, *Reznicek 9819 & Reznicek* (MICH*, ctb). **Miami Co.:** Miami County State Lake, 16 May 1964, *Harms 2046* (NY). **KENTUCKY. Barren Co.:** ca. 3 mi SSW of Haywood, Brigadoon State Nature Preserve, 14 Jun 1997, *Naczi 6472 & Heeg* (KNK*). **Bath Co.:** 4 mi N of Salt Lick, 12 May 1999, *Naczi 7830* (DOV). **Calloway Co.:** Backusburg, W Fork Clarks River, 30 May 1973, *Athey 2332* (MUR). **Campbell Co.:** ca. 2 mi S of Alexandria, along E side of route 27, 5 Jun 1996, *Naczi 5649 et al.* (DOV*). **Fayette Co.:** Lexington, 6 Jun 1942, *McFarland 93* (MO, NA, PENN, PH, TENN, US). **Graves Co.:** Folsomdale, 24 Apr 1972, *Athey 1608* (MUR, WKU). **Henderson Co.:** Henderson, Audubon State Nature Preserve, 14 Jun 1997, *Naczi 6477 & Heeg* (KNK*). **Laurel Co.:** ca. 6 mi WNW of Bernstadt, along E side of Rockcastle River, 21 May 1998, *Naczi 7139 & Ford* (DOV*). **Letcher Co.:** S from Whitesburg, just S of crest of Pine Mountain, 17 May 1994, *McKinney 6177* (DOV). **Madison Co.:** 5 mi SW of center of Richmond, 15 Jun 1998, *Naczi 7373 & Reznicek* (DOV*). **Monroe Co.:** ca. 8 mi SE of Tompkinsville, S of route 216, 23 May 1998, *Naczi 7236 & Ford* (DOV*). **Pendleton Co.:** 2 mi ESE of Falmouth, 3 Jun 1994, *Naczi 4039 & Thieret* (DOV, WIN, ctb). **MARYLAND. Cecil Co.:** 1.0 mi SE of Conowingo, 0.2 mi E of route 222 bridge, along Octoraro Creek, 29 May 1999, *Naczi 8051* (DOV*). **Kent Co.:** N of Copeland, 6 Jun 2001, *McAvoy 5112* (DOV). **Montgomery Co.:** Cropley, along Potomac River, 4 May 1929, *Blake 10833* (MT, NA). **MICHIGAN. Allegan Co.:** 18 mi S of Grand Rapids, 18 Jun 1942, *Bazuin 4551* (KY). **Ingham Co.:** College Woods, [no day] Jun 1891, *C.F. Wheeler s.n.* (MICH*). **Washtenaw Co.:** 4.75 mi S of Ann Arbor, 17 May 1938, *Hermann 9419* (NA, US). **Wayne Co.:** ca. 2.5 mi E of Belleville, Lower Huron Metropark, N side of Huron River, 24 May 1991, *Reznicek 8759 et al.* (MICH*, VPI, ctb). **MINNESOTA. Fillmore Co.:** Forestville State Park, adjacent to South Branch Root River, 19 Jun 1984, *G.A. Wheeler 8361* (ctb*). Houston Co.: Beaver Creek Valley State Park, 19 Jun 1984, *Wheeler 8391* (ctb). **MISSISSIPPI. Lowndes Co.:** 2 mi S of Artesia, 15 May 1989, *Bryson 8557* (ctb). **Oktibbeha Co.:** 2.5 mi E of Mississippi State University, 15 May 1989, *Bryson 8586 & Naczi* (OS, ctb*). **Tishomingo Co.:** Yellow Creek Quad., Burns Hollow, 15 May 1979, *Rogers 46688* (TENN). **Tunica Co.:** ca. 11 mi S of Tunica, 24 Apr 1992, *Bryson 11400 & Newton* (MO, ctb). **MISSOURI. Boone Co.:** Columbia, Grindstone Park, 8 Jun 1996, *Reznicek 10184 et al.* (DOV, MICH). **Callaway Co.:** T47N, R8W, section 3, 24 Apr 1991, *Currier 91-004* (ctb*). **Christian Co.:** 0.5 mi S of end of road FF, 27 Apr 1985, *Castaner 8265* (DOV). **Cooper Co.:** 0.9 mi N of junction of routes AE & Z, 21 May 1981, *Castaner 6380* (ctb*). **Jackson Co.:** Independence, 2 Jun 1895, *Bush 709* (DOV, NY). **Schuyler Co.:** 3 mi E of Livonia, along E side of Chariton River, 1 Jul 1933, *Palmer 41061a & Steyermark* (MO). **Scott Co.:** 2.4 mi S of Blodgett, 0.6 mi S on main road into Fox Meadow Estates, 16 May 1992, *Jones 8546 & Jones* (MICH*). **NEBRASKA. Richardson Co.:** SE of Rulo, along Nemaha River, 22 Jun 1940, *Reynolds 1450* (MO, NA). **NEW JERSEY. Hunterdon Co.:** Lambertville, foot of Goat Hill, near Delaware River, 31 May 1924, *Long 30383* (PH). **Mercer Co.:** N of Moore, 29 Apr 1922, *Mackenzie s.n.* (NY). **NEW YORK. Monroe Co.:** Near Honeoye Falls, 15 Jun 1941, *Matthews 4339* (KY, MICH, MO, MT, NA, PENN, TENN, US). **Tompkins Co.:** Ithaca, Six Mile Creek, 8 Jun 1919, *Wiegand 11595* (MICH, MO, MT, PENN, PH, US). **NORTH CAROLINA. Durham Co.:** 3 or 4 mi N of Durham, ca. 0.25 mi E of Old Oxford Road, along S side of Eno River, 8 May 1972, *Leonard 5440 & Moore* (KY, MO, MUR, MICH*, TENN, VPI). **Lee Co.:** 2 mi W of Moncure, near Deep River, 3 Jun 1960, *Radford 43205* (KY, TENN). **OHIO. Butler Co.:** E of Miami University campus, E of Marcum Conference Center, 30 Apr 1991, *Vincent 4539* (MU*). **Lawrence Co.:** 0.5 mi W of Burlington, 21 Apr 1992, *Cusick 30148* (MICH). **Montgomery Co.:** ca. 2 mi SW of Farmersville, ca. 0.2 mi E of Anthony Road, 0.3 mi SSW of junction of Anthony Road and Manning Road, 29 May 1998, *Naczi 7363 & Ford* (DOV*). **OKLAHOMA. Cherokee Co.:** 7.5 mi NNE of Tahlequah, 13 May 1987, *Naczi 1591* (DOV). **Delaware Co.:** along N shore of Lake Eucha, 1.6 mi E of route 59/10, 25 May 1994, *Reznicek 9775 & Reznicek* (MICH*, ctb). **McCurtain Co.:** ca. 9 mi NE of Broken Bow, 12 May 1987, *Naczi 1576* (DOV, MICH). **Muskogee Co.**, Braggs Hill Canyon, 6 May 1940, *Bebb 5163* (NA). **PENNSYLVANIA. Bedford**

Co.: 2.25 mi WNW of Everett, 17 Jun 1944, *Berkheimer 4920* (PENN, PH). **Berks Co.:** 0.75 mi W of Sinking Spring, 6 Jun 1943, *Berkheimer 3668* (PENN, PH, TENN). **Bucks Co.:** E of Ottsville, by Tinicum Creek, 30 May 1925, *Long 32469* (PENN, PH). **Centre Co.**, Woodward, 6 Jun 1937, *Wahl 2539 & Clausen* (NA, US). **Franklin Co.:** ca. 1.5 mi WSW of Yeakle Mill, 7 May 1993, *Kunsman 10614* (PH). **Lancaster Co.:** Shenk's Ferry Ravine, 22 Jun 1940, *Tanger 3885* (PENN, PH). **Westmoreland Co.:** Near Saunders, Turtle Creek, 27 May 1933, *Bright 8838* (PENN). **SOUTH CAROLINA. McCormick Co.:** E of Savannah River, Steven's Creek Preserve, 17 Apr 1992, *Sorrie 6257 et al.* (bas). **TENNESSEE. Cannon Co.:** ca. 1.5 mi NE of Sugar Tree Knob Church, 3.0 mi W of TN 146, N side of Short Mountain Road, 3 May 1989, *Orzell & Bridges 9436* (MICH*). **Cheatham Co.:** S of I-40 and TN 239 junction, above large truck park, 28 Apr 1993, *Kral 82118* (MICH*, ctb). **Davidson Co.:** Nashville, 30 May 1990, *Naczi 2518A & Kral* (DOV). **Dekalb Co.:** 0.4 mi W on TN 141 from junction TN 96 at Center Hill Dam, 30 May 1988, *Thompson 88-617* (BEREA). **Dyer Co.:** NW of Dyersburg, 29 Apr 1949, *Sharp 12231 et al.* (TENN). **Franklin Co.:** Near Sherwood, 3 May 1941, *Shanks 1305* (TENN). **Obion Co.:** ca. 3.5 mi E of Ridgely, 27 Jun 1995, *Naczi 4852 & Reznicek* (DOV). **Perry Co.:** SE of Linden on old SR 13, E side of Buffalo River, 4 May 1993, *Kral 82279* (MICH*, ctb). **Putnam Co.:** Caney Fork River, 27 Apr 1973, *Kral 49694* (MO, PH). **Rutherford Co.:** W of Murfreesboro, off highway 96, Scales Mountain, 26 Apr 1987, *McKinney 2420* (ctb*). **Trousdale Co.:** ca. 3 mi N of Hartsville, 4 May 1973, *Kral 49794* (MO, PH). **VIRGINIA**. **Appomattox Co.:** Just N of Bent Creek, 11 Jun 1967, *Harvill 16519* (MO). **Bath Co.:** ca. 0.4 mi S of Healing Springs, 23 Jun 1994, *Naczi 4482 & Thieret* (DOV). **Fauquier Co.:** 2.5 mi below Thorofare Gap, 13 May 1945, *Allard 11243* (MT, PENN, VPI). **Lunenburg Co.:** ca. 13 mi SE of Lunenburg, along Flat Rock Creek, 3 Jun 1986, *Wieboldt 5982* (MICH, MO, VPI, ctb). **Prince George Co.:** By James River, Indian Point, 6 May 1940, *Fernald & Long 11768* (MO, PH, US). **Rockbridge Co.:** Natural Bridge, Cedar Creek, 30 May 1891, *Churchill 91* (MO). **Surry Co.:** Along James River, Claremont Wharf, 20 May 1939, *Fernald & Long 9862* (PH, US, VPI). **Wythe Co.:** Jackson's Ferry, 22 Jun 1940, *Hermann 10649* (NA). **WEST VIRGINIA. Cabell Co.:** Guyandotte, 13 Apr 1995, *Cusick 32274* (MICH, MO, MU, VPI, ctb). **Fayette Co.:** ca. 8 mi NE of Beckley, New River Gorge, 20 May 1985, *Wieboldt 5523* (MICH, VPI, ctb). **Mason Co.:** 0.5 mi down 16 Mile Creek Road (78), W of route 35, 22 May 1991, *Vincent 4707 & Hickey* (MU*). **Pendleton Co.:** ca. 3.25 mi WNW of Cherry Grove, 23 May 1988, *Reznicek 8140 & Reznicek* (MICH, MO, VPI, ctb). **Wayne Co.:** Mouth of Big Creek, 6 May 1938, *MacFarland 4353* (NA). **WISCONSIN**. **Grant Co.:** T4N, R6W, sect. 15, 26 May 1979, *Tans 1920* (WIS). **Green Co.:** On "K" near Oakley store, 2 Jun 1958, *Fell 58-176* (WIS). **LaCrosse Co.:** Branch of Coon Creek in Bohemian Valley, 19 Jun 1959, *Hartley 6774* (WIS).

Carex juniperorum Catling, Reznicek, & Crins, Syst. Bot. 18:497. TYPE: CANADA. ONTARIO. HASTINGS CO.: 7 km NE of Shannonville, S side of hwy. 401, 9 Jun 1991, *Catling 9100* (HOLOTYPE: DAO, n.v.; ISOTYPES: KNK*, MICH).

Perennial herb, densely caespitose. *Rhizomes* very short, 0.1–2.1 mm long between shoots or branches of the rhizomes, covered with cataphylls, with internodes 0.1–1.6 mm long and 1.3–1.9 mm thick. *Shoot bases* surrounded by cataphylls, dark red-purple to ferruginous, usually dark brown tinged with red-purple; red-purple coloration extending 17–68 mm above base of plant. *Reproductive shoots* 8.2–45 cm tall, spreading; culms 1.9–9.1 cm tall, the tallest 3.2–9.1 cm high, greatly overtopped by the leaves, 0.15–0.32 of shoot height, 0.3–0.7 mm wide at midheight, smooth except denticulate just basal to terminal spike, acutely trigonous and three-winged or occasionally four- or five-angled and four- or five-winged, dilated just basal to terminal spike, 0.8–1.3 mm wide just basal to terminal spike. *Cataphylls* glabrous, multicostate, with cells with their outer walls bulging. *Leaves* 6–11, blades 1.1–43 cm long, 0.7–4.2 mm wide, the widest 2.2–4.2 mm wide, deep green, flat to barely plicate, glabrous, adaxial surface smooth or minutely papillate or sparsely antrorsely scaberulous in distal portion, abaxial surface smooth or minutely papillate; margins of wider blades hyaline, hyaline portions 0.05–0.2 mm wide; margins of narrower blades green; margins of all blades smooth or antrorsely scaberulous in distal portion; leaf sheaths 1.4–8.2 cm long, tight, glabrous; adaxial face of sheaths with hyaline band, hyaline band with apex truncate; ligules truncate to depressed-lingulate, 0–0.7 mm long. *Vegetative shoots* 9.8–45 cm tall; leaves like those of reproductive shoots; pseudoculms 1.3–5.6 cm tall, 1.1–3.7 mm wide at mid-height, 0.11–0.16 of shoot height. *Infructescence* a single terminal spike and (0–)1–3 lateral spikes. *Spikes* androgynous, simple, with staminate scales and perigynia spirally and densely imbricate. Terminal spike atop erect or ascending culm, 5.4–13.1 mm long, 4.9–8.8 mm wide; staminate portion 3.1–8.4 mm long, the longest 3.6–8.4 mm long, 0.4–0.9 mm wide, 8–17-flowered, on peduncle 0.1–1.4 mm long; pistillate portion overlapping and exceeding staminate portion or slightly exceeded by staminate portion, 5.4–9.4 mm long, 4.9–8.8 mm wide, 4–8-flowered. Lateral spikes on ascending to spreading peduncles arising from base of culm; peduncles 0.7–6.3 cm long, capillary, flat, narrowly two-winged, dilated just basal to spike; spikes similar to terminal spikes except staminate portion 1.7–2.9 mm long, pistillate portion (2–)4–6-flowered. Proximalmost *staminate scale* of each terminal spike 0.9–1.6 mm long, 0.13–0.25(–0.34) of length of staminate portion of terminal spike, 1.1–1.6 mm wide, short-cylindric, truncate or subtruncate (very broadly ovate), longitudinally 1-veined in basal 0.7–0.8, with longitudinal and narrow green band centered on vein, with green band narrowly bordered by dark brown; margins connate in basal 0.3–0.8, free apically, tightly sheathing adjacent distal staminate scales, hyaline. Distalmost *pistillate scale* of each spike 3.0–10.1 mm long, 1.1–1.5 mm wide, lanceolate, leaf-like, acute, awnless, green and 1–5-veined except for margins, margins hyaline, whitish, hyaline margins 0.05–0.2(–0.3) mm wide. Proximalmost pistillate scale of each spike leaf-like. Proximalmost pistillate scale of terminal spikes 12–36 mm long, the longest 16–36 mm long; basal portions 1.6–3.4 mm wide, completely concealing perigynia, green with hyaline margins, green portion 3–9-nerved, hyaline margins 0.05–0.2 mm wide; distal portions green, long-acuminate, with antrorsely scaberulous margins. Other pistillate scales morphologically intermediate between distalmost and proximalmost scales. *Filaments* laminar, 0.20–0.30 mm wide, usually slightly wider than anthers. *Anthers* 3, 1.1–1.7 mm long. *Styles* jointed with summits of achenes, portions distal to achenes withering with age. *Stigmas* 3, 0.8–1.2 mm long, withering with age. *Perigynia* (3.9–)4.2–5.0(–5.4) mm long, 1.7–2.1 mm wide, 2.0–2.6(–3.0) times as long as wide, 2.0–2.3 times as long as achenes, ascending to spreading, subrotund to very broadly trigonous in cross-section, 2-ribbed, nerveless, glabrous, pale green to tan, narrowly ovoid to narrowly ellipsoid with obovoid body and compressed-deltoid beak; body tapered from widest point to subacute base, abruptly contracted to beak; beak (1.2–)1.4–1.8(–2.2) mm long, 0.30–0.38(–0.43) of perigynium length, straight, smooth or barely scaberulous on angles, apex entire. *Achenes* 2.0–2.5 mm long, 1.6–2.1 mm wide, 1.0–1.4 times as long as wide, tightly enveloped by perigynia, subrotund to very broadly trigonous in cross section, brown with 3 longitudinal paler brown lines that intersect at style base, subglobose, basally abruptly contracted to light tan stipe, beakless; stipes 0.3 mm long, 0.7–0.8 mm wide (Figs. 3B, 5B).

Representative Specimens. Specimens marked with asterisks are those measured for statistical analyses. **CANADA. ONTARIO. Hastings Co.:** 5.5 km NE of Shannonville, W of Salmon River, 11 Jun 1991, *Catling 9102* (MICH*); 2 km SSW of Lonsdale, 13 Jun 1994, *Catling 20285 & Norris* (MICH*). **U.S.A. KENTUCKY. Bath Co.:** Salt Lick, 12 May 1940, *McFarland 4799* (NA*); 1 mi W of Polksville on US 60, "Blue Clays" on Fearing Road, 31 May 1991, *Campbell s.n.* (MICH*); ca. 5 mi ESE of Owingsville, ca. 0.5 mi S of route 60, 0.3 mi E of Ore Mine Road, 16 May 1994, *Naczi 3890* (DOV*, MICH, WIN, ctb). **Fleming Co.:** ca. 4 mi E of Hillsboro, along N side of route 1013, 28 May 1998, *Naczi 7321 & Ford* (DOV*, MICH). **Lewis Co.:** 3.2 mi E of routes 10 & 57 junction in Tollesboro, S of route 10, 5 May 1994, *Naczi 3802 et al.* (DOV*, VDB, WIN, ctb); ca. 3.5 mi ESE of Trinity, Hughes Knob, 5 May 1994, *Naczi 3808 et al.* (APSC, DOV*, VDB, WIN, ctb); ca. 3.3 mi SW of Concord, N side of Crooked Creek Road, 30 May 1996, *Naczi 5524 et al.* (DOV*, WIN); ca. 1 mi E of Concord, N side of route 8, 30 May 1996, *Naczi 5538 & Trauth* (APSC, DOV*, MICH, VDB, VPI, WIN, ctb). **OHIO. Adams Co.:** 1.5 mi N of West Union on S side of Adams Lake, Adams Lake State Park, 6 May 1991, *Reznicek 8742 et al.* (MICH*, OS); 3.5 mi NW of West Union, Chaparral Prairie Preserve, Hawk Hill Rd., 6 May 1991, *Reznicek 8744 et al.* (MICH*); 3/5 mi S of Lynx, Lynx Prairie, 6 May 1991, *Reznicek 8748 et al.* (DOV*, MICH, OS); 3 mi SW of Lynx, "Hanging Prairie" N of Black Run Rd., 6 May 1991, *Reznicek 8750 et al.* (MICH*); ca. 3 mi NE of Peebles, S side of route 32, 16 May 1994, *Naczi 3878* (DOV*, WIN, ctb). **VIRGINIA. Montgomery Co.:** Radford, Wildwood Park, W-facing slope above Connelly's Run, 9 Jun 1999, *Wieboldt 10214* (MICH*, VPI).

Carex timida Naczi & B.A. Ford, sp. nov. TYPE: U.S.A. KENTUCKY. ROWAN CO.: ca. 6.5 mi S of center of Morehead, ca. 0.25 mi downslope from W side of route 1274, upslope from Sugar Camp Branch, ca. 1.3 road mi N of junction of routes 1274 and 801, 1 Jun 1996, *Naczi 5598 & Trauth* (HOLOTYPE: DOV*; ISOTYPES: BRIT, CAN, DAO, EKY, F, GA, GH, IBE, KNK, KY, MDKY, MICH, MO, MU, NCU, NY, OS, PH, TENN, UARK, UNA, US, USCH, VDB, VPI, WIN, ctb).

A *Carex jamesii* basibus surculorum purpureis, rostris perigyniorum brevioribus differt; a *Carex juniperorum* culmis altioribus, laminis foliorum latorum viridimarginatis, spicis terminalibus 2–3(–4) perigyniis instructis, partibus hyalinis squamarum pistillatarum distalibus 0.4–0.7 mm latis differt; a speciebus ambabus partibus staminatis spicarum brevioribus, squamis staminatis longioribus differt.

Perennial herb, densely caespitose. *Rhizomes* very short, 0.1–0.5 mm long between shoots or branches of the rhizomes, covered with cataphylls, with internodes 0.1–0.2 mm long and 1.4–1.8 mm thick. *Shoot bases* surrounded by cataphylls, dark red-purple to ferruginous, usually dark brown tinged with red-purple; red-purple coloration extending 34–47 mm above base of plant. *Reproductive shoots* 17–45 cm tall, spreading; culms 4.6–34 cm tall, the tallest 9.0–34 cm high, slightly to moderately overtopped by the leaves, (0.39–)0.59–0.83 of shoot height, 0.4–1.0 mm wide at midheight, smooth except denticulate just basal to terminal spike, acutely trigonous and three-winged, dilated just basal to terminal spike, 0.7–1.3 mm wide just basal to terminal spike. *Cataphylls* glabrous, multicostate, with cells with their outer walls bulging. *Leaves* 4–6(–8), blades 4.1–35 cm long, 1.0–4.3 mm wide, the widest (1.6–)2.1–4.3 mm wide, medium green, flat to barely plicate, glabrous, adaxial surface smooth or sparsely antrorsely scaberulous in distal portion, abaxial surface smooth; margins green, smooth or antrorsely scaberulous in distal portion; leaf sheaths 1.3–6.9 cm long, tight, glabrous; adaxial face of sheaths with hyaline band, hyaline band with apex subtruncate to slightly convex; ligules subtruncate to depressed-lingulate, 0.2–1.8 mm long. *Vegetative shoots* 18–45 cm tall; leaves like those of reproductive shoots; pseudoculms 3.2–7.6 cm tall, 1.5–2.9 mm wide at mid-height, 0.14–0.20 of shoot height. *Infructescence* a single terminal spike and 1–3 lateral spikes. *Spikes* androgynous, simple, with staminate scales and perigynia spirally and densely imbricate. Terminal spike atop widely spreading to nodding culm, 6.8–8.8 mm long, 4.6–6.8 mm wide; staminate portion 2.4–5.6(–6.2) mm long, the longest 3.4–5.6(–6.2) mm long, 0.6–0.8(–1.0) mm wide, 2–12-flowered, on peduncle 0.4–2.3 mm long; pistillate portion overlapping and exceeding staminate portion or slightly exceeded by staminate portion, 6.8–8.5 mm long, 4.6–6.8 mm wide, 2–3(–4)-flowered. Lateral spikes on widely spreading to nodding peduncles arising from base of culm; peduncles 1.4–21 cm long, capillary, flat, narrowly two-winged, dilated just basal to spike; spikes similar to terminal spikes except staminate portion 1.4–4.2 mm long. Proximalmost *staminate scale* of each terminal spike (1.9–)2.1–3.3 mm long, (0.35–)0.44–0.65(–0.77) of length of staminate portion of terminal spike, 0.9–1.7 mm wide, short-cylindric, truncate or subtruncate (very broadly ovate), longitudinally 1-veined in basal 0.7, with longitudinal and narrow green band centered on vein, transversely brown-banded distal to apex of green band or with brown patch completely surrounding green band; margins connate in basal 0.3–0.8, free apically, tightly sheathing adjacent distal staminate scales, hyaline. Distalmost *pistillate scale* of each spike 3.1–8.6 mm long, 1.6–2.4 mm wide, ovate, usually acute and awnless but occasionally with awn to 2.3 mm long, center green and 3–7-veined, margins hyaline, whitish with brown band paralleling margin, hyaline margins 0.4–0.7 mm wide. Proximalmost pistillate scale of each spike with morphology dependent on spike position; in terminal spikes, proximalmost scale usually leaf-like, rarely like distalmost scale; in lateral spikes, proximalmost scale like distalmost scale. Proximalmost pistillate scale of terminal spikes 11–42(–81) mm long, the longest 17–42(–81) mm long; basal portions 1.6–2.1 mm wide, partially concealing perigynia, green with hyaline margins, green portion 5–12-nerved, hyaline margins 0.05–0.3 mm wide; distal portions green, long-acuminate, with antrorsely scaberulous margins. Other pistillate scales, if present between proximalmost and distalmost scales, morphologically intermediate between distalmost and proximalmost scales. *Filaments* laminar, 0.15–0.20 mm wide, usually slightly wider than anthers. *Anthers* 3, 0.4–1.5 mm long. *Styles* jointed with summits of achenes, portions distal to achenes withering with age. *Stigmas* 3, 1.4–1.6 mm long, withering with age. *Perigynia* (4.0–)4.4–5.6(–6.0) mm long, 1.6–2.1 mm wide, (2.2–)2.5–3.1 times as long as wide, 1.9–2.4 times as long as achenes, ascending to spreading, subrotund to very broadly trigonous in cross-section, 2-ribbed, nerveless, glabrous, pale green to tan, narrowly ovoid to narrowly ellipsoid with obovoid body and compressed-deltoid beak; body tapered from widest point to subacute base, abruptly contracted to beak; beak (1.4–)1.7–2.3(–2.5) mm long, 0.34–0.44 of perigynium length, straight, scaberulous on angles, apex entire. *Achenes* 2.1–2.5 mm long, 1.6–2.1 mm wide, 1.0–1.4 times as long as wide, tightly enveloped by perigynia, subrotund to very broadly trigonous in cross section, brown with 3 longitudinal paler brown lines that intersect at style base, subglobose, basally abruptly contracted to light tan stipe, beakless; stipes 0.3–0.5 mm long, 0.7–0.9 mm wide (Figs. 3C, 4, 5C).

Additional Specimens Examined. Specimens marked with asterisks are those measured for statistical analyses. **U.S.A. ALABAMA. Colbert Co.:** ca. 4 mi S of Tuscumbia, N slope of Little Mountain, 31 Mar 1935, *Harper 3325* (MO, NY*, PH, US). **Jackson Co.:** 9 mi S of Huntland [Tennessee], by Ala. 65, 28 Apr 1972, *Kral 45800* (MO, ctb*). **Madison Co.:** Near Huntsville, W slope of Monte Sano Mountain, 14 Apr 1935, *Harper 3331* (MO, NY, PH, US); E Huntsville, Mt. Monte Sano, along Bankhead Parkway, 2 May 1974, *Bryson 492* (ctb); E side of Huntsville, summit of Monte Sano Mountain, along entrance drive to Monte Sano State Park, 25 May 1998, *Naczi 7264 & Ford* (DOV*, MICH, VDB, WIN, ctb). **ARKANSAS. Baxter Co.:** Clifty Canyon Botanical Area, Ozark National Forest, T17N, R12W, NE 1/4 of section 33, 14 Apr 1992, *Hyatt 4528.03* (MICH*), T17N, R12W, NW 1/4 of section 32, 30 Apr 1992, *Hyatt 4815.03* (VDB). **Howard Co.:** To NE of Cossatot River and Arkansas highway 4 crossing, 10 May 1986, *Bryson 4333* (MICH, VDB, ctb); ca. 8 mi W of Umpire, N of route 4, along W side of Cossatot River, 17 May 1988, *Naczi 1918* (MICH*), 17 May 1988, *Naczi 1921* (MICH). **Montgomery Co.:** Ouachita National Forest, ca. 0.2 mi W of Little Missouri Trail's W end, along Blaylock Creek, T4S, R27W, SE 1/4 of SE 1/4 of section 29, 15 Apr 1996, *Hyatt 6937* (MICH*). **Pike Co.:** Ouachita National Forest, along Little Missouri River, SW of Raven Creek, T5S, R27W, N edge of section 5, 19 Apr 1997, *Hyatt 7343* (DOV, MICH*). **Polk Co.:** Blackfork Mountain, in ravine NE of Little Cemetery, T1N, R32W, W1/2 of SE1/4 of section 26, 4 May 1982, *Rettig 503* (VDB), 4 May 1982, *Rettig 504* (VDB); Along Cossatot River above route 246 bridge, 3 May 1983, *Rettig 810* (VDB), *Rettig 825B* (VDB), 10 May 1986, *Bryson 4323* (IBE, MICH, MO, TENN, VDB, ctb), 12 May 1987, *Naczi 1579* (DOV), 14 May 1987, *Castaner 9681* (MO, ctb), 13 May 1990, *Jones 4648 & Jones* (MICH, MO, VDB, ctb), 18 May 1993, *Jones 10139 & Jones* (MICH, VPI*), 20 May 1994, *Naczi 3949 & Ford* (DOV); Queen Wilhelmina State Park, below and to N of visitor center and Arkansas highway 88, T1S, R32W, section 11, 10 May 1986, *Bryson 4287* (MICH, MO, TENN, VDB, ctb), 11 May 1989, *Naczi 2137* (DOV*, ctb), 20 May 1994, *Naczi 3940 & Ford* (DOV). **Stone Co.:** ca. 2 mi NW of Fifty-six, Ozark National Forest, Sylamore Ranger District, T16N, R12W, section 27, 28 Jun 1993, *Hyatt 5653* (VDB). **INDIANA. Jay Co.:** 2 mi SE of Boundary, 14 May 1921, *Deam 33879* (NY, PH*). **Lawrence Co.:** Bedford, Wilson Park, along Spider Creek, 5 Jun 1934, *Kriebel 1768* (PH*). **KENTUCKY. Campbell Co.:** ca. 2 mi S of Alexandria, along E side of route 27, 5 Jun 1996, *Naczi 5650 et al.* (DOV*). **Monroe Co.:** ca. 8 mi SE of Tompkinsville, S of route 216, 23 May 1998, *Naczi 7232 & Ford* (DOV*, MICH, MU, TENN, USCH, VDB, VPI, WIN, ctb), *Ford 98100 & Naczi* (WIN). **Rowan Co.:** Type locality, 28 May 1998, *Naczi 7313 & Ford* (DOV, WIN), *Ford 98145 & Naczi* (WIN). **MISSOURI. Taney Co.:** 6 mi SE of Protem, 4 mi S of Ocie, in Big Cedar Hollow, just W of Taney Co. line, section 18, 30 Apr 1938, *Steyermark 5303* (MO, NA*). **OHIO. Montgomery Co.:** E, Anthony Road, 0.3 mi SSW, junction of Manning Road, NE1/4, section 5, German Twp., 14 May 1985, *Cusick 25229* (MU*), ca. 2 mi SW of Farmersville, ca. 0.2 mi E of Anthony Road, 0.3 mi SSW of junction of Anthony Road and Manning Road, 29 May 1998, *Naczi*

7357 & Ford (DOV, MICH, WIN, ctb), *Ford 98153 & Naczi* (WIN). **[Preble or Butler Co.]:** N of Oxford, E Hueston's woods, 20 May 1934, *Belk s.n.* (MU*). **OKLAHOMA. LeFlore Co.:** NW and below State Line Historical Site, N of Oklahoma highway 1, 10 May 1986, *Bryson 4307* (MICH*, MO, VDB, ctb). **TENNESSEE. Franklin Co.:** Huntland, 3 May 1939, *Svenson 10036* (TENN); 2.6 mi S of Huntland, 28 Apr 1972, *Kral 45837* (MO, VDB), 24 May 1998, *Naczi 7242 & Ford* (DOV*, MICH, TENN, USCH, VDB, VPI, WIN, ctb), *Ford 98108 & Naczi* (WIN). **Wilson Co.:** Cedars of Lebanon State Park, 28 May 1989, *McNeilus 89-287* (IBE, MICH*, MO, TENN, VDB, ctb).

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GENETIC DIVERSITY IN THE *CAREX JAMESII* COMPLEX (CYPERACEAE: SECT. *PHYLLOSTACHYAE*) WITH INSIGHTS INTO THE EVOLUTION AND ORIGIN OF THE NEWLY DESCRIBED SPECIES *CAREX TIMIDA*

Bruce A. Ford

Department of Botany
University of Manitoba
Winnipeg, Manitoba
R3T 2N2, CANADA
bford@cc.umanitoba.ca

Robert F.C. Naczi

Claude E. Phillips Herbarium
Dept. of Agriculture & Natural Resources
Delaware State University
Dover, DE 19901-2277, U.S.A.
rnaczi@dsc.edu

ABSTRACT

The *Carex jamesii* complex is composed of three species: *C. jamesii*, *C. juniperorum*, and *C. timida*. Despite the morphological similarity of *C. jamesii* and *C. timida*, these two taxa are not closely linked in a cluster analysis using genetic identity values. Rather, *C. timida* is grouped with *C. juniperorum*. The close genetic similarity between these two species confirms the findings of a previous phylogenetic study that showed that *C. juniperorum* and *C. timida* are sister species. *Carex timida* populations from the Ouachita Mountains of Arkansas are genetically unique and blur the distinctiveness between the latter species and *C. juniperorum*. Such a finding could be a sampling artifact. Alternatively, the plants found in the Ouachita Mountains may be closest to the ancestor that gave rise to *C. juniperorum* and *C. timida*. A comparison of genetic, phylogenetic, and phenetic relationships provides insights into the delineation of infraspecific taxa and justification for the recognition of *C. timida* at the species level.

ABSTRACT

El complejo *Carex jamesii* está compuesto por tres especies: *C. jamesii*, *C. juniperorum*, y *C. timida*. A pesar de la semejanza morfológica de *C. jamesii* y *C. timida*, estos dos taxa no están fuertemente unidos en un análisis cluster usando valores de identidad genética. En su lugar, *C. timida* está agrupado con *C. juniperorum*. La fuerte similitud genética de estas dos especies confirma los hallazgos de un estudio filogenético previo que mostró que *C. juniperorum* y *C. timida* son especies hermanas. Las poblaciones de *Carex timida* de la montañas Ouachita de Arkansas son genéticamente singulares y enturbia la distinción entre la última especie y *C. juniperorum*. Tal hallazgo puede ser un artefacto de muestreo. Alternativamente, las plantas que se encuentran en las montañas Ouachita pueden ser más cercanas al ancestro que dio lugar a *C. juniperorum* y *C. timida*. Una comparación de las relaciones genéticas, filogenéticas, y fenéticas proporcionan una mejor comprensión de la delineación de los taxa infraespecíficos y la justificación para el reconocimiento de *C. timida* a nivel específico.

INTRODUCTION

Carex L. section *Phyllostachyae* Tuck. ex Kük. is a well-defined group of 10 species (*C. backii* Boott; *C. basiantha* Steud.; *C. jamesii* Schwein.; *C. juniperorum* Catling, Reznicek, & Crins; *C. latebracteata* Waterfall; *C. saximontana* Mack.; *C. superata*

Naczi, Reznicek, & B.A. Ford; *C. timida* Naczi & B.A. Ford; *C. willdenowii* Willd.; C. sp. nov. Saarela & B.A. Ford) that is endemic to forested and semi-forested habitats in North America. This section has been the subject of considerable systematic research (Catling et al. 1993; Ford et al. 1998a, 1998b, 1998c; Naczi et al. 1998; Starr et al. 1999; Naczi & Ford 2001; Saarela and Ford in press) with new insights having been gained not only into the taxonomy, phylogeny, and genetic structure of this section, but the genus *Carex* as a whole. One of the most unexpected findings of our research has been the discovery of a proportionately large number of undetected or undescribed species. These new species turn out to be members of widespread species complexes that are masquerading under a single name. Undetected species usually become apparent when plants from the northeastern and central United States and adjacent Canada are compared with specimens from the southeastern United States or western North America. This trend was evident in our earlier study of the *C. willdenowii* complex (*C. willdenowii* s. str.; *C. basiantha*; *C. superata*) (Ford et al. 1998c; Naczi et al. 1998) and most recently in our investigation of *C. jamesii* s. lat. (*C. jamesii* s. str.; *C. juniperorum*; *C. timida*) (Naczi & Ford 2001) and *C. backii* (*C. backii* s. str.; *C. saximontana*; C. sp. nov.) (Saarela & Ford in press).

The *C. jamesii* complex is a well-defined, monophyletic assemblage of taxa (Ford et al. 1998b; Starr et al. 1999) distinguished from other species in section *Phyllostachyae* by a combination of filiform stigmas, pistillate scales that do not conceal the perigynium, and perigynium bodies that are abruptly contracted into a beak. Molecular studies indicate that all three species share identical ITS sequences (Starr et al. 1999; Starr pers. comm.). Morphologically, *C. juniperorum* is the most divergent member of this complex being distinguished by its numerous perigynia (4-9 per inflorescence), short culms (<1/3 the length of the leaves), and lack of hyaline margins on the pistillate scales. *Carex jamesii* and *C. timida* are characterized by their relatively few perigynia (1-3 per inflorescence), elongate culms (subequal to the length of the leaves), and pistillate scales with conspicuously hyaline margins. Both species are superficially similar but can be readily distinguished by differences in cataphyll epidermal cell morphology, sheath color, and proximal staminate scale length.

Isozyme analysis has provided important ancillary data for systematic studies of *Carex* and in particular for recent taxonomic investigations of species complexes in section *Phyllostachyae* (Ford et al. 1998a, 1998b, 1998c). The intent of this study was to: 1) assess the taxonomic status of *C. timida* using isozyme data; 2) determine the degree of genetic divergence within and between species in the *C. jamesii* complex; and 3) compare the phylogenetic inferences from isozyme data to the evolutionary hypothesis proposed by Naczi and Ford (2001).

MATERIALS AND METHODS

A total of 649 individuals were collected from 26 populations (16 of *C. jamesii*, 4 of *C. juniperorum*, and 6 of *C. timida*) (Table 1). Our study included all *C. jamesii* and *C. juniperorum* populations examined by Ford et al. (1998a, 1998b) plus additional populations of *C. jamesii* and *C. timida* that were collected after the completion of these studies. The methodology for field sampling and enzyme analysis follows that of Ford et al. (1998c). Eleven enzymes coded by 15 interpretable, putative loci were included in this study. The 15 loci and their associated alleles were: aspartate aminotransferase, AAT-1 (a); diaphorase DIA-1 (a to e), DIA-2 (a); glucose-6-phosphate isomerase, GPI-2 (a to f); leucine aminopeptidase, LAP-1 (a to c); malate dehydrogenase, MDH-1 (a to b), MDH-2 (a to c); menadione reductase, MDR (a to b); peroxidase, PER-2 (a); phosphoglucomutase, PGM-1 (a to e), PGM-2 (a to e); shikimate dehydrogenase, SKD (a to c, allele c is a null allele observed in population 20 of *C. timida*); superoxide dismutase, SOD (a to b); and triose-phosphate isomerase, TPI-1 (a to d), TPI-2 (a to c). Allele frequencies, Nei's unbiased genetic identities (I) (Nei 1978), and an UPGMA (unweighted pair-group method) phenogram were calculated using BIOSYS-1 (Swofford & Selander 1981). Total genetic diversity for each species (H_T), average diversity within (H_S) and among populations (D_{ST}), and the coefficient of genetic differentiation (G_{ST}) were calculated using Nei and Chesser's (1983) procedure, unbiased for sample size, using GENESTAT-PC v. 2.1 (Lewis & Whitkus 1989). These analyses included both monomorphic and polymorphic loci in their calculations.

RESULTS

A total of 15 putative loci were surveyed in this study with all loci, expect AAT-1, DIA-2, and PER-2 being polymorphic in one or more populations. *Carex jamesii* had 12 polymorphic loci, while 9 variable loci were found in *C. juniperorum* and *C. timida*. *Carex jamesii* also had the greatest allelic diversity with 42 alleles identified, while 30 and 31 different alleles were observed in *C. juniperorum* and *C. timida*, respectively. With the exception of unique alleles for PGM-1, the allozymes found in *C. timida* and *C. juniperorum* were a subset of those found in *C. jamesii* (Table 2).

Genetic variability statistics fell within the range previously reported for *C. jamesii* and *C. juniperorum* (Ford et al. 1998a) (Table 3). The mean number of alleles per locus (K) ranged from 1.2 in *C. juniperorum* and *C. timida* (population 52, Hastings Co., Ontario and population 53, Monroe Co., Kentucky, respectively) to 2.1 in the Campbell Co., Kentucky population of *C. jamesii* (population 2). The percentage of polymorphic loci (P) was variable and ranged from 20.0 in the Monroe Co., Kentucky population of *C. timida* (population 53) to

TABLE 1. Collection data for populations of the *Carex jamesii* complex. Population codes are referred to parenthetically following each citation. Vouchers are deposited in WIN except where noted.

Carex jamesii Schweinitz

CANADA. ONTARIO. Essex Co.: Anderdon Twp., 5 km NE of Amherstburg, 22 May 1994, *Ball 940526* (22). **Niagara Regional Mun.:** Louth Twp., Twenty Mile Creek, Jordan, 13 Jun 1979, *Ball 79039* (PWB in TRTE (31). **Waterloo Co.:** Wilmot Twp., 8 km W of New Dundee on the Nith River, 3 Jun 1982 *Ball 82074* (PWB in TRTE) (32). **U.S.A. ARKANSAS. Franklin Co.:** ca. 1 mi N of Cecil, Citadel Bluff Army Corps of Engineers Park, 19 May 1994, *Naczi 3923 & Ford* (21). **Newton Co.:** ca. 3 mi NE of Boxley, Lost Valley Recreation Area of Buffalo National River, 19 May 1994, *Naczi 3917 & Ford* (13). **Scott Co.:** ca. 2 mi N of Y City, W of route 71 and S of Fourche La Fave River, 20 May 1994, *Naczi 3939 & Ford* (18). **INDIANA. Grant Co.:** Taylor University Arboretum, SW edge of Upland, 17 May 1994, *Rothrock 3255* (9); Stellers Road, 1.3 mi N of Matthews, 17 May 1994, *Rothrock 3254* (8). **KENTUCKY. Boone Co.:** 3 air mi S of Petersburg, ca. 0.3 mi W of route 20 along S side of Woolper Creek, 12 Jun 1994, *Naczi 4096* (39). **Campbell Co.:** Highland Heights, 10 May 1994, *Naczi 3826* (2); Silver Grove, N of route 8, floodplain of Ohio River, opposite St. Anne's Convent, 12 May 1995, *Naczi 4575 & Ganss* (51). **Mason Co.:** ca. 2 air mi W of Dover, along S side of route 8, 29 May 1994, *Naczi 4027 & Flynn* (33); ca. 2 air mi W of Dover, along S side of route 8, 29 May 1994, *Naczi 4028 & Flynn* (34). **MISSISSIPPI. DeSoto Co.:** ca. 2 mi N of Walls, along E side of route 61, 25 May 1994, *Naczi 4026 et al.* (24). **OHIO. Montgomery Co.,** SW of Farmersville, E side of Anthony Road, 0.3 mi SW of its junction with Manning Road, 29 May 1998, *Ford 98152 & Naczi* (57). **VIRGINIA. Bath Co.:** ca. 0.4 mi S of Healing Springs, along W side of route 220, 23 Jun 1994, *Naczi 4482 & Thieret* (41).

Carex juniperorum Catling, Reznicek, & Crins

CANADA. ONTARIO. Hastings Co.: Tyendinaga Twp., E side of Salmon River, ca. 15 km W of Napanee, 24 Jul 1995, *Ford 9566 et al.* (52). **U.S.A. KENTUCKY. Bath Co.:** ca. 5 air mi ESE of Owingsville, 16 May 1994, *Naczi 3890* (5). **Lewis Co.:** ca. 3.5 air mi ESE of Trinity, 5 May 1994, *Naczi 3808 et al.* (1). **OHIO. Adams Co.:** ca. 3 air mi NE of Peebles, 16 May 1994, *Naczi 3878* (7).

Carex timida Naczi & B.A. Ford

U.S.A. ARKANSAS. Polk Co.: SW of town of Rich Mountain on summit of Rich Mountain, Queen Wilhelmina State Park, along N side of route 88, in vicinity of trailhead of Spring Trail, 20 May 1994, *Naczi 3940 & Ford* (20); ca. 8 mi E of Vandervoort, N of route 246 and E of Cossatot River, 20 May 1994, *Naczi 3949 & Ford* (16). **KENTUCKY. Monroe Co.:** SE of Tomkinsville, along the W side of route 216, 6 road mi E of its junction with route 163, along McFarland Creek, 23 May 1998, *Ford 98100 & Naczi* (53). **Rowan Co.:** ca. 6.5 air mi S of center of Morehead, ca. 0.25 mi down slope from W side of route 1274, upslope from Sugar Camp Branch, ca. 1.3 road mi N of junction of routes 1274 and 801, 28 May 1998, *Ford 98145 & Naczi* (55). **OHIO. Montgomery Co.:** SW of Farmersville, E side of Anthony Road, 0.3 mi SW of its junction with Manning Road, 29 May 1998, *Ford 98153 & Naczi* (56). **TENNESSEE. Franklin Co.:** S of Huntland, along E side of route 97, 2.6 road mi S of its junction with route 122, 24 May 1998, *Ford 98108 & Naczi* (54).

73.3 in the Grant Co., Indiana population of *C. jamesii* (population 8). The average observed heterozygosity within populations (H_{obs}) ranged from 0.137 in the Bath Co., Virginia population of *C. jamesii* (population 41) to 0.336 in the Grant Co., Indiana population of this same species (population 8). The expected heterozygosity in each population based upon Hardy-Weinberg expectations (H_{exp}) was less than that observed in each population with values ranging from

Table 2. Allozyme frequencies for polymorphic loci in *Carex jamesii*, *C. juniperorum*, and *C. timida* as averages for each species (except where noted). *N* = number of individuals used in the calculation of averages.

Locus	**Allele**	***C. jamesii*** **(*N* = 383)**	***C. juniperorum*** **(*N* = 112)**	***C. timida*** **Pop. 53–56 (*N* = 98)**	***C. timida*** **Pop. 16 (*N* = 24)**	***C. timida*** **Pop. 20 (*N* = 32)**
DIA-1	A	0.360	0.509	0.500	0.500	0.484
	B	0.026	–	–	–	0.016
	C	0.391	0.246	0.398	0.500	0.484
	D	0.001	0.009	–	–	–
	E	0.221	0.237	0.102	–	0.016
GPI-2	A	0.297	–		–	–
	B	0.124	0.500	0.500	0.500	0.500
	C	0.159	–	–	–	–
	D	0.409	–	–	–	–
	E	0.009	0.500	0.372	0.500	0.500
	F	–	–	0.128	–	
LAP-1	A	0.008	0.019	–	–	–
	B	0.987	0.972	1.000	1.000	1.000
	C	0.005	0.009	–	–	–
MDH-1	A	0.537	0.960	1.000	0.979	0.984
	B	0.463	0.040	–	0.021	0.0.16
MDH-2	A	0.026	0.054	1.000	1.000	0.938
	B	0.026	0.009	–	–	0.031
	C	0.948	0.938	–	–	0.031
MDR	A	0.057	–	–	–	–
	B	0.943	1.000	1.000	1.000	1.000
PGM-1	A	0.020	–	–	–	–
	B	0.095	–	–	–	–
	C	0.885	–	–	1.000	–
	D	–	–	1.000	–	–
	E	–	1.000	–	–	1.000
PGM-2	A	0.054	0.063	–	–	–
	B	0.534	–	–	–	–
	C	0.003	0.938	–	0.625	1.000
	D	0.363	–	–	–	–
	E	0.047	–	1.000	0.375	–
SOD	A	0.979	0.977	1.000	1.000	1.000
	B	0.021	0.023	–	–	–
SKD	A	0.005	–	0.194	1.000	–
	B	0.995	1.000	0.806	–	–
	C					
	(null allele)	–	–	–	–	1.000

TABLE 2. cont.

Locus	**Allele**	***C. jamesii*** (*N* = 383)	***C. juniperorum*** (*N* = 112)	***C. timida*** **Pop. 53–56** (*N* = 98)	***C. timida*** **Pop. 16** (*N* = 24)	***C. timida*** **Pop. 20** (*N* = 32)
TPI-1	A	0.009	0.004	0.372	0.167	0.469
	B	0.337	0.991	0.628	0.833	0.469
	C	0.631	0.004	–	–	–
	D	0.023	–	–	–	–
TPI-2	A	0.004	0.504	0.372	0.500	0.484
	B	0.449	0.004	0.128	–	0.016
	C	0.547	0.491	0.500	0.500	0.500

0.082 in the Bath Co., Virginia population of *C. jamesii* (population 41) to 0.261 in the Mason Co., Kentucky population of this same species (population 34).

Gene diversity statistics (Table 4) indicated that *C. juniperorum* had the lowest total gene diversity (H_T) (0.135), while that for *C. jamesii* (0.265) and *C. timida* (0.247) was almost twice as great. A similar trend was seen within-populations (H_S), with the lowest value found in *C. juniperorum* while much higher values were observed in *C. jamesii* (0.188) and *C. timida* (0.141).

The gene diversity among populations (D_{ST}) and coefficient of genetic differentiation (G_{ST}) were also variable with extremely low values found in *C. juniperorum* (D_{ST} = 0.007, G_{ST} = 0.049), while relatively high values were associated with *C. jamesii* (D_{ST} = 0.077, G_{ST} = 0.290) and *C. timida* (D_{ST} = 0.106, G_{ST} = 0.429). Taken together these numbers indicate that species within the *C. jamesii* complex harbor as little as 57.1% (*C. timida*) to as much as 95.1% (*C. juniperorum*) of their genetic diversity within populations.

Intra-specific genetic identity values were variable, and in some instances surprisingly low (Table 5). Average values ranged from 0.990 for *C. juniperorum* to 0.852 in *C. timida*. The low value found in this latter species was largely the result of the presence of unique alleles for the isozymes PGM-1, PGM-2, and SKD in the Arkansas populations (populations 16 and 20) of this taxon (Table 5). No activity was observed for SKD in population 20 suggesting that these plants may have lost the ability to express this enzyme phenotype.

Inter-specific genetic identity values were lower than those observed within species and ranged from 0.655 (*C. jamesii* and *C. timida*) to 0.760 (*C. juniperorum* and *C. timida*) (Table 5). These lower values can be attributed to the presence of diagnostic or high frequency alleles in all species. Alleles for the isozymes MDH-2, PGM-1, and PGM-2 helped to differentiate *C. jamesii* from *C. timida* and/or *C. juniperorum* (Table 2). The high genetic identity between *C. juniperorum* and *C. timida* was the result of the presence of similar alleles for PGM-1 and/or PGM-2 in Arkansas populations of *C. timida* and populations of *C. juniperorum*. All

TABLE 3. Genetic variability in 26 populations of the *Carex jamesii* complex: sample size (*N*), mean number of alleles per locus ± SE (*k*), percentage of polymorphic loci ± SE (*P*) (a locus is considered polymorphic if the frequency of the most common allele does not exceed 0.99), observed heterozygosity ± SE (H_{obs}), expected heterozygosity ± SE (H_{exp}) (Unbiased estimate Nei [1978]).

Population #	***N***	***k***	***P***	H_{obs}	H_{exp}
Carex jamesii					
2	38	2.1 ± 0.3	66.7	0.211 ± 0.095	0.195 ± 0.061
8	31	1.9 ± 0.2	73.3	0.336 ± 0.123	0.250 ± 0.069
9	30	1.9 ± 0.3	53.3	0.329 ± 0.121	0.253 ± 0.073
13	30	1.7 ± 0.2	53.3	0.264 ± 0.116	0.168 ± 0.058
18	26	1.5 ± 0.2	33.3	0.262 ± 0.116	0.149 ± 0.060
21	34	1.5 ± 0.2	40.0	0.259 ± 0.114	0.147 ± 0.060
22	13	1.3 ± 0.1	33.3	0.333 ± 0.126	0.173 ± 0.066
24	31	1.9 ± 0.3	46.7	0.252 ± 0.111	0.181 ± 0.065
31	24	1.9 ± 0.3	53.3	0.331 ± 0.125	0.198 ± 0.066
32	19	1.7 ± 0.2	60.0	0.270 ± 0.114	0.163 ± 0.058
33	20	1.7 ± 0.2	53.3	0.333 ± 0.124	0.217 ± 0.064
34	9	1.8 ± 0.2	60.0	0.341 ± 0.118	0.261 + 0.069
39	18	1.4 ± 0.2	33.3	0.333 ± 0.126	0.179 + 0.068
41	34	1.4 ± 0.2	26.7	0.137 ± 0.090	0.082 + 0.082
51	12	1.4 ± 0.2	33.3	0.333 ± 0.126	0.177 ± 0.067
57	14	1.6 ± 0.2	40.0	0.310 ± 0.118	0.216 ± 0.072
Carex juniperorum					
1	34	1.7 ± 0.2	46.7	0.214 ± 0.106	0.164 ± 0.058
5	27	1.7 ± 0.2	53.3	0.208 ± 0.103	0.131 ± 0.052
7	29	1.4 ± 0.2	33.3	0.205 ± 0.105	0.115 ± 0.054
52	22	1.2 ± 0.1	20.0	0.200 ± 0.107	0.102 ± 0.055
Carex timida					
16	24	1.4 ± 0.1	40.0	0.231 ± 0.105	0.156 ± 0.059
20	32	1.7 ± 0.3	40.0	0.265 ± 0.116	0.153 ± 0.062
53	25	1.2 ± 0.1	20.0	0.200 ± 0.107	0.102 ± 0.055
54	20	1.3 ± 0.1	26.7	0.267 ± 0.118	0.137 ± 0.061
55	26	1.3 ± 0.1	26.7	0.267 ± 0.118	0.136 ± 0.060
56	27	1.3 ± 0.1	33.3	0.267 ± 0.118	0.164 ± 0.062

populations of *C. timida* could be distinguished from *C. juniperorum* by the presence of the allele MDH-2a (Table 2).

A cluster analysis of populations using Nei's (1978) unbiased genetic identity values indicated the presence of two distinct groups, one corresponding to *C. jamesii* and a second to *C. juniperorum/timida*. Syntopic populations of *C. jamesii* and *C. timida* (population 56 and 57) were separated with no intermediates being detected. Within the second cluster, *C. juniperorum* and *C. timida* formed indistinct groups owing to the allelic similarity of the two Arkansas populations of *C. timida* with *C. juniperorum* (Fig. 1).

TABLE 4. Gene diversity statistics for the *Carex jamesii* complex. H_T = total gene diversity, H_S = within population gene diversity, D_{ST} = gene diversity among populations, G_{ST} = coefficient of genetic differentiation.

Species	H_T	H_S	D_{ST}	G_{ST}
Carex jamesii	0.265	0.188	0.077	0.290
Carex juniperorum	0.135	0.128	0.007	0.049
Carex timida	0.247	0.141	0.106	0.429

TABLE 5. Matrix of genetic identity coefficients (range) for all pairwise comparisons of sampled populations (*N*) of the *Carex jamesii* complex.

Species	*N*	*C. jamesii*	*C. juniperorum*	*C. timida*
Carex jamesii	16	0.901 (0.697–1.000)		
Carex juniperorum	4	0.744 (0.683–0.834)	0.990 (0.985–1.000)	
Carex timida	6	0.655 (0.545–0.779)	0.760 (0.695–0.845)	0.852 (0.717–0.984)

DISCUSSION

Taxonomic and Phylogenetic Implications

Our isozyme study provides allelic data that supports the recognition of three species in the *C. jamesii* complex (cf. Naczi & Ford 2001). Each species is distinguished by at least one unique or high frequency allele, and with one exception (see below), each forms a distinctive group in the cluster analysis of genetic identity values. Despite the morphological similarity of *C. jamesii* and *C. timida*, these two species were consistently separated in the cluster analysis. Even when these species occur in mixed populations (e.g., populations 56 and 57), no intermediates were detected.

Phylogenetic relationships within section *Phyllostachyae* have been explored in a number of papers, with Naczi and Ford (2001) having investigated the relationship of the newly described *C. timida* to other members of the section. Despite the morphological similarity of *C. jamesii* and *C. timida*, this study suggests that *C. timida* and *C. juniperorum* are sister species and that *C. jamesii* is basal to this clade. Our genetic distance analysis of isozyme data substantiates this hypothesis.

The discovery of genetically unique populations of *C. timida* from the Ouachita Mountains of Arkansas, which blur the distinctiveness between the latter species and *C. juniperorum*, was surprising, especially since morphologically these plants have been shown to be *C. timida* (Naczi and Ford 2001). There

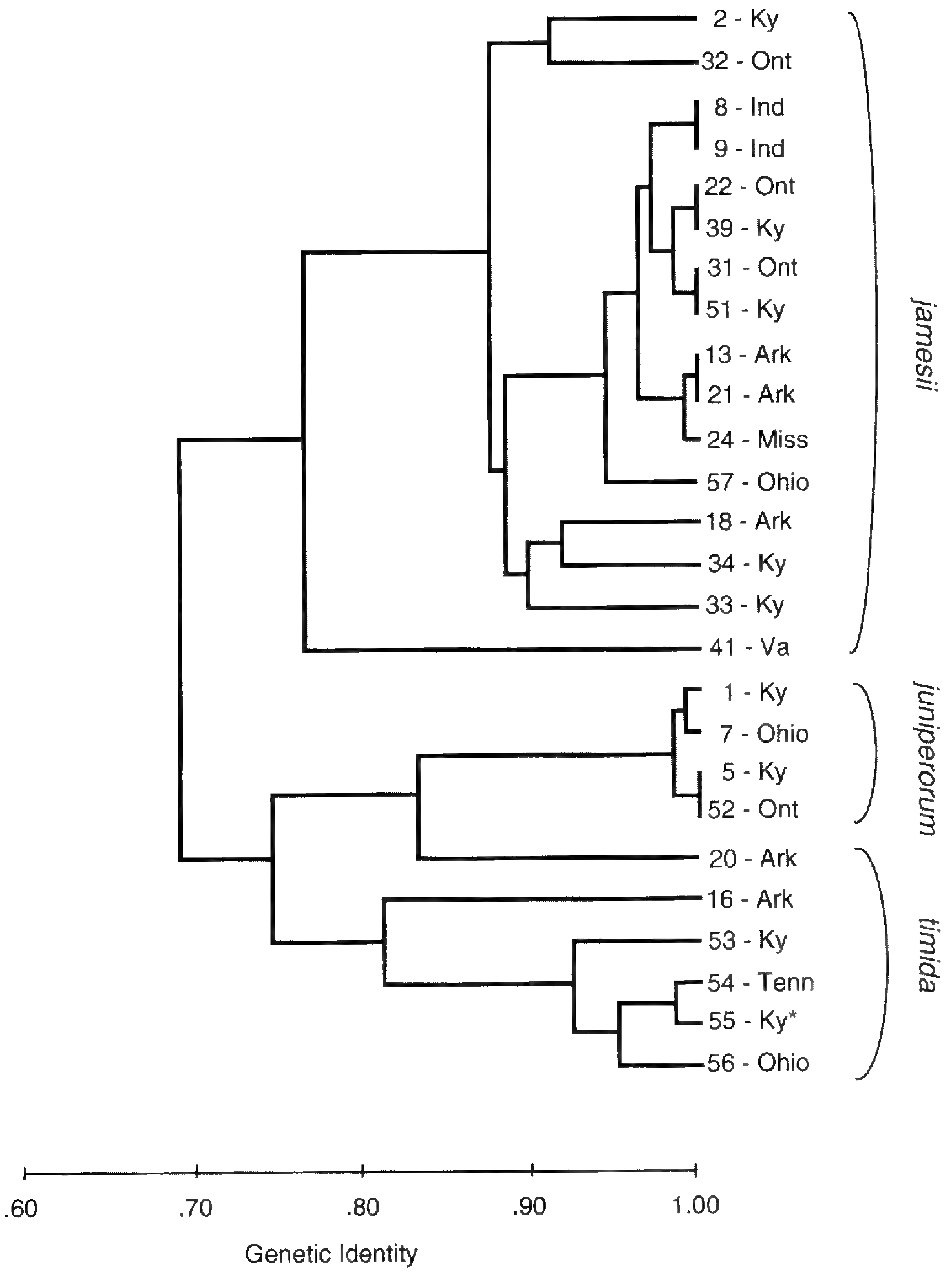

Fig. 1. Phenogram of 26 populations of the *Carex jamesii* complex using Nei's (1978) unbiased genetic identity values and UPGMA cluster analysis. * = type locality for *C. timida*. Cophenetic correlation coefficient = 0.915.

are, however, a number of possible explanations for this finding. One possibility is that the lack of distinct groups is a sampling artifact. If more loci had been surveyed, other diagnostic alleles, such as MDH-2a, might have been found resulting in the formation of more distinctive clusters. Another possibility is that the *C. timida* populations sampled from the Ouachita Mountains (especially population 20) are closest to the ancestor that gave rise to *C. juniperorum* and *C. timida*, accounting for their unique positions in the cluster analysis. Alternatively, *C. juniperorum* could have arisen from a population, or populations, of *C. timida* similar to those found in western Arkansas. The Ouachita Mountains are a recognized glacial refugium and a center of endemism (Robinson & Allen 1995); a number of narrowly distributed plant and animal species occur in this region (Kral & Bates 1991; Robinson & Allen 1995). Many species that found refuge here are thought to have moved northward following the events of Pleistocene glaciation (Robinson & Allen 1995). In some instances, these more northerly populations became isolated from populations in the south resulting in the formation of new species (Ross & Ricker 1971; Robinson & Allen 1995). This phenomenon could account for the origin of *C. juniperorum* and the occurrence of genetically unique populations of *C. timida* in the Ouachita Mountains.

Genetic Variability and Diversity

Table 3 and 4 indicate that *C. juniperorum* possesses about half the genetic variability and diversity found in *C. timida* and *C. jamesii*. This pattern is similar to that found in our study of *C. willdenowii* s. lat., where *C. superata* was thought to possess half of the variation/diversity found in the other species of this complex due to its very short culms (could restrict pollen and seed movement) and restricted distribution (limited gene flow, selection due to environmental homogeneity (Ford et al. 1998c). Like *C. superata*, *C. juniperorum* has extremely short culms, with inflorescences that are crowed in the base of the plant. Furthermore, this species is rare and occurs in disjunct regions in southern Ontario, Kentucky, Ohio, and Virginia (Naczi and Ford 2001). The combined evidence suggests that factors similar to those operating in *C. superata* may be influencing the genetic structure of *C. juniperorum*.

At the opposite end of the spectrum is *C. jamesii*. This is the widest ranging species in the *C. jamesii* complex and is sympatric with both *C. timida* and *C. juniperorum*. *Carex jamesii* has the highest number of polymorphic loci (12 out of 15), the greatest number of alleles, and the highest genetic variability and diversity values (H_T and H_S) for any species in this clade. In addition, with the exception of unique alleles for PGM-1, the allozymes found in *C. timida* and *C. juniperorum* are a subset of those found in *C. jamesii*. The widespread nature of *C. jamesii*, and its adaptation to a variety of climatic and ecological conditions, may be factors contributing to the high levels of genetic diversity and variability found in this species. Being only one node away from the ancestor that gave rise to the *C. jamesii* clade (cf. Naczi & Ford 2001), it is also possible that *C. jamesii* retains much of the variation found in the ancestor to this group accounting for this species extensive allelic diversity.

Insights into the Delineation of Infraspecific Taxa and Justification for Recognizing *C. timida* as a Distinct Species

A comparison of the evolutionary hypothesis proposed in this paper with the superficial similarity found between *C. timida* and *C. jamesii* allows us to explore issues surrounding the recognition of infraspecific taxa and justification for recognizing *C. timida* at the species level. Infraspecific categories are frequently used by taxonomists as a means of recognizing poorly differentiated taxa or taxa distinguished by seemingly minor morphological differences. Current phylogenetic methods may not be appropriate for determining relationships at this level since these relationships are not necessarily hierarchical and the characters used to define taxa are not always discrete. This fact, along with problems associated with outgroup selection, has led most caricologists to develop infraspecific classifications using phenetic methods (e.g., Murray 1969; Reznicek & Ball 1980; Crins & Ball 1983; Reznicek 1987; Standley 1985; Crins & Ball 1989a, 1989b; Ball & Zoladz 1994; Dunlop & Crow 1999). One might wish to consider *C. timida* as a subspecies of *C. jamesii* because of the close morphological similarity of these two taxa. Indeed, an evaluation of the results of our phenetic study might have made this a tenable conclusion (cf. Naczi & Ford 2001). However, when the results of our phylogenetic and genetic research are considered it is clear that the recognition of *C. timida* as a subspecies of *C. jamesii* would have created a clade composed entirely of artificial taxa. While infraspecific relationships are not necessarily hierarchical, infraspecific classifications do represent explicit phylogenetic hypotheses. This study shows that genetic and phylogenetic divergence is not necessarily correlated with striking morphological differences: morphologically similar taxa are not necessarily closely related. We submit that infraspecific classifications based entirely on grouping morphologically similar taxa can lead to the recognition of artificial species. Further, we suggest that if taxa possess clear-cut differences, no matter how narrow, it is best to recognize these taxa as distinct species. Infraspecific taxa should exhibit some degree of intergradation thus making the identification of a significant number of individuals impossible even under the most perfect circumstances. Using this criterion, *C. timida* is best recognized as a distinct species.

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Book Notices

Stuart Gentling and Scott Gentling. 2001. **Of Birds and Texas.** (ISBN 0-292-72834-4, hbk.) University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. (Orders: http://www.utexas.edu/utpress, 512-471-4032). $75.00 hbk., 228 pp., 50 color plates, 28 color remarques, 8 figures, 9 7/8" × 12 7/8".

Of Birds and Texas is an edition of the original elephant folio limited edition published by the artists in1985. It is an extremely personal work, if that word can be used of two people. They have written essays detailing the history of this publication and their fascinating research on John James Audubon to whom the folio edition was dedicated. In addition each plate is accompanied by a brief explication of their own relationship to the subject of the painting. The volume was meant to read and so includes an essay, *Self Portrait with Birds*, by the nature writer, John Graves. But the paintings are the focus after all. Naturally there are color differences between the folio edition and this one, but the accessibility of the book more than compensates for any loss. The emotional identification of the artists with the landscapes and birds and the careful attention to detail make each painting memorable.

The book is an exceptional tribute to Audubon.—*Ruth Ginsburg, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

Editor's note on Of Birds and Texas.—Of the 50 color plates, 10 are of landscapes of Texas and the remaining 40 are of birds. However, the Gentlings have painted more than just birds, there are at least 17 species of native, naturalized or cultivated plants in full color. Some of the plants painted in flower, fruit, and their spectacular foliage include, Water Hyacinth, Yellow Lotus, White Water-Lily, Sweetgum, Saw Greenbrier, Cedar Elm, Common Trumpet-Creeper, Texas Bluebonnet, Sycamore. Don't miss the flora for fauna.

"God hath made three beautiful things, birds, and women, and flowers,"—*John Sturat Blackie, The Botanist's song, 1869.* This is almost the perfect book.

Chrisopher Kelly (Editor). 2000. **Jean-Jacques Rousseau The Reveries of the Solitary Walker, Botanical Writings, and Letter to Franquieres.** Translated and annotated by Charles E. Butterworth, Alexandra Cook, and Terence E. Marshall. (ISBN 1-58465-007-9, hbk.) University Press of New England, 23 South Main Street, Hanover, NH 03755-2058, U.S.A. (Orders: Plymbridge Distributors Ltd., Estover Plymouth, PL6 &P2, UK 603-643-7100, ext. 233). £47.00 (ca. $60) hbk., 349 pp. Frontispiece, 6 1/8" × 9 1/4".

In the middle of the 20th century, the taxonomist, Lloyd H. Shinners, wrote that he was testing the validity and hope of the most romantic of sciences in an age hostile and alien to it. The writings of Jean-Jacques Rousseau, the 'Father of the Romantic Movement' offer an interesting perspective on that earlier time when the science of botany was emerging. *Jean-Jacques Rousseau* offers an admirable translation of the nature essays and letters about botany, and thus makes available to the English reader a lesser known side of the great philosopher. The copious and well-written notes provide a valuable background to the circumstances of the walks as well as a short history of botany. Rousseau's deep appreciation of the beauties of nature and the lyricism of his writing are well served by this excellent book.—*Ruth Ginsburg, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

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STENOTIS (RUBIACEAE), A NEW SEGREGATE GENUS FROM BAJA CALIFORNIA, MEXICO

Edward E. Terrell[1]

Research Collaborator
Department of Systematic Biology-Botany
Natural History Museum, Smithsonian Institution
Washington, D.C. 20560, U.S.A.

ABSTRACT

Seven former *Hedyotis* (Rubiaceae) species native to Baja California, Mexico, are revised and placed in a new genus, *Stenotis*, on the basis of seed and other morphological characters, chromosome number, and recent DNA evidence. Keys, descriptions, distributions, and synonyms are provided. Two of the species are annual herbs (*Stenotis arenaria*, *S. asperuloides*), and five are perennial woody herbs or shrublets (*S. australis*, *S. brevipes*, *S. gracilenta*, *S. mucronata*, and *S. peninsularis*). Two varieties are recognized in *S. asperuloides*.

RESUMEN

Se revisan siete especies de *Hedyotis* (Rubiaceae) originarias de Baja California, México, y se colocan en un nuevo género, *Stenotis*. La ubicación en este género se basa en caracteres de la semilla y en otros caracteres morfológicos, en el número de cromosomas, y en evidencias recientes derivadas del ADN. Se presentan claves taxonómicas, descripciones, distribuciones y sinónimos. Dos de estas especies son hierbas anuales (*Stenotis arenaria* y *S. asperuloides*), y cinco son plantas perennes de tallo leñoso o pequeños arbustos (*S. australis*, *S. brevipes*, *S. gracilenta*, *S. mucronata*, y *S. peninsularis*). Se reconocen dos variedades dentro de la especie *S. asperuloides*.

INTRODUCTION

Early explorations in Baja California, Mexico, by T.S. Brandegee, I.M. Johnston, and others from 1844 to 1924 turned up eight new species assigned to *Houstonia* or *Hedyotis* (Hedyotideae; Rubiaceae). Seven of these species (excluding *Hedyotis vegrandis* W.H. Lewis [*Houstonia prostrata* Brandegee] of uncertain affinity), sometimes termed the *Hedyotis mucronata* group, include two annual herbs and five perennial herbs or shrublets. An additional species, *Hedyotis greenei* A. Gray, occurs in Arizona and is closely related to *H. arenaria*, but is excluded from the present study pending further study of its relationships. These species differ in morphology from the approximately six so-called *Hedyotis* species occurring in Mexico outside of Baja California, whose relationships require further study.

Previous work on *Houstonia* (Terrell 1996) and other related genera showed that two taxonomically meaningful characters are seed morphology and chromosome number. The seeds (Fig. 1) of the seven Bajan species are generally ellipsoid with a more or less centric punctiform hilum, but some species have a

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[1] Address for correspondence: 14001 Wildwood Dr., Silver Spring, MD 20905, U.S.A.

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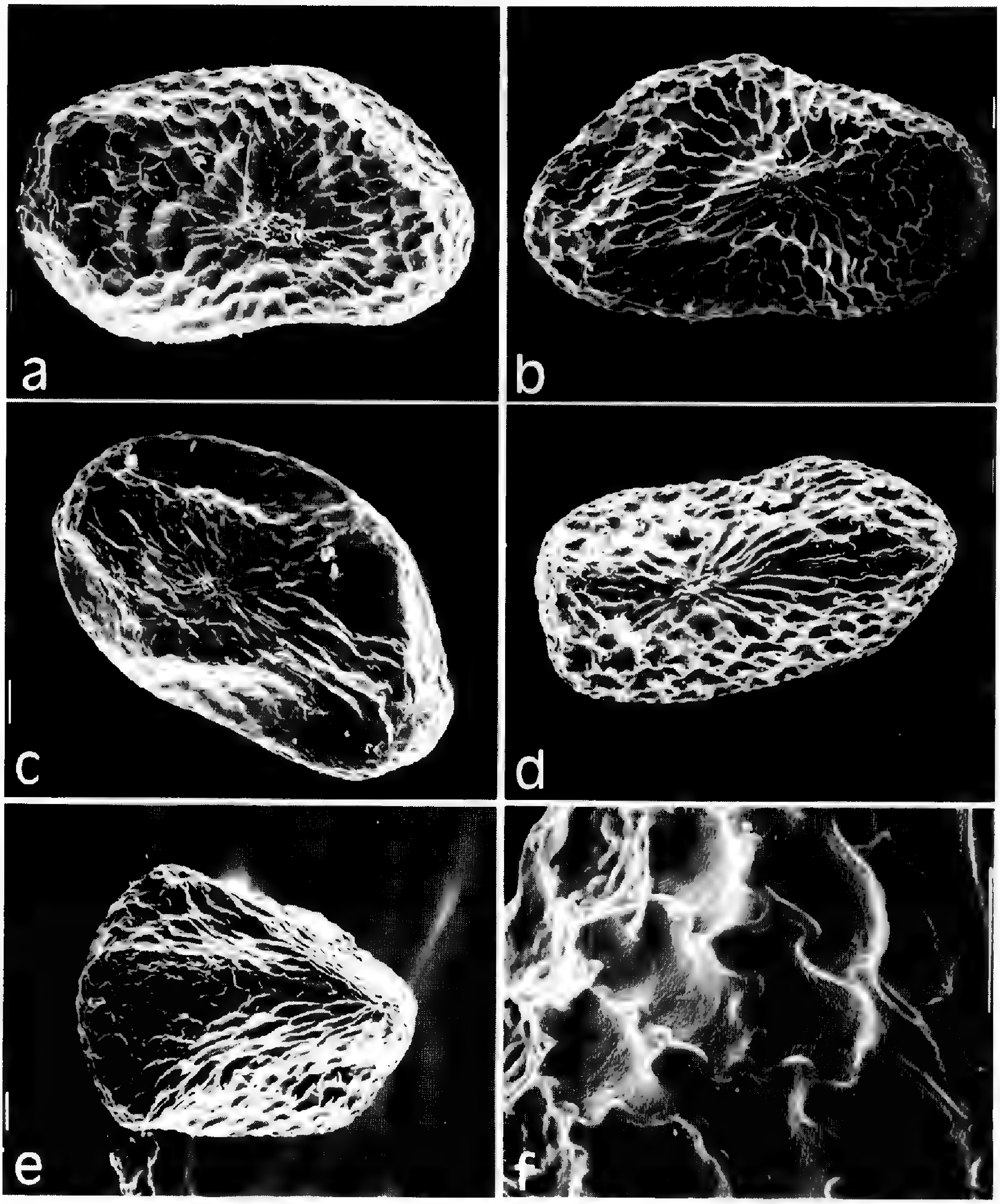

Fig. 1. Seeds of *Stenotis* examined by scanning electron microscopy. Scale bars at left/right borders are 50 microns. a-e. ventral views showing centric hilums. A. *Stenotis mucronata, Wiggins 14424* (TEX). B. *Stenotis australis, Carter et al. 2337* (GH). C. *Stenotis asperuloides, Carter 2606* (US). D. *Stenotis arenaria, Brandegee s.n.*, 10/14/1893 (NY, US). E. *Stenotis arenaria*, same collection. F. Testa surface and sinuous areole walls, *Stenotis arenaria, Lewis 5341* (US).

conspicuous ventral hilar ridge or vary somewhat in being irregularly and obtusely angulate, with a punctiform hilum more or less centered on the ventral ridge. Generally, these seeds exhibit morphology distinctive among Mexican and American species of *Hedyotis* s.l. Five of these species are reported to have a chromosome number of x=13 (Lewis 1962), a unique number in the Hedyotideae (Terrell 1996). A recent DNA study (Church 2001, unpublished) has shown that four of the species form a clade distinct from species of *Houstonia* (Terrell 1996) and *Stenaria* (Terrell 2001).

The heterogeneous genus *Hedyotis* was discussed by Terrell (1996) and compared with *Houstonia* and *Oldenlandia* species. More recently, DNA results from Bremer and Manen (2000) found *Hedyotis* to be paraphyletic. All North American species of *Hedyotis* are distinct from the type species, *H. fruticosa*, which is representative of a group of Sri Lankan and other Asian species. One species of the Asian group has a chromosome number of 2n=90–160 (Kiehn 1986), and the seeds of these species also differ from the North American species (Terrell 1996).

In consideration of the uniqueness of the Asian species, the Baja Californian species heretofore treated as *Hedyotis* need a new generic name. The name chosen here, *Stenotis*, is derived in two parts: first, "Sten-," from *Stenaria*, a recently named genus (Terrell 2001), whose name was based on *Houstonia* subgenus *Stenaria* Raf.; second, from the root "-otis," meaning "ear," which terminates the name *Hedyotis*. Also, the Greek word, "stenos," meaning "narrow," is descriptive of the narrow leaves of the plants in the new genus.

SYSTEMATIC TREATMENT

Stenotis Terrell, gen. nov. TYPE SPECIES: *Stenotis mucronata* (Benth.) Terrell.

Herbae annuae vel perennes lignosae; folia 3–50 mm longa, 0.3–6.0 mm lata, plerumque linearia vel anguste elliptica; inflorescentia cymosa, floribus heterostylis; corollae 2–18 mm longae infundibuliformes vel hypocrateriformes albae vel roseolae; capsulae 1.3–5.0 mm longae 1.3–4.0 mm latae subglobosae vel turbinatae; semina 0.3–1.0 mm longa 0.2–0.7 mm lata paulo compressa plus minusve ellipsoidea pagina ventralis convexa vel rotundata hilo punctiformi; chromosomatum numerus x=13.

Annual, soft-stemmed, or perennial woody-stemmed herbs or shrublets. Stems 3–100 cm tall, terete or angular, branched. Leaves 3–50 mm long, 0.3–6.0 mm wide, linear, filiform, or subterete to narrowly elliptic or narrowly oblanceolate, thin or thickish. Stipules to 1.5 mm long, to 2 mm wide, whitish, scarious, toothed, lobed, or entire. Inflorescence cymose, terminal or axillary, earliest flowers sometimes sessile, later flowers pedicelled. Flowers heterostylous. Hypanthium (calyx cup) hemispherical or cup-shaped; calyx lobes 0.5–2.5 mm long, usually linear or lanceolate. Corollas 2–18 mm long, salverform or funnelform, white, pink, or rose, 8-nerved, tube longer than lobes. Pin flowers with stigma lobes 0.3–1.8 mm long. Thrum flowers with anthers 0.5–1.7 mm long. Capsules 1.3–5.0 mm long, 1.3–4.0 mm wide, subglobose or turbinate, 2/3 to 7/8 inferior, with 8 dark nerves, dehiscing loculicidally then septicidally; placenta attached ca. 1/3 to 2/5 of distance from base to top of septum. Seeds to ca. 47 per capsule, 0.3–1.0 mm long, 0.2–0.7 mm wide, brown or black, slightly or somewhat dorsiventrally compressed, elliptic, oblong or irregularly obtusely angled in outline, dorsal face flat or convex, ventral face flat or convex to rounded with large hilar ridge, hilum punctiform, centric, testa reticulate. Chromosome number x=13 for five species, others unknown.

Distribution.—Baja California, Mexico.

The following key is partly derived from Johnston (1924) and Wiggins (1980).

1. Plants annual, soft-stemmed.
2. Leaves 0.5–6.0 mm wide; oldest flowers mostly sessile; corollas white ______ **1. S. arenaria**
2. Leaves 0.3–2.0(–3.5) mm wide; flowers all or mostly pedicelled; corollas pink, rose, or white ______ **2. S. asperuloides**
1. Plants perennial, stems woody at least at base.
3. Plants densely canescent or densely puberulent; rare species of southern Baja California Sur ______ **7. S. peninsularis**
3. Plants glabrous or glabrate.
4. Stems angular in cross section; leaves often fascicled, to 18 mm long.
5. Plants stout, bushy; leaves numerous, crowded ______ **6. S. mucronata**
5. Plants slender, not bushy; leaves not numerous, not crowded; known mainly from San Diego Island ______ **5. S. gracilenta**
4. Stems terete; leaves not fascicled, to 50 mm long.
6. Corollas (4–)5–10(–11) mm long ______ **3. S. australis**
6. Corollas (8–)10–18 mm long ______ **4. S. brevipes**

1. Stenotis arenaria (Rose) Terrell, comb.nov. *Houstonia arenaria* Rose, in Vasey, G. and J.N. Rose, Contr. U.S. Natl. Herb. 1:70.1890. *Hedyotis arenaria* (Rose) W.H. Lewis, Rhodora 63:221.1961. TYPE: MEXICO. BAJA CALIFORNIA: La Paz, 20 Jan–5 Feb 1890, *Palmer 28* (LECTOTYPE, here designated: US!; ISOLECTOTYPES: F! GH! NY!)

Small annual herb. Stems 3–30 cm tall, slender, quadrangulate to terete, erect or spreading, glabrous to scaberulous, with slender branches 2–20 cm long from any or all nodes. Leaves 5–40 mm long, 0.5–6.0 mm wide, sessile or lower leaves with short petioles, thin, 1-nerved, narrowly oblanceolate, narrowly elliptic, or linear, glabrous. Stipules to ca. 1 mm long and wide, rounded, with several marginal teeth, some gland-tipped. Inflorescence with earliest flowers sessile in axils of peduncles or branches, surpassed by later erect peduncles or pedicels to 16 mm long, (sometimes appearing secund), buds obovate. Hypanthium glabrous; calyx lobes 0.5–2.0 mm long, 0.2–0.4(–0.7) mm wide, lanceolate or narrowly lanceolate. Corollas 2–6 mm long, funnelform, white; tube 1–3.5 mm long, 0.6–3 mm wide at throat, sometimes abruptly flared at throat, glabrous within; lobes 1–3 mm long, 0.5–2 mm wide, ovate. Pin flowers with stigma lobes 0.3–1.0 mm long, linear, exserted to ca. 1 mm beyond throat, anthers at or just below corolla sinuses. Thrum flowers with anthers 0.5–1.0 mm long, oblong, subsessile or on filaments to 1 mm long, exserted to ca.1 mm beyond throat, stigmas near midpoint of tube. Capsules 2–3(–4) mm long and wide, 3/4–7/8 inferior, subglobose to subturbinate, tan or straw-colored with 8 darker nerves, thin-walled. Seeds 0.4–0.9 mm long, 0.25–0.60 mm wide, in outline oblong or elliptic or irregularly obtusely angled, dorsal face flat or convex, ventral face with large rounded hilar ridge, testa reticulate. Chromosome number n=13 (Lewis 1962).

Phenology.—Flowering August-September to April.

Distribution.—Sandy places, granitic talus, and similar habitats at low elevations; Mexico, Baja California Sur in Cape region from La Paz south to end of peninsula.

Selected representative specimens examined: **MEXICO. Baja California:** 1 km S of Caduano, *Lewis 5341* (MO, SMU, TEX, US); 11 km N of Santa Anita, *Moran 6919* (ARIZ, GH, K, MEXU, MICH, TEX); San José del Cabo, *Purpus s.n.*, Jan–Feb 1901 (F, MO, NY, US); Arroyo de San Bartolo, 1.5 mi NW of village of San Bartolo, *Wiggins 14751* (ARIZ, GH, K).

An Arizona species, *Hedyotis greenei* A. Gray, is being studied to determine whether it is conspecific with *S. arenaria*.

I have examined 26 collections of *S. arenaria*. This species appears to intergrade slightly with *S. asperuloides*.

2. Stenotis asperuloides (Benth.) Terrell, comb. nov. *Hedyotis asperuloides* Benth., Bot. Voy. Sulphur 19, t. 13. 1844. *Houstonia asperuloides* (Benth.) A. Gray, Proc. Amer. Acad. Arts 5:158. 1861. TYPE: MEXICO. BAJA CALIFORNIA: Cape San Lucas, *Hinds s.n.*, 1841 (LECTOTYPE, here designated: K!, not found at BM).

Small annual herb. Stems to 2.8 dm tall (28 cm), very slender, terete or slightly angulate, ascending or decumbent, spreading, glabrous or puberulent-scabrous near base, diffusely much-branched from base or all nodes, internodes longer than leaves. Leaves 3–30 mm long, 0.3–2.0(-3.5) mm wide, sessile, linear or filiform, glabrous or scabrous above, glabrous beneath, obtuse or acutish. Stipules to 1 mm long, to 2 mm wide, rounded or truncate, margin with several linear or lanceolate teeth, some gland-tipped. Inflorescence spreading, flowers often numerous, earliest flowers sessile or shortly pedicellate, later flowers on filiform pedicels to ca. 30 mm long, buds obovate. Hypanthium glabrous to pubescent; calyx lobes 0.6–2.3 mm long, linear or lanceolate, obtuse or acute. Corollas 3–11 mm long with lobes extended, funnelform or subsalverform, pink, rose, or white, sometimes with blue or green central nerves on lobes and reddish spots at throat and with black spots externally near midpoint of tube, glabrous or puberulent externally; tube 2–7 mm long, 1–4 mm wide at throat, sometimes abruptly widened distally, glandular-puberulent or puberulent within especially near throat; lobes 1.5–5.0 mm long, 1–4 mm wide, ovate. Pin flowers with stigma lobes 1.0–1.4 mm long, linear, exserted to 1 mm long, anthers sessile near midpoint of corolla tubes. Thrum flowers with anthers 1.0–1.3 mm long, linear, sessile or subsessile, exserted just beyond corolla sinuses, stigmas included. Capsules 1.3–5.0 mm long, 1.3–2.0 mm wide, about 7/8 inferior, turbinate, oblong, or elliptic, brown, pale brown, or whitish with ca. 8 conspicuous dark nerves, thin-walled. Seeds 0.3–0.6 mm long, 0.2–0.4 mm wide, dorsal face flat or convex, shape quite variable, ventral face with conspicuous angulate hilar ridge or irregularly angulate or elliptic or oblong in outline with more rounded hilar ridge, with testa shallowly reticulate. Figure 2 (from Bentham's protologue, 1844).

Phenology.—Flowering October to May.

The species is quite variable, especially in flower shape. Certain collections appear to resemble *H. arenaria* to some extent. Number of collections examined: 26.

Two varieties have been recognized, as follows.

KEY TO VARIETIES

1. Calyx lobes 0.8–2.3 mm long, often acute; corollas 6–11 mm long; capsules 2–5 mm long, usually longer than wide ________ var. **asperuloides**

1. Calyx lobes 0.6–1.3 mm long, often obtuse; corollas 3–6 mm long; capsules 1.3–2.0 long, usually equally long and wide ________ var. **brandegeana**

2a. Stenotis asperuloides var. **asperuloides**

Calyx lobes 0.8–2.3 mm long, often acute. Corollas 6–11 mm long; tubes 3.5–6.5 mm long; lobes 2–5 mm long, 1–4 mm wide. Capsules 2–5 mm long, 1.5–2.0 mm wide, narrowly turbinate, oblong, or elliptic. Chromosome number: n=13 (Lewis 1962).

Distribution.—Sandy or gravelly flats or slopes, dunes, dry banks, stream beds, and similar habitats at low elevations near ocean and inland. Mexico: Baja California Sur, Cape region from La Paz area to southern end of peninsula.

Selected representative specimens examined: **MEXICO. Baja California:** plateau E of La Paz, along road to Punta Coyote, *Carter 2606* (GH, K, LL, MO, US); Pacific coast N of Arroyo de Candelaria, NE of Cabo San Lucas, *Constance 3187* (F, GH, K, LL, MICH, MO, NY, US); 1 km NW of El Triunfo off hwy 11, *Lewis 5337* (MO, SMU, TEX, US); 2.5 km NE of Cabo San Lucas, *Moran 7044* (ARIZ, GH, K, MEXU, MICH, TEX); 2 mi E of Buena Vista, *Reeder & Reeder 6754* (ARIZ, ENCB); 8 mi N of Todos Santos, *Shreve 7216* (ARIZ, MICH, US).

2b. Stenotis asperuloides var. **brandegeana** (Rose) Terrell, comb. nov. *Houstonia brandegeana* Rose, in Vasey, G. and J.N. Rose, Contr. U.S. Natl. Herb. 1:70. 1890. *Hedyotis asperuloides* f. *brandegeana* (Rose) W.H. Lewis, Rhodora 63:221. 1961. *Houstonia asperuloides* var. *brandegeana* (Rose) Wiggins, in Shreve, F. & I.L. Wiggins, Veg. & Fl. Sonoran Desert 2:1400. 1964. *Hedyotis asperuloides* var. *brandegeana* (Rose) Terrell, Phytologia 71:224. 1991. TYPE: Mexico. Baja California: La Paz, 20 Jan–5 Feb 1890, Syntypes: *Palmer 31* and *24a* (LECTOTYPE, here designated: *Palmer 31* (US!); ISOLECTOTYPES: F!, GH!, K!, MEXU!). Rose in the protologue cited *Palmer 31* and *24a* together, which therefore are syntypes. *Palmer 31* is the better and most widely distributed collection.

Calyx lobes 0.6–1.3 mm long, often obtuse. Corollas (3–)3.5–6.0 mm long, tubes 2–3 mm long, lobes 1.5–3.3 mm long, 1.0–2.2 mm wide. Capsules 1.3–2.0 mm long and wide, shortly turbinate to elliptic. Chromosome number: n=13 (Lewis 1962).

Distribution.—Mexico. Baja California. Same distribution as var. *asperuloides*. In the protologue Rose noted that this taxon occurred in the same habitats as *H. asperuloides*.

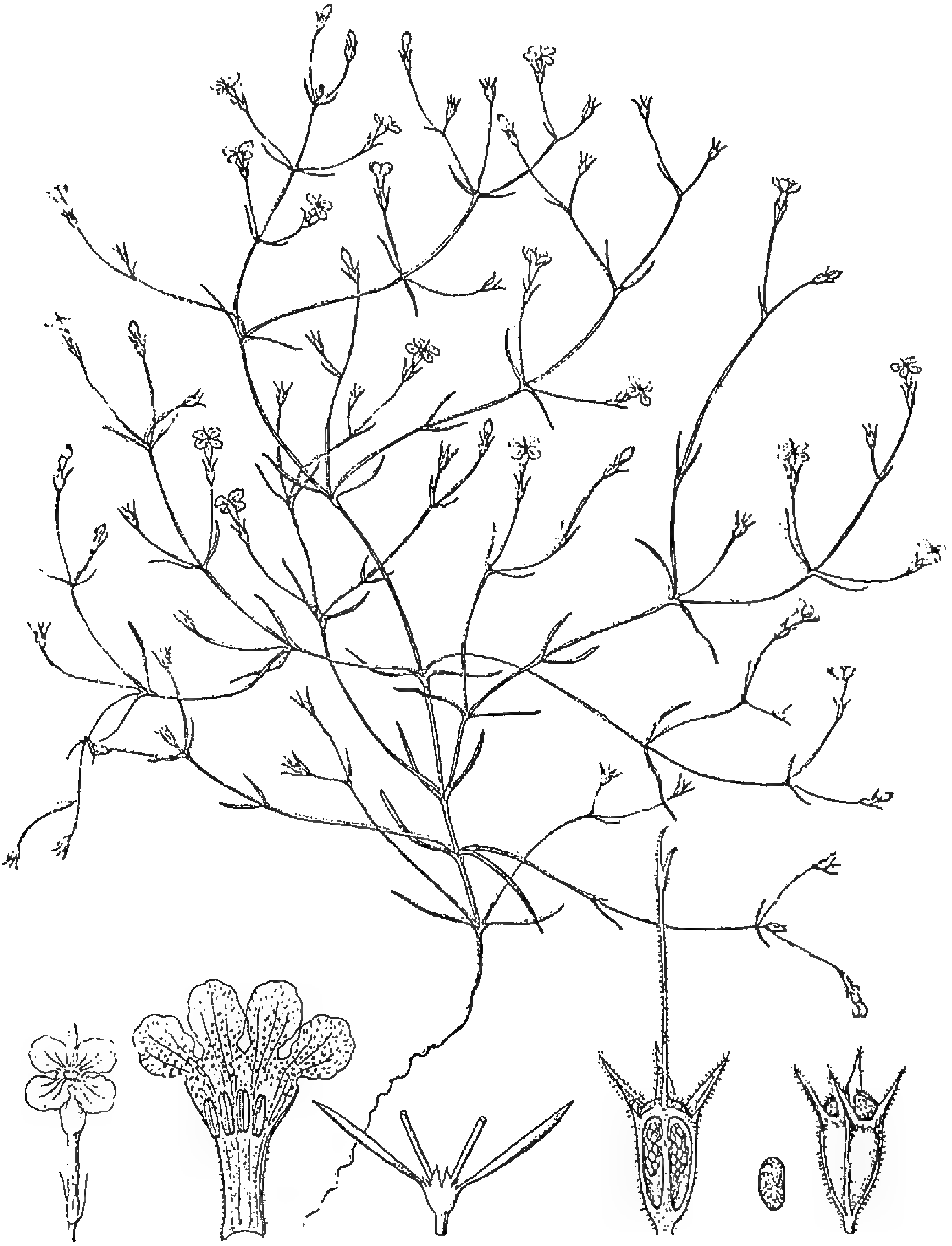

Fig. 2. ***Stenotis asperuloides*****. Drawing of holotype, Plate XIII, Bentham's protologue, 1844. Left to right (all magnified): flower; corolla cut open; leaves and stipules; ovary section; seed; capsule.**

Selected representative specimens examined: **MEXICO. Baja California:** La Paz, *Palmer 24a*, 20 Jan–5 Feb 1890 (US); near hwy 1 SE of San Bartolo, 28.2 mi SE of El Triunfo, *Daniel 2522* (ASU); valley 4.8 km SW of Santiago, *Carter et al. 2182* (ARIZ, F, GH, K, MO, US); 4 km SE of San Pedro, *Lewis 5336* (MO, SMU, TEX, US); Punta Frailes, *Dawson 1113* (MICH).

This variety intergrades somewhat with var. *asperuloides*; however, I here follow Wiggins (1964) in maintaining it as a variety, although Johnston (1924) noted that it "can scarcely be distinguished". In herbarium specimens I found certain collections with conspicuously smaller capsules and somewhat smaller flowers. Without having seen these plants in the field or having available other evidence I prefer to retain var. *brandegeana*. Number of collections seen: 8.

3. **Stenotis australis** (I.M. Johnst.) Terrell, comb. nov. *Houstonia australis* I.M. Johnst., Univ. Calif. Publ. Bot. 7:446. 1922. *Hedyotis saxatilis* W.H. Lewis, Rhodora 63:222. 1961, non *Hedyotis australis* W.H. Lewis & D.M. Moore, Southw. Naturalist 3:208. 1959. TYPE: MEXICO. BAJA CALIFORNIA: Binorama, 27 Sep 1899, *T.S. Brandegee s.n.* (HOLOTYPE: UC-201101!).

Perennial woody herb. Stems to ca. 6 dm tall, woody toward base, slender, subterete, ascending or spreading, glabrous or minutely puberulent in inflorescence, epidermis brownish or grayish, often shredding. Leaves to 40 mm long, to 2 mm wide, sessile, linear or filiform, glabrous or minutely puberulent, obtuse or acute and somewhat indurate at apex. Stipules 0.5–1.5 mm long and wide, truncate to deltoid, with 1-few marginal teeth to ca. 1.5 mm long, sometimes gland-tipped. Inflorescence cymose, terminal. Earliest flowers sessile or subsessile, later flowers on pedicels to 10 mm long. Hypanthium glabrous or densely puberulent; calyx lobes 1–2 mm long, lanceolate or linear-lanceolate, acute. Corolla (4–)5–10(–11) mm long, narrowly funnelform, pink, light pink, or lavender-pink, throat sometimes yellow, glabrous or densely whitish-puberulent externally; tube 3–7 mm long, somewhat widened distally, glabrous or puberulent distally within; lobes 1.5–3.5 mm long, 1–2 mm wide, ovate. Pin flowers with stigma lobes 1–1.5 mm long, linear, exserted ca.1 mm beyond throat, anthers included just below throat. Thrum flowers with anthers ca.1 mm long, elliptic or oblong, sometimes curved, purplish, subsessile or filaments to 0.4 mm long, partly or fully exserted. Capsules (1.5–)2–2.5(–3) mm long, equally wide, 3/4–4/5 inferior, subglobose, often whitish with dark ribs. Seeds 0.45–0.8 mm long, 0.3–0.6 mm wide, usually longer than wide, rather shiny, in outline oblong or irregular, dorsal and ventral faces flat or slightly convex, testa minutely and shallowly reticulate. Chromosome number: $2n = 26$ (Lewis 1962).

Phenology.—Flowering and fruiting September to April.

Distribution.—Granite outcrops, rocky cliffs, canyon walls, among granite boulders in oak forest; altitudes 250–2000 m (750–6000 feet); Mexico. Baja California: Cape Region from San Bartolo (south of La Paz) south to tip of peninsula in the Sierra de la Laguna and Sierra de la Victoria. The type locality ("Binorama" or Vinorama) is apparently southeast of La Paz. Number of collections seen: 13.

Selected representative specimens examined. **MEXICO.** BAJA CALIFORNIA: Ca. 2.4 km SE of Rancho San Bernado, *Carter 2693* (LL, US); La Laguna, Sierra de la Laguna, E of Todos Santos, *Carter et al. 2337* (GH, US); Sierra de la Laguna, *Hammerly 392* (CAS, GH, US); near canyon mouth, El Chorro, *Moran 7300* (GH, MEXU, US).

4. Stenotis brevipes (Rose) Terrell, comb. nov. *Houstonia brevipes* Rose, in Vasey, G. & J.N. Rose, Contr. U.S. Natl. Herb. 1:83. 1890. *Hedyotis brevipes* (Rose) W.H. Lewis, Rhodora 63:221. 1961. TYPE: MEXICO. BAJA CALIFORNIA: protologue stated "only a single specimen collected near Santa Rosalia, in a cañon, 24 Feb–3 Mar, 1890, *Palmer 202* (LECTOTYPE, here designated: US!; ISOLECTOTYPES: F! GH! NY! US!). See explanation below.

Perennial herb or shrublet. Stems to ca. 1 m tall, herbaceous or becoming woody toward base, crown or base to 1 cm thick, terete, ascending or spreading, glabrous, epidermis gray, sometimes shedding. Leaves 5–30(–50) mm long, 0.3–1 (–2) mm wide, sessile, linear or filiform, glabrous, acute or mucronulate at apex. Stipules less than 2 mm long and wide, subtriangular, apices truncate or rounded, with marginal teeth. Inflorescences cymose, terminal, few-flowered. Earliest flowers short-pedicelled or subsessile, later flowers with pedicels to ca. 12 mm long. Hypanthium glabrous; calyx lobes 0.5–2 mm long, 0.2–0.8 mm wide, (in fruit equalling or slightly surpassing capsule), triangular to lanceolate, acute or obtuse. Corolla (8–)10–18 mm long, salverform, pink, lavender, rose, or white, glabrous externally; tube (6–)8–13 mm long, usually about 3–4 times longer than lobes, slender, abruptly widened around anthers in pin flowers, glabrate or puberulent distally within; lobes 1.5–4(–5) mm long, 1–2.5(–3) mm wide, ovate, glabrous or minutely densely puberulent. Pin flowers with stigma lobes 0.7–1.8 mm long, linear, exserted 1–2 mm beyond throat, anthers included, located near 3/4-point of tube. Thrum flowers with anthers 1–1.5 mm long, versatile, elliptic or oblong, subsessile or on filaments to 0.5 mm long, exserted partly or fully at corolla lobe sinuses. Capsules 1.5–3.5 mm long, equally wide, subglobose, 2/3–4/5 inferior, light tan with slightly darker nerves. Seeds 0.6–1 mm long, 0.3–0.7 mm wide, in outline elliptic or oblong, ventral face flat or slightly concave, testa shallowly reticulate. Chromosome number: 2n=26 (Lewis 1962).

Phenology.—Flowering October to June.

Distribution.—In sandy, rocky, or gravelly places, canyon walls and floors, talus slopes, granitic outcrops, bay margins, at low altitudes; Mexico: Baja California, central and east side of Baja California peninsula and on various offshore islands in Gulf of California, from ca. 24° to 29° N latitude. Number of collections examined: 41.

Selected representative specimens examined. MEXICO. BAJA CALIFORNIA. Arroyo del Salto, E of La Paz, *Carter 2593* (K, LL, US); Isla Coronado, *Carter 4337* (ENCB, MICH); Arroyo Culebriado, Sierra de la Gigantea, *Carter & Ferris 4064* (ARIZ, MICH, TEX, US); 4.4 mi NW of El Triunfo, *Daniel 2488* (ASU); Coyote Bay, Bahia Concepcion, *Gentry 4063* (GH, MO, NA); San Nicholas Bay, *Johnston 3723* (F, GH, K, MO, NY, US); Arroyo del Salto, Cape Region, *Moran 7140* (ARIZ, GH, TEX); NW side of San Marcos Island, Bay of California, *Moran 8945* (KANU, LL, MO, NY, PH); Carmen Island, *Palmer 836* (F, GH, K, MICH, NY, US); Isla Ceralvo, Gulf of California, *Wiggins 17754* (ENCB, MEXU, MICH, US); Santispaquis, Bahia de la Concepcion, *Wiggins & Wiggins 17975* (BM, MEXU, MICH, TEX, US).

Vasey and Rose (1890) provided a detailed explanation of Palmer's collecting activities, but data on the type labels are confusing. The collections were made in 1890, although the US and GH specimens are labeled 1889. Palmer collected at Santa Rosalia from February 20 to March 3, 1890, then departed, but returned on March 15. Of the type specimens cited, the lectotype and GH isotype are labeled as "February 24 to March 3," but the US isotype is labeled as just "1889". The F and NY isotypes also bear the collection number 202 and look like pieces of the same plant as the other types, but are labeled "March 15, 1890". As only one specimen was collected originally, the US and GH specimens must be parts of the same plant. The F and NY specimens were apparently collected on March 15 on Palmer's return. These are cited here as isotypes; possibly they should be considered paratypes.

This species and *H. mucronata* are the two most wide-ranging species of *Stenotis*.

5. Stenotis gracilenta (I.M. Johnst.) Terrell, comb. nov. *Houstonia gracilenta* I.M. Johnst., Proc. Calif. Acad. Sci. ser. 4, 12:1174. 1924. *Hedyotis gracilenta* (I.M. Johnst.) W.H. Lewis, Rhodora 63:222. 1961. TYPE: MEXICO. BAJA CALIFORNIA: rocky slope facing sea, San Diego Island, 27 May 1921, *I.M. Johnston 3927* (HOLOTYPE: CAS-1306!; ISOTYPES: GH! K! US!). (Isotypes labeled "gracillima").

Limited description based on holotype and two isotypes with damaged or immature flowers and description in Johnston (1924) and Wiggins (1964).

Perennial shrublet with thick woody base. Stems to 20 cm or more tall, slender, angulate, woody, decumbent, glabrous or slightly glandular, much-branched, epidermis on old stems gray or brown, shredding. Leaves to 15 mm long, to 1 mm wide, sessile, frequently fasciculate, filiform, coriaceous, acute or mucronulate. Stipules less than 1 mm long, subtriangular or lobed, sometimes with short, glandular teeth. Hypanthium glabrous; calyx lobes to 2.5 mm long, linear-lanceolate. Corollas 10–12 mm long with lobes extended, salverform, pink with darker rose lines extending to throat; tube 5–6 long; lobes ca. 2 mm or more long. Capsules 1.5–2.5 mm long and wide, 2/3–3/4 inferior subglobose or slightly longer than wide. Seeds (2 seen) ca. 0.8 mm long. Flowering May. Chromosome number unknown.

Distribution.—Mexico: Type collection from San Diego Island, Gulf of California, Baja California. This small island is 75 miles NNW of La Paz and just south of San José Island. Another collection from San Francisco Island (*Wiggins et al. 377*, DS) agrees with the protologue.

Johnston (1924) noted that the type collection resembled both *H. brevipes* and *H. mucronata*, particularly the latter; consequently, it seems likely that *H. gracilenta* is a hybrid of these two species, and my study tends to confirm this. *Hedyotis gracilenta* needs field study and is here provisionally treated as a species. The taxonomic treatment by Wiggins (1980) stated that it occurs on several islands in the Gulf of California between Loreto and La Paz, but I have seen only the two collections cited.

Wiggins 17812 (MICH) from San Diego Island and *Wiggins et al. 378*, (DS, MEXU, MICH, US) from San Francisco Island were labeled by Wiggins as *H. gracilenta*; however, the former is *H. mucronata*, the latter *H. brevipes*. *Houstonia mucronata* was collected on San Diego Island by Moran (*9592*, MICH).

6. Stenotis mucronata (Benth.) Terrell, comb. nov. *Hedyotis mucronata* Benth., Bot. Voy. Sulphur 19. 1844. *Houstonia mucronata* (Benth.) B.L. Rob., Proc. Amer. Acad. Arts 45:401. 1910. TYPE: MEXICO. BAJA CALIFORNIA: Bay of Magdalena, Oct–Nov 1839, *G.W. Barclay 3093* (LECTOTYPE, here designated: BM!; ISOLECTOTYPE: K!).

Houstonia fruticosa Rose, Contr. U.S. Natl. Herb. 1:132. 1892. TYPE: MEXICO. BAJA CALIFORNIA: Beach, Carmen Island, 1–7 Nov 1890, *Palmer 885* (LECTOTYPE, here designated: US-47256!; ISOLECTOTYPES: CAS!, F!, GH!, K!, MO!, NY!, US!); photo F! of US type.

Perennial shrublet or herb. Stems 2–9 dm tall, stout, to 1.5 cm thick at base, glabrous, with gray, tan, or yellowish shredding epidermis, densely leafy, much-branched, branches erect or ascending. Leaves 3–18 mm long, to 1.8 mm wide, sessile, fascicled, linear or subterete, thickened, straight or falcate, glabrous or scabridulous, mucronulate. Stipules to 1 mm long and wide, deltoid or ovate, entire or lobed, with brownish marginal glands. Inflorescences terminal, cymose, few-flowered. Flowers subsessile, or with pedicels to ca. 10 mm long. Hypanthium glabrous; calyx lobes 1.3–3 mm long, 0.5–1.2 mm wide, lanceolate, ovate, or obovate, thickened, acute, sometimes with a stipitate gland on sinus margin. Corolla 8–14 mm long, salverform, white or tinged or lined with pink or rose; tube 6–10 mm long, about 1 mm wide at base, only slightly widened distally, glabrate within; lobes 1.5–4 mm long, 1–3 mm wide, ovate. Pin flowers with stigma lobes 1–1.5 mm long, linear, exserted 1–2 mm beyond corolla throat, anthers included, attached at 3/4- to 4/5-point of corolla tube. Thrum flowers with anthers 1.0–1.5 mm long, elliptic or oblong, whitish, sessile at corolla sinuses, somewhat exserted, stigma included, extended to ca. 1/2- to 2/3-point of corolla tube. Capsules 2–3 mm long and wide, 3/4–7/8 inferior, subglobose, broadly rounded or retuse at apex. Seeds 0.65–0.95 mm long, 0.35–0.6 mm wide, in outline elliptic, oval, or oblong, ventral face flat or slightly convex, testa shallowly reticulate. Chromosome number: 2n=26 (Lewis 1962).

Phenology.—Flowering November to June.

Distribution.—Beaches, dunes, salt flats, and rocky slopes and cliffs near beaches; Baja California between approx. 24º and 26° N; coastal areas along the Gulf of California and offshore islands from Coronados Island (ca. 26°) south to La Paz area (ca. 24°); also, Magdalena Bay area (S of 25°) on west side of B.C. peninsula. This species is fairly frequent in suitable habitats, judging by the many specimens seen (27 collections).

Selected representative specimens examined. **MEXICO. BAJA CALIFORNIA:** Punta Prieta, Bahia de la Paz, *Carter & Kellogg 3221* (K, MICH, US); Carmen Island, SE shore, *Johnston 3836* (BM, F, GH, MO, NY, US); San Francisco Island, *Johnston 3954* (GH, NY, US); Ceralbo Island, Gulf of California, *Johnston 4035* (GH, MO, NY, US); Magdalena Bay, *Mason 1947* (F, GH, K, NY, US); San Francisco Island, *Moran 3726* (BM, MICH, TEX, US, WIS); Santa Margarita Island, *Rose 16306* (US); 6.8 mi E of La Paz on road to Pichilingue Bay, *Wiggins 14751* (ENCB, GH, K, TEX); Las Cruces, 22.5 mi SE of La Paz, *Wiggins 15671* (BM, MICH, US).

7. **Stenotis peninsularis** (Brandegee) Terrell, comb. nov. *Houstonia peninsularis* Brandegee, Zoe 5:160. 1903. *Hedyotis peninsularis* (Brandegee) W.H. Lewis, Rhodora 63:222. 1961. TYPE: MEXICO. BAJA CALIFORNIA SUR: Sierra de la Trinidad, Cape region, Nov 1902, *T.S. Brandegee s.n.* (LECTOTYPE, here designated: UC!; ISOLECTOTYPES: GH!, US!, VT!).

Perennial woody herb or shrublet. Stems to 50 cm tall, woody toward base (to at least 1 cm thick), subterete, erect, very densely canescent or densely puberulent with grayish or brownish hairs to 0.2 mm long, epidermis brownish, shredding. Leaves to 40 mm long, 0.5–2 mm wide, sessile, sometimes fasciculate, linear, very densely canescent, some hairs gland-tipped, obtuse, revolute. Stipules to ca. 1 mm long and wide, truncate, with 1-few marginal hair-like teeth, often gland-tipped. Inflorescences terminal, cymose. Flowers sessile or with pedicels to 5 mm long. Hypanthium densely canescent; calyx lobes 0.8–3 mm long, lanceolate or narrowly lanceolate, acute or obtuse. Corolla to 17 mm long, salverform, purple, densely to sparsely pubescent externally, pubescent to glabrate within; tube 6–12 mm long, narrow, scarcely or only slightly wider at throat; lobes 2–6 mm long, 1–3.3 mm wide, ovate. Pin flowers with stigma lobes ca. 1 mm long, exserted ca. 1 mm beyond corolla throat, anthers included just below throat. Thrum flowers with anthers 1.1–1.7 mm long, linear-oblong, exserted on filaments to ca. 1 mm long. Capsules 2–2.8 mm long and wide, 2/3–7/8 inferior, subglobose, dark brown varying to whitish with conspicuous nerves, hirtellous. Seeds (only seen from *Purpus 427*; one capsule), 0.6–0.75 mm long, 0.35–0.5 mm wide, in outline oblong, elliptic, or irregularly angular, dorsal face flat or slightly convex, ventral face broadly rounded or more angulate, testa shallowly reticulate. Chromosome number unknown.

Phenology.—Flowering November to March.

Distribution.—Mexico: Baja California Sur in the Sierra de la Trinidad, Cape region. Only the two collections known. Brandegee (1903) stated that "It grows abundantly ... generally on nearly perpendicular bluffs barren of other vegetation."

Additional specimens examined. **MEXICO. BAJA CALIFORNIA SUR:** Sierra de la Trinidad, Cape region, Jan–Mar 1901, *C.A. Purpus 427* (MO! US!).

Brandegee (1903) stated that the species was based on collections by Purpus and himself, but he did not cite particular collections in the protologue for *H. peninsularis*. The collections by Brandegee and Purpus are the only two collections known to me of this rare species. The better collection and the one labeled as a new species was the Brandegee collection. This little-known species appears to be related to the other perennial Baja California species, *H. brevipes* and *H. mucronata*. Two Marcus E. Jones collections (*24341*: GH, and *27137*: BM, F, MO, NY) were labeled *H. peninsularis*, but are actually *H. australis* and *H. brevipes*, respectively.

ACKNOWLEDGMENTS

I thank the curators of the herbaria cited here for access to their valuable collections. I am especially grateful to John Wiersema and Piero Delprete for their meticulous reviews. Dan Nicolson and Harold Robinson contributed helpful assistance with the Latin description, and Gene Rosenberg provided the resumen.

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BOOK NOTICES

ALAN E. BESSETTE, ARLEEN RAINIS BESSETTE, WILLIAM K. CHAPMAN, and VALERIE CONLEY CHAPMAN. 2000. **Wildflowers of Maine, New Hampshire, and Vermont in color.** (ISBN 0-8156-0586-2, pbk.). Syracuse University Press, 621 Skytop Road, Suite 110, Syracuse, NY 13244-5290, U.S.A. (Orders: http://sumweb.syr.edu/su_press/, twalsh01@syr.edu, 315-443-5547, 315-443-5545 fax). $24.95, pbk., 163 pp, 362 color photos, 6 1/2" × 9 1/4".

The book includes 'nearly 400 photographs' of showy species, those most likely to be marveled at, each species with a brief, mid-technical description. The "primary reference source for nomenclature and terminology" is the "Revised Checklist of New York State Plants by R.S. Mitchell and G.C. Tucker." The photos are nicely done and most of them show aspects of the foliage as well as the flowers—the volume is worth having for the photos. Within each of the six color categories, the species are sorted by a series of key-like alternatives, using features of flowers, habit, and leaves to help the user navigate toward matching a photo with plant in hand. A "Visual Glossary," "Glossary of Terms," "Index of Common Names," and "Index of Genera and Species" also provide help toward this goal.

Lay it perhaps to the bias of a non-novice, but it's hard for me to appreciate the value of this artificial color-arrangement of species, compared to the broader usefulness of grouping the photos by family. Users of this book who would want to check the identity of species by reference to the pithy descriptions and semi-technical 'keys' probably have enough botanical background and savvy to appreciate floral similarities acquired through evolution.—*Guy L. Nesom, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

DANIEL ZOHARY and MARIA HOPF. 2000. **Domestication of Plants in the Old World, Third Edition.** (ISBN 0-19-850356-3, pbk.). Oxford University Press, 2001 Evans Road, Cary, NC 27513, USA (Orders: www.oup-usa.org, 800-451-7556). $34.95, 316 pp, illustrated, 9 1/4" × 6 1/8".

As a student of ethnobotany (falling mostly on the anthropological side of the spectrum) I was genuinely excited to see this book. *Domesticated Plants in the Old World* makes available a wealth of information in a concise text that is both exhaustively researched and elegantly written. The book contains ten chapters followed by site orientation maps and chronological charts, references, and an index. The book begins with a discussion of the sources of evidence for the origin and spread of cultivated plants, including archaeological evidence, evidence from living plants, and radiocarbon dating and dendrochronology. The following seven chapters individually cover cereals, pulses, oils and fibre crops, fruit trees and nuts, vegetables and tubers, condiments, and dye crops. Chapter nine discusses plant remains in representative archaeological sites and is followed by a conclusion covering the beginning of domestication and horticulture. This edition differs from the previous editions in that it includes the most recent findings from molecular biology about the genetic relations between domesticated plants and their wild ancestors, added information on several new crop plants and incorporates extensive new archaeological data about the spread of agriculture. The chapter on "Fruit collected from the wild" that appeared in previous editions has been omitted from this edition. I would highly recommend this book for anthropology and botany classes dealing with the origins of agriculture. It is a finely produced text that should also gain extended readership among lay readers interested in the subject.—*Kevin D. Janni, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A., kjanni@brit.org.*

TAXONOMIC REVIEW OF *HOUSTONIA ACEROSA* AND *H. PALMERI*, WITH NOTES ON *HEDYOTIS* AND *OLDENLANDIA* (RUBIACEAE)

Edward E. Terrell[1]

Research Collaborator
Department of Systematic Biology-Botany
National Museum of Natural History
Smithsonian Institution
Washington, D.C. 20560-0166, U.S.A.

ABSTRACT

Generic relationships among *Houstonia*, *Oldenlandia*, and *Hedyotis* are discussed. Seed and other morphological characters, chromosome numbers, and limited DNA data support the division of *Hedyotis* into smaller genera. The taxonomy and nomenclature of *Houstonia acerosa* and *H. palmeri* are revised to accommodate two recently described varieties, *H. acerosa* var. *tamaulipana* and *H. palmeri* var. *muzquizana*.

RESUMEN

Se analizan las relaciones genéricas entre *Houstonia*, *Oldenlandia* y *Hedyotis*. Datos de la semilla, otros caracteres morfológicos, número de cromosomas, y datos limitados del ADN apoyan la división de *Hedyotis* en géneros más pequeños. Se revisó la taxonomía y la nomenclatura de *Houstonia acerosa* y *H. palmeri* para acomodar dos variedades recientemente descritas, *H. acerosa* var. *tamaulipana* y *H. palmeri* var. *muzquizana*.

GENERIC RELATIONSHIPS

The first part of this paper discusses the Linnean genera *Houstonia*, *Hedyotis*, and *Oldenlandia*, whose relationships have been debated for several decades. The second part reviews and revises the taxonomy and nomenclature of *Houstonia acerosa* and *H. palmeri* from the southwestern United States and/or Mexico. These species were treated under *Hedyotis* by Turner (1995a, 1995b, 1997).

The genus *Houstonia*, with 20 North American species, was the subject of a monograph (Terrell 1996a) that recognized two subgenera. Subgenus *Houstonia* has x=7 and 8 chromosomes and seeds with a ventral cavity lacking a hilar ridge (these species including the type, *H. caerulea*, are delicate herbs with salverform corollas). Subgenus *Chamisme* has seeds with an elongate hilar ridge in a ventral depression. Section *Amphiotis* (the *H. purpurea* group) has x=6 chromosomes and funnel-shaped corollas, and section *Ericotis* (the *H. rubra* group) has x=11 chromosomes, more variable corollas, and more complex seed morphology. The seeds of *Houstonia* sens. lat. are crateriform, referring to the presence of a ventral cavity or depression.

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[1] Address for correspondence: 14001 Wildwood Dr., Silver Spring, MD 20905, U.S.A.

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The type species of *Houstonia* and the two related genera, *Hedyotis* and *Oldenlandia*, showed marked morphological differences (Terrell 1975). It is instructive to review the taxonomic treatments of these three genera in the major floras of the eastern and mid-Atlantic United States. In the two latest editions of Gray's Manual, Robinson and Fernald, 7th edition, (1908), recognized *Houstonia* with ten species and *Oldenlandia* with one species, and in the 8th edition Fernald (1950) listed eleven species of *Houstonia* and moved two species formerly in *Oldenlandia* to *Hedyotis*. Gleason (1952) in the widely-used Britton and Brown flora recognized *Houstonia* with nine species and *Oldenlandia* with two species. Gleason and Cronquist's Manual (1991) recognized only the genus *Hedyotis*, with ten species. I believe that the three earlier floras provided more accurate taxonomic treatments of these genera. The 1991 Manual was apparently strongly influenced by the publications of F.R. Fosberg, who consistently held a very broad concept of *Hedyotis*. Terrell (1996a) reviewed the history of all three genera in detail, and noted that Fosberg (1943) in his study of Polynesian *Hedyotis* recognized five subgenera while commenting that "many botanists would regard these groups as genera."

Seed morphology (reviewed by Terrell 1996a) provides effective morphological criteria when considered together with chromosome number. *Oldenlandia* and *Hedyotis* were found to have non-crateriform seeds (lacking ventral cavities or depressions with or without hilar ridges), in contrast to the crateriform seeds of *Houstonia*. *Oldenlandia* (Terrell 1990) generally has a chromosome number of x=9 and seeds which are very small and trigonous with punctiform hilums on one of the three ridges; however, there are a few dissimilar species often included within *Oldenlandia* that do not have these characteristics. The genus has a worldwide distribution, but is most abundant in Africa, and several authors have provided taxonomic treatments of the African species, notably Bremekamp (1952) and Verdcourt (1976).

Hedyotis sens. lat. is a worldwide, heterogeneous, "dust-bin" genus that includes several distinct groups of species. Verdcourt (1976) and Halford (1992) commented that *Hedyotis* needs to be broken down into smaller, more homogeneous units. The selection of a type species has been controversial. The species selected has been approved by at least one nomenclatural committee, as *H. fruticosa* L., a native to Sri Lanka having a number of related species in Asia. Selection of the alternative species, *H. auricularia* L., would wreak havoc with the nomenclature and taxonomy, as the seeds and other characters suggest oldenlandioid relationships, and furthermore this species has been made the type of another genus, *Exallage* Brem. (Bremekamp 1952). *Hedyotis fruticosa* and its Asian relatives are not closely related to the approximately 20 North American, primarily Mexican, species of *Hedyotis*, nor to the varied Hawaiian species. Chromosomes of certain Mexican species have the numbers x=9, 13, and 17 (Lewis in Terrell et al. 1986). Preliminary data on chromosome numbers of Asian species suggest high numbers of chromosomes (Kiehn 1986). DNA data for *Hedyotis* and *Oldenlandia* indicated that both are paraphyletic (Bremer & Manen 2000).

TAXONOMY OF *HOUSTONIA ACEROSA* AND *H. PALMERI*

Houstonia acerosa (A. Gray) Bentham & Hooker, a species of southwestern United States and Mexico south to San Luis Potosí, was among the 20 monographed species of *Houstonia* (Terrell 1996a). Like the related species *H. palmeri*, *H. acerosa* was placed in the subgenus *Chamisme* Raf., section *Ericotis* (Terrell) Terrell. The species is quite variable; e.g., the leaves vary from whorled to opposite, fasciculate or scarcely fasciculate, the inflorescence is reduced and with sessile flowers and capsules or varies to pedicellate and cymose. It has generally been treated as two varieties or subspecies under the epithets *polypremoides* or *bigelovii* (see nomenclatural summary below).

Earlier I recognized two subspecies (Terrell 1979) or in later years (unpublished) either two varieties or subspecies. In preparing my monograph, however, I departed from my previous views by stating that the variation seemed a continuum, and recognized only one variable species. My earlier course may have overemphasized the intergradation, and here I recognize three varieties in *H. acerosa*.

The species was discussed by Turner (1995a) under the genus name *Hedyotis*, and his publication in the August 1995 issue of Phytologia preceded the publication of my monograph by about two months. This resulted in my completing work on a *Houstonia* monograph before Turner's paper appeared. He cited my overview of *Hedyotis* and related genera (Terrell 1991), which provided the names and synonyms of North American species. He recognized the varieties *acerosa* and *polypremoides* and two new ones, var. *potosina* and var. *tamaulipana*. In 1996(b) I did not recognize Turner's varieties, and Turner (1997) provided what he called a vigorous rebuttal. I have reviewed Turner's varieties again, and present here a revision incorporating Turner's data and recognizing one of his two varieties. This has been an attempt to reconcile our differences of opinion, and I hope that we can henceforth leave the taxonomic matters as they are, and let future botanists study the species in the light of new knowledge.

The following key outlines the new taxonomic treatment, and is followed by the nomenclature reorganized from Terrell (1996a).

1. Internodes usually 3–10 mm long; leaves mostly verticillate, fasciculate, numerous, often crowded and overlapping, acerose; flowers and capsules sessile or on pedicels to 3 mm long, sometimes densely grouped ____________ var. **acerosa**
1. Internodes usually 10–25 mm long; leaves opposite or some verticillate, not or some leaves fasciculate, not crowded or overlapping, linear or acerose; flowers and capsules on pedicels 3–22 mm long, the inflorescence often open and diffuse.

2. Corolla tubes 4–12 mm long; calyx lobes 2–7 mm long __________ var. **polypremoides**
2. Corolla tubes 3–4 mm long; calyx lobes 1.0–2.6 mm long __________ var. **tamaulipana**

A full description of *Houstonia acerosa* s.l. was presented in Terrell (1996a). This is here supplemented by the preceding key, a revised distribution map, and revised synonymy.

Houstonia acerosa (A. Gray) Bentham & Hooker f. var. **acerosa**, Gen. Pl. 2:60. 1873. *Hedyotis acerosa* A. Gray, Smiths. Contr. Knowl. 3:81. 1852. *Oldenlandia acerosa* (A. Gray) A. Gray, Smiths. Contr. Knowl. 5:67. 1853. *Mallostoma acerosa* (A. Gray) Hemsley, Biol. Centr.-Amer., Bot. 2:31. 1881. *Ereicoctis acerosa* (A. Gray) Kuntze, Rev. Gen. Pl. 1:281. 1891, (orth. var. of *Ereicotis*. TYPE: U.S.A. TEXAS: "Western Texas to El Paso, New Mexico," May–Oct 1849, *C. Wright 237* (HOLOTYPE: GH!; ISOTYPES: BM! GH! MO! US!). As Turner (1995a) pointed out, Wright's collection was made in late June 1849 in present day Kinney or Val Verde County, southwest Texas.

Habitat and distribution.—Rocky or gravelly places, mountain slopes, mesas, washes, arroyos, desert grassland, desert scrub, often on limestone, also in clay, sandy, or gypseous soils; associated with *Prosopis*, *Acacia*, pinyon-juniper, or oak-juniper; 400–2500 m, usually 900–2000 m (3000–6500 ft); United States: Central and southwestern Texas; Mexico: central Chihuahua to San Luis Potosí (Fig. 1).

Houstonia acerosa (A. Gray) Bentham & Hooker f. var. **polypremoides** (A. Gray) Terrell, comb. nov. *Houstonia polypremoides* A. Gray, Proc. Amer. Acad. Arts 21:379. 1886. *Hedyotis polypremoides* (A. Gray) Shinners, Field & Lab. 17:168. 1949. *Hedyotis acerosa* var. *polypremoides* (A. Gray) W.H. Lewis, Ann. Missouri Bot. Gard. 55:31. 1968, nom. superfl. (see *Hedyotis acerosa* var. *bigelovii*). *Houstonia acerosa* subsp. *polypremoides* (A. Gray) Terrell, Brittonia 31:168. 1979. TYPE: MEXICO. CHIHUAHUA: Santa Eulalia Mts., 26 Sep 1885, *C.G. Pringle 356* (LECTOTYPE, designated by Lewis, 1968: GH!; ISOLECTOTYPES: BM! CINC! F! K! MO! NA! NY! PH-2! US-2! VT-2!). SYNTYPE: MEXICO. CHIHUAHUA: Santa Eulalia Mts., 29 May 1885, *Pringle 16* (BM! CINC! F! GH! K! MO! NA! NY! PH-2! US-2! VT!).

Houstonia polypremoides var. *bigelovii* Greenman, Proc. Amer. Acad. Arts 32:291. 1897. *Hedyotis acerosa* var. *bigelovii* (Greenman) W.H. Lewis, Ann. Missouri Bot. Gard. 55:397. 1969. TYPE: U.S.A. NEW MEXICO: Mexican Boundary Survey, Florence Mts., Jun 1852, *Bigelow 437* (HOLOTYPE: GH!). The Florence Mountains are thought to be the Florida Mountains, south of Deming, Luna Co., New Mexico (fide R. Spellenberg pers. comm.).

The so-called autonym rule (Art. 22.3, Greuter et al. 2000) applies to *Houstonia polypremoides* var. *bigelovii* Greenman, as its publication in 1897 created a var. *polypremoides*, which then has precedence over var. *bigelovii*, when the latter is considered synonymous with *Houstonia polypremoides* A. Gray.

Habitat and distribution.—Habitats similar to those of var. *acerosa*; New Mexico, western Texas, where it intergrades with var. *acerosa*; Mexico: Chihuahua, northern Coahuila (Fig. 1).

Houstonia acerosa (A. Gray) Bentham & Hooker f. var. **tamaulipana** (B.L. Turner) Terrell, comb. nov. *Hedyotis acerosa* A. Gray var. *tamaulipana* B.L. Turner, Phytologia 79:87–88. 1995. TYPE: MEXICO. TAMAULIPAS: Mpio. Villagran, 1 mi E of Ejido de San Lazaro ca. 24° 35' N, 99° 13' W, 1500 ft, 11 Oct 1959, *M.C. Johnston & J. Graham 4281k* (HOLOTYPE: TEX!). [Fig. 1]

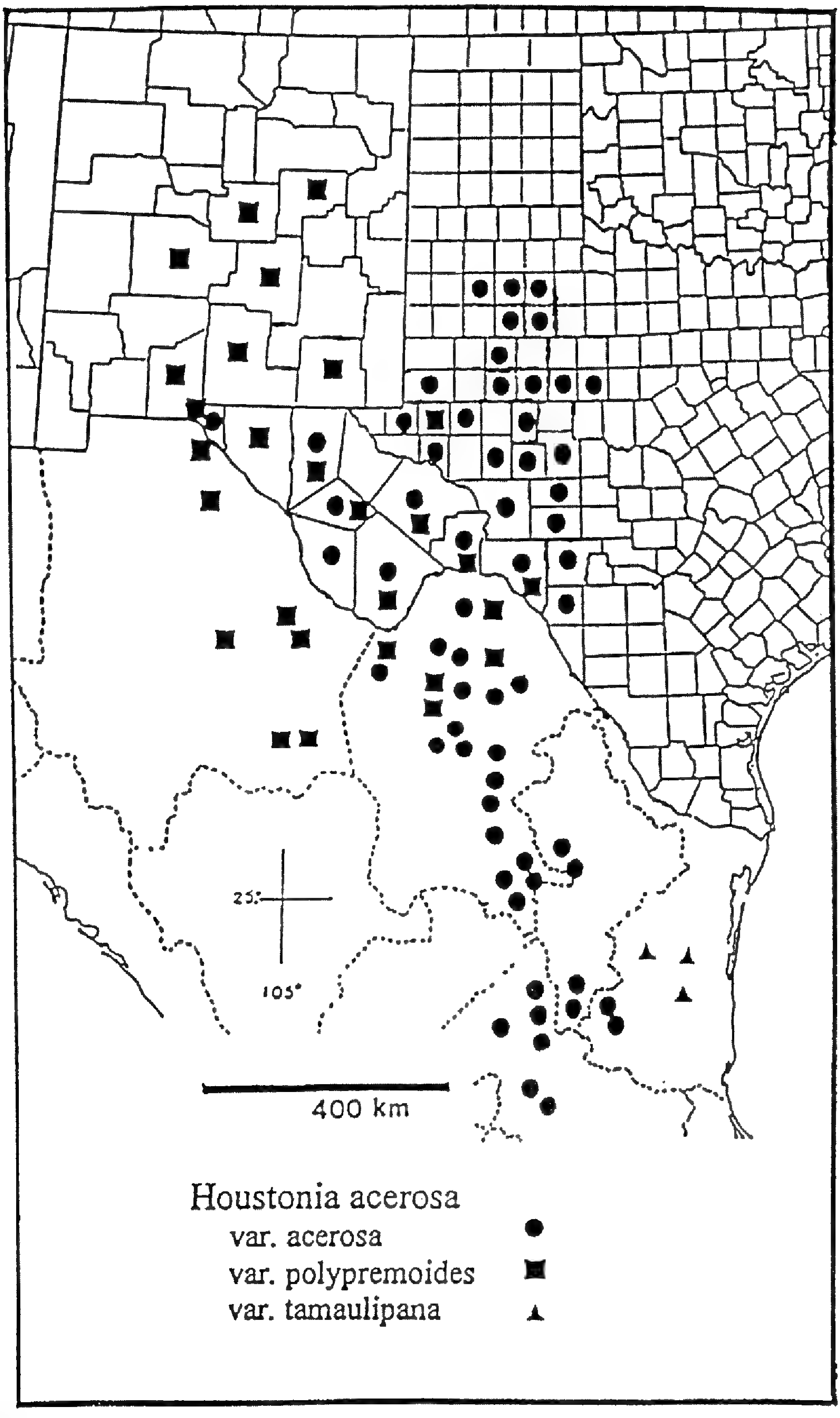

Fig. 1. Distribution of the three varieties of *Houstonia acerosa*.

In my monograph I stated that I had studied three collections of *H. acerosa* from Tamaulipas at TEX that were possibly a distinct variety, and had finally concluded the differences were insufficient to merit their being distinct. Later, I had re-borrowed these three collections from TEX because of uncertainty whether they should be a new variety. I then decided again to not distinguish them as a new variety. As it turned out, these collections were recognized by Turner (1995a) as var. *tamaulipana*. In my 1996b paper I stuck by my previous conclusion and did not consider var. *tamaulipana* B.L. Turner as a distinct variety. After further consideration I here recognize it as distinct and somewhat resembling var. *polypremoides* but differing in two overlapping floral characters. It occurs in a separate area in Tamaulipas at the southeast end of the range of *H. acerosa* in somewhat different habitats, as noted by Turner, who provided a map of the distribution.

Additional specimens examined. **MEXICO. TAMAULIPAS:** Mpio. San Carlos, 6 mi S of San Carlos on the road to Padilla, 1600 ft, calcareous terraces of Arroyo de San Carlos, 13 Dec 1959, *Johnston 5007A* (TEX); Mpio. Casas, 5 mi E of Casas on Victoria Soto la Marina hwy, 28 Sep 1960, *Johnston 5784B* (TEX).

Hedyotis acerosa var. **potosina** B.L. Turner

Turner (1995a) distinguished *Hedyotis acerosa* var. *potosina*, a new variety from Mexico, as follows:

1. Stems with internodes much-shortened, forming low pulvinate mat-like plants mostly 2–5 cm high; corolla tubes mostly 8–10 mm long; southernmost Coahuila and southwards to San Luis Potosí ____ var. **potosina**
1. Stems not as described in the above, mostly 5–15 cm high, forming well defined rather naked stems; corolla tubes mostly 3–7 mm long ____ **(other varieties)**

I rejected this variety (Terrell 1996b), stating that I considered it as part of a cline, as the plants northward from Monterrey or Saltillo became larger and less pulvinate.

To judge var. *potosina* more objectively I compared specimens from 22 collections (including *Lundell 5048*, HOLOTYPE LL!, ISOTYPE US!) at herbarium US from Mexico and southwest Texas, in the following characters: Height of plants, internode length, corolla tube length, corolla lobe length, corolla length, and calyx lobe length, the last three characters being possibly useful characters not mentioned by Turner. The collections were grouped in five categories as to origin: San Luis Potosí; Coahuila south of Saltillo; Coahuila at or near Saltillo; Coahuila north of Saltillo; and from three southwest Texas counties. (Collection data are listed in Appendix 1).

Turner stated that var. *potosina* was a mat-forming plant "having a very different growth habit than found in var. *acerosa*." My own finding is that it is a small, but erect plant in the southern part of its range with basal or near basal tufts of narrow needle-like leaves; however, I believe that northward the plants are gradually taller and appear less tufted, thus forming a cline.

Table 1 has only the raw data, as I believe that these are sufficient in themselves to be easily interpreted. The data show that (1) specimens from near or south of Saltillo average slightly shorter; (2) Mexican specimens differed very little in internode length or corolla tube length, regardless of location, and there was much overlap; (3) the last three characters differed very little among the four geographic locations; (4) the southwest Texas collections generally were similar to Mexican collections, especially those from north of Saltillo. There is so much overlap in height and corolla tube length that there is no objective basis for recognizing var. *potosina*. The last three "additional characters" provide information, but show no differences.

Houstonia palmeri A. Gray

Houstonia palmeri A. Gray, a species of northern Mexico, was, like H. *acerosa*, the subject of a short paper by Turner (1995b), which preceded the publication of my H*oustonia* monograph (1996a) by about two months. Turner's paper recognized a new variety, var. m*uzquizana*.

My monograph provided a description, synonyms, and distribution of var. *palmeri*, from which the data below are taken, with modifications from Turner's data. Turner selected *Palmer 395* (GH) as the type for the synonym, *H. longipes* S. Watson, whereas I selected *Palmer 394* (see below). His selection has priority over mine.

Houstonia palmeri A. Gray var. **palmeri**, Proc. Amer. Acad. Arts 17:202. 1882. *Hedyotis palmeri* (A. Gray) W.H. Lewis, Rhodora 63:222. 1961. TYPE: MEXICO. COAHUILA: Lerios, 45 mi E of Saltillo, 10,000 ft, Jul 1880, *Palmer 397* (LECTOTYPE, designated by Turner, 1995b, GH!; ISOLECTOTYPES: K! NA! NY! PH! US!). SYNTYPE: MEXICO. Coahuila, 40 mi S of Saltillo, Sierra Madre, 25 Jul–1 Aug 1880, *Palmer 398* (F-2! GH! K! NA! NY! US-2! VT!). At GH 397 and 398 are on the same sheet.

Houstonia longipes S. Watson, Proc. Amer. Acad. Arts 18:97. 1883. *Hedyotis longipes* (S. Watson) W.H. Lewis, Rhodora 63:222. 1961. TYPE: MEXICO. NUEVO LEÓN: Monterrey, 17–26 Feb 1880, *Palmer 395* (LECTOTYPE, designated by Turner, 1995b GH! ; ISOLECTOTYPES: K! NA! NY! PH! US-2!).

Habitat and distribution.—Gravelly, rocky, or sandy places, rock crevices, often over limestone, shale, or gypsum, associated with oak, pine, *Agave, Acacia, Yucca, Larrea, Prosopis*; usually 700–2300 m (2300–7500 ft; Mexico: Coahuila, Nuevo León, and San Luis Potosí.

Houstonia palmeri var. **muzquizana** (B.L. Turner) Terrell, comb. nov. *Hedyotis palmeri* var. *muzquizana* B.L. Turner, Phytologia 79:91.1995. TYPE: MEXICO. COAHUILA: Mpio. M. Múzquiz, ca. 130 road km NW of Múzquiz on Hwy 2A, *Nesom & Mayfield 7380* (HOLOTYPE: TEX!; ISOTYPE: MEXU).

In my monograph (Terrell 1996a) I commented that plants in the Múzquiz area have longer corollas, but later questioned (Terrell 1996b) whether Turner's variety deserved recognition. I have now seen five additional collections in a further loan from Turner and accept var. *muzquizana* as consistently having longer

TABLE 1. *Houstonia acerosa*: Measurements for six characters from Mexico and Texas Collections.

Collections	Height of plants (cm)	Internode length (mm)	Corolla tubes length (mm)	Corolla lobes length (mm)	Corolla length totals (mm)	Calyx lobes length (mm)
Mexico, San Luis Potosi						
Lundell 5048	4–7	2–3	7	3	10	4–6
Whiting 911	4–7	1–3	6–7	3	9–10	4–6
Purpus 5013	4–6	0–2	7–8	3–4	10–12	3-4
Nelson 4533	3–6	0–1	7	4–5	11–12	2.5–3
Coahuila, south of Saltillo						
Palmer 353	9–10	0–3	8–9.5	3--5	11–14.5	5–6.5
Palmer 400	4–6	3–5	9–11	4–5	13–16	3–6
Shreve 8540	5–7	2–5	8–11.5	3–4	11–15.5	4–6
Coahuila, at /near Saltillo						
Palmer 126	3–8	0–2	5–9.5	3–5	8–14.5	4.2–4.5
Pennell 17264	3–4	2	6	4	10	2–4
Pennell 17292	4–6	2–3	7.5	4	11.5	4–4.5
E. & B. Terrell 4431	4–6	0–2	5.5–10	3–5	8.5–15	4.5–6.5
Coahuila, north of Saltillo						
Palmer 401	8	3–5	8	4	12	5–6
Palmer 402	10–13	3–5	–	2	9	–
Johnston 7202	8	0–2	6	2	8	3–4
Chiang et al. 7550Q	6–7	2	9	3	12	4–4.5
Reveal et al. 2602	5–7	4–6	5–8.5	2.5–4	7.5–11.5	3.5–5
Texas						
PECOS CO.: Lewis 5517	8–12	3–6	–	–	–	2–5
TERRELL CO.:						
E.J. Palmer 33530	8–11	4	4–6	3	7–9	3–4.5
Orcutt 734	8–10	to 7	5	3	8	5–6
Wooton 9/29/11	7–13	3–5	–	–	–	2–5
VAL VERDE CO.:						
Rose 17986	7–8	5	4	3	7	2–3
E.J. Palmer 11057	6–10	4–7	7–8	2–3	9–11	4–6

corollas. I note also that collections I have examined are mostly the pin form, with long styles and short stamens.

All collections of var. *muzquizana* were shown in the detailed distribution map provided by Turner (1995b).

Turner (1995b) provided a key to the varieties as follows:

Mature corolla tubes mostly (6–)8–10 mm long; pedicels mostly 20–30 mm long; n. Coahuila ____ var. **muzquizana**

Mature corolla tubes mostly 4–5(–8) mm long; pedicels mostly 5–20 mm long; s. Coahuila, Nuevo León ____ var. **palmeri**

APPENDIX 1

Collections cited in Table 1. All collections in herbarium US.

MEXICO. San Luis Potosi: Charcas, *Lundell 5048*; road between Doctor Arroyo, N. L. and Matehuala, S.L.P., *Nelson 4533*; Minas de San Rafael, *Purpus 5013*; Charcas, *Whiting 911*. **Coahuila:** 22 km. ESE of La Cuesta del Plomo on Muzquiz-Boquilla Hwy., *Chiang et al. 7550Q*; 25 mi S of Monclova, *Johnston 7202*; Saltillo, *Palmer 126*; 27 mi S of Saltillo, *Palmer 353*; 40 mi S of Saltillo, *Palmer 400*; 25 mi S of Monclova, *Palmer 401*; 100 mi N of Monclova, *Palmer 402*; Saltillo, *Pennell 17264*; Saltillo, *Pennell 17292*; along rt. 57, 14 mi S of Castanos, 8.5 mi S of rd jct of 57 and 53, *Reveal et al. 2602*; 11 mi S of Saltillo, *Shreve 8540*; 10.5 mi E of Saltillo, *E. & B. Terrell 4431*. **U.S.A. Texas. Pecos Co.:** 11 mi S of Fort Stockton, *Lewis 5517*. **Terrell Co.:** Sanderson, *Orcutt 734*; near Feodora, *E. J. Palmer 33530*; Sanderson, *Wooton s.n., 9/29/11*. **Val Verde Co.:** Comstock, *E. J. Palmer 11057*; vic. Del Rio, *Rose 17986*.

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NOMENCLATURAL CHANGE IN THE *DIGITARIA COGNATA* COMPLEX (POACEAE: PANICEAE)

Joseph K. Wipff

Herbarium
Pure Seed Testing, Inc.
P.O. Box 449
Hubbard, OR 97032 U.S.A.

ABSTRACT

Digitaria pubiflora is raised to specific rank.

RESUMEN

Digitaria pubiflora se eleva al rango específico.

During the preparation of *Digitaria* A. Haller for the *Manual of Grasses for North America* and after a reevaluation of the subspecies of *D. cognata* (Schult.) Pilger, it was concluded that the elevation of *Digitaria cognata* subsp. *pubiflora* (Vasey) Wipff to specific rank was warranted.

Wipff and Hatch (1994) recognized two subspecies of *D. cognata*, but a reevaluation of these taxa using principal components analysis showed the two taxa to be distinct and easily distinguished from one another. The key morphological characters separating the two taxa are: 1) the number of veins; 2) venation pattern (equidistant vs. non-equidistant veins); 3) the vestiture pattern of the lower lemmas; and 4) spikelet shape. Also, in the area of sympatry the two taxa maintain their morphological distinctness and no putative hybrids between the two taxa were found in the populations studied or from the 1,839 herbarium specimens examined. A future paper will discuss the data warranting the following new combination, which is made now for its use in the forthcoming *Manual of Grasses for North America*.

Digitaria pubiflora (Vasey) Wipff, comb. et stat. nov. BASIONYM: *Panicum autumnale* Bosc *ex* Sprengel var. *pubiflorum* Vasey, [Descr. Cat. Grasses US: 9. 1885. nom. nud.] Dept. Agric. Bot. Div. Bull. 8:35. 1889. *Digitaria cognata* (Schult.) Pilger subsp. *pubiflora* (Vasey) Wipff, Sida 13:120. 1988. TYPE: UNITED STATES. TEXAS. El Paso Co.: "Mts. near Paso del Norte," May 1881, *G.R. Vasey s.n.* (LECTOTYPE: Wipff & Hatch 1994: US!; ISOLECTOTYPE: US!).

KEY TO TAXA

Lower lemmas 7 veined, veins non-equidistant; spikelets glabrous or with a narrow strip of pubescence between the veins; spikelets obovoid to broadly elliptic ______ **2. D. cognata**

Lower lemmas 5-veined, veins equidistant; spikelets densely pubescent between the veins; spikelets narrowly elliptic ______ **3. D. pubiflora**

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NEOTYPIFICATION OF *ENSLENIA ALBIDA* AND A NEW COMBINATION IN *AMPELAMUS* FOR *CYNANCHUM LAEVE* (APOCYNACEAE: ASCLEPIADOIDEAE)

Alexander Krings

Herbarium, Department of Botany
North Carolina State University
Raleigh, NC 27695-7612, U.S.A.
Alexander_Krings@ncsu.edu

ABSTRACT

Recent taxonomic advances are supportive of recognition of various climbing milkweed genera previously submerged in *Cynanchum* L. Although caution regarding resurrection of unispecific *Ampelamus* Raf. has been suggested, recent acceptance has been implicit through a listing of the genus in a synopsis of the subtribes and genera of the tribe Asclepiadeae. As the name is currently in "standardized" use among weed scientist and has additionally appeared in recent drafts, a note regarding the correct nomenclature is warranted. This paper addresses the typification and synonymy of the entity variously known as *Gonolobus laevis* Michx., *Cynanchum laeve* (Michx.) Pers., *Vincetoxicum gonocarpus* Walt. var. *laevis* (Michx.) Britton, *Enslenia albida* Nutt., and *Ampelamus albidus* (Nutt.) Britton.

RESUMEN

Los avances taxonómicos recientes apoyan el reconocimiento de varios géneros de algodoncillos trepadores incluidos previamente en *Cynanchum* L. Aunque se ha pedido precaución con respecto a la resurrección del género monotípico *Ampelamus* Raf., ha sido implícita la aceptación reciente mediante un listado del género en una sinopsis de las subtribus y géneros de la tribu Asclepiadeae. Como el nombre está actualmente en uso "estandarizado" entre especialistas en malas hierbas y además ha aparecido en recientes borradores, está justificada una nota que trate de la nomenclatura correcta. Este artículo trata de la tipificación y sinonimia de la entidad conocida como *Gonolobus laevis* Michx., *Cynanchum laeve* (Michx.) Pers., *Vincetoxicum gonocarpus* Walt. var. *laevis* (Michx.) Britton, *Enslenia albida* Nutt., y *Ampelamus albidus* (Nutt.) Britton.

INTRODUCTION

Cynanchum laeve (Michx.) Pers. was originally described as *Gonolobus laevis* Michx. in 1803. However, due to mixed elements on the type sheet, namely flowers and angled follicles of *G. suberosus* (L.) R. Br. (*Gonolobus gonocarpus* (Walter) Perry) and leaves of *Gonolobus laevis* Michx., confusion has surrounded the correct nomenclature of this entity (see Vail 1899, Woodson 1941, Drapalik 1969 for more detailed discussions). Reconciling the material with Michaux's description of *Gonolobus laevis*, Vail (1899) accepted the corresponding elements on the sheet as belonging to the taxon in her time known primarily as *Enslenia albida* Nutt. or *Ampelamus albidus* (Nutt.) Britton and designated the appropriate elements on the sheet as the type for *Gonolobus laevis* Michx. An image of the specimen is available in the IDC microfiche (#6211) set of the Michaux herbarium on fiche 29 of volume I.

A type specimen was not designated by Nuttall (1818) in his original description of *Enslenia albida* on the other hand, although he clearly described (p. 165) the 5-parted corolla of linear-oblong petals and the entirely free, deeply bifid coronal segments of the species. Based on his description in the "Genera of North American Plants" (Nuttall 1818), it is likely that he saw at least three specimens in the course of the work—presumably collected from the following localities:

> "Near Shepherdstown, on the gravelly banks of the Potomac, Virginia" (U.S.A), "on the high sandy banks of the river Scioto" (Ohio, U.S.A), and "near Cincinnati (Ohio)" (U.S.A).

Unfortunately, no specimens bearing these localities, or the distinctive asterisk notation used by Nuttall on herbarium sheets when describing new genera or species, could be found at PH—the repository for the majority of types from his "Genera" (Pennell 1936; Stuckey 1966). In addition, no such specimens could be found at BM (the eventual repository for Nuttall's private herbarium and most post-"Genera" collections), E, F, GH, K, LIV, MANCH, MO, and NY—all potential collections to host Nuttall material (Pennell 1936; Stuckey 1966; Stafleu & Cowan 1981). The herbaria of DWC, FI, and P were also contacted, but no responses were received. Specimens of *Enslenia* collected by Nuttall in Arkansas (i.e., post-"Genera") were found at BM, G-DC, NY, and PH, however. In addition, two specimens from Ohio were found respectively at G-DC and OXF. Of the two specimens residing at G-DC, the one from Arkansas was received by DeCandolle in 1825 and the one from Ohio in 1824. Unfortunately, labels on both specimens are in DeCandolle's hand and not in Nuttall's. Thus, aside from DeCandolle's word, there is no other evidence that Nuttall actually saw the specimens. On the other hand, there is no reason to believe that DeCandolle would forge the specimens' history. Nuttall apparently passed through Ohio only three times in his life: Jun–Jul 1816, Oct–Nov 1818, and Mar 1834 (Pennell 1936). Interestingly, the Ohio specimen at G-DC bears inflorescences in full bloom. In the northern United States, the species is known to flower primarily through August (Gleason 1952). It is unlikely that flowering would occur in mid-Oct through November or in early March. Thus, it can be deduced that the material is likely part of Nuttall's original collection of the species in the summer of 1816, prior to his later description of the novelty in his "Genera." In the absence of any other material with labels in Nuttall's own hand, the Ohio specimen at G-DC is here chosen as the neotype of *Enslenia albida* Nutt. It should be noted however, that the Ohio collection at OXF may also belong to Nuttall's original 1816 collection. Aside from the species name, the OXF specimen label bears the locality ("Ohio"), "com. Nuttall," and a year which I could not completely make out ("18?0"). The specimen also bears an inflorescence and flowers, leading to the same deduction concerning its potential year of collection as the Ohio specimen at G-DC.

Unfortunately, due to an earlier homonym (i.e., *Enslenia* Raf., Fl. Ludovic. 1817), the generic name *Enslenia* was unavailable for the climbing milkweed taxon named by Nuttall. Rafinesque (1819) instead suggested that *Ampelamus* (*Ampelos* [αμπελοζ] = vine, *Psammos* [ψσαμμοζ] = sand) be used. Britton (1894) first validly published the requisite combination for the species name. Unfortunately, Britton (1894) spelled the genus "*Ampelanus*." This spelling was followed by Vail (1899) and appears again in the key to the Asclepiadaceae in Gleason (1952), although not in the description of the genus and species. However, as Britton (1894) explicitly noted that he made the combination "to maintain Rafinesque's very suggestive name," most recent authors (e.g., Woodson 1941; Shinners 1964; Liede 1997a, 1997b) have recognized "*Ampelanus*" as an orthographic error to be corrected to *Ampelamus*.

Numerous authors have treated the respective names in *Gonolobus*, *Enslenia*, and *Ampelamus* in synonymy within Persoon's 1805 combination of *Cynanchum laeve* (Michx.) Pers., based on Michaux's *Gonolobus laevis* (see Woodson 1941; Shinners 1964; Radford et al. 1968; Correll & Johnston 1970). However, recent taxonomic advances are supportive of recognition of various climbing milkweed genera previously submerged in *Cynanchum* L. (Liede 1997a, 1997b; Liede & Meve 1997). Although Liede (1997a) suggested caution regarding resurrection of *Ampelamus* Raf., she implied acceptance through listing of the genus in a synopsis of the subtribes and genera of the tribe Asclepiadeae (Liede 1997b). As *Ampelamus albidus* is currently in use as the "standardized" name accepted by the Weed Science Society of America (Patterson et al. 1989) and has additionally appeared in recent drafts (e.g., Weakley, in prep.), a note establishing the correct name of the entity is warranted. Resurrection of this unispecific genus requires a new combination based on *Gonolobus laevis* Michx.

SYSTEMATIC TREATMENT

Ampelamus laevis (Michx.) Krings, comb. nov. *Gonolobus laevis* Michx., Fl. Bor.-Amer. 1:119. 1803. *Cynanchum laeve* (Michx.) Pers., Syn. pl.1:274. 1805. *Vincetoxicum gonocarpus* Walt. var. *laevis* (Michx.) Britton, Mem. Torrey Bot. Club 5:266. 1894. TYPE: U.S.A. ILLINOIS: *Michaux* (HOLOTYPE: P, IDC-#6211, 1:29!).

Enslenia albida Nutt., Gen. N. Amer. pl. 1:164. 1818. *Ampelamus albidus* (Nutt.) Britton ("*Ampelanus*"), Bull. Torrey Bot. Club 21:314. 1894. TYPE: U.S.A. OHIO: [1816], *Nuttall* (NEOTYPE: here designated, G-DC!)

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BOOK NOTICE

WARREN L. WAGNER, DERRAL R. HERBST, and S.H. SOHMER. 1999. **Manual of the Flowering of Hawai'i, Revised Edition, (2 volumes).** (ISBN 0-8248-2166-1, hbk.). Published in association with Bishop Museum Press, University of Hawai'i, Press, 2840 Kolowalu Street, Honolulu, HI 96822-1888, uhpbooks@hawaii.edu, 808-956-8697). $95.00 (2 vols.), 1919 pp, illustrated.

The 1999 volumes update the first edition (1990). "Over 180 additional naturalized species have been documented. ... "Thirty-three new taxa of native plants have been discovered. ... Field studies have resulted in the rediscovery of 27 species presumed extinct, the resurrection of 25 taxa relegated to synonymy in the *Manual*, and more precise information on the condition of much of the endemic and indigenous flora." "Species added in the past decade bring the totals to 152 families [vs. 146 in edition 1], 737 genera [vs. 649], and 2089 species [vs. 1817]."

Most of the 'revised-ness' of the 1999 edition is in the extensive Supplement, which includes information on newly described species, nomenclatural changes, and new island records, a bibliography of important taxonomic references published since the first edition, and a new preface. The text has been modified where corrections would not alter pagination of the first edition—primarily an updating of the status of 271 species newly listed as endangered or threatened. The types of information included in the Supplement are: "nomenclatural (7) and taxonomic name changes (120); resurrections of taxa from synonymy (25); new native taxa (33); records of naturalized species previously undocumented (108); records for naturalized species previously known only in cultivation or as adventives (75); new island (233) or significant intraisland range extensions of both naturalized and native species (13); the rediscovery of species presumed extinct (27); correct names for plants previously misidentified (25), particularly in the Manual; changes in distributions status (5); and a few miscellaneous notes."

The Supplement for the revised edition is available as a PDF file at the Smithsonian Systematic Biology/Botany web page, http://www.nmnh.si.edu/departments/botany.html under Research.—*Guy L. Nesom, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

PRELIMINARY RESULTS TOWARD A REVISION OF THE *AMARANTHUS HYBRIDUS* SPECIES COMPLEX (AMARANTHACEAE)

Mihai Costea

University of Agronomical Sciences
Dept. of Botany
Bd. Marasti, 71331, Sector 1
Bucuresti, ROMANIA
coste_amihai@hotmail.com

Andrew Sanders

Herbarium
Dept. of Botany and Plant Science
University of California
Riverside, CA, 92521-0102, U.S.A.
andrew.sanders@ucr.edu

Giles Waines

Dept. of Botany and Plant Science
University of California
Riverside, CA, 92521-0102, U.S.A.
giles.waines@ucr.edu

ABSTRACT

The present study is a review of the *Amaranthus hybridus* complex based on new morphological and anatomical characters. Two new combinations are proposed—*A. hybridus* subsp. *quitensis* and *A. powellii* subsp. *bouchonii*. Based on characters such as phyllotaxy, leaf traces and other morphological characters the division of the genus into subgenera is also discussed.

RESUMEN

El presente estudio es una revisión del complejo *Amaranthus hybridus* basado en caracteres morfológicos y anatómicos. Se proponen dos nuevas combinaciones—*A. hybridus* subsp. *quitensis* y *A. powellii* subsp. *bouchonii*. También se analiza la división del género en subgéneros en base a la filotaxis, los rastros foliares y otros caracteres morfológicos.

INTRODUCTION

The genus *Amaranthus* L. consists of about 70 species, of which about 40 are native to the Americas and the rest to Australia, Africa, Asia and Europe. The most frequently used infrageneric classification involves 2 subgenera and was suggested by Sauer (1955)—*Acnida* (L.) Aellen ex K.R. Robertson which comprises dioecious species and *Amaranthus* that includes monoecious species. Traditionally subgenus *Amaranthus* is divided in two sections, *Amaranthus* and *Blitopsis* Dumort. Recently, Mosyakian and Robertson (1996) proposed elevating the two sections of subgenus *Amaranthus* to subgeneric rank, subgenus *Amaranthus* and subgenus Al*bersia* (Kunth) Gren & Godr. (= section *Blitopsis*). Yet, they did not provide new characters to justify their revised treatment and the question of the most appropriate subgeneric classification apparently has remained open.

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In spite of the fact that it has been the object of many studies, the genus *Amaranthus* is still poorly understood, being widely considered a "difficult" genus. Currently, the taxonomic problems are far from being clarified especially because of the widespread nomenclatural disorder caused chiefly by repeated misapplication of names. Most of the problems are concentrated in the most studied group of species, the *A. hybridus* aggregate. Sauer's monograph of grain Amaranths (1950, 1967) has solved most of the nomenclature problems and provided an extensive taxonomic treatment for the species involved. Yet nomenclature and taxonomic confusion among these closely related taxa has persisted in the literature and herbarium collections, especially in Europe. Because of such "serious nomenclature discrepancies" Jalas and Suominen (1980) were forced to present a collective map for the occurrence of "*A. hybridus*, *A. paniculatus*, *A. patulus* and *A. powellii*" in Europe. This quotation is a good example of the present confused situation. One wonders what the authors understood by "*A. patulus*" since it is known that this name is a synonym of *A. hybridus* or is sometimes comprehended as *A. cruentus* (Aellen 1964). The actual taxonomic concepts in this group of species—assuming that the nomenclature problems are solved—ranges between two different extremes. At one extreme is Sauer's treatment (1950, 1967) that recognizes as species the cultivated taxa (*Amaranthus caudatus*, *A. cruentus* and *A. hypochondriacus*) and at the other is Greuter's (1981, 1984) who lumps the cultivated species with their putative wild progenitors (*A. quitensis*, *A. hybridus* and *A. powellii* respectively). All possible intermediate combinations between these two opposed treatements—many of them published since the beginning of the century by Thellung (1907, 1914, 1919)—were also used (Aellen 1959, 1964, 1972; Dostal 1950; Morariu 1952; Brenan 1961, 1981; Gusev 1972; Ehrendorfer 1973; Townsend 1974, 1985, 1988; Carretero 1979, 1985, 1990; Stace 1991, 1997; Lambinon 1992; Cherepanov 1995; etc.).

The evolutionary origins of grain amaranths are still unclear. Sauer (1967, 1976, 1993) suggested two possible hypotheses. The monophyletic hypothesis states that the three cultivated species originated from a single wild progenitor—*A. hybridus*, followed by subsequent introgressive hybridization with two other wild species in different regions. According to this hypothesis, the first domesticated species was *A. cruentus*, derived from *A. hybridus* in Central America, followed by the domestication of *A. hypocondriacus* by repeated crossing of *A. cruentus* with *A. powellii* in Mexico and of *A. caudatus* by crossing with *A. quitensis*. The polyphyletic hypothesis suggests that each of the three-grain species was domesticated separately from a different wild species. In concordance with this hypothesis, *A. hypochondriacus* was domesticated in Mexico from *A. powellii*, *A. cruentus* from *A. hybridus* in Central America and *A. caudatus* from *A. quitensis* in South America. Detailed studies of the relationship among amaranth species using cytological or molecular methods are contradictory, supporting separately both hypotheses (Pal & Khoshoo 1972, 1973; Hauptli & Jain 1984; Greizerstein & Poggio 1992; Greizerstein et al. 1997; Transue et al. 1994; Lanoue et al. 1996; Chan & Sun 1997). The taxonomic achievement of all these studies was that they proved the individuality of the taxa involved, against the lumping tendencies.

Other remaining taxonomic questions concern the status of *A. bouchonii* Thell. and *A. quitensis* Kunth. The first taxon is regarded as conspecific with *A. powellii* S. Watson by Sauer (1967), Carretero (1990), Akerroyd (1993), but is maintained at the species level by Hügin (1987), Stace (1991, 1997), Kerguélen (1993), Wilkin (1992). The second taxon, *Amaranthus quitensis*, was synonymised with *A. hybridus* by Coons (1975, 1978) but kept separate by almost all other authors.

This study is only the beginning of a revision of this difficult complex. Set aside for the moment are the following topics: the relationship between the closely related taxa, *A. dubius* Mart. and *A. spinosus* L. and their affinity with *A. hybridus*; the appropiate position of some other taxa (*A. brandegei* Standley, *A. bigelovii* Uline & Bray, *A. viscidulus* Greene, *A. scariosus* Benth., *A. lepturus* S. F. Blake, *A. celosioides* H.B.K. and *A. pallidiflorus* F. Muell) and the role of hybridization and its consequences within the *A. hybridus* aggregate and among the dioecious amaranths.

Amaranthus caudatus, together with A. *hypochondriacus* and *A. cruentus*, have created a great interest during recent years as agricultural crops in many regions of the world, due to the exceptionally high nutritional value of their seeds and leaves. Hundreds of articles document the nutritional value, the agronomical potential, genetic resources and breeding of amaranths. For a good review on the nutritional value and production methods see Kauffman and Wagoner (1984), Kauffman and Weber (1988), Kauffman (1992). For a comprehensive review on genetic resources and breeding see Brennan et al. (2000).

MATERIAL AND METHODS

To assess anatomical variation the taxa were sampled between 1991 and 1996. Seeds collected from the wild flora or received from various Botanical Gardens were cultivated in the Botanical Garden of the University of Agronomy Bucharest, Romania. Generally 4 to 6 populations or accessions were used for each taxon involved in the study. Seedlings, young shoots, stems of different ages, mature leaves, fruits and seeds were liquid preserved in a 50–70% mixture of formalin, acetic acid and alcohol (FAA) and embedded in Paraplast or paraffin. For the study of the vascular system of the stem, plants were chosen that lacked sylleptic branching, to avoid examination of branch trace bundles. Typically stems from 25 plants, for each population were serially sectioned at 10 mm, stained with safranin and fast green, and studied with transmission and polarized light. Furthermore, 100 seedlings for each population were grown in order to assess the cotyledon shape and the stem anatomy in juvenile stage.

Regarding the pericarp structure, fruits ranging from very young to mature were examined, but characters refer only to the latter ones. Fruits were embedded in white paraffin and transverse and longitudinal sections of 5–7 µm thickness were stained with Toluidine Blue.

The SEM study of fruits, seeds and pollen was carried on with a Hitachi S-4100 SEM at 15KV, using a Bio-Rad Sputter-Coatter SC-500. Fifty fruits and seeds were collected from each of the 50 individuals per population examined. The same number of pollen grains per taxon was used in order to assess the morphology of the pollen grains.

Morphology (without SEM) was studied using plants collected in the field in different parts of Europe and United States. Loans or other collections were examined from the following herbaria: ARIZ, B, BH, BP, BPI, BRIT, BUAG, BUC, BUCA, BUCF, BUCM, CAS, CL, CLA, CM, CRA, DAV, DS, DUKE, FLAS, I, IA, IAGB, IASI, IBE, ISC, LA, LIL, MICH, MIL, MIN, MO, MSC, NA, OKL, PRH, RB, RSA, SMU, SOM, TEX, UCR, UMO, US, UTEP, VAL, VALA, VAB, VDB, VF, WIS, Herbarium University of Agronomical Sciences Timisoara, Romania; Herbarium Faculty of Silviculture Brasov, Romania; Herbarium Natural Sciences Museum Ploiesti, Romania (not listed in Index Herbariorum).

Taking into account the confusion that prevails in many herbaria, we considered it useful to cite the typical accessions of grain amaranth species cultivated at Ames, Iowa during 1984–1989, deposited now at NA (Appendix 1). Almost all these plants bear Lehmann's name and are part of the U.S. National Plant Germplast System. We often cited Sauer's specimens which were cultivated at Berkley, Davis, Madison, St. Louis or Winsconsin. In addition, we cited Grant's specimens which were cultivated at MacDonald College of Mc Gill University. In specimens citation we abbreviated: s.l. = same location and s.f. = seeds from (for the cultivated specimens).

Seed samples for most amaranth species are available to future researchers from a large and diverse germplasm collection of the U.S. National Plant Germplasm System http://www.ars-grin.gov. Also, for European material we recommend Gatersleben (Germany) germplasm collection.

Characters

Many species of the genus are greatly affected by environmental factors (nutritional elements, water availability, light conditions, injurious factors, etc.) exhibiting a great morphological variability with little taxonomic significance. An enormous number of such inconsistent states (mostly based on extremely variable characters like: plant height, branching, color of the whole plant or only of stems or petioles, abnormalities in the shape of inflorescence etc.) have received in the past various taxonomic ranks, increasing artificially the complexity of the genus. For example, in *Amaranthus retroflexus* more than 60 varieties, forms and subforms (Thellung 1914; Priszter 1953; Morariu 1952) have been described. In the present study, besides the recognized floral characteristics, emphasis is placed on less well known characters, but ones which appear to be more stable.

Our understanding of variation in *Amaranthus* would improve if more care were taken in the preparation of specimens. Plants should preferably be collected when well-developed fruits and seeds are present. In addition, to improve chances of correct identification, a range of individuals from the same population and a range of flowers, fruits and seeds belonging to the same plant should be collected and examined.

Leaf and Stem.—The phyllotaxis and the courses of vascular bundles were previously studied only for *A. caudatus* (Gravis & Constantinesco 1907), *A. graecizans* and *A. hybridus* (Wilson 1924). We extended these studies to the other common species of the *A. hybridus* group and to eight more species from the subgenus *Albersia* (Costea & DeMason 2001). The *phyllotaxis* varies within the same plant: the basal leaves (from the first 4 nodes) are arranged according to a 1/2 divergence. However, the phyllotaxis of the leaves from nodes 5–21(–23) may be regarded as constant for each species. Phyllotaxis varies within the genus, being predominantly 2/5 for the species of subgenus *Amaranthus* and 1/3 for the species of the subgenus *Albersia*. Towards the apex of the stem it may be 3/8 in the species of the subgenus *Amaranthus* and 2/5 in the species of the subgenus *Albersia*. The *vascular system* in *Amaranthus* is closed. The *leaf traces* consist of one large median bundle (M), two lateral (L) bundles, and, depending on the level in the stem, 2 intermediary (i) and 2–6 (1–3 orders) of marginal small bundles, m, m', m". The bundles within a leaf trace have a symmetrical, and characteristic, zigzag arrangement. The configuration of leaf traces can be expressed by means of a formula as follows: m" m' m L i M i L m m' m". Although the number of bundles varies along the stem, there is always a *maximum number of bundles within a leaf trace* that can be found at a certain level in the stem, this number being constant for each species. It varies from 11 bundles in *Amaranthus caudatus*, *A. cruentus* and *A. hypochondriacus* to 9 bundles in *A. hybridus*, *A. powellii* and *A. retroflexus*, 7 bundles in *A. albus*, 5 bundles in *A. blitum*, *A. viridis*, *A. deflexus*, *A. blitoides*, *A. graecizans* and 3 bundles in *A. crispus*. For more detailed information about phyllotaxis, the vascular system, trichomes and the anatomy of the stem in amaranths see Costea and DeMason (2001).

The *general shape, the apex* and *the base of lamina and cotyledons* were described following Hickey (1978). The *leaf anatomical pattern* is constant within the genus. *Stomata* in both upper and lower epidermis are anomocytic for all species examined—observations that disagree with Timonin (1986a,b) who found even on the same leaf anomo-, haplo-, dia-, para-, latero-, ecyclo- and helicocytic stomata. The *indument* consists of uniseriate trichomes or mixed multiseriate and uniseriate trichomes. Lamina is dorsiventral, exhibiting "Kranz" structure, without taxonomic significance within the genus, due to lack of variability.

The Inflorescence.—The flowers are arranged in small and very contracted cymes, the first flower within each cyme, in monoecious species, being male. For this reason, young plants of dioecious species are often misidentified as monoecious species (commonly as *A. hybridus* or *A. powellii*). Exceptions to this rule are *A. dubius and A. spinosus* which have the male and female flowers in separate cymes (Murray 1940; Eliasson 1988). The cymes are agglomerated, axillary and additionally arranged in racemose or spiciform terminal, large and complex synflorescences. Although extremely variable, there is usually a tendency towards a morphological "type." Therefore the inflorescence can be characterized by the *number, thickness, orientation and density of branches* and thus can be useful for a preliminary identification of *Amaranthus* species.

The Flowers.—*The length of bracteoles* in some species (*A. hybridus* and *A. retroflexus*) is variable and continuous, therefore without taxonomic significance. The sterile flowers of hybrids tend to be associated with longer (than normally) bracteoles (Brenner unpublished). As a result of selection, grain amaranths have usually short bracteoles, but sometimes, *A. hypochondriacus* may show bracteoles twice as long as the tepals, as in the wild species. The *morphology of the tepals and the ratio between the tepals and the fruit* provide the best technical and quick identification characteristics. *The color of the mid-vein* of the tepals may be green (*A. hybridus*) or yellowish and inconspicuous (*A. powellii*) and it can be examined on dried material (on old specimens the color fades, but generally remains visible).

The Pollen.—Erdtman (1966) defined the "*Amaranthus*" pollen grain type also present in other *Amaranthaceae* genera and even in several other centrospermous families (Nowicke 1993). The pollen grain is pantoporate, apolar, small (with D = 18–28μm). Generally it has more than 18 sunken pores, uniformly distributed and having the apertural membrane granulated. Tectum with granules or spinules (see also Eliasson 1988; Costea 1998a,b). Characters: *the diameter of the pollen grain*; *number and diameter of pores*; *density of granules or spinules* on the surface of the pollen grain according to the following scale: high = 20–30 granules or more/1μm^2; medium = 10–19 granules/μm^2 and low = 2–9 granules /1μm^2.

The Fruits.—**a.** General characters as seen under 50 × magnification or more (see also Klopfer & Robel 1989a; Costea 1997b).

Fruit transverse circumscissile, indehiscent or irregularly dehiscent.—Usually transverse dehiscence versus indehiscence is a constant characteristic, useful for species separation. In some species with normally circumscissile dehiscence (*A. hybridus* and to a less extent *A. powellii*), a transition between indehiscent, irregularly dehiscent and circumscissile fruit may be observed in the same population or even on the same plant. Other characters are: *the general form of the fruit*: spherical, ovoid, ellipsoidal etc.; *the form of the fruit toward the stigma region*: abruptly narrowed toward the stigma region, a short beak being conspicuous (*A. cruentus*) or fruit gradually narrowed toward the stigma region (*A. hypochondriacus, A. powellii*), with the apex truncate to rounded, or acute; *the ratio between the length and the width of the fruit*; *position of the dehiscence line*: in the upper half, at the middle or in the lower half of the fruit; *general pattern of pericarp wrinkling*; *size of stigma branches*: width at the base and length; *position of stigma branches*: erect or recurved.

b. *SEM characters of fruits*.–*Surface of pericarp* observed with the SEM at 300× magnification or more. To describe the patterns of the pericarp surface, we slightly modified the classification of Klopfer and Robel (1989a) as follows: Type A ("paniculatus" type, Klopfer & Robel 1989a). -Cells very irregularly shaped and ramified. Principal axis of the cells not more than three times longer than the longest secondary axis. Anticlinal walls irregularly waved (Fig. 1, A, B). Type B ("bouchonii" type, Klopfer & Robel 1989a). -Cells ramified, 4–6 times longer than wide. The anticlinal walls Ω or S-waved (Fig. 1, C, D, E). Type C ("patulus" and "deflexus" types, Klopfer & Robel 1989). -Cells less ramified or not ramified, 8–12 times longer than wide. Anticlinal walls mostly S-waved (Fig. 1, F). Type D ("albus" type, Klopfer & Robel 1989a). -Cells less ramified or not ramified 1.5–2 times longer than wide. Anticlinal walls weekly S-waved. Type E ("lividus" type, Klopfer & Robel 1989a). -Cells not ramified, 3–4 times longer than wide with anticlinal walls straight to S-waved. The delimitation of these 5 types is somehow arbitrary because with respect to pericarp surface features, the species of subgenus *Amaranthus* are more variable than was suggested before (Klopfer & Robel 1989a). Almost all species examined in the *hybridus* complex present, even on a single fruit, a continuous transition between two types. Therefore, the character of the surface patterns should be regarded more as a tendency toward a type. Even so, in some cases it is useful to separate, for example, the subspecies of *A. powellii* (subsp. *powellii* presents the type A surface character, while subsp. *bouchonii* shows variation between B and C types). In the subgenus *Albersia* nearly all species are characterised by a unique type of surface organisation, D or E (Klopfer & Robel 1989a; Costea 1998a).

c. *Structure of pericarp*.–The mature pericarp has a very simple structure, being 2–4 layered. The epicarp and endocarp are always 1-layered, while the mesocarp, according to the species, may be *1-layered* (*A. powellii, A. hybridus, A. retroflexus*) or *2-layered* (*A. hypochondriacus, A. caudatus* and *A. cruentus*).

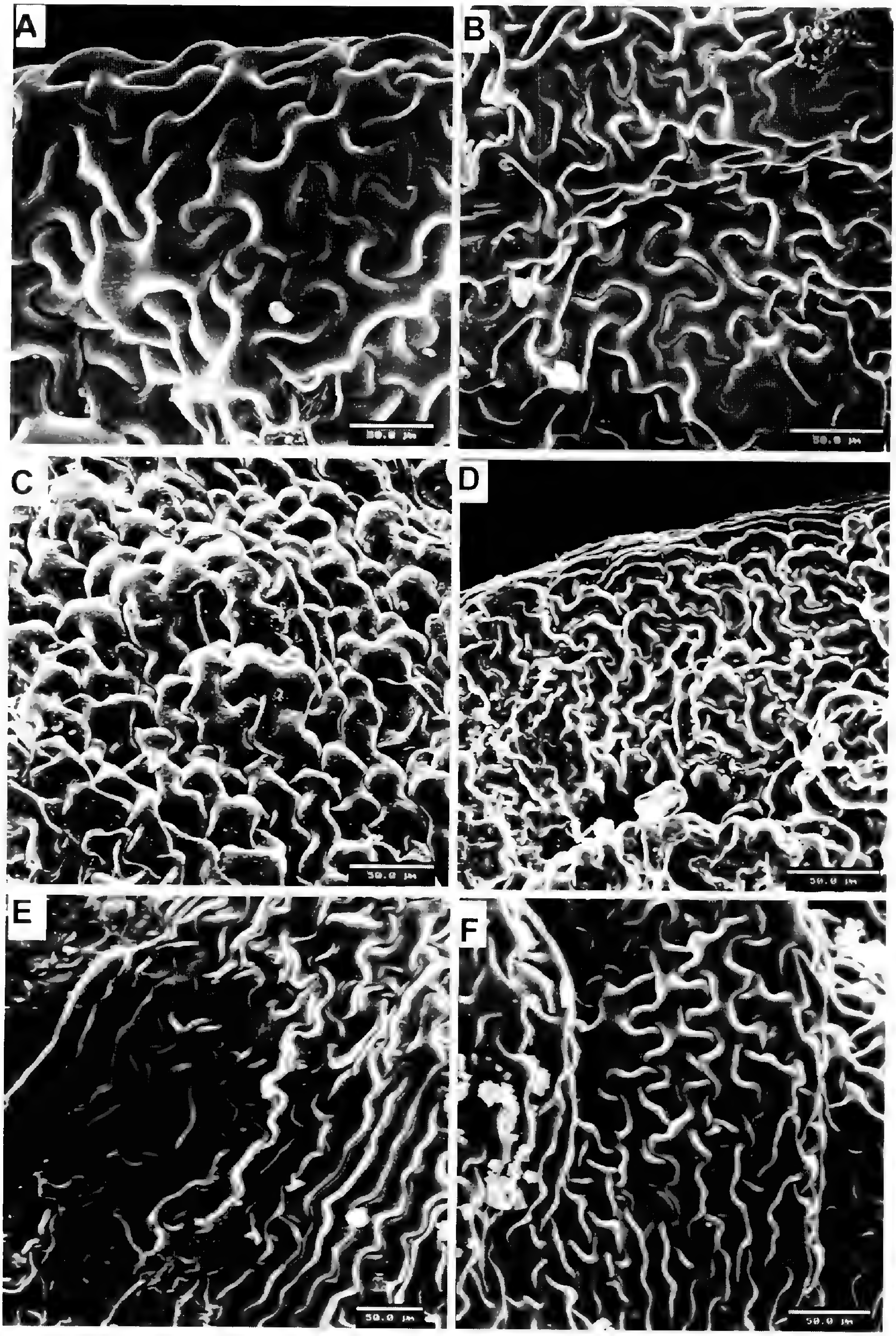

Fig. 1. (Plate 1). Surface of pericarp in *Amaranthus hybridus* agg. A. *Amaranthus powellii* subsp. *powellii*; B. *Amaranthus retroflexus*; C. *Amaranthus cruentus*; D. *Amaranthus hybridus*; E.–F. *Amaranthus powellii* subsp. *bouchonii*.

In some cases the mesocarp originally consists of a single cell layer but finally is crushed and becomes usually no longer distinguishable (*A. hybridus*). As a consequence, the pericarp in these taxa is apparently 2-layered. The taxonomic importance of pericarp structure, mechanism of dehiscence and analysis of the dehiscence-indehiscence character are the object of different study (Costea, Waines & Sanders, in ed.).

The Seeds.—The diagnostic features of the seeds were largely neglected due to their small size. Descriptions of seeds were also produced by Kowal (1954), Klopfer and Robel (1989b), Esparza-Sandoval et al. (1996) and Costea (1997c). The seeds of grain species are more variable, dark or light colored, the character being controlled by multiple alleles and additional loci (Kulakow et al. 1985; Kulakow 1987; Kulakow & Jain 1990). The following features (including the sculpture) should be observed under 50× magnification or more (Fig. 2, A): *The shape of the seeds as seen from above*, is variable between species but more or less constant within a species: circular, elliptic, obovate, etc. As *seen laterally*, the seeds usually exhibit a lenticular shape. The seeds are usually differentiated into a central, convex zone and a marginal, plane zone, exceptions to this rule being rare and diagnostic. This shape allows the seeds to float and disperse by water. *The size*—defined by the length of the two diameters—is constant when the plants grow in the same environmental conditions. Otherwise, variations of 0.1–0.2 mm from the average are possible. *Appearance of the seed base*, where the hilum and radicle are located: the tip of the hilum surpasses the tip of the radicle (subgenus *Amaranthus*, exception—*A. hybridus*) or the tip of the hilum is below the tip of the radicle (subgenus *Albersia*) (Kowal 1954; Costea 1997c). The presence between the hilum and the radicle, toward the center of the seed, of a furrow; a concavity or a concavity continued by a furrow can be also an useful additional character. *The shape of the seed margin* observed from profile may be acute (usually), rounded or truncated (rare). *The sculpture of the seeds* is the result of the concentrically distribution of the cells from the exotesta. The following variations are possible: the sculpture is evident only on the marginal zone, in the central zone being inconspicuous (usually); both the central and the marginal zone are sculptured; both the central and the marginal zone are almost smooth, and the central zone is sculptured while the marginal one is smooth or distinctly wrinkled. *The color of the seeds* is commonly dark-brown to blackish, or whitish-yellowish, sometimes with reddish nuances at the species cultivated as cereals. Many cultivars of *A. caudatus* have pink cotyledons visible through the seed coat. The color may be uniform or not in the last case usually with the marginal zone paler.

SEM characters of seeds refer to the ornamentation of the exotesta in the marginal zone of the seeds, as observed under 300 ×, or more magnification. We used the terminology proposed by Barthlott and Ehler (1977). *The aspect of*

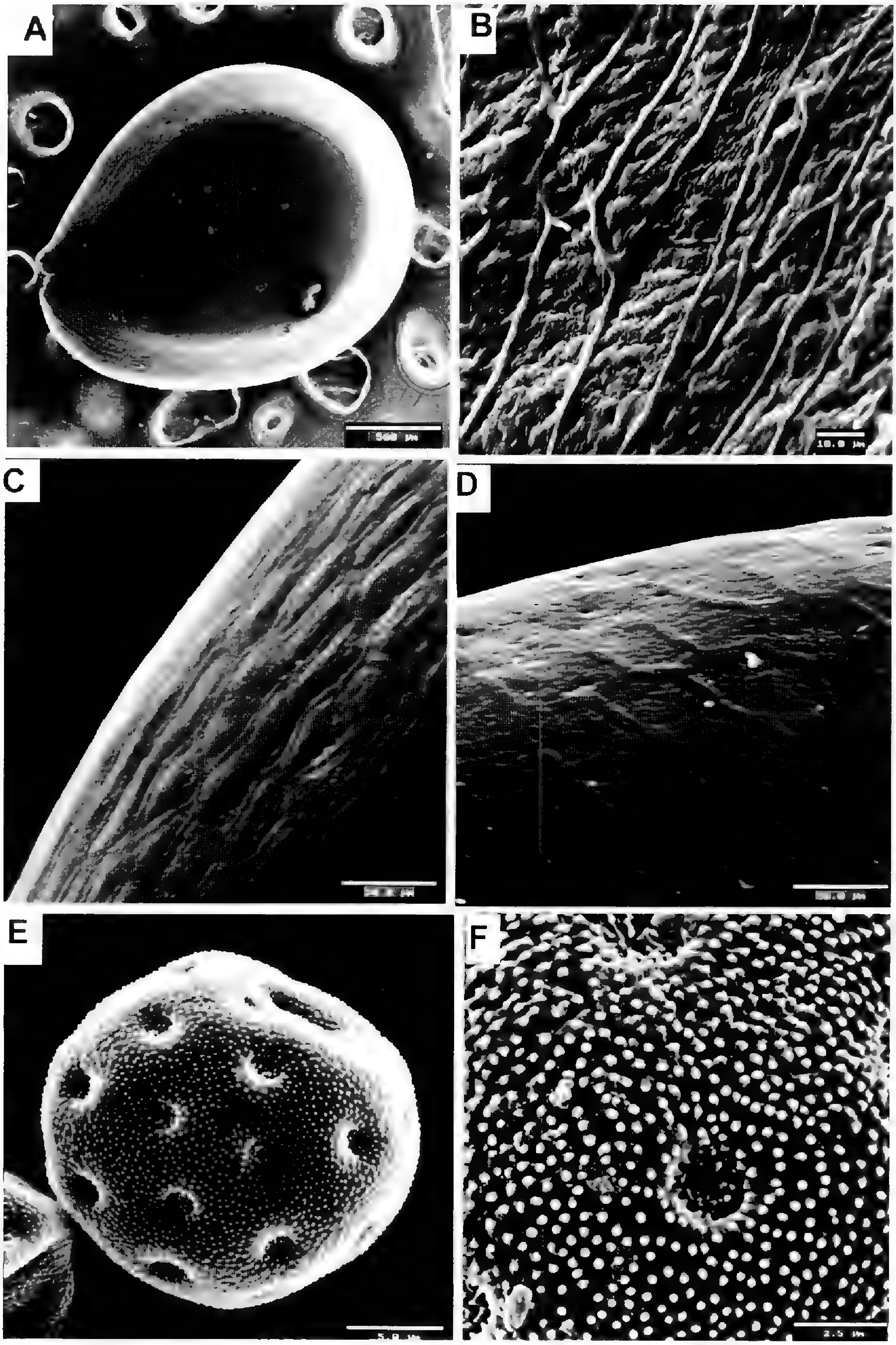

FIG. 2. (Plate 2). A. Seed. General view. *Amaranthus powelii* subsp. *powellii*; B. Sculpture of exotesta on the marginal zone of the seed. *Amaranthus caudatus* (light coloured seed); C) *Amaranthus powellii* subsp. *powellii*; D. *Amaranthus powellii* subsp. *bouchonii*; E. Pollen. *Amaranthus hybridus* subsp. *hybridus*; F. *Amaranthus hybridus* subsp. *quitensis*.

the anticlinal (prominent or inconspicuous) and *periclinal* (flat, concave or convex with the sculpture of the epicuticular waxes smooth or punctiform) walls were noted.

All the above mentioned characteristics are useful for the taxonomy of the genus but difficult to use for the current identification of taxa. For this purpose we recommend the same identification keys surveyed by Brenner et al. (2000) which are mostly based on the traditional characters.

Hybrids

Hybridization is the main source of the taxonomic problems within the *A. hybridus* aggregate. Yet the frequency of hybridization within populations and sometimes the fertility of hybrids has been over estimated (Priszter 1949, 1958). In fact, experimental hybridizations undertaken (Murray 1940; Greizerstein & Poggio 1992) showed that such events occur infrequently and that the F1 plants have a reduced fertility (usually 80–98%, rarely 60%). The mean outcrossing rate for the cultivated species is 3.5 to 34 % (Jain et al. 1982; Hauptli & Jain 1985; Agong & Ayiecho 1991; Espitia-Rangel 1994). Not surprisingly, considering that often amaranths grow in large, mixed species populations, introgression does occur, the result being formation of hybrid swarms. Hybrid plants are often difficult to ascribe to one of the species, or even to associate with the correct parental species. In the temperate regions the phenomenon commonly involves the three weedy species—*A. retroflexus*, *A. hybridus* and *A. powellii*. Gene flow may also occur between the domesticated species (*A. hypochondriacus*, *A. cruentus* and *A. caudatus*) or between the domesticated species and their wild relatives. The last situation occurs frequently in the regions where grain amaranths are cultivated and the related weed species grow in the vicinity (for example in Mexico, Ecuador, Guatemala, Peru, and Africa). In such regions the species limits blur resulting in an extremely difficult complex. Often, the pattern of variation is impossible to explain if we take into consideration only the "classical" species, suggesting that some other local (unknown ?) taxa are involved too. A possible explanation of this variability in some areas could be that outcrossing rates are higher in certain environmental conditions, depending for example on the pollinators (Hauptli & Jain 1985) and probably other factors too. It is hazardous to evaluate such plants only morphologically; detailed studies using molecular markers are necessary in the future if the consequences of hybridization are to be properly understood. However, to date molecular methods have not contributed much to the understanding of this complex of species because of their contradictory results. The attempt to evaluate the relationships between cultivated and wild amaranths, using plants possessing a degree of introgression (or even misidentified), can lead to unrealistic results and the future studies must involve careful use of both molecular and morphological methods.

The species of the subgenus *Amaranthus* hybridize with the species of the subgenus *Acnida* (Murray 1940; Sauer 1955) complicating even more the interpretation of the variability in *A. hybridus* agg. The gene pool of the grain amaranths also includes the 10 dioecious species (Brenner 1990; Brenner et al. 2000), the potential of variation being enormous. The consequence of hybridization between species of the subgenus *Amaranthus* and subgenus *Acnida*, in North America, is a subject that deserves future attention. The F1 hybrids within subgenus *Amaranthus* and those between species of the subgenus *Amaranthus* and subgenus *Acnida*, are often not strictly intermediate morphologically between their two parents, having abnormal inflorescences with very dense, crowded branches. They can easily be recognized by the great number of densely packed bracteoles that subtend the often-sterile flowers. For their accurate identification, one has to take into careful consideration what potential parent species are present in the field where the hybrids were collected. Fortunately, the species of the subgenus *Amaranthus* (and *Acnida* ?) do not hybridize with the species of the subgenus *Albersia* (Priszter 1949, 1958).

TAXONOMIC TREATMENT

The division of the genus into three subgenera—*Acnida*, *Amaranthus* and *Albersia*—suggested by Mosyakin and Robertson (1996), appears to be most appropriate because it would permit revision at the section level of the heterogeneous subgenus *Albersia* (= sect. *Blitopsis* Dumort.) already started by the two authors. We support this classification with new morpho-anatomical characters. Also the fact that hybrids between the Subgenus *Amaranthus* and the Subgenus *Albersia* are unknown confirms the separation of *Albersia* as a subgenus.

1. Dioecious plants ____ Subgenus **Acnida**
1. Monoecious plants.
    2. Phyllotaxis predominantly 2/5; largest leaf traces in stems with 9–11 bundles; seeds with hilum at or above the radicle level ____ Subgenus **Amaranthus** (= *section Amaranthus*)
    2. Phyllotaxis predominantly 1/3; largest leaf traces in stems with 3, 5, or 7 bundles; seeds with hilum beneath tip of the radicle ____ Subgenus **Albersia** (= Subgenus *Amaranthus* section *Blitopsis* Dumort.)

Within the subgenus *Amaranthus*, we support the treatment of Sauer (1950, 1967) in maintaining the cultivated taxa distinct as species from their supposed wild progenitors, supporting it with new morphological and anatomical evidence. We do not claim that combination may not be necessary in the final revision of this difficult group. However for the moment, lumping appears to be a too simple and arbitrary solution. Until the day that the variability and the relationships between all the taxa involved will be understood we consider it more appropriate to maintain them as separate species.

1. Amaranthus caudatus L., Sp. Pl. 990. 1753. TYPE: "Habitat in Peru, Persia, Zeylonia"; LINN 1117/26.

Amaranthus mantegazzianus Passerini, Ind. Sem. Hort. Bot. Parma 4. 1865.
Amaranthus edulis Spegazzini, Physis (Buenos Aires) 3:163. 1917.

Stout erect to arching annual up to 1–1.5(–2) m high. Cotyledons narrow-elliptic, 13 × 4–5 mm, with acute apex and base; petiole about 10 mm long. Leaves rhombic-ovate to elliptic. Trichomes multicellular with uniseriate cells. Inflorescence large and showy, with the terminal part 10–30(–40) cm long, thick, pendent to erect, usually red or purplish, rarely white or yellow. Sometimes the inflorescence is similar to *A. hybridus*, consisting of many lateral, more or less perpendicular branches. Bracteoles 3–4 mm long, about 1.2–1.5 times longer than the tepals, usually not exceeding stigma branches. Tepals 5, equal, outwardly curved or erect, 1.9–2.5(–3) mm long, obovate to broadly-spathulate, mucronate, overlapping each other, with the mid-veins uniform, yellowish-brown. Fruit circumscissile dehiscent, longer than the tepals, 1.5–2.5 mm long, a little longer than wide, ovoid, weakly longitudinally wrinkled, with the dehiscence line in the lower half, gradually or abruptly narrowed toward stigma region. Pericarp surface is type A. Seeds 1.3–1.5 × 1.25–1.35 mm, round to asymmetrically-round. Between the hilum and the radicle a furrow extends almost to the middle of the seed. The seeds are differentiated into central and marginal zones. Two distinct types of seeds exist: a) whitish-yellowish in color, ovoid in lateral view, with marginal zone smooth or irregularly wrinkled, often with the pink embryo visible through the seed coat, and the central zone conspicuously sculptured; the border of the seed rounded or truncated; cells of the exotesta in the marginal zone elongated (30–50 μm length) with prominent anticlinal walls and periclinal walls plane and verrucose (Fig. 2, B). b) dark-brown seeds, lenticular, with marginal zone sculptured and central zone smooth; uniformly colored; cells of the exotesta as in the whitish-yellowish seeds but the periclinal walls smooth; border of the seeds is acute. Pollen grains 22–24 μm with 30–40 pores of 1.5–1.8 μm diameter. Density of granules medium. 2n =32.

The relationships within *A. caudatus* were studied by Coons (1975, 1982) and we share that author's view of infraspecific classification.

Distribution and ecology.—In Europe, *A. caudatus* is grown primarily as an ornamental, and rarely escapes from cultivation in waste places. *A. caudatus* as a grain crop, originated at high elevations in South America, in northwestern Argentina, Ecuador, Peru and Bolivia, the closest wild taxon being *A. hybridus* subsp. *quitensis*. In the native areas you can often find transitional forms between the two taxa. The question remains whether *A. cruentus* also participated in the development of *A. caudatus*. Using the data from nuclear DNA and restriction-site chloroplast variation, Lanoue et al. (1996) found that *A. caudatus* and *A. cruentus* are more closely related to each other than to their respective putative progenitors. Chan and Sun (1997) stated also that *A. caudatus* is more closely related to *A. cruentus*, and both of them nearer to *A. hybridus* than to *A. quitensis*. These data are not confirmed by cytological studies (Pal & Khoshoo 1972, 1973; Hauptli & Jain 1984; Greizerstein & Poggio 1992; Greizerstein et al. 1997). Also, other mollecular studies, using RAPD markers indicate that *A. caudatus* is more closely related to *A. hypochondriacus* than to *A. cruentus* (Transue et al. 1994). Sauer (1967) stated that when growing together with the other two cultivated grain species, *A. caudatus* does not usually form hybrids and crossing barriers in *A. caudatus* have also been observed by Coons (1975, 1982). However, among the accessions cultivated at Ames, Iowa between 1984–1989 and deposited at NA, many of the plants impossible to ascribe to a definite species were obviously related morphologically to *A. caudatus*. In all cases such plants have obovate to spathulate tepals, only partially overlapping each other, and narrower than in typical *A. caudatus* but wider than in any other species, suggesting a degree of introgression. Two morphologic types are commonly encountered:

1) The plants from Morelos, Mexico identified as "*A cruentus*" by Lehmann or "*A. hybridus* subsp *paniculatus*" by Spjut, apparently represent a definite land race probably involving *A. cruentus* and *A. caudatus* [(*Spjut 8808, 8810, 8821; Lehmann: AMES 5501* (Type 1 and 2), *5502, 5179, 5182, 5183, 5188, 5193, 5195, 5196, 5197* (Type 1 and 2) *5198* (Type 1 and 2), *5200, 5201, 5202*, (NA)]. Besides this recognizable type, many other accessions bear morphological "traces" of *A. caudatus* but there are more heterogenous suggesting either the participation of *A. cruentus* or *A. hypochondriacus*, or both, in their origins.

2) The plants from Ecuador identified as "*A. hybridus*" by Lehmann or "*A. hybridus* subsp. *quitensis*" by Spjut, probably involve *A. caudatus* and *A. hybridus* (Ecuador, *Lehmann, PI 490663, PI 490664, PI 490666, PI 490667, PI 490670, PI 490716, PI 490718, PI 490719, PI 490722, PI 490672, PI 490715, PI 490723, PI 490724, PI 490725, PI 490726, PI 490728, PI 490730, PI 490731, PI 490732, PI 490735, PI 490737, PI 490742, PI 490746, PI 490747, PI 490748, PI 490752*. These specimens are different from the red Ecuadorian "sangorache," another example of taxonomic incertitude in grain amaranths. Sauer included it within *A. quitensis* and Brenner et al. (2000) suggest the same. Coons accepted it as a variety of *A. hybridus* (s.l, including. *A. quitensis*) (1975, 1978). As noted by Coons, even if closely related to *A. caudatus* and *A. hybridus* (incl. *A. quitensis*) and to a less extent with *A. cruentus*, "sangorache" presents some unique features such as the tepals position and the form of the fruits. We also think that it deserves separate recognition—at least as a variety (if not as a subspecies)—but its position in relation within the species complex requires further investigation.

Representative specimens examined. **AFRICA. ETHIOPIA. Harege Prov.:** Harar, escaped from cultivation, 9°5'N, 42°17'E, 7 Sep 1963, *Burger 3237* (US). 20 km from Harar Leprosarium "Besadimo," 1425 m, 3 Aug 1967, *E. Westphal & Westphal-Stevels 994* (MO). **Illubabor Prov.:** 8 km SW Teppi, 7°9'W, 35°18'E,1300 m, 9 Dec 1964, *Meyer 8995* (NA). **Kefa Prov.:** E of Jima, Oct 57, *Anderson s.n.* (WIS). **Shoa Prov.:** Addis Abeba, Hugh Rouk, 12 Jan 1965, *Meyer 9093* (NA). **KENYA. Eastern Prov.:** Mount Kenya, 3630 m, 21–27 Sep 1909, *Mearns 1377* (A). **SOUTH AFRICA:** Pretoria-Riviera, cultivated, 1 Jun 1964, *Schliechen 9983* (A).

ASIA. ISRAEL: Sharon Plain, Herzliyah, near Yarkon bridge, 21 Apr. 1935, *Eig, Zohary & Grizi 730* (A, BH, FLAS, MO, NA). **NEPAL:** s.f. Marku Valley, Sirsagarhi, "grain crop," 30 Jan 1951, *Sauer 1505C* (WIS). s.f. the SW Slopes of Annapurna, "cultivated as grain," 28°20'N, 83°45'E, 2000 m, 1 Nov 1954, *Sauer 1776* (WIS). **PAKISTAN. Ladak Prov.:** Indus Valley, Leh to Kaitse, 12–14 Jul 1856, *Schlagintweit 1486* (GH). **INDIA:** s.f. unknown locality, collected in Aug 1910 and cultivated at New York, *Arnold s.n.* (BH). **Tamil Nadu:** s.f. Madras, 23 Sep 1964, *Sauer 3964b* (NA, WIS); s.l., 30 Aug 1964, *Sauer 3962* (MO, NA, WIS); s.l., 16 Sep 1964, *Sauer 3964 a* (WIS). **CHINA:** s.f. Yunnan, 3 Sep 1940, *Cowgill 2087* (BH). s.f. Mowhsien, Szechwan, 2000 m, "cultivated crop," 9 Jan 1950, *Sauer 1503 A* (WIS). **JAPAN. Hondo:** Tokyo, "cultivated," 26 Oct 1959, *Makino 11254* (CAS).

EUROPE. SWEDEN. Stockholm: s.f. Stockholm, Botanical Garden, *Grant 219* (WIS). **ENGLAND:** s.f. unknown locality cultivated at New York, Ithaca, 7 Aug 1960, *Bailey 8417* (BH). **FRANCE. Doubs:** s.f. Besancon, Botanical Garden of the University of Besancon, *Grant 218* (WIS). **Loire-Atlantique:** s.f. Nantes, Botanical Garden of Nantes, *Grant, 216, 217* (WIS). **ROMANIA. Constanta Co.:** Medgidia, "cultivated as ornamental and ruderal," 15 Sep 1995, *Costea s.n.* (BUAG).

NORTH AMERICA. UNITED STATES: CALIFORNIA. Santa Barbara Co.: Santa Barbara, 22 Jan 1958, *Pollard s.n.* (CAS). **San Bernardino Co.:** Rialto, 1 Oct 1933, *Wheeler 2141* (DS). **Ventura Co.:** Casitas Pass Rd., Foster Park, 23 Oct 1965, *Pollard s.n.* (CAS). **Santa Clara Co.:** Palo Alto, 22 Jan 1958 *Pollard s.n.* (CAS). 18 Sep 1968, *McClintock s.n.* (NA). **FLORIDA. Alachua Co.:** Gainesville, 14 Sep 1953, *West s.n.* (FLAS). **ILLINOIS**. Chicago (cultivated), 13 Jul 1958, *Pollard s.n.* (DUKE, FLAS); s.l., 13 Jul 1987, *Plowman 14507* (US). **MINNESOTA. Stearns Co.:** St Cloud, 807 S, 6th Avenue, 26 Sep 1991, *Lindstrom 1991* (KSC). **NEW YORK. Tompkins Co.:** Ithaca, 28 Sep 1936, *Allen 6391* (BH); s.l., 11 Sep 1914; s.l., 29 Jul 1920; s.l., 20 Oct 1920; s.l., 17 Sep 1924; s.l., 23 Jul 1928, *Bailey s.n.* (BH); s.l., 3 Aug 1948, *Dress 1405* (BH, NA); s.l., 31 Aug 1948, *Dress 1232* (BH, NA). **VIRGINIA. Buchanan Co.:** Upper Prater, 11 Aug 1988, *Churchill 88234* (MSC). **WISCONSIN. Dane Co.:** Madison, Oct 1924, *Davis s.n.* (WIS).

SOUTH AMERICA. PERU. Dep. Ayacucho: Prov. Cercado, Ayacucho, 2800 m, 10 Mar 1964, *Gade s.n.* (WIS). **Dep. Cuzco:** Urubamba, 21 Apr 1915, *Cook & Gilbert 256* (NA). Paruro, 10 May 1964, *Gade s.n.* (WIS). **Dep. Huancavelica:** Mejorada, 31 Oct 1948, *Sauer 1283D* (WIS). **BRASIL. Mun. Curtiba:** Parana, "ornamental," 26 Jul 1980, *Kammrow 1368* (WIS). **BOLIVIA. Prov. Cochabamba:** Cochabamba, 31 Oct 1948, *Sauer 1241, 1333, 1303* (DAV, DS, GH, NA, WIS); s.l., 12 Dec 1948, *Sauer 1179* (MO, DAV, DS, GH, MO, NA, WIS). s.f. Cochabamba, grown at Botanical Garden Illinois, March-May 1948, *Fuller s.n.* (NA). **Prov. La Paz:** s.f. Sacaba, 19 Nov 1959, *Sauer 2540* (NA, WIS). s.f. Tajma, 17 Dec 1959, *Sauer 2542* (NA, WIS). s.f. Chulumani, Nov 1959, *Sauer 2539* (WIS). **ARGENTINA:** cultivated, 20 Apr 1942, *Hunzinker 2083, 2083 Bis* (BH). **Prov. Salta:** Dep La Vina, Puerto de Dias, cultivated, 1200 m, 1941, *Hunzinker 1321* (A).

2. Amaranthus cruentus L., Syst. Nat. ed. 10, 1269. 1759. (**Fig. 3**). TYPE: "CHINA"; LINN 117/19. *A. hybridus* L. subsp. *cruentus* (L.) Thell. var. *paniculatus* (L.) Thell., Fl. Adv. Montpell. 205. 1912. *A. hybridus* L. subsp. *cruentus* (L.) Thell. proles *paniculatus* (L.) Thell., Ascherson & Graebner, Syn. Mitteleur. Fl. 5:247. 1914. *A. hybridus* L. subsp. *paniculatus* (L.) Hejny, Dostal, Kvetevna CSSR. 444. 1950. *A. hybridus* L. subsp. *incurvatus* (Tim. ex Gren. & Godr.) Brenan var. *cruentus* Mansf., Die Kulturpflanze 2:54. 1959.

Amaranthus paniculatus L. Sp. Pl. ed. 2, 2:1406. 1763.
Amaranthus sanguineus L. p.p., Sp. Pl. ed. 2, 2:1407. 1763.
? *Amaranthus chlorostachys* Willd., Hist. Amaranth. 34. 1790.

Erect annual 0.5–1.5 m, usually reddish throughout. Cotyledons lanceolate to narrow-ovate, 16 × 5–6 mm, with rounded apex and cuneate base; petiole about

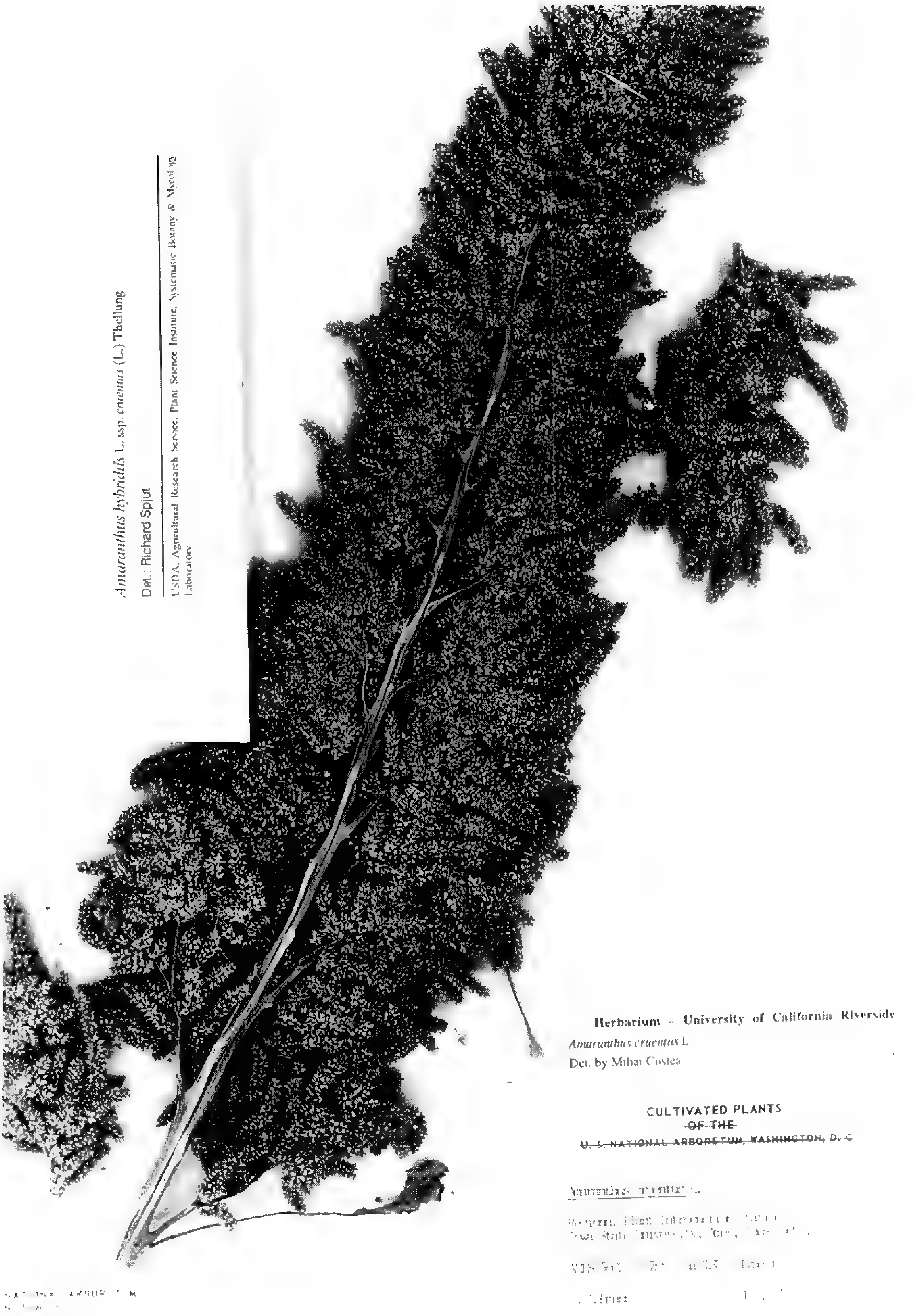

Fig. 3. *Amaranthus cruentus*, from Lehmann, AMES 5602 (NA).

7 mm long. Leaves rhombic-ovate to broadly-lanceolate, 4–15 × 2–18 cm. Trichomes multicellular with cells uniseriate. Inflorescence usually with many lateral, perpendicular, thin branches. Bracteoles 2–3 mm long, equalling or slightly longer than the tepals. Tepals 5, almost equal (one is approximately 0.5 mm longer than the other 4), oblong, acute, with the mid-veins uniform, yellowish-brown. Fruit circumscissile dehiscent, 2–2.5 mm long abruptly narrowed toward the stigma region, a short, thin rostrum being evident. Fruit about 1.5 times longer than wide, obovate to rhombic, 2–2.5 mm long, with the dehiscence line at the middle or in the upper half. The pericarp is almost smooth or weakly wrinkled above the dehiscence zone. Type of pericarp surface variable: A to B. (Fig. 1, C). Seeds obovate to elliptic-asymmetrical 1.25–1.6 × 1.1–1.2 mm, whitish or yellowish, rarely dark-brown. The pale seeds are very much like the ones described for *A. caudatus*. The differences are that the furrow between the hilum and the radicle is prolonged only about 1/3 of the way through the diameter of the seeds and that the pink tint is usually absent. The dark seeds exhibit a concavity above the hilum and have both the central and the marginal zone (especially) sculptured. The cells of the exotesta as in *A. hybridus*. The border of the seed is acute. Pollen grains 20–25 µm, with 33–45 pores of 1.9–2.1 µm; density of spinules medium. 2n = 32, 34.

Distribution and ecology.—Apparently originated in Central America from the wild species *A. hybridus*, as a grain crop. Sauer (1950) and Sanchez-Del Pino, Flores Olvera and Valdes (1999) noted transitional forms between the two species in Mexico but such examples also occur in Central America and Africa. Together with the other two grain amaranth species, it was introduced into the Old World by the Spaniards and then into Asia and Africa. Today it is cultivated worldwide, mostly as a garden ornamental. In United States, South America, Zaire, Sierra Leone, Ethiopia, India and Middle East it is cultivated as a cereal and in many other countries it is being evaluated experimentally for this purpose. The commercial grain amaranth crop involves both *A. cruentus* and *A. hypochondriacus* as well as hybrids between the two. In Africa *A. cruentus* is also cultivated as a potherb, bearing the name "African spinach" or "Sudan spinach," or is used as animal fodder. The leaves have a high content of protein and vitamins. This species sometimes escapes from cultivation in ruderal places.

Representative specimens examined: **AFRICA. EGYPT:** Bashtil, 21 Oct 1974, *Mosein & Riad Higazy 18* (MO). **ETHIOPIA:** Road from Arba Minch to Soddo, 108 km from Arba Minch; 1180 m, 7 Feb 1968, *E. Westphal & J. M. C. Westphal 323b* (US). **NIGERIA. State North East:** Distr. Gembu, Mobilla Plateau, 10 May 1972, *Gbile et al. 1337* (MO). **CAMEROON. Prov. Sud-Ouest:** Dep. Fako, Bakingili, 4°04'N, 9°02'E, 0–30 m, 12 Jun 1984, *Thompson & Rawlins 1383* (MO, CM). Nkoubisson, Collection Garden of Department of Agriculture ENSA, 17 Dec 1976, *J.M.C. Westphal 7375* (NA); s.l., 18 Dec 1976, *J.M.C. Westphal 9010* (NA). **UGANDA. Distr. Kampala City:** Botanical Garden of Makerere University, 0°17'N, 32°34'E, 1200 m, 27 Feb 1972, *Katende 1735* (MO). **KENYA:** s.f. unknown locality cultivated at Miami, Florida, 7 Sep 1920, *Shantz 51847* (BH). **ZAIRE (CONGO). Distr. Shaba:** 15 km of Lubumbashi, 22 Dec 1961, *Schmitz 7522* (MO). **BURUNDI. Distr. Bujumbura:** Bujumbura, 780 m, 15 Sep 1974, *Auquier 4090*

(MO); s.l., 800 m, May 1978, *Lambinon 78/388* (MO). Rushubi, 3°22'S, 29°28'E, 1650 m, Mar 1981, *Reekman 9612* (MO). **SOUTH AFRICA. Eastern Cape:** Grahamstown, cultivated, 2400 m, 30 Jul 1972, *Bayliss 1377* (BH).

AUSTRALIA AND OCEANIA. PAPUA NEW GUINEA: East Highlands Distr.: Norey Kora Swamp, 6°30S, 145°75'E, 1400 m, cultivated, Oct 1966, *Wheeler & Anu 5857* (A).

ASIA. INDIA: s.f unknown locality cultivated at New York, Ithaca, 15 Aug 1933, *Gilmore 13600, 15595* (BH). Pembra, Malabar Wynsod, Millet's Garden, 800 m, 16 Apr 1963, *Noble # O* (NA, WIS). **CHINA. Kwangsi:** near San-t'ai-ling, 28 Aug 1937, *Taam Ying-Wah s.n.* (BH). **VIETNAM. Annam (Trung Phan region):** Tourane (Da Nang), Jul 1927, *J. Clements & M. S. Clements 3309* (US). **PHILIPPINES.** Mindanao Island: Davao, Apr 1903, *DeVore & Hoover 112* (US). **INDONESIA. Holmahera Island:** Kampung, Pasir Putih, cultivated, 13 Feb 1981, *Taylor NM III P704* (A). **E Coast:** Vicinity of Loemban Ria, Asahan, 5 Feb 12 Apr 1934, *Bocea 8022* (US). Adian Rindang, vicinity of Hoeta Tomoeau Dolok, 17 Nov–10 Dec 1935, *Bocea 8710* (A).

AUSTRALIA. New South Wales: Summer Hill, "spontaneous in garden," May 1970, *Michael M8* (WIS).

NORTH AMERICA. UNITED STATES. ARIZONA. Navajo Co.: s.f. Hotevilla, Hopi Indian Reservation, 6 Nov 1950, *Sauer 1343 E* (WIS); s.l., May–Aug 1959, *Sauer 2530* (WIS). **ALABAMA. Jefferson Co.:** Birmingham, ruderal, 4 Oct 1968, *Kral 33646* (SMU). **CALIFORNIA. San Bernardino Co.:** San Gabriel Mountains, San Antonio Canyon, Chapman Ranch above Mountain Baldy Village, 1300 m, *Thorne & Thorne 191074* (RSA). **Santa Clara Co.:** Stanford University, 28 Oct 1896, *Dudley 24899* (SMU). Palo Alto Harbor, ruderal, 11 Aug 1974, *Thomas 17504* (DS). Palo Alto, along Alma Street, near Channing Street, 27 Sep 1961, *Thomas 9791* (CAS, DAV). **San Joaquin Co.:** Calaveras River bottom, 17 Sep 1927, *Stanford 170585* (DS). **KENTUCKY:** unknown locality, cultivated, 1817, *Short s.n.* (NA). **MICHIGAN. Ingham Co.:** near Lansing (ruderal), 13 Oct 1866, *Bailey s.n.* (BH). **MISSOURI. Boone Co.:** Columbia, "ruderal," 18 Aug 1933, *Dimes 983* (UMO). East Higlands, ruderal, 9 Aug 1933, *Dimes 921* (UMO). **NEW YORK. Albany Co.:** near Londonville (ruderal), 12 Sep 1932, *Muenscher 17858* (BH); s.l., 23 Sep 1928, *Burnham 17206* (BH). **PENNSYLVANIA. Allegheny Co.:** N side of Pittsburgh, ruderal, 4 Aug 1946, *Buker s.n.* (CM). **Bucks Co.:** West Bristol, ruderal, 17 Jul 1952, *Long 75306* (CM). **WISCONSIN. Dane Co.:** Madison, "waste ground," Oct 1938, *Shinners s.n.* (WIS). **HAWAII. Honolulu Co.:** Aina Haina, 27 Oct 1978, *Bush 939* (US, NA).

CENTRAL AMERICA AND GREATER ANTILLES. MEXICO. CHIAPAS.: Bonifilo Ocosingo, 26 Nov 1976, *Calzad et al. 2869* (WIS). **JALISCO.:** Mpio. De Cuantilan, 19°28'13"N, 104°11'04"W, 750 m, 28 Aug 1991, *Cevallos et al. 140* (SMU). **MICHOACAN.:** Patzcuoro, 2050 m, 20 Oct 1979, *Caballero 1106* (WIS); s.l., 14 Oct 1949, *Caballero 1059* (WIS). **OAXACA.:** s.f. Jicatepec, Aug 59, *Sauer 2529* (WIS). **PUEBLA.:** s.f. Acatlan, 30 Oct 1948, *Sauer 1278* (GH, MO, NA, UC, WIS). **CUBA. Ciudad de la Havana:** Havana, Estacion Central Agronomica, cultivated, *Baker 2843* (GH). **HAITI. Tortuga Island,** Vicinity of la Valle, 3 May 1929, *E. C. Leonard & G. M. Leonard 15302* (US). **GUATEMALA. Dep. Alta Verapaz:** Coban, 2 Nov 1950, *Sauer 1265-F* (WIS). Cubilquitz, 350 m, Aug 1903, *Tuerckheim s.n.* (GH). **Dep. Chimaltenango:** s.f. Chimaltenango, 28 May 1948, *Sauer 1168* (MO, NA, WI); s.l., *Sauer 1159, 1183* (DAV, NA); s.l., *Sauer 1184, 1178* (DS, GH, UC, NA, WIS); s.l., 10 Oct 1948, *Sauer 1267, 1240* (MO, NA, WIS); s.l., 31 Oct 1948, *Sauer 1240, 1279* (MO, WIS, NA); s.l. and same date *Sauer 1276, 1159, 1129, 1264, 1305,* (DS, GH, NA, UC, WIS); s.l. and same date *Sauer 1323, 1296* (DAV, NA, UC); s.l., 20 Nov 1948, *Sauer 1373, 1374* (MO, NA, WIS); s.l. and same date *Sauer 1367* (NA); s.l., 9 Dec 1948, *Sauer 1380* (MO, WIS, NA); s.l., 23 Dec 1948, *Sauer 1240* (DAV, MO, NA, WIS); s.l., 1 Feb 1949, *Sauer 1949* (MO, NA, WIS). s.f. San Juan Sactepequez, 18 Oct 1948, *Sauer 1177* (NA, DAV); s.l., 30 Oct 1948, *Sauer 1322, 1269, 1286, 1176, 1321, 1275, 1265* (NA, UC, WIS); s.l., 6 Nov 1948, *Sauer 1265* (DAV, UN); s.l., 20 Nov, *Sauer 1369, 1176* (DAV, UN). **NICARAGUA. Rivas:** Isla Ometepe, Volcan Maderas, 11°27–28'N, 85°31–32', 400–800 m, 24 Sep 1984, *Robleto 1273* (MO). **EL SALVADOR:** San Salvador, cultivated, Jun 1922, *Calderon 739* (GH). 20 Dec 1921–4 Jan 1922, "weed in garden," *Standley 19238* (GH, US).

SOUTH AMERICA. VENEZUELA: Bolivar, on the Orinoco, 75 m, Feb–Mar 1921, *L. H. Bailey & Z.*

Bailey 839 (BH). **COLOMBIA. Dep. Antioquia:** Robledo, 1560 m, 12 Sep 1965, *Grisales 11* (US). **Dep. Cesar:** Becerril, Jul 1970, *Ruddle s.n.* (WIS). **PERU. La Liberdad:** Trujillo, Hacienda la Encalada, 2300 m, 13 Feb 1957, *Sagastegui 38* (US). **BRASIL. Distr. Federal:** Paranoa at Lagoa Paranoa Lake, 12 Dec 1965, *Irwin et al. 11239a* (MO). **Distr. Santa Catarina:** Florianopolis, 20 m, 8 Aug 1964, *Klein 5353* (US).

3. Amaranthus hybridus L., Sp. Pl. 990. 1753. Type: "Habitat in Virginia"; LINN 1117/19.

Annual to 0.5–1.5(–2) m, usually erect. Stems weakly to densely pubescent above, multiseriate hairs being mixed with uniseriate hairs. Leaves rhombic-ovate to broadly-ovate-lanceolate. Inflorescence dark-green, either with many crowded slender, lateral branches, or lax, with only a few flexuous branches. Bracteoles 2.5–4(–6) mm long, narrow, about 1.2–1.5 to 2 times longer than the tepals. Tepals 5, almost equal, or one of them longer, 1.5–2.5(–3) mm long, with the mid-vein dark-green, with very variable form and length: a) narrowly-ovate to oblong-lanceolate, acute to subacute, erect, shorter than the fruit or b) oblong-lanceolate, obovate to spathulate, erect to outwardly curved, equal to longer than the fruit. Fruit usually circumscissile dehiscent, 1–1.5 times longer than wide, with the dehiscence line at the middle or in the upper half, more or less abruptly narrowed toward the stigma region and coarsely wrinkled above the dehiscence line. Infrequently plants with indehiscent or irregularly dehiscent fruits may be also encountered. Stigma branches are short, slender, erect (0.9–1.4 mm length and 0.1–1.18 mm width at the base). Type of pericarp surface variable: B to C (Fig. 1D). Seeds 1–1.4 × 1–1.35 mm, broad-elliptical to circular, lenticular. The tip of the hilum is placed below or at the same level as the tip of radicle. Seeds differentiated into central and a marginal zones, both sculptured. The cells of the exotesta are polygonal, 25–35 μm, with prominent anticlinal walls and convex, finely sculptured periclinal ones. The border of the seed is acute. Color dark brown to black, sometimes with the marginal zone having a paler tint.

Amaranthus hybridus is an extremely variable species, especially in Mexico, Central and South America and Africa (see also Sauer 1950). Coons (1975, 1978), after a meticulous study of their relationships, considered *A. quitensis* a synonym of *A. hybridus*. However she admited that one character, the inner tepal index, may be significant though not correlated with other characters. The description by Kunth (1817) of the pistilate flowers of *A. quitensis*: "calyx quinquepartitus; laciniis lanceolato-oblongis, obtusis" is actually a better description of *A. hybridus*. Thellung (1914) amended the description of *A. quitensis*: "tepals 5, about 2 mm long, spathulate with the apex broad-rounded (with mucro), with a green mid-vein continued into the mucro. Fruit shorter (rarely as long as) than the perianth." We consider that both descriptions together are more likely to represent *A. quitensis*. These features induced Bolos and Vigo (1974) to include *A. quitensis* as a subspecies of *A. retroflexus*. However, the real affinities of *A. quitensis* are more with *A. hybridus*, in which we include it as a subspecies. The hybrid between subsp. *hybridus* and subsp. *quitensis* has a pollen viability of 60% (Greizerstein & Poggio 1992), a value that shows both the affinity and the distinctness of the two taxa. Also, Greizerstein et al. (1997) showed significant differences in karyotype formulae and asymmetry indexes between the two taxa. Molecular evidence for the distinctness of the two taxa was provided by Chan and Sun (1997). We find the pollen of the two subspecies of *A. hybridus* easy to differentiate.

Amaranthus hybridus (especially subsp. *quitensis*) stands apart from *Amaranthus powellii* and *A. retroflexus* in its ecology and in its flowering and fruiting times in temperate regions, being about 2–4 weeks later. Native to Eastern North America, Mexico, Central and South America, but now a widespread and noxious ruderal and segetal weed.

1. Cotyledons narrow-elliptic to elliptic with rounded or obtuse apex; most tepals narrowly-ovate to oblong-lanceolate, acute or subacute, erect, shorter than the fruit; tectum with medium density of granules ____ **A. hybridus** subsp. **hybridus**
1. Cotyledons lanceolate, with acute apex; most tepals spathulate to obovate, obtuse or truncated, almost erect or outcurved, longer (rare equal) than the fruit; tectum with high density of spinules ____ **A. hybridus** subsp. **quitensis**

3a. Amaranthus hybridus subsp. hybridus (Fig. 4).

Amaranthus patulus Bertol. Comment. Itinere Neapol. 19. 1837. *A. hybridus* L. subsp. *patulus* (Bertol.) Carretero var. *patulus*, Collect. Bot. (Barcelona) 11:127. 1979. *A. hybridus* L. subsp. *cruentus* (L.) Thell. var. *patulus*. (Bertol.) Thell., Fl. Adventice Montpell. 8:206. 1912. *A. hybridus* L. subsp. *hypochondriacus* (L.) Thell. "proles" *cruentus* (L.)Thell. *var. patulus* (Bertol.) Thell., Ascherson & Graebner, Syn. Mitteleur. Fl. 5:244. 1914.

Amaranthus incurvatus Tim. ex Gren. & Godr., Prosp. Fl. France 8. 1846. *A. hybridus* L. subsp. *incurvatus* (Tim. ex Gren. & Godr.) Brenan var. *incurvatus*, Watsonia 4:268. 1961.

Amaranthus chlorostachys auct., non Wild.

Cotyledons narrow-elliptic to elliptic, 10–12 × 4 mm, with rounded or obtuse apex. Pollen grains 22–28 µm with 25–35 pores of 1.4–1.6 µm in diameter. Density of granules medium. (Fig. 2, E). $2n = 32, 34$.

The name *A. hybridus* was rejected as ambiguous by some authors because it was widely and persistently misapplied to *A. powellii* or *A. hypochondriacus*. As all these species were clearly typified, we cannot follow such a view. Another name "*A. chlorostachys*" which was very much used to designate this taxon, is based on a single green plant, within a red-coloured population of cultigens from India (*A. paniculatus WILLD 17521*(B)). It appears that Willdenow described this mutant as a separate cultigen, which later authors, ambiguously but constantly synonymized either with *A. hybridus* or with *A. powellii* (especially in Europe).

Sauer (1950) distinguished a "northern race" and a "tropical race" of *A. hybridus*. We subscribe to this practical, non-systematic grouping. The northern race is the "typical" *A. hybridus*, a common weed in the temperate regions of the world that causes little taxonomic problems. Sometimes introgression with *A. retroflexus*, *A. powellii* or dioecious species has been documented, but usually individuals are easy to identify. The length of bracteoles and the inflorescence

Fig. 4. *Amaranthus hybridus* subsp. *hybridus*, from *McWilliams 15123* (IA)

are variable, continuous and not correlated. Consequently, further infraspecific separation of a var. (subsp.) "hybridus" with bracteoles about 2 times longer than the tepals and inflorescence dense with many lateral crowded branches, and a var. (subsp.) "*patulus*" with bracteoles about 1–1.5 times longer than the tepals and an inflorescence less ramified and more lax, seems arbitrary.

The variability of the "tropical race"—common in Mexico, South America and Africa—is on the other hand exceptional, suggesting in our view that sometimes, additional taxa (unknown or other than the ones examined in this study) have contributed to the variability. Often these plants can be named *A. hybridus* only in a broad sense. If we use the tepal length character, such plants fall again into the two categories; **a)** plants with flowers that have the tepals longer than the fruit, and **b)** plants with flowers that have the tepals equal or shorter than the fruit. Within the first category, we encountered among plants from Mexico a distinctive variation that might deserve taxonomic recognition. It resembles subsp. *quitensis* but is obviously different, with tepals acute, mucronate, recurved, and up to 2 times longer than the fruit. Such plants were identified by Sauer as "*A. scariosus* × *A. hybridus* ?" or "*A. hybridus*, atypical" and were also observed and cited by Sanchez-Del Pino et al. (1999). Examples:

Chiapas: Municipio of Venustiano, Carranza, 25 Oct 1966, *Laughlin 2699* (DUKE). **Durango:** Oct 1896, *Palmer 759* (GH). **Hidalgo:** Rio Tula, 1700 m, 15 Mar 1965, *Quintero 2673* (DS). **Oaxaca:** Valley of Oaxaca, 1560 m, 8 Jul 1897, *Pringle s.n.* (CM, IA, MICH, MIN). 15 km SE of Oaxaca, 1740 m, 1 Oct 1962, *Ugent & Flores 2628* (WIS); Upper slopes of Cerro San Felipe, 17°9'N 96°50'W, 3 Oct 1962, *Ugent & Flores 2706* (WIS). Chimalapa, 1100 m, 16°42'N 94°05'W, 23 Oct 1984, *Maya 763* (MO); 16°43'N 94°08'W, 14 Nov 1984, *Maya 899* (MO). **Tamaulipas:** San Jose, 20 Feb 1939, *Le Sueur 112* (ARIZ).

The plants from the second category are even more variable suggesting, in our view, the participation of other taxa than *A. powellii*, *A. cruentus* or (and) *A. hypochondriacus*. Besides the "typical" variation *of Amaranthus hybridus*, we have encountered the following situations:

1) Plants reddish throughout.

2) The inflorescence composed of lax monochasial cymes (ripidium) with the rachis and the secondary axes visible (usually cymes in *Amaranthus* are very contracted and such details cannot be easily observed). Such lax cymes may be arranged in thick spiciform inflorescences, resembling *A. powellii* or in very branched inflorescences, with many patent, lateral branches (as in typical *A. hybridus*).

3) The bracteoles extremely thin, acicular, spinescent, rigid, 2–4(–5) times longer than the flowers.

4) The bracteoles arranged more or less at right angles to the main branches of the inflorescence, giving a general bristly appearance.

5) The bracteoles strongly recurved.

6) Variable number of tepals, 3–5, membranous, very unequal, without green mid-veins.

7) Tepals spathulate to obovate.
8) Tepals reduced, very small.
9) Variable number of stames, 3–5.
10) Fruit spherical, indehiscent, irregularly dehiscent or circumcissile with the pericarp smooth, the apex rounded (without a "beak") and the stigma branches very thin and erect.

The plants may exhibit one or more of the above characteristics, sometimes in combination with the usual features of *A. hybridus*. The variation is continuous, and at least for the moment, it was impossible to classify it into distinct types. As Sauer suggested (1950), collecting more material from these regions is needed for a better understanding of this taxon.

Distribution and ecology.—Originally from Eastern North America, Mexico and Central America, but now widespread all over the world as a weed in cultivated or waste places.

Representative specimens examined. **AFRICA. ALGERIA. Tilimsen:** vicinity of Tlimsen, 250 m, 24 Aug 1932, *Faure s.n.* (US). **ZIMBABWE. Mashonaland East:** Salisbury City (Harare), 3 Mar 1979, *Bayliss 8999* (MO). **Que Que Distr.:** Silsbury, 15 Mar 1978, *Chipunga 165* (MO). **MALAWI:** Ulongue, Zone A, 17 Oct 1985, *Patel & Bauda, 2799* (MO).

ASIA. PAKISTAN. Azad Kashmir: Mazaffarabad Distr., 4 Oct 1975, *Chaudhri et al 320* (MO). **Punjab:** Rawalpindi Distr. Islamabad, University of Islamabad, 2200 m, 2 Sep 1975, *Chaudhri et al. s.n.* (CM). **Swat:** Marghazar, 1300 m, 14 Oct 1975, *Shah et al 501* (A). **CHINA. Huanan:** Cili, 390 m, 9 Sep 1984, *Chow et al 395* (A). **JAPAN. Honshu:** Pref. Kyoto, Goma, Hiyoshi-cho, Funai-Gun, 200 m, 29 Sep 1991, *Murata & Takahashi 70295* (A). **Miyagi:** Miyagino-mushi, 3 Oct 1972, *Naito 72103* (A, MO). **Musashi:** Tokyo-to, Hondo, 22 Oct 1960, *Furuse s.n.* (A).

AUSTRALIA AND OCEANIA. AUSTRALIA. New South Wales: Woolloomooloo, 33°52'S, 151°13'E, 6 Apr 1976, *Coveny 7788* (A, RSA). Summer Hill, May 1970, *Michael M9* (WIS). **Queensland:** Brisbane, Kingaroy, 15 Apr 1947, *Smith 3027* (A).

EUROPE. SWITZERLAND. Basel: Klein Riechen, 10 Sep 1932, *Aellen s.n.* (WIS). **SPAIN. Catalunya:** Barcelona, Can Tunis, 23 Sep 1913, *Sennen 1789* (GH). **ITALY. Prov. Modena:** Formigine, Aemilia, 22 Sep 1917, *Fiori & Beguinot 2428* (BH, GH). **Prov. Turin:** La Molineta, 11 Sep 1852, *Perrier de la Bathie s.n.* (GH). **ROMANIA. Mun. Bucharest:** near Bucharest, 75 m, 26 Sep 1971, *Morariu 3334* (CM). Bucharest, Campus of the University of Agronomic Sciences, 12 Sep 1994, *Costea s.n.* (BUAG).

NORTH AMERICA. CANADA. Lambton Co.: Squirell Island, 2 Oct 1957, *C & L.O. Geiser 893 aSq* (WIS). **UNITED STATES. ALABAMA. Dallas Co.:** 5 mi E of Selma, 35 m, 23 Sep 1965, *Demaree 52967* (SMU, WIS). **Lamar Co.:** 7 mi N of Millport, 26 Jul 1987, *Gasparini 156* (IBE). **ARIZONA. Pinal Co.:** San Tan Village, near Sacaton, 29 Sep 1925, *Peebles et al.* 160 (ARIZ). **New Jersey.** Copper Point, 6 Nov 1932, *Whitte s.n.* (ARIZ). **ARKANSAS. Benton Co.:** Butler Creek bottoms, Sulphur Springs, 920 m, 2 Sep 1966, *Demaree 54209* (OKL, SMU, WIS). **Crittenden Co.:** W Memphis, 70 m, 16 Sep 1969, *Demaree 61082* (IBE, SMU). **Lincoln Co.:** Gould, 32 m, *Demaree 70227* (IBE). **Montgomery Co.:** top of Cristal Mountain, 580 m, 24 Nov 1965, *Demaree 53340* (SMU, WIS). **Nevada Co.:** Prescott, 300 m, 15 Aug 1970, *Demaree 62606* (DS, SMU). **Pulaski Co.:** Little Rock, 100 m, 20 Oct 1965, *Demaree 52919* (OKL, SMU). **Saline Co.:** Benton, 90 m, 19 Sep 1965, *Demaree 52912* (MSC, OKL, SMU, WIS). **CALIFORNIA. Los Angeles Co.:** Bryant Ranch, 13 Sep 1932, *Wolf 5215* (RSA). **Riverside Co.:** ranch near Tamecula, 27 Sep 1940, *Stubblefield 402998* (RSA). **San Francisco Co.:** San Francisco, Embarcadero at Montgomery Street, 22 Sep 1957, *Howell s.n.* (RSA, CAS, DAV). San Francisco, Fort Point, 29 Sep 1974, *Norris 256346* (RSA). **Santa Barbara Co.:** Santa Barbara, 7 Sep 1957, 2 Oct 1957, *Pollard s.n.* (CAS, SMU).

Ventura Co.: Ventura River's bed near Casitas Spring, 24 Sep 1965, *Pollard s.n.* (CAS). Horn Canyon Creek near Ojai Avenue, 2 Aug 1960, *Pollard s.n.* (DAV). **CONNECTICUT.** Southington, 16 Sep 1904, *Andrews s.n.* (BH). **FLORIDA. Alachua Co.:** Gainesville, E side of SW 17th Street, 20 Jul 1970, *Perkins 663* (FLAS). W of Gainesville, ca. 1/2 mi W of I-75 on N side of FL 26, 12 Jul 1990, *Gilliand 11* (FLAS, NA). **Broward Co.:** 2 mi W of Coral Springs, 21 Feb 1970, *McCart 11305* (FLAS). **Lee Co.:** Western Sanibel Island, 6 Dec 1972, *Brumbach 8126* (FLAS). **Indian River Co.:** W of Wabasso Island, 7Aug 1968, *D'Arcy 2299* (FLAS). **GEORGIA. Elbert Co.:** W of Elberton, garden of Stinchcomb Church Road, 23 Aug 1977, *Dunn 1243* (FLAS). **Ogelthorpe Co.:** Lexington, 29 Sep 1965, *Demaree 53018* (WIS). **Illinois. Champaign Co.:** Urbana, 2 Oct 1947, *Jones 17668* (MIN). **Union Co.:** Panther's Den, 7 Aug 1959, *MacMahon 715* (MIN). **Randolph Co.:** Old Kaskaskia, Kaskaskia Island, 21 Oct 1959, *Evers 63076* (MIN). **Madison Co.:** Collinsville, 9 Nov 1967, *Demaree 57461* (SMU, WIS). **Jackson Co.:** 2 1/2 mi of Carbondale, 19 Oct 1985, *Handel s.n.* (CM). River Forest, 8 Oct 1896, *E.T Harper & S. A. Harper s.n.* (ISC, WIS). **Iowa. Johnson Co.:** Oxford Twp., 80°N, 08°W, 24 Sep 1975, *Kantor 605* (IA). 10 mi N of Johnston 20 Aug 1952, *Anderson s.n.* (WIS). **Linn Co.:** Coggon, 15 Oct 1965, *McWilliam 15123* (US). **Muscatine Co.:** near Fruitland, 25 Sep 1909, *Shimk s.n.* (IA). Pine Mills, 28 Aug 1892, *Reppert s.n.* (IA). **INDIANA. Jackson Co.:** near Carbondale, 19 Oct 1985, *Handel s.n.* (CM). **Ripley Co.:** along Laughery Creek, E of Friendship, 13 Oct 1934, *Deam 55896* (MIN). **Steuben Co.:** E side of James Lake, 20 Sep 1914, *Deam 15484* (MIN). **Cloud Co.:** Concordia, between 5 & 6 Streets, 1 Sep 1940, *Fraser 622* (KSC). Salem, 20 Jul 1930, *Brooks 1445* (SMU). **KANSAS. Riley Co.:** Manhattan, H.A. Goff Farm, 23 Sep 1969, *Goff s.n.* (KSC). **Saline Co.:** Salina, 31 Aug 1930, *Hancin 695* (KSC). 17 Aug 1931, *Blake 11380* (MSC). Cambridge, 27 Sep 1896, *Blankinship s.n.* (ISC). **MICHIGAN. Lanawee Co.:** Hidden Lake Gardens of Michigan State University, 15 Sep 1960, *Freeman 18* (MSC). **MISSISIPPI. Grenada Co.:** 2.7 mi N of Gore Springs, 12 Aug 1986, *Morris 2471* (IBE). **Leflore Co.:** 7.5 mi N of Green Wood, 27 Aug 1959, *McDaniel 1276* (IBE). **Jones Co.:** 1 mi E of Laurel, 29 Sep 1978, *Morgan 1279* (IBE). **Madison Co.:** Natchez Trace Parkwey, 22 Sep 1948, *McDougall 1777* (US). **Monroe Co.:** vicinity of Aberdeen, 4 Sep 1994, *MacDonald 7599* (IBE). **Washington Co.:** Just N Leland, 28 Aug 1990, *Bryson 10271* (IBE). **Missouri.** Kansas City, 25 Sep 1913, *Rose 15133* (US). **Jackson Co.:** 14 Oct 1943, *Bush 316* (MIN). **Jasper Co.:** Webb City, 7 Oct 1949, *Palmer 49851* (UMO). **Lawrence Co.:** Sycamore Hollow, 20 Sep 1950, *Palmer 51143* (UMO). **Lincoln Co.:** N of Troy, 15 Sep 1952, *Sauer 1616* (WIN). **St. Louis Co.:** Saint Louis, 20 Sep 1975, *Boufford & Muehlenbach 17995* (CM); s.l., 21 Aug 1949, *Shinners 11568* (MIL, SMU, WIS). **Nevada. Clark Co.:** 1.5 mi S of Moapa, 450 m, *Niles 3100* (ARIZ). **NORTH CAROLINA. Chemung Co.:** Elmira, 21 Sep 194, *Smith 2306* (BH). **Granville Co.:** Wilton, 2 Sep 1937, *Godfrey 2150* (NA). **Iredell Co.:** 0.8 mi W NW of Scotts, then 2.6 mi S, 24 Oct 1958, *Ahles 51921* (FLAS). **Orange Co.:** Korstian Division, E of Route 1712, 400 m, 22 Sep 1988, *Palmer 1333* (DUKE). **Wake Co.:** 0.5 mi NW of Sandy Ridge or the intersection of NC 50 and County Road 1900, *Wilbur 45364* (DUKE). **Wilson Co.:** State Road 1649, 3 mi S of Lucuma, 22 Oct 1991, *Wilbur 60002* (DUKE). **NEW YORK. Bronx Co.:** New York, near the Botanical Garden, 21 Oct 1986, *Nee 33270* (CM, WIS). **Kings Co.:** Long Island, 25 Sep 1955, *Brooks 3977* (BH). **Tompkins Co.:** ca. 2 mi S of Ithaca, 22 Sep 1943, *Schuster 8217* (DUKE). Ithaca, 1 Oct 1941, *Thorne 213* (IA). Ithaca, 6 Oct 1926, *Bailey s.n.* (BH). 10 Sep 1917, *Bailey s.n.* (BH) 21 Aug 1916, *Metcalf 6395* (BH). **Ohio. Portage Co.:** Kent, 20 Sep 1913, *Hopkins s.n.* (CM). **Richland Co.:** Mansfield, 12 Aug 1895, *Wilkinson s.n.* (BH). **OKLAHOMA. Kay Co.:** near Tonkawa, 4 Aug 1913, *Stevens 1841* (US). **Cleveland Co.:** Little River bottoms, 25 Sep 1920, *Jeffs 1309* (OKL). **Muskogee Co.:** s.l., 28 Aug 1927, *Little Jr. 2711, 2487, 2197* (OKL). **Ottawa Co.:** Ottawa, 29 Aug 1913, *Stevens 2557* (MIN). **PENNSYLVANIA. Allegheny Co.:** 4km N. of Tarentum, 2 Sep 1990, *Zand 339* (BH, CM). **Bearer Co.:** 18.2 mi Wet Raccon St. Park., 9 Oct 1965, *Farnsworth s.n.* (CM). near Georgetown, along Ohio River shore, 1 Sep 1951, *Henrici 15112* (CM). **Bedford Co.:** 1/2 mi S-SE Hyndman, 300 m, 2 Sep 1940; *Berkheimer 2212* (CM). **Berks Co.:** 1/2 mi S of Bethel, 110 m, 19 Sep 1948, *Berkheimer s.n.* (IA). 2 mi NE of Kutztown, 6 Oct 1986, *Nee 33266* (CM). **Butler Co.:** Petersville, 23 Aug 1922, *Herbert & Graham s.n.* (CM). **Centre Co.:** Oak Hall, Mill Pond, 10 Sep 1939, *Wahl 434* (BH). **Delaware Co.:** Upper Darby, 0.2 mi SE of intersection between Marshall Road and 69th street Boulevard, 30 Sep 1941, *Wheeler 603148* (RSA). **Westmoreland Co.:** Penn, South Huntington Township, 40°14'N, 79°45'W, 270 m, 12 Aug 1974, *Utech 94-1959* (CM). **TENNESSEE. Davidson Co.:** s.f. unknown locality cultivated at Ames, Iowa, 1 Oct 1965, *McWilliams 1826* (WIS). **Lake Co.:** Near Markham, 15 Aug 1947, *Sharp et al. 6266* (WIS). **Shelby Co.:** Presidents Island, Mempnis, 60 m, 25 Oct 1952, *Demaree 33190* (GH). **Washington Co.:** Johnson City, 813 Forest Avenue, 15 Oct 1994, *Churchill 94206* (MSC). **TEXAS. Brazos Co.:** College Hills Woodlands (cultivated), 9 Sep 1942, *Reeves s.n.* (SMU). **Sunset Co.:** 8 mi Tyler, 14 Oct 1944, *Moore 917* (BH, GH). **VIRGINIA. Bedford Co.:** 15 Sep 1869, *Curtiss s.n.* (GH). Quantico, 20 Aug 1915, *Tidestrom 7582* (NA). **Campbell Co.:** intersection of Waterlik and Leesville Rds., 26 Aug 1978, *Ramsey & Freer 26303* (SMU, WIS). Diggs Beach on St. Rte. 643, 8 Oct 1978, *van Montfrans 2106* (FLAS). **Giles Co.:** New Port, 580 m, 14 Aug 1958, *Iltis 19938* (WIS). **Wisconsin. Richland Co.:** 1 mi NE of Richland Center, 20 Aug 1983, *Nee 43787* (MO). **Rock Co.:** near Edgerton, 5 Sep 1952, *Sauer 1597* (WIS). **WASHINGTON D.C.** 10 Sep 1897, *Steele s.n.* (DUKE); s.l., 11 Aug 1949, *Freeman 417* (NA).

MEXICO AND GREATER ANTILLES. BERMUDA. St. George Island: South Road, 31 Aug 1913, *Collins 189* (GH); s.l., 10 Mar 1908, *Brown 538* (GH). **MEXICO. Chiapas:** Mpio. Pokolum, Tenejapa 1600 m, *Breedlove 6091* (DS); s.l. 22 Nov 1964, *Breedlove 7423* (WIS). **Chihuahua:** Mpio. Batopilas, Barranca de Batopilas, 2100 m, 10 Oct 1973, *Bye 5391* (ECON). Nobogame, 28°30'N, 108°30'W, 1800 m, 10 Sep 1987, *Laferriere 545* (WIS). **Hidalgo:** San Bartolo, Tutotepec, 1000 m, 4 Nov 1973, *Gimate 861* (ARIZ, UMO, CAS). **Distr. Federal:** Mexico City, campus of UNAM, 2300 m, 4 Sep 1986, *Nee 32980* (CM, WIS). **Jalisco:** Guadalajara, Oct 1896, *Palmer 626, 629, 630* (GH, US). 15 km W of Guadalajara, 20°43'N, 103°24'W, 1700 m, 26 Sep 1978, *Iltis & Lasseigne 625* (WIS). Volcan Colima, 19°39'N, 103°32'W, 1750–1800 m, 24 Sep 1978, *H.H. Ilis et al 559* (WIS). **Michoacan:** N of Mason Nuevo, 2300 m, 31 Jul 1977, *Bennett et al. 721* (UMO). Distr. Ixtlan, Mpio. Comaltepec, S of Comaltepec, 17°33'N, 96°31'W, 2000 m, 8 Dec 1987, *Lopez Lopez 5* (MO). **Nuevo Leon:** 35 mi of Monterrey, Hacienda Vista Hermosa, 700 m, 27 Jun 1939, *White 1592* (ARIZ). **Oaxaca:** Nayarit, 11 Jul 1948, *Sauer 28* (MO). Valley of Etla, Sep 1895, *Aloarry 749* (GH). **Puebla:** Puebla, Rancho Pasadas, 2194 m, 25 Aug 1909, *Nicolas 292* (CM). **Veracruz:** Distr. Papautla, Tajin, 3 Dec 1947, *Gonzales 105* (BH). Mpio. Xalapa, Claviejo, Xalapa Botanical Garden, 19°30'30"N, 96°56'30"W, 300 m, 18 Sep 1986, *Nee 33066* (WIS, CM). Remundandero, Feb 1923, *Purpus 8870* (GH). Mpio. Emiliano Zapata, Barranca de San Antonio, 590 m, *Hernadez 62* (MO). between Veracruz and Villahermosa, km marker 180, 70 m, *Croat 62122* (MO). Mpio. Coatepec, 3 km N of Coatepec, 19°29'N, 96°57'W, 1250 m, 22 Aug 1986, *Nee 32852* (WIS). Rancheria Palmas Cuatas, Ignacio de la Llave, 6 m, 12 Aug 1966, *Martinez 21739* (DAV). **BAHAMAS. Crooked Island:** Landrail Landing, 6 Jun 1977, *Corell & Proctor 48773* (US). **CUBA:** Valley of San Angustina, 21 Mar 1903, *Britton et al. 512* (CM). **GUATEMALA. Dep. Alta Verapaz:** s.f. Coban cultivated at Davis, California 29–31 Oct 1948, *Sauer 1309* (WIS). **Dep. Juatipa:** 1.2 km N of el Progreso (W side of the Road) to Jalapa, 1040–1060 m, 27, 30, 31 Dec 1975, *Iltis G 14* (WIS). **Dep. Santa Rosa:** Santa Rosa, 930 m, Aug 1892, *Heyde & Lux 4062* (GH). **NICARAGUA. Dep. Esteli:** Santa Cruz, 13°01N, 86°18'W, 950–1000 m, 9 Nov 1980, *Moreno 4561* (MO). Loma Ocotecalzado, 13°10'N, 86°18'W, 1260–1300 m, *Stevens et al 15589* (MO). **COSTA RICA. Prov. Cartago:** Cartago, 1400 m, Nov 1887, *Cooper 5908* (GH, US). **Prov. San Jose:** San Jose, 1100 m, Jan 1896, *Tanduz 9856* (GH). **PANAMA. Chiriqui:** vicinity of Boquete, 1000–1250 m, 12–13 Dec 1966, *Lewis et al 594* (GH, NA, UC). Bambito, 1400 m, 12 Mar 1974, *Tayson 7240* (US).

SOUTH AMERICA. COLOMBIA. Cauca: Cordillera Central, River Palo, between Tacueyo and La Tolda, 1780–1900 m, 14 Dec 1944, *Cuatrecasas 19472* (GH). **BRASIL:** Bello Horizonte, 1000 m, 5 Mar 1945, *William & Assis 6461* (GH). **Goias:** Corumba de Goias, 16°S, 49°W, 1000 m, 3 Dec 1965, *Irwin et al 10991* (RB). **Parana:** Parque Nacional de Iguacu, Picado do Benjamin, 400 m, 26 May 1949, *Duarte & Pereira 1911* (RB). **Rio Grande do Sul:** Minas, 16 Apr 1935, *Hoffman 6* (RB). **BOLIVIA. Yungas.** 1890, *Bang 231* (GH). Hacienda Simaco above the road to Tipuani, 1400 m, Jan 1920, *Buchtien 5401* (GH).

3b. Amaranthus hybridus subsp. **quitensis** (Kunth) Costea & Carretero, comb. nov. BASIONYM: *Amaranthus quitensis* Kunth, Humb., Bonpl. & Kunth, Nov. Gen. Sp. 2., folio: 156; ed. 4:194. 1817. *A. retroflexus* L. subsp. *quitensis* (Kunth) O. Bolos & Vigo, Butll. Inst.

Catalana Hist. 38:89. 1974. *A. hybridus* L. var. *quitensis* (Kunth) Covas, Darwiniana 5:329-368. 1941. TYPE: ECUADOR: "Crescit in ripa fluvii Guallabambae, alt 1030 hex," (Regno Quitensi), 6, 1802, *Humboldt & Bonpland 3082* (HOLOTYPE: P?).

Amaranthus caudatus sensu Greuter et al., Med-Checkl. 1:46. 1984. p.p., non L. s. str.

Cotyledons lanceolate, 12 × 2–2.5 mm, with acute apex. Pollen grains 25–30 µm with 28–35 pores of 1.2–1.4 µm in diameter. The pollen differs to subsp *hybridus* by the tectum with high density of spinules. (Fig. 2, F). 2n= 32.

We share a different view from Coons (1975, 1978) over the boundaries of this taxon. The tepals can be variable, erect to recurved as in other species (for example *Amaranthus retroflexus*). More important are the length and shape of tepals. Therefore the type of this taxon is indeed *Humboldt & Bonpland 3082* deposited in Paris (P).

The length of bracteoles is variable in subsp. *quitensis* too. Typically the bracteoles are 1.5–2 times longer than the tepals. The plants from Galapagos Islands have shorter bracts, 1–1.2 times longer than the tepals and also stand apart in that their flowers have tepals and bracteoles with very large, ramified, green mid-veins with very narrow membranous margins. In the present account we do not include *A. hybridus* var. *sangorache* (Coons 1975, 1978) within *A. hybridus* subsp. *quitensis* more research being necessary in order to clarify the status of this taxon.

Distribution and ecology.—A native riverbank pioneer in tropical South America, where it is a noxious weed, this plant is more dependent on a warm climate than subsp. *hybridus*. Even though it was recorded in Europe since the 19th century, as a casual in most countries, it is naturalised only in the Azores and Balearic Islands (Akeroyd 1993). It has also been collected in Australia.

Representative specimens examined: **SOUTH AMERICA. ECUADOR. Charles Island:** Black Beach, 19 May 1932, *Howell 9381* (CAS). **Isabela Island:** Tagus Cove, Jun 1899, *Snodgrass & Heller 219* (GH). **Santa Cruz:** along "Old Trail" from Academy Bay toward Bella Vista, 5–100 m, 24 Jan 1964, *Wiggins 18334A* (CAS). Bella Vista, 200 m, 27 Jan 1967, *Fosberg 44851* (RSA). Academy Bay, Apr 1953, *Bowman 46110* (CAS). El Chato, 31 Jul 1966, *Colinvaux s.n.* (CAS). **PERU. Dep. Cajamarca:** Valley of Rio Chamaya, 36 km W of Pucara, 5°55'S, 79°19'W, 1100 m, 18 Apr 1984, *Croat 58375* (CAS). **Dep. Cusco:** Prov. Urubamba, 1/2 mi E of Urubamba, 2800 m, *Iltis & Ugent 1160* (CAS). **Dep. Piura:** 37,3 km of Pucara, 5°47'S, 79°27W, 1550 m, *Croat 58392* (CAS). **BRASIL. Estado do Rio Grande do Sul:** Serra Geral, 17 Mar 1983, *Silveira & Frosi 544* (RB). **BOLIVIA. Andres Ibanez:** 12km E of center of Santa Cruz, 17°46' to 47', 63°04'W, 375 m, 4 Feb 1987, *Nee 33988* (CM). W side of Santa Cruz, 17°47'S, 63°40'W, 420 m, 14 Jan 1987, *Nee 35481* (CM). 15 km of Cotoca, 17°42'S, 62°53'W, 325 m, 28 Jan 1989, *Nee 37776* (WIS). **Santa Cruz:** Prov. Caballero: 2km NW of Rio San Isidro bridge in San Isidro, along to highway to Comarapa, 18°02'S, 64°27'W, 1575 m, 29 Dec 1995, *Nee 46591* (ADA). Angostura, 550 m, 25 Jun 1966 *Steinbach s.n.* (RSA). ca. 21 km SE of Palmar del Oratorio, 18°02'S, 63°01'W, 365 m, 22 Jan 1989, *Nee 37648* (WIS). Ichilo, Buena Vista, 17°27'S, 63°40'W, 370 m, 2 Aug 1987, *Nee 33510* (CM). **PARAGUAY. Guaira:** Tororo, Camino a Polilla, 25°55'S, 55°15'W, 10 Dec 1988, *Degen 1035* (MO). Centro Forestier, Pta. Stroessner – Alta Parana 250 m, 24 May 1982, *Stuts 310* (MO). **URUGUAY. Dep. Montevideo:** Pocitos, Mar 1924, *Herter 68154* (MSC, WIS). **ARGENTINA. Prov. Buenos Aires:** La Belgica, 17°34'S, 63°13'W, *Nee 33475* (ISC). Hudson, 15 May 1945, *Hunzinker 661* (A); s.l., 15 May 1945, *Hunzinker 2260*

(GH). Pergamino, 22 Mar 1929, *Parodi 8910* (GH). **Prov. Catamarca:** Ancasti, Rio Chico, 28 Nov 1950, *Brizuela 759* (CM). Dep. La Paz, El Bello, 3 Mar 1950, *Brizuela 1211* (MICH, CAS). **Prov. Chaco:** Dep San Martin, La Leonor, 26–27 May 1988, *Schinini 26222* (GH). **Prov. Formosa:** Dep. Pilcomayo, Ruta 86 al km 55, 9 Feb 1948, *Morel 4594, 6542* (UMO). 3 km of Portenito, 6 Oct 1947, *Morel 3857* (US). S of Laguna Primavera, 20 Dec 1949, *Morel 9110* (CM). **Prov. Misiones:** Dep. San Pedro, Cataraguatay (Centro) 11 May 1949, *Montes 1625* (CAS, WIS). Pasadas, 21 Jul 1945, *Bertoni 1519* (A); s.l., 17 Nov 1907, *Ekman 117, 118* (US, GH). Isla Pindoi, Jul 1945, *Grovetto 3435* (CAS). **Prov. Salta:** El Potrero, 30 Mar 1950, *Brizuela, 1099* (US). Dep. Boqueron, 68 km NE de Filadelfia, 10 Dec 1992, *Krapovickas et Cristobal 44281* (MO). Dep. Candelaria, El Datil, 7 Feb 1949, *Montenegro 349* (CAS). Dep Rosario de la Frontera, La Junta, 690 m, 29 Jan 1935, *Carbone 12700* (GH). **Prov. Tucuman:** La Ramada, 450 m, 2 Apr 1933, *Deirano 9666* (GH). Dep Rio Chico, Escaba, 600 m, 5 Dec 1913, *Onetti 1653* (GH). Dep Seales, la Florida, 270 m, Jun 1913, *Monetti 11659* (GH). **CHILE:** s.f. Angol, grown at Cornell University, Jul–Aug 1937, *Murray 36023 (10)* (BH).

4. Amaranthus hypochondriacus L., Sp. Pl. 991. 1753. (**Fig. 5**). TYPE: "Habitat in Virginia"; LINN 1117/24.

Amaranthus chlorostachys Willd. var. *erythrostachys* (Moq.) Aellen, Hegi, Illustr. Fl. Mittel.-eur. ed. 2, 3(1-2):482. 1959. *A. hybridus* L. subsp. *hybridus* var. *erythrostachys* Moq., DC., Prodr. 13(2):259. 1849. *A. hybridus* L. var. *hypochondriacus* (L.) Robinson, Rhodora 10:32. 1908. *A. hybridus* L. subsp. *hypochondriacus* (L.) Thell. proles *erythrostachys* (Moq.) Thell., Ascherson & Graebner, Syn. Mitteleur. Fl. 5:241. 1914.

Amaranthus flavus L. Syst. Nat. ed. 10. 2:1269. 1759.

Amaranthus frumentaceus Buch. Hamilt. ex Roxb., Fl. Ind. 3:613. 1832.

Amaranthus anardana Buch. Hamilt. in Wall. ex Moq.-Tand., DC. Prodr. 13(2):256. 1849.

Amaranthus leucocarpus S. Wats., Proc. Amer. Acad. Arts. 10:347. 1875.

Amaranthus leucospermus S.Wats., Proc. Amer. Acad. Arts. 22:446. 1887.

Like *A. cruentus*, but inflorescence usually stiff, with thick branches. Cotyledons as in *A. cruentus* but larger, 18 × 5 mm. Bracteoles 3–5 mm long, about 1.5 mm longer (sometimes 2 times longer) than the tepals. Tepals 5, one equal to or longer than the fruit, the others 4 shorter, lanceolate, with the mid-vein brown-reddish. Fruit circumscissile, tapering gradually toward the stigma region, 1.5–2 mm long, about 2 times longer than wide, with the dehiscence line in the upper half. Stigma branches thick, spreading, about 1.6–1.8 mm long and 0.6–0.8 mm wide at the base. Type of pericarp surface variable: A to B. All the other morphological characteristics of the fruits and dark seeds correspond to those of *A. powellii*. The pale seeds are very much like those described for *A. caudatus*, differing in having the cells of the exotesta inconspicuous (because their anticlinal walls are inconspicuous) and the periclinal walls evidently wrinkled. Pollen grains of 18–23 µm, with 32–45 pores of 1.3–1.5 µm in diameter. Density of granules medium. $2n = 32, 34$.

Distribution and ecology.—This species is originally from North America, where its closest wild relative *A. powellii* is common, though at the same time it is evidently related to the cultivated *A. cruentus*. Sauer (1993) suggests that it is probable that it is of hybrid origin from those two taxa. This relationship is also supported by some molecular studies (Transue et al. 1994; Kirkpatrik 1995; Chan

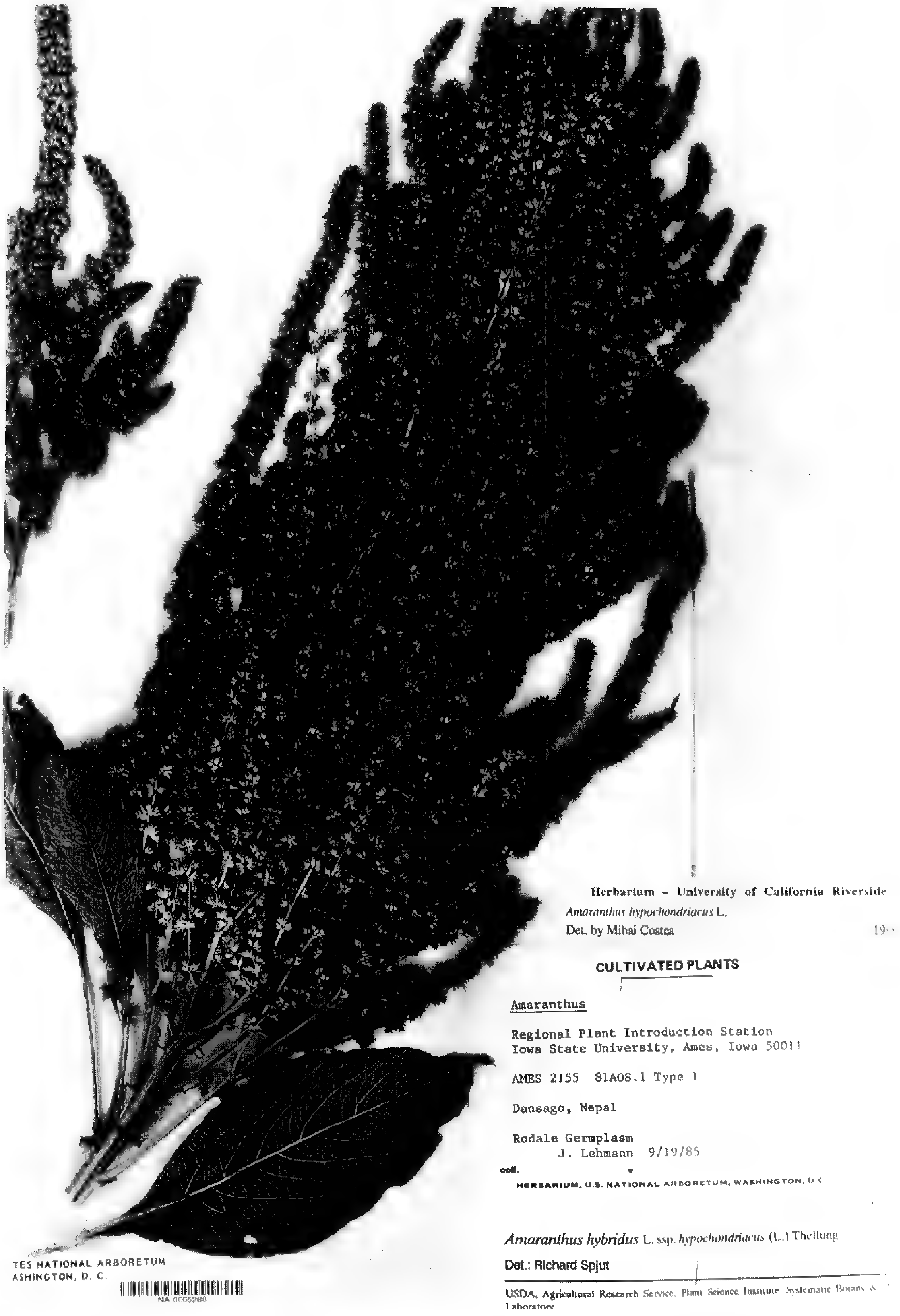

Fig. 5. *Amaranthus hypochondriacus*, from Lehmann, AMES 2155 (NA)

& Sun 1997). Like *A. cruentus*, it is cultivated as an ornamental, for grain and as a potherb.

Representative specimens examined: **AFRICA. KENYA. Nairobi Distr.:** Nairobi, Ministry of Works Estate, W Bahati, 1678 m, 12 Feb 1969, *Mwangangi 1331* (MO).

ASIA. PAKISTAN. Baltistatan: Skardu, 2150 m, 16 Aug 1936, *Koelz 9627, 2928* (NA). **Swat Distr.:** Fatehpur, 1270 m, 17 Oct 1975, *Shah et al 690* (A). **INDIA:** s.f. unknown locality cultivated at Kutztown, Pennsylvania, 12 Sep 1984, *Strudwick & Reider RRC 1175* (MO). Sholur, 15 Mar 1963, *Noble # M* (NA, WIS). Kasalhado, 14 Feb 1963, *Noble # j* (NA, WIS). E Jakatala, Badaga, 1780 m, 14 Feb 1963, *Noble # k* (WIS). Northern Thuneri, 1900 m, 27 Jul 1993, *Noble s.n.* (WIS); s.l., 30 Aug 1964, *Sauer 3952, 3942c* (NA, WIS). **Jammu and Kashmir:** Srinagar, 1400 m, 20 Sep 1956, *Polunin 56/819* (MO, NA, WIS). Tangmarg, 1900 m, 16 Aug 1956, *Polunin 56/300* (MO, WIS). Sind Valley, Rezan, 2400 m, 31 Aug 1956, *Polunin 56/617* (MO, WIS, NA). near Miragund, 1400 m, 15 Sep 1959, *Polunin 56/804* (WIS). Upper Nilgiri Hills, Kil Kotagari, 1800 m, 18 Sep 1962, *Noble # e* (WIS). Wangat Nullah at Khanan, 2000 m, *Polunin 56/759* (MO, NA). **Tamil Nadu:** near Coonoor, 21 Jan 1963, *Noble # b* (NA, WIS). Madras, Kurumba Villages, 1370 m, 18 Nov 1962, 16 Dec 1963, 20 Jan 1963, *Noble s.n.* (WIS). s.f. Kurumba, 6 Oct 1964, *Sauer 3949b* (MO, WIS, NA); s.l., 2 Nov 1964, *Sauer 3950, 3954b* (WIS, NA, MO). **Uttar Pradesh:** s.f. Mussorie, collected by Lal (1961), cultivated in New York, Ithaca, Aug–Nov 1969, *Sauer 2845* (BH, NA, WIS). **NEPAL:** s.f. Marku Valley, Sirsagarhi, 10 Nov 1950, cultivated, *Sauer 1495D* (A). **SRI LANKA**. **Distr. North Central Province:** Anurahdapura, 60–61 mi from Kandy on the road to Jaffna South Kagama, 24 Feb 1973, *Townsend 73/117* (US). **Central Province:** Matale Distr., Sigiriya Wewa, 11 Mar 1973, *Townsend 73/205 (US)*. **CHINA**. **Prov. Heilongjiang:** Ping Shan, 45°57'N, 127°23'E, 370 m, 2 Sep 1993, *NACPEC, HLJ-37* (NA). Border between Prov. Hopeh and Honan, Chicungshan, 400–900 m, 18 Jun 1917, *Bailey s.n.* (BH). s.f. Muping Sikong, 2500 m, 10 Nov 1950, *Sauer 1489-E* (GH). **Szechwan:** s.f. Mowhsien, 2000 m, 10 Nov 1950, *Sauer 1499-F, 1484-D* (GH). **Yunnan:** Muli, Wachin, Schawan, 3000 m, "side of field," 1937, *Yu 14481, 14482* (A). **Ho-pei:** Near Chou Cheng, 26 Sep 1948, *Beach 238* (US).

EUROPE. NORWAY. Oslo: Oslo, s.f. Botanical Garden, University Norway, 3 Sep 1940, *Gillett 40 5-2* (NA). **SWEDEN. Stockholm:** Stockholm. s.f. Botanical Garden of Stockholm, *Grant 225* (WIS). **ITALY**. **Friuli Venezia-Giulia:** s.f. Udine, Botanical Garden of Instituto Tecnico Zanon, *Grant 426* (NA). **FRANCE**. **Doubs:** Besancon, s.f. Botanical Garden of the University de la Ville, *Grant 428* (NA). **Loire-Atlantique:** s.f. Botanical Garden Nates, unknown date, *Grant 223, 227, 227b* (NA). *231* (WIS). **HOLLAND. Noord-Holland:** Amsterdam, s.f. Botanical Garden of Amsterdam, *Grant 131* (WIS). **GERMANY. Nordrhein Westfalen:** Bonn, s.f. Botanical Garden, University Bonn, *Grant 428* (NA). **AUSTRIA**. **Burgenland:** Pamnagen, Aug 1954, *Patzak s.n.* (DAV). **RUSSIA**. s.f. unknown locality grown in Ithaca, New York, 31 Jul 1936, *Muenscher s.n.* (BH). **ROMANIA. Cluj Co.:** s.f. Cluj, cultivated at Ithaca, New York, 19 Jul 1970, *Dress 9943* (BH). **Mehedinti Co.:** Orsova, ruderal, 9 Jul 1966, *Morariu s.n* (BUCA). **LITHUANIA. Neman:** s.f. Kaunas, cultivated in Ottawa, Canada, 1939, *Zinck 39-97-7* (BH). **IRAN:** s.f. unknown locality cultivated at Glenn Dale, Maryland, 11 Aug 1939, *Cowgill 2355* (BH).

NORTH AMERICA. CANADA. ONTARIO: Ottawa, cultivated at Dominion Botanical Garden, 29 Aug 1939, *Lawrence 682* (BH). **UNITED STATES. CALIFORNIA**. **San Bernardino Co.:** San Bernardino Valley, 300 m, 16 Sep 1907, *Parish 6472* (MIN). **Yolo Co.:** Davis, on the campus, 10 Aug 1978, *Kellner s.n.* (DAV). **FLORIDA. Citrus Co.:** Inverness, 3385 South Highlands, 20 Jul 1989, *Johnston s.n.* (FLAS). **KANSAS. Washington Co.:** SE corner of the County, 13 Oct 1938, *Holman s.n.* (KSC). **MICHIGAN. Gratiot Co.:** Alma, Sept 1935, *Davis s.n.* (BH). **MINNESOTA. Dakota Co.:** Inner Grove, ruderal, 14 Sep 1930, *Jones 513* (MIN). **MISSOURI. Jakson Co.:** Independence, 2 Sep 1895, *Mackenzie 21111* (MIN, ISC). **NEBRASKA. Adams Co.:** Hastings, 20 Oct 1934, *Rose de Lima 300* (CM). **NEW YORK. Onondaga Co.:** Syracuse, SE corner of Onondaga Lake, 21 Aug 1916, *Wiegand 6396* (MO, GH). **Tompkins Co.:** Ithaca, "weed in garden," 14 Aug 1919, *Bailey s.n.* (BH); s.l., ruderal, 24 Aug 1925 *Muenscher s.n.* (BH). Cinders, College of Agriculture, ruderal, 12 Sep 1923, *Burnham 15065* (BH). **PENNSYLVANIA. Dane Co.:** Murphy's Creek, 22 Aug 1945, *Hale s.n.* (WIS). **Erie Co.:** 10 Aug 1894, *Miller s.n.*

(CM). Stoyestown, 20 Jul 1873, *Patterson 6210* (CM). **WISCONSIN. Rock Co.:** Beloit, 9 Aug 1936, *Anthony s.n.* (WIS). **Oneida Co.:** Minoqua (ruderal), 24 Sep 1981, *Harrington 36* (WIS).

MEXICO. Chihuahua: Rio Mayo, Guasaremos, 20 Sep 1935, *Scott Gentry 1844* (NA). s.f. Rancho Tigre, 17 Oct 1948 *Sauer 1193, 1396* (BH, NA, WIS). **Colima:** Colima, August 1897, *Palmer 120* (DS). **Distr. Federal:** s.f. Mpio. Atlapulco, San Gregorio, 28 May 1948, *Sauer 1171* (MO, GH, NA, WIS); s.l., 31 Oct 1948, *Sauer 1211* (GH, MO, NA, WIS); s.l., 31 Jan 1949, *Sauer 1404* (MO, GH, NA, WIS). **Guerrero:** s.f. Chilapa, 20 Aug 1948 – 21 Jan 1949, *Sauer 1162-E* (MO, GH, NA, WIS). Pemex N of Chilpancingo, "ruderal," 20 Aug 1972, *Dunn et al. 20477* (UMO). **Jalisco:** Tlajomulco, 25 Aug 1947, *Sauer 1174* (BH, GH, MO, NA, WIS). **Mexico:** Temascaltepec de Gonzales, Timbres, 1660 m, 15 Oct 1932, *Hinton 2137* (MO). Mpio. **Michoacan:** Zacapan, 25 Aug 1947, *Sauer 1170* (BH, NA). Zacapu, 25 Aug 1947, *Sauer 1395* (DS, MO, NA, WIS). Opopeo, 30 Oct 1948, *Sauer 1274* (BH). **Oaxaca:** Clavillones in Zimatlan area, 30 Oct 1948, *Sauer 1266* (MO, NA, WIS). **Puebla:** San Jeronimo Teocuizmalco, 31 Oct 1948, *Sauer 1239* (NA, WIS). **Sonora:** Rio Mayo, cultivated, 20 Sep 1935, *Scott Gentry 1843* (GH). Rio Mayo, Rancho el Moschite, 11 Oct 1979, *Nabhan GN 975A* (GA). **Tlaxaca:** San Berabe Amaxac, 5 Oct 1949, *Sauer 1535* (GH, MO, UC, NA, WIS). San Miquel del Milagro, 30 Oct 1949, *Sauer, 1288, 1293, 1277, 1139* (GH, MO, NA, WIS). **Veracruz:** between Tequila and Orizaba, 15°45'N, 97°5'W, 1600 m, Jan 1984, *B. Benz & K. Benz 980* (WIS).

5. **Amaranthus powellii** S.Wats., Proc. Amer. Acad. Arts. 10:347. 1875. Type: Described from a plant cultivated at Harvard University "from seeds brought from Arizona by Col Powell," *Powell s.n.* (HOLOTYPE: US 16163; ISOTYPE: MO).

Erect annual 0.5–1.5(–2) m, with stem glabrous to puberulent mostly in the inflorescence region, with trichomes multicellular and uniseriate. Cotyledons narrow-elliptic, 10–12 × 3 mm, with acute to rounded apex and acute to cuneate base; petiole about 5–6 mm long. Leaves, broadly-elliptic to rhombic or lanceolate, 3–8 × 2–6 cm. Bracteoles rigid, heavy, 4.5–6(–8) mm long, about 2–3(–4) times longer than the tepals. Tepals 3–5, evidently unequal; one tepal is 2.2–3 mm long, the others 1.2–1.6 mm long, linear-lanceolate to elliptic, with the mid-veins inconspicuous (only in the longest tepal may be partially visible). The longer (outer) tepal surpassing the fruit, the shorter (inner) tepals shorter than (or as long as) the fruit. Fruit dehiscent or indehiscent, elliptical to obovoidal, 1.5–2 times longer than wide, when dehiscent with the dehiscence line in the upper half, gradually narrowed toward the stigma region, the apex of the fruit truncated. Stigma branches thick, spreading from the base, 1.9–2.2 mm long and 0.08–0.1 mm thick at the base. Seeds lenticular, differentiated into central zone and marginal zones. Colour black to dark brown, uniform. Pollen grains 18–23 µm with 30–45 pores of 1.1–1.3 µm in diameter. Density of granules low to medium.

Sauer (1967) and afterward other authors (Jalas & Suominen 1980; Carretero 1985, 1990; Akeroyd 1993 etc.) considered the "European" taxon *A. bouchonii*, to be conspecific with *A powellii* on the basis of their similarity. The study of isozymes (Wilkin 1992) failed to establish satisfactorily the distinctness of these two taxa, but the author maintained *A. bouchonii* at the specific level. The same option was followed by Cacciato (1982), Hügin (1986, 1987), Kerguélen (1993), Stace (1991, 1997).

Studying European plants we found the indehiscent character of the fruit to be constant. For example, European plants of *A. bouchonii* cultivated for eight years in the vicinity of *A. powellii*, *A. hybridus* and *A. retroflexus*, in the Botanical Garden of the University of Agronomical Sciences Bucharest, maintained their character. Greizerstein and Poggio (1992); Greizerstein et al. 1997) found differencies in chromosome number, chromosomal asymmetry and total DNA that supports *A. bouchonii* as an independent taxon. There is also a tendency toward ecological separation of the two variants in Europe: *A. bouchonii* populations occur primarily along riverbanks as pioneers, while *A. powellii* is a ruderal or segetal weed.

Based on our observations, in North America, plants with indehiscent fruits are more variable than in Europe. Some of them could be easily associated with *A. powellii* but others with *A. hybridus*. In both situations the same plant may bear only indehiscent fruit (especially *A. powellii*) or a mixture of circumscissile, iregularly dehiscent and indehiscent fruits (especially *A. hybridus*-like plants). Sometimes the dehiscence line is partially visible but the fruit does not open. The phenomenon occurs naturally. It is possible that the process of evolution of this taxon is taking place simultaneously in America and Europe, and that in Europe the varieties with indehiscent fruits have acquired more stability and consistency. It is also probable that the European *A. bouchonii* forms have reached America.

After close morphological and anatomical examination we found some new characters that, together with the previous data, suggest the subspecies rank for the plants with indehiscent fruit.

1. Inflorescence stiff and erect, ± unbranched or with a few widely spaced, long branches. Fruit circumcissile, 2 times longer than wide, irregularly wrinkled above the dehiscence line, with the pericarp surface type A. Seeds with an indistinct furrow extending 1/3 to midway through the seeds, with the marginal zone almost smooth ________________ **A. powellii** subsp. **powellii** (Figs. 1A; 2 A, C; 6)
1. Inflorescence often not strictly erect, more lax, with many lateral branches. Fruit indehiscent or irregularly dehiscent, 1.5 times longer than wide ± smooth with the type of pericarp surface variable: B to C. Seeds with a concavity above the hilum and the radicle, with the marginal zone evidently sculptured ________ **A. powellii** subsp. **bouchonii** (Figs. 1 E, F; 2 B; 7)

5a. Amaranthus powellii subsp. powellii (Fig. 6).

Amaranthus chlorostachys Willd. var. *pseudo-retroflexus* Thell., Vierteljahrssch. Naturf. Ges. Zurich 52:443. 1907. *Amaranthus hybridus* L. subsp. *hypochondriacus* (L.) Thell. var. *chlorostachys* (Willd.) Thell. f. *pseudo-retroflexus* Thell., Ascherson & Graebner, Syn. Mitteleur. Fl. 5:239. 1914. *Amaranthus chlorostachys* Willd. var. (subsp.) *powellii* (S.Wats.) Priszter, Ann. Sect. Hort. Vit. Budapest, 2 (2):144. 1953. *Amaranthus hybridus* L. subsp. *hybridus* var. *pseudo retroflexus* (Thell.) Carretero, Collect. Bot. 11(4):125. 1979.

Amaranthus chlorostachys sensu Hayek, Prodr. Fl. Penins. Balcan. 1:160. 1927.; Davis, Fl. Turkey 2:341. 967.; Cacciato, Fl. Ital. 1:179. 1982.

Amaranthus hybridus" sensu Aellen in Tutin & al. (eds.), Fl. Eur., ed 1, 1:109 (1964); Fl. Palaest. 1:181. 1966.

Fig. 6. *Amaranthus powellii* subsp. *powellii*, from the type (*Powell s.n.*, US 16163).

Amaranthus hybridus subsp. *hybridus* sensu Townsend, p.p., non L. s. str., Fl. Zambesiaca 9(1):49. 1988.
Amaranthus hypochondriacus sensu Greuter et al., Med Checklist 1:47. 1984. p.p., non L. s. str.
Amaranthus hypochondriacus var. *chlorostachys* sensu Morariu, Fl. R.P.R. 1:586. 1952.

Inflorescence stiff, erect, ± unbranched or with a few widely spaced, long branches; the terminal branches are usually much longer than the lateral ones. Bracteoles usually 2–3 times longer than the tepals. Fruit 2 times longer than wide, coarsely wrinkled above the dehiscence line. Pericarp surface type A (Fig. 1 A). Seeds elliptic to obovate, 1.25–1.3 × 1–1.1 mm, the marginal zone almost smooth. Cells of the exotesta with inconspicuous anticlinal and almost smooth, plane periclinal walls (Fig. 2, A, C); border of the seed acute. $2n = 32, 34$.

Distribution end ecololgy.—Worldwide weed, native to North and South America. In Europe it is a very frequent ruderal and segetal weed frequently mistakenly called "*A chlorostachys*," "*A.hybridus*" or "*A hypochondriacus*."

Representative specimens examined: **AFRICA. ETHIOPIA. Shewa:** Addis Ababa, near University College, 2300 m, 13 Dec 1965, *Wilde Duyfies 9235* (MO). Alemaya, College of Agriculture, 2050 m, 9 Apr 1968, *Westphal & Westphal Stevels s.n.* (MO). **UGANDA:** Muzingura-Kashaarara, 00°20'S, 30°26'E, 1900 m, 16 Dec 1987, *Rwaburindore 2550* (MO). **TANZANIA. Iringa:** Mufindi, 8°31'S, 35°10'E, 30 May 1989, *Kayombo 642* (MO).

ASIA. PAKISTAN. Kurram Valley Distr.: Makai to Parachinar, 1700 m, 15 Oct 1975, *Dar & al. 77* (A). **INDIA. Jammu and Kashmir:** Upper Nilgiri Hills, 1930 m, 23 Jun 1963, *Noble s.n.* (WIS).

AUSTRALIA AND OCEANIA. AUSTRALIA. New South Wales, 15 Mar 1970, *Michael M6* (WIS). **NEW ZEALAND. Waitemata Co.:** Marangi Bay, 36°44'S, 174°45'E, 30 Mar 1974, *Bangerter 5157* (NA).

NORTH AMERICA. CANADA. Lambton Co.: Forest, 2 Oct 1963, *Geiser 3374* F (WIS). **UNITED STATES. ARIZONA. Cochise Co.:** Chiricahua Mountains, W side of mountain, on road to Chiricahua National Monument, 2150 m, 14 Oct 1943, *Kearney & Peebles* 15119 (CAS). **Coconino Co.:** Homestead, Flagstaff, 2100 m, 15 Aug 1935, *Whiting 756/1471* (ARIZ). **CALIFORNIA. Alpine Co.:** Markleeville, 1800 m, 10 Aug 1964, *Howell 40910* (CAS). **Inyo Co.:** White Mountains, Antelope Springs, 1800 m, 22 Aug 1985, *Morefield 3110* (ARIZ). **Lassen Co.:** Sierra Nevada, Susanville, 1400 m, 8, 9 Jul 1974, *Howell 50500* (CAS). **Monterey Co.:** King City, 5 Aug 1963, *Howell 39616* (CAS). 7 Aug 1963, *Howell 40067* (CAS). **San Joaquin Co.:** 5 mi W of Stockton, 14 Aug 1953, *Sauer 1642* (WIS). **Santa Barbara Co.:** San Antonio Road near Hollister Ave., 19 Aug 1957, *Pollard s.n.* (CAS). **Santa Clara Co.:** San Francisco Creek, 29 Jul 1973, *Wiggins 22055* (DS). **Sonoma Co.:** near Guerneville, 3 Sep 1951, *Rubtzoff 734* (CAS). **Ventura Co.:** Ojai Valley, Lama Drive, 8 Nov. 1967, *Pollard s.n.* (CAS, MIN). Ojai, Ojai Avenue, between Gorham Road and San Antonio Creek crossing, 16 Oct 1966, *Pollard s.n.* (CAS). along Front Street, 5 Oct 1960, *Pollard s.n.* (CAS). Mirror Lake, 25 Jul 1959, *Pollard s.n.* (CAS). Southern Pacific Road, near San Juan Barranca crossing, 20 Sep 1960, *Pollard s.n.* (CAS). Ortonville, 19 Oct 1962, *Pollard s.n.* (CAS). **Yolo Co.:** Merrit Island, near junction 140 and 142, 3.5 mi S Clarksburg, 18 Aug 1969, *Quick 69-20* (CAS). **McKinley Co.:** Zuni reservation, 13 Aug 1978, *Nabhan 1037* (ARIZ). **COLORADO. Adams Co.:** Bennett, Kiowa Creek at route 36 bridge, 2 Sep 1974, *Churchill s.n.* (MSC). **Mineral Co.:** Don Juan Mountains, 5 mi bellow the summit Wolf Creek Pass, 2600 m, 28 Jul 1928, *Wolf 3074* (CAS, DS, BH). **IDAHO. Blaine Co.:** Hailey, 23 Aug 1909, *Woods & Tidestrom 2814* (US). Spencer, 26 Jun 1916, *Rust 420* (CAS). **Nez Perces Co.:** Forest, 17 Jul 1896, 1100 m, *A. A. Heller & E. G. Heller 3428* (US). **IOWA. Palo Alto Co.:** Lost Island Lake, 17 Jul 1934, *Ada Hayden 4006* (IA). **MASSACHUSETTS. Hampshire Co.:** Haydenville, 3 Sep 1975, *Ahles 81290* (UMO, CM, IA). **Bristol Co.:** Dighton, 5 Oct 1956, *Seymour 17042* (WIS). **Worcester Co.:** Lancaster, 12 Sep 1943, *Seymour 6006* (WIS). Leicester, 7 Aug 1944, *Gates s.n.* (WIS). **MICHIGAN. Grawford Co.:** 1 mi N of Seven Mile Road and 4 mi W of Beaver Creek Road, 14 Sep. 1992, *Chittenden & Peil 1108* (MSC). **Allegon Co.:** Holland, Hope College, 16 Sep 1976, *Gillis 13485* (MSC). **Shiawassee Co.:** 12458 Warner Rd., Laingsburg, 17 Aug 1984, *Harwood 285445* (MSC). **Mecosta Co.:** along Michigan Northern Railroad track, 50 m W of center of village Stanwood, 29 Aug 1984, *Rabeler 832* (DUKE, MSC). **MINNESOTA. Freeborn Co.:** Albert Lea, 16 Sep 1979, *Ownbey 6495* (MIN). **Heunepin Co.:** Minneapolis, N end of University of Minnesota campus, 17 Sep 1970, *Ownbey 4398* (MIN). **Mower Co.:** Brownsdale, 26 Aug 1981, *Smith 5576* (MIN). **Washington Co.:** along the street Criox River, 26 Sep 1988, *Smith 15117* (MIN). **MISSOURI. Jasper Co.:** near Joplin, 17 Aug 1920, *Palmer 18754* (UMO). St. Louis, 7 Apr. 1958, *Muehlenbach 1435* (UMO); s.l., 26 Jun 1971, *Muechlenbach 3587* (MO, NA). **NEVADA.** S of Carlin, 26 Aug 1984, *Williams & Tiehm s.n.* (CAS). **Lander Co.:** Trout Creek, 16 Aug 1937, *Goodner & Henning 67842* (DUKE). **Washoe Co.:** N of Sparks, near Wild Creek Golf Course, 1100 m, 14 Sep 1984, *Williams s.n.* (CAS). **NEW MEXICO. Dona Ana Co.:** Organ Mountains, 1400 m, 23 Sep 1906, *Wooton & Standley s.n.* (US). **Grant Co.:** Fort Bayard, 28 Aug 1905, *Blumer 42* (GH). **Valencia Co.:** El Morro National Monument, 4 Aug 1939, *Vogt 20* (ARIZ). **NEW YORK. Chemung Co.:** Elmira, 20 Sep 1941, *Smith 2303, 2304* (BH). **Madison Co.:** Oneida Lake, 6 Sep 1939, *Allen 20005* (BH). **Tompkins Co.:** South Hill, Ithaca, 23 Aug 1933, *Allen 18316* (BH). **OREGON. Benton Co.:** (without location) 1908, *Gilkey s.n.* (US). **Polk Co.:** along Hwy. 99 W, N of Hoffman Road, 16 Jul 1982, *Hasse 2513* (ARIZ). **PENNSYLVANIA. Bedford Co.:** Coleraine township school, Route #326, 3 Sep 1972, *Duppstadt s.n.* (MIN). near Cessna, 30 Aug 1941, *Berkheimer 2934-B* (CM). **Berks Co.:** 2 mi NE of Kutztown, 6 Oct 1986, *Nee 33265* (CM). 1/2 mi NE of Trexler, 18 Aug 1953, *Schaeffer 44911* (US). **Lawrence Co.:** 0.25 mi SE of New Bedford along Marr Road. 8 Sep 1990, *Bonnie & Isaac 354389* (CM). **RHODE ISLAND. New Port Co.:** Block Island, Old Harbor, 19 Aug 1913, *Fernald & Long 9463* (GH). **TEXAS. Brewster Co.:** Chisos Mts., 4 Aug 1931, *Mueller 7986* (US). **UTAH. Iron Co.:** Cedar City, 1900 m, 15 Sep 1968, *Howell & True 45349* (CAS). **Salt Lake Co.:** Salt Lake City, 28 Aug 1939, *W.C. Muenscher & M.V. Muenscher, 15913* (BH). **WISCONSIN. Columbia Co.:** 1 mi W at Hwy 51, 22 and 60 intersection, 22 Sep 1964, *Weis 30* (WIS). 1 mi SW of Columbus, 10 Sep 1956, *Iltis & Koeppen 8174* (WIS). **Dane Co.:** Madison, Oct 1949, *Bergseng s.n.* (WIS). **Green Co.:** roadside in Juola, 29 Sep 1957, *Fell 57-1400* (WIS). **Jefferson Co.:** 1.5 mi NE of Fort Atkinson, 6 Sep 1981, *Nee 21934* (WIS). **Milwaukee Co.:** Milwaukee, Lake Park, 15 Aug 1939, 20 Aug 1939, *Shinners 983, 985* (MIL, WIS). **Lincoln Co.:** Near Round Lake, 22 Aug 1955, *Seymour 16239* (WIS). **Ozaukee Co.:** Grafton, 8 Sep 1973, *Strenger 37* (WIS). **Portage Co.:** 9 mi W of Plover River, 31 Jul 1964, *Mauritz 867* (WIS). **WYOMING. Goshen Co.:** Southern Powder River Basin/SE Plains: Goshen Hole, Bump Sullivan Reservoir, ca. 4 mi S of Yoder, 1300 m, 28 Aug 1994, *Nelson 34530* (UTEP). **Laramie Co.:** near Hillsdale, 1800 m, 14 Aug 1959, *Porter & Porter 8019* (DS, CAS). **Yakima Co.:** Washington, Naches Heights, 31 Aug 1937, *W.C. Muenscher & M.V. Muenscher 11292* (BH).

MEXICO. Baja California: Rio Santo Domingo, 4 mi above Mission, 12 Sep 1930, *Wiggins & Demaree 4789* (ARIZ). Santa Catarina, 1200 m, *Broder 363* (DS). **Chihuahua:** Mojarachic, 25 Aug 1938, *Knobloch 5513* (MSC). Temosachi, Nabogame, 28°00'N, 108°30'W, 1800 m, *Laferriere 546* (ARIZ). **Hidalgo:** near Tolcayuca 2350, 23 Aug 1970, *Baron 55* (CAS, UMO). Zempoala 2450 m, 28 Sep 1975, *Ventura 339* (UMO). **Michoacan:** 10 mi of Hidalgo, 7 Jul 1947, *Sauer 1112* (MO). 1/3 mi N on road to La Barca, 19° 58'N, 102°16'W, 29 Jul 1960, *Sauer 491* (WIS). **Morelos:** Jiutepec, Jul 1965, *Alcocer 8* (ISC). **Sonora:** Las Tierritas de El Temblor, Sierra de El Tigre, 18–24 Aug 1940, *White 3393* (DS).

SOUTH AMERICA. PERU. Dep. Arequipa: Prov. Caraveli, 20 Km N of Puerto Chala, 15 Jan 1963, *H.H Iltis, C.M. Iltis, D. Ugent & V. Ugent* 1578 (WIS). **Dep. Lima:** Prov. Huarochiri, Surco, 2000 m, 24 Apr 1940, *Asplund 11025* (US). **BOLIVIA. Dep. Chuquisaca:** Prov. Oropeza, Villa Maria, 12 Apr 1963, *D. Ugent & Carderas 4948* (WIS). **CHILE. Prov. Cautin:** Temuco, 110 m, 2 Mar 1935, *Montero 2303* (GH).

5b. Amaranthus powellii subsp. **bouchonii** (Thell.) Costea & Carretero, comb. nov. **(Fig. 7)**. BASIONYM: *Amaranthus bouchonii* Thell. in Monde Pl. 27 (160):4. 1926. *A. hybridus* L. subsp. *bouchonii* (Thell.) O. Bolos & Vigo in Butl. Inst. Catalana Hist. Nat. 38:89. 1974. *A. hybridus* L. var. *bouchonii* (Thell.) Lambinon. Candollea, 52:239–279. 1997. TYPE: Bordeaux, Allee du Boutant, Chemin remblaye avec des balayures du port, 25 Sep 1925, *A. Bouchon* (HOLOTYPE: ?)

Fig. 7. *Amaranthus powellii* subsp. *bouchonii*, from *Carraway and Vertes 8* (UTEP).

Inflorescence often not strictly erect, more lax with many lateral branches. Bracteoles shorter and thinner compared to subsp. *powellii*, 1.8–2.3 times longer than the tepals. Fruit indehiscent, about 1.5 times longer than wide, with the pericarp ± smooth. Pericarp surface type B to C (Fig. 1, E, F). Seeds usually broad-ovate to round (rare obovate), 0.9 × 1–1.2 mm, with the marginal zone sculptured and the margin of the seed usually rounded (Fig. 2 D). Cells of exotesta with prominent anticlinal walls, polygonal, 25–30 µm length; periclinal walls plane, finely sculptured. The origin unknown with certitude but relationship with *A. powellii* subsp. *powellii* undeniable. 2n = 32.

Typical specimens examined: **EUROPE. NETHERLANDS. Prov. Noord-Holland:** Beverwijk, 23 Aug 1983, *Akkerman s.n.* (UTEP). **FRANCE. Puy-de Dome:** Clermont-Ferand, unknown author, Sep 1960 (MSC, SMU). **Gironde:** Bordeaux, Jul 1960, *Aellen s.n.*(A). **SWITZERLAND. Haut-Rhin:** Sundhoffen, 9 Sep 1962, *Aellen s.n.* (A). **ITALY. Lombardy:** Comosee, 23 Aug 1984, *Neuffco 386* (UTEP).

NORTH AMERICA. UNITED STATES. CALIFORNIA. Los Angeles Co.: Arcadia, Winie Way and Santa Anita, 24 May 1962, *Schmid s.n.* (DAV). **Fresno Co.:** Huntington Lake, Big Creek, 1400 m, 2 3Aug 1951, *Pollard s.n.* (CAS). **Plumas Co.:** Belden, 660 m, 21 Sep 1959, *Howell 43244* (CAS). **Riverside Co.:** Riverside, *Sanders 20048* (UCR, UTEP). **Ventura Co.:** Santa Monica Mountains, 1 mi SE of Camarillor, 200 m, 19 Sep 1958, *Raven & Thompson 13726* (CAS). **OREGON. Benton Co.:** 4.5 mi N of Corvalis on Highland Drive, 6 Aug 1979, *Carraway & Verts 11200* (UTEP). Colorado Lake Road, 4 Oct 1959, *Johnson 93* (IA). **Hood River Co.:** 10 Sep 1924, *Henderson 300* (MO). **MONTANA. Lake Co.:** in the vicinity of Montana Biological Station, Yellow Bay, E shore of Flathead Lake, 850 m, 5 Aug 1965, *Thomas s.n.* (DS). **PENNSYLVANIA. Bucks Co.:** West Bristol, along Pond Street, 20 Jul 1950, *Long 71768* (CM). **Thurston Co.:** 5 mi W of Olimpia, 15 Aug 1936, *Meyer 786* (GH). **WASHINGTON. Whatcom Co.:** Lynden, 21 Aug 1939, *Munscher 10558* (BH). Ten Mile, 31 Aug 1943, *Munscher 16104* (BH). **King Co.:** Seattle, on the University of Washington campus, 17 Sep 1967, *Simpson 370* (US).

6. Amaranthus retroflexus L., Sp. Pl. 991. 1753. Type: "Habitat in Pensylvania"; LINN 1117/22.

Annual with erect stem, up to 1.5(–2) m. Cotyledons lorate (oblong, ratio 6:1, see Hickey 1978) 13 × 2–2.5 mm, with acute apex and cuneate base; petiole 5–6 mm long. Plant scurfy-villous in and for some distance below the inflorescence, both multiseriate and uniseriate trichomes present. Leaves ovate or rhombic-ovate, 3–7 × 2–4 cm, usually coarsely pubescent beneath, at least along the veins. Inflorescence usually with many short, thick and crowded branches, the terminal part about as long as the laterals. Bracteoles (2.5–)4–6(–8) mm, 1–3 times longer than the tepals. Tepals 5, ± outcurved 2.5–3 mm long, linear-cuneate to spathulate, rounded, truncate or emarginate, usually mucronate at the tip, often with inconspicuous or pale mid-veins. The tepals much longer than the fruit. Fruit circumscissile, about 2 times longer than wide, obovoid, gradually narrowed toward the stigma region. Dehiscence line in the upper part of the fruit, coarsely wrinkled above the dehiscence line. Type of pericarp surface variable, A to B (Fig. 1 B). Seeds obovate 1.1–1.25 × 0.8–0.9 mm, lenticular. Between the hilum and the radicle a furrow extends almost to the middle of the seed. The seeds are differentiated into a central, smooth zone and a marginal, sculptured zone. Color dark-brown to black, uniform. Pollen grains 20–27 µm, with 30–42 pores of 1.1–1.4 µm in diameter. Density of granules high. $2n = 34$.

Usually *A. retroflexus* offers no identification problems, yet we have encountered interesting specimens sharing the characteristics of *A. retroflexus* and *A. powellii*, but somehow different from both. These plants seem to belong to a distinct type that occurs in the dry mountains of Arizona and southern California. They resemble *Amaranthus* × *tucsonensis* recently described by Henrickson (1999) from Arizona. Henrickson suggests only one of the parents-*A. hybridus*. In our opinion, based on the description and illustration, the flowers are closer to *A. retroflexus* var. *delilei* (Richt. & Lor.) Thell. but the general habit indicates *A. powellii*. Unfortunately, we could not examine neither the type nor the specimens cited in the study. The plants we examined are fertile, suggesting that they are not F1 hybrids and further research will be necessary to clarify if they are only a variety of *A. retroflexus* or a stabilized hybrid. Examples:

ARIZONA. Apache Co.: White Mountains, 10 mi S of McKays Peak, 2270 m, 31 Aug 1948, *Gould & Robinson 4998* (ARIZ). **Navajo Co.:** Pinaleno Mountains, West Peak, 2600 m, 12 Sep 1989, *Mc Laughlin 5809* (ARIZ); s.l., 2660 m, 6 Sep 1944, *Darrow et al. 1179* (SMU). Snow Flat, 2600 m, 6 Sep 1944, *Darrow et al. 1178* (SMU). N of Grasshopper Ruin, 28 Aug 1971, 1800 m, *Bohrer 1496* (ARIZ). **Gila Co.:** Sierra Ancha Wilderness Area, 2000 m, 21 Sep 1991, *Imdorf 271* (ARIZ). **CALIFORNIA. San Bernardino Co.:** San Bernardino Mountains, 116°55'W, 34°11.25N, 1590 m, 18 Sep 1994, *Sanders 15690* (UCR, ARIZ). NW Shore of Baldwin Lake, 116°49.11W, 36°16.53N, 2043 m, *Sanders & Helmkamp 19489* (UCR).

Distribution and Ecology.—This plant is a native of North America, but has become a cosmopolitan weed.

APPENDIX 1

Representative accessions cultivated in Rodale Germplasm, Ames, Iowa between 1984–1989, deposited at NA.

Amaranthus caudatus

USA. AMES 5125, 5127, 2191, 2212, 2213. **PERU**. PI 490437, PI 490438, PI 490439, PI 490440. **INDIA**. PI 166107, PI 175039, PI 166045, PI 480576. **NEPAL**. AMES 2079, 2165, 2168, 2169, 2182, 2190, PI 427224, PI 427225, PI 427228.

Amaranthus cruentus

CANADA. (Montreal) AMES 5327. **USA.** AMES 2264, 3216; California, San Rafael, AMES 5165. **MEXICO.** Chapingo, Inia, AMES 5548; Puebla, AMES 5638, 5640; Sonora, San Bernardo, AMES 5320. **GUATEMALA.** Choatalum, AMES 5271, 5275; San Pedro Corcha, AMES 5269; Aldea Choatalum, AMES 5272, 5273, 5276, 5277 (type 2); Chimaltenango, AMES 5330; Guatemala City, AMES 5278, 5279 (type 1); Coban, AMES 5270, 5279 (type 2), 5298; Chimaltenango, San Martin, AMES 5299; PI 433228, PI 490658, PI 451825, PI 451826; AMES 5676; **PERU**. Ayacucho, AMES 5346. **PORTUGAL.** Evora, AMES 5649. **CHINA.** AMES 1981, 2016, 5313, 5327. **INDIA.** R-129 A-2250, Spjut 8809; PI 288278, PI 274280, PI 288281; AMES 2037, 2228; Coimbatore, AMES 1977, 5386. **NEPAL.** PI 490656; Pokhara, AMES 2089, 2092; Chauri Jari, AMES 2061, 2089. **MALYSIA.** AMES 2054. **TAIWAN,** AMES 1991, 1992, 2201. **INDONESIA.** AMES 2042, 2049, 2044. **ETHIOPIA.** AMES 2003. **ZAMBIA.** PI 494768, PI 494769. **GHANA.**

AMES 1959, 1961, 1963, 1968, 1969, 1970, 1971, 1978, 2006, 2008, 2011, 2012, 2013. **BENIN.** AMES 5108. **NIGERIA**. AMES 1973, 2055, 2056, 2057, 2058, 2250. **TANZANIA**. AMES 1979, 2004. **ZAIRE.** North Shaba Province, AMES 5369. **DAHOMEY.** AMES 1964, 2000, 2249 (type 1 and 2). **ORIGIN UNKNOWN.** AMES 1985, 2081, 2087, 5151, 5303, 5362, 5384, 5686.

Amaranthus hypochondriacus

USA. AMES 2211, 3079, 3078, 5140; Pennsylvania, AMES 8271, 8404; Pennsylvania, K-254; PI 477917. **MEXICO.** Tulyehualco, AMES 2260; PI 490753; San Miquel, Chiconcuac, AMES 5474; Huazulco, Morelos, AMES 5190, 5503, 5637; Oaxaca, AMES 5215; Jautetelco, Morelos, AMES 5503, 5505; Distr Federal, AMES 5499; Chapingo, AMES 2085 (type 1 and 2). **CHILE.** AMES 5355. **PERU.** Lima, AMES 7600. **AFGHANISTAN.** AMES 5610. **INDIA.** Coimbatore, AMES 1976; PI 274276, PI 274278, PI 274279, PI 480752, PI 480787, PI 480790, PI 480791, PI 480793, PI 480796, PI 480797, PI 480798, PI 480799, PI 480800, PI 480804, 480806, PI 480807, PI 480810, PI 480811, PI 480818, PI 480821, PI 480823, PI 480865, PI 480870, PI 480871. Uttar Pradesh, PI 166045, PI 337611, PI 480814, PI 480815, PI 480819, PI 480820, PI 480866, PI 480872, PI 480874, PI 480875, PI 490756, AMES 2036. Tamil Nandu Agriculture University, AMES 2230, PI 480802, PI 480805, PI 480822, PI 480974. **NEPAL.** PI 427228, PI 490759; Kathmandu, AMES 2071, 2077 (type 1 and 2), 2162; Patra Sanghu, AMES 2163; Tatopani, AMES 2064, 2160, 2167; Chhana, AMES 2173; Charyari, AMES 2061, 2155, 2185; Nagma, AMES 2166, 2186; Tibrikot, AMES 2159; Chauri, Jahari, AMES 2086; Khallaged, AMES 2157, 2158, 2172; Batra, AMES 2178, 2184, 2194, 2253; Rodlkhola, AMES 2175; Delhlkot, AMES 2170; Ranka, AMES 2162; Mahadeb, AMES 2171 (type 1 and 2), 2077; Vid Mahuri, AMES 2176; Rotehala, AMES 2177; Tata Village, AMES 2062; Chauri Jari AMES 2067. **INDONESIA.** Ames 2043. **TANZANIA.** AMES 1979. **NIGERIA.** AMES 1975, 2055, 2256. **GHANA.** AMES 2001 (Type 2), 2002. **ORIGIN UNKNOWN.** AMES 5141, 5151, 5152, 5158, 5161, 5163, 2081, 2082, 2088, (Type 2), 5361, 5381, 5657, PI 490757.

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NOTES ON SOME LITTLE KNOWN *AMARANTHUS* TAXA (*AMARANTHACEAE*) IN THE UNITED STATES

Mihai Costea

University of Agronomical Sciences
Dept. of Botany
Bd. Marasti, 71331, Sector 1
Bucuresti, ROMANIA
coste_amihai@hotmail.com

Andrew Sanders

Herbarium
Dept. of Botany and Plant Science
University of California
Riverside, CA, 92521-0102, U.S.A.
andrew.sanders@ucr.edu

Giles Waines

Dept. of Botany and Plant Science
University of California
Riverside, CA, 92521-0102, U.S.A.
giles.waines@ucr.edu

ABSTRACT

Amaranthus blitum L. and its infraspecific variability in the United States are analyzed using classical morphological and some new Scanning Electron Microscope characters. Two new combinations within *A. blitum* are proposed, *A. blitum* subsp. *oleraceus* and *A. blitum* subsp. *emarginatus* var. *pseudogracilis*. For the first time, *A. graecizans* L. is confirmed as occurring in North America. Some nomenclatural issues involving *A. blitum* L. and *A. graecizans* L. are also discussed.

RESUMEN

Se analiza *Amaranthus blitum* L y su variabilidad intraespecífica en los Estados Unidos, utilizando los caracteres clásicos y algunos nuevos observados con el Microscopio Electrónico de Barrido. Se proponen dos combinaciones nuevas para *Amaranthus blitum*, *A. blitum* subsp. *oleraceus* y *A. blitum* subsp. *emarginatus* var. *pseudogracilis*. Por primera vez se confirma la presencia de *Amaranthus graecizans* en Norte América. Se analizan también algunos problemas de nomenclatura de *Amaranthus blitum* y *Amaranthus graecizans*.

INTRODUCTION

Many of the roughly 75 species of the genus *Amaranthus* are native to the Americas. Of these, 10 are dioecious (Sauer 1955) and about 40 monoecious. Approximately 10 of these American species are now widespread weeds, some of them being listed among the worst weeds of the world (e.g., *A. retroflexus*, *A. hybridus*, *A. powellii*, and *A. viridis*—Holm et al. 1977; Holm et al. 1997). In return, the Americas have received few species of weedy amaranths from the Old World, though *A. blitum* (subsp. *blitum*) and *A. graecizans* are examples. Among the species introduced to North America, *A. blitum* is especially worthy of attention because in Europe, Africa and Asia it is often a troublesome weed in irrigated crops (Holm et al. 1977; Hügin 1986, 1987; Costea 1998a, b). In the United States, Teitz et al. (1990) stated that in "recent years *A. lividus* (= *A. blitum*) has

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become the most serious weed problem in vegetable production in Ohio" in crops such as lettuce, radish, celery and carrot. Furthermore, *A. blitum* is a valuable leaf vegetable crop and is cultivated as such in Asia, Africa, and the Pacific Islands.

After a survey of the 40 of the most important herbarium collections in the United States, as well as the floristic literature, for a revision of the *A. hybridus* complex, it became obvious that *A. blitum* is inadequately understood in North America. This taxon is often confused with *A. viridis* and its infraspecific variability has received no attention.

Likewise, *A. graecizans* is poorly understood in North America. The name *Amaranthus graecizans* has been widely used in North America (e.g., Kearny & Peebles 1960; Hitchcock & Cronquist 1973; McGregor 1986), but has always been misapplied to *A. albus* or *A. blitoides*. In view of this past nomenclatural confusion, the name *A. graecizans* is probably regarded with suspicion by many botanists in North America. We show that this species has been introduced into the United States, and suggest that it may still exist.

The purpose of this paper is not a comprehensive review of the status of these taxa in the United States, but rather to provide the necessary information from which a better understanding of them can develop. To facilitate correct identification, detailed descriptions are provided for each taxon in this species group using both traditional characters and new ones such as trichomes, sculpture of the seed coat and pollen morphology.

The seeds are usually differentiated in a central, convex zone and a marginal, plane zone, exceptions from this rule being rare (*A. blitum* subsp. *oleraceus*). The SEM characters of seeds pertain to the ornamentation of the exotesta in the marginal zone, as observed under 300×, or more magnification. The sculpturing of the seeds is described using the terminology proposed by Barthlott and Ehler (1977). The appearance of the *anticlinal* (prominent or inconspicuous) and *periclinal* (flat, concave or convex with the sculpture of the epicuticular waxes smooth or punctiform) walls of the epidermal cells is noted.

The pollen grains are pantoporate, apolar, small (with $D = 18–28\ \mu m$) and generally have more than 18 sunken pores, uniformly distributed and having the apertural membrane granulated. The tectum has granules or spinules. See also Eliasson (1988), Nowicke (1993), Costea (1998a,b). Pollen characters include: the diameter of the pollen grain; number and diameter of pores; density of granules or spinules on the tectum according to the following scale: high = 20–30 granules or more/1 μm^2; medium = 10– 19 granules/μm^2 and low = 2–9 granules /1 μm^2. The SEM observations were carried on with a Hitachi S-4100 SEM at 15KV, using a Bio-Rad Sputter-Coatter SC-500.

Some nomenclatural issues with respect to these introduced taxa are discussed as well, including two new combinations

NOMENCLATURE

Amaranthus blitum

Amaranthus blitum and *A. lividus* have been long known to be synonyms (Hooker 1885; Thellung 1914) and the choice between the two names generated an interesting nomenclatural problem, since both taxa were described by Linneus in 1753. Both Moquin-Tandon (1849) and Thellung (1914) considered *A. blitum* to include *A. graecizans*, based on the synonyms they cite under *A. blitum*. Because of this confusion Brenan (1961) stated that the name *A. blitum* should be rejected as *nomen confusum*, and he used instead *A. lividus*. More recently, Brenan and Townsend (1980) proposed explicitly that *A. blitum* be placed on the list of *nomina rejicienda* as *nomen ambiguum*. The Committee for Spermatophyta recommend that *A. blitum* not be rejected (Brumitt 1984). This decision was made on the basis of the fact that "since the last century, and in the present century (*A. blitum*) was used in the correct sense *of A. lividus* or has not been used at all."

In order to establish the priority of two possible legitimate names of equal priority it is necessary to determine which author was the first to unite them. That choice is definitive (Art 57. 2 Berlin Code, Art 11.4 Tokyo Code).

Thellung (1914) selected the name *A. lividus* in which he included:
Amaranthus blitum L. = *Amaranthus lividus* proles *ascendes*—wild plants with prostrate stems and small leaves.
Amaranthus lividus L. = *Amaranthus lividus* proles *lividus* ("typicus")—cultivated forms with vigorous, ascending or erect stems and large leaves, entire plant red-colored.
Amaranthus oleraceus L. = *Amaranthus lividus* proles *oleraceus*—cultivated plants, very much like proles *lividus* but green-colored.

According to Filias et al. (1980) the choice between the two names was made before Thellung (1914) by Hooker in Flora of British India (1885), but in favor of *A. blitum*. Therefore, *Amaranthus blitum* is the valid name and Recommendation 14a of the Tokyo Code (1998) should be followed. Consequently according to Filias et al. (1980) the wild, small-leaved form retains the name *A. blitum* L., being typified by the specimen on the Linnean Herbarium 1117/4. The cultivated forms—*A. oleraceus* and *A. lividus*—are together *A. blitum* var *oleraceus* (L.) Hooker fil., this name being typified by the specimen on sheet 1117/13.

It is interesting that even though the name *A. blitum* has predominantly been used in recent years, the name *A. lividus* it is still employed, even in some recent treatments of the genus (e.g., Townsend 1988; Akeroyd 1993).

Amaranthus graecizans

Linnaeus' phrase name for *A. graecizans*, *A. floribus triandris conglomeratis axillaribus, foliis lanceolatis obtusis*, is appropriate but the geographic source he reported, Virginia, is incorrect. Uline and Bray (1884) reported from America the following related taxa: *A. blitoides* S. Wats., *A. albus* L., *A. graecizans* L. and *A. blitum* L., included by Moquin-Tandon (1849) in the former genus *Pyxidium*. The two authors observed that the American plants of what was called *A. graecizans* were in fact the same as *A. albus* (supposed to have an American origin) and thus they synonymised the two names, choosing as valid, the first one, which was *A. graecizans*. The nomenclature confusion at that moment was even more complex because as we have shown, at least before Thellung (1914), Moquin-Tandon (1849) was using the name *A. blitum* to designate what we call now *A. graecizans* and other authors (e.g., Hooker 1885) to include both taxa. In such circumstances it is easy to understand why Uline and Bray (1884) were actually able to recognize clearly only *A. blitoides* "*by its four or five sepals, thick at the base, and by the prostrate habit*." From that point, the idea that *A. graecizans* = *A. albus* persisted in many North American floras even as late as 1986 (McGregor 1986).

Amaranthus graecizans was probably frequently misapplied to *A. blitoides* due to the resemblance between *A. graecizans* subsp. *grecizans* and *A. blitoides*.

In both editions of the checklist of the vascular plants of the United States, Canada and Greenland (Kartesz 1980; Kartesz 1994) *A. graecizans* is no longer listed among the species of the genus *Amaranthus*.

1. Amaranthus blitum L., Sp. Pl. 990. 1753. Type: "Habitat in Europa temperatiore"; LINN 1117/4 (the correct specimen, Fillias et al. 1980).

Annual with stems up to 1m, procumbent, ascending to erect, glabrous or with sparse, multicellular, uniseriate hairs. Leaves, 2–8 × 1–5 cm, rhombic-ovate, short-cuneate to truncate at base, shallowly emarginate to obtuse-retuse at apex, somewhat fleshy, green or reddish. Flowers both in axillary cymose clusters and in a terminal variable inflorescence: short, dense and thick to long thin, branched and flexuous. Bracteoles triangular-ovate, shorter than the tepals, with the mid-vein green, usually with two lateral branches. Tepals 3, equal, 1.5–2 mm long and 0.2–0.4 mm wide, linear to (rarely) spatulate. One tepal (rarely 2) with green mid-vein enlarged above the middle, the others entirely membranous, with the mid-vein hardly noticeable. Fruit indehiscent, 1–1.5 mm longer than wide, ellipsoidal to globose, gradually or abruptly-narrowed toward the stigma region. Locule only slightly larger than the seed. Chromosome number: $2n=34$.

On the basis of morphology and ecology, three subspecies can be recognized. Although the habitus of plants, morphology of stem and size of leaves usually varies between subspecies (see descriptions), the most reliable characters are the size of seeds and fruits. Also the infraspecific taxa of *A. blitum* can be recognized from the plantlet stage which is uncommon for amaranths, well known to be very difficult to separate in this phenophase.

1\. Cotyledons with rounded to truncate apex, 9–18 × 3–6 mm. Pollen grains with pores of 2.4–3.3 µm. Fruit of 1.7–2.6(–3) mm long, with the pericarp 4-layered. Seeds of 1.1–1.8 mm in diameter ______ 2
  2\. Cotyledons of 15–18 × 5–6 mm. Bracteoles with the midvein branched. Seeds of 1.2–1.6(–1.9) × 1.2–1.6(–1.9) mm with inconspicuous sculpture and rounded margins ______ subsp. **oleraceus** (Figs. 4, 5C)
  2\. Cotyledons of 9–10 × 3 – 3.3 mm. Bracteoles with the mid-vein unbranched. Seeds of (1.1–)1.2 × 1–1.1 mm with evident sculpture and acute margin ______ subsp. **blitum** (Figs. 1, 5A, 5D)
1\. Cotyledons with acute apex, 6–7 × 3–6 mm. Pollen grains with pores of 1.6–1.9 µm. Fruit of 1.2–1.8 mm, with the pericarp 3-layered. Seeds of 0.8–1.1 mm in diameter ______ subsp. **emarginatus** (Figs. 2, 3, 5C, 5E)

1a. Amaranthus blitum subsp. **blitum** (**Fig. 1**). *Albersia blitum* (L.) Kunth, Fl. Berol., ed. 2, 2:144. 1838. *Euxolus blitum* (L.) Gren., Mem. Soc. Emul. Doubs. ser 3, 10:652. 1869. [Flora Jurass. 652. 1869)].

Amaranthus ascendens Loisel., Not. Fl. France 141. 1810. *Amaranthus blitum* L. var. ("b") *ascendens* ("*adscendens*") (Loisel.) DC., Cat. Pl. Horti Monsp. 4. 1813. *Amaranthus lividus* L. proles *ascendens* (Loisel.) Thell., Ascherson & Graebner, Syn. Mitteleur. Fl. 5:321. 1914. *Amaranthus lividus* L. var. *ascendens* (Loisel.) Thell. ex Hayw. & Druce, Advent. Flora Tweedside 177. 1919. *Amaranthus lividus* L. subsp. *ascendens* (Loisel.) Thell. ex Wachter, Heukels, Geill. Schoolpl. Nederl., ed. 11, 169. 1934.

Amaranthus viridis auct., non L.

The plants are normally green. The stem procumbent to ascending and without prominent ribs. Cotyledons lanceolate, 9–10 × 3–3.3 mm, with rounded apex and cuneate base; petiole 4–5 mm. Fruit, 2 mm long, when fresh with the pericarp almost smooth, when dried irregularly wrinkled in the zone with the seed, the rest of the fruit being smooth. Stigma branches, thin (0.9–1.1 mm long and 0.2–0.25 mm wide at the base) often no longer observable when the fruit is dried. Seeds, (1.1–)1.2 × 1–1.1 mm, broad-ovate to circular, differentiated into central and marginal zones. The marginal zone sculptured with the cells of the exotesta polygonal, 25–40 µm length, with the anticlinal walls prominent and the periclinal walls plane and minutelly punctiform sculptured (Fig. 5A). The margin of the seed acute. Color dark—brown to black with the marginal zone usually paler. Pollen grains 19–23 µm with 32–45 pores of 2.4–3.3 µm diameter (Fig. 5D).

Distribution and ecology.—Native to Mediterranean region, Eurasia and North Africa where it was cultivated as a potherb until the 18th century, when it was largely replaced by *Spinacia oleracea*. In these regions it is a frequent weed in vegetable gardens, and in waste places. In the United States this name was usually misapplied to *A. blitum* subsp. *emarginatus* which is more frequent. Subspecies *blitum* appears casually in waste places in urban settings. The only herbarium specimen seen from the United States was: **New York**. Central Park, 1861, *Austin* s.n (GH).

1b. Amaranthus blitum subsp. **emarginatus** (Moq. ex Uline & Bray) Carretero,

Fig. 1. *Amaranthus blitum* subsp. *blitum*.

Munoz Garmendia & Pedrol, Ann. J. Bot. Madrid 44:599. 1987. *Amaranthus emarginatus* Moq. ex Uline & Bray, Bot. Gaz. (Crawfordsville) 19:319. 1894. TYPE: INDONESIA: "*Amaranthus polygonoides* L. ?, Java, 1842–44, *Zollinger 1646*" (LECOTYPE: P; ISOLECTOTYPE: FI, G, STR; cf. Hügin 1987. 461).

Euxolus viridis L. var. (e) *polygonoides* Moq., DC., Prodr. 13(2):273. 1849. *Amaranthus ascendens* Loisel. var. *polygonoides* (Moq.) Thell., Mem. Soc. Sci. Nat. Cherbourg 38:215. 1912. *Amaranthus lividus* L. proles *polygonoides* (Moq.) Thell., Ascherson & Graebner, Syn. Mitteleur. Fl. 5:321. 1914. *Amaranthus lividus* L. var. *polygonoides* (Moq.) Thell. ex Druce, Bot. Soc. Exch. Club Brit. Isles 5:574. 1920. *Amaranthus lividus* L. subsp. *polygonoides* (Moq.) Thell. ex Probst, Wolladventivfl. Mitteleur. 74. 1949. *Amaranthus ascendens* subsp. *polygonoides* (Moq.) Thell. ex Priszter, Agartud. Egyet. Kert- Szologazdasagtud. Karanak Evk. 2:221. 1953. *Amaranthus blitum* subsp. *polygonoides* (Zollinger ex Moq.) Carretero, Ann. J. Bot. Madrid 41:276. 1985.

Similar to *Amaranthus blitum* subsp. *blitum*, differing in the following characters: slender stems, up to 70 cm long, prostrate to ascending. Cotyledons narrow-elliptic, 6–7 × 2–2.3 mm with acute apex and base; petiole about 4 mm long. Leaves not fleshy, long-cuneate at base and deeply emarginate to bilobed at apex. Tepals 2(–3)0.75–1.5(–1.8) mm long, obtuse. Fruit longer than the tepals, globose to ovoid (1.0–)1.2–1.8(–2.0) mm long, 1–1.5 mm longer than wide, evidently larger than the seed. Seeds 0.8–1.1 × 0.8–1.1 mm, circular, with the hilum prominent on the outline of the seed. The marginal zone more evidently sculptured than in subsp. *blitum* (Fig. 5B). Pollen grains as in subsp. *blitum* but pores of 1.4–1.8 µm in diameter (Fig. 5E). Chromosome numbers: 2n=34. The appropriate rank of this taxon requires further investigation. Hügin (1986, 1987) and Costea (1998a,b) treated it as a species.

The habit of the plants is variable:

1. Prostrate plants, leaves (0.75–)1–2(–3.5) cm long; inflorescence entirely formed from axillary cymes (terminal part absent or reduced ______ var. **emarginatus**
1. Ascending more vigurous plants with leaves 2–4(–6) cm long, inflorescence mainly terminal, long, thin, flexuous ______ var. **pseudogracilis**

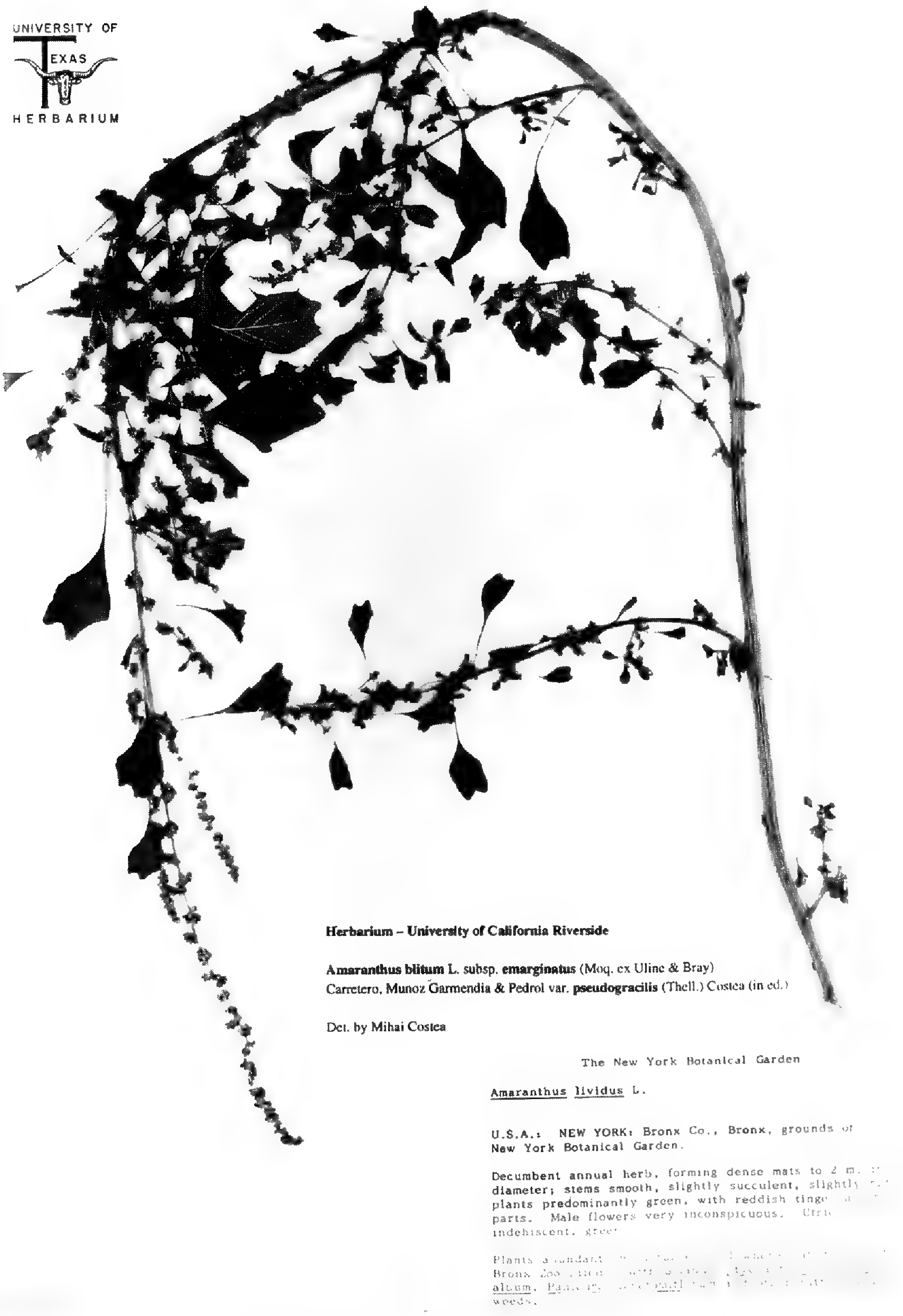
a. Amaranthus blitum subsp. **emarginatus** Moq. ex Uline & Bray var. **emarginatus** (**Fig. 2**).

b. Amaranthus blitum subsp. **emarginatus** var. **pseudogracilis** (Thell.) Costea, comb. et stat. nov. (**Fig. 3**). BASIONYM: *Amaranthus lividus* L. proles *polygonoides* f. *pseudogracilis* Thell., Ascherson & Graebner, Syn. Mitteleur. Fl. 5:321. 1914. *Amaranthus emarginatus* subsp. *pseudogracilis* (Thell.) Hügin, Willd. 16: 463. 1987. TYPE: "im Botanischen Garten Strasburg," 8.8 1904, *A. Ludwig 12130* (B) specifying "Unter dem falschen Namen *Euxolus caudaus*."

Amaranthus viridis auct., non L.

Distribution and Ecology.—Native to and very widespread in the tropics, but also introduced into the warm temperate regions of North America and Europe. The two wild subspecies are partially sympatric, but are separated ecologically, subsp. *emarginatus* being more demanding of warm climates than subsp. *blitum*. The varieties of subsp. *emarginatus* are further ecologically sepa-

FIG. 2. *Amaranthus blitum* subsp. *emarginatus* var. *emarginatus*.



Herbarium – University of California Riverside

Amaranthus blitum L. subsp. **emarginatus** (Moq. ex Uline & Bray)
Carretero, Munoz Garmendia & Pedrol var. **pseudogracilis** (Thell.) Costea (in ed.)

Det. by Mihai Costea

The New York Botanical Garden

Amaranthus lividus L.

U.S.A.: NEW YORK: Bronx Co., Bronx, grounds of
New York Botanical Garden.

Decumbent annual herb, forming dense mats to 2 m. [illegible]
diameter; stems smooth, slightly succulent, slightly [illegible]
plants predominantly green, with reddish tinge [illegible]
parts. Male flowers very inconspicuous. Utric
indehiscent, gree

Plants abundant [illegible]
Bronx Zoo [illegible]
album, Panicum [illegible]
weeds.

Fig. 3. *Amaranthus blitum* subsp. *emarginatus* var. *pseudogracilis*.

rated in that variety *emarginatus* grows preferentially on sandy alluvium on the banks of rivers, on lakeshores and beaches, while variety *pseudogracilis* is found mostly as a weed in irrigated vegetable crops and nurseries. This subspecies is the most widespread form of *A. blitum* found in the United States.

Representative specimens examined for var. *emarginatus*: **FLORIDA. Dade Co.:** Key Biscayne, Cape Florida State Park, 15 Mar 1969, *Gillis 7688* (A). Homestead, Bay Front Park, 5 Nov 1977, *Correll and Popenoe 49092* (A). **Hillsborough Co.:** 12 mi SE of Tampa ("beach area"), 28 Oct 1960, *Ray et al 10605* (GH). **Leon Co.:** Tallahassee, Lake Ella, 10 Jul 1986, *Anderson 9737* (BRIT). Near F.S.U. campus, 6 Oct 1994, *Anderson 15283* (BRIT). 30 Oct 1976, *Brumbach 9087* (GH). **Manatee Co.:** 20 mi E of Bradenton, 27 Apr 1975, *Genelle and Fleming 2040* (RSA, FLAS). **LOUISIANA. Parish Calcasieu:** 4 mi S of Lake Charles, 13 Jul 1969, *Thieret 31617* (SMU). **Massachusetts. Hampshire Co.:** University of Massachusetts campus, Amherst, 17 Sep 1966, *Ahles 64683* (SMU). **NEW YORK. Bronx Co.:** New York, 26 Sep 1937, *Moldenke 10534* (VDB). **Madison Co.:** shore of Oneida Lake, Lewis Point, 14 Sep 1938, *House 26133* (GH). **NORTH CAROLINA. Duplin Co.:** 2 mi W of Greenevers (weed in broccoli) 15 Oct 1991, *Wilbur 59784* (DUKE). **PENNSYLVANIA. Bradford Co.:** shore of Susquehanna River at Homets Ferry, 3 Sep 1962, *Wahl 20220* (GH). 14 Aug 1955, *Wahl 16564* (GH). **Travis Co.:** at Hornsby Bend Sewage treatment Plant (Montopolis Quadrangle), 19 Apr 1986, *Carr 7281* (TEX).

Representative specimens examined for var. *pseudogracilis*: **FLORIDA. Alachua Co.:** Gainesville, University of Florida Campus, 13 Oct 1967, *D'Arcy 2197* (FW). **Lee Co.:** Eastern Sanibel, 20 Oct 1976, *Brumbach 9077* (BRIT). 21 Nov 1972, *Brumbach 8110* (GH). **TEXAS. Orange Co.:** Orange, 55 May 1937, *Cory 22306* (A). **MISSOURI. Cape Girardeau Co.:** Cape Girardeau weed in green house, *Brooks 7868* (VDB). **PENNSYLVANIA. Philadelphia Co.:** Holmesburg, 2 Jul 1942, *Long 58418* (GH). **NEW YORK:** grounds of New York Botanical Garden, 13 Oct 1984, *Nee 30150* (TEX).

1c. Amaranthus blitum subsp. **oleraceus** (L.) Costea, comb. nov. (**Fig. 4**). BASIONYM: *Amaranthus oleraceus* L., Sp. Pl., ed. 2, 1403. 1763. TYPE: LINN 1117/3.

Euxolus oleraceus (L.) Moq., DC., Prodr. 13(2):273. 1849. *Albersia oleracea* (L.) Boiss., Fl. Or. 4:991. 1879. *Albersia blitum* var. *oleraceus* (L.) Hooker fil., Fl. Brit. Ind. 4:721. 1885. *Amaranthus lividus* L. proles *oleraceus* (L.) Thell., Ascherson & Graebner, Syn. Mitteleur. Fl. 5:321. 1914. *Amaranthus ascendens* Loisel. var. *oleraceus* (L.) Thell. ex Priszter, Agartud. Egyet. Kert- Szologazdasagtud. Karanak Evk. 2:221. 1953. *Amaranthus lividus* subsp. *oleraceus* (L.) Soó, Acta Bot. Sci. Hung. 10:376. 1964.

Amaranthus lividus L., Sp. Pl. 990. 1753. *Euxolus lividus* (L.) Moq., DC. Prodr. 13(2):273. 1849. *Amaranthus lividus* L. proles *lividus* ("typicus") (L.) Thell., Ascherson & Graebner, Syn. Mitteleur. Fl. 5:321. 1914.

We present this taxon for comparison and because it is a potentially valuable vegetable, though it appears not to have yet been used for this purpose in North America.

It is very much like subsp. *blitum* but differs in the following characters: the plants are green to purple. The stem is erect, very thick, strongly ribbed. Cotyledons narrow, ovate to lanceolate, 15–18 × 5–6 mm, with rounded or truncate apex and acute base; petiole 10–12 mm long. Fruit 2.3–3.5 mm, when dry with the pericarp coarsely wrinkled. Stigmas branches well-developed (2 mm long and 0.5–0.6 mm wide at the base) and persistent when the fruit is dried. Seeds 1.2–1.6(–1.9) × 1.2–1.6(–1.9) mm, circular, not differentiated into central and marginal zones. The sculpture of the margin is inconspicuous at <100 × magnification. The cells of the exotesta in the marginal zone often inconspicuous

Fig. 4. *Amaranthus blitum* subsp. *oleraceus*.

(the anticlinal walls are inconspicuous) with the periclinal walls less punctiform sculptured than in subsp. *blitum* (Fig. 5 C). Margin of the seed rounded. Color dark-brown to blackish, uniform. Pollen as in subsp. *blitum*.

Originated as a selection of *A. blitum* subsp. *blitum* and exists only as a cultivated vegetable. The only herbarium specimens of *A. blitum* subsp. *oleraceus* seen from U.S. were those of the accessions PI 606281 and PI606282 cultivated at Ames, Iowa (originally from Bangladesh). Chan (1996), Chan and Sun (1997) refer to these accessions as "unidentified species—AMES 5366." Based on molecular techniques the authors separate it both from *A. blitum* and *A. tricolor*. Unfortunately the accession PI 288277 used by the authors (Chan 1996; Chan & Sun 1997) as "*A. lividus*" (= *A. blitum*) and the others from India—Ames 5123, 5146, 5315, 5387, PI 271465, PI 288277 and PI 608661—do not belong for sure to *A. blitum*. All these plants are related to *A. tricolor* as circumscribed by Aellen (1959). These results show that the complex *A. tricolor* is still poorly understood and a revision of the group is necessary. For future studies we recommend the germplasm collection of the U.S. National Plant Germplasm System *http://www.ars-grin.gov*.

2. **Amaranthus viridis** L. Sp. Pl., ed. 2, 1405. 1763. TYPE: "Habitat in Europa, Brasilia," LINN 1117/15.

Amaranthus gracilis Poiret, Lam., Encycl. Suppl. 1:312. 1810.

Annual, with stem up to 1 m tall, ascending to erect, glabrous to sparsely pubescent above, the trichomes being multicellular and uniseriate. Cotyledons lanceolate, 12 × 2.5 mm, with acute apex and acute to decurrent base; petiole 5–6 mm long. Leaves 3–8 × 2–5 cm, rhombic-ovate, entire to shallowly emarginate at apex. Inflorescence mostly terminal, long, thin, flexuous, ramified or not. Bracteoles about 1mm long, acute, triangular-ovate, shorter than the tepals. Tepals 3, equal, 0.8–1.5 × 0.3–4 mm, bent along the fruit, narrow-spatulate to narrow-obovate, with the mid-vein green, enlarged above the middle. Fruit indehiscent, 1.2–1.5 mm, ellipsoidal to globose, usually gradually narrowed toward the stigma branches. As a rule, the pericarp is strongly wrinkled, muricate, but sometimes almost smooth. Stigma branches thin (0.9–1.1 mm long and 0.05–0.075 mm wide at the base). Seeds 1–1.2 × 0.9–1.1mm, circular with an inconspicuous hilum, differentiated into central and marginal zones. The margin of the seed is acute. The sculpture of the seeds is variable, two "types" being possible:

1) Seeds entirely verrucose.
2) Seeds with inconspicuous sculpture, resembling *A. blitum* subsp. *oleraceus*.

On the basis of the verrucose seeds, Kowal (1954) circumscribed the Section *Puncticulate* that includes *A. viridis* and *A. acutilobus*. Because this characteristic varies within a species, it is evidently that the section *Puncticulate* created by Kowal can not be recognized.

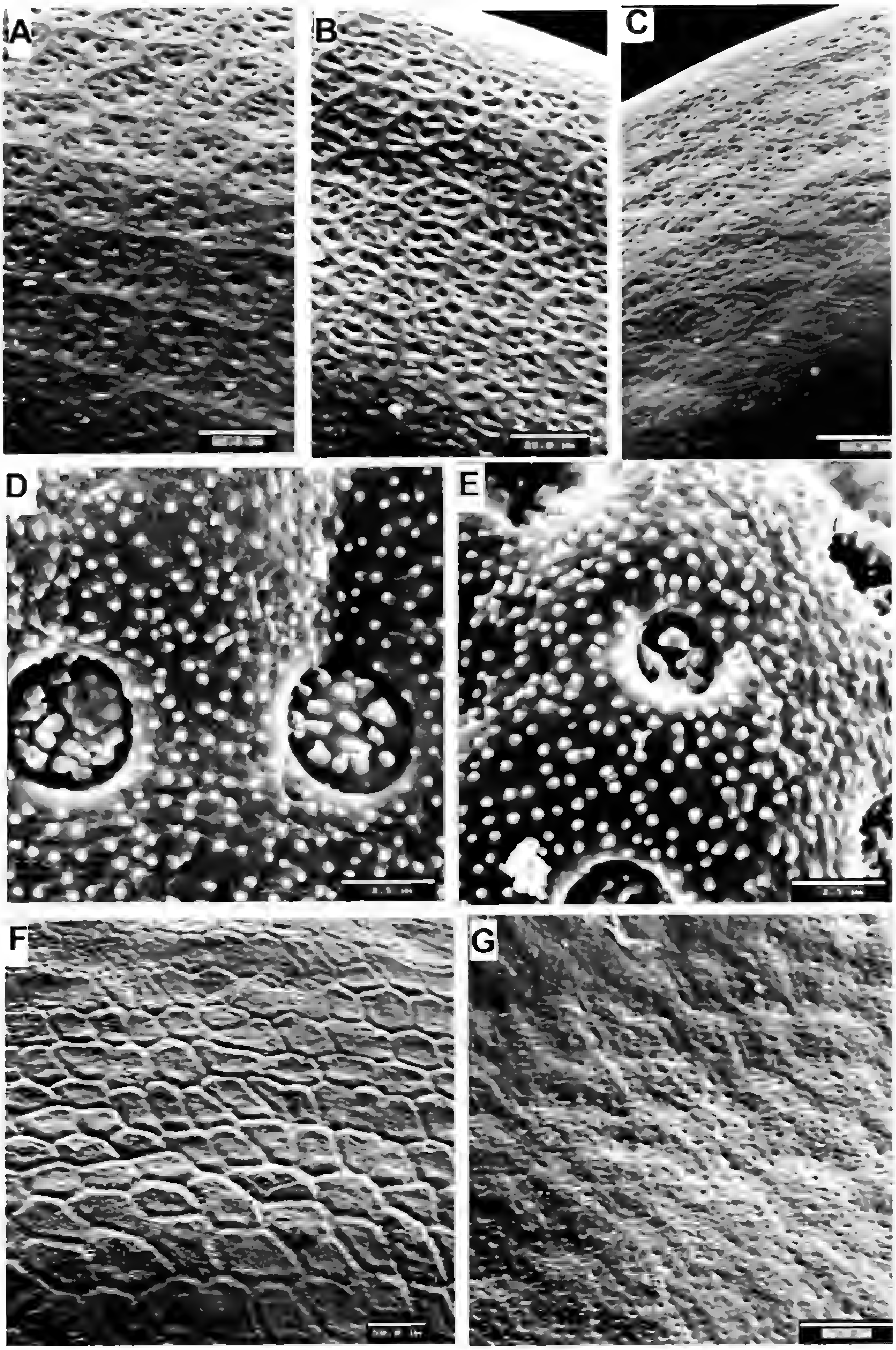


Fig. 5. A–C. Surface of exotesta on the seed margin. A. *Amaranthus blitum* subsp. *blitum* (scale bar 50 µm); B. *A. blitum* subsp. *emarginatus* (scale bar 25 µm); C. *Amaranthus blitum* subsp. *oleraceus* (scale bar 50 µm). D–E. Pollen (scale bar 2.5 µm). D. *Amaranthus blitum* subsp. *blitum*; E. *Amaranthus blitum* subsp. *emarginatus*. F–G. Surface of exotesta on the seed margin. (scale bar 50 µm). F. *Amaranthus graecizans* subsp. *graecizans*; G. *Amaranthus graecizans* subsp. *sylvestris*.

Pollen grains 18–20 µm with 32–40 pores of 1.9–3.2 µm diameter. Density of granules medium. Brenner observed (unpublished) that plants grown in the green house produce abundant nectar.

The name *A. viridis* is sometimes misapplied to *A. blitum* in North America. For the nomenclature and typification of *A. viridis* see Thellung (1914), Merril (1936), Coons (1975, 1981). Even though related to *A. blitum*, *A. viridis* is unquestionable a distinct species.

Distribution and ecology.—Native to South America according to the majority of authors, but "possibly of Asian origin" (Townsend 1988). This is practically a cosmopolitan noxious weed in the tropical and subtropical regions of the world. It has been introduced into the warmer temperate regions of Europe, North America, Asia, Africa and Australia.

Representative specimens examined: **MISSISSIPPI. Washington Co.:** just NE of Leland, 1 Sep 1990, *Bryson 10315* (IBE). **SOUTH CAROLINA. Richland Co.:** Columbia, 22 Aug 1971, *Leonard et al. 4939* (SMU). **TEXAS. Arkansas Co.:** Rockport, 5 Jun 1958, *D. S. & H. B. Correll 18948* (LL). **Brazoria Co.:** San Bernard Refuge, 11 Aug 1969, *Fleetwood 9539* (TEX). **Brazos Co.:** College Station Texas, 29 Nov 1949, *Parmalee 91* (TEX). **Calhoun Co.:** Matagorda Isle, 19 Jul 1973, *Hartman et Smith 3648* (TEX). **Harris Co.:** Houston, 10 Jun 1958, *Traverse 747* (LL). **Travis Co.:** 30°16'43"N, 97°29'00"W, 140m, 16 Jun 1996, *Carr 15530* (TEX). Austin, 23 May 1986, *Carr 7466* (TEX). **Webb Co.:** Laredo, 8 Apr 1965, *Cuesta 22* (LL).

3. Amaranthus graecizans L., Sp. Pl. 990. 1753. TYPE: "Habitat in Virginia"; LINN 1117/3.

Annual with erect to ascendant stems, up to 80 cm, in the upper part with trichomes like *A. blitoides* [uniseriate trichomes consisting from 2(–3) cells with the terminal cells spherical, much larger than the basal one], in addition multicellular uniseriate trichomes are present. Leaves 2–4(–5) × 1–3 cm linear, lanceolate to rhombic—ovate or rhombic-elliptic, without a conspicuous hyaline margin. Bracteoles equal to or longer than the tepals with the mid-vein ramified. Tepals 3, 1.5–2 mm long, elliptic to lanceolate-oblong, gradually or abruptly narrowed into a mucro, with the mid-vein ramified. Fruit usually circumscissile (sometimes indehiscent), (2–)2.2–2.5(–2.7) mm, broad-ellipsoidal to globose, gradually narrowed toward the stigma region, with the dehiscence line in the lower part, strongly-wrinkled. Stigmas 2–2.25 mm long and 0.4–0.6 mm thick at the base. Seeds circular, 1.0–1.3 × 1.0–1.3 mm, lenticular, with a short furrow above the hilum, differentiated into central and marginal zones. Margin of the seed acute. Pollen grains 21–25 µm with 19–32 pores of 1.5–1.7 µm in diameter. Density of granules medium. Chromosome number: 2n=32.

Amaranthus graecizans differs from *A. albus* in not having spinescent bracteoles and by its larger seeds. From *A. blitoides* it can be distinguished by the erect or ascendant stems, possession of only 3 tepals, the absence of a hyaline margin on the leaf blades and by its smaller seeds.

Native in the Mediterranean region, including North Africa. The two widespread subspecies differ in leaf shape and seed sculpture.

1. Leaf blade lanceolate, usually 1–1.5 cm broad; marginal zone of the seeds with prominent cells whose periclinal walls are smooth (Fig.5F) ________________ **A. graecizans** subsp. **graecizans**
1. Leaf blade rhombic-ovate to ovate-elliptic, up to 4 cm broad; marginal zone of the seeds with inconspicuous cells, whose periclinal walls are minutely punctiform sculptured (Fig. 5G) ________________ **A. gracizans** subsp. **sylvestris**

3a. Amaranthus graecizans subsp. graecizans

Amaranthus angustifolius Lam., Encycl. 1:115. 1783., nom. illeg.

3b. Amaranthus graecizans subsp. sylvestris (Vill.) Brenan, Watsonia 4:273. 1961. (Fig. 6).

Amaranthus angustifolius Lam. var. *sylvestris* (Vill.)Thell. in Schinz & Keller, Fl. Schweiz ed. 4, 1:222. 1923. *Amaranthus sylvestris* Vill., Cat. Pl. Jard. Strasbourg 111. 1807. *Amaranthus graecizans* var. *sylvestris* (Vill.) Ascherson in Schweif., Beitr. Fl. Aethiop. 176. 1867.

Distribution and ecology.—*A. graecizans* subsp. *graecizans* is found in the warmer regions of Europe, through most of Africa and in tropical Asia, especially India. Plants belonging to subsp. *sylvestris* have generally the same range as subsp. *graecizans* but penetrate into the cooler regions of Europe, southwest Asia and northwest India. Another subspecies—subsp. *thellungiacus* (Nevski) Gusev, having leaf-blades narrowly linear or lanceolate to rhomboid spathulate and long-aristate tepals and bracteoles, awns 0.3–1 mm, divergent, has a more restricted range: Middle Asia, India and also sporadically introduced in Africa (Townsend 1988).

In the United States we have seen only 2 specimens belonging to subsp. *sylvestris*, both from NEW JERSEY. Camden Co.: Camden, "on ballast," 9 Aug 1879, *Parker s.n.* (RSA); same location, 30 Aug 1879 *Parker s.n.* (RSA). It is almost certain that this plant is more widespread than these collections suggest, being probably under collected or misidentified as *A. blitoides* (especially with var. *reverchonii*) or *A. albus*. Also, there are numerous herbaria that we did not survey for this species group as it was not a primary focus of our research.

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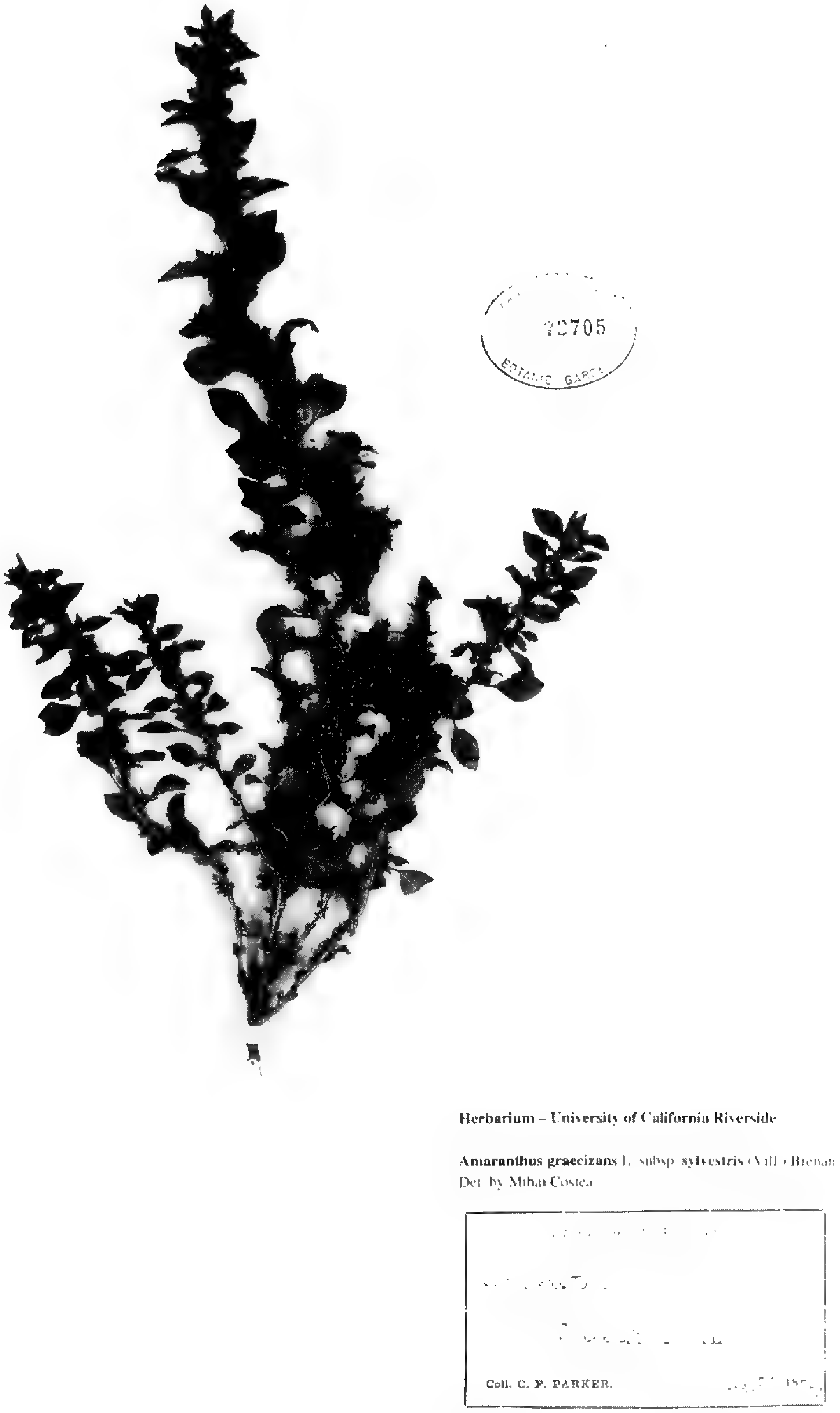

FIG. 6. *Amaranthus graecizans* subsp. *sylvestris*, *Parker s.n.* (RSA).

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CAREX CUMBERLANDENSIS, A NEW SPECIES OF SECTION *CAREYANAE* (CYPERACEAE) FROM THE EASTERN UNITED STATES OF AMERICA

Robert F.C. Naczi

Claude E. Phillips Herbarium
Department of Agriculture and Natural Resources
Delaware State University
Dover, DE 19901-2277, U.S.A.
rnaczi@dsc.edu

Robert Kral

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, TX 76102-4060, U.S.A.

Charles T. Bryson

USDA–ARS
Southern Weed Science Research Unit
P.O. Box 350
Stoneville, MS 38776, U.S.A.
cbryson@ars.usda.gov

ABSTRACT

Carex cumberlandensis is described as new from mesic forests in Alabama, Arkansas, Georgia, Indiana, Kentucky, Mississippi, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia. Previously, specimens of *C. cumberlandensis* had been confused with *C. digitalis* and *C. abscondita*. *Carex cumberlandensis* has vegetative shoots much taller than the culms, very narrow staminate spikes, short staminate scales, and obtuse staminate scales, all of which distinguish it from *C. digitalis*. Unlike *C. abscondita*, *C. cumberlandensis* has the lower spikes on long and drooping or nodding peduncles, distichously imbricate perigynia, the bract blade of the distalmost lateral spike (12–)17–51 times as long as wide, and always densely caespitose habit. The chromosome number of *C. cumberlandensis* is $2n = 23$ II.

RESUMEN

Se describe como nuevo *Carex cumberlandensis* de los bosques mesófilos de Alabama, Arkansas, Georgia, Indiana, Kentucky, Mississippi, Carolina del Norte, Ohio, Pennsylvania, Carolina del Sur, Tennessee, Virginia, y West Virginia. Previamente, se habían confundido especímenes de *C. cumberlandensis* con *C. digitalis* y *C. abscondita*. *Carex cumberlandensis* tiene renuevos vegetativos mucho más altos que los cúlmenes, espigas estaminadas muy estrechas, escamas estaminadas cortas y obtusas, todo lo cual lo distingue de *C. digitalis*. Al contrario que *C. abscondita*, *C. cumberlandensis* tiene las espigas inferiores nutantes o colgantes en largos pedúnculos, utrículos imbricados dísticamente, la lámina de la bráctea de la espiga lateral más distal (12–)17–51 veces más larga que ancha, y siempre un hábito densamente cespitoso. El número cromosómico de *C. cumberlandensis* es $2n = 23$ II.

INTRODUCTION

Carex section *Careyanae* Tuck. ex Kük. is a group of sedges endemic to eastern North America that is most diverse in mesic deciduous forests of the southeastern United States. Tuckerman (1843) first used the name “Careyanae” for this

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group, but without description or designation of rank. Kükenthal (1909) validated the name at the rank of section, but circumscribed *Carex* sect. *Careyanae* to include species currently placed in *Carex* sect. *Laxiflorae* Kunth and *Carex* sect. *Siderostictae* Franchet ex Ohwi. Most authors since Kükenthal (e.g. Mackenzie 1935; Fernald 1950; Bryson 1980; Manhart 1986; Gleason & Cronquist 1991) have included sect. *Careyanae* s.s. in sect. *Laxiflorae*. Bryson (1980) and Manhart (1986), based on morphological and biochemical evidence, respectively, found sect. *Laxiflorae* s.l. to consist of two subgroups that correspond to sect. *Careyanae* s.s. and sect. *Laxiflorae* s.s. A phylogenetic analysis of sect. *Laxiflorae* and closely related sections revealed that sect. *Careyanae* s.s. and sect. *Laxiflorae* s.s. are not each other's sister groups and are best treated as separate sections (Naczi 1989, 1992). In addition, molecular evidence supports the separation of sect. *Careyanae* and sect. *Laxiflorae* (Starr et al. 1999). Thus, various lines of evidence indicate sect. *Careyanae* is worthy of recognition.

Morphologic apomorphies that diagnose sect. *Careyanae* include perigynia acutely triangular in cross-section and perigynia with numerous (usually 40 or more), longitudinal sclerenchyma traces ("nerves" of earlier authors, e.g. Fernald 1950; Gleason & Cronquist 1991) that are impressed in living perigynia but raised in dried perigynia (Naczi, 1989, 1992, 1997). Additional character states shared by members of sect. *Careyanae*, though not unique to them, include glabrous leaf and bract blades, long-sheathing proximal bracts, usually unisexual spikes with the terminal one staminate, and glabrous perigynia with entire apices. This section contains eight species and three nonautonymic varieties (with synonyms from recent floras and taxonomic works in brackets or parentheses): *C. abscondita* Mack. [*C. abscondita* var. *glauca* (Chapm.) Fernald, *C. abscondita* var. *rostellata* Fernald, *C. magnifolia* Mack.], *C. austrocaroliniana* L.H. Bailey, *C. careyana* Torr., *C. digitalis* Willd. var. *asymmetrica* Fernald, *C. digitalis* var. *digitalis*, *C. digitalis* var. *macropoda* Fernald, *C. laxiculmis* Schwein. var. *copulata* (L.H. Bailey) Fernald [*C. copulata* (L.H. Bailey) Mack.], *C. laxiculmis* var. *laxiculmis* (×*C. absconditiformis* Fernald), *C. plantaginea* Lam., *C. platyphylla* J. Carey, and one undescribed species (the subject of this paper).

During the course of studies on sect. *Careyanae*, we noticed specimens in several herbaria labeled as *C. abscondita* or as *C. digitalis* that do not match the descriptions or types of these names. Field work and additional herbarium work revealed these specimens to represent an undescribed species here named *C. cumberlandensis*. In this paper, we describe this species and clarify its relationships with other taxa in sect. *Careyanae*.

Carex cumberlandensis Naczi, Kral, & Bryson, sp. nov. (**Figs. 1, 2**). TYPE: U.S.A. ALABAMA. WINSTON CO.: ca. 10 mi N of Double Springs, Sipsey River Recreation Area of Bankhead National Forest, E of river and S of bridge, T9S, R8W, NE1/4 of section 8, 4 May 1991, *Naczi 2868* (HOLOTYPE: DOV*; ISOTYPES: AUA, GH, MICH, MO, NCU, NY, US, USCH, VDB, WIN, ctb).

A *Carex digitalis* surculis vegetativis quam culmis 1.4–3.3plo altioribus, spicis terminalibus 0.6–1.3 mm latis, squamis staminatis brevioribus, squamis staminatis obtusis differt; a *Carex abscondita* habitu semper dense caespitoso, laminis bractearum subtenentes spicas laterales summas (12–)17–51plo longioribus quam latioribus, pedunculis proximalibus plerumque cernuis vel nutantibus, pedunculis spicarum proximalium (28–)44–84(–91) mm longis, spicis perigyniis paucioribus instructis, perigyniis distichis differt.

Perennial herb, densely caespitose. *Rhizomes* short, 0.4–2.2 mm long between shoots or branches of the rhizomes, 1.5–1.9 mm thick, covered with cataphylls 1.3–1.8 mm long. *Shoot bases* surrounded by cataphylls, stramineous, lacking purplish coloration. *Reproductive shoots* erect or ascending; culms 7.3–27.4 cm tall, 0.4–0.7 mm wide at mid-height, smooth throughout, obtusely trigonous. *Cataphylls* glabrous, stramineous to whitish, multicostate. *Leaves* of reproductive shoots with blades 0.4–52 cm long, 1.2–5.8(–6.6) mm wide, the widest (3.2–) 3.7–5.8(–6.6) mm wide, green, flat to barely plicate, margins smooth or antrorsely scaberulous, adaxial surface smooth or sparsely antrorsely scaberulous on main veins, abaxial surface smooth; leaf sheaths 2.1–10.6 cm long, tight, glabrous; adaxial face of sheaths with hyaline and glabrous band, hyaline band with apex slightly concave to slightly convex; ligules lingulate with apex obtuse. *Vegetative shoots* 14.6–47.0 cm tall, (1.4–)1.7–3.3 times as tall as culms; pseudoculms 3.4–7.8 cm tall, 0.10–0.18 of vegetative shoot height. *Infructescence* a single terminal spike and 2–3 lateral spikes, usually with the distal 2–3 spikes overlapping, rarely with all spikes separate; proximalmost bract with blade 7.1–25.2 cm long and (0.5–)0.9–1.8 times as long as culm; bract blade of distalmost lateral spike 0.9–15.4 cm long, 1.3–3.5 mm wide, (12–)17–51 times as long as wide, and much exceeding terminal spike. *Spikes* 3–4 per culm, simple, single at nodes, erect; terminal spike 5.1–21.2 mm long, the longest (7.6–)9.6–21.2 mm long, 0.6–1.3 mm wide, entirely staminate, 4–24-flowered, on erect and smooth peduncle 2.1–44(–71) mm long, usually overlapping distalmost lateral spike and slightly exceeding it or slightly exceeded by it, rarely exceeding distalmost lateral spike and separate from it; lateral spikes 5.3–17 mm long, 2.8–4.1 mm wide, entirely pistillate, 4–8(–9)-flowered, the perigynia distichously imbricate, the internode between the proximalmost perigynia 1.8–3.0 mm long, on smooth peduncles, the proximal ones usually pendulous; the longest peduncle drooping or nodding, (28–)44–84(–91) mm long. *Staminate scales* (2.6–)2.8–3.5(–3.8) mm long, 1.1–1.7 mm wide, narrowly elliptic to elliptic, obtuse, center green and 1-nerved, margins hyaline and whitish or whitish with ferruginous speckles and streaks. *Pistillate scales* 1.3–2.2 mm long, 1.4–2.1 mm wide, 0.41–0.55 times as long as perigynium, broadly ovate, obtuse, center green and 1-nerved; margins entire, hyaline, whitish to tawny, infrequently with ferruginous speckles and short streaks. *Anthers* 3, 1.2–1.8 mm long. *Styles* jointed with summits of achenes, portions distal to achenes withering with age, portion proximal to achene (style base) persistent and becoming achene beak; base 0.1–0.2 mm wide. *Stigmas* 3,

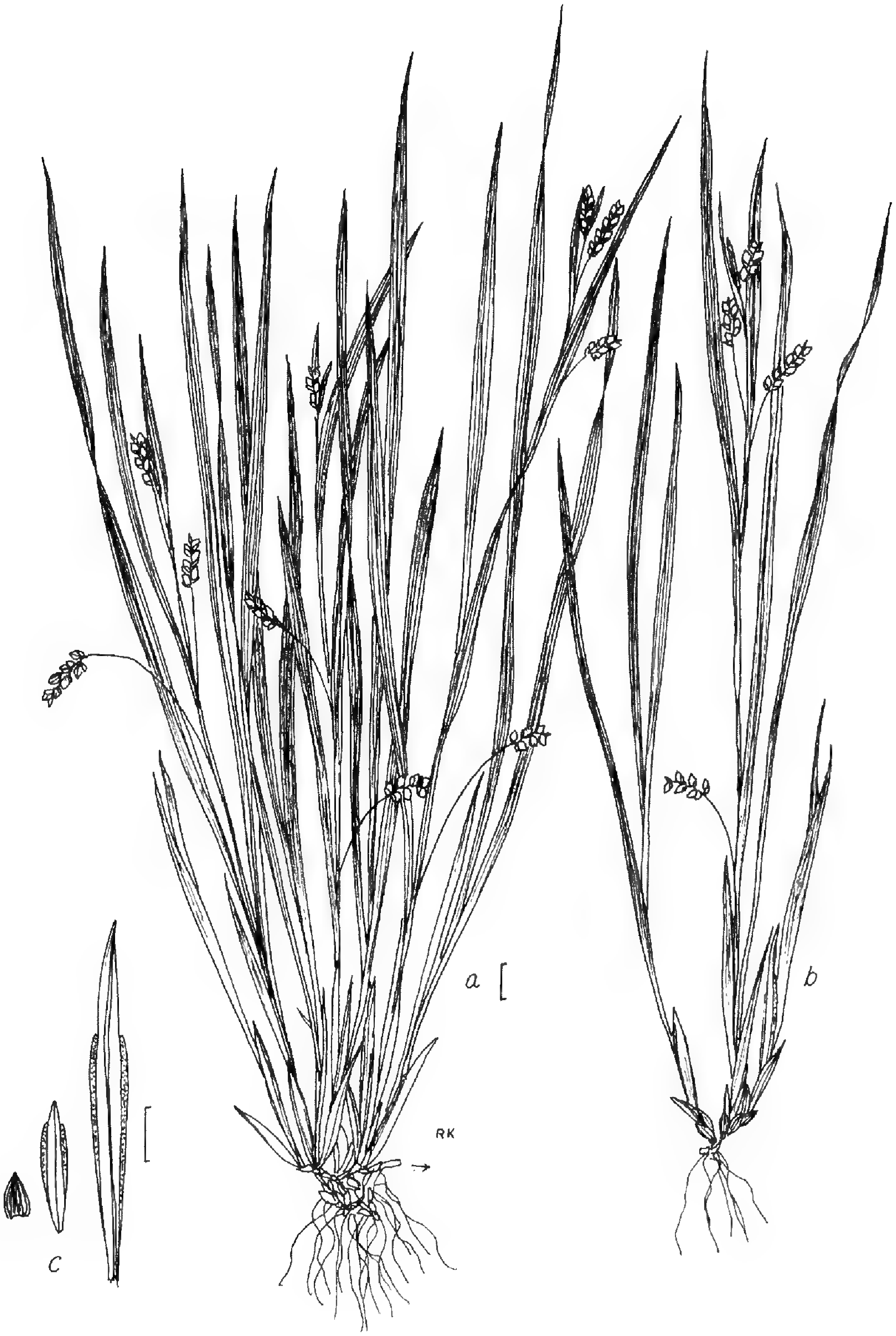

Fig. 1. *Carex cumberlandensis*. a. Habit. b. Offshoot from clump showing pair of immature vegetative shoots (shorter than when mature) flanking central reproductive shoot. c. Rhizome cataphyll (left), proximal shoot cataphyll (middle), and distal shoot cataphyll (right). Scale bars equal 1 cm, with the scale the same for a and b. Drawn by Robert Kral from the holotype.

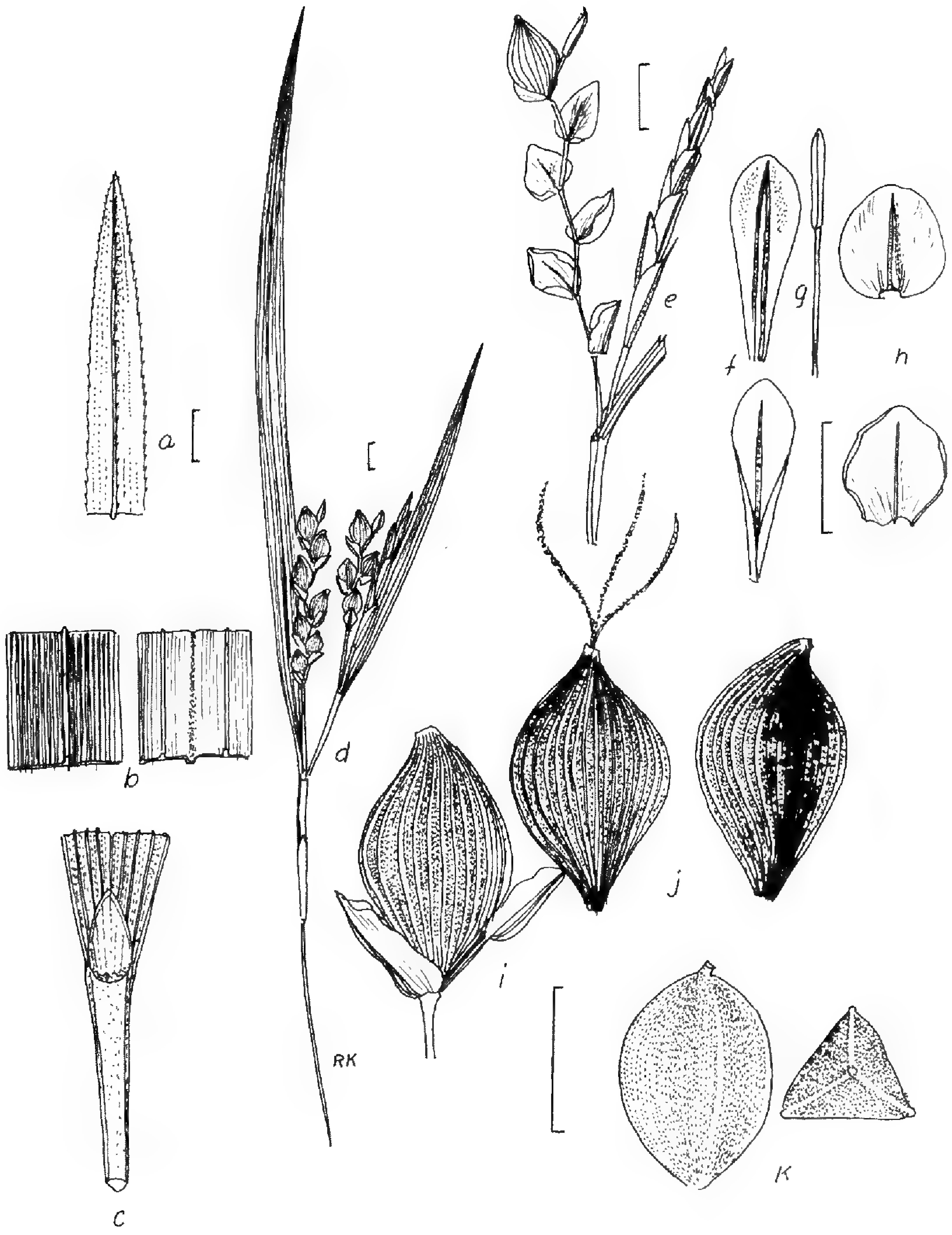

FIG. 2. *Carex cumberlandensis*. a. Tip of leaf blade, abaxial surface. b. Portions of leaf midblade, abaxial surface (left) and adaxial surface (right). c. Sheath-blade junction of bract, with culm removed, adaxial surface. d. Distal portion of culm. e. Pair of spikes from apex of culm, with a lateral (pistillate) spike from which all but one perigynium has been shed (left), and a terminal (staminate) spike (right). f. Staminate scales, abaxial surface (upper) and adaxial surface (lower). g. Stamen. h. Pistillate scales, abaxial surface (upper) and adaxial surface (lower). i. Apex of lateral spike showing a perigynium with subtending scale and, distally, a scale subtending an undeveloped perigynium. j. Perigynia, front (abaxial) view (left) and lateral view (right). k. Achenes, lateral view (left) and top view (right). Scale bars equal 2 mm, with the scale the same for each illustration within each group for a–c, f–h, and i–k. Drawn by Robert Kral from the holotype.

0.8–1.3 mm long, withering with age. *Perigynia* 2.9–3.8 mm long, 1.5–2.1 mm wide, 1.6–2.3 times as long as wide, 1.4–1.5 times as long as achene bodies, ascending, acutely triangular in cross section, abaxial faces slightly convex to flat, adaxial face slightly concave to flat, nerves shallowly impressed in living perigynia and slightly raised in dry perigynia, nerves 43–54, glabrous, green to brown, dull, ellipsoid or obovoid, gradually tapered from widest point to truncate base, gradually or abruptly tapered to subacute or acute apex, beakless or with minute beak; beaks 0–0.2 mm long, 0–7% of perigynium length, bent abaxially, smooth, entire. *Achenes* 2.2–2.9 mm long, 1.4–1.8 mm wide, tightly enveloped by perigynia, obovoid to ovoid, acutely trigonous, faces slightly concave to flat, brown, basally abruptly contracted to stipe, apically abruptly contracted to beak; stipe 0.1–0.2 mm long, vertical or slightly bent; body 1.9–2.7 mm long, with widest point 0.9–1.5 mm from body apex; beak 0.1 mm long, bent abaxially 30–60° from vertical.

Previously, herbarium specimens of *Carex cumberlandensis* have been identified as *C. digitalis* and *C. abscondita*. However, *C. cumberlandensis* and *C. digitalis* are only superficially similar. The most obvious similarity for them is their sharing of proximal spikes borne on long peduncles, a plesiomorphy in the section (Naczi, unpubl. phylogenetic analysis of sect. *Careyanae*). Thus, the similarity between *C. cumberlandensis* and *C. digitalis* is not indicative of a close relationship between these two species. Four features distinguish *C. cumberlandensis* and *C. digitalis*. *Carex cumberlandensis* has vegetative shoots much taller than the culms [tallest vegetative shoot per specimen/tallest culm per specimen = (1.4–)1.7–3.3], very narrow staminate spikes (0.6–1.3 mm wide), short staminate scales [2.6–3.5(–3.8) mm long], and obtuse staminate scales. *Carex digitalis* differs from *C. cumberlandensis* in having vegetative shoots shorter than to slightly exceeding the culms [tallest vegetative shoot per specimen/tallest culm per specimen = 0.5–1.3(–1.8)], wider staminate spikes [(1.0–)1.2–2.7 mm wide], longer staminate scales (3.6–5.5 mm long), and acute staminate scales. A scatter plot of measurements for two of the differences between *C. cumberlandensis* and *C. digitalis*, vegetative shoot height/culm height vs. width of staminate spike, provides complete separation of these two species (Fig. 3, with specimens measured for this plot indicated in the asterisked citation of the holotype of *C. cumberlandensis*, asterisked citations of representative specimens of *C. cumberlandensis*, asterisked specimens cited in Appendix A, and specimens cited in Appendix B).

Carex cumberlandensis is most similar to *C. abscondita*, which is the species with which *C. cumberlandensis* is most often confused. These two species share vegetative shoots much taller than culms, very narrow staminate spikes, short staminate scales, and obtuse staminate scales, the same four features that distinguish *C. cumberlandensis* from *C. digitalis* (Fig. 3). Each of these features is a synapomorphy within sect. *Careyanae* and possessed by only *C.*

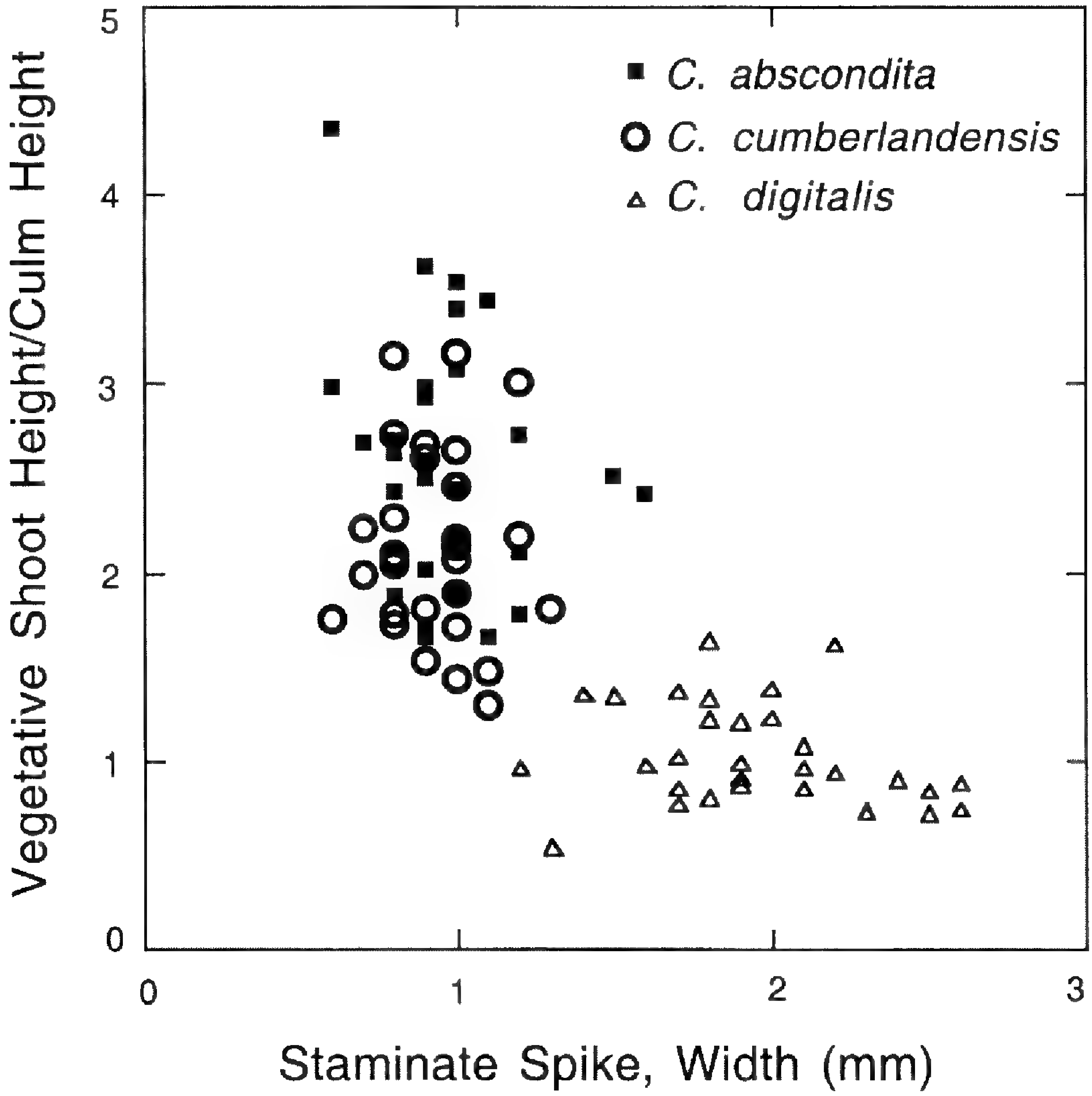

Fig. 3. Scatter plot of tallest vegetative shoot per specimen/tallest culm per specimen vs. width of longest staminate spike per specimen for *Carex abscondita, C. cumberlandensis,* and *C. digitalis.*

cumberlandensis and *C. abscondita.* Thus, *C. cumberlandensis* and *C. abscondita* appear to be sister species (Naczi, unpubl. phylogenetic analysis of sect. *Careyanae*).

Carex cumberlandensis differs from *C. abscondita* in several ways. First, *C. cumberlandensis* is always densely caespitose, whereas *C. abscondita* is often loosely caespitose. The growth form of *C. abscondita* appears to vary clinally, with plants from the southern portions of its range having a looser habit than those from the north. In fact, plants of *C. abscondita* from the northernmost portion of its range (northern Virginia and northward) are usually densely caespitose. Second, the proximal peduncles of *C. cumberlandensis* are much longer than those of *C. abscondita* [longest (per plant) peduncle of a proximal spike (28–)44–84(–91) mm long in *C. cumberlandensis* vs. (7.0–)15–42(–49) mm long in *C. abscondita*]. Third, the peduncles of *C. cumberlandensis* usually droop or nod (the proximal spikes are usually pendulous), but those of *C. abscondita* are usually erect or, at most, spreading (the spikes have their apices pointing upward). The distichously imbricate perigynia of *C. cumberlandensis* versus spirally imbricate ones of *C. abscondita* constitute a fourth difference between the two species. Fifth, *C. cumberlandensis* has fewer perigynia per spike than does *C. abscondita* [longest spike per plant with 4–8(–9) perigynia, including undeveloped or aborted ones, in *C. cumberlandensis* vs. (6–)8–13 perigynia in *C. abscondita*]. Finally, the value of the length/width ratio of the blade of the bract of the distalmost lateral spike is greater in *C. cumberlandensis* than it is in *C. abscondita* [(12–)17–51 for *C. cumberlandensis* vs. 5.6–17(–26) for *C. abscondita*]. On a scatter plot of greatest number of perigynia per spike vs. length of longest peduncle of lateral spike, specimen clusters for *C. abscondita* and *C. cumberlandensis* are well resolved (Fig. 4, with specimens measured for this plot the same as measured for Fig. 3). Although measurements overlap for each of these features, simultaneous consideration of them allows unambiguous identification of all specimens except for a few depauperate ones. Specimens that are somewhat difficult to identify based on these two features can be determined with certainty through consideration of additional features, such as habit (densely caespitose vs. loosely caespitose), arrangement of the perigynia (distichous vs. spiral), and length/width ratio of bract blades.

Thus, *Carex cumberlandensis* is a species with several diagnostic features that distinguish it from morphologically similar taxa. Despite the slight overlap of measurements of some key characters among *C. cumberlandensis*, *C. abscondita*, and *C. digitalis*, we have seen no specimens that simultaneously overlap in more than one or two key characters between *C. cumberlandensis* and *C. abscondita* or *C. cumberlandensis* and *C. digitalis*.

The chromosome number of *C. cumberlandensis* is $2n = 23$ II, determined from metaphase I of pollen mother cells (methods in Naczi 1999). Though the studied plants were from two populations, they yielded the same count [vouchers: Alabama, Winston Co., ca. 10 mi. N of Double Springs, *Naczi 2966* (DOV, MICH); Georgia, Stephens Co., ca. 3 mi. N of Toccoa, *Naczi 2965* (DOV, MICH)]. *Carex abscondita* (one plant studied) has a chromosome number of $2n = 24$ II (Naczi, 1999). Because *Carex* species commonly exhibit intraspecific variability in chromosome number, it is premature to conclude the chromosome numbers of *C. cumberlandensis* and *C. abscondita* do not overlap.

Carex cumberlandensis inhabits mesic forests. The forests are deciduous or sometimes mixed with hemlock. These forests usually have diverse herbaceous floras. Frequent vascular plant associates of *C. cumberlandensis* include *Anemone acutiloba* (DC.) G. Lawson, *Carex amphibola* Steud., *C. laxiflora* Lam., *C. rosea* Willd., *Circaea lutetiana* (L.) Asch. & Magnus, *Galium circaezans* Michx., *Hexastylis arifolia* (Michx.) Small, *Houstonia purpurea* L., *Lindera benzoin* (L.) Blume, *Podophyllum peltatum* L., *Polystichum acrostichoides* (Michx.)

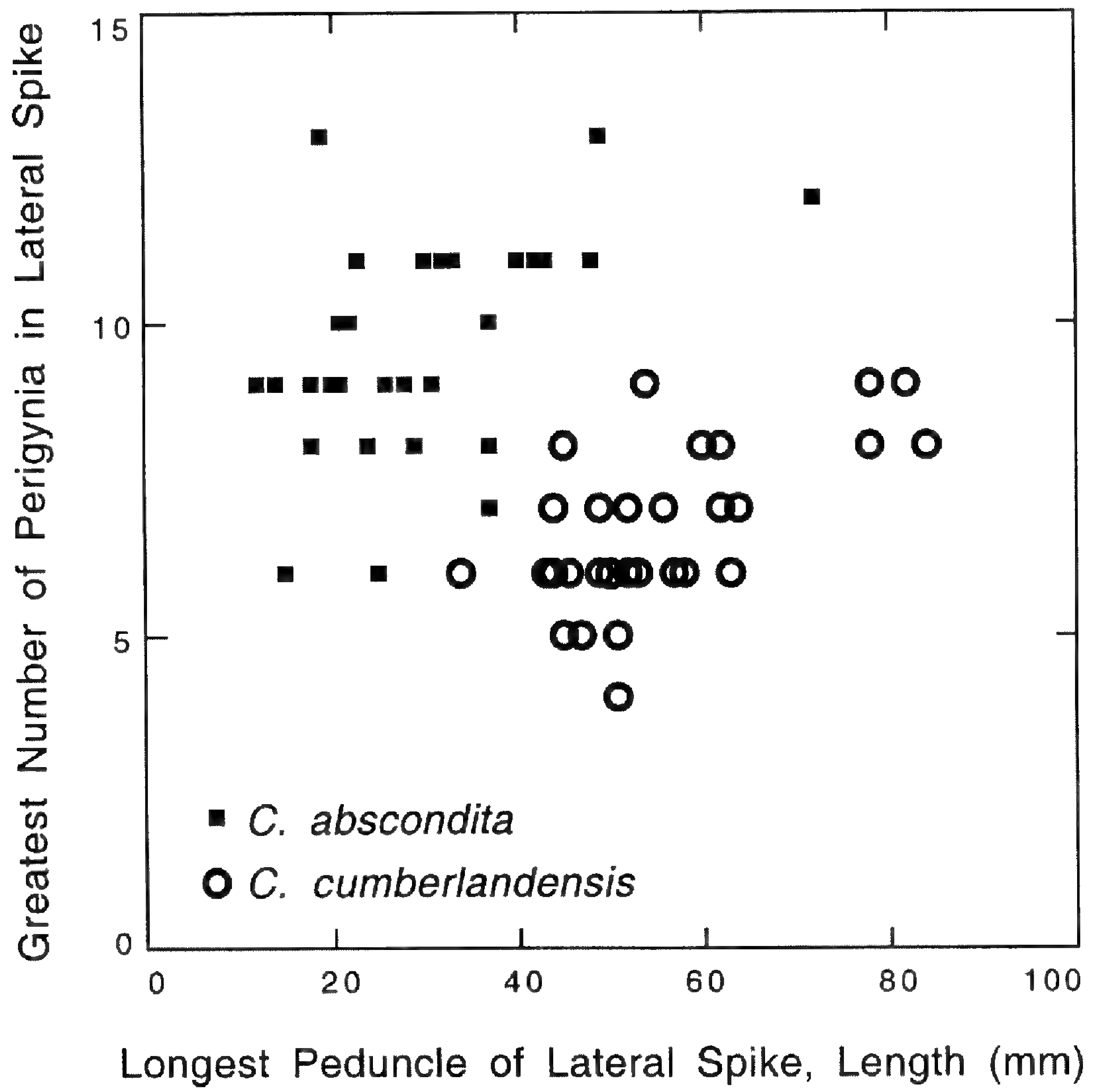

Fig. 4. Scatter plot of greatest number of perigynia in lateral spike (including undeveloped or aborted perigynia) vs. length of longest peduncle of lateral spike for *Carex abscondita* and *C. cumberlandensis*.

Schott, *Sanicula canadensis* L., *Scutellaria elliptica* Muhl., and *Tiarella cordifolia* L. The substrates of *C. cumberlandensis* are slightly acidic to circumneutral loams, sandy loams, loamy sands, and clays (Naczi, unpubl. data).

Carex cumberlandensis ranges from southwestern Pennsylvania south to Georgia and west to Arkansas (Fig. 5). The range of this species is entirely within unglaciated terrain, though *C. cumberlandensis* closely approaches the southern limits of glaciation (Flint 1971) in southern Ohio, northern Kentucky, and southern Indiana. A substantial disjunction appears to exist in the range of *C. cumberlandensis*. A population in Franklin County, Arkansas (*Naczi 2155*) is about 400 km (250 mi) from the nearest known population in the main portion of the species' range (*Naczi 4846 & Reznicek*, Tennessee, Dyer County). The Arkansas population, in the Boston Mountains subdivision of the Ozark Mountain physiographic region (Robison & Allen 1995), is the only one known

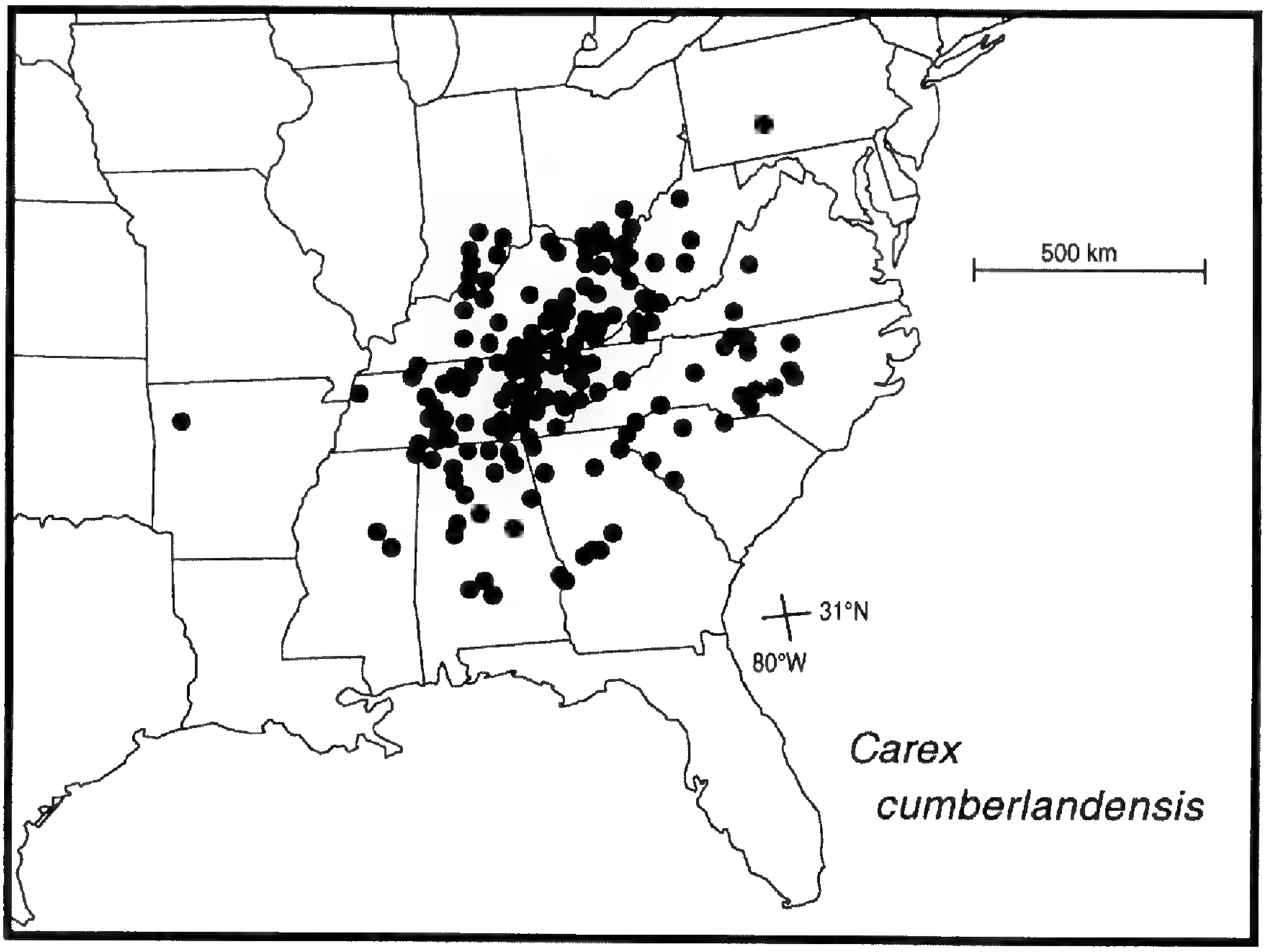

Fig. 5. Geographic distribution of *Carex cumberlandensis*.

west of the Mississippi River. Several other flowering plant species of forests and forest edges exhibit a similar disjunction between the Ozark Mountains and regions east of the Mississippi River, including *Carex ouachitana* Kral, Manhart, & Bryson (Naczi & Bryson 1990; McNeilus 1992), *C. willdenowii* Willd. (Naczi et al. 1998), *Castanea ozarkensis* Ashe (Johnson 1988; Nixon 1997), *Cotinus obovatus* Raf. (Little 1977), *Fothergilla major* Lodd. (Smith 1988; Meyer 1997a), *Leptopus phyllanthoides* (Nutt.) G.L. Webster (Clark 1967; Smith 1988), *Magnolia tripetala* L. (Little 1977; Meyer 1997b), *Monarda virgata* Raf. (Scora 1967; Smith 1988), *Neviusia alabamensis* A. Gray (Long 1989), and *Trillium pusillum* Michx. var. *ozarkanum* (Palmer & Steyerm.) Steyerm. (Cabe & Werth 1995).

Carex cumberlandensis occurs in several physiographic provinces, but most of its range lies in the Appalachian Plateaus (including the Cumberland Plateau), Interior Low Plateaus, and Piedmont. It is most common in eastern Kentucky, central and eastern Tennessee, and northern Alabama. *Carex cumberlandensis* is rare and local on the Coastal Plain. For the Coastal Plain, only eight populations are known, from Alabama (Butler, Lowndes, Russell, and Wilcox counties), Georgia (Stewart County), Mississippi (Choctaw and Winston counties), and Tennessee (Dyer County). The specimens cited below are a representative sample of about 280 records (about 810 total specimens) of *C. cumberlandensis* we have studied. Collections of *C. cumberlandensis* date from at least 1844 (*Rugel 108*, Tennessee, Sevier County). Long-standing confusion of *C. cumberlandensis* with *C. abscondita* and *C. digitalis* accounts for why the relatively well-collected, widespread, and common *C. cumberlandensis* had escaped recognition for so long.

Because of past confusion of *C. cumberlandensis* with *C. digitalis* and *C. abscondita*, the distributions of the latter two species need clarification. The range of *C. digitalis* includes the entire region inhabited by *C. cumberlandensis* and is quite extensive: southern Nova Scotia, central Maine, and southern Ontario west to southern Wisconsin and south to central peninsular Florida and eastern Texas (Bryson 1980; Oldham & Zinck 1997). Bryson (1980) provides a map of the range of *C. digitalis*, including its varieties. Since *C. cumberlandensis* has been confused most often with *C. abscondita*, we provide a map of the range of *C. abscondita* (Fig. 6) and cite representative specimens of it (Appendix A). *Carex abscondita* occurs mostly east and south of the range of *C. cumberlandensis*: eastern Massachusetts, southwestern Kentucky, and southeastern Missouri south to northern Florida and eastern Texas (Figs. 6, 7). *Carex abscondita* is most frequent on the Coastal Plain. Since *C. abscondita* is absent from Indiana, Ohio, and West Virginia, reports of this species from these states (e.g. Mackenzie 1935; Deam 1940; Fernald 1950; Manhart 1986; Cusick 1988; Gleason & Cronquist 1991; Ohio Division of Natural Areas and Preserves 2000) almost certainly refer to *C. cumberlandensis*. In addition, though *C. abscondita* occurs in Kentucky and Tennessee, many of the previous reports of this species from these states (e.g. Manhart 1986; Cusick 1989; Chester et al. 1993; McKinney et al. 2000) refer to *C. cumberlandensis*.

Though *C. abscondita* is absent from most of the range of *C. cumberlandensis*, the two species are sympatric in southeastern and southern portions of the range of *C. cumberlandensis* (Fig. 7). Infrequently, plants of these two species do grow syntopically. We have observed *C. cumberlandensis* and *C. abscondita* growing together in Butler, Coosa, Tuscaloosa, Wilcox, and Winston counties, Alabama; Jasper and Monroe counties, Georgia; and Winston County, Mississippi. In localities of syntopy, *C. abscondita* tends to grow in moister soils than *C. cumberlandensis*. We have never observed hybrids or intermediates between *C. cumberlandensis* and *C. abscondita*.

We have selected *cumberlandensis* as an epithet for this new species because the Cumberland Plateau of eastern Kentucky, eastern Tennessee, and northern Alabama is the center of its distribution, the area in which it is most common, and the region in which it is a very characteristic element of the understory of mesic forests.

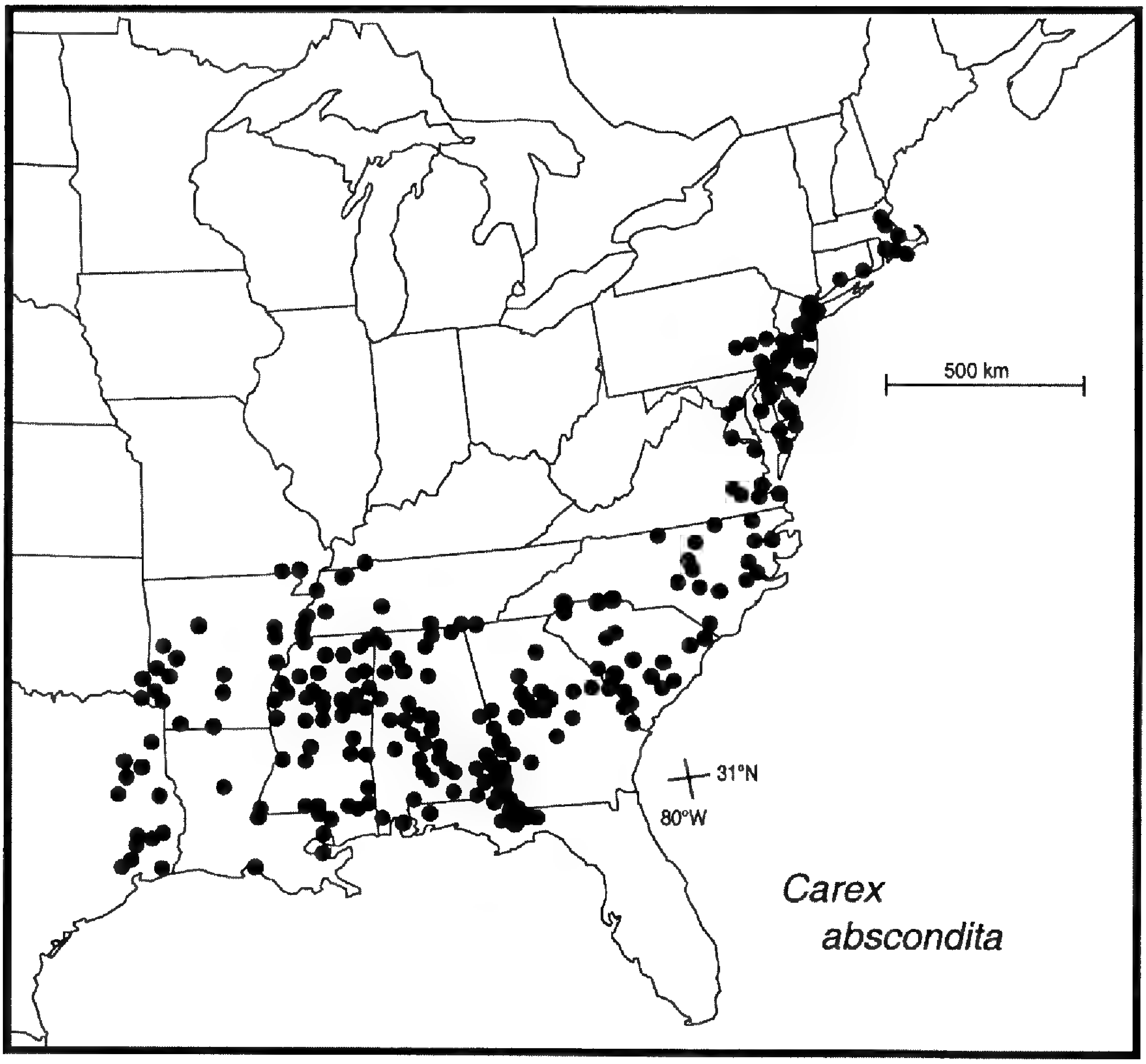

Fig. 6. Geographic distribution of *Carex abscondita*.

IDENTIFICATION KEY FOR MEMBERS OF *CAREX* SECTION *CAREYANAE*

This key is designed for identification of complete and ample specimens bearing mature and healthy perigynia. Occasionally, insects induce galls in the perigynia of members of *Carex* section *Careyanae*. Because these galls distort the morphology of the perigynia, one should avoid considering affected perigynia when identifying these taxa. Relative to healthy perigynia, perigynia with galls are usually paler (especially basally), more elongate, more excurved, much less likely to contain mature achenes, and shed earlier.

The terminal spike is entirely staminate. The lateral spikes are entirely pistillate, except in *C. laxiculmis* (with the basal scales of the lateral spikes sterile or subtending staminate flowers). In addition, plants of some of the taxa (especially *C. digitalis* var. *macropoda*) occasionally have a few staminate flowers terminating the otherwise pistillate lateral spikes.

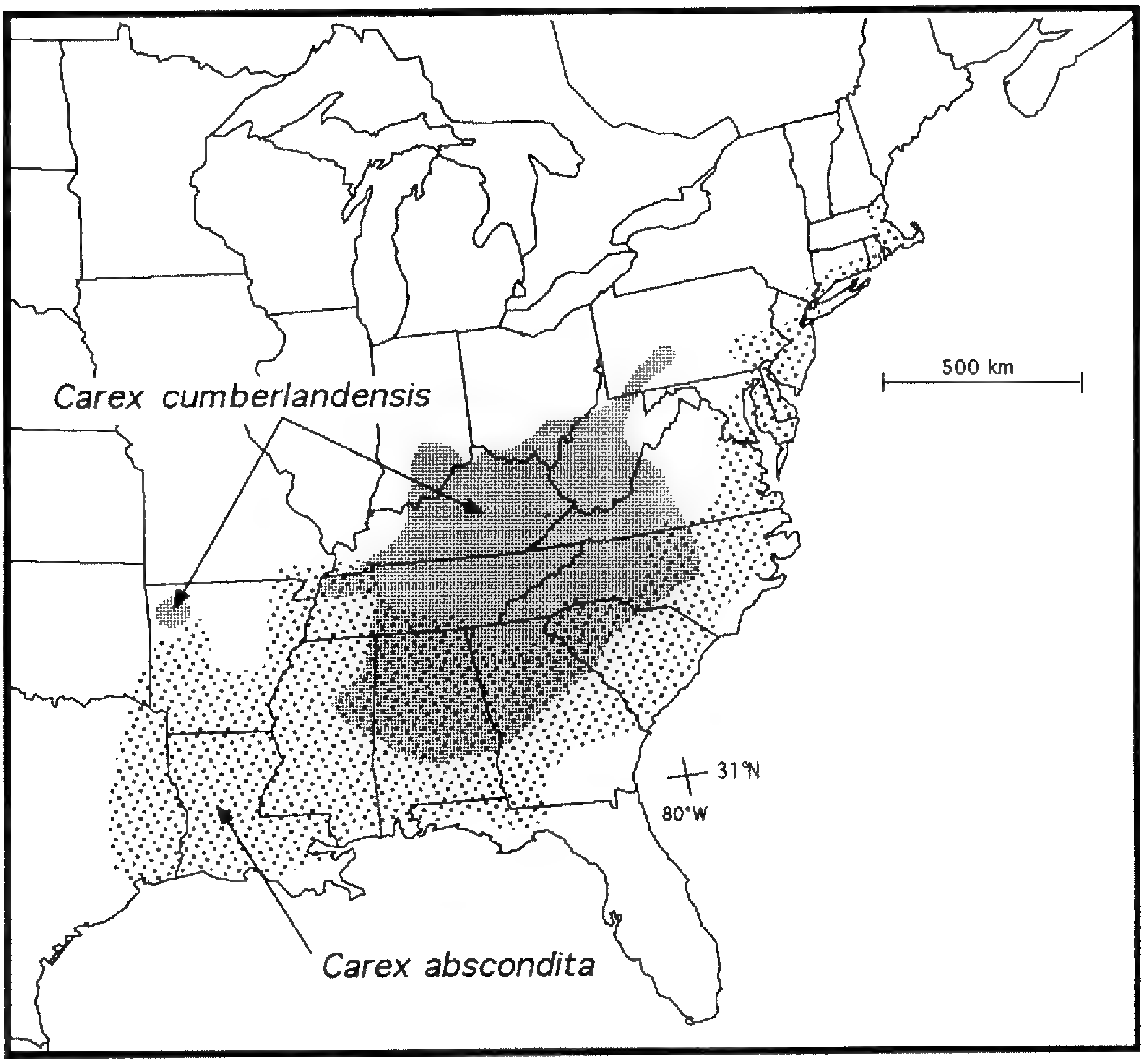

Fig. 7. Regions of sympatry and allopatry of *Carex cumberlandensis* and *C. abscondita*.

Length of the peduncle for lateral spikes is measured from the base of the peduncle (at the node of its subtending bract) to its summit (at the base of the lowest scale in the spike surmounting the peduncle). Thus, peduncle length includes the portion of the peduncle included in the bract sheath.

1. Shoot bases brownish, with purplish coloration completely absent.
   2. Foliage green or glaucous; leaf blades of vegetative shoots 1.0–3.5 times as wide as bract blades; widest leaf blade 0.2–1.4 cm wide; bract blades from middle and proximal portions of culms 4.5–24 cm long.
      3. Proximalmost scale of each lateral spike subtending a perigynium.
         4. Terminal spikes 0.6 -1.4(–1.6) mm wide; staminate scales obtuse, those from middle region of terminal spike 2.6–3.6(–3.8) mm long; vegetative shoots much taller than culms, tallest vegetative shoot (1.4–)1.7–3.7(–4.9) times as tall as tallest culm.
            5. Perigynia distichously imbricate; longer lateral spikes with 4–8(–9) perigynia; peduncles of proximal spikes usually drooping or nodding,

the longest (per plant) peduncle (28–)44–84(–91) mm long; bract blade of distalmost lateral spike (12–)17–51 times as long as wide; densely caespitose **Carex cumberlandensis**

5. Perigynia spirally imbricate; longer lateral spikes with (6–)8–13 perigynia; peduncles of proximal spikes usually erect, the longest (per plant) peduncle (7.0–)15–42(–49) mm long; bract blade of distalmost lateral spike 5.6–17(–26) times as long as wide; loosely or densely caespitose **Carex abscondita**

4. Terminal spikes (1.0–)1.2–2.7 mm wide; staminate scales acute, those from middle region of terminal spike 3.6–5.5 mm long; vegetative shoots shorter than or slightly taller than culms, tallest vegetative shoot 0.5–1.3(–1.8) times as tall as tallest culm.

6. Terminal spike usually surpassing bract blade of distalmost lateral spike; longest (per plant) peduncle of terminal spike (6.3–)8.1–15.9 cm long; widest leaf blade 2.0–2.9(–3.5) mm wide; each perigynium face 7–10-nerved **Carex digitalis** var. **macropoda**

6. Terminal spike usually surpassed by bract blade of distalmost lateral spike; longest (per plant) peduncle of terminal spike 0.9–7.2(–11.4) cm long; widest leaf blade 2.7–4.5(–5.3) mm wide; each perigynium face (8–)11–15-nerved.

7. Perigynia 2.5–3.3 mm long, apex barely excurved **Carex digitalis** var. **digitalis**

7. Perigynia 3.2–4.2 mm long, apex noticeably excurved **Carex digitalis** var. **asymmetrica**

3. Proximalmost scale of each lateral spike sterile or subtending a staminate flower.

8. Foliage usually glaucous; longest (per plant) terminal spike (1.0–)1.2–2.5 cm long; widest leaf blade 6.4–11.8 mm wide **Carex laxiculmis** var. **laxiculmis**

8. Foliage usually bright green; longest (per plant) terminal spike 0.6–2.0(–2.3) cm long; widest leaf blade 5.3–8.3 mm wide **Carex laxiculmis** var. **copulata**

2. Foliage glaucous; leaf blades of vegetative shoots 3.8–9.0 times as wide as bract blades; widest leaf blade 1.1–2.5 cm wide; bract blades from middle and proximal portions of culms 2.0–6.2 cm long **Carex platyphylla**

1. Shoot bases purplish, with purplish coloration ranging from slight tinging of brown background in basal 1.5 cm of shoots to strong staining that obscures brown background and extends to 10 cm high.

9. Widest leaf blade 1.0–2.5 cm wide; peduncles of lateral spikes usually erect or spreading.

10. Bracts from middle and proximal portions of culms bladeless or with blades 0.1–1.9 cm long; perigynia 3.7–4.9 mm long; longest (per plant) lateral spike with 9–13 perigynia **Carex plantaginea**

10. Bracts from middle and proximal portions of culms with blades 2.1–9.2 cm long; perigynia 5.0–6.6 mm long; longest (per plant) lateral spike with 4–9 perigynia **Carex careyana**

9. Widest leaf blade 0.3–0.6 cm wide; peduncles of lateral spikes usually drooping **Carex austrocaroliniana**

Representative specimens of *Carex cumberlandensis*. Specimens marked with an asterisk are those measured for scatter plots (Figs. 3, 4). **U.S.A. ALABAMA**. **Butler Co.:** ca. 0.5 mi. N of Oaky Streak, 17 May 1995, *Naczi 4686* (DOV). **Cleburne Co.:** ca. 10 mi. S of Borden Springs, 23 Apr 1990, *Kral 77370* (VDB). **Colbert Co.:** ca. 4 mi S of Allsboro, 27 May 1986, *Bryson 4399* (MICH, ctb*). **Coosa Co.:** 1.8 mi S of Marble Valley, along N side of Paint Creek, 29 Apr 2000, *Naczi 8526 & Ford* (DOV*, MICH, ctb). **Jackson Co.:** 9 mi. S of Huntland, by Alabama 65, 28 Apr 1972, *Kral 45814* (MO, VDB, ctb*). **Jefferson Co.:** just W of Tafford, 2 May 1980, *Kral 64863* (VDB). **Lawrence Co.:** Bankhead National Forest, Thompson Creek, 1 Jun 1978, *Bryson 2099* (MO, TENN, ctb*). **Limestone Co.:** NE of Athens, ca. 1 mi. W of I-65, Hays Mill Road, 19 May 1995, *Kral 84718* (DOV, VDB). **Lowndes Co.:** 4.5 mi. E of Braggs, Alabama 21, 6 Apr 1993, *Kral 81988* (DOV, VDB). **Madison Co.:** Monte Sano Mountain, 9 May 1981, *Manhart 265 & Bryson* (MICH, TENN, ctb), 22 May 1983, *Bryson 3529* (MICH, ctb), 6 May 1991, *Naczi 2876* (DOV*). **Marshall Co.:** ca. 1 mi. W of Grant, in Fletcher's Hollow, 19 Apr 1935, *Harper 3348* (GH, MO, NY, PH*, US). **Russell Co.:** 2 mi. SW of Holy Trinity, 3 May 1996, *Naczi 5209* (DOV, VDB, ctb). **Talladega Co.:** NW of Chandler Springs, off Alabama 77, 8 May 1984, *Kral 71344* (VDB). **Tuscaloosa Co.:** ca. 8 mi. ESE of Windham Springs, E side of Black Warrior River, 22 May 1996, *Naczi 5459* (DOV, ctb). **Walker Co.:** ca. 30 mi NW of Northport, 4 Jun 1971, *Kral 42893* (VDB, ctb*); Sipsey, along W side of Sipsey Fork of Black Warrior River, 2 Jun 1997, *Naczi 6442* (DOV). **Wilcox Co.:** ca. 4.5 mi. SW of Camden, E of route 41, 24 May 1993, *Naczi 3096* (DOV). **Winston Co.:** ca. 5 mi. W of Grayson, Bankhead National Forest, Sipsey River Recreation Area, 5 May 1978, *Bryson 1892* (TENN, VDB, ctb). **ARKANSAS**. **Franklin Co.:** ca. 3 mi. E of Cass, Redding Recreation Area, 13 May 1989, *Naczi 2155* (DOV*, ctb). **GEORGIA**. **Jasper Co.:** 3.5 mi. E of Ocmulgee, 6 Apr 1949, *Smith 4873 & Duncan* (NA); ca. 14 mi. SW of Monticello, 19 May 1997, *Naczi 6054* (DOV, MICH, VDB, ctb). **Monroe Co.:** ca. 2.5 mi SW of Russellville, 25 Apr 2000, *Naczi 8398 & Ford* (DOV*, VDB, ctb). **Stephens Co.:** ca. 3 mi. N of Toccoa, along Toccoa Creek, 3 May 1991, *Naczi 2855* (GA, DOV*, MICH). **Stewart Co.:** ca. 5 mi. NE of Omaha, 22 May 1997, *Naczi 6121* (DOV, ctb). **Talbot Co.:** ca. 4 mi NE of Pleasant Hill, 25 Apr 2000, *Naczi 8425 & Ford* (DOV, VDB, ctb). **Upson Co.:** ca. 3 mi SW of Thomaston, 25 Apr 2000, *Naczi 8414 & Ford* (DOV). **Walker Co.:** NW of junction of routes 136 & 27, along route 136, 9 May 1981, *Manhart 243* (MICH, TENN, US, VDB); In the Pocket of Pigeon Mountain, 1 May 1982, *Manhart 444 & Muzzy* (DOV*, FLAS, TENN, US, ctb). **INDIANA**. **Brown Co.:** Brown County State Park, 16 Jun 1982, *Manhart 515 & Muzzy* (MICH, MO, TENN, US). **Crawford Co.:** ca. 0.5 mi. N of English, 26 May 1911, *Deam 8463* (NY); 1.5 mi. S of Grantsburg, slope of Little Blue River, 9 Jun 1919, *Deam 27807* (GH); ca. 1 mi S of Wyandotte Cave, 13 May 1922, *Deam 35617* (PH*). **Harrison Co.:** 2.5 mi. SE of Corydon, 26 May 1919, *Deam 27673* (NY). **Jennings Co.:** ca. 0.75 mi. above Vernon, along N fork of Muscatatuck River, 23 Jun 1912, *Deam 11305* (GH, NY). **Lawrence Co.:** ca. 2 mi. NE of Tunnelton, bluffs of Guthrie Creek, 17 May 1918, *Deam 24852* (US). **Orange Co.:** ca. 1 mi. SE of Orangeville, 1 Jun 1926, *Deam 43219* (NY, PH*); 6 mi. E of Baden Springs, 16 Jun 1982, *Manhart 518 & Muzzy* (MO, US). **Perry Co.:** ca. 2.5 mi. SW of St. Croix, 29 Apr 1927, *Deam 44130* (NY); 4.9 mi. N of Bristow, along E side of route 145, 27 May 1990, *Naczi 2503* (DOV*, PH, US, VDB, ctb). **Scott Co.:** 1 mi. N of Lexington, 20 May 1919, *Deam 27584* (NY). **KENTUCKY**. **Adair Co.:** ca. 9 mi. S of Columbia, along W side of route 704, 16 Jun 1998, *Naczi 7387 & Reznicek* (DOV). **Barren Co.:** ca. 3 mi. SSW of Haywood, Brigadoon State Nature Preserve, 14 Jun 1997, *Naczi 6460 & Heeg* (DOV, KNK, ctb). **Bell Co.:** ca. 5 mi. NW of Pineville, along E side of route 92, 29 May 1993, *Naczi 3149* (DOV, MICH, VDB, ctb). **Boyd Co.:** S of Ashland, above Hurricane Fork Road, 24 May 1993, *Cusick 30901* (MICH). **Boyle Co.:** Central Kentucky Wildlife Refuge, 13 May 1992, *McKinney 4991 & Gladu* (KNK). **Casey Co.:** 2.9 mi. S of Ellisburg, 18 Jun 1998, *Naczi 7451 & Reznicek* (DOV). **Clay Co.:** Benge, S of route 472 and S of Mill Creek, 28 May 1993, *Naczi 3135 & Reznicek* (DOV, MICH, VDB, ctb). **Clinton Co.:** ca. 3.3 mi. WNW of Albany, 23 May 1998, *Naczi 7186 & Ford* (DOV). **Cumberland Co.:** 3.0 mi. SW of Amandaville, along W side of route 704, 9 May 1991, *Naczi 2893* (DOV*, MICH, US, VDB, ctb). **Estill Co.:** ca. 8.5 mi SW of Irvine, 12 May 1999, *Naczi 7784* (DOV). **Fleming Co.:** ca. 4 mi. E of Hillsboro, 28 May 1998, *Naczi 7325 & Ford* (DOV, WIN, ctb). **Hardin Co.:** 3.2 mi. W of Summit, Meeting Creek (Hoover Branch) Gorge, 26 May

1979, *Cranfill 4336* (MICH). **Harrison Co.:** ca. 1.5 mi. NE of Sunrise, Quiet Trails State Nature Preserve, 21 Jun 1997, *Naczi 6628* (DOV, KNK, ctb). **Hart Co.:** ca. 2.3 mi. NNE of Canmer, 17 Jun 1998, *Naczi 7425 & Reznicek* (DOV, MICH, ctb). **Jackson Co.:** near South Tree Recreation Area, 16 Jun 1982, *Manhart 503 & Muzzy* (MO). **Knott Co.:** SE of Cody, 20 May 1994, *McKinney 6192* (TENN). **Knox Co.:** ca. 3 mi. NNE of Barbourville, 29 May 1993, *Naczi 3143* (DOV). **Laurel Co.:** ca. 5.5 mi. WNW of Bernstadt, 19 Jun 1997, *Naczi 6521 & Heeg* (DOV, ctb). **Lawrence Co.:** NE of Fallsburg, above route 707, 24 May 1993, *Cusick 30922* (CM, MICH). **Leslie Co.:** along highway 421, W from Hyden, ca. 7 mi. E of Clay County line, 21 May 1992, *McKinney 5035* (EKY, KNK). **Lewis Co.:** Laurel Fork, 19 May 1988, *Cusick 27393* (NY, VDB). **McCreary Co.:** Barthell SW Quadrangle, Rock Creek (west), 19 May 1989, *Campbell s.n.* (KY). **Martin Co.:** 1 mi. NW of Add, along Pack Branch above Martin County Lake, 1 Jun 1993, *Cusick 30967* (MICH). **Monroe Co.:** ca. 8 mi. SE of Tompkinsville, 23 May 1998, *Naczi 7208 & Ford* (DOV*, WIN). **Ohio Co.:** L. B. Davidson Wildlife Management Area, 4 May 1992, *McKinney 4953* (EKY, KNK). **Pendleton Co.:** 2 road mi. ESE of eastern edge of Falmouth, 3 Jun 1994, *Naczi 4053 & Thieret* (DOV, MICH, PH, VDB, ctb). **Powell Co.:** ca. 2 mi. SSE of Slade, Natural Bridge State Nature Preserve, 22 Jun 1997, *Naczi 6663* (DOV, KNK). **Pulaski Co.:** General Burnside State Park, 16 Jun 1982, *Manhart 510 & Muzzy* (MICH, TENN). **Rockcastle Co.:** 2.5 mi. N of junction of routes 490 and 89, 16 Jun 1982, *Manhart 509 & Muzzy* (MICH, TENN). **Rowan Co.:** N of Triplett, Burnt House Branch, 15 May 1987, *Cusick 26398* (VDB). **Russell Co.:** SW end of Cave Springs Road (between forks), 20 Jun 1993, *Campbell s.n.* (KY). **Warren Co.:** ca. 11.5 mi. NNE of Bowling Green, along S side of Clay Lick Creek, 15 Jun 1997, *Naczi 6500 & Heeg* (DOV). **Wayne Co.:** 1.75 mi. N of Kentucky-Tennessee line, along route 167, 15 Jun 1982, *Manhart 499 & Muzzy* (MICH, TENN). **Whitley Co.:** ca. 8 mi. E of Williamsburg, 29 May 1993, *Naczi 3150* (DOV, MICH, US, VDB, ctb). **MISSISSIPPI**. **Choctaw Co.:** ca. 4 mi. NNE of Ackerman, near Horse Branch, 4 May 1981, *McDaniel 25006* (ctb*). **Tishomingo Co.:** Yellow Creek Quad., Burns Hollow, 15 May 1979, *Rogers 46684* (TENN). **Winston Co.:** 3.5 mi. NW of Louisville, Tombigbee National Forest, 26 Apr 1977, *Byson 1523* (ctb*); ca. 6.3 mi. NNW of Louisville, 29 May 1997, *Naczi 6277 et al.* (DOV). **NORTH CAROLINA**. **Alexander Co.:** 5 mi. E of Vashti, 13 May 1956, *Radford 11194* (NCU). **Anson Co.:** 8 mi. S of Lilesville, near Pee Dee River, 20 May 1961, *Radford 43609* (NCU, US). **Lee Co.:** 2 mi. W of Moncure, near Deep River, 3 Jun 1960, *Radford 43209* (NCU, TENN). **Madison Co.:** ca. 5 mi. W of Hot Springs, along Mine Hollow Branch, 22 May 1971, *Leonard 4788* (MICH, NCU, NY, VDB, WVA). **Montgomery Co.:** Uwharrie National Forest, along W fork of McLean Creek, Park's Place Road, 18 May 1970, *Leonard 3201 & Radford* (MO, NCU). **Orange Co.:** Chapel Hill, [no date], *Ashe 2062* (OS, PH, US). **Polk Co.:** R.R. Melrose, 19 May 1899, *Churchill s.n.* (GH). **Stanly Co.:** NE of Richfield, along Yadkin River, 6 May 1951, *Godfrey 51129 & Fox* (MO, NY). **Yadkin Co.:** near Yadkin River bridge, route 67, 30 May 1981, *Manhart 323 & Smith* (MICH). **OHIO: Adams Co.:** 3/5 mi. S of Lynx, 6 May 1991, *Reznicek 8745 & Reznicek* (MICH). **Gallia Co.:** ca. 10 mi. SW of Gallipolis, valley of upper part of Claylick Run, 25 May 1988, *Reznicek 8170 & Reznicek* (MICH). **Scioto Co.:** Nile Twp., W side of Rock Lick, 20 May 1985, *Carr 6538* (MICH). **Vinton Co.:** Knox Twp., sect. 31, 13 May 1991, *Cusick 29517* (ctb). **PENNSYLVANIA**. **Blair Co.:** E of Altoona, Brush Mountain, 15 Jun 1929, *Bright 1905* (CM), *Bright 1906* (CM), *Bright 1908* (CM). **SOUTH CAROLINA**. **Abbeville Co.:** Sumter National Forest, E-facing slopes at Johns Creek, 21 Jun 1992, *Hill 23443 & Wilson* (GH, MICH). **Lancaster Co.:** 13.7 mi. NNW of Lancaster, overlooking Catawba River, 21 Apr 1953, *Duncan 15630 & Hardin* (PH*). **McCormick Co.:** 3.2 km W of Edgefield County line, Sumter National Forest, NW of junction of S-204 and SC 28, 18 Apr 1996, *Nelson 17142* (MICH, USCH). **Oconee Co.:** ca. 4 mi. W of Walhalla, 3 May 1990, *Naczi 2358* (DOV*). **Pickens Co.:** ca. 5 mi. S of Rocky Bottom, 3 May 1989, *Naczi 2092* (DOV*, ctb). **Union Co.:** ca. 9 mi. WSW of Union, 8 May 1993, *Horn 6588* (MICH). **TENNESSEE**. **Anderson Co.:** Norris Dam State Park, near Clear Creek, 12 May 1987, *McNeilus 87-794* (MICH, TENN). **Bledsoe Co.:** NW of Pikeville, 16 May 1934, *Harger 7827* (GH, TENN). **Blount Co.:** Great Smoky Mountains, White Oak Sink area, 12 May 1980, *Bryson 2945 & Bryson* (ctb*). **Campbell Co.:** 1 mi. S of Morley on route 25W, 13 May 1980, *Bryson 2956 & Bryson* (ctb*). **Cannon Co.:** N side of North Short Mountain Road, 3 May 1989, *Orzell & Bridges 9438* (MICH*). **Cheatham Co.:** Pegram, 16 Jul 1939, *Svenson 10346* (GH). **Clay Co.:** Along Turkey Creek, 29 Apr 1991, *McNeilus 91-190*

(TENN). **Coffee Co.:** W outskirts of Manchester in Oakwood subdivision, 6 May 1989, *Kral 76195* (VDB). **Cumberland Co.:** 3.0 mi. on Hinch Mountain Road S of its junction with old route 127, 8 May 1986, *Wofford 86-43 & Ma* (ctb*). **Davidson Co.:** ca. 5 mi. NE of junction of Tennessee 12 and Marrowbone Creek Road, 16 May 1971, *Kral 42612* (MO, VDB, ctb). **DeKalb Co.:** E of Spencer, along upper King Creek by road to Fall Creek Falls, 3 May 1986, *Kral 73349* (VDB). **Dickson Co.:** 2.8 mi. W of White Bluff by route 70, 13 May 1975, *Kral 55379* (MICH). **Dyer Co.:** ca. 6 mi. NW of Dyersburg, N of route 182, 27 Jun 1995, *Naczi 4846 & Reznicek* (DOV, MICH). **Franklin Co.:** Sewanee, Lost Creek Cove, 24 Jun 1938, *Svenson 9689* (GH, VDB). **Grundy Co.:** Fiery Gizzard Gorge, along Big Gizzard Creek, 15 May 1965, *Clark 1771* (NCU*). **Hardin Co.:** 6.8 mi. SE of Savannah on Tennessee 69, 2 May 1970, *Kral 38916* (VDB). **Hickman Co.:** 4–4.5 mi. W of Centerville, by Tennessee 50, 4 May 1993, *Kral 82267* (DOV, TENN, VDB). **Humphreys Co.:** ca. 5 mi. NNW of Bucksnort, by Tennessee 230, 19 May 1989, *Kral 76304* (VDB). **Jackson Co.:** NW of Gainesboro, above Cumberland River, 14 May 1992, *Kral 80515 & Rust* (DOV, VDB). **Lawrence Co.:** ca. 8 mi. WSW of Lawrenceburg, Knob Creek, by Tennessee 242, 5 May 1990, *Kral 77462* (VDB). **Lewis Co.:** Meriwether Lewis Park, 17 May 1971, *Kral 42648* (MO, VDB). **Loudon Co.:** ca. 1.5 mi. E of Centerville Store, along Big Hill Road, 4 May 1993, *McNeilus 93-406* (MICH, TENN). **Macon Co.:** S of and below Lafayette by route 10, 5 May 1975, *Kral 55211* (MICH). **Maury Co.:** along Big Bigby Creek at E side of Sandy Hook, 19 May 1993, *Kral 82294* (DOV, VDB). **Monroe Co.:** SE of Pumpkin Center, between Chilhowee Lake and junction of routes 129 and 72, 15 May 1980, *Bryson 2987 & Bryson* (ctb*). **Moore Co.:** ca. 3 mi. W of Motlow State Campus and SW of Tullahoma, 26 Apr 1989, *Kral 76096* (VDB). **Morgan Co.:** Rugby, 18 Jun 1938, *Svenson 9331* (GH, NY). **Overton Co.:** 3.4 mi. E of Alpine, 31 Apr 1971, *Kral 42328* (VDB, ctb). **Perry Co.:** SE of Linden on old SR 13, on E side of Buffalo River, 4 May 1993, *Kral 82278* (DOV, TENN, VDB). **Putnam Co.:** ca. 8 mi. SE of Cookville, 10 May 1988, *McKinney 2843-3* (ctb*). **Scott Co.:** Along Low Gap Road, 24 May 1994, *McNeilus 94-304* (TENN). **Sequatchie Co.:** NW of Dunlap, along Little Brush Creek, 29 May 1990, *Naczi 2512 & Kral* (DOV*, MICH, VDB). **[Sevier Co.]:** between Sevierville and the French Broad River, May 1844, *Rugel 108* (MICH, NA, VDB). **Stewart Co.:** Land Between the Lakes, along Bee Creek, tributary of Bear Creek, 14 May 1982, *Patrick 4256 & DeSelm* (VDB). **Sumner Co.:** 2.5 mi. S of Westmoreland, Taylor Hollow, 17 May 1979, *Carter 1816* (ctb). **Union Co.:** ca. 7 mi. W of Maynardville, Big Ridge State Park, 30 May 1995, *Naczi 4747 & Naczi* (DOV, MICH, VDB, ctb). **Van Buren Co.:** 6-7 mi. E of Spencer, by Tennessee 30, 1 May 1971, *Kral 42364* (VDB). **Warren Co.:** Rock Island, Rock Island State Park, 27 May 1993, *Naczi 3115 & Reznicek* (DOV, MICH, VDB, ctb). **Wayne Co.:** ca. 5 mi. W of Iron City, just E of Cypress Creek bridge, 5 May 1990, *Kral 77494* (VDB). **White Co.:** ca. 3.9 mi. E of Sparta, along highway 70, 12 May 1986, *McKinney 2135* (VDB). **VIRGINIA. Buchanan Co.:** NE of Slate, 20 May 1993, *Wieboldt 8545* (DOV). **Franklin Co.:** ca. 10.5 km SWof Ferrum, 11 May 1995, *Wieboldt 9202* (DOV). **Rockbridge Co.:** Natural Bridge, 28 May 1909, *Bartram s.n.* (PH*). **Scott Co.:** ca. 6 mi. NE of Gate City, W of route 669 crossing of Copper Creek, 21 Jun 1993, *Naczi 3171 et al.* (DOV, MICH). **Wise Co.:** ca. 1.75 mi. SW of Norton, Powell Mountain, 2 Jun 1988, *Wieboldt 6675* (MICH). **WEST VIRGINIA. Nicholas Co.:** U.S. highway 41, above Meadow River, 28 May 1987, *Brant 1116 & O'Donnell* (MO). **Ritchie Co.:** ca. 2 mi. NW of Ellenboro, 8 May 1985, *Cusick 24199 & Ortt* (MICH, NCU). **Wayne Co.:** mouth of Big Creek, 6 May 1938, *McFarland 4355 & Plymale* (NA).

APPENDIX A

Representative Specimens of *Carex abscondita*. Specimens marked with an asterisk are those measured for scatter plots (Figs. 3, 4). **U.S.A. ALABAMA. Autauga Co.:** ca. 5.5 mi ENE of Autaugaville, 28 May 1997, *Naczi 6274* (DOV*). **Baldwin Co.:** 1 mi. SE of Spanish Fort, 24 Apr 1964, *McDaniel 4257* (IBE). **Barbour Co.:** Blue Springs, Choctawhatchee River, 7 Jun 1976, *Kral 58187* (DOV, VDB). **Bibb Co.:** near Lightsey's Mill, Cahaba River bottoms, 6 Jun 1935, *Harper 3395* (GH, NY); ca. 6 mi SE of Centreville, 5 May 1987, *Naczi 1527* (DOV*). **Butler Co.:** ca. 0.5 mi. N of Oaky Streak, 17 May 1995, *Naczi 4689* (DOV). **Coosa Co.:** 1.8 mi S of Marble Valley, along N side of Paint Creek, 29 Apr 2000, *Naczi 8529 & Ford* (DOV*). **Dale Co.:** Just NW of Ozark, 24 May 1975, *Kral 55862* (TENN). **Dallas Co.:** ca. 9 mi. SE of

Selma, 16 May 1995, *Naczi 4653* (DOV). **Geneva Co.:** 5 mi. NW of Hartford, bottoms of Choctawhatchee River, 18 May 1966, *McDaniel 7552* (IBE, VDB). **Jackson Co.:** 1 mi. W of Scottsboro, 3 May 1939, *Svenson 10193* (GH, MO, NY, PH, TENN). **Lee Co.:** Auburn, 10 May 1901, *Earle s.n.* (NY). **Madison Co.:** Ardmore, Limestone Creek, 19 May 1995, *Kral 84677* (MICH, VDB). **Marion Co.:** ca. 3 mi. N of Guin, 25 Apr 1941, *Harper 3845* (GH, NY). **Mobile Co.:** Mobile, 23 Apr 1968, *LeLong 4386* (USAM). **Monroe Co.:** 1.8 mi N of routes 47-83 junction in Midway, 28 Apr 1991, *Naczi 2819* (DOV*). **Morgan Co.:** 1.6 mi. N of Florette, along Cotaco Creek, 9 May 1986, *Naczi 1030A* (DOV*). **Tuscaloosa Co.:** ca. 8 mi. ESE of Windham Springs, E side of Black Warrior River, 22 May 1996, *Naczi 5454* (DOV). **Wilcox Co.:** ca. 4.5 mi. SW of Camden, E of route 41, 24 May 1993, *Naczi 3095* (DOV). **Winston Co.:** ca. 10 mi. N of Double Springs, Sipsey River Recreation Area of Bankhead National Forest, 4 May 1991, *Naczi 2870* (DOV*, MICH). **ARKANSAS. Cross Co.:** W of Birdeye, 20 May 1990, *Naczi 2448* (DOV*). **Howard Co.:** ca. 8 mi. W of Umpire, 17 May 1988, *Naczi 1924* (MICH, ctb). **Lafayette Co.:** Bodcow Bayou, 6 May 1995, *Hyatt 6366 & Hyatt* (DOV*, MICH). **Montgomery Co.:** 1.2 mi. E of Pine Ridge, 11 May 1989, *Naczi 2142* (MICH, UARK). **Phillips Co.:** 1.5 mi. N of West Helena, 15 May 1987, *Naczi 1598* (MICH, UARK, ctb). **Pope Co.:** N of Dover, 20 May 1980, *Davis 2231* (VDB). **Scott Co.:** ca. 2 mi. N of Y City, 10 May 1989, *Naczi 2131* (MICH, UARK), 20 May 1994, *Naczi 3937 & Ford* (DOV*). **Sevier Co.:** 8 mi. E of DeQueen, 10 May 1989, *Naczi 2126* (MICH, UARK, ctb). **CONNECTICUT. [New Haven County]:** Milford, 27 Jun 1901, *Eames s.n.* (NY). **[New London County]:** Waterford, 13 Jun 1896, *Graves s.n.* (GH). **DELAWARE. New Castle Co.:** ca. 3 mi. NW of Glasgow, 4 Jun 1986, *Naczi 1313* (DOV); SW of McKays Corner, 7 Jun 1988, *Naczi 2008* (DOV*); 0.4 mi S of Townsend, 31 May 1999, *Naczi 8089* (DOV*). **Kent Co.:** ca. 2.5 mi SSW of Blackiston, 5 May 2001, *Naczi 8710* (DOV). **Sussex Co.:** between Georgetown and Millsboro, 21 Jun 1926, *True 200a* (PH). **DISTRICT OF COLUMBIA.** Washington, 9 Jun 1901, *Steele s.n.* (NY). **FLORIDA. Calhoun Co.:** 15 mi. N of Wewahitchka, 18 May 1965, *McDaniel 6234* (IBE, MO, NY, VDB). **Gadsden Co.:** S side of Chattahoochee, Apalachicola River, 18 Mar 1975, *Kral 57343* (DOV, MICH, TENN, VDB); Chattahoochee, 27 May 1997, *Naczi 6223* (DOV*). **Jackson Co.:** Floodplain of Apalachicola River between U.S. 90 and Jim Woodruff Dam, 14 Apr 1982, *Manhart 425 & Gholson* (DOV*); ca. 1 mi. N of Marianna, along W side of Chipola River, 6 May 1989, *Naczi 2109* (DOV). **Santa Rosa Co.:** W of Jay, 27 Mar 1956, *Godfrey 54609* (GH). **GEORGIA. Burke Co.:** 7 mi. NE of Shell Bluff, near Savannah River, 18 May 1989, *Naczi 2190* (DOV*). **Chattahoochee Co.:** ca. 9 mi W of Cusseta, 23 May 1997, *Naczi 6133* (DOV*). **Early Co.:** ca. 1.5 mi. NW of Hilton, along Chattahoochee River, 18 May 1995, *Naczi 4713* (DOV, MICH). **Effingham Co.:** ca. 2.5 mi N of Clyo, 2 May 1991, *Naczi 2832* (DOV*). **Hancock Co.:** ca. 13 mi. E of Sparta, 20 May 1996, *Naczi 5385* (DOV). **Harris Co.:** ca. 6 mi. W of Mulberry Grove, along S side of Mulberry Creek, 24 May 1997, *Naczi 6151* (DOV*). **Jasper Co.:** ca. 14 mi. SW of Monticello, 19 May 1997, *Naczi 6055* (DOV). **Monroe Co.:** just S of Dames Ferry, W side of Ocmulgee River, 19 May 1997, *Naczi 6059* (DOV); ca. 2.5 mi SW of Russellville, 25 Apr 2000, *Naczi 8400 & Ford* (DOV). **Screven Co.:** Blue Springs, 2 May 1991, *Naczi 2839* (DOV*). **KENTUCKY. Calloway Co.:** along Dalton Road off KY 280, 22 May 1990, *McKinney 4198 & Hamilton* (EKY, VDB). **LOUISIANA. Grant Parish:** 1.0 mi. S of Packton on US 167, 19 May 1995, *Hyatt 6434* (MICH). **Iberia Parish:** Weeks Island, 15 Apr 1983, *Wofford 83-6 & Murrell* (TENN). **Washington Parish:** ca. 2 mi E of Franklinton, 13 May 1972, *Rogers 8067* (TENN). **West Feliciana Parish:** ca. 4 mi. NW of Saint Francisville, 2 May 1988, *Naczi 1820* (DOV*). **MARYLAND. Anne Arundel Co.:** Patuxent Research Refuge, 1 Jun 1945, *Hermann 11437* (GH). **Prince Georges Co.:** 1.5 mi. SE of Suitland, 1 Jun 1939, *Hermann 10331* (PH). **Somerset Co.:** 2 mi. N of Princess Anne, 23 May 1938, *Tatnall 3798* (GH, PH). **Talbot Co.:** 4.25 mi. WNW of Easton, 5 Jul 1941, *Earle 3414* (PH). **Worcester Co.:** 1.6 mi. SW of Public Landing, along Tanhouse Creek, 7 Jun 1988, *Naczi 2012* (DOV*). **MASSACHUSETTS. Bristol Co.:** Dighton, 24 Jun 1957, *Seymour 17122* (GH). **[Dukes County]:** Martha's Vineyard, between Town Hall and Menemsha, Chilmark, 19 Jun 1917, *Seymour 1882* (GH). **Norfolk Co.:** Dedham, 23 Jun 1879, *Faxon s.n.* (US). **MISSISSIPPI. Bolivar Co.:** ca. 3 mi. SE of Choctaw, 23 Apr 1992, *Bryson 11358 & Newton* (DOV, ctb). **Carroll Co.:** N of Vaiden, along a tributary of Hurricane Creek, 5 Jun 1996, *Bryson 15309* (DOV, MICH, ctb). **Forrest Co.:** ca. 10 mi. SE of Hattiesburg, 30 Apr 1988, *Naczi 1818* (DOV). **Holmes Co.:** 6.2 mi. E of Thornton, 14 Apr 1992, *Bryson*

11224 & Newton (DOV, ctb). **Lafayette Co.:** ca. 5 mi. ENE of Oxford, 8 Jun 1996, *Bryson 15324* (DOV, ctb). **Lee Co.:** W of Tupelo, 17 Apr 1992, *Bryson 11328* (DOV, ctb). **Lowndes Co.:** ca. 10 mi. S of Columbus, 11 Apr 1987, *Bryson 5336* (DOV, MICH, ctb). **Oktibbeha Co.:** ca. 15 mi. S of Starkville, Noxubee Wildlife Refuge, 26 May 1980, *Bryson 3053 & Mathies* (ctb). **Pearl River Co.:** just S of Carriere, 10 Apr 1936, *Harper 3477* (NY); ca. 3.2 mi S of Marion-Pearl River Co. line, 26 Apr 1991, *Bryson 10750 et al.* (DOV*, ctb). **Tallahatchie Co.:** ca. 8 mi. N of Charleston, 21 Apr 1988, *Bryson 7345 & Morris* (DOV, MICH, ctb). **Tishomingo Co.:** ca. 1.2 mi. S of Mingo, along Cedar Creek, 17 May 1992, *Bryson 11707 & Warren* (DOV, ctb). **Union Co.:** 6 mi. SE of New Albany, E branch of Okannatie Creek, 18 May 1990, *Bryson 9954* (DOV*, MICH, ctb). **Wilkinson Co.:** 1.2 mi. W of Lessley, 11 May 1990, *Naczi 2392* (DOV). **Winston Co.:** ca. 6.3 mi. NNW of Louisville, 29 May 1997, *Naczi 6283 et al.* (DOV). **Yalobusha Co**.: ca. 6 mi NE of Oakland, 9 Apr 1991, *Bryson 10621* (DOV*, ctb). **MISSOURI. Dunklin Co.:** ca. 7 mi. NW of Campbell, along old channel of Saint Francis River, 22 May 1993, *Reznicek 9431 et al.* (DOV*, MICH). **Ripley Co.:** SW of Neelyville, 24 May 1989, *Yatskievych 89-131 et al.* (MO). **NEW JERSEY. Bergen Co.:** Paramus, 25 Jun 1935, *Svenson 6655* (GH). **Cumberland Co.:** ca. 2 mi. N of Newport, 21 Jun 1994, *Naczi 4389 & Thieret* (DOV*, MICH). **Mercer Co.:** Imlaystown, 30 Jun 1926, *Long 32985* (GH). **Salem Co.:** 1 mi. S of Pittsgrove, 26 May 1923, *Dreisbach 1329* (CM). **NEW YORK. Nassau Co.:** Glen Cove, 15 Jun 1907, *Bicknell 2046* (PH). **NORTH CAROLINA. Columbus Co.:** ca. 2 mi. NE of Whiteville, 21 May 1992, *Reznicek 8967 & Reznicek* (DOV, MICH). **Craven Co.:** 1 mi. NW of Vanceboro, 13 May 1950, *Blomquist 14961 & Batson* (NY). **Pitt Co.:** 2 mi. E of Winterville, 14 Jun 1958, *Radford 34985* (GH). **OKLAHOMA. McCurtain Co.:** ca. 9 mi. NE of Broken Bow, 12 May 1987, *Naczi 1575* (DOV*). **PENNSYLVANIA. Bucks Co.:** Tullytown, 31 May 1899, *Williamson s.n.* (PH). **Dauphin Co.:** 1.75 mi. E of Lykens, 10 Jun 1952, *Berkheimer 13006* (PH). **Lehigh Co.:** 1.25 mi. W by slightly NW of Lehigh Furnace, 25 Jun 1922, *Pretz 11382* (MSC). **Philadelphia Co.:** near Cedar Grove, 8 Jul 1926, *Benner s.n.* (GH). **Schuylkill Co.:** ca. 1.3 mi. WSW of Summit Station, 5 Jul 1938, *Wagner 7401* (PH). **RHODE ISLAND. Bristol Co.:** Bristol, 11 Aug 1961, *Seymour 19460* (MO). **SOUTH CAROLINA. Cherokee Co.:** 6.2 mi. NW of Gaffney, 2 May 1990, *Naczi 2355* (DOV*). **Clarendon Co.:** Manning, 23 May 1914, *Stone 311* (NY, PH). **Edgefield Co.:** Sumter National Forest, 3.2 air mi. SSE of Lick Fork Dam, 22 May 1997, *Nelson 18240* (DOV, USCH). **Greenville Co.:** E of Caesars Head, 31 May 1995, *Naczi 4761 & Naczi* (DOV*, MICH). **Newberry Co.:** ca. 8 mi. NW of Newberry, 14 May 1996, *Horn 10310* (DOV, NBYC). **Richland Co.:** Congaree Swamp National Monument, ca. 2 km N of Weston lake, 29 Apr 1998, *Nelson 19096* (DOV*, USCH). **TENNESSEE. Dyer Co.:** ca. 6 mi. S of Dyersburg, 27 Jun 1995, *Naczi 4839 & Reznicek* (DOV, MICH). **Hamilton Co.:** Behind Tennessee Welcome Center, I-75, 30 Apr 1996, *McNeilus 96-197* (TENN). **Lincoln Co.:** just E of New Hope, 4 Apr 1983, *Sommers s.n.* (VDB). **Marion Co.:** ca. 2 mi. S of Jasper, 29 May 1990, *Naczi 2509 & Kral* (DOV). **Perry Co.:** Mousetail Landing State Park, E side of Tennessee River, 17 May 1990, *Kral 77633* (VDB). **Tipton Co.:** ca. 2.5 mi. NW of Gilt Edge, 27 Jun 1995, *Naczi 4827 & Reznicek* (DOV, MICH). **Weakley Co.:** ca. 5 mi. NW of Greenfield, 28 Jun 1995, *Naczi 4868 & Reznicek* (DOV, MICH). **TEXAS. Harris Co.:** ca. 3 mi. N of US 90 at Sheldon, 5 Apr 1989, *Orzell & Bridges 9018* (MICH*). **Jasper Co.:** ca. 14 mi. W of Kirbyville, 3 May 1988, *Naczi 1830* (MICH, ctb). **Marion Co.:** ca. 3 mi. S of Jefferson, 12 May 1988, *Naczi 1871* (MICH, ctb). **Smith Co.:** ca. 15 mi. N of Tyler, 7 May 1987, *Naczi 1539* (MICH, PH, TEX, ctb). **VIRGINIA. Princess Anne Co.:** Little Neck, 17 Jun 1935, *Fernald et al. 4593* (GH, PH). **Sussex Co.:** 3.8 mi. WNW of Sussex, 4 Jun 1986, *Wieboldt 6019* (DOV*). **Westmoreland Co.:** 0.5 mi. S of Nomini Grove, 8 Jun 1940, *Hermann 10504* (PH).

APPENDIX B

Specimens of *Carex digitalis* measured for scatter plot (Fig. 3). Equal numbers of specimens were measured for *C. digitalis* var. *digitalis* (d), *C. digitalis* var. *asymmetrica* (a), and *C. digitalis* var. *macropoda* (m). All vouchers are at DOV. **U.S.A. ALABAMA. Butler Co.:** ca. 0.5 mi N of Oaky Streak, 17 May 1995, *Naczi 4687* (m). **Conecuh Co.:** ca. 5 mi SSE of center of Evergreen, 17 May 1995, *Naczi 4696* (a). **Coosa Co.:** ca. 6 mi SW of Unity, 29 Apr 2000, *Naczi 8504 & Ford* (a). **Lawrence Co.:** Borden Creek, Bankhead National Forest, 15 May 1992, *Bryson 11612* (m). **Madison Co.:** Huntsville, Monte

Sano State Park, 6 May 1991, *Naczi 2881* (d). **Marion Co.:** S of Bear Creek, 15 May 1992, *Bryson 11592* (a). **Monroe Co.:** 1.8 mi N of route 47-83 junction in Midway, 28 Apr 1991, *Naczi 2817* (m). **ARKANSAS. Cross Co.:** W of Birdeye, 20 May 1990, *Naczi 2441* (m). **Stone Co.:** ca. 3 mi ENE of Fifty Six, 20 May 1986, *Naczi 1204* (d). **FLORIDA. Hamilton Co.:** Holton Creek Wildlife Management Area, 3 Apr 2000, *Abbott 13392* (a). **Leon Co.:** ca. 1 mi W of Bloxham, 5 May 1989, *Naczi 2099* (a). **GEORGIA. Effingham Co.:** ca. 2.5 mi N of Clyo, 2 May 1991, *Naczi 2831* (a). **Screven Co.:** Blue Springs, 2 May 1991, *Naczi 2838* (a). **Talbot Co.:** ca. 4 mi NE of Pleasant Hill, 25 Apr 2000, *Naczi 8428 & Ford* (m). **Towns Co.:** 0.3 mi W of Rabun Co. border, W of route 76, 3 May 1991, *Naczi 2859* (d). **INDIANA. Perry Co.:** 4.9 mi N of Bristow, 27 May 1990, *Naczi 2504* (d). **KENTUCKY. Adair Co.:** ca. 9 mi S of Columbia, 16 Jun 1998, *Naczi 7399 & Reznicek* (d). **Boone Co.:** 3 mi S of Petersburg, 12 Jun 1994, *Naczi 4106* (d). **Campbell Co.:** ca. 2 mi S of Alexandria, 5 Jun 1996, *Naczi 5646 et al.* (d). **Hardin Co.:** ca. 8.5 mi ENE of center of Elizabethtown, 15 Jun 1997, *Naczi 6507 & Heeg* (d). **Laurel Co.:** ca. 5.5 mi WNW of Bernstadt, 19 Jun 1997, *Naczi 6540 & Heeg* (m). **Mclean Co.:** ca. 0.6 mi SSW of Beech Grove, 14 Jun 1997, *Naczi 6484 & Heeg* (m). **MICHIGAN. St. Clair Co.:** ca. 2 mi WNW of Blaine, 17 Jun 1988, *Naczi 2025* (d). **MISSISSIPPI. Pearl River Co.:** ca. 3.2 mi S of Marion-Pearl River Co. line, 26 Apr 1991, *Bryson 10749 et al.* (a). **Winston Co.:** ca. 5 mi NW of Louisville, 11 Apr 2000, *Naczi 8338 et al.* (m). **OKLAHOMA. McCurtain Co.:** ca. 9 mi NE of Broken Bow, 12 May 1987, *Naczi 1574* (m). **PENNSYLVANIA. Clinton Co.:** ca. 2.3 mi NE of Rosecrans, 4 Jul 1995, *Naczi 4894 & Naczi* (d). **SOUTH CAROLINA. Dorchester Co.:** W of Givhans, 19 Apr 1991, *Naczi 2763* (a). **York Co.:** ca. 3 mi NW of Bethany, 3 May 1989, *Naczi 2080* (m). **TEXAS. Jasper Co.:** ca. 14 mi W of Kirbyville, 3 May 1988, *Naczi 1831* (a). **VIRGINIA. Halifax Co.:** 5 mi SW of Republican Grove, 30 Apr 1986, *Wieboldt 5944* (m).

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A SYNOPSIS OF THE FERNS AND FERN ALLIES OF NEBRASKA, WITH MAPS OF THEIR DISTRIBUTION

Steven B. Rolfsmeier
Charles E. Bessey Herbarium
University of Nebraska State Museum
University of Nebraska–Lincoln
Lincoln, NE 68588-0514, U.S.A

Robert B. Kaul
Charles E. Bessey Herbarium
University of Nebraska State Museum
University of Nebraska–Lincoln
Lincoln, NE 68588-0514, U.S.A

David M. Sutherland
Department of Biology
University of Nebraska at Omaha
Omaha, NE 68182-0040, U.S.A.

ABSTRACT

An annotated list and county-by-county distribution maps are presented for the 32 species of ferns and fern allies native to Nebraska, based upon field and herbarium studies and critical evaluation of the literature. Native to the state are *Isoëtes melanopoda*, *Selaginella rupestris*, five species of *Equisetum*, and 25 species in 18 genera of ferns. Three native species are here verified for the first time, based upon recent collections: *Matteuccia struthiopteris* var. *pensylvanica*, *Ophioglossum engelmannii*, and *Pellaea glabella* ssp. *glabella*. *Isoëtes melanopoda* was rediscovered in 2000, the first record since 1941. Rejected are published reports of *Lycopodium annotinum*, *Selaginella densa*, *Equisetum* ×*litorale*, *E. palustre*, *E. pratense*, *E. variegatum*, *Asplenium trichomanes*, *Azolla caroliniana*, *Botrychium dissectum*, *B. matricariifolium*, *B. multifidum*, *B. neglectum*, *Cryptogramma acrostichoides*, *Ophioglossum vulgatum*, *Osmunda cinnamomea*, *O. claytoniana*, *O. regalis*, and *Woodsia scopulina*. Some erroneous reports have been published repeatedly for more than a century, but others are recent.

RESUMEN

Se presentan un lista anotada y mapas de distribución por condados, de las 32 especies de helechos y otras pteridófitas nativas del estado de Nebraska (EE.UU.), basados en estudios de campo, examen de herbarios, y evaluación crítica de la literatura. Como nativas para este estado se cuentan *Isoëtes melanopoda*, *Selaginella rupestris*, cinco especies de *Equisetum*, y 25 especies de helechos distribuidas en 18 géneros. Se citan tres especies como nativas por primera vez, basándose en recolecciones recientes: *Matteuccia struthiopteris* var *pensylvanica*, *Ophioglossum engelmannii*, y *Pellaea glabella*. *Isoëtes melanopoda* fue redescubierta en el año 2000, siendo el primer registro de esta especie desde 1941. Se rechazan como erróneas las citas publicadas de la presencia de *Lycopodium annotinum*, *Selaginalla densa*, *Equisetum* ×*litorale*, *E. palustre*, *E. pratense*, *E. variegatum*, *Asplenium trichomanes*, *Azolla caroliniana*, *Botrychium dissectum*, *B. matricariifolium*, *B. multifidum*, *B. neglectum*, *Cryptogramma acrostichoides*, *Ophioglossum vulgatum*, *Osmunda cinnamomea*, *O. claytoniana*, *O. regalis*, y *Woodsia scopulina*. Algunas de estas citas erróneas han sido publicadas en repetidas ocasiones desde hace más de un siglo, mientras que otras son recientes.

SIDA 19(4): 1015 – 1026. 2001

INTRODUCTION

While preparing our *New Century Flora of Nebraska* (Kaul, Sutherland, & Rolfsmeier, in prep.), we reinterpreted and corrected many dubious or erroneous reports of the state's flora, among which those of the ferns and their allies were especially confused and contradictory.

The earliest credible report of Nebraska's complete vascular flora was the list by H.J. Webber (1890), but the first definitive account of Nebraska's ferns was that of Thomas J. Fitzpatrick (1920), which was based upon holdings in the Charles E. Bessey Herbarium (NEB) of the University of Nebraska-Lincoln. The only floristic manuals solely devoted to the state's flora (Petersen 1923; Winter 1936) were also based upon that herbarium's collection, which greatly expanded under Bessey's direction from the 1880s until his death in 1915. Regional and more extensive books that include Nebraska were based upon that and many other collections in and outside Nebraska: Britton & Brown (1896, 1913, but not Gleason (1952)); Rydberg (1932), Fernald (1950), Petrik-Ott (1979), Lellinger (1985), GPFA-Great Plains Flora Association (1977, 1986), FNA-Flora of North America Editorial Committee (1993), and various journal papers. With each succeeding publication, old distributional errors were perpetuated and new ones were introduced.

The only county-by-county maps of all the state's ferns and fern allies were those of *Atlas of the Flora of the Great Plains* (GPFA 1977), to which we contributed, and of *The Pteridophytes of Kansas, Nebraska, South Dakota and North Dakota* (Petrik-Ott 1979). The state-outline maps of *Flora of North America* (FNA 1993) are more generalized. There are mapping errors in all those publications that we seek to correct in this paper, and our extensive field and herbarium work has added many distributional records.

A continuing source of errors is the E.M. Hussong collection at NEB, supposedly from Franklin County in the 1890s, according to the labels. The collection includes ferns and many angiosperms that are far out of range for Nebraska. For example, *Osmunda regalis* has been attributed to Nebraska for more than a century, based upon those specimens, but it is yet unknown anywhere in the state, and Franklin and nearby counties lack suitable habitat. The handwriting on the labels is not Hussong's, and we reject the records as representing Nebraska plants.

The massive cattle-ranching and agricultural development of the past 150 years has greatly reduced the state's natural vegetation, especially that of the prairies, but suitable habitats remain and most species can be found today, if only in remote or widely scattered sites. Most pteridophytes in Nebraska are at the edge of their range and, as such, many have always been scarce, and a few have not been seen for decades. Relatively pristine are the Sandhills, 23,000 square miles of prairie-vegetated, uncultivated dunes and sandplains, the high water-table producing thousands of lakes, ponds, marshes, and fens; and the valley of the Niobrara River, its bluffs and sheltered tributaries lined for much of its length with forests of ponderosa pine and hardwoods. Some species in Niobrara Valley forests and Sandhills fens are apparently relicts from cooler, wetter, early post-Pleistocene times, such as the now-disjunct *Ophioglossum pusillum, Dryopteris cristata, D. carthusiana, Athyrium filix-femina*, and many angiosperms and animals (Kaul et al. 1988; Kaul & Rolfsmeier 1993). The ponderosa pine forests of the Pine Ridge, Wildcat Hills, and Niobrara River valley still have much native flora, as do some of the oak-hickory forests of the Missouri River valley and its tributaries. With ranching and agrarian settlement came suppression of prairie fires, leading to major expansion of deciduous forests in the eastern, wettest third of the state, but their pteridophyte flora has not correspondingly expanded and is yet confined to the region of the original forests there.

MATERIALS AND METHODS

We have collected most species in the field during our combined 86 years of field work from 1964 through 2001. In addition, we examined all specimens at these herbaria in Nebraska: Charles E. Bessey Herbarium (NEB) at the University of Nebraska-Lincoln; University of Nebraska at Omaha (OMA); University of Nebraska at Kearney; Chadron (CSCN), Peru, and Wayne state colleges; Cedar Point Biological Station; Doane College; and Nebraska Wesleyan University. We also examined all Nebraska-collected specimens at the University of Kansas (KANU), Kansas State University (KSC), Fort Hays State University, University of South Dakota (SDU), South Dakota State University (SDC), and University of Wyoming (RM), and we saw some Nebraska specimens at the Missouri Botanical Garden (MO) and the New York Botanical Garden (NY).

Our nomenclature follows *Flora of North America* (FNA 1993), with synonyms as used in our cited references that specifically attributed the plants to Nebaska by text, map, or both. Species marked with a black diamond (♦) are here verified for the first time as native to Nebraska and were discovered in the late 1990s and 2000. Year of first collection is given for the rarer species, some of which have not been found again. Counties and some physiographic features are named in Figure 1, and all species are mapped by county in Figure 2.

ACCEPTED SPECIES

Division LYCOPODIOPHYTA

ISOËTACEAE

Isoëtes melanopoda Gay & Durieu ex Durieu.—Collected from the Rainwater Basins several times, 1880s–1941, but not again until 2000. Most habitat long since drained and plowed for agriculture. Mapped for the entire eastern half of

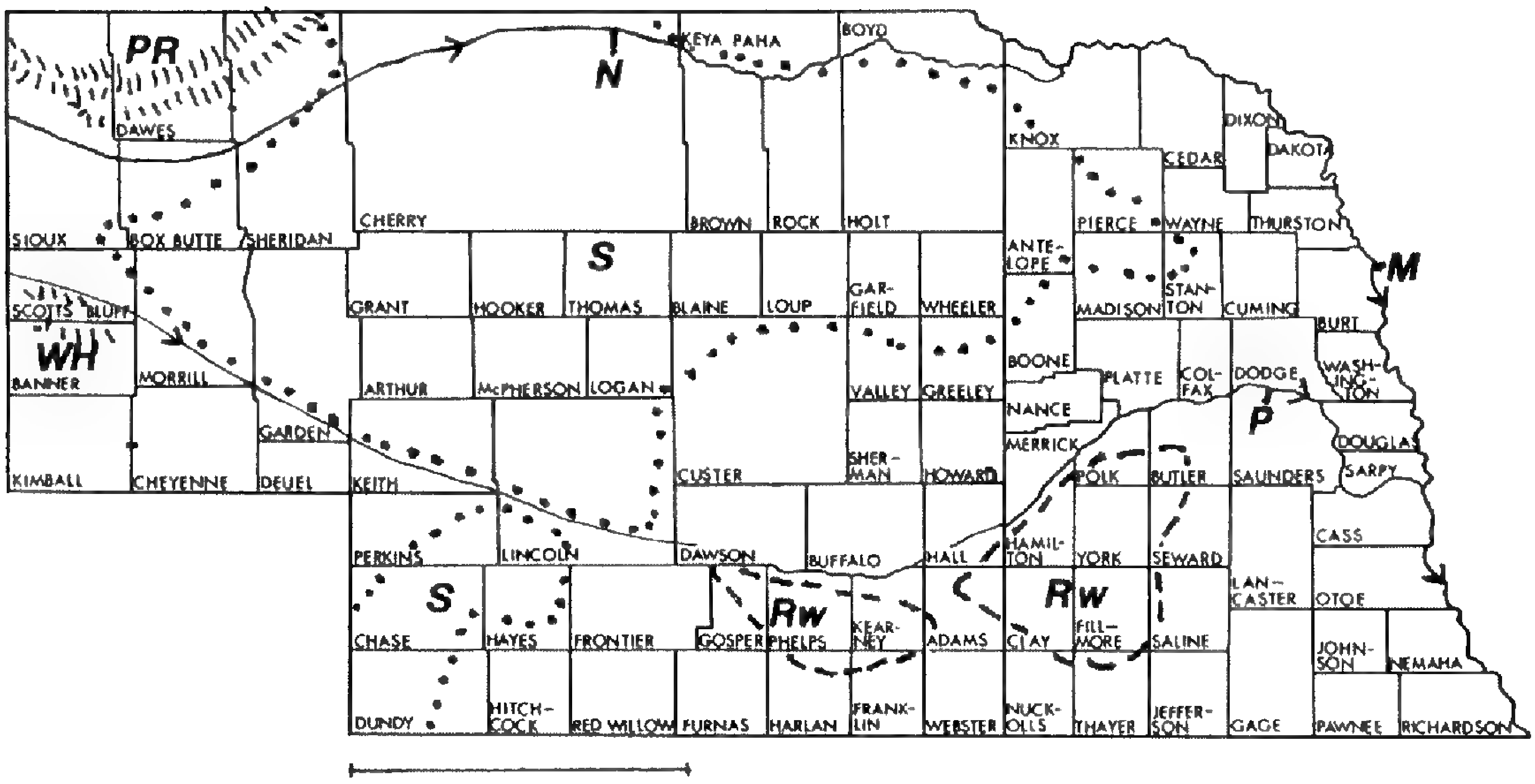


Fig. 1. Map of Nebraska with counties, major rivers, and some physiographic areas identified. *M*: Missouri, *N*: Niobrara, and *P*: Platte rivers. *PR*: Pine Ridge, and *WH*: Wildcat Hills, both forested with ponderosa pine. *Dotted line(S)*: Sandhills–prairie-vegetated dunes and sandplains, with thousands of ponds, lakes, marshes, and fens; *dashed line(Rw)*: Rainwater Basins–level plains once having hundreds of shallow ponds, these now mostly drained and plowed for agriculture. *Scale bar = 100 mi/160 km.*

the state by FNA-Taylor et al. (1993), but known only from five south-central counties.

SELAGINELLACEAE

Selaginella rupestris (L.) Spring.—Locally abundant in parts of the Niobrara and Little Blue river drainages, scattered elsewhere.

Division EQUISETOPHYTA

EQUISETACEAE

Equisetum arvense L.—Common state-wide, except absent from the southwest.

Equisetum ×ferrisii Clute [=*Equisetum intermedium* (A. A. Eaton) Rydb.-Rydberg (1932)].—Occasional in the eastern half of the state; many reports in GPFA (1977) were based upon depauperate specimens of *E. hyemale*.

Equisetum fluviatile L. [=*Equisetum limosum* L.-Bessey (1892)].—Known only by collections from the eastern Sandhills in 1892, 1909, and 2000, and from one site near the Missouri River, 1941–1952, 1987, 2001. Mapped for the entire northern half of the state by FNA-Hauke (1993).

Equisetum hyemale L. ssp. **affine** (Engelm.) Calder & Roy L. Taylor [=*Equisetum affine* Engelmann-Rydberg (1932); *Equisetum hyemale* L.-Bessey (1892), Britton & Brown (1896, 1913), GPFA (1977); *Equisetum hyemale* L. var. *affine* (Engelm.) A.A. Eaton-GPFA (1986); *Equisetum robustum* A. Braun-Webber (1890), Fitzpatrick (1920), Rydberg (1932)].—Common over most of the state, except the southwest.

Equisetum laevigatum A. Braun [=*Equisetum kansanum* J.H. Schaffn.–Rydberg (1932)].—Common statewide.

Division POLYPODIOPHYTA

ASPLENIACEAE

Asplenium platyneuron (L.) Britton, Sterns, & Poggenb.—First collected in 1986, by J. Locklear in Jefferson County (Rolfsmeier et al. 1988), where locally abundant; a single plant discovered and photographed in Washington County in 1988 (Garabrandt 1988), the photograph at OMA. It remains to be seen whether this plant will increase its range in Nebraska as it has elsewhere (Wagner & Johnson 1981).

AZOLLACEAE

Azolla mexicana C. Presl.—Sporadically abundant, sometimes massively so.

DRYOPTERIDACEAE

Athyrium filix-femina (L.) Mertens var. **cyclosorum** Rupr. [=*Asplenium filix-foemina* (L.) Bernh.–Botanical Survey of Nebraska (1893); *Athyrium angustum* (Willd.) C. Presl–Rydberg (1932)].—Known only as independent 1893 collections by J.M. Bates, F.C. Clements, and P.A. Rydberg, on different dates and at different sites in the Niobrara River valley, and perhaps yet present in pristine forests of Long Pine Canyon. The sites are disjunct from the main ranges of var. *cyclosorum* to our west and var. *angustum* (Willd.) G. Lawson to our east. FNA-Kato (1993) attributed only var. *angustum* to Nebraska, but the specimens from the wild, with their rounded sori and long-ciliate indusia, are var. *cyclosorum*. In 1979, R.E. Brooks annotated those specimens as ssp. *cyclosorum* (Rupr.) C. Christens., but in GPFA (1986) he did not attribute the species to Nebraska; the key to varieties there is incorrect. Petrik-Ott (1979) did not specify infraspecific taxa, and an Adams County specimen she cited but did not map was from a garden; several other specimens in herbaria are of cultivated plants.

Cystopteris bulbifera (L.) Bernh.–GPFA (1977, 1986).—First collected in 1972 (Anderson 1974), in Richardson County in the extreme southeastern corner of the state, and still abundant at that site, but unknown elsewhere in the state. Not attributed to Nebraska by FNA-Haufler et al. (1993).

Cystopteris fragilis (L.) Bernh. [=*Filix fragilis* (L.) Gilib.–Petersen (1923), Rydberg (1932)].—Common in the northern and eastern halves of the state.

Cystopteris protrusa (Weath.) Blasdell.—Common in the eastern one-fifth of the state, especially southeastward.

Cystopteris tenuis (Michx.) Desv. [=*Cystopteris fragilis* (L.) Bernh., in part–GPFA (1977, 1986)].—Locally abundant in the eastern one-fifth of the state. Moran (1983) and FNA-Haufler et al. (1993) mapped it for one station in the extreme west, but we cannot verify its presence there.

Dryopteris carthusiana (Vill.) H.P. Fuchs [=*Aspidium spinulosum* Sw.–Webber (1890); *Dryopteris spinulosa* (O.F. Müll.) Kuntze-Fitzpatrick (1920), Petersen (1923), Rydberg (1932); *Dryopteris spinulosa* (O.F. Müll.) Watt-GPFA (1986)].—Collected infrequently between 1892 and 2001; locally common today at scattered sites in the paper-birch forests of the Niobrara River valley in Cherry County, and in oak-wooded ravines between bluffs of the Missouri River in Dakota and Thurston counties.

Dryopteris cristata (L.) A. Gray.—Collected by Rydberg in 1893 from shrub-filled fens of Hooker County, in the Sandhills, disjunct 150 mi/240 km west of the main range; not found since then, but potentially persisting in the many remaining fens. Erroneously attributed also to adjacent Thomas County by Petersen (1923) and GPFA (1977), based upon incorrect interpretation of the location as written on the labels.

♦**Matteuccia struthiopteris** (L.) Tod. var. **pensylvanica** (Willd.) C.V. Morton.—First collected from the wild in 2000, in native habitat in Thurston County, remote from past or present habitations. Commonly cultivated but not known to have naturalized in the state, although seemingly capable of doing so.

Onoclea sensibilis L.—Abundant today in Sandhills marshes and in the Elkhorn, Loup, and lower Little Blue river valleys, but rare and mostly extirpated elsewhere.

Woodsia obtusa (Spreng.) Torr.—Occasional to locally common in rocky woods in the eastern one-fifth of the state.

Woodsia oregana D.C. Eaton ssp. **cathcartiana** (B.L. Robins.) Windham.—Occasional in the western two-thirds of the state. Mapped for all but the extreme southeastern corner of the state by FNA-Windham (1993), but absent from a much greater area (Fig. 2).

MARSILEACEAE

Marsilea vestita Hook. & Grev.—Locally abundant, sometimes massively so, in the Platte River valley and Rainwater Basins, scarce elsewhere.

Pilularia americana A. Braun.—First and last collected in 1966, from a large, shallow Sandhills lake in Cherry County (McGregor 1967).

OPHIOGLOSSACEAE

Botrychium campestre W.H. Wagner & Farrar.—First collected in 1982, from a bur-oak and red-cedar forest on the floodplain of the Niobrara River, Brown County (Freeman & Churchill 1983, as *B. matricariifolium* A. Braun, but later formally described as *B. campestre* in Wagner & Wagner (1986)), and still thriving there; two nearby populations discovered in 2000.

Botrychium virginianum (L.) Sw.—Common in eastern and northern counties, less so westward. Mapped for the entire state by FNA-Wagner and Wagner (1993), but unknown to us in the entire southwestern half, which lacks suitable habitat.

♦**Ophioglossum engelmannii** Prantl.—Known only by collections in 1999 from Pawnee County, the northern edge of its range.

Ophioglossum pusillum Raf. [=*Ophioglossum vulgatum* L. var. *pseudopodum* (S.F. Blake) Farw.–Fernald (1950), Brooks (1980), GPFA (1986)].—Locally abundant on peat mounds in northwestern Sandhills fens, and on shallow peat near springs in the Niobrara River valley. First collected in 1912, but not again until 1982 and subsequently at seven other sites. The habitats are not especially threatened, and a few are preserved.

PTERIDACEAE

Adiantum pedatum L.—Common in oak-hickory forests on bluffs near the Missouri River and nearby tributaries, and known from a single collection from Rock County, in the Niobrara River valley.

Argyrochosma dealbata (Pursh) Windham [=*Notholaena dealbata* Kunze–Webber (1890), Britton & Brown (1913), Fitzpatrick (1920), Petersen (1923), Rydberg (1932), Fernald (1950), GPFA (1977, 1986)].—First and last collected in 1888, from Weeping Water Valley, Cass County. The site, now severely disturbed by quarrying of limestone, is northernmost for the species.

Cheilanthes feei T. Moore [=*Cheilanthes lanuginosa* Nutt.–Webber (1890)].—Uncommon in western counties, absent elsewhere; mapped for the entire state by FNA-Windham & Rabe (1993).

Pellaea atropurpurea (L.) Link.—Mapped for the entire state by FNA-Windham (1993), but known to us only from one western county, where it is locally abundant in narrow, shady, cool canyons, and from seven eastern counties, where it is uncommon.

♦ **Pellaea glabella** Mett. ex Kuhn ssp. **glabella**.—The only specimen we have seen is our collection from Gage County, 1998, although the plant was earlier mapped for Nebraska by Gastony (1988), but without citation of specimens. It was then attributed to the state and mapped for Richardson County by FNA-Windham (1993), perhaps based upon Gastony's map.

THELYPTERIDACEAE

Thelypteris palustris Schott var. **pubescens** (G. Lawson) Fernald [=*Aspidium thelypteris* (L.) Sw.–Webber (1890); *Dryopteris thelypteris* (L.) A. Gray–Fitzpatrick (1920), Petersen (1923), Rydberg (1932); *Thelypteris palustris* Schott–GPFA (1977, 1986)].—Common now in Sandhills marshes and fens, sometimes massively so, and locally abundant in the Elkhorn and Loup river drainages and in Jefferson County; essentially extirpated elsewhere.

EXCLUDED SPECIES

Division LYCOPODIOPHYTA

LYCOPODIACEAE

Lycopodium annotinum L. was reported for Nebraska by Petrik-Ott (1975, 1979) and GPFA (1977), based upon an 1892 specimen supposedly from Cherry County and attributed to J.M. Bates. Bates included no label with the specimen, and all label data are in the handwriting of Thomas J. Fitzpatrick. Al-

Adiantum pedatum

Argyrochosma dealbata

Asplenium platyneuron

Athyrium filix-femina cyclosorum

Azolla mexicana

Botrychium campestre

Botrychium virginianum

Cheilanthes feei

Cystopteris bulbifera

Cystopteris fragilis

Cystopteris protrusa

Cystopteris tenuis

Dryopteris carthusiana

Dryopteris cristata

Equisetum arvense

Equisetum x ferrissii

Equisetum fluviatile

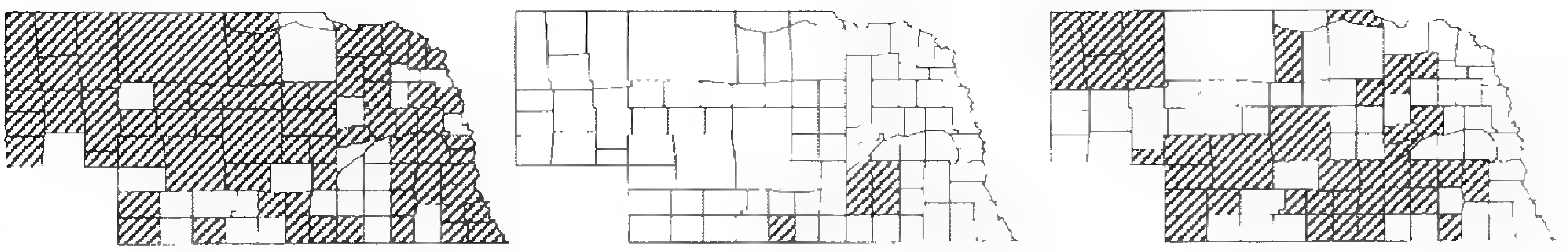
Equisetum hyemale affine

Fig. 2. Distribution maps of all Nebraska species of ferns and fern allies, as collected from 1873 through 2001. The records for each shaded county are supported by at least one voucher specimen deposited in an herbarium cited in this paper.

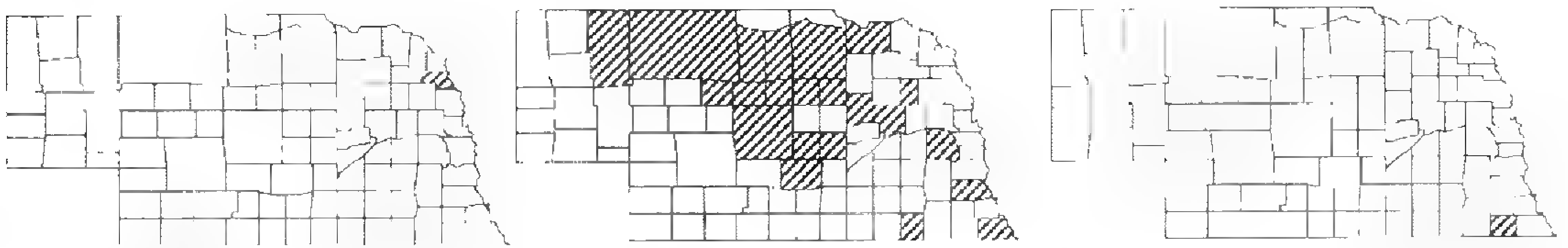
though correctly identified, the specimen was rejected by Brooks (1978) because the mosses with the specimen are not native to Nebraska, and Petrik-Ott (1979), in the addendum to her book, agreed. Neither this nor any other species of *Lycopodium, sensu lato*, is known in Nebraska.

SELAGINELLACEAE

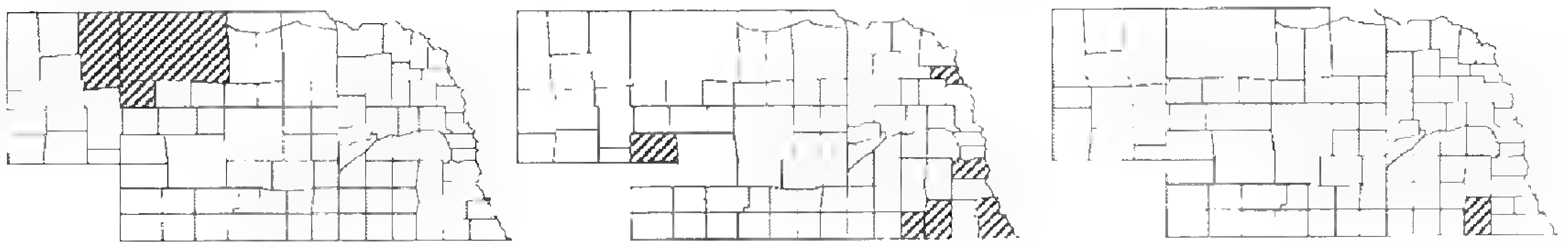
Selaginella densa Rydb. was reported from Holt County by Petrik-Ott (1975, 1979) and GPFA (1977), but based upon a misidentified specimen of *S. rupestris*. It was attributed to Nebraska and mapped for the extreme northwestern corner of the state by FNA-Valdespino (1993), but we have not found it there, although it is nearby in Wyoming and South Dakota.



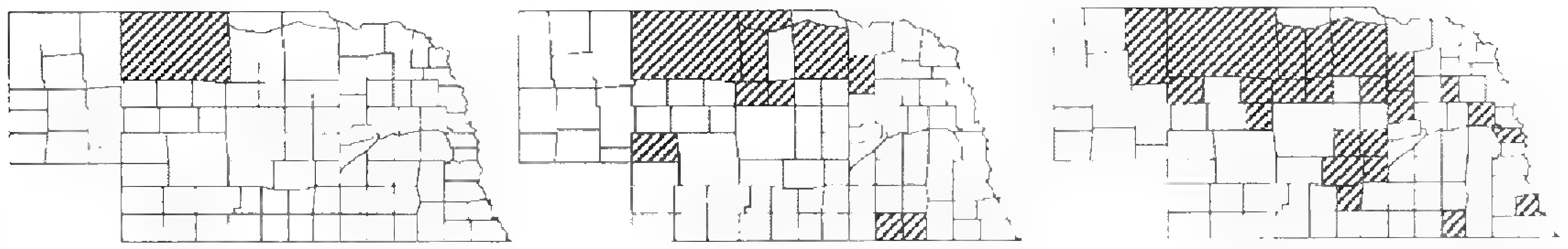
Equisetum laevigatum *Isoetes melanopoda* *Marsilea vestita*



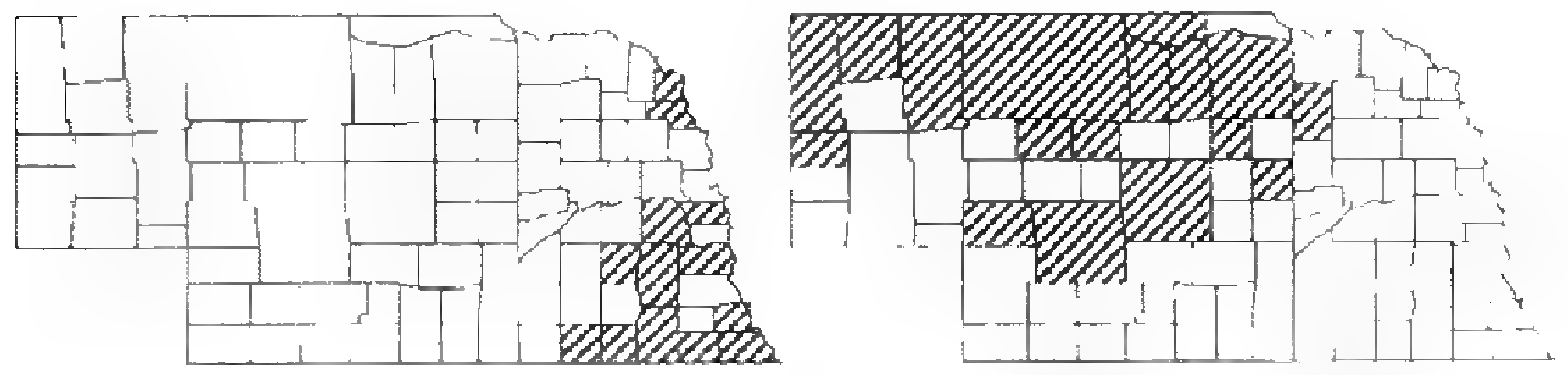
Matteuccia struthiopteris pensylvanica *Onoclea sensibilis* *Ophioglossum engelmannii*



Ophioglossum pusillum *Pellaea atropurpurea* *Pellaea glabella glabella*



Pilularia americana *Selaginella rupestris* *Thelypteris palustris pubescens*



Woodsia obtusa *Woodsia oregana cathcartiana*

Fig. 2. (cont.)

Division EQUISETOPHYTA

EQUISETACEAE

Equisetum ×litorale Kühlew. ex Rupr. was mapped for the entire northern half of Nebraska by FNA-Hauke (1993), but we have neither collected it in the state nor have we seen voucher specimens in any herbarium.

Equisetum palustre L. was reported for Nebraska by Taylor (1970), but we have not seen specimens.

Equisetum pratense Ehrh. Bessey (1892) reported a specimen from Sowbelly Canyon, Sioux County, supposedly collected in August, 1890, but we have not found such a specimen.

Equisetum variegatum Schleich. ex F. Weber & D. Mohr was reported for various localities across the state by Webber (1890), Fitzpatrick (1920) and Petersen (1923), but those reports were based upon misidentified, depauperate specimens of *Equisetum laevigatum*. The records were rejected by Petrik-Ott (1975, 1979) and Brooks (1986).

Division POLYPODIOPHYTA

ASPLENIACEAE

Asplenium trichomanes L. ssp. ***trichomanes*** was not reported for Nebraska by Moran (1982), but it was both mapped and cited for the state by FNA-Wagner et al. (1993). Moran (1995, *in litt.*) could not account for the discrepancy. The nearest vouchered stations we know are in the Black Hills of South Dakota.

AZOLLACEAE

Azolla caroliniana Willd. Reports before 1950 were made by authors who did not distinguish this from *Azolla mexicana*. Both species were reported for Nebraska by FNA-Lumpkin (1993), but the distinction is difficult and requires mature megaspores, which are lacking in most of our specimens. We reject reports of *A. caroliniana*, as did Petrik-Ott (1979), until further evidence is available.

DRYOPTERIDACEAE

Woodsia scopulina D.C. Eaton was reported by Rydberg (1932), but we have not found vouchering specimens. It occurs in the Black Hills of South Dakota and perhaps is in the nearby Pine Ridge of Nebraska's northwestern corner.

OPHIOGLOSSACEAE

Botrychium dissectum Spreng. was reported (as *Botrychium obliquum* Muhl.) by Petersen (1923), who suggested that the latter name might be correct for the Hussong collection of *B. multifidum* (which see, below).

Botrychium matricariifolium A. Braun was reported as new to Nebraska by Freeman & Churchill (1983) and Brooks (1986), based upon specimens of *Botrychium campestre* (*q.v.* above), which was not described until 1986.

Botrychium multifidum (S.G. Gmel.) Rupr. A specimen (*Hussong s.n.*) at NEB, supposedly from Franklin County, was so identified by Petrik-Ott (1975, 1979). The specimen is from a large collection of very doubtful provenance, and the record was excluded by GPFA (1977, 1986) and is rejected by us.

Botrychium neglectum A. Wood was reported by Britton and Brown (1913), Fitzpatrick (1920), and Petersen (1923), the latter two reports being based on the specimen later reported as *B. multifidum* by Petrik-Ott (1979). The placement of this name is in doubt, and Brooks (1986) included it as a synonym of *B. matricariifolium*.

Ophioglossum vulgatum L. was first reported for Nebraska by Bates (1912). All reports before 1980 were by authors who did not distinguish this species from *O. pusillum* Raf., of which there are old and recent records for the state.

OSMUNDACEAE

Osmunda cinnamomea L. was reported for Nebraska by Lellinger (1985) but not by GPFA (1977, 1986) or FNA-Whetstone & Atkinson (1993); we have not found vouchering specimens.

Osmunda claytoniana L. was reported by Fitzpatrick (1920), based upon a specimen at NEB "without definite locality and doubtfully referred to Nebraska." The report was later accepted by Rydberg (1932) and rejected by Petrik-Ott (1975, 1979).

Osmunda regalis L. var. ***spectabilis*** (Willd.) A. Gray was first reported for Nebraska in 1897 (*Fern Bull.*, p. 66), based upon specimens at NEB that were collected by E. M. Hussong, supposedly from Franklin County but of doubtful provenance. The report was reiterated by Britton & Brown (1913), Fitzpatrick (1920), Petersen (1923), Petrik-Ott (1975, 1979), and Lellinger (1985), but not by Fernald (1950), Gleason (1952), GPFA (1977, 1986), or FNA-Whetstone & Atkinson (1993). Franklin County lacks suitable habitat, and the plant has not been found anywhere in the state.

PTERIDACEAE

Cryptogramma acrostichoides R. Br. was reported by Fitzpatrick (1920) and Petersen (1923) on the basis of a single frond that was sent to C.E. Bessey for determination. The specimen is from a collection by E.M. Hussong and supposedly from Franklin County, but with doubtful locality data that is not written in Hussong's hand. Petrik-Ott (1975, 1979) considered the specimen not to be from Nebraska, and so do we.

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EXPANSION OF THE EXOTIC AQUATIC PLANT *CRYPTOCORYNE BECKETTII* (ARACEAE) IN THE SAN MARCOS RIVER, TEXAS

Robert D. Doyle[1]

University of North Texas
Department of Biology, Institute of Applied Sciences
PO Box 310559, Denton, TX 76203-0559, U.S.A.

ABSTRACT

Cryptocoryne beckettii Thw. ex R. Trim. is an exotic aquatic plant recently found in the San Marcos River, Texas. The species is currently expanding rapidly within the lower portions of the upper San Marcos River. The distribution and areal extent of the species was quantified on three occasions between April 1998 and August 2000. During this 28-month period, the number of individual colonies increased from 11 to 63, and the total areal coverage increased from 171 to 646 m^2. The average rate of areal expansion during this period was 80% per year. Most colonies of *C. beckettii* were found to be small (< 5 m^2), although in August 2000 three colonies were greater than 50 m^2 in size. All colonies were found at water depths between 30 and 120 cm and appeared to favor more rapidly flowing water. This preference for shallow, rapidly flowing areas of the river makes *C. beckettii* a potentially serious threat to *Zizania texana* Hitchc., an endangered plant endemic to the San Marcos River, that occupies a similar river zone. All known colonies of *C. beckettii* are currently downstream from the remaining stands of *Z. texana*.

RESUMEN

Cryptocoryne beckettii Thw. ex R. Trim. es una planta acuática exótica encontrada recientemente en el río San Marcos, Texas. La especie está actualmente expandiéndose rápidamente por las partes bajas de la cuenca alta del San Marcos. La distribución y área de extensión de la especie fue cuantificada en tres ocasiones entre abril de 1998 y agosto de 2000. Durante este periodo de 28 meses, en número de colonias individuales se incrementó de 11 a 63, y el área total de recubrimiento se incrementó de 171 a 646 m^2. La tasa media de expansión del área durante este periodo fue del 80% por año. La mayoría de las colonias de *C. beckettii* son pequeñas (< 5 m^2), aunque en agosto de 2000 tres colonias eran mayores de 50 m^2. Todas las colonias se encontraron en profundidades de agua entre 30 y 120 cm y parecían favorecer un flujo de agua más rápido. Esta preferencia por las áreas del río poco profundas y con flujo rápido hace de *C. beckettii* una amenaza potencial seria para *Zizania texana* Hitchc., una planta endémica amenazada del río San Marcos, que ocupa una zona fluvial similar. Todas las colonias conocidas de *C. beckettii* están actualmente aguas abajo de las posiciones restantes de *Z. texana*.

INTRODUCTION

The San Marcos River, Hays County, Texas, originates from a series of springs along the San Marcos Springs fault within the city of San Marcos, Texas. The river flows 130 km to its confluence with the Guadalupe River near the city of Gonzales. The upper river, defined as the eight km between its origin and its

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[1] Current Address: Baylor University, Department of Biology, PO Box 97388, Waco, TX 76798, U.S.A.

confluence with the Blanco River, is the subject of substantial interest due to the presence of several endangered species (USFWS 1996). The river maintains relatively constant temperature and water chemistry year around, and this constancy may be responsible for the biological uniqueness of the system (Hannan & Dorris 1970; Lemke 1989; Groeger et al. 1997). This river supports the greatest known diversity of aquatic organisms in Texas, and several of the more rare species are limited to the upper portion of the river (Staton 1992; USFWS 1996). Considered an ecologically sensitive and critical habitat by the US Fish and Wildlife Service (USFWS 1996), the upper river harbors several endangered aquatic species, including *Zizania texana* Hitchc. (Texas wild rice), *Typhlomolge rathbuni* Stejner. (San Marcos blind salamander), and *Etheostoma fonticola* Jordan & Gilbert. (fountain darter), and the threatened *Eurycea nana* Bishop. (San Marcos salamander). *Gambusia georgei* Hubbs & Penden. (San Marcos gambusia) is a fish species thought to have recently gone extinct from the San Marcos River.

The river's spring-fed waters provide excellent habitat for the luxuriant growth of numerous more common aquatic plant species as well. Lemke (1989) reported the presence of 27 species of aquatic flowering plants as well as two species of aquatic ferns and two aquatic bryophytes. Unfortunately, eight of these species are exotic to the United States including some that are known to spread aggressively. The most abundant plant found in the upper river is now the notorious *Hydrilla verticillata* (L.f.) Royle, a non-native plant know to cause substantial management and ecological problems (see Langeland 1996). Another introduced aquatic plant species here is *Hygrophila polysperma* (Roxb) T. Anderson, native of India and Malaysia. Angerstein and Lemke (1994) hypothesized that the high growth potential of *H. polysperma* also poses a serious threat to the native flora and the biotic integrity of the San Marcos ecosystem. Although there is little historic information on the distribution of *H. polysperma* during the 25 or so years it has been in the system, it appears to have expanded dramatically during the last 15 years. In his survey of the upper river, Lemke (1989) categorized *H. polysperma* (although misidentified as *Hygrophila lacustris* (Schlecht. & Cham.) Nees as "uncommon" which he defined as "restricted to one or a few locations in the study area." Today, this species is widespread in the upper river and second only to *H. verticillata* in abundance (Doyle, unpublished data). *Hygrophyla polysperma* appears able to compete with *H. verticillata* (Les and Wunderling 1981) and apparently can easily outcompete *Ludwigia repens* Forst., a native aquatic macrophyte which has a similar growth form (Francis 2000). One other exotic aquatic plant species know to inflict damage on native flora is *Myriophyllum spicatum* L. (see Madsen et al. 1991) a species found abundantly in Spring Lake at the headwaters of the San Marcos River, although only rarely in the river itself.

Recently, a new exotic aquatic plant species identified as *Cryptocoryne beckettii* Thw.ex R.Trim. was found in the San Marcos River (Rosen 2000). The identification provided by Rosen (2000) was based only on vegetative characteristics, but more recent observations of floral characteristics from a sample collected from the river and grown in quarantine culture appear to confirm this species identification (Ken Saunders, Texas Parks and Wildlife Department (TPWD), personal communication). In this paper, I report information on the distribution and recent expansion of this species within the San Marcos River based on three vegetation assessments conducted between April 1998 and August 2000.

METHODS

The distribution and abundance of *C. beckettii* in the San Marcos were assessed in 1998, 1999, and 2000 as part of a larger vegetation assessment of the flora of the entire river. The specific survey dates (with river flow rates for those dates in parentheses) were: April 02, 1998 (6.20 cms); August 27, 1999 (3.88 cms); and August 25, 2000 (3.42 cms).

For each colony seen, its geographic location and the colony size were recorded using a high-resolution GPS unit (Trimble Pro XR), which was set to record data only where spatial resolution was considered "excellent" (±70- to 100-cm point resolution). Colonies larger than approximately 16 m^2 were mapped by circumnavigating each colony with the GPS unit. Water depth was also measured, using a standard depth pole depth gauge. For the larger colonies, the depth recorded was the depth considered to be most representative of the overall colony. Smaller colonies were mapped by recording a GPS point in the geographic center of a colony and recording North/South and East/West dimensions. Water depth was recorded where the GPS point was taken. In sections of the river where water was deeper and without a clear view of the bottom (> 1.7 m), I searched for *C. beckettii* by dragging a heavily weighted plant rake attached to a rope. Although not quantitative, this sampling technique is effective in determining presence/absence of submersed aquatic plants. *Cryptocoryne beckettii* was not found in any of the deeper portions of the river.

In 1998 and again in 2000 vegetative voucher specimens were collected from the river. I have not observed the species in flower in the river.

Flow velocities were taken in March 2001 at two of the larger colonies located near the upper end of Reach 12, using a Marsh-McBirney (Flo-Mate Model 2000). The measurements were taken just above the plant canopy (ca. 20 cm off the bottom).

RESULTS

Location of colonies, August 2000

Cryptocoryne beckettii has only been observed in the lower portions of the upper San Marcos River (Fig. 1). In August 2000, the most upstream colony was located just below the "power line." That location, named for the high-voltage

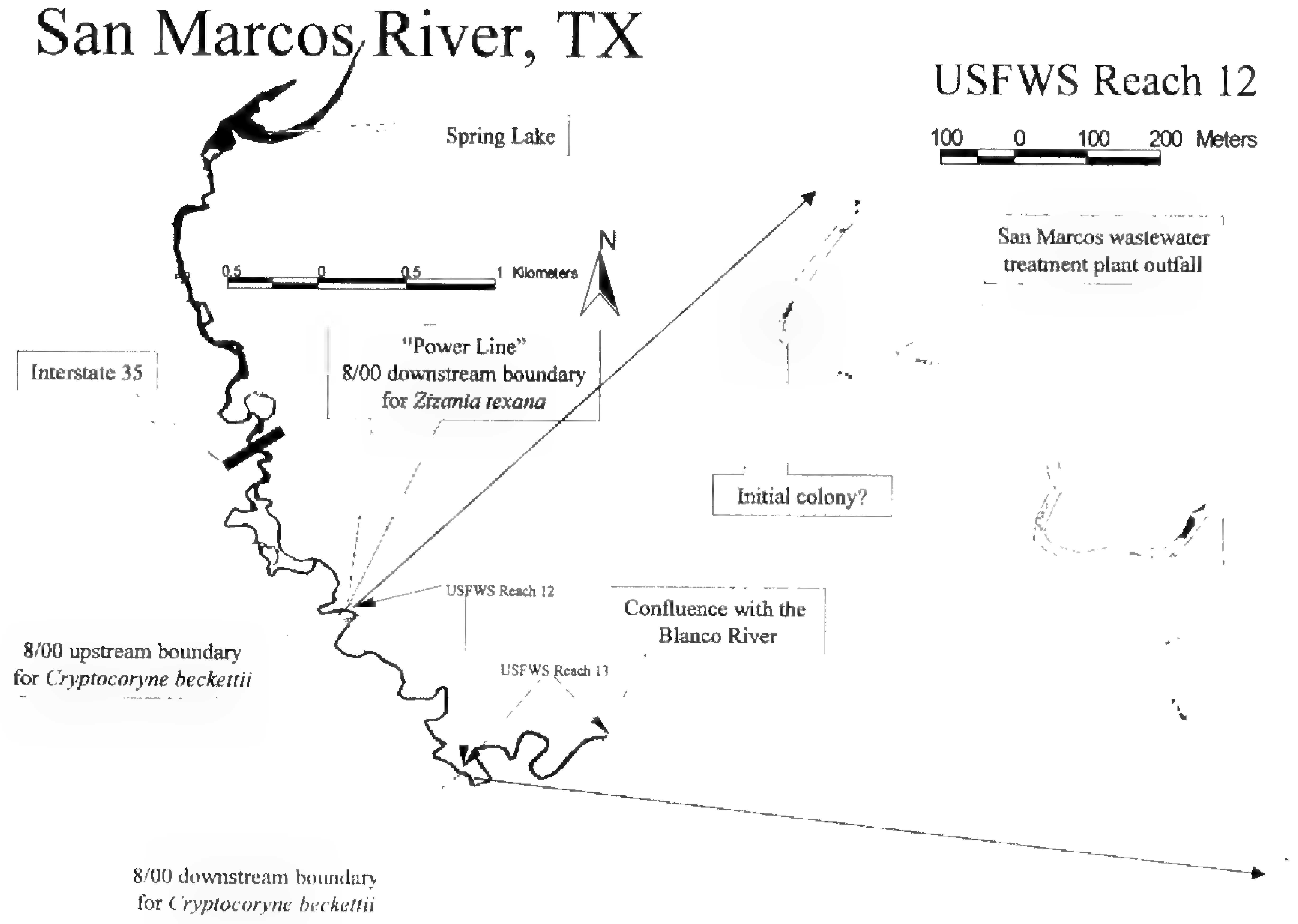

Fig. 1. Distribution of *Cryptocoryne beckettii* in the San Marcos River, Hays County, Texas, U.S.A. on August 25, 2000.

power line that crosses the river, is the beginning of the USFWS monitoring Reach 12. This colony was located about 20 m downstream of the southernmost stand of *Z. texana*, which is just upstream of the power line crossing. *Cryptocoryne beckettii* was widely distributed throughout Reach 12 and was the dominant aquatic macrophyte in that Reach (Table 1). Unlike most of the river, Reaches 12 and 13 are largely shaded by riparian tree canopy and are very sparsely populated by aquatic macrophytes. Total coverage by aquatic macrophytes in these sections is only about 3.6% of the total Reach area, and *C. beckettii* accounted for 73% of all aquatic vegetation coverage in that area.

Only four tiny colonies of *C. beckettii* totaling 1.0 m^2 were found in Reach 13. These were located just downstream of the division between Reaches 12 and 13.

Water depth and size of colonies, August 2000

In August 2000, most *C. beckettii* colonies were located at depths of 30 to 90 cm (Fig. 2). No colonies were located in water shallower than 30 cm nor in water deeper than 120 cm. Although 27% of all colonies were located in water deeper than 90 cm, these colonies tended to be small, so the areal coverage in deeper water was only about 13% of the total areal coverage. Because the August 2000 survey was conducted at relatively low river flow (3.42 cms), I believe all colonies surveyed remain completely submersed throughout the year.

TABLE 1. Abundance of all aquatic plant species in USFWS Reaches 12 and 13 of the San Marcos River, TX, in Oct 2000. Species are identified as exotic (E) or native (N).

Species	Total Area (m^2)	Number of colonies
REACH 12		
Cryptocoryne beckettii (E)	644.5	59
*Heteranthera dubia** (N)	7.9	9
Hydrilla verticillata (E)	11.3	8
Hygrophila polysperma (E)	197.9	29
Justicia americana (N)	4.3	3
Nuphar luteum (N)	5.5	4
Sagittaria platyphylla (N)	<0.1	1
Vallisneria americana (N)	9.5	2
*Zosterella dubia** (N)	7.9	9
REACH 13		
Cryptocoryne beckettii (E)	1.0	4
Hygrophila polysperma (E)	7.25	12
Nuphar luteum (N)	42.4	7

**Zosterella dubia* = *Heteranthera dubia* = *Heteranthera liebmannii*

Most *C. beckettii* colonies in the San Marcos River were small in August 2000. Of the 63 discreet colonies identified, 42 were < 5 m^2. At the same time 48% of the total population occurred in only three colonies, which ranged in size from 53 to 160 m^2.

Expansion of colonies over three years, 1998–2000

In all three surveys, the majority of all colonies were less than 5 m^2 in size, and relatively few colonies were greater than 10 m^2 (Fig. 3A). However, between 1998–2000 the absolute number of colonies in each size class increased (Fig. 3B) indicating that the population continued to expand and that individual colonies were continuing to grow in size.

The number of colonies and the area covered by *C. beckettii* increased significantly during the survey period (Fig. 4). In April 1998 there were only 11 colonies of *C. beckettii*, and 68% of the total areal coverage was found in one large colony located in the shallows on the inside of a bend in the river just above the wastewater treatment plant (Fig. 1). The total number of colonies between April 1998 and August 2000 increased from 11 to 63 (Fig. 4A), while total areal coverage of the species increased from 171 m^2 to 646 m^2 (Fig. 4B). The rate of increase in areal coverage averaged about 80% per year.

Flow velocity over *Cryptocoryne beckettii* colonies

In March 2001, the flow over two large *C. beckettii* colonies was 0.56 and 0.75 m s^{-1}. These colonies were located near the upstream limits of the population, but appeared visually similar to most of those observed within the river.

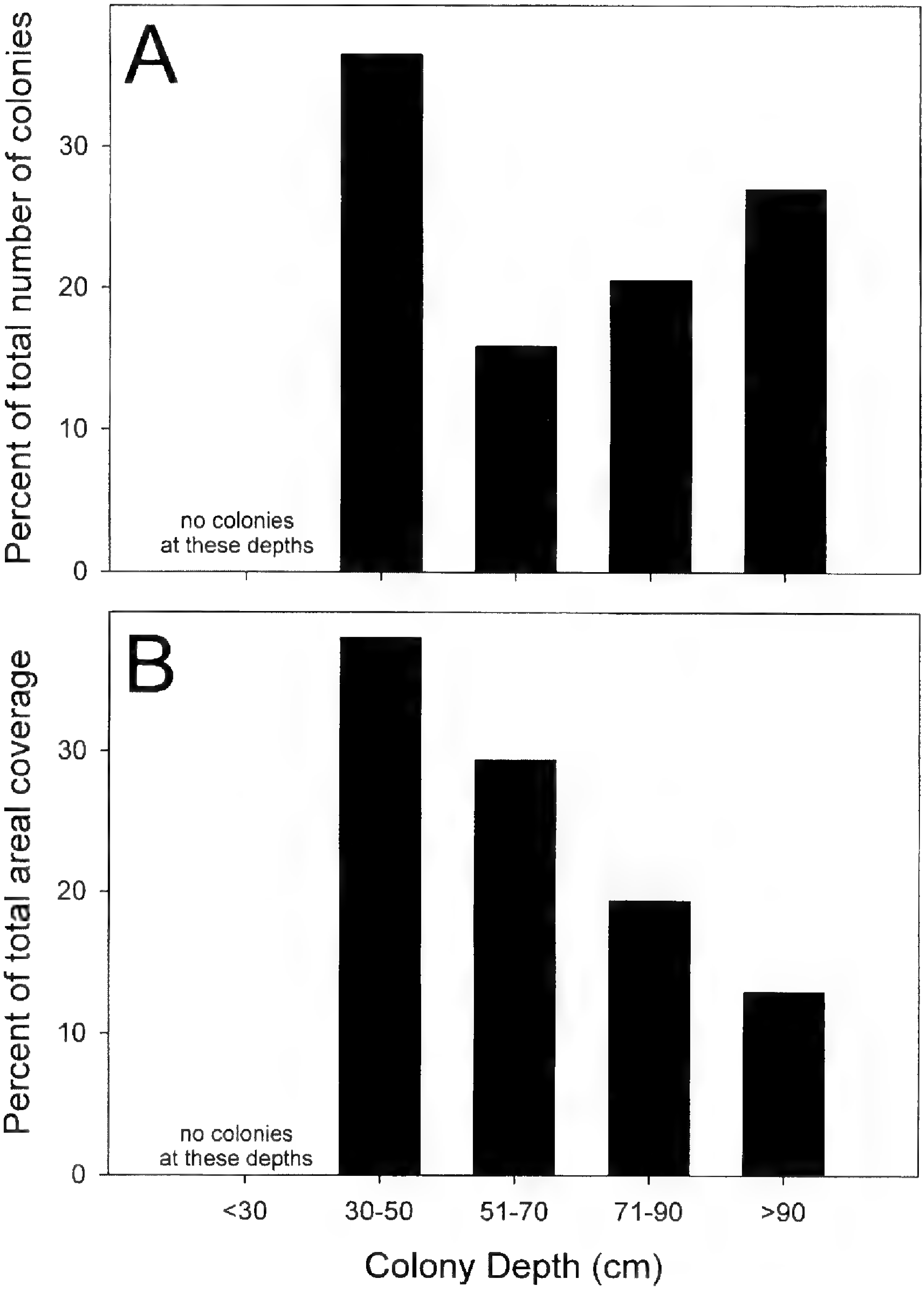

Fig. 2. Distribution of *Cryptocoryne beckettii* at measured water depths. (A) Frequency of colonies at different depths. (B) Frequency of percent of total areal coverage at different depths. Measurements taken on August 25, 2000 in the San Marcos River, Hays County, Texas, U.S.A.

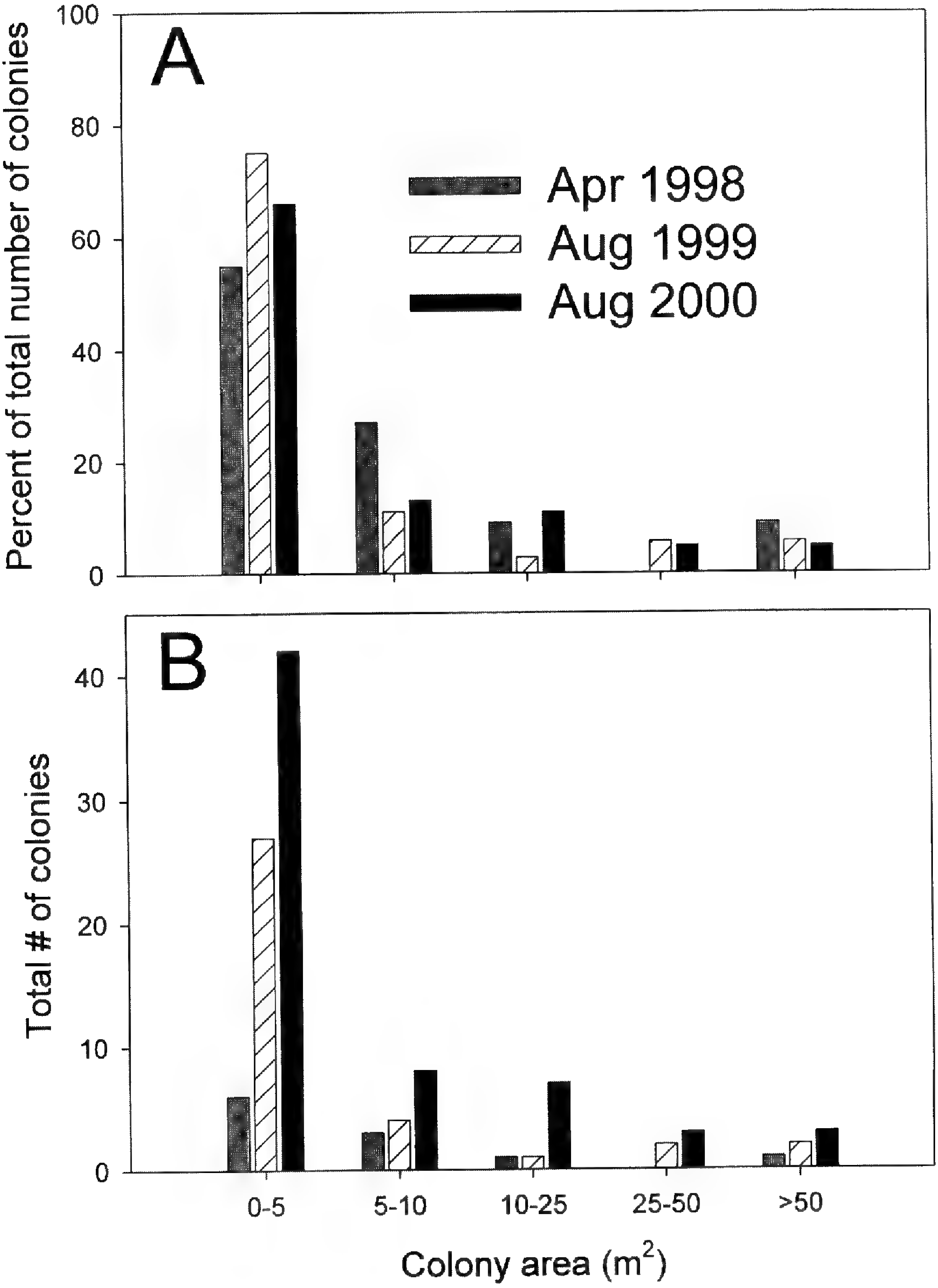

Fig. 3. Distribution of *Cryptocoryne beckettii* colonies in the San Marcos River, Texas, by size classes. (A) Percent of colonies in each size class. (B) Number of colonies in each size class.

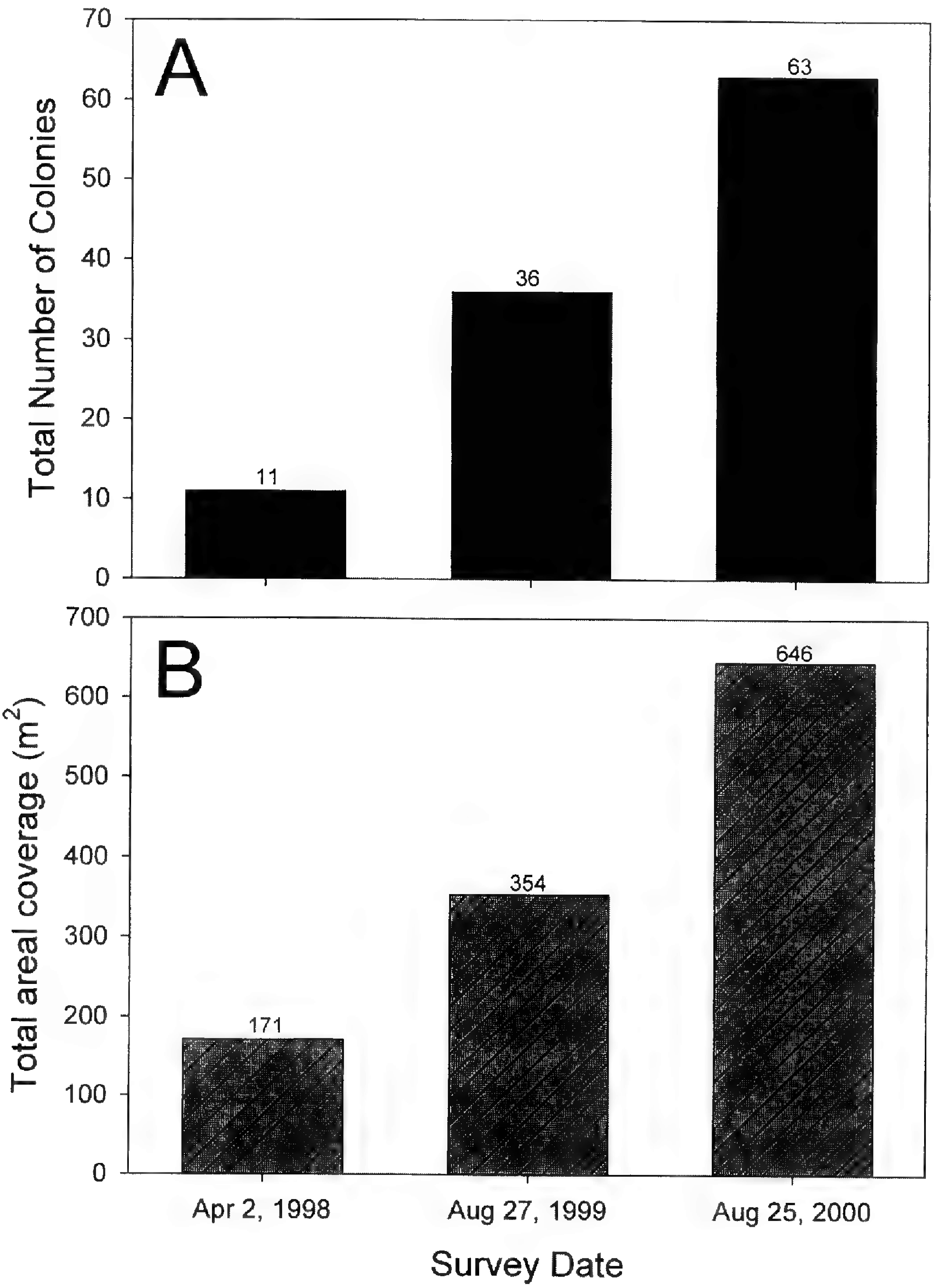

Fig. 4. Number of colonies (A) and total areal coverage (B) of *Cryptocoryne beckettii* in the San Marcos River, Texas, 1998–2000. Exact number of colonies or total areal coverage is given above the bar for each sampling period.

DISCUSSION

Many introduced aquatic plant species have spread beyond their native ranges, and some problematic weeds have expanded in spectacular fashion in their new habitat (Cook 1990). These alien species may interact with the native flora in various ways (Falinski 1998), such as filling a long-empty ecological niche in the community (supplementary interaction), filling a recently vacated niche (compensatory), or displacing one or more native species with similar biological and ecological requirements from a filled niche (substitutive). Although reliable criteria to determine accurately the ultimate weed potential of new invaders have not been developed (Mack 1996; Zamora et al. 1989), species that are likely to interact with native flora in negative ways should be considered to have high noxious weed potential (Bazzaz 1986).

Expansion of *Cryptocoryne beckettii*

During the survey period, *C. beckettii* increased at an alarmingly rapid rate. Between April 1998 and August 1999, *C. beckettii* areal coverage expanded at an annual rate of 80.2%. Between August 1999 and August 2000, the areal coverage of the population increased by 82.5%. Although the rate of expansion is likely to slow as the most suitable habitats become colonized, at the current average rate of expansion (80% per year) *C. beckettii* could cover 100% of Reach 12 in less than five years.

Potential threat to *Zizania texana*

The morphology of *Z. texana* and *C. bekettii* differ substantially. *Zizania texana* is characterized by long, ribbon-like leaves often observed to be 1–2 m in length (Terrell et al. 1978) while the ovate leaves of *C. beckettii* are typically only 15–30 cm in length, including both petiole and blade. Even so, I believe the introduction of *C. beckettii* into the San Marcos ecosystem may pose a substantial threat to *Z. texana,* because the two species appear to have similar depth and flow preferences. Poole and Bowles (1999) surveyed 44 individual stands of *Z. texana* in August 1994 and found that the water depth for these stands averaged 0.75±0.16 m (95% c.i.). In August 2000, the 63 surveyed colonies of *C. beckettii* were in an average water depth of 0.72±0.07 m (95% c.i.), indicating that the two species occupy virtually identical depth zones within the river. Furthermore, both species appear to favor locations with relatively high current velocity. Poole and Bowles (1999) further reported that the 44 stands of *Z. texana* had an average current velocity of 0.56 (±0.20) m s^{-1} (95% c.i.). Although current velocity near *C. beckettii* was measured only once and at only two colonies, the observed velocity range of 0.56 to 0.75 m s^{-1} indicates that this exotic species occupies a flow environment very similar to that of *Z. texana.*

One major habitat difference between the two species may indicate a difference in the degree of shading that can be tolerated. *Zizania texana* is most frequently found in full sun, while, at present, *C. beckettii* is found predominantly in more heavily shaded regions of the river. However, historical, unpublished data from TPWD indicate that within the past five years there have been stands of *Z. texana* extending farther downstream than the current distribution into sections of the river now dominated by *C. beckettii*.

The fact that *C. beckettii* may have similar habitat preferences to *Z. texana* does not indicate that it can or will displace remaining stands of the native plant. In fact, it is possible that established *Z. texana* stands, like other established native species such as *Vallisneria americana* Michx. will be a very effective competitor against an invading alien species (see Smart et al. 1994). However, given that the distribution of *Z. texana* is currently much reduced from historic levels (USFWS 1996), an aggressively expanding alien species such as *C. beckettii* may quickly occupy habitat that might otherwise be re-colonized by *Z. texana*.

Management recommendation

Eradication is ultimately the most desirable response to a new plant invasion, especially when it appears likely to interfere with an important native species. However, this outcome is most likely when plant populations are relatively small and contained; large or widely distributed populations require considerably more knowledge, money, and effort to achieve eradication (Coblentz 1990; Zamora & Thill 1999). The current abundance and distributional pattern of *C. beckettii* appears to lend itself to implementing an eradication effort. In August 2000, the population of *C. beckettii* was relatively small (646 m^2) and limited to a 1.7 km stretch of the upper San Marcos River. All existing stands of *Z. texana* are located upriver of this area, and very few other native species are present within the affected reaches. However, the explosive increase in *C. beckettii* observed to date indicates that the situation is likely to quickly become much more difficult to control.

Should control actions be considered, a holistic, ecosystem-based approach should be utilized. Control plans that focus on a single alien species without addressing the underlying disturbance phenomena that permitted the successful invasion, deal only with the effect of environmental degradation and not the causes (Edwards 1998). Single species approaches may simply delay an inevitable permanent establishment of the alien in the region or simply trade one invasive species for another equally damaging one (Hobbs and Humphries 1995). In the San Marcos River, *C. beckettii* has invaded a portion of the river that was virtually empty of aquatic vegetation. Given the apparent suitability of this species for this particular area and the apparent popularity of the species within the aquarium trade (illustrated by the large number of sites on the World Wide Web devoted to this genus), the likelihood of re-introduction is high. At a minimum, eradication efforts should be followed by an aggressive restoration effort to fill the "empty niche" with more desirable, native vegetation such as *Zizania texana* and *Vallisneria americana*.

ACKNOWLEDGMENTS

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VASCULAR PLANT TYPES IN THE ARIZONA STATE UNIVERSITY HERBARIUM

Stefanie M. Ickert-Bond and Donald J. Pinkava

Department of Plant Biology
Arizona State University, Box 871601
Tempe, AZ 85287-1601, U.S.A.

ABSTRACT

Founded in 1896 by Fredrick M. Irish, the vascular plant herbarium at Arizona State University (ASU) acts as a repository for plants particularly from the desert Southwest and Mexico. It now contains over 230,000 specimens, of which 735 have been designated as types including paratypes. Here we present a list that documents 384 major vascular plant type specimens and includes verified holotypes, lectotypes, syntypes and neotypes and their duplicates. Regionally the majority of the specimens are from the United States (186) and Mexico (178), while 13 from South America and 7 from the Old World. Taxonomically, the majority of type specimens belong to the Asteraceae (84), followed by Polygonaceae (56), Cactaceae (34), Scrophulariaceae (27), Fabaceae (16), the Agavaceae (13), and Acanthaceae (10). Historically prominent are 60 isotype specimens collected by C.G. Pringle, a prominent early plant collector in Mexico from 1885 to 1909. Numerous type collections were also made by James R. Reveal, Noel H. Holmgren, Howard S. Gentry and George B. Hinton. For each basionym typified by an ASU specimen, which is accompanied by a copy of the original publication, we here list collector(s) and collection number, locality information (restricted to country and state or equivalent demographic unit), and date of collection.

RESUMEN

Fundado en 1896 por Frederick M. Irish, el herbario de plantas vasculares de la Universidad del Estado de Arizona (ASU) actúa como un repositorio de plantas, principalmente del desierto del Suroeste y México. Actualmente el herbario cuenta con 230.000 ejemplares, de los cuales 735 corresponden a ejemplares tipo incluyendo también paratipos. Se presenta una lista que documenta 384 de los más importantes ejemplares tipo de plantas vasculares, incluyendo holotipos, lectotipos, sintipos, y neotipos, y sus duplicados. Regionalmente, la mayoría de los ejemplares son de los Estados Unidos (186) y de México (178); mientras que 13 son de América del Sur y 7 de Viejo Mundo. Taxonómicamente, la mayoría de los ejemplares tipo pertenecen a las familias Asteraceae (84), seguida de Polygonaceae (56), Cactaceae (34), Scrophulariaceae (27), Fabaceae (16), Agavaceae (13), y Acanthaceae (10). Históricamente, los más importantes son 60 isotipos colectados por C.G. Pringle, prominente colector en México entre 1885 y 1909. Se cuenta además con ejemplares tipo de los colectores James R. Reveal, Noel H. Holmgren, Howard S. Gentry y George B. Hinton. Cada basiónimo tipificado por un ejemplar en ASU, incluye una copia de la publicación original. Se listan además, el colector(es), y número de colecta, información de la localidad (restringida al país y estado o unidad demográfica equivalente) y a la fecha de la colecta.

INTRODUCTION

Since the herbarium was founded by Fredrick M. Irish in 1896, the vascular plant herbarium has grown to over 230,000 specimens, centering on floristics of the

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desert Southwest and Mexico, but many worldwide collections are represented. Frederick Mortimer Irish received his Bachelor of Science degree at the University of Iowa in 1895 and briefly taught high school in his hometown of Dubuque, Iowa, before accepting the position at Tempe Normal School in 1896 (Thomas 1960). "Cap" Irish served not only as the biology science teacher, but also as football coach, captain of the Military Company, and leader of student activities such as the Cactus Walking Club and the Girl's Hiking Club (Hopkins & Thomas 1960; Trauth-Nare & Pinkava 2000).

"He knew the flowers and could call them by name. As a botanist he was an authority" (Thomas 1960, p. 549). Irish was instrumental in establishing the herbarium. When Irish came to Tempe he brought with him his personal collections. Over the years more than 700 specimens bearing his name have been processed; some duplicates have been eventually deposited at the Desert Botanical Garden (DES). His early collections in the Salt River Valley are a valuable historical record of the diversity of plants in the Phoenix area of the time. Irish was appointed Registrar at the newly named Arizona State Teachers College in 1925 and served in this position till his death in 1941 (Thomas 1960).

James A. McCleary followed Irish as curator and botany professor. His interests were in bryophytes and desert plants and he and his students added approximately 3,000 specimens from 1947-1959 with only minimal financial assistance (McCleary, pers. comm.). By 1960, according to the new curator, Norman H. Russell, professor and departmental chair, more than 15,000 specimens were shelved in the herbarium. It was housed on the third floor of the now Life Science Center A Wing, Arizona State University (Rubinoff 1973). Russell's research interests included study of *Viola* and numerical taxonomy.

Donald J. Pinkava became director of the herbarium and Assistant Professor of Botany in 1964, after receiving a Ph.D. in Botany from Ohio State University, studying the genus *Berlandiera* DC. (Asteraceae). His research has focused on the Asteraceae, floristics of Cuatro Ciénegas, Coahuila, Mexico (resulting in 52 type collections and 5 original descriptions) and most recently on cacti, particularly the Opuntioideae of the Southwest. The ASU Herbarium houses one of the nation's largest collections of Cactaceae, including the best documented vouchered collection for chromosome counts. The Arizona State University Herbarium received official recognition when assigned its acronym, ASU, in 1966 (Anonymous 1966). It was then recognized as one of only 105 resource herbaria in the United States (Anonymous 1974). In 1971 the herbarium was moved to its present site, the third floor of the new C Wing of the Life Science Center (LS C392). During Pinkava's tenure as director, several members of the faculty, curators and especially his graduate students were responsible for the growth of the herbarium.

Throughout the 1960s and 1970s Pinkava received much assistance from the very knowledgeable curator, Ms. Elinor Lehto; her contributions were immeasurable. Upon her retirement in 1980, Bruce Parfitt served as acting curator, until the position was upgraded to half-time curation and half-time research position, which was filled by Thomas Daniel, who received his Ph.D. from the University of Michigan. As an expert on Neotropical Acanthaceae, his studies resulted in several types. Upon the appointment of Tom Daniel as curator of the herbarium at the California Academy of Sciences, Leslie R. Landrum, who also received his Ph.D. from the University of Michigan, accepted in 1986 the position as curator and research scientist in the Department of Botany. He is an expert on New World Myrtaceae. An herbarium grant from the National Science Foundation created a permanent half-time position for a collections' manager, which rotates from student to student and provides an important learning experience. As curator, Landrum's objectives have been to enlarge the holdings of Southwestern plants, and acquire material from Mexico, South America and the Caribbean, where he and many of his students carry out current studies. Increased interest has also been placed upon the Phoenix Flora project (URL: http://www.asu.edu/ces/CAPLTER.htm), part of the Central Arizona- Phoenix Long-Term Ecological Research Project (CAP LTER) awarded to the Center for Environmental Studies, funded by the National Science Foundation. Present staff of the ASU herbarium includes Pinkava, retired Director (Biosytematics of Opuntioideae, Southwest floristics), and Landrum, Curator (Systematics of South American Myrtinae, Southwest floristics).

The ASU herbarium serves as repository of specimens worldwide and particularly from the southwestern United States. Emphasis is on producing a Manual of the Vascular Plants of Arizona, portions of which are being published as they become available in the Journal of the Arizona-Nevada Academy of Science. From 1992 to 2001, treatments of 68 families or portions thereof, were prepared by experts, including ASU staff and students (Mason et al. 1992). These publications make the treatments available for researchers, pending the publication of the completed Flora.

TYPE COLLECTIONS

The ASU vascular plant herbarium houses 735 type specimens including 26 holotypes, 338 isotypes, 3 isolectotypes, 13 isosyntypes, 4 isoneotypes, 233 paratypes, and 118 isoparatypes. The following list documents 384 vascular plant type specimens in the Arizona State University Herbarium (ASU) and includes verified holotypes, lectotypes, syntypes and neotypes and their duplicates. Regionally, the majority of the specimens are from the United States (186) and Mexico (178), while 13 are from South America and 7 from the Old World. Taxonomically the majority of type specimens belong to the Asteraceae (84), followed by Polygonaceae (56), Cactaceae (34 of which 15 are holotypes), Scrophulariaceae (27), Fabaceae (16), Agavaceae (13), and Acanthaceae (10). Historically prominent are 60 isotypes collected by C.G. Pringle, a prominent early plant collector in Mexico from 1885 to 1909 (Davis 1936). Numerous type collections were also made by James R. Reveal, Noel H. Holmgren, Howard S. Gentry, and George B. Hinton (Ickert-Bond and Pinkava 2000). The list of type specimens is arranged phylogenetically by division and then alphabetically by family, genus, species, and infraspecific categories. For each basionym typified by an ASU specimen accompanied by a copy of the original publication, we here list collector(s) and collection number, locality information (restricted to country and state or equivalent demographic unit), and date of collection.

In the 1960s the irreplaceable type specimens were filed among the general collection and were thus subject to much unnecessary handling. The specimens are now housed in two separate herbarium cabinets. The use of these specimens is limited to only trained taxonomists, who appreciate the value of these specimens in accordance with the recommendations set forth by the International Code of Botanical Nomenclature (Greuter et al. 2000), "Recommendation 7A . It is strongly recommended that the material on which the name of a taxon is based, especially the holotype, be deposited in a public herbarium or other public collection with a policy of giving bona fide botanists open access to deposited material, and that it be scrupulously conserved ". The types are specially curated in acid-free genus folders (e.g., palm folders) and additionally each specimen is protected by a species folder, all from Herbarium Supply Company, California. Copies of original descriptions are accompanying the type specimens. They are fastened on a herbarium sheet with archival clear-hold press-on mounting corners from Light Impressions, New York. Specimens were checked against the original publication and the type status was verified. Cross-referencing dummy sheets are placed in the main herbarium.

Some specimens that are cited in the protologue are missing from the ASU type collection; they are out on loan or were never received. This type list is the first account of the history of the ASU herbarium and the first list of its type specimens. We plan to update this list in the future with a supplement of all new types since this publication. We feel that the printed version of the type list allows for convenient checking of type specimens. A searchable list of all type specimens including paratypes, isotypes and clonotypes as well as some images of types is planned for the future, and will be made available at a later point through the web page of the ASU herbarium (URL: http://lsvl.la.asu.edu/herbarium/). The construction of such a web page will take some time and this paper version will serve in the interim.

VASCULAR PLANT TYPES IN THE ARIZONA STATE UNIVERSITY HERBARIUM

POLYPODIOPHYTA

ASPLENIACEAE

Asplenium montanum C.L. Willdenow forma **shawangunkense** T. Reeves, Amer. Fern J. 64:105. 1974. USA. New York: 18 Oct 1973, *T. Reeves R500* (HOLOTYPE). ASU 67981.

DRYOPTERIDACEAE

Cystopteris utahensis M.D. Windham & C.H. Haufler, Amer. Fern J. 81: 13. 1991. USA. Utah: 2 Jul 1990, *M.D. Windham 90-282 with Windham* (ISOTYPE). ASU not found.

Woodsia cochisensis M.D. Windham, Contr. Univ. Michigan Herb. 19:54. 1993. USA. Arizona: 31 Aug 1985, *M.D. Windham 781 with G. Yatskievych* (ISOTYPE). ASU not found.

Woodsia neomexicana M.D. Windham, Contr. Univ. Michigan Herb. 19:52. 1993. USA. New Mexico: 23 Aug 1990, *M.D. Windham 90-365 with Rabe* (ISOTYPE). ASU not found.

POLYPODIACEAE

Goniophlebium pringlei W.R. Maxon, Proc. U.S. Natl. Mus. 27: 953. 1904. Mexico. Veracruz: 30 Nov 1903, *C.G. Pringle 11855* (ISOTYPE). ASU 60335.

PTERIDACEAE

Astrolepis cochisensis (L.N. Goodding) D.M. Benham subsp. **arizonica** D.M. Benham, Amer. Fern J. 82:60. 1992. USA. Arizona: 5 Sep 1989, *D.M. Benham 1312* (ISOTYPE). ASU 158448.

Cheilanthes yavapensis T. Reeves ex M.D. Windham, Contr. Univ. Michigan Herb. 19:33. 1993. USA. Arizona: 18 Nov 1980, *M.D. Windham 202* (ISOTYPE). ASU not found.

Pellaea lyngholmii M.D. Windham, Contr. Univ. Michigan Herb. 19:40. 1993. USA. Arizona: 23 Sep 1990, *M.D. Windham 90-420 with Lyngholm* (ISOTYPE). ASU not found.

Pellaea ternifolia (A.J. Cavanilles) J.H.F. Link subsp. **arizonica** M.D. Windham, Contr. Univ. Michigan Herb. 19:47. 1993. USA. Arizona: 18 Mar 1981, *M.D. Windham 246 C* (ISOTYPE). ASU 115789.

MAGNOLIOPHYTINA-DICOTS

ACANTHACEAE

Dyschoriste novogaliciana T.F. Daniel, Polibotanica 2:1. 1996. Mexico. Nayarit: 16 Mar 1982, *T.F. Daniel 2051* (ISOTYPE). ASU 208318.

Justicia masiaca T.F. Daniel, Brittonia 47:408. 1995. Mexico. Sonora: 14 Jan 1983, *T.F. Daniel 2456* (ISOTYPE). ASU 220596.

Mirandea andradenia T.F. Daniel, Southw. Naturalist 31:170. 1986. Mexico. Taumalipas: 12 Aug 1984, *T.F. Daniel 3693 with M. Baker* (ISOTYPE). ASU 142778.

Mirandea huastecensis T.F. Daniel, Syst. Bot. 3:428. 1979. Mexico. Nuevo Leon: 10 Jul 1978, *T.F. Daniel 252* (ISOTYPE). ASU 110135.

Mirandea sylvatica S. Acosta, Phytologia 57:249. 1985. Mexico. Tabasco: 26 Apr 1983, *F. Ventura 20168* (ISOTYPE). ASU 147810.

Tetramerium butterwickianum T.F. Daniel, Syst. Bot. Monogr. 12:89. 1986. Mexico. Michoacan: 27 Nov 1983, *T.F. Daniel 3267 with M. Butterwick* (ISOTYPE). ASU 141588.

Tetramerium emilyanum T.F. Daniel, Syst. Bot. Monogr. 12:74. 1986. Mexico. Michoacan: 26 Nov 1983, *T.F. Daniel 3258 with M. Butterwick* (ISOTYPE). ASU 141733.

Tetramerium mcvaughii T.F. Daniel, Syst. Bot. Monogr. 12:92. 1986. Mexico. Michoacan: 26 Nov 1983, *T.F. Daniel 3247 with M. Butterwick* (ISOTYPE). ASU 141590.

Tetramerium rzedowskii T.F. Daniel, Syst. Bot. Monogr. 12:104. 1986. Mexico. Michoacan: 24 Mar 1982, *T.F. Daniel 2145* (ISOTYPE). ASU 141586.

Tetramerium sagasteguianum T.F. Daniel, Syst. Bot. Monogr. 12:110. 1986. Peru. Cajamarca: 30 Aug 1985, *T.F. Daniel 4319 with M. Butterwick* (ISOTYPE). ASU 142681.

APIACEAE

Angelica callii M.L. Mathias & L.C. Constance, Madroño 24:78. 1977. USA. California: 18 Oct 1965, *T. & V. Call 2459* (ISOTYPE). ASU 108729.

Lomatium junceum R. Barneby & N.H. Holmgren, Brittonia 31:96. 1979. USA. Utah:

27 May 1978, *N.H. Holmgren et al. 8778* (ISOTYPE). ASU 113743.

Prionosciadum megacarpum J.M. Coulter & J.N. Rose, Contr. U.S. Natl. Herb. 3:308. 1895. Mexico. Oaxaca: 10 Oct 1894, *C.G. Pringle 4688* (ISOTYPE). ASU 50595.

Sanicula moranii P. Vargas, L.C. Constance & B.G. Baldwin, Brittonia 50:122. 1998. Mexico. Baja California: 19 May 1973, *R. Moran 20929* (ISOTYPE). ASU 170073.

AQUIFOLIACEAE

Ilex pringlei P.C. Standley, Contr. U.S. Natl. Herb. 23:675. 1923. Mexico. Puebla: 25 Apr 1904, *C.G. Pringle 10003* (ISOTYPE). ASU 50602.

ASCLEPIADACEAE

Asclepias welshii N.H. Holmgren & P.K. Holmgren, Brittonia 31:110. 1979. USA. Utah: 20 Jun 1978, *N.H. Holmgren 9009 with P. Holmgren* (ISOTYPE). ASU 113750.

Marsdenia tressensii S.A. Caceres & G.N. Morillo, Bonplandia (Corrientes) 7:34. 1993. Argentina.: 21 Oct 1988, *S.A. Caceres 426* (ISOTYPE). ASU 191309.

ASTERACEAE

Achaetogeron versicolor J.M. Greenman, Proc. Amer. Acad. Arts 41:255. 1905. Mexico. Hidalgo: 7 Aug 1904, *C.G. Pringle 8849* (ISOTYPE). ASU 50584.

Acourtia fragrans J. Rzedowski, Bol. Soc. Bot. Mexico 45:102. 1983. Mexico. Puebla: 6 Jan 1981, *J. Rzedowski 37174* (ISOTYPE). ASU 184636.

Acourtia hintoniorum B.L. Turner, Phytologia 75:404. 1993. Mexico. Nuevo Leon: 13 Nov 1993, *G.B. Hinton 23934 et al.* (ISOTYPE). ASU 202296.

Acourtia huajuapana B.L. Turner var. **actinomorpha** J. Rzedowski, Bol. Soc. Bot. Mex. 45:104. 1983. Mexico. Guerrero: 23 Dec 1980, *J. Rzedowski 37160* (ISOTYPE). ASU 184565.

Alomia stenolepis S.F. Blake, J. Wash. Acad. Sci. 27:375. 1937. Mexico. Sonora: 7 Mar 1935, *H.S. Gentry 1434* (ISOTYPE). ASU 89075.

Barroetea subuligera A. Gray var. **latisquama** J.M. Greenman, Proc. Amer. Acad. Arts 40:35. 1904. Mexico. Jalisco: 27 Oct 1903, *C.G. Pringle 8773* (ISOTYPE). ASU 17584.

Bidens rosea Schz. Bip. var. **aequisquamosa** M.L. Fernald, Proc. Amer. Acad. Arts 43:68. 1907. Mexico. Michoacan: 1 Nov 1905, *C.G. Pringle 10109* (ISOTYPE). ASU 50605.

Carminatia alvarezii J. Rzedowski & G. Calderon, Anales Esc. Nac. Ci. Biol. 31:9. 1987. Mexico. Oaxaca: 25 Oct 1980, *J. Rzedowski 37075* (ISOTYPE). ASU 147806.

Carminatia anomala B.L. Turner, Pl. Syst. Evol. 160:173. 1988. Mexico. Puebla: 6 Oct 1984, *Sundberg 3032 with M. Levin* (ISOTYPE). ASU 141518.

Chrysactinia lehtoae D. Keil, Madroño 23:374. 1976. Mexico. Sinaloa: 25 Nov 1975, *E. Lehto L19551 with T.H. Nash and J.J. Landye* (HOLOTYPE). ASU 80003.

Chrysanthellum keilii B.L. Turner, Phytologia 64:437. 1988. Mexico. Michoacan: 29 Aug 1981, *D. Keil 15222 with M.L. Lane* (ISOTYPES). ASU 123621, 176521.

Chrysothamnus nauseosus (P.S. Pallas) Britt. subsp. **iridis** L.C. Anderson, Great Basin Naturalist: 41:311. 1981. USA. Utah: 29 Sep 1979, *S.L. Welsh 19258* (ISOTYPE). ASU 108397.

Cirsium clokeyi S.F. Blake, Proc. Biol. Soc. Wash. 51:8. 1938. USA. Nevada: 6 Aug 1937, *I.W. Clokey 7456* (ISOTYPE). ASU 66713.

Cymophora pringlei B.L. Robinson, Proc. Amer. Acad. Arts 43:39. 1907. Mexico. Guerrero: 22 Sep 1905, *C.G. Pringle 10068* (ISOTYPE). ASU 18329.

Erigeron acomanus R. Spellenberg & P. Knight, Madroño 36:115. 1989. USA. New Mexico: 14 Jul 1983, *P. Knight 2689* (ISOTYPE). ASU 176290.

Erigeron arisolius G.L. Nesom, Phytologia 69:243. 1990. USA. Arizona: 28 Aug 1981, *G.L. Nesom 4521* (ISOTYPE). ASU 174639.

Erigeron basaseachensis G.L. Nesom, Phytologia 66:426. 1989. Mexico. Chihuahua: 18 Aug 1984, *G.L. Nesom 5089 with P. Lewis* (ISOTYPE). ASU 160286.

Erigeron bistiensis G.L. Nesom & B. Hevron, Madroño 42:12. 1995. USA. New Mexico: 3 Jun 1993, *B. Hevron 1975 with J. Merz* (ISOTYPE). ASU 191569.

Erigeron byei S. Sundberg & G.L. Nesom, Phytologia 69:278. 1990. Mexico. Chihuahua: 19 May 1985, *R. Scott 471 with T. Ayers, M. Lavin & A. Whittemore* (ISOTYPE). ASU 202297.

Erigeron chiangii G.L. Nesom var. **lamprocaulis** G.L. Nesom, Phytologia 73:119. 1992. Mexico. Coahuila: 3 Jun 1992, *G. Nesom 7408 with M. Mayfield* (ISOTYPE). ASU 190098.

Erigeron coroniglandifer G.L. Nesom, Phytologia 66:432. 1989. Mexico. Chihuahua: 28 Aug 1983, *G.L. Nesom 4964* (ISOTYPE). ASU 160287.

Erigeron cuatrocienegensis G.L. Nesom, Madroño 28:143. 1981. Mexico. Coahuila: 12 Jun 1968, *D.J. Pinkava P5511 with E. Lehto, D.J. Keil* (HOLOTYPE). ASU 80536.

Erigeron eruptens G.L. Nesom, Phytologia 66:438. 1989. Mexico. Chihuahua: 27 Apr 1985, *R. Spellenberg 8070 et al.* (ISOTYPE). ASU 143251.

Erigeron rybius G.L. Nesom, Syst. Bot. 7:457. 1982. USA. New Mexico: 30 Aug 1981, *G.L. Nesom 4535* (ISOTYPE). ASU 124943.

Erigeron sceptrifer G.L. Nesom, Phytologia 69:248. 1990. Mexico. Chihuahua: 23 Aug 1981, *G.L. Nesom 4477* (ISOTYPE). ASU 174638.

Erigeron scopulinus G.L. Nesom & V.D. Roth, J. Arizona-Nevada Acad. Sci. 16:39. 1981. USA. Arizona: 9 Jun 1976, *V.D. Roth s.n.* (ISOTYPE). ASU 140787.

Eupatorium saltillense B.L. Robinson, Proc. Amer. Acad. Arts 43:31. 1907. Mexico. Coahuila: 5 Oct 1905, *C.G. Pringle 10080* (ISOTYPE). ASU 18777.

Flaveria mcdougallii M.E. Theroux, D.J. Pinkava & D. Keil, Madroño 24:13. 1977. USA. Arizona: 27 Jan 1976, *M.E. Theroux 1675* (ISOTYPE). ASU 84121.

Gaillardia powellii B.L. Turner, Southw. Naturalist 17:183. 1972. Mexico. Coahuila: 11 Apr 1970, *B.L. Turner 6023* (ISOTYPE). ASU 130037.

Grindelia fraxino-pratensis J.L. Reveal & J. Beatley, Bull. Torrey Bot. Club 98:334. 1971. USA. Nevada: 21 Aug 1968, *J.L. Reveal 1887 with N.H. Holmgren* (ISOTYPE). ASU 50079.

Grindelia hintoniorum G.L. Nesom, Phytologia: 68:328. 1990. Mexico. Nuevo Leon: 15 May 1984, *G.B. Hinton 18666 et al.* (ISOTYPE). ASU 147845.

Gutierrezia ionensis C.L. Lunell, Amer. Midl. Naturalist 2:194. 1912. Neotypified by M.A. Lane, Syst. Bot. 10:25. 1985. USA. Oregon: 27 Aug 1983, *M.A. Lane 3054* (ISONEOTYPE). ASU 130892.

Halimium exaltatum J.N. Rose & P.C. Standley, Contr. U.S. Natl. Herb. 23:833. 1923. Mexico. Michoacan: 27 Oct 1907, *C.G. Pringle 10409* (SOTYPE). ASU 16235.

Haplopappus enormidens R. Moran, Phytologia 34:371. 1976. Mexico. Baja California: 19 Jul 1975, *R. Moran 22602* (ISOTYPE). ASU 85778.

Haplopappus juarezensis R. Moran, Trans. San Diego Soc. Naturalist Hist. 15:154. 1969. Mexico. Baja California: 17 Sep 1966, *R. Moran 13556* (ISOTYPE). ASU 200010.

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Book Notices

Bernard K. Maloney. (editor). 1998. **Human Activities and the Tropical Rainforest: Past, Present, and Possible Future.** (ISBN 0-7923-4858-3, hbk.). Kluwer Academic Publishers, P.O. Box 17, 3300 AA Dordecht, The Netherlands. (Orders: Kluwer Academic Publishers Group, 101 Philip Drive, Norwell, MA 02061, U.S.A. US$142.00, hbk., 206 pp., figures, 6 1/2" × 9 1/2".

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2) Landscape sensitivity in the Humid Tropics: A geomorphological appraisal. Michael F. Thomas
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10) Conclusion. Bernard K. Maloney

This is an important contribution to the scientific understanding of the human impact on Neotropical Rainforests. This text would work well in ethnobiology and conservation biology graduate courses. It encompasses a broad geographic scheme and takes on the subject matter with an interdisciplinary approach. Future editions would be improved by including a subject index. I would recommend this book to researchers interested in the human aspect to biodiversity and ecosystem conservation. —*Kevin D. Janni, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A., kjanni@brit.org.*

S.H.J.V. Rapanarivo, J.J. Lavranos, A.J.M. Leeuwenberg, and W. Röösli. 1999. **Pachypodium (Apocynaceae). Taxonomy, Ecology and Cultivation.** (ISBN 90-5410-485-6, hbk.). A.A. Balkema Publishers, Old Post Road, Brookfield, VT 05036-9704, www.balkema.nl, balkema@balkema.nl, 802-276-3837 fax, 31-10-4135947). $48.00, 128 pp, 80 color photos.

This taxonomic monographic revision of *Pachypodium* (Apocynaceae) is based on studies of living plants both in the wild and in cultivation. The genus is comprised of 23 species, eight of which are endemic to Madagascar. Other species occur in continental Africa. There is the generic description followed by a key to species is followed by a treatment of species. Each species is treated systematically and includes a line drawing, color photo(s), and a distribution map. Some of the line drawings are a little on the rough side, however, the 80 color photos (plates) are very nice. I find one new combination presented, *Pachyupodium* ***gracilius*** (H. Perrier) Rapanarivo, comb. nov. The book is rounded out with a chapter on *Pachypodium* in cultivation followed by an index of exsiccatae, a nice index. —*Barney Lipscomb, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

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PLANT SPECIES-AREA RELATIONSHIPS IN TEN NORTH CENTRAL TEXAS PROTECTED NATURAL AREAS

Monica Granados

Department of Biology
Texas Wesleyan University
1201 Wesleyan
Fort Worth, TX 76105-1536, U.S.A

Robert J. O'Kennon

[1]Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, TX 76102-4060, U.S.A,
bokennon@brig.org

Bruce F. Benz[1]

Department of Biology
Texas Wesleyan University
1201 Wesleyan
Fort Worth, TX 76105-1536, U.S.A
benzb@txwes.edu

ABSTRACT

The study of species-area relationships in protected natural areas (PNAs) is an effective tool for designing nature reserves and managing biological diversity. Ten North Central Texas PNAs were studied to understand how plant species richness is related to PNA size. The species-area model was applied to total plant species, native plant species, selected native speciose plant families and invasive plant species. Results indicate that area is a significant predictor of species richness ($r^2 = \geq 0.60$) for both total species and native species in North Central Texas PNAs. Habitat diversity as measured by topographic relief and topographic abruptness is also shown to be a significant predictor of plant species richness in North Central Texas PNAs. Introduced species richness could not be predicted from area alone but was explained by perimeter and perimeter/area ratio and one proxy measure of habitat diversity. The estimates of z values range from 0.15 to 0.30, while c ranges from 0.60 to 1.42 for species-area relationships, both of which fall within the range of values estimated by previous research. Such estimates allowed us to evaluate effective management schemes for North Central Texas PNAs plant diversity. The results of this research permit us to examine the invasion of exotic flora in Texas PNAs and to predict how such invasions will reduce native species richness if conservation management practices are not implemented.

RESUMEN

El estudio de las relaciones entre el área y el número de especies en áreas naturales protegidas es una herramienta efectiva para el diseño de reservas y el manejo de la diversidad biológica. Diez áreas naturales protegidas del norte del estado de Tejas fueron estudiadas para entender como la riqueza de especies vegetales está relacionada con el tamaño del área. El modelo especies-área fue aplicado al número total de especies vegetales, las especies nativas, ciertas familias de plantas con muchas especies, y especies exóticas invasoras. Los resultados indican que el área es un predictor significativo de la riqueza de especies ($r^2 \geq 0.60$) para el número total de especies y el número de especies nativas dentro de estas áreas naturales protegidas. La diversidad del hábitat que se midió por medio del total de relieve topográfico y lo accidentado de la topografía también es un predictor significativo de la riqueza vegetal en estas áreas. El número de especies exóticas no se pudo predecir por el área únicamente, sino que se pudo por medio del perímetro del área y la proporción perímetro por área, y uno de los dos estimadores topográficos de diversidad de hábitat. Las estimaciones del valor de z del

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modelo de MacArthur y Wilson son de 0.15 a 0.30, mientras que la *c* varía desde 0.60 a 1.42 para las relaciones de especies-área. Tales estimaciones nos permiten evaluar los esquemas de manejo de la diversidad vegetal de las áreas naturales protegidas del norte de Texas. Los resultados de esta investigación nos permiten examinar las razones por las cuales las especies exóticas invasoras han colonizado las áreas naturales protegidas y predecir como tales invasiones reducirán la riqueza de especies nativas si no se implementan pautas de manejo para su conservación.

INTRODUCTION

The conservation of biodiversity is a priority issue for ecologists and conservationists worldwide (Myers & Knoll 2001; Novacek & Cleland 2001). As a result, protected natural areas (PNAs) have been created in order to protect, manage and monitor native and endemic biota from habitat destruction and the invasion of introduced and transient species. Such invasions have lead conservationists and ecologists to engage in management programs to preserve natural habitats and prevent extinction. The theory of island biogeography (MacArthur & Wilson 1967) has been used on many occasions in order to measure species richness as well as recommending practices for ecological restoration (Hanski and Matts 1997; He and Legendre 1996; Lawrey 1991; Lomolino et al. 1989). Here we contribute to the existing body of island biogeographic research by examining the floristic richness of ten protected natural areas in North Central Texas.

Island biogeography attempts to document the equilibrium existing between colonization and extinction rates of species on islands. The well-established theory developed by MacArthur and Wilson (1967) uses this equilibrium theory as a focal point for understanding biotic richness on islands and protected areas surrounded by urban, agricultural and forestry developments. This equilibrium is based upon empirical evidence that demonstrates a positive correlation between island size and species richness (Meffe et al. 1997:132). Island biogeography theory explains island biological richness based on the degree of isolation usually measured as the distance from the nearest source habitat. Other factors that influence species richness on islands include colonization rates based upon distance from a source habitat and species turnover based on habitat availability.

Variation in species richness is due in part to the rate at which species can successfully colonize PNAs. Colonization rates can differ and usually depend on the vagility of species able to occupy an area and the distance between island and source habitat. Short-lived species usually colonize areas that have been cleared or severely disturbed. Many PNAs experience high colonization rates because they are adjacent to disturbed source habitats. Colonists of protected areas are commonly exotic species that are managed or introduced into adjacent areas subject to forest exploitation or agriculture (Alverson et al. 1994:83).

Species turnover refers to the balance of immigration and extinction of species continuously enlarged by the arrival of new species from mainland sources and their continuous reduction by extinction through competition for space (Brown & Lomolino 1989). In PNAs and on islands close to continental source habitats, species turnover is greater due to higher colonization rates. Oceanic islands that are the same size but more isolated support lower species richness because of lower species turnover due to lower colonization rates.

The use of island biogeography in PNAs has been a subject of considerable interest for several reasons. The first is that many protected natural areas are effectively islands of a natural habitat in a sea of human dominated ecosystems. Increasingly, PNAs are located in areas where transient species have easy access for invasion. Secondly, these islands of natural habitat usually represent small isolated areas that vary in shape and size which are important criteria particularly relevant for designing and establishing reserves. Finally, the less isolated or the closer an island is to a mainland or source habitat, the more species that island is destined to harbor. Natural dispersal explains the diverse biota of oceanic islands while anthropogenic encouraged dispersal explains the significant encroachment on protected areas by invasive species leading to the loss of native species and the increasing numbers of naturalized exotic species in such areas. Island biogeography has also been used to determine the minimum effective size required for reserves, to characterize community structure, to manage species richness, to measure the effect of disturbance on communities, to estimate extinction rates and for defining conservation biology.

MacArthur and Wilson's (1967:16) initial formulation of the theory of island biogeography ($S=cA^z$, where S = species number, A= area and c and z are constants) indicated that the value of z usually lies between 0.2 and 0.35. Since then, studies have shown that areas located on continents or large islands have z values that range from 0.17 to 0.57. Studies done by Chown et al. (1998:564) empirically derived z values can range from 0.1 to 0.45 for species on oceanic islands. Crawley and Harral (2001) derived z values ranging from 0.18 and 0.57 for spatial scales ranging from 0.01 m^2 to 110 ha for species in southern England. We add empirical support of estimates of z that are in line with those obtained from other continental areas.

Simberloff (1988) and others have argued that area is an effective predictor of species' richness because it is a proxy for habitat diversity. As area increases, so too does habitat diversity. Likewise, other researchers have demonstrated that island elevation and island complexity are significant predictors of species' richness in addition to area . Habitats are an important component of protected areas because they represent the diverse combinations of resources and environmental conditions that plant species can inhabit. The number of differing habitats in a park or reserve can vary tremendously and can result in greater species' number per area. Examples of this have been studied by Williams (1943) who showed that as area increases, so does the diversity of physical habitats. Simberloff (1988) also pointed out that the majority of the species-area relationships documented are in fact accounted for by the fact that larger sites have more species not only because the area is greater but because larger sites have more habitats than smaller sites and that habitat diversity by itself can explain species richness better than area alone. The results of these studies show that habitat diversity is an important component of area that determines species richness so we have made the effort to estimate habitat diversity in North Central Texas protected areas as well.

Many PNAs have lost habitat diversity due to fragmentation and homogenization. Fragmentation is generally accounted for by human activities that disturb or modify natural habitats resulting in the loss of native biota. Invasion of exotic species through habitat disturbance or modification tends to exacerbate the effects on native biota causing further loss of native species. This encroachment on natural landscapes is promoted by agricultural and forestry practices as well as urbanism. The result of such invasions leave PNAs progressively more disturbed as exotic species become more numerous and abundant and losses of native biota increase (Mooney & Cleland 2001).

Edge effects are particularly important in the loss of native species in PNAs. The outer boundary of any habitat island is subject to external factors that modify natural conditions to create novel habitats that can be invaded by species with general habitat requirements (Meffe et al. 1997:294). Edge effects can be especially detrimental because these effects cause PNAs below a certain size or with a significant edge to area relation to lack sufficient natural habitat core area that many native species might need in order to survive. As the natural core area decreases in size, native species are lost and replaced by invasive species that dominate the edges and colonize the core. Invasive species' habitat requirements are often more generalized which allow them to readily invade the protected area's edge. A preponderance of evidence suggests that edge effects play a critical role in PNA management. We examine edge effects by examining PNA perimeter as a predictor of PNA floristic composition.

METHODS

The ten protected natural areas studied are located within the Cross Timbers and Prairies and Blackland Prairies regions in north Central Texas (Fig. 1). The Blackland Prairies consist of about 11,500,000 acres with dark-colored calcareous clays interspersed with gray acid sandy loams (Correll & Johnston 1970; Diggs et al. 1999). The flora typically consists of *Bouteloua curtipendula*, *Bouteloua hirsuta*, *Sporobolus asper*, *Buchloe dactyloides*, *Bouteloua rigidiseta*, *Ulmus crassifolia*, and *Maclura pomifera* and is considered to be true prairie. According to Diggs et al. (1999) the Cross Timbers and Prairies vegetation types encompass roughly 6,879,662 hectares (17,000,000 acres), with 404,686 of those hectares (1,000,000 acres) designated as the East Cross Timbers, 1,214,058 hectares (3,000,000 acres) designated as the West Cross Timbers and 2,630,459 hect-

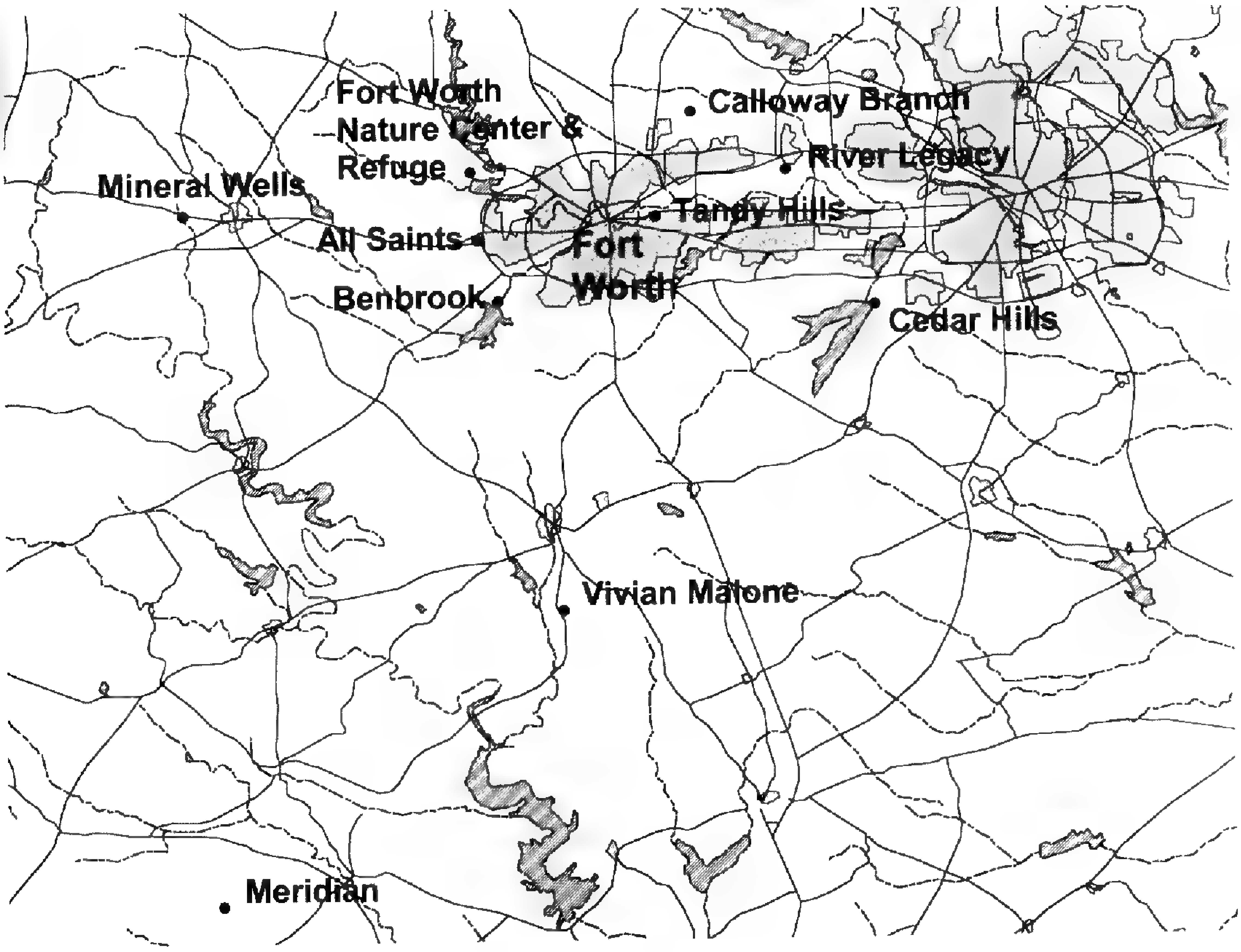

Fig. 1. Location of 10 protected natural areas in north central Texas that are the subject of the present study. Scale is approximately 1:400,000; north is toward the top of the page; gray areas are urban development, shaded areas a reservoirs, gray lines are highways, dash-dotted lines are streams.

ares (6,500,000 acres) as Grand Prairie. These areas range from savanna to dense brush and which consist of Oaks and other woodland vegetation with neutral to slightly acidic clay soils over limestone. The flora consists of *Elymus canadensis*, *Erioneuron pilosum*, and other plants found in the Poaceae family (see Diggs et al. 1999).

Existing plant lists from each of ten PNAs in North Central Texas were analyzed. Six variables were tabulated from each list: total species number, native species number and introduced species number, as well as the number of native legumes, composites and grasses. The number of species in each of these three families was incorporated in our analysis because they are the most species-rich families of the North Central Texas flora and therefore might be significant predictors of habitat loss (Leach et al. 1991:34). These variables were considered the dependent variables in the regression analyses.

Native plant species are those that have been present in a particular area before Columbus (Diggs et al. 1999:11). All other plants that have arrived since then and which are reproducing freely in nature are considered naturalized and were included in the total species count. Introduced species were defined as any species that is not of North American origin and has been introduced since Columbus (Diggs et al. 1999:12). Introduced species recorded in these PNAs include exotic ornamentals (e.g. *Iris* spp., *Narcissus* spp., *Nandina domestica, Photinia serratifolia, Ligustrum* spp. and *Wisteria* spp.) that have been shown to be invasive and capable of becoming serious pests (Diggs et al. 1999:60). However, horticultural species found around buildings or foundations were not included in the introduced species' counts.

Topographic maps were used to locate and examine habitat diversity in each PNA. The maps used are scale 1:24,000 USGS quads for Euless, Hurst, west Cleburne, Covington, Blum, Meridian, Mineral Wells, Benbrook, Haltom City, Lake Worth, Arlington, Duncanville, Cedar Hill, and Britton, Texas. Habitat diversity was estimated using two proxy measures: overall topographic relief and the maximum topographic abruptness over 0.75 mile transects situated in order to maximize the number of contour intervals encountered. The perimeter of each PNA was measured on the same topographic maps. The size of each PNA was based upon data provided by both private and/or public landowners and land-managers.

The model was estimated using linear regression after log transformation of dependent and independent variables. Statistical analysis was accomplished using SPSS and Sigma Plot.

RESULTS

The PNAs range in area from 20.2 hectares (50 acres) to 1416 hectares (3500 acres). Their perimeters range from 1609 m (< 1 mile) to more than 33,796 m (>21 miles). The number of contour lines intersecting 1207 m (0.75 mile) transects ranged from 1 to 22 for topographic abruptness, and topographic relief ranged from 15.25 to 61 m (50–200 ft) (Table 1).

The Asteraceae, Fabaceae and Poaceae were the most speciose families in all ten PNAs. Total species richness ranged from 160 species to 592. Native species richness ranged from 144 to 517; introduced species richness ranged from 15 to 75. Asteraceae species richness ranged from 31 to 76, Fabaceae ranged fromfour to 46 and Poaceae ranged from 15 to 59 (Table 2, Fig. 2). Total species richness increases with PNA size.

Area is a significant predictor of total species richness in North Central Texas PNAs both for total and native species richness as well as for species number in the Fabaceae, Poaceae and Asteraceae ($r^2 \geq 0.4$) (Table 3). Total species richness could be explained 52 percent of the time by area. The estimate of z for total species was 0.18 and c was estimated as 2.03. Tandy Prairie, Vivian Malone, and the Fort Worth Nature Center have higher than average species richness, while other PNAs such as All Saints and Benbrook exhibit low species richness (Fig. 2).

TABLE 1. Physical and geographic characteristics of ten protected natural areas in north central Texas.

PNA*	Area in hectares (acres) (AREA)	Perimeter in meters (miles) (PERI)	Elevation in m asl (ft asl)	Topographic Relief (REL)	Abruptness (ABR)
All Saints	24.3 (60)	1287 (0.8)	229 (750)	20	1
Benbrook	20.2 (50)	1287 (0.8)	212 (694)	48	2
Calloway Branch	40.5 (100)	3058 (1.9)	189 (620)	40	3
Cedar Hills State Park	739 (1826)	23,818 (14.8)	244 (800)	130	14
FW Nature Center	1416.4 (3500)	34,601 (21.5)	181 (594)	101	10
Lake Mineral Wells	1329 (3283)	18,829 (11.7)	259 (850)	160	12
Meridian	204 (505)	6598 (4.1)	317 (1040)	79	5
River Legacy	393 (972)	11,265 (7.0)	183 (600)	73	8
Tandy Hills	64.7 (160)	5150 (3.2)	177 (580)	77	13
Vivian Malone	58.7 (145)	2253 (1.4)	229 (750)	72	9

* Variable acronyms in parentheses.

Native species number (Table 3) is explained by area 54 percent of the time. The estimate of *z* based on native plant species richness is 0.17, while *c* is 1.99. Both Tandy Prairie and Vivian Malone display high species richness in comparison to other areas, while Benbrook and All Saints display low native species richness.

Variation in species' number for grasses was explained by area 62 percent of the time. *c* is 1.34 and *z* is 0.14. The relationship between grass species richness and area indicates that Tandy Prairie has one of the highest numbers of grass species, followed by Calloway Branch, Vivian Malone and Meridian. Benbrook, All Saints and River Legacy have relatively few grass species by comparison.

Asteraceae species' richness could be explained by area 50 percent of the time. The estimate of *c* is 1.30, while *z* is 0.15. The Asteraceae are most abundant in Tandy, Vivian Malone, the Fort Worth Nature Center and Cedar Hills State Park.

Variation in Fabaceae species' richness was explained by area only 46 percent of the time. The estimate of *c* is 0.60 and *z* is 0.30. PNAs such as Tandy Hills, Vivian Malone, Calloway Branch and Benbrook have a greater than an average number of legume species.

Area was not a significant predictor of introduced species' richness ($F = 3.5$, $p< 0.1$, $r^2 = 0.30$) (Table 3); however, the number of introduced species could be predicted from perimeter ($F=6.4$, $p<0.04$, $r^2=0.45$). A perimeter/area ratio variable was also a significant predictor of introduced species richness ($F=8.6$, $p<0.05$, $r^2 = 0.52$). Protected natural areas that have high numbers of introduced species have a large perimeter and a high perimeter/area ratio (Figure 2). This indicates that areas possessing more edge per unit area have greater numbers of introduced

TABLE 2. Floristic characteristics of ten protected natural areas in north central Texas.

PNA*	Total Species (TSP)	Native Species (NS)	Introduced Species (IS)	Number Asteraceae (AS)	Number Fabaceae (FS)	Number Poaceae (PS)
All Saints**	160	144	16	29	4	15
Benbrook	184	169	15	31	15	16
Calloway Branch	260	230	30	42	20	28
Cedar Hills State Park	434	375	59	64	33	44
FW Nature Center	592	517	75	76	46	55
Lake Mineral Wells	392	365	27	61	46	40
Meridian	280	258	22	35	26	44
River Legacy	277	250	27	40	18	26
Tandy Hills	437	380	57	63	35	59
Vivian Malone	382	344	38	54	27	37

* Variable acronyms in parentheses. ** List of plants provided by R. Sanders (BRIT)

species. The *z* values calculated from perimeter and perimeter/area ratio range from 0.3 to 1.1 respectively. Introduced species richness is greatest in Tandy Prairie, Cedar Hills State Park, Fort Worth Nature Center, and Vivian Malone, while the other areas have a lower than average number of introduced species.

Habitat diversity as estimated by topographic abruptness and total topographic relief was a significant predictor of both total species and native species richness. A topographic profile that included the number of contour lines intersecting 0.75 mile transects explained a significant amount of the variation in total species ($F=37.8$, $p<0.001$, $r^2 = .82$) and native species' richness ($F=40.9$, $p< 0.001$; $r^2=0.84$). Overall topographic relief is also a significant predictor of total species' richness ($F=14.9$, $p<0.005$, $r^2=0.65$) and native species' richness ($F=17.4$, $p<0.003$, $r^2=0.83$). *c* ranges from 1.14 to 2.2 and *z* varies from 0.41 to 0.55.

DISCUSSION

The estimates of *c* and *z* obtained from the plant species and area of these ten protected natural areas in North Central Texas occur within the range established by previous research. MacArthur and Wilson (1967) suggest that *z* should vary between 0.2 and 0.35 on isolated islands and from 0.17 to 0.19 in continental areas. Other researchers (Chown et al. 1998) have shown that *z* ranges from 0.10 to 0.45 for the flora and fauna on oceanic islands. Estimates of *z* for North Central Texas range from 0.14 to 0.30. Estimates of *c* for these ten North Central Texas protected areas range from 0.58 to 2.03. MacArthur and Wilson showed that *c* should vary with the degree of isolation and the taxonomic groupings of organisms studied.

Area predicts native species' richness and total species' richness. Habitat

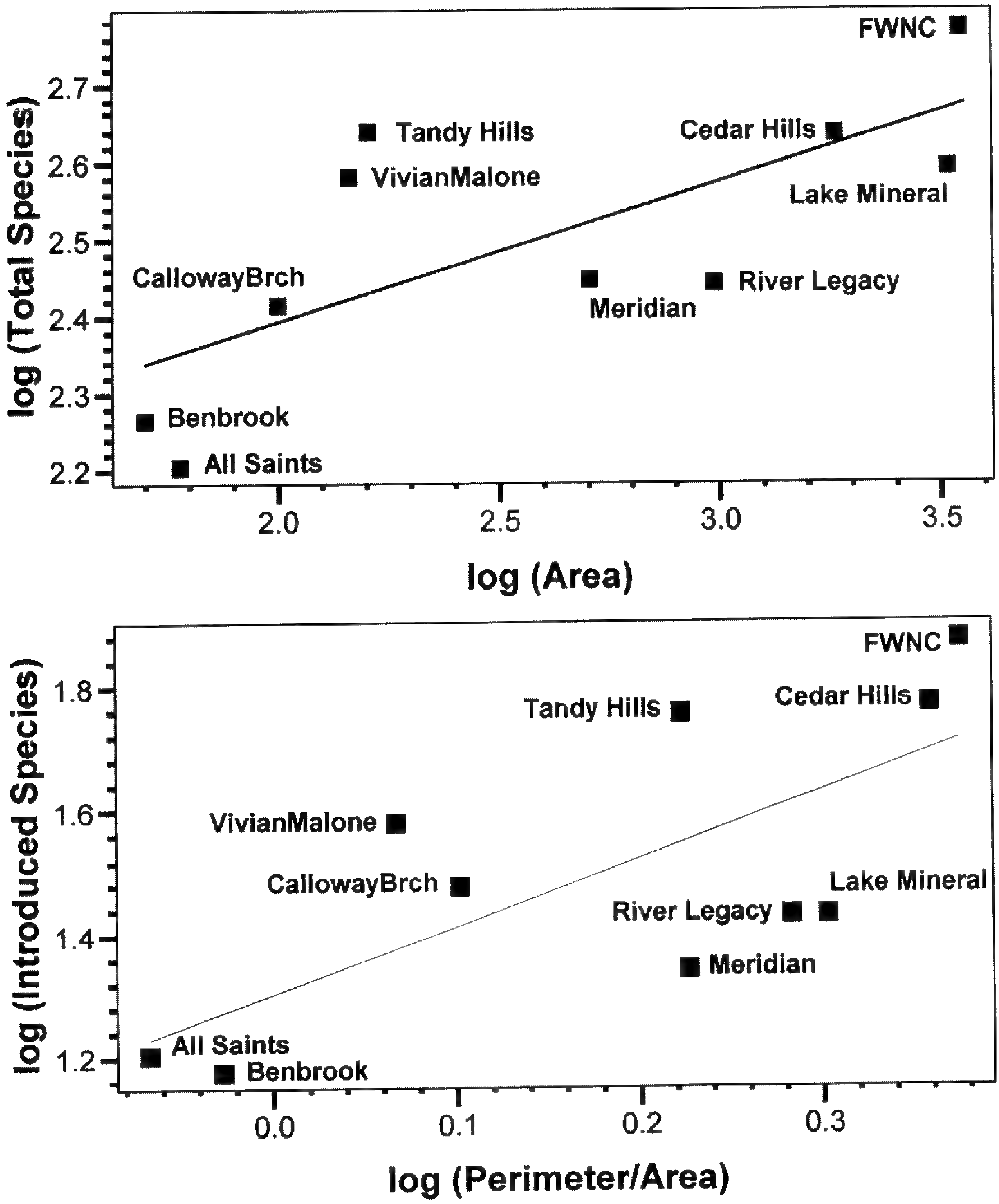

Fig. 2. Above, regression plot of total species and area. Regression parameters are provided in Table 3. Below, regression plot of introduced species and perimeter/area.

diversity as estimated by topographic abruptness and overall topographic relief explain species' richness for both native and total species. Estimates of habitat diversity appear to better explain species richness than area. Our results confirm those of other researchers who show that habitat diversity is generally a better predictor of species richness presumably because greater topographic

TABLE 3. Regression equations and test statistics for floristic richness indicators of ten protected natural areas in north central Texas. Variable acronyms can be found in Tables 1 and 2.

TSP = 2.03 + 0.18 (AREA)	$r^2 = 0.52$	F = 8.8	$p < 0.05$
NSP = 1.99 + 0.18 (AREA)	$r^2 = 0.55$	F = 9.6	$p < 0.05$
ASP = 1.31 + 0.14 (AREA)	$r^2 = 0.46$	F = 6.8	$p < 0.05$
LSP = 0.58 + 0.30 (AREA)	$r^2 = 0.46$	F = 6.9	$p < 0.05$
PSP = 1.06 + 0.18 (AREA)	$r^2 = 0.40$	F = 5.1	$p < 0.05$
ISP = 1.02 + 0.19 (AREA)	$r^2 = 0.30$	F = 3.5	ns
ISP = 1.30 + 0.30 (PER)	$r^2 = 0.45$	F = 6.4	$p < 0.05$
ISP = 1.30 + 1.09 (PER/AREA)	$r^2 = 0.52$	F = 8.6	$p < 0.05$
TSP = 2.20 + 0.42(ABR)	$r^2 = 0.82$	F = 37.8	$p < 0.001$
NSP = 2.14 + 0.41(ABR)	$r^2 = 0.84$	F = 40.9	$p < 0.001$
ISP = 1.13 + 0.48 (ABR)	$r^2 = 0.62$	F = 13.0	$p < 0.01$
TSP = 1.49 + 0.55(REL)	$r^2 = 0.65$	F = 14.9	$p < 0.005$
NSP = 1.40 + 0.55 (REL)	$r^2 = 0.83$	F = 17.4	$p < 0.05$
ISP = 0.51 + 0.54 (REL)	$r^2 = 0.35$	F = 4.2	ns

relief provides for a greater variety of habitat types offering more opportunities for a greater number of species (Simberloff 1988).

Introduced species' number could not be explained by area. Both perimeter and perimeter/area ratio explain a significant amount of the variation in introduced species across protected areas. The PNAs with a high number of introduced species have a high perimeter/area ratio suggesting some of these protected areas are fragments of natural habitat with permeable edges. High perimeter to area ratios increase PNA's permeability to invasive species. The easy invasion of introduced species, many of which are weedy intruders that are often wind dispersed and/or horticultural exotics that produce an abundance of enticing seasonal fruits that are dispersed by birds and omnivorous mammals are not only invasive but pernicious.

Our analyses demonstrate that management plans are necessary to conserve the native species still existing in the protected natural areas of north central Texas by preventing the invasion of non-native species. It is possible that for every introduced species that is successfully surviving in these PNAs, a native species might be displaced. The ongoing competition between native and introduced species will continue until these areas are managed appropriately or the amount of edge relative to area diminishes. These areas were probably once subject to periodic fires (Leach & Givnish 1991) which allowed the native biota to colonize open areas and survive more abundantly than introduced species in north central Texas. Such periodic fires have worked in the past to create and maintain suitable environment for native species and a detrimental environment for most introduced species. Most of the invasive species that are now successfully colonizing these areas are not only successful, but they are naturalizing relentlessly because periodic fires are no longer allowed.

It has long been argued that the optimal shape for a refuge should be circular and that small linear protected areas have a greater chance of becoming significantly modified by invasive species (Simberloff 1988:479) which change protected natural areas into protected anthropogenic areas. As a result, park or reserve shape, the amount of edge relative to area, and park size continue to be debated because although the model can predict species richness based upon area, it fails to incorporate park shape and edge-area considerations. In this study we have shown that many of the areas have an existing shape and size that grant increased access to invasive plant species.

Appropriate management of these PNAs in North Central Texas should take two courses of action. One focus would be to increase park size, especially for those areas that exhibit high perimeter/area ratio, including Tandy Stratford Prairie, Vivian Malone and the Fort Worth Nature Center. By doing this, edge effects will diminish by increasing the core area where many native and some endemic species still thrive. Adding area to these PNAs could potentially buffer them from edge effects (boundary permeability) and enhance their ability to maintain native species' richness. Adding area is perhaps difficult because of competition from more lucrative land-use options. An alternative to increasing their size might be to impose zoning restrictions in land developments adjacent to these PNAs. Restrictions on planting native species in urban areas found near PNAs could diminish the influx of non-native species that typically invade and colonize such areas (e.g. *Nandina* spp., *Photinia* sp., *Ligustrum* spp). Coupling restrictions on urban plantings and increasing the size of PNAs would insure that native species in PNAs would be protected better than the smaller reserves in the urban landscape because larger, protected sites are more likely to be able to accommodate disturbance than small, unprotected reserves.

In conclusion, the conservation of PNAs is an ongoing process. Disturbance takes place inside and out, succession follows and colonization by both native and introduced species will continue. One of the most critical concerns should be to determine which species will be successful in the long run. Incorporating appropriate conservation management schemes will make it possible to lower extirpation rates and insure the native species' likelihood of survival. Protected natural area size, shape, habitat diversity, edge effects, proximity to disturbed communities, and distance from source habitats all play important roles in maintaining the natural biota in PNAs. We believe that the use of the species-area model will aid in managing and controlling PNAs' species composition and give the public an idea of how invasion of introduced plant species can be harmful to such areas now and in the future.

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STATUS OF *QUERCUS* × *LEANA* AND *QUERCUS* × *RUNCINATA* (FAGACEAE) IN ILLINOIS

Gordon C. Tucker

Department of Biological Sciences
Eastern Illinois University
Charleston, IL 61920-3099, U.S.A.
cfgct@eiu.edu

John E. Ebinger

Department of Biological Sciences
Eastern Illinois University
Charleston, IL 61920-3099, U.S.A.
cfjee@eiu.edu

ABSTRACT

The oak hybrids *Quercus* × *leana* Nutt. (*Q. imbricaria* × *Q. velutina*) and *Q.* × *runcinata* (A. DC.) Engelm. (*Q. imbricaria* × *Q. rubra*) are occasionally encountered as scattered individuals throughout Illinois. Populations consisting of many individuals of these two hybrid taxa are not known in Illinois, and only rarely have suspected backcross individuals been found. A Principal Components Analysis (PCA) involving the parent taxa and the supposed hybrids indicates that little introgression occurs, each taxon appearing as a distinct cluster on the PCA graph. A study involving hybrid specimens encountered in the herbaria of the state indicates that *Q.* × *leana* is the most common taxon, being found in 31 counties, *Q.* × *runcinata* being known from only 11 counties.

RESUMEN

Los robles híbridos *Quercus* × *leana* Nutt. (*Q. imbricaria* × *Q. velutina*) y *Q.* × *runcinata* (A. DC.) Engelm. (*Q. imbricaria*× *Q. rubra*) se encuentran ocasionalmente como individuos esparcidos por todo Illinois. Se conocen en Illinois poblaciones que se componen de muchos individuos de estos dos taxa híbridos, y sólo raramente se han encontrado individuos que se sospeche que son retrocruzamientos. Un Análisis de Componentes Principales (PCA) de los taxa parentales y los supuestos híbridos indica que ocurre poca introgresión, ya que cada taxon aparece como un cluster diferente en el gráfico del PCA. Un estudio de los especímenes híbridos encontrados en los herbarios del estado indica que *Q.* × *leana* es el taxon mas frecuente, encontrándose en 31 condados, mientras que *Q.* × *runcinata* se conoce sólo de 11 condados.

INTRODUCTION

Oak woodlands, whether savanna, open woodlands or mixed forests of oak and hickory or oak and pine are found throughout the northern hemisphere and southward into India and the higher elevations in tropical America (Stearns 1991). In North America oaks dominate a variety of community types, from the extensive oak-scrub communities of California, to the oak savannas of the prairie peninsula, to the oak dominated forests of the eastern United States. Overall, about 400 species are recognized in the western hemisphere, the United States claiming 90 species, with numerous hybrids being reported (Sargent 1933; Stearns 1991; Nixon 1997).

Because oaks are wind-pollinated many hybridize readily. Extensive populations of oak hybrids are uncommon, the individual hybrids being comparatively rare as wild plants (Palmer 1948). In Illinois, both *Quercus* × *leana* Nutt.,

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a hybrid involving *Q. imbricaria* Michx. and *Q. velutina* Lam., and *Q.* × *runcinata* (A. DC.) Engelm., with the parents being *Q. imbricaria* and *Q. rubra* L., are occasionally found in the wild; Biagi and Jensen (1995) reported them to be the most frequently encountered oak hybrids in Indiana. Herbarium collections of these hybrids are usually from the edge of woods, along fencerows, in open pastures, and other relatively open, disturbed habitats. The present study was undertaken to determine the distribution of *Q.* × *leana* and *Q.* × *runcinata* in Illinois, their morphological variation, and their habitat preferences.

METHODS AND MATERIALS

The distribution of *Quercus* × *leana* and *Q.* × *runcinata* in Illinois was determined by examining specimens from the following herbaria (A, DEK, EIU, F, GH, KNOX, ILL, ILLS, ISM, MO, MOR, MWI, SIU), consulting literature sources, and contacting many of the state's field botanists. Also, both authors made efforts to locate additional specimens on their numerous field trips through much of Illinois during the past two years. These specimens were studied to determine the geographic ranges and morphological variation of the probable hybrids. Where there was sufficiently detailed information, some sites where these hybrids had been recorded, were visited between 1998 and 2000 and searched for the presence of oak hybrids. In appendix 1 the Illinois counties where each hybrid taxon is known are listed with a representative specimen that we have annotated. For a few counties where *Quercus* × *runcinata* has been reported we have not seen a specimen, we list the specimen cited by Jones and Fuller (1955).

Initially, the herbarium specimens were separated into probable hybrid taxa based on the morphological characteristics listed in Table 1. After removal of duplicate, incomplete, and immature specimens, 25 specimens of *Quercus* × *leana* and five specimens of *Q.* × *runcinata* were available for subsequent analysis. These specimens, as well as 22 randomly selected specimens of each of the probable parents (*Q. imbricaria, Q. rubra, and Q. velutina*), from throughout their known ranges in Illinois, were scored for the seven vegetative characteristics listed in Table 2. Only vegetative characters could be used as few of the hybrid specimens had fruits attached, and only specimens collected in late summer and with mature leaves were scored. All characters were measured for each specimen (usually three or more measurements) and the measurements from the probable parental species plotted to confirm that gaps existed in order to permit the use of scored characters. Of these characters, the number of bristles present was determined by picking the side of the blade with the most bristles, while the angle of the major vein to the midvein was determined using a major vein that extended into the blade lobe. The data were analyzed by principal components analysis (PCA) using NTSYS-pc version 1.70 (Rohlf 1993). All characters were standardized, the PCA was performed using a correlation matrix, and the data were transformed by a square root transformation (Sokal & Rohlf 1969).

Table 1. A morphological comparison of *Quercus* × *leana*, *Q.* × *runcinata*, and their purported parental taxa.

Character	Quercus velutina	Quercus × leana	Quercus imbricaria	Quercus × runcinata	Quercus rubra
Terminal bud pubescence	densely pubescent	lightly pubescent	glabrous & ciliate	glabrous & ciliate	glabrous & ciliate
Petiole length	>30 mm	18–30mm	<15mm	18–30mm	>30mm
Blade apex	acuminate	acute to acuminate	obtuse to acute	acute to acuminate	acuminate
Blade sinuses	>25 mm deep	<25 mm deep	none	<25 mm deep	>25 mm deep
Blade width/ length ratio	0.70–1.00+	0.38–0.65	0.25–0.40	0.43–0.65	0.70–1.00+
Bristles on one side of blade	15–26	2–7	0	2–7	15–26
Major vein angle	34–45°	34–45°	50–65°	35–45°	35–49°

Table 2. Characters scored for the principal component analysis involving specimens of *Quercus imbricaria*, *Q. rubra*, and *Q. velutina* and the probable hybrids of these taxa.

1. Terminal bud scales pubescence (1 = glabrous and ciliate, 2 = lightly pubescent and ciliate, 3 = densely pubescent and ciliate).
2. Petiole length (mm).
3. Blade apex shape (1 = obtuse to acute, 2 = acuminate).
4. Blade lobing (1 = not lobed, 2 = shallowly lobed, the sinuses mostly less than 25 mm deep, 3 = deeply lobed, many sinuses more than 30 mm deep).
5. Blade width at widest point/length ratio.
6. Bristles present on one side of the blade (1 = a single terminal bristle, 2 = 2–6 bristles, 3 = 8 or more bristles).
7. Angle of major lobe vein to midvein (1 = >50°, 2 = <50°).

RESULTS AND DISCUSSION

Quercus × *leana* has an extensive geographic range throughout much of the eastern United States from Pennsylvania to Michigan, and south to Missouri, North Carolina, and Maryland (Palmer 1948). The type specimen was collected in Cincinnati, Ohio by T. G. Lea in 1842 (GH!). Jones and Fuller (1955) reported *Quercus* × *leana* for seven Illinois counties (Clay, Cook, Fulton, Peoria, Richland, Sangamon, and Will). The present study indicates that this taxon is relatively common, occurring in 31 Illinois counties (Fig. 1). Of the more than 100 herbarium specimens of this taxon examined, only three had sufficient label information to allow relocation of the original tree. Also, hybrids were found at

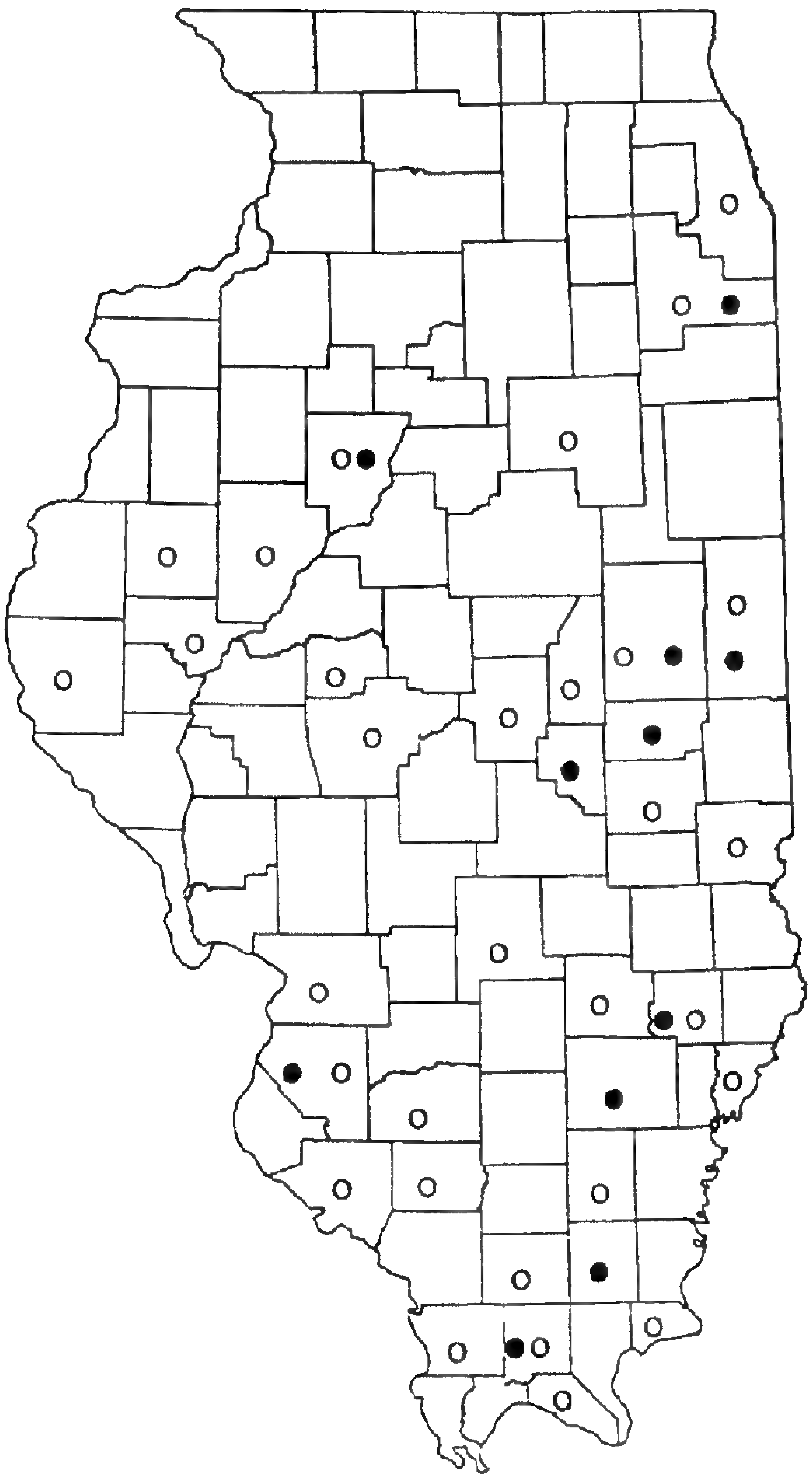

Fig. 1. Illinois map showing the known distribution of *Quercus* × *leana* (○) and *Q.* × *runcinata* (●).

four new sites. At six of these sites, only one hybrid individual was found, while two trees were found at one site. All were in disturbed habitats (fence row, forest edge, open field) with the probable parents nearby.

Quercus × *runcinata* also has an extensive geographic range, being reported from throughout most of the northeastern and north central United States in Kentucky, Illinois, Indiana, Maryland, Missouri and Pennsylvania (Palmer 1948). In Illinois this hybrid was reported for only six counties (Champaign, Johnson, Richland, St. Clair, Wayne, and Will) by Jones and Fuller (1955), while an update of this work added Peoria County (Winterringer & Evers 1960). During the present study specimens were recorded from four additional counties (Douglas, Moultrie, Saline, and Vermilion), bringing the total to 11 counties (Fig. 1). No living hybrids were found during the present study, but information on herbarium labels indicates that only individual trees were found, and that they were associated with disturbed habitats.

In our PCA involving specimens of the three purported parental taxa (*Q. imbricaria*, *Q. rubra*, and *Q. velutina*), and all of the probable hybrid specimens scored, the first two principal components accounted for 72% and 15%, respectively, 87% of the total variance. In the resulting plot the 96 specimens separate into five distinct groups, three representing the parental taxa, the remaining two representing the two hybrid taxa (Fig. 2). The extent of blade lobing and blade width/length ratio (characters 4 and 5) are most important in determining OTU scores on the first principal component. The extent of pubescence on the terminal bud and the number of bristles on the blade (characters 1 and 6) are most important in determining OTU scores on second principal component.

The five clusters in the PCA plot are distinct, well-separated, and do not contain recognizable subgroups (Fig. 2). In this plot OTU's representing *Quercus* × *leana* fall between those representing *Quercus imbricaria* and *Q. velutina*. The compact nature of this group suggests that the specimens are probably F1 hybrids and probably do not represent backcrosses to either parent. Similar results are obtained for *Q.* × *runcinata*, OTU's representing that taxon are located between those representing *Q. imbricaria* and *Q. rubra* (Fig. 2).

Morphological characteristics of the leaves were important in separating both *Quercus* × *leana* and *Q.* × *runcinata* from the parental taxa since nearly all of the specimens examined were sterile (Table 1). In both hybrid taxa the leaves are similar, with petioles between 18 and 30 mm long, blades shallowly 3- to 9-lobed with the sinuses mostly less than 25 mm deep, a width/length ratio of less than 70%, an acute to acuminate blade apex, and between 2 and 7 bristles on each side of the blade (Fig. 3). In *Q. imbricaria* the entire margined leaves are not lobed, the petioles are usually less than 15 mm long, and the obtuse to acute blade apex has a single terminal bristle. In contrast, the leaves of both *Q. rubra* and *Q. velutina* have petioles that commonly exceed 30 mm in length, deeply lobed blades with some sinuses more than 30 mm deep, a blade width/length ratio above 70%, an acuminate blade apex, and commonly 15 to 26 bristles on each side of the blade (Table 1).

Though the leaves of *Quercus rubra* and *Q. velutina* are very similar, these two taxa are easily separated. Generally the clustered terminal buds of *Q. velutina* are 4-angled, 7–10 mm long, and with densely pubescent and ciliate scales; those of *Q. rubra* ovoid, less than 6 mm long, and the scales mostly glabrous and lightly ciliate (Mohlenbrock 1986; Gleason & Cronquist 1991). Terminal bud characteristics are also useful in separating the two hybrid taxa. In both the terminal buds are fairly short, mostly less than 6.5 mm long. In *Q.* × *leana* the buds are commonly slightly 4-angled and the scales are lightly to densely pubescent and ciliate. *Quercus* × *runcinata*, in contrast, has ovoid buds

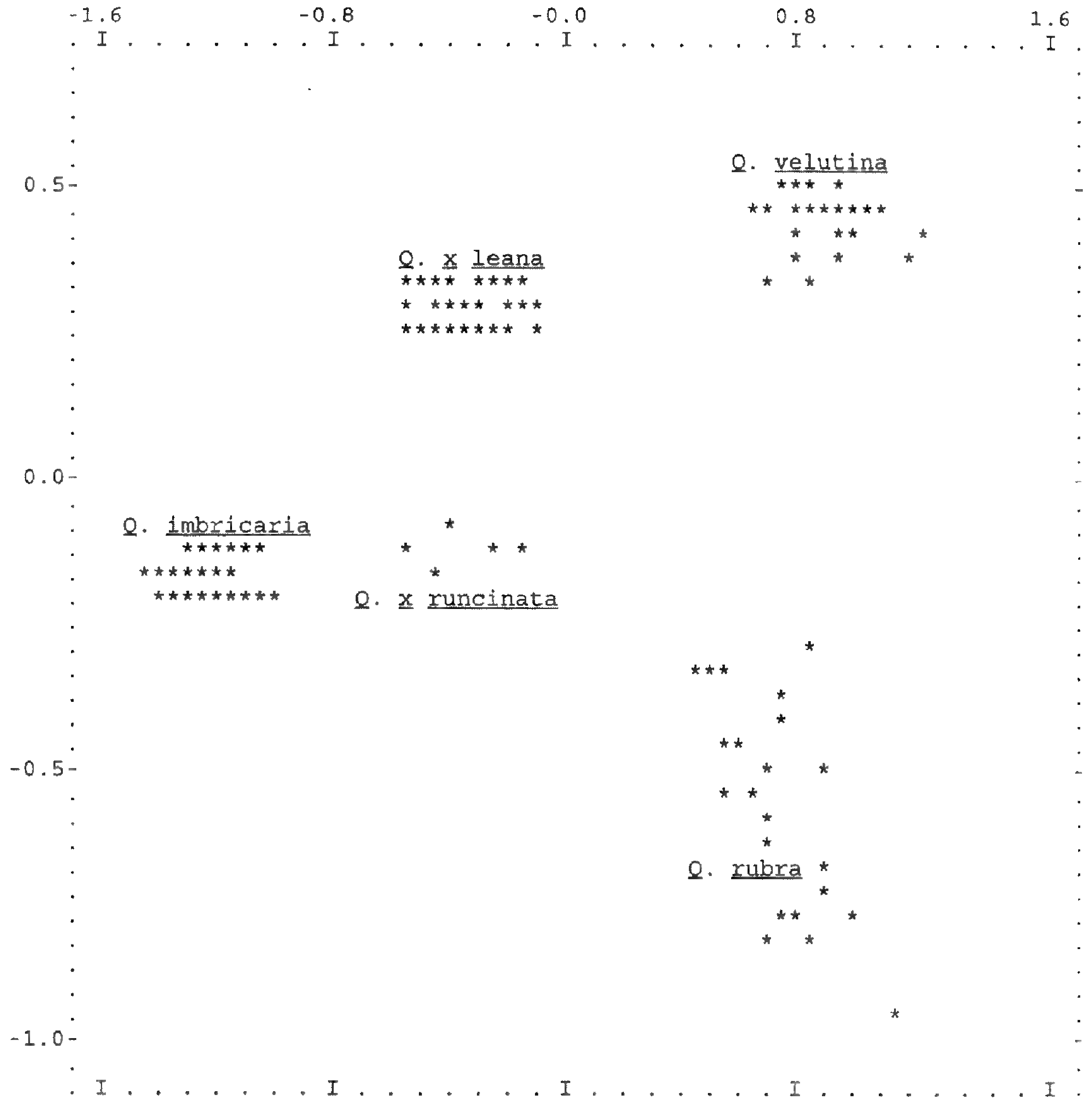

FIG. 2. Plot of axis 1 vs. 2 of a principal component analysis using 7 variable for 22 specimens of *Quercus imbricaria, Q. rubra* and *Q. velutina* along with 30 specimens of their probable hybrids.

with scales that are glabrous with lightly ciliate margins, similar to the terminal buds found in both *Q. imbricaria* and *Q. rubra* (Table 1).

Few of the hybrid specimens bore mature acorns. Acorns of *Quercus* × *leana* were similar to, but slightly smaller than those of *Q. velutina*, the caps of both with loose, pubescent scales. Also, acorns of *Q.* × *runcinata* were similar to, but smaller than those of *Q. rubra*. Both taxa have glabrous to lightly puberulent, tightly appressed scales.

The present study suggests that the oak hybrids *Quercus* × *leana* and *Q.* × *runcinata* are uncommon, usually occurring as isolated individuals in disturbed habitats. Palmer (1948) mentions that these hybrids have been grown from seed, and that the mature foliage and fruits of these offsprings are intermediate be-

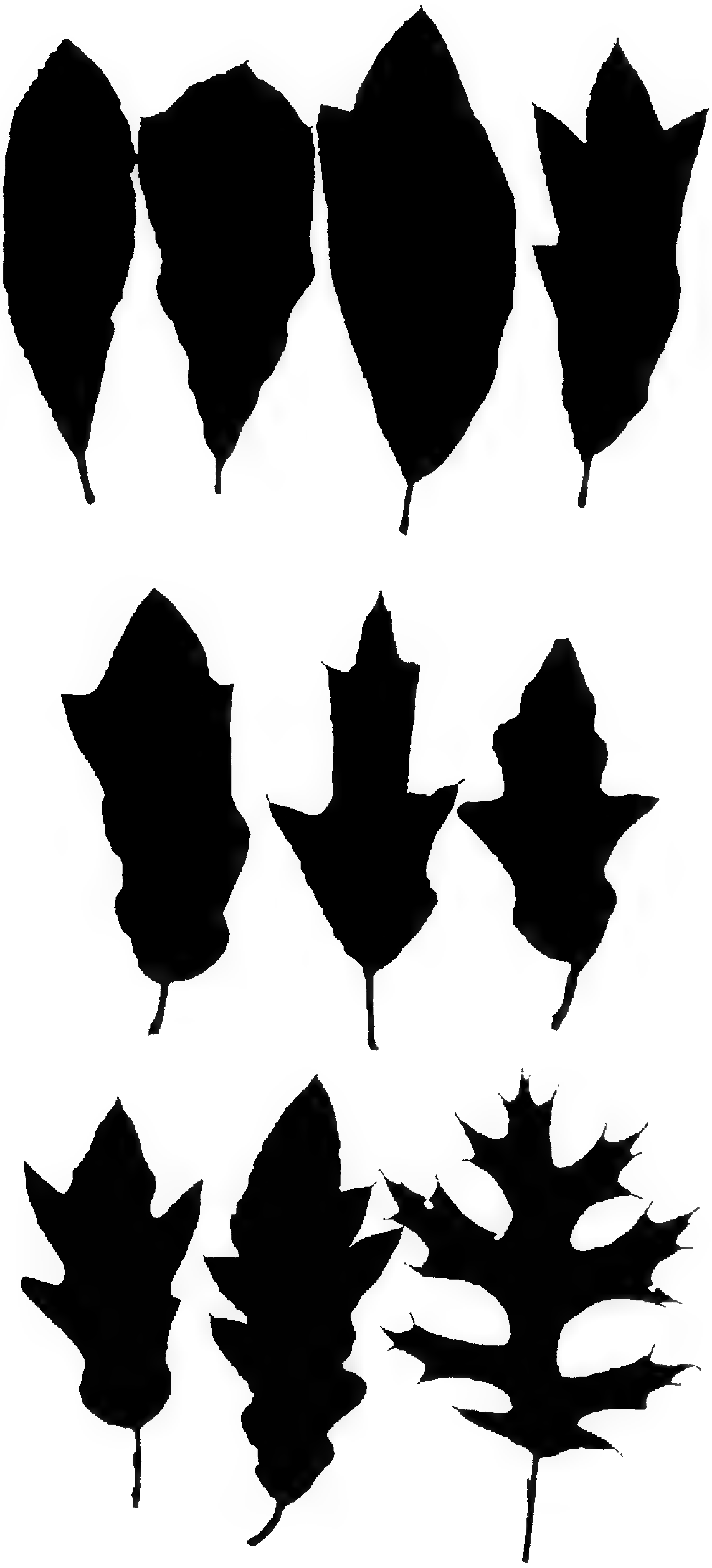

Fig. 3. Leaf variation found in Illinois specimens of *Quercus* × *leana*. The upper left leaf represents *Q. imbricaria*, the one at the lower left *Q. velutina*, the remainder showing the variation found on various specimens of *Q.* × *leana*.

tween the purported parents. During the present study one tree was found that bore large numbers of acorns. Of the 250 acorns collected from beneath this tree, only 14 appeared to be of firm and of normal size, but none germinated. The remaining acorns were smaller, had a relatively soft pericarp, and lacked a fully developed embryo. The small number of viable fruit suggests that seedlings rarely develop.

APPENDIX 1

Illinois counties where *Quercus* × *leana* and *Q.* × *runcinata* have been found with a representative collection from each county giving locality, date collected, collector, and herbarium where the specimen is deposited.

Quercus × **leana** Nutt. **Adams Co.:** wooded bluff, W section Siloam Springs State Park, 29 Sep 1961, *R.A.Evers 71960* (ILLS). **Champaign Co.:** bluff top of Sangamon River, N of Mahomet, 18 Jun 1953, *R.A.Evers 38112* (ILLS). **Clark Co.:** woodland border, SW of Moriah, 3 Sep 1970, *R.A.Evers 103546* (ILLS). **Clay Co.:** woodland border, N of Louisville, 4 Jun 1953, *R.A.Evers 37511* (ILLS). **Coles Co.:** EIU campus, Panther Trail, W of football stadium, Charleston, 9 May 2000, *G.C.Tucker 12022* (EIU, ILLS, MOR). **Cook Co.:** woods, Columbia Woods Forest Preserve, Willow Springs, 17 Jul 1963, *R.A.Evers* 77205 (ILLS). **Fayette Co.:** edge of lowland old field, N side of Becks Creek, Dean Hills Nature Preserve, 8 mi E of Ramsey, NE1/4 S10 T8N R2E, 29 Aug 2000, *D.T.Busemeyer, M.A.Faust, & R.L.Phillippe 306* (ILLS). **Fulton Co.:** Bemadolte, *J.Wolf s.n.*(ILL). **Hamilton Co.:** roadside S of Dahlgren, 14 Sep 1951, *R.A.Evers 32566* (ILLS). **Hardin Co.:** wooded bluff, 4 mi S of Karbers Ridge, 8 Jul 1958, *R.A.Evers 57806* (ILLS). **Johnson Co.:** open uplands, sandy soil, Simpson, 3 Oct 1919, *E.J.Palmer 16670* (MO). **Livingston Co.:** roadside, 10 mi N of Rowe, 22 May 1945, *G.D.Fuller 10351* (ISM). **Macon Co.:** Spitler Wood State Park, 14 Oct 1965, *R.A.Evers 86074* (ILLS). **Madison Co.:** woodland, Godfrey, 1 Oct 1953, *H.E.Ahles 7599* (ILL). **Massac Co.:** floodplain of Ohio River, 6 mi N of Metropolis, near Rocky Branch, 18 Oct 1973, *W.McClain 853* (EIU). **McDonough Co.:** top of dry ridge, Pleasant Valley, 18 May 1948, *R.M.Myers 516* (ISM, MWI, SIU). **Menard Co.:** woods, Lincoln New Salem State Park, 23 May 1963, *R.A.Evers 76017* (ILLS). **Peoria Co.:** wooded edge of parking lot, W of visitor center near power lines, Wildlife Prairie Park, NW1/4 S29 T9N R7E, 2 Jul 2000, *G.C.Tucker 12124* (EIU, ILLS). **Perry Co.:** edge of woods, 8 Jul 1953, *J.O.Neill s.n.* (ILLS). **Piatt Co.:** woodland border, Lodge Park, S of Lodge, 3 Jun 1971, *R.A.Evers 105252* (ILLS). **Randolph Co.:** bottomland woods, 1 mi S of Leanderville, 8 Jul 1953, *R.A.Evers 38991* (ILLS). **Richland Co.:** flat uplands, near Olney, 15 May 1923, *E.J.Palmer 22626* (MOR). **Sangamon Co.:** Washington Park, Springfield, 15 Apr 1945, *V.S.Eifert 9958* (ISM). **Schuyler Co.:** 6 Sep 1849, *S.B.Mead s.n.* (KNOX). **St. Clair Co.:** near Aldolf Engelmann's farm, 4 Jun 1874, *G.Engelmann s.n.* (MO). **Union Co.:** roadside woods, 1 mi S of Jonesboro, 9 Jul 1956, *F.B.Buser 6461* (ILLS). **Vermilion Co.:** edge of upland woods, Middle Fork Nature Preserve, W edge of Kickapoo State Park, NW1/4 S5 T19N R12W, 16 Oct 2000, *J.E.Ebinger 29400* (EIU). **Wabash Co.:** edge of woods and road, Beall Woods Nature Preserve, 2 mi E of Keensburg, S11 T2S R13W, 6 Jun 2000, *J.E.Ebinger 28583* (EIU). **Washington Co.:** uncommon hybrid along railroad tracks along IL 177 at Venedy, 26 Jun 1993, *M.A.Basinger & C.Giedeman 5878* (ILLS). **Will Co.:** edge of woods, Marley, 22 Jun 1987, *A.Chase 26* (ILL, MO). **Williamson Co.:** pasture woodland N of Marion, 21 Sep 1950, *R.A.Evers 27868* (ILLS).

Quercus × **runcinata** (A. DC.) Engelm. **Champaign Co.:** woods, Crystal Lake Park, Urbana, 18 Oct 1960, *R.A.Evers 68121* (ILLS). **Douglas Co.:** edge of woods, Kaskaskia River near Chesterville, 13 Oct 1970, *A.Jones 2886* (ILL). **Johnson Co.:** upland woods, limestone outcrops, Simpson, 3 Oct 1919, *E.J.Palmer 16666* (MO). **Moultrie Co.:** tree 40–50 ft tall along edge of small woods by the Illinois Central RR, 1.5 mi NW of Allenville, NE1/4 SE1/4 S17 T13N R5E, 25 Jun 1973, *L.Dennis 1547* (EIU). **Peoria Co.:** in Peoria, drive overlooking Illinois River, 27 Sep 1949, *G.S.Winterringer 19434* (ISM).

Richland Co.: Turkey Creek, *R.Ridgway 26.* **Saline Co.:** sandstone outcrop on Murray Bluff, S of Carrier Mills, 30 Jul 1954, *R.A.Evers 45369* (ILLS). **St. Clair Co.:** upper edge of bluff road, vic. Southern rr, 20 Nov 1960, *J.O.Neill 15529* (ISM, MO, SIU). **Vermilion Co.:** Kickapoo State Park, 24 Jul 1971, *D.Seigler 4726* (ILL). **Wayne Co.:** near Sannon Bridge, 21 Oct 1914, *R.Ridgeway 91.* **Will Co.:** property of Mrs. Koneeny, rt. 1, Mokena, Oct 1961, *F.A.Swink s.n.* (MOR).

ACKNOWLEDGMENTS

The authors would like to thank the herbarium curators for the use of the oak specimens used to complete the study.

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BOOK NOTICE

PETER F. FFOLLIOTT, LUIS A. BOJORQUEZ-TAPIA, and MARIANO HERNANDEZ-NARVAEZ. 2001. **Natural Resource Management Practices: A Primer.** (ISBN 0-8138-2541-5, hbk.). Iowa State University Press, 2121 South State Street, Ames, IA 50014-8300, U.S.A. (Orders: www.isupress.com, 800-862-6657, 515-292-0155, 515-292-3348 fax). US$52.95, hbk., 250 pp., illustrated, 6" × 9".

Table of Contents:

This is a concise primer on ecological conservation and natural resource management practices. As a quick reference for researchers or as a text for students in conservation classes, *Natural Resource Management Practices*, is a much needed book on the subject. Covering aspects of watershed and agroforestry practices, as well as the rehabilitation of disturbed lands this book should gain a wide readership in academia.—*Kevin D. Janni, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A., kjanni@brit.org.*

THE VASCULAR FLORA OF MADISON COUNTY, TEXAS

Amanda K. Neill[1] and Hugh D. Wilson

Department of Biology Herbarium (TAMU)
Texas A&M University
College Station, TX 77843-3258, U.S.A.

ABSTRACT

A survey of the vascular flora of Madison County, Texas, was conducted from May 1996 to April 2000. The flora consists of 985 species in 488 genera and 136 families. The largest families in the flora are the Asteraceae (127 species), Poaceae (123 spp.), Fabaceae (76 spp.), Cyperaceae (63 spp.), and Euphorbiaceae (32 spp.). The species are compiled in an annotated list that includes for each species the common name, collection citations, and a designation as to whether that species is considered native or introduced. Habitat types where each species occurs are included in the list. Unusual habitats, introduced species, and rare and endemic taxa are discussed.

RESUMEN

Una investigación de la flora vascular de Madison County, Texas, fue realizada desde mayo de 1996 a abril de 2000. La flora está formada por 985 especies pertenecientes a 488 géneros y 136 familias. Las familias mayores son las Asteraceae (127 especies), Poaceae (123 esp.), Fabaceae (76 esp.), Cyperaceae (63 esp.), y Euphorbiaceae (32 esp.). Las especies se han compilado en una lista comentada que incluye para cada especie el nombre vernáculo, citas de las recolecciones, y una designación de si se considera nativa o introducida. Se incluyen en la lista los tipos de los hábitats en que vive cada especie. Están comentados los hábitats inusuales, especies introducidas, así como táxones raros y endémicos.

INTRODUCTION

Madison County, like many other counties of Texas, has lacked an in-depth floristic evaluation. A complete state-wide flora has long been a goal of Texas botanists. Lundell's *Flora of Texas* (1942) was intended to be a ten-volume series, but the project was abandoned in 1955. Correll and Johnston's *Manual of the Vascular Plants of Texas* (1970) incorporated Lundell's work, and remains the only reference with dichotomous keys encompassing the entire state. Updated checklists of the Texas flora have been compiled by Gould (1975a), Hatch et al. (1990), and Jones et al. (1997). Although these reference species by region or vegetational area, no county-by-county species information is available due to the dearth of local floristic studies. Reed (1997) compiled the *Manual of the Dicot Flora of Brazos and Surrounding Counties*, technically including Madison County. However, less than 200 collections from this county were available for reference from Texas A&M University's two herbaria at the time (FTC Herbarium Specimen Browser, internet reference).

Almost a century ago, Texas botanist William Bray stated that "before the

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[1] Present address: Institute of Systematic Botany, The New York Botanical Garden, Bronx, NY 10458-5126, U.S.A.

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flora of Texas suffers further radical changes, the schools of the state ought to cooperate in securing a complete and authentic list of species represented by carefully collected and well-preserved specimens" (Bray 1906). While the colleges and universities of Texas have a great tradition of ecological and systematic studies, a century has brought us but little closer to a modern state-wide flora. The radical floristic changes of which Bray spoke continue unabated and often unobserved, and the labor-intensive floras of Texas counties are still woefully few.

The objectives of this county flora were to 1) collect, identify, and preserve specimens of all vascular plants occurring in Madison County, Texas; 2) generate a species list for the county and delineate patterns of plant communities by habitat preference; and 3) analyze the flora for disjuncts, notable range extensions, endemics, recent invaders, and rare taxa. This article is provided as a summary of the first author's M.S. thesis research (Neill 2000). Information is also available on the Madison County Flora Website at <http://BIOCOURSE.BIO.TAMU.EDU/graduate-students/neilla/madhome.htm>. This site includes annotated species lists, searchable in several formats, as well as maps and links to images.

Site Description

Madison County comprises 302,451 acres (122,398 ha) in east-central Texas between 30°49' and 31°06' N latitude and 95°37' and 96°13' W longitude (Ramos 1997). The county is bordered on the west by the Navasota River and Brazos County, on the east by the Trinity River and Houston County, on the north by Leon County, and on the south by Bedias Creek and Grimes and Walker counties (Fig. 1). The county seat and largest city is Madisonville, situated about 90 mi (142 km) NNE of Houston.

The land surface is flat to gently rolling and generally slopes to the southeast, with elevations ranging from 420 ft (128 m) above sea level south of Normangee to 140 ft (43 m) above sea level along the lower Trinity River and Bedias Creek (a tributary of the Trinity) (U.S.G.S. 1962–1989). The eastern two-thirds of the county are drained by these watercourses, which converge at the southeastern corner. While the Trinity is a hydrologically tamed river with a historical floodplain 10 miles wide and now largely under cultivation, Bedias Creek is for most of its length a small, deep creek with extensive bottomlands of oxbow lakes, swamps, and frequently flooded ridge-and-swale topography. The Navasota River (a tributary of the Brazos River) drains the western third of Madison County, where it meanders through a wide and wooded floodplain of sloughs, natural lakes, terraces, and ravines.

The geology of East Texas is the result of alluvium washed southward by rivers and deposited in layers upon the advance and retreat of coastal waters in the Gulf of Mexico. This deposition occurred in the region during the Eocene

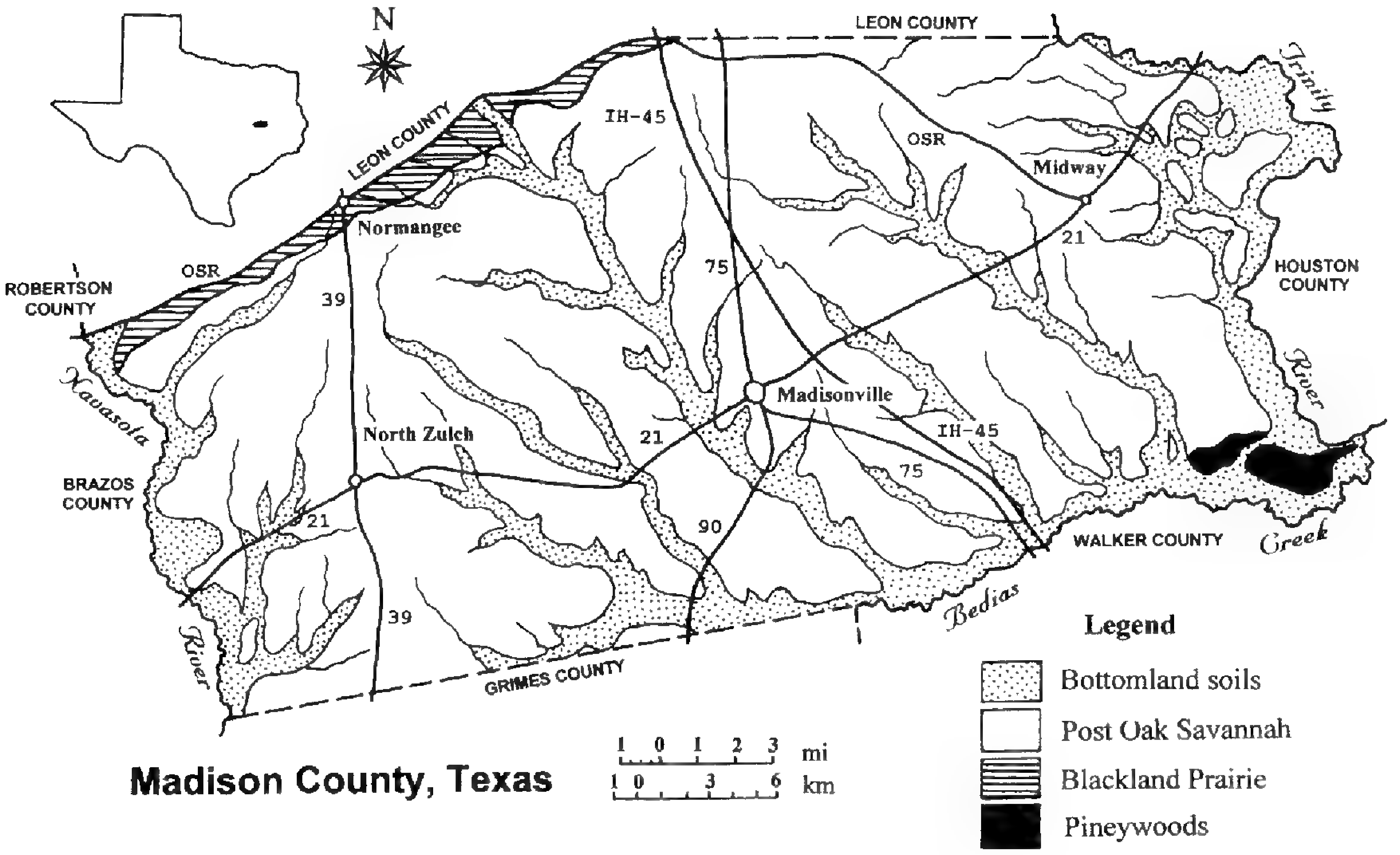

Fig. 1. Location and map of bottomland soils and vegetation zones. Adapted from Gould et al. (1960) and Neitsch (1994)

Epoch (58 to 37 mya) of the Tertiary Period (Spearing 1991). The Eocene layers deposited in Madison County are members of the Claiborne Group and are composed of clays, shales, siltstones, sandstones, and lignites (Neitsch 1994). Neitsch (1994) lists 12 soil associations in the county, with six upland soils and three prairie soils, all loamy sands and clays. Three bottomland soils of alluvial clay cover modern floodplains and young terraces.

The Madison County frost-free growing season averages 250 days, with a mean maximum July temperature of 96°F (35°C) and a mean minimum January temperature of 38°F (3°C). Precipitation peaks in the spring and fall and averages 41.6 in (106 cm) annually (Ramos 1997).

Cultural History

Although no major archaeological sites have been found in Madison County, some Indian camp sites and kitchen-middens have been found that date from 3000 B.C. (Madison County Historical Commission 1984). Tribes of the Caddo Confederacy formed permanent settlements in the eastern part of the county, where the people cultivated corn and squash. Nomadic tribes that occupied the county include the Bedias, who frequented Bedias Creek and its confluence with the Trinity River, and apparently had a village in this peninsular area (Neitsch 1994; Texas Almanac 1951).

French and Spanish explorers, missionaries, and soldiers began leading expeditions through the area in the mid-sixteenth century. The first Spanish settlement, Bucareli—where present-day Texas Highway 21 crosses the Trinity River—was established in 1774 as an outpost against French invasion. Bucareli was abandoned in 1779 due to flooding, epidemics, and raids by the nomadic Comanches (Madison County Historical Commission 1984).

Madison County is most historically significant for containing the intersection of two early roads. Originally Indian trails, these roads were used by missionaries, explorers, and eventually settlers. The Old San Antonio Road (OSR), also known as El Camino Real, or the King's Highway, connected settlements in the East with those in San Antonio and Mexico. Today, this modern highway forms most of the northern border of Madison County. At the town of Midway, another road known as La Bahia Trail split from OSR and led southwest to the mission at Goliad (U.S. Dept. of the Interior 1998).

Madison County was organized in 1853, and settlement increased rapidly to a population of 3000 by 1860 (Texas Almanac 1951). By 1900, the population had grown to 10,432, and 71,000 acres were being farmed (Richardson 1940). Over 20,000 acres of this was in cotton. Three railroads were built through the county, and the population peaked in 1930 at 12,227 inhabitants (Ramos 1997; Richardson 1940). Pasture and hayland for beef cattle production have replaced most cultivated crops today. Seventy percent of the county is used as rangeland, hayland, and pasture (Neitsch 1994). Fishing and hunting are important land uses in the county, with many properties leased for seasonal duck and deer hunting.

Botanical History

Every vegetation map available represents Madison County as an ecotone. Past ecologists and botanists in Texas recognized that the area around the 96th meridian, which divides the county in half, is a zone where western xerophytic grasslands mingle with eastern mesophytic forests (Bray 1906; Blair 1950; Cronquist 1982; Tharp 1926). Allred and Mitchell (1955), Correll and Johnston (1970), Cory and Parks (1937), and Gould et al. (1960) generally agree upon the boundaries of the three major vegetation zones converging in Madison County; these vegetation zones commonly are called the Pineywoods, Blackland Prairies, and Post Oak Savannah (Fig. 1).

Correll and Johnston (1970) described the vegetational areas largely in accordance with past descriptions. The Pineywoods region of East Texas represents the most mesophytic area of Texas and is characterized by extensive pine and pine-hardwood forests with intermittent swamps. Madison County's eastern edge is one of the most westward-extending tongues of this vast vegetational zone. The Blackland Prairies region lies in three diagonal bands trending NE-SW across east-central Texas. Of the two southern bands of Blackland Prairie, the San Antonio Prairie occupies the border of northwestern Madison County, and the Fayette Prairie is sometimes shown to extend into the south-central portion of the county. The Post Oak Savannah region interdigitates with the Blackland Prairies. A belt of Post Oak Savannah occupies most of central Madison County.

Although no extensive vegetational studies have been conducted in Madison County, past research has included floristic aspects found within the county. Both Launchbaugh (1952) and Hightower (1987) investigated changes in vegetation structure in response to disturbance in the San Antonio Prairie. Diamond (1980) described remnant plant communities of the Fayette Prairie, which is the southern disjunct of the Blackland Prairie proper, placing the northern limits of the Fayette Prairie in Grimes and Walker counties. McCaleb (1954) analyzed the vegetation of the southern Post Oak Savannah and included Madison County within his Oak-Hickory Forest Region. Allen's (1974) vegetational study of the lower Navasota described plant communities along the watershed in Grimes County and points south. Apparently, none of the above investigators conducted research within Madison County. There are no resultant voucher specimens for the county in the Tracy (TAES) or Biology Department (TAMU) herbaria at Texas A&M University (FTC Herbarium Specimen Browser, internet reference).

METHODS

Vascular plants were collected at frequent and regular intervals in Madison County, from May 1996 to April 2000. Public lands (roadsides, railroad rights-of-way, city parks, and cemeteries) were investigated, and habitats identified as unusual were revisited over several seasons. With the assistance of a local newspaper article (Levey 1998), private landowners were contacted for permission to collect on their properties. Other private lands were chosen with the aid of aerial photographs, overflight in a small chartered plane, and topographic and soils maps, in order to survey both agricultural/livestock land-use areas and to investigate possible unusual or undisturbed habitats. Urban areas (Madisonville, Normangee, North Zulch, and Midway) provided disturbed upland sites supporting a unique, weedy flora. Riparian and lacustrine systems were accessed at bridges, on private property, and by canoe.

At the time of plant collection, data were recorded on the specific habitat and relative abundance of the species in the area. Publications describing similar research were reviewed for exposure to floristic protocol. References include Allen (1974), McCaleb (1954), Reed (1997), Starbuck (1984), and Wilson (1972). References used for plant identification were Correll & Johnston (1970), Diggs et al. (1999), and Reed (1997). Grasses were identified with *The Grasses of Texas* (Gould 1975b), and identifications were verified by Stephan Hatch and Dale Kruse at the S.M. Tracy Herbarium in College Station, Texas (TAES). Sedges (*Carex* sp.) were identified with an unpublished key to the *Carex* of Texas provided by Stanley Jones, curator of the Botanical Research Center, College Station, Texas (BRCH), and identifications were verified by him. Other experts consulted were Monique Reed (TAMU), Theodore Barkley at the Botanical Research Institute of Texas (BRIT), and Richard Rabeler at the University of Michigan Herbarium (MICH). Taxonomic classification essentially followed the Cronquistian system (Cronquist 1988), with the exception of familial treatment of the Tupelo family (Nyssaceae), Chickenspike family (Sphenocleaceae), and Dodder family (Cuscutaceae). Voucher specimens collected throughout the project were deposited in the herbaria at Texas A&M University in College Station, Texas (TAMU, TAES), and are available for examination.

A search of the Flora of Texas Consortium Browser (2000a) revealed some species that the authors did not find in the county, and these are included in the checklist. Only those specimens held at TAMU and TAES were seen by the authors. Numerous older specimens had been labeled "Madison County" but actually were collected northwest of Normangee in Leon County. The location and identification of species collections held at ASTC, LL, TEX, SHST, and SMU have not been verified.

RESULTS AND DISCUSSION

Madison County vascular plant collections resulted in a total of 2254 specimens. The flora is comprised of 1041 taxa with 985 species in 488 genera and 136 families. The five largest plant families are Asteraceae (127 species), Poaceae (123 spp.), Fabaceae (*sensu stricto*) (76 spp.), Cyperaceae (63 spp.), and Euphorbiaceae (32 spp.). These five families contain approximately 44% of the species found in Madison County. Further numerical distributions of the flora are found in Table 1.

Major Vegetational Habitats

Thirteen major habitat types were classifiable in Madison County. These habitats are essentially those described for Robertson County, Texas, by Starbuck (1984). Riparian habitats and lowlands include habitats in water, near water, and low areas within floodplains. Aquatic emergent (AEM), aquatic floating (AFL), and aquatic submerged (ASU) are habitat categories for obligate aquatic species and those plants that were found in standing water due to flooding. Habitats along the banks and frequently (two or more times a year) flooded areas of riverine and lacustrine bodies of water were divided into major riparian (RLM) and minor riparian (RUM) habitats. Major riparian habitat is that of the Navasota and Trinity rivers, whereas minor riparian habitats are those along creeks and ponds. Lowland habitats flooded once a year or less frequently were divided by woody cover into terrestrial lowland woods (TLW), terrestrial lowland open (TLO), and terrestrial lowland mixed (TLM). Drier upland areas were similarly divided into terrestrial upland woods (TUW), terrestrial upland open (TUO), and terrestrial upland mixed (TUM). Two of Starbuck's habitat groups, parasite (PAR) and epiphyte (EPI), better describe plant habits, but were maintained for consistency in this text. Two of Starbuck's habitats were not used. His bog (BOG)

TABLE 1. Distributional summary of the Madison County flora.

Taxa	Families	Genera	Species
Ferns & Allies	11	13	14
Gymnosperms	3	4	5
Dicots	101	357	697
Monocots	21	114	269
Total	136	488	985

habitat applies to the acidic *Sphagnum* bogs found in the deep sands of Robertson County (Bryant 1977; Starbuck 1984). This habitat is not present in Madison County. Starbuck's terrestrial prairie (TPR) habitat was used in his text solely for specimens collected by Hightower (1987) at a remnant prairie locality. Although certain plant species in Madison County could be characterized as prairie species, no undisturbed prairie habitats are intact in the county today.

Aquatic habitats such as oxbow lakes, stock ponds, reservoirs, drainage ditches, and shallow creek and river margins supported a unique flora. Uncommon herbs found in these habitats include *Juncus repens*, *Nelumbo lutea*, *Thalia dealbata*, and *Utricularia radiata*. Lowland and riparian habitats contain the most diverse flora in Madison County. The extensive wooded floodplains of the Navasota River and Bedias Creek exemplify typical bottomland hardwood vegetation. Trees most common in low, moist areas of the county include *Carya aquatica*, *Fraxinus pennsylvanica*, *Nyssa sylvatica*, *Planera aquatica*, *Quercus lyrata*, *Q. nigra*, *Q. phellos*, *Tilia americana*, and *Ulmus crassifolia*. Disturbances to this area include logging, flooding, and cattle grazing. Due to agricultural use and the construction of levees and dams, the Trinity River floodplain forests are less extensive. Some segregation of species was found when comparing collections from the two major riparian habitats (RLM). Species found only within the Navasota River floodplain include *Amsonia illustris*, *Aristolochia tomentosa*, *Baptisia alba*, *Brunnichia ovata*, *Carex complanata*, *C. crus-corvi*, *Mikania scandens*, *Planera aquatica*, *Prunus caroliniana*, *Tillandsia recurvata*, *Urtica chamaedryoides*, and *Zizaniopsis miliacea*. Species found only within the Trinity River floodplain include *Amorpha fruticosa*, *Ampelopsis cordata*, *Carex retroflexa*, *Clematis reticulata*, *Equisetum laevigatum*, *Hibiscus moscheutos*, *Panicum virgatum*, and *Woodwardia areolata*. Terrestrial lowland open habitats (TLO) were typically found in deforested areas or river floodplains, low pastures, moist roadside ditches, and other open areas near bodies of water. These habitats are often disturbed by grazing and mowing and thus support a variety of weedy invader species as well as native perennial herbaceous species.

Level upland sites in Madison County are prime locations for pastures and haymeadows, as they were mostly cleared in the last century for cropland. Most wooded areas within what would be considered uplands are nearly always found along creeks, and so would be included in the terrestrial lowland classifications for this study. True wooded upland sites (TUW) and mixed upland habitats (TUM) do occur, and these may be categorized into three general association types:

1. Post Oak – Winged Elm – Yaupon Association

This association encompasses nearly all upland wooded sites in the county, and is typical of the Post Oak Savannah vegetation type. The association is found in areas with sandy loam topsoil and gray clay subsoils and is characterized by *Quercus stellata*, *Ulmus alata*, and *Ilex vomitoria*.

2. Blackjack Oak – Post Oak – Winged Elm Association

Characterized by the presence of *Quercus marilandica*, sites exhibiting this association are generally more poorly drained than those with the Post Oak – Winged Elm – Yaupon association. The aspect of these sites is also that of the Post Oak Savannah vegetation type but was frequently found with tall grasses seen in the Blackland Prairie vegetation type, such as *Andropogon ternarius*, *Sorghastrum nutans*, and *Schizachyrium scoparium*.

3. Southern Red Oak – Sweet Gum – Post Oak Association

This association is occurs in the eastern third of the county and is characterized by a dominance of *Quercus falcata* and *Liquidambar styraciflua*. These sites have acidic sandy soils with good drainage. The best examples of this association are found in the uplands along Youngs Creek Canyon and Cobb Creek Canyon. These localities are discussed in the Unique Habitats section. The Padina series of deep sands is frequently found at these sites. *Sassafras albidum* and *Pinus taeda* are also found in this association.

Terrestrial upland open habitat (TUO) is ubiquitous and easily accessed in Madison County. Like open lowland sites, these generally roadside and pasture habitats are characterized by non-native herbs and grasses, although it is here that many of the showy and popular wildflowers of Texas also may be seen. Open upland habitats are first to suffer in summer drought conditions, when even narrow county roadsides are mown for hay in this county. It is difficult to find examples of this habitat type that have not experienced disturbance. Pasture sites are frequently invaded by *Prosopis glandulosa* and *Acacia farnesiana*.

Epiphytes (EPI) found in the county are restricted to *Pleopletis polypodioides*, *Tillandsia recurvata*, and *T. usneoides*. Parasites (PAR) found in the county include *Cuscuta cuspidata*, *C. glomerata*, *C. obtusifolia*, *Orobanche multiflora*, and *Phoradendron tomentosum*.

Unique Habitats

Several localities in Madison County, primarily on private lands, exhibit unusual characteristics that deserve special mention. Isolated populations of *Pinus taeda* are found at several places in the county, but the only area that deserves designation as the East Texas Pineywoods vegetation type is found in southeastern Madison County, on the peninsula formed by the confluence of the Trinity River and Bedias Creek and extending up Bedias Creek for several miles, although this area also contains some lowland hardwood forest. Species collected only in this habitat include *Aristolochia serpentaria*, *Carex hyalina*, *Dioscorea villosa*, *Lygodium japonicum*, and *Spiranthes praecox*.

No intact, undisturbed pieces of the San Antonio Blackland Prairie are preserved in Madison County. The narrow band of prairie that once followed OSR from the Navasota River to a few miles east of Interstate Highway 45 has been lost to grazing, crops, and encroachment of woody species. Although the roadsides are occasionally mown, some portions of this stretch of road contain pockets of prairie herbs along the fencelines and treelines. These sites support species including *Astragalus distortus*, *Buglossoides arvensis*, *Eriogonum longifolium*, *Eryngium yuccifolium*, *Lythrum alatum*, *Orbexilum simplex*, *Penstemon australis*, *Rudbeckia grandiflora*, *R. maxima*, and *Silphium radula*. Roadsides along OSR are the best places in the county for wildflower viewing in the spring and summer.

The Navasota River will continue to host some of the most unique habitats in Madison County if the wild stretch of it south of Lake Limestone is allowed to remain unimpounded. The upper terraces along the river consist of deep sands where a high water table produces springs and nearly bog-like seeps. Here, two springs supported a number of species not found elsewhere in the county: *Baccharis halimifolia*, *Galium obtusum*, *Hydrocotyle ranunculoides*, *Juncus debilis*, *Polypogon monspeliensis*, *Ranunculus sceleratus*, *Saccharum baldwinii*, *Sagittaria platyphylla*, and *Taxodium distichum*. The flows of these springs have been altered by landowners to provide water for livestock, but the habitat is still rich and unique. One site also had a spring-seep area surrounded by *Myrica cerifera* and *Rubus argutus* and harbored a few species typically associated with true bogs, such as *Pluchea foetida*, *Rhexia mariana*, and *Fuirena squarrosa*. Unfortunately, in 1999 the site was excavated to create a small tank, and the altered hydrology may not continue to support these unusual plants.

Numerous natural lakes and oxbows are found along the Navasota River. Oxbows in low woods near the river host several aquatic and terrestrial species rarely or never seen elsewhere in the county. Some of these are *Didiplis diandra*, *Eragrostis hypnoides*, *Juncus repens*, *Oldenlandia boscii*, *Saururus cernuus*, and *Utricularia radiata*. Just south of OSR on the Navasota River lies a string of natural lakes in the open floodplain. These lakes have a unique flora differing from that of the oxbow lakes. Species found in and around these lakes include *Bacopa rotundifolia*, *Eleocharis palustris*, *Justicia americana*, *Nelumbo lutea*, *Nuphar lutea*, *Sphenoclea zeylanica*, and *Zizianiopsis miliacea*. Most of these species were found nowhere else in the county. Plants in these bodies of water are somewhat protected from curious botanists by snapping turtles and nesting alligators.

The Navasota River has created ancient high river terraces, which appear as a series of hills that are easily seen from OSR. These hills have bald tops with a white sand summit ringed by scrubby Post Oak woods, and rocky sides with rich prairie-like pockets. These unusual hills host species with distinctly xeric, western affinities. Species restricted to the sands include *Argemone albiflora*, *Asclepias viridiflora*, *Croptilon rigidifolium*, and *Mirabilis linearis*. *Rivina humilis* was found under the oaks near the summit of one of these hills. Species only seen on the rocky hillsides include *Loeflingia squarrosa* and *Opuntia humifusa*. The latter was covered with the scale insects (Homoptera: Coccoideae) from which the red pigment cochineal is extracted. The grassy areas of the hillside were the only sites for *Dalea compacta* in the county.

In the northern portion of the county are two creeks that drain into the Trinity River, Youngs Creek and Cobb Creek. These creeks have cut down into the ancient terrace of sand, clay, and mudstone to form deep canyons, creating a landscape unlike that in any other part of Madison County. However, the two creeks have very different histories, and this is reflected in their floras. Youngs Creek Canyon formed within the past 70 years as the result of an excavation by the owners in an attempt to divert the creek and reduce flooding of the surrounding cropland (Leon Wakefield, pers. comm. 1997). The easily eroded soil was quickly washed down to the ironstone bedrock, creating sculpted walls more than seven meters high, bizarre monolithic pinnacles of sandstone, and waterfalls. The surrounding land exhibits the uncommon Southern Red Oak - Sweet Gum - Post Oak association, but the canyon itself has not yet developed a unique flora. Only two species, *Hydrocotyle umbellata* and *Najas guadalupensis*, were found solely at Youngs Creek Canyon. Future monitoring of species recruitment at this easily accessible canyon could provide an interesting study of colonization in a situation of unusual disturbance.

The uplands around Cobb Creek are similar to those around Youngs Creek, but the maze of spring-fed gullies and canyons was created without human interference. This locality supports a flora that is allied with that of northeastern Texas and has produced several species range extensions. Species found only along springs and low banks of Cobb Creek are *Apios americana*, *Aralia spinosa*, *Carex emoryi*, *Onoclea sensibilis*, *Quercus shumardii*, *Triadenum walteri*, and *Woodwardia areolata*. One very unusual habitat at this canyon was a site with a hanging garden on the canyon wall that was continued in some aspects on the cliff above. The woods on the cliff were mostly composed of *Quercus marilandica*. Species found nowhere in the county other than this site include *Areolaria grandiflora*, *Echinacea angustifolia*, *Lactuca hirsuta*, *Liatris elegans*, *Osmunda cinnamomea*, and *Spiranthes tuberosa*. Other species unique to wooded upper banks of Cobb Creek include *Dichanthelium ravenelii*, *Erythonium albidum*, *Hieracium gronovii*, and *Packera obovata*. Species never or only rarely encountered elsewhere and occurring on high sandy banks and open areas include *Alophia drummondii*, *Cuphea carthagenensis*, *Cuphea glutinosa*, *Drosera brevifolia*, *Euphorbia tetrapora*, *Hypericum gymnanthum*, *Juglans nigra*, *Lepuropetalon spathulatum*, and *Rotala ramosior*.

One area of the county is of particular and current interest because of its impending destruction. As reported in Hipp (2000), a 27,400-acre (11,089 ha) reservoir is planned on upper Bedias Creek at the junction of Madison, Grimes, and Walker counties. The impoundment will obliterate some of the most pristine and mature low woodlands along Bedias Creek. Species found only in the area scheduled to be inundated are *Carex corrugata*, *Orbexilum pedunculatum*, *Poncirus trifoliata*, and *Liatris cymosa*, an endemic discussed in the following section. The proposed reservoir will possibly flood the only area in the county where *Spiranthes parksii*, an endangered orchid, has been collected. This species is also discussed in the following section. Opponents of the Bedias reservoir have expressed concern for the loss of wildlife habitat and possible archaeological sites. We would add that the proposed reservoir threatens some of the greatest plant diversity and grandest natural beauty in Madison County.

Range Extensions, Invaders, and Rare Taxa

This project found 40 species, in 11 genera and 5 families, not previously collected in the counties surrounding Brazos County and Texas A&M University, which was the area covered by Reed (1997). The most notable range extension is that of *Vicia lutea*, or Yellow Vetch. Madison County collections of *V. lutea* constitute the first record of its presence in Texas, as discussed in Neill (1999). Already known to occur in North Carolina, Louisiana, and California, this annual Mediterranean weed now is to be expected in other Texas counties. Three dramatically invasive species with few local records were found in Madison County: *Alternanthera philoxeroides*, *Lygodium japonicum*, and *Petrorhagia dubia*. These exotics will undoubtedly become familiar weeds in the area.

One hundred fifty non-Texas-native taxa were found in the county, or over 14% of the total taxa of Madison County. The majority of these non-natives are roadside and pasture weeds, favored by disturbance and occasionally introduced for forage. A few non-native crop species were found as waifs or persisting small populations. Examples of these crops include *Asparagus officinalis*, *Brassica rapa*, *Solanum esculentum* var. *cerasiforme*, and *Triticum aestivum*. Non-native species introduced for horticultural purposes were found in varying stages of persistence at old abandoned home sites and at cemeteries throughout the county. Examples of species restricted to these sites and not appearing to be adventive are *Canna* × *generalis*, *Ficus carica*, *Hedera helix*, *Hemerocallis fulva*, *Hibiscus syriacus*, *Hippeastrum bifidum*, *Lagerstroemia indica*, *Lantana camara*, *Ligustrum lucidum*, *Liriope spicata*, *Oxalis rubra*, *Stenotaphrum secundatum*, and *Wisteria sinensis*. Horticultural species appearing mildly adventive in that they occurred in areas where they were not likely to have been planted, or they were witnessed to be reproducing in localized areas, include *Ailanthus altissima*, *Gladiolus italicus*, *Iris pallida*, *Mirabilis jalapa*, *Nandina domestica*, *Narcissus jonquilla*, *Pyrus calleryana*, *Rosa multiflora*, and *Solanum capsicastrum*. A number of horticultural escapes are well known invaders and are established and naturalized throughout the county, including *Albizia julibrissin*, *Ligustrum sinense*, *Lonicera japonica*, *Melia azedarach*, and *Sapium sebiferum*.

Texas endemics found within Madison County are *Cucurbita pepo* var. *texana*, *Krigia cespitosa* f. *gracilis*, *Lechea san-sabeana*, *Liatris cymosa*, *Lupinus subcarnosus*, *L. texensis*, *Palafoxia rosea* var. *rosea*, *Spiranthes parksii*, and *Valerianella florifera* (Flora of Texas Consortium 2000b).

Three species of special concern were collected and are discussed below. The source for federal information is Texas Parks & Wildlife (1991).

Carex hyalina Boott.—This sedge was collected only at one site, in sandy upland pine woods near the Trinity River-Bedias Creek confluence. *Carex hyalina* was considered rare and imperiled in 1990 and was a federal candidate under review for possible listing as Category 2 and either threatened or endangered in Texas. This species seems to be more common than previously thought and currently has no federal status.

Liatris cymosa (H. Ness) K. Schum.—This endemic species is restricted to approximately six counties in southeast Texas. Although its restricted range places it in danger of extinction, this species is not under federal review for listing. This species was collected only at one site, on eroded clay at the edge of low woods near Bedias Creek in south-central Madison County.

Spiranthes parksii Correll.—This endemic species was federally listed as rare and endangered in 1982, and is restricted to approximately eight counties in southeast Texas. This species has been collected twice in the south-central part of the county. Other likely habitats in the county were searched, but it was never encountered by the authors.

ANNOTATED CHECKLIST OF THE SPECIES OF MADISON COUNTY, TEXAS

Vascular plant families are alphabetically arranged within their respective divisions. Angiosperm families are subdivided into the Magnoliopsida (Dicots) and Liliopsida (Monocots). Taxa are listed alphabetically within families by genus, species, and subspecific epithets, and authorities are given for all species. Latin names are followed by common names. Parenthetical annotation includes a designation of nativity to Texas, indicated by N (native) or I (introduced), followed by abbreviations of the major vegetational habitats in which the taxon was collected. Alphabetically, these are: aquatic emergent (AEM), aquatic floating (AFL), aquatic submerged (ASU), epiphyte (EPI), parasite (PAR), major riparian (RLM), minor riparian (RUM); terrestrial lowland mixed (TLM), open (TLO), and woods (TLW); and terrestrial upland mixed (TUM), open (TUO), and woods (TUW). Voucher specimen numbers collected by Neill (*N*) are held at TAMU and TAES herbaria at Texas A&M University. Other collectors' numbers are given with the collector's surname and herbarium abbreviation: Stephen F. Austin University (ASTC), Botanical Research Institute of Texas (BRIT and SMU), University of Texas (LL and TEX), and Sam Houston State University (SHST). Common names and nativity data are from Correll and Johnston (1970), Diggs et al. (1999), and Hatch et al. (1990).

LYCOPODIOPHYTA

ISOETACEAE

Isoetes melanopoda J. Gay & Durieu ex Durieu, Quillwort (N; AEM) *N 2545*

EQUISETOPHYTA

EQUISETACEAE

Equisetum laevigatum A. Br., Smooth Horsetail (N; RLM) *N 1942*

POLYPODIOPHYTA

ASPLENIACEAE

Asplenium platyneuron (L.) B.S.P., Ebony Spleenwort (N; TLW, TUM) *N 595, 1203, 1246*

AZOLLACEAE

Azolla caroliniana Willd., Water Fern (N; AFL) *N 130, 981, 1997*

BLECHNACEAE

Woodwardia areolata (L.) T. Moore, Chain Fern (N; RUM) *N 2081, 2666*

DRYOPTERIDACEAE

Onoclea sensibilis L., Sensitive Fern (N; RLM, RUM) *N 581, 2667*

Woodsia obtusa (Spreng.) Torr., Common Woodsia (N; RUM, TLW, TUW) *N 56, 596, 1587, 1660*

MARSILEACEAE

Marsilea macropoda A. Br., Water-clover (N; TLW) *N 1934*

OPHIOGLOSSACEAE

Botrychium biternatum (Savigny) Underw., Cutleaved Grapefern (N; TLW) *N 2390*

Botrychium lunaroides (L.) Sw., Grapefern (N) *Wilson 6269* (TAMU)

Ophioglossum crotalophoroides Walter, Heartleaf Adder's Tongue (N) *Wilson 6267, 6268* (TAMU)

OSMUNDACEAE

Osmunda cinnamomea L., Cinnamon Fern (N; TLM) *N 2668*

POLYPODIACEAE

Pleopeltis polypodioides (L.) Andrews & Windham ssp. *michauxiana* (Weath.) Andrews & Windham, Resurrection Fern (N; EPI) *N 558*

SCHIZACEAE

Lygodium japonicum (Thunb.) Swartz, Japanese Climbing Fern (I; TUW) *N 1432*

PINOPHYTA

CUPRESSACEAE

Juniperus virginiana L., Eastern Red Cedar (N; TUM, TUO) *N 83, 341, 2013, 2456*

Platycladus orientalis (L.) Franco., Arborvitae (I; TLM) *N 630*

PINACEAE

Pinus echinata Mill, Shortleaf Pine (N; TUM) *N 1116*

Pinus taeda L., Loblolly Pine (N; TLW, TUW) *N 1225, 1453, 2054, 2520*

TAXODIACEAE

Taxodium distichum (L.) Rich., Bald Cypress (N; RUM) *N 217*

MAGNOLIOPHYTA: MAGNOLIOPSIDA

ACANTHACEAE

Dicliptera brachiata (Pursh.) Spreng. (N; RLM) *N 825*

Hygrophila lacustris (Schlecht. & Cham.) Nees, Lake Acanthus (N; RLM) *N 834*

Justicia americana (L.) Vahl, American Water-willow (N; RLM) *N 1888*

Justicia ovata (Walter) Lindau var. *lanceolata* (Chapm.) R.W. Long, Lanceleaved Water-willow (N; RLM, TLM, TLW) *N 59, 284, 1655, 2196*

Ruellia humilis Nutt., Low Ruellia (N; TUO) *N 203, 624, 982, 1684, 1799, 1806*

Ruellia nudiflora (Engelm. & A. Gray) Urban, Violet Ruellia (N; TLW, TUO) *N 985, 1998*

Ruellia strepens L., Limestone Ruellia (N; RLM, TLW) *N 582, 1642*

ACERACEAE

Acer negundo L., Boxelder (N; RUM, TLW, TUM) *N 141, 1010, 1582, 2184*

AMARANTHACEAE

Alternanthera philoxeroides (Mart.) Griseb., Alliga tor weed (I; AEM) *N 1915*

Amaranthus albus L., Tumbleweed Amaranth (N; TUO) *N 2699*

Amaranthus palmeri S. Wats., Palmer Amaranth (N; TUM, TUO) *N 2242, 2262*

Amaranthus polygonoides L., Tropical Amaranth (N; TUO) *N 244*

Amaranthus rudis Sauer, Weedy Amaranth (N; RLM, RUM, TLO) *N 815, 963, 2182, 2208*

Amaranthus spinosus L., Spiny Amaranth (I; TUO) *N 243, 2308*

Amaranthus viridis L., Green Amaranth (I; TUO) *N 2241, 2269*

Froelichia drummondii Moq., Drummond Snakecotton (N) *Taubenhaus 2643* (TAES)

Froelichia floridana (Nutt.) Moq., var. *floridana* Florida Snakecotton (N; TUO) *N 242*

Froelichia floridana (Nutt.) Moq. var. *campestris* (Small.) Fern., Florida Snakecotton (N; TUO) *N 727, 2216*

Gossypianthus lanuginosus (Poir.) Moq. in A. DC. var. *lanuginosus*, Woolly Cottonflower (N; TUO) *N 1072*

Iresine rhizomatosa Standl., Rootstock Bloodleaf (N; RLM, RUM) *N 868, 1013*

ANACARDIACEAE

Rhus aromatica Aiton var. *serotina* (Greene) Rehd., Fragrant Sumac (N; TUM, TUO, TUW) *N 529, 2098, 2561*

Rhus copallina L., Flameleaf Sumac (N; TLM, TUM, TUW) *N 733, 1134, 1724*

Rhus glabra L., Smooth Sumac (N; TLM) *N 147*

Toxicodendron radicans (L.) Kuntze. ssp. *radicans*, Poison Ivy (N; TLM, TUW) *N 157, 1452, 1457*

APIACEAE

Bowlesia incana Ruiz & Pav., Hoary Bowlesia (I; RUM) *N 2503*

Chaerophyllum tainturieri Hook. var. *dasycarpum* Hook. ex S. Wats., Hairyfruit Chervil (N; TLM) *N 1239, 1577*

Chaerophyllum tainturieri Hook. var. *tainturieri*, Chervil (N; TLO, TLW) *N 521, 1271*

Cicuta maculata L. var. *maculata*, Spotted Water-hemlock (N; RUM, TLM, TUM) *N 75, 648, 1810, 1953*

Cyclospermum leptophyllum (Pers.) Sprague, Slimlobe Celery (I; RUM, TLM, TLW) *N 1597, 2160, 2536*

Cynosciadium digitatum DC., Finger Dogshade (N; RUM, TLO, TLW) *N 52, 1669, 1741, 1925*

Daucus pusillus Michx., Rattlesnake Weed (I; TLO, TUO) *N 602, 1690, 1835, 2625*

Eryngium hookeri Walp., Hooker Eryngo (N; RLM, TLO, TUO) *N 127, 583, 1750, 1882, 1956, 1979*

Eryngium prostratum Nutt. ex DC., Creeping Eryngo (N; RUM, TUW) *N 251, 1912, 2614*

Eryngium yuccifolium Michx. var. *yuccifolium*, Button Snakeroot (N; TUM, TUO) *N 182, 642*

Hydrocotyle ranunculoides L.f., Floating Water-pennywort (N; AEM, RUM) *N 1346, 1989*

Hydrocotyle umbellata L., Umbrella Water-pennywort (N; RUM) *N 603*

Hydrocotyle verticillata Thunb. var. *triradiata* (A. Rich.) Fern., Whorled Water-pennywort (N; RUM, TLO) *N 1746, 2509*

Hydrocotyle verticillata Thunb. var. *verticillata*, Whorled Water-pennywort (N; RLM) *N 118, 1988*

Limnosciadium pinnatum (DC.) Math. & Const., Arkansas Dogshade (N; RLM, TLW) *N 121, 1571, 1926*

Limnosciadium pumilum (Engelm. & A. Gray) Math. & Const., Prairie Dogshade (N; RUM, TUW) *N 1634, 1663*

Polytaenia nuttallii DC., Prairie Parsley (N; TLM, TUM, TUO) *N 63, 621, 764*

Polytaenia texana (J.M. Coult. & Rose) Math. & Const., Texas Prairie Parsley (N; RUM) *N 2041*

Ptilimnium nuttallii (DC.) Britton, Nuttall Mock Bishops Weed (N; TUM, TUO) *N 23, 566, 615, 1797, 2650*

Sanicula canadensis L., Canada Snakeroot (N; TLW, TUW) *N 599, 1412, 1557*

Spermolepis divaricata (Walter) Raf. ex Ser., Forked Scaleseed (N; TUM, TUO) *N 1789, 2624*

Spermolepis inermis (Nutt. ex DC.) Math. & Const., Spreading Scaleseed (N; TUO) *N 2599*

Torilis arvensis (Huds.) Link., Hedgeparsley (I; TLM, TUM) *N 753, 1581*

Trepocarpus aethusae Nutt. ex DC. (N; RLM, TLM) *N 53, 587*

APOCYNACEAE

Amsonia illustris Woods., Blue Star (N; RLM, TLO, TLW) *N 1347, 1657, 1995, 2322*

Apocynum cannabinum L., Dogbane (N; TUM, TUO) *N 1801, 2281*

Trachelospermum difforme (Walter) A. Gray, Climbing Dogbane (N; RLM, TLO, TLW, TUM, TUW) *N 233, 610, 1675, 1745, 1919, 2323, 2612*

AQUIFOLIACEAE

Ilex decidua Walter, Possum-haw (N; RLM, TUM, TUW) *N 422, 665, 943, 1051, 1110, 1208, 1447*

Ilex longipes Chapm. ex Trel. var. *hirsuta* Lundell, Georgia Holly (N) *Dixon 432* (SMU) (Lundell 1943)

Ilex opaca Aiton, American Holly (N; RLM, TUW) *N 216, 1665*

Ilex vomitoria Aiton, Yaupon Holly (N; RLM, TUM, TUW) *N 215, 942, 1050*

ARALIACEAE

Aralia spinosa L., Devil's Walking Stick (N; RUM) *N 2073*

Hedera helix L., English Ivy (I; TLM) *N 1244*

ARISTOLOCHIACEAE

Aristolochia serpentaria L. var. *hastata* (Nutt.) Duchartre, Virginia Dutchman's Pipe (N; TLW) *N 2382*

Aristolochia tomentosa Sims, Woolly Pipe-vine (N; RLM) *N 2341*

ASCLEPIADACEAE

Asclepias amplexicaulis Sm., Blunt-leaf Milkweed (N; TLO, TUW) *N 1662, 1757*

Asclepias obovata Ell., Milkweed (N; TUM) *N 2058*

Asclepias oenotherioides Cham. & Schltdl., Primrose Milkweed (N; TLO, TUM, TUO) *N 238, 569, 1871*

Asclepias tuberosa L., Butterfly Milkweed (N; TLM, TUO) *N 70, 1802, 1836*

Asclepias verticillata L., Whorled Milkweed (N; TUM, TUO) *N 91, 718, 1795, 1813*

Asclepias viridiflora Raf., Green Antelope Horn (N; TUM) *N 1870*

Asclepias viridis Walter, Antelope Horn (N; TUO) *N 207, 279, 702, 1527*

Cynanchum laeve (Michx.) Pers., Smooth Swallow-wort (N; RLM) *N 900*

Matelea cyanchoides (Englem.) Woods, Sand Milkvine (N; TLW, TUM, TUO) *N 1682, 1727, 1775*

Matelea gonocarpos (Walter) Shinners, Milkvine (N; TLW, TUM) *N 214, 531, 1498, 1861*

ASTERACEAE

Achillea millefolium L. var. *occidentalis* DC., Yarrow (I; TUO) *N 81*

Ambrosia artemisiifolia L., Common Ragweed (N; TUM, TUO) *N 2086, 2394*

Ambrosia psilostachya DC., Western Ragweed (N; TLO, TUM, TUO) *N 266, 928, 1020, 2370, 2701*

Ambrosia trifida L., Giant Ragweed (N; RLM, TLO, TUO) *N 34, 820, 961, 2286*

Amphiachyris dracunculoides DC., Annual Broomweed (N; TUO) *N 326, 911, 2180, 2713*

Arnoglossum plantagineum Raf., Indian Plantain (N; TLM, TUM) *N 96, 1579*

Artemesia ludoviciana Nutt., Louisiana Sagewort (N; TUM, TUO) *N 1118, 2153, 2696*

Aster drummondii Lindl. var. *texanus* (Burgess) A.G. Jones, Texas Aster (N; TUM) *N 1104*

Aster ericoides L., Heath Aster (N; TLW, TUO) *N 986, 1066, 2425*

Aster fragilis Willd., Aster (N; TLM) *N 1016*

Aster lanceolatus Willd., Aster (N; TLO) *N 1040*

Aster lateriflorus (L.) Britton, California Aster (N; RLM, TUM) *N 949, 1123*

Aster oolentangiensis Ridd., Azure Aster (N; TUM, TUO) *N 1096, 2413*

Aster patens Aiton var. *gracilis* Hook., Skydrop Aster (N; TUO) *N 1071*

Aster patens Aiton var. *patens*, Skydrop Aster (N; TUM, TUO) *N 329, 1137, 2368, 2427*

Aster patens Aiton var. *patentissimus* (Lindl. ex DC.) T. & G., Skydrop Aster (N; TUM) *N 1793*

Aster praealtus Poir., Tall Aster (N; RLM) *N 885*

Aster sericeus Vent. var. *microphyllus* DC., Silky Aster (N; TUM, TUO) *N 1078, 1651, 2369, 2426*

Aster subulatus Michx. var. *ligulatus* Shinners, Lawn Aster (N; TLO, TUO) *N 947, 1069*

Astranthium integrifolium (Michx.) Nutt., Western Daisy (N; TUO) *N 2605*

Astranthium integrifolium (Michx.) Nutt. ssp. *ciliatum* (Raf.) DeJong, Western Daisy (N; TLM) *N 2578*

Baccharis halimifolia L., Eastern Baccharis (N; RUM) *N 2329*

Baccharis neglecta Britton, Roosevelt-weed (N; TUO) *N 328, 1001, 1084*

Berlandiera pumila (Michx.) Nutt., Soft Greeneyes (N; TUM, TUO) *N 80, 2154*

Bidens bipinnata L., Spanish Needles (N; TLM, TLW, TUM) *N 774, 2391, 2424*

Bigelowia nuttallii L.C. Anders, Slender Bigelowia (N; TLM) *N 2044*

Boltonia asteroides (L.) L'Her., White Boltonia (N; TUM) *N 1776*

Boltonia diffusa Ell., Small Boltonia (N; TUM, TUO) *N 2087, 2108*

Calyptocarpus vialis Less., Horseherb (N; TUO) *N 2239*

Centaurea americana Nutt., American Basketflower (N; TLO, TUO) *N 133, 617*

Chaetopappa asteroides (Nutt.) DC., Common Least Daisy (N; TLO, TUO) *N 1222, 1706, 2474*

Chrysopsis pilosa Nutt., Soft Goldaster (N; TLO, TUM) *N 104, 178, 1781, 1996, 2256*

Cirsium altissimum (L.) Spreng., Iowa Thistle (N) *Cory 54578* (LL)

Cirsium engelmannii Rydb., Engelman Thistle (N; TUO, TUW) *N 698, 1952*

Cirsium horridulum Michx., Bull Thistle (N; TLM, TUO) *N 551, 1491*

Cirsium texanum Buckl., Southern Thistle (N; TUM) *N 1866*

Conyza canadensis (L.) Cronq. var. *canadensis*, Horsetail (N; TUO, TUW) *N 1047, 2710*

Conyza canadensis (L.) Cronq. var. *glabrata* (A. Gray) Cronq., Horsetail (N; TLM, TUO) *N 2295, 2693*

Coreopsis basalis (Dietr.) Blake, Goldenmane Tickseed (N; TLO, TUM, TUO) *N 33, 1845, 2616*

Coreopsis grandiflora Hogg. ex Sweet var. *longipes* (Hook.) T. & G., Bigflower Tickseed (N; TLO, TUM, TUO) *N 463, 1466, 1798, 2568*

Croptilon divaricatum (Nutt.) Raf., Slender Scratch Daisy (N; TUM, TUO) *N 277, 775, 2251, 2328*

Croptilon rigidifolium (E.B. Smith) E.B. Smith, Scratch Daisy (N; TUM, TUO) *N 1873, 2392*

Dracopsis amplexicaulis (Vahl) Cass., Clasping Coneflower (N; TLW, TUO) *N 1751, 2569*

Echinacea angustifolia DC. var. *angustifolia*, Black Sampson (N; TLM) *N 2671*

Echinacea sanguinea Nutt., Purple Coneflower (N; TLM, TUM) *N 1710, 1784*

Eclipta prostrata (L.) L., Yerba de Tago (N; RLM, RUM, TLM) *N 839, 980, 2198, 2683*

Elephantopus carolinianus Raeusch, Leafy Elephantfoot (N; RLM, RUM, TLW) *N 294, 774, 832, 2330, 2396*

Engelmannia peristenia (Raf.) Goodman & C.A. Lawson, Engelmann's Daisy (N; TLO, TUO) *N 515, 1826, 2567*

Erigeron strigosus Muhl. ex Willd. var. *beyrichii* (Fisch. & Mey.) T.&G. ex A. Gray, Prairie Fleabane (N; TLO, TUO) *N 565, 2637*

Erigeron strigosus Muhl. ex Willd. var. *strigosus*, Prairie Fleabane (N; TLM, TLO, TUM, TUW) *N 1807, 1899, 2046, 2598, 2613*

Erigeron tenuis T. & G., Slender Fleabane (N; TLM, TLO, TLW, TUO) *N 39, 1302, 1515, 1622, 2636*

Eupatorium capillifolium (Lam.) Small, Dog-fennel (N; TUM, TUO) *N 773, 1113, 2387*

Eupatorium coelestinum L., Mistflower (N; RLM, RUM, TLW) *N 738, 838, 2116*

Eupatorium compositifolium Walter, Yankeeweed (N; TUM, TUO) *N 984, 2185, 2299, 2431*

Eupatorium incarnatum Walter, Pink Boneset (N; TLM, TLW) *N 1026, 2388, 2417*

Eupatorium semiserratum DC., Boneset (N; RUM, TUO) *N 2226, 2247*

Eupatorium serotinum Michx., Late Boneset (N; RLM, RUM, TUM, TUO) *N 225, 293, 739, 2119, 2215*

Eurybia hemispherica (Alex.) Nesom, Low Aster (N; TLM, TUM, TUO) *N 2412, 2420, 2695*

Euthamia leptocephala (T.&G.) Greene (N; TLM, TUO) *N 2378, 2430*

Evax candida (T.&G.) A. Gray, Silver Rabbit-tobacco (N; TUM, TUO) *N 547, 1852, 2564*

Evax prolifera DC., Bighead Rabbit-tobacco (N; TLW) *N 1263*

Evax verna Raf., Manystem Rabbit-tobacco (N; TUO) *N 1520*

Facelis retusa (Lam.) Schultz-Bip. (I; TLW, TUO) *N 1511, 2475, 2497*

Gaillardia pulchella Foug., Indian Blanket (N; TUO) *N 208, 2393*

Gnaphalium falcatum Lam., Cudweed (I; TLW) *N 1248, 1927*

Gnaphalium obtusifolium L., Fragrant Cudweed (N; TLM, TLW, TUO) *N 2294, 2423, 2697*

Gnaphalium pensylvanicum Willd., Pennsylvania Cudweed (N; TLW, TUO) *N 387, 1252, 1574*

Gnaphalium purpureum L., Purple Cudweed (N; TUO, TUW) *N 655, 1965*

Helenium amarum (Raf.) Rock var. *amarum*, Sneezeweed (N; RLM, TUW) *N 166, 654*

Helenium flexuosum Raf., Purplehead Sneezeweed (N; TLO) *N 2552, 2611*

Helenium microcephalum DC., Smallhead Sneezeweed (N; TUO) *N 568*

Helianthus annuus L., Sunflower (N; TLO, TUO) *N 73, 2204*

Helianthus debilis Nutt. ssp. *cucumerifolius* (T.&G.) Heiser, Cucumberleaf Sunflower (N; TUO) *N 1957, 2113*

Helianthus grosseserratus Martens, Sawtooth Sunflower (N; TLM, TLO) *N 1017, 1045*

Helianthus hirsutus Raf., Hairy Sunflower (N; RUM, TUM) *N 2011, 2045*

Heterotheca mariana (L.) Ell., Maryland Camphorweed (N; TLO) *N 1825* (*Chrysopsis mariana* (L.) Ell.)

Heterotheca subaxillaris (Lam.) Britton & Rusby var. *latifolia* (Buckl.) Gandhi & Thomas, Camphorweed (N; TLO, TLW, TUM) *N 939, 1132, 2395*

Heterotheca subaxillaris (Lam.) Britton & Rusby var. *subaxillaris*, Camphorweed (N; TLO) *N 638*

Hieracium gronovii L., Hawkweed (N; RUM) *N 2675*

Hymenopappus scabiosaeus L'Her. var. *artemisiifolius* (DC.) Gandhi & Thomas, Ragweed Woolly-white (N; TLO, TUO) *N 1514, 1608, 2593*

Hymenopappus scabiosaeus L'Her. var. *scabiosaeus* (T.&G.) B.L. Turner, Flattop Woolly-white (N; TUM) *N 505, 535*

Iva angustifolia Nutt. ex DC., Narrowleaf Marshelder (N; TLO, TUM, TUO) *N 983, 1083, 2230, 2254, 2337*

Iva annua L., Marshelder (N; RLM, TLM, TLO) *N 845, 964, 2206*

Krigia cespitosa (Raf.) Chambers f. *cespitosa*, Weedy Dwarf Dandelion (N; TLM, TLW) *N 1295, 2531, 2583*

Krigia cespitosa (Raf.) Chambers f. *gracilis* (DC.) Kim, Dwarf Dandelion (N; TLM, TUO) *N 514, 1540, 2530, 2584*

Krigia dandelion (L.) Nutt., Tuber Dwarf Dandelion (N; TUM, TUO) *N 536, 1320, 2558*

Krigia occidentalis Nutt., Western Dwarf Dandelion (N; TUO) *N 2494*

Krigia virginica (L.) Willd., Virginia Dwarf Dandelion (N; TUO) *N 2562*

Lactuca canadensis L., Wild Lettuce (N; TLW, TUM, TUO) *N 1783, 2027, 2090, 2109, 2653*

Lactuca floridana (L.) Gaertn., Florida Lettuce (N; TUW) *N 1664, 1910*

Lactuca hirsuta Muhl. var. *albiflora* (T.&G.) Shinners, Hairy Lettuce (N; TLM) *N 2672*

Lactuca ludoviciana (Nutt.) Ridd., Wild Lettuce (N; TUO) *N 2651*

Lactuca serriola L., Prickly Lettuce (I; RLM) *N 852*

Liatris cymosa (H. Ness) K. Schum., Branched Gayfeather (N; TUM) *N 2298*

Liatris elegans (Walter) Michx., Pinkscale Gayfeather (N; TLM) *N 2669*

Liatris mucronata DC., Gayfeather (N; TLM, TUM, TUO) *N 2231, 2314, 2429*

Liatris squarrosa (L.) Michx., Gayfeather (N; TUO) *N 719, 1087, 2692*

Liatris squarrosa (L.) Michx. var. *alabamensis* (Alex.) Gaiser, Gayfeather (N; TLM, TUO) *N 2014, 2051*

Mikania scandens (L.) Willd., Climbing Hemp (N; RLM, RUM) *N 221, 847, 937*

Oligoneuron nitidum (T.&G.) Small, Flat-top Goldenrod (N; TUO) *N 1049, 2380*

Packera obovata (Muhl. ex Willd.) Weber & Cove, Golden Groundsel (N; TLW) *N 2515*

Packera tampicana (DC.) Jeffrey, Butterweed (N; RLM, TLW, TUO) *N 72, 425, 1272, 2521*

Palafoxia rosea (Bush) Cory var. *rosea*, Rose Palafoxia (N; TUM, TUO) *N 709, 1796, 2089, 2229, 2414*

Palafoxia texana DC. var. *ambigua* (Shinners) B.C. Turner & Morris, Texas Palafoxia (N; TUO) *N 2315*

Palafoxia texana DC. var. *texana*, Texas Palafoxia (N; TUM) *N 90*

Pluchea camphorata (L.) DC., Camphor Marsh-fleabane (N; RLM, TLM) *N 867, 954, 2205, 2332*

Pluchea foetida (L.) DC., Stinking Marsh-fleabane (N; RUM) *N 239*

Pluchea odorata (L.) Cass., Purple Marsh-fleabane (N; RLM) *N 291, 2331*

Pterocaulon virgatum (L.) DC., Wand Blackroot (N; TUO) *N 2317*

Pyrrhopappus carolinianus (Walter) DC., Carolina False Dandelion (N; TUO) *N 1556, 1904, 2634, 2652*

Pyrrhopappus pauciflorus (D. Don.) DC., Manystem False Dandelion (N; TLM) *N 2582*

Ratibida columnifera (Nutt.) Woot. & Standl., Mexican-hat (N; TUO) *N 2654*

Rudbeckia grandiflora (D. Don.) J.F. Gmel ex DC. var. *alismifolia* (T.&G.) Cronq., Rough Coneflower (N; TUM) *N 2691*

Rudbeckia grandiflora (D.Don.) J.F. Gmel. ex DC. var. *grandiflora*, Rough Coneflower (N; TUM) *N 180*

Rudbeckia hirta L. var. *hirta*, Black-eyed Susan (N; TUO) *N 27*

Rudbeckia hirta L. var. *angustifolia* (T.V. Moore) Perdue, Black-eyed Susan (N; TUM) *N 503*

Rudbeckia hirta L. var. *pulcherrima* Farw., Black-eyed Susan (N; TUM, TUO) *N 1756, 1859*

Rudbeckia maxima Nutt., Great Coneflower (N; TUM, TUO) *N 177, 564, 2010*

Senecio ampullaceus Hook., Texas Groundsel (N; TLM, TLW, TUO) *N 48, 1265, 1484, 2453*

Silphium gracile A. Gray; Simpson Rosinweed (N; TLO, TUO) *N 646, 1612, 2646*

Silphium radula Nutt., Roughstem Rosinweed (N; TUM, TUO) *N 1809, 2007*

Solidago canadensis L. var. *gilvocanescens* Rydb., Common Goldenrod (N; TUO) *N 1003*

Solidago canadensis L. var. *scabra* T.&G. Common Goldenrod (N; TUM) *N 1130*

Solidago gigantea Aiton var. *serotina* (Aiton) Cronq., Giant Goldenrod (N; TLM) *N 2448*

Solidago nemoralis Aiton var. *nemoralis*, Oldfield Goldenrod (N; TUO) *N 989, 1901*

Solidago radula Nutt., Rough Goldenrod (N; TUO) *N 1030, 2316*

Solidago rugosa P. Mill, Wrinkled Goldenrod (N; TUO) *N 1006*

Solidago salicina Ell., Willowleaf Goldenrod (N; TUM, TUO) *N 784, 1080, 2694* (*S. patula* Muhl. ex Willd. var. *strictula* Torr. & A. Gray)

Solidago speciosa Nutt. var. *rigidiuscula* T.&G., Noble Goldenrod (N; TUO) *N 2379*

Solidago ulmifolia Muhl. ex Willd., Elmleaf Goldenrod (N; TLM, TUO) *N 2297, 2415*

Solidago ulmifolia Muhl. ex Willd. var. *microphylla* A. Gray., Elmleaf Goldenrod (N; TUM, TUO) *N 268, 784, 2233*

Soliva sessilis Ruiz & Pavon, Burweed (I; TLW, TUO) *N 449, 1575, 1740*

Soliva stolonifera (Brot.) Loud., Burweed (I; TLW) *N 1262*

Sonchus asper (L.) Hill, Prickly Sowthistle (I; TUO) *N 1613, 2496*

Taraxacum officinale G.H. Weber ex Wiggers, Dandelion (I; TUO) *N 2495*

Tetraneuris scaposa (DC.) Greene, Bitterweed (N) *Gonzales 15* (TAES)

Verbesina encelioides (Cav.) Benth. & Hook f. ex A. Gray, Cowpen Daisy (N; TUO) *N 2367, 2389*

Verbesina virginica L., Frostweed (N; RLM, RUM, TUW) *N 1048, 2181, 2227, 2321*

Vernonia baldwinii Torr., Baldwin Ironweed (N; RLM, RUM) *N 292, 862, 2156*

Vernonia missurica Raf., Missouri Ironweed (N) *Jones & Jones 407* (TAES)

Vernonia texana (A. Gray) Small, Texas Ironweed (N; RUM, TLW, TUM, TUW) *N 1913, 2088, 2228, 2246, 2428, 2656*

Xanthium strumarium L., Cocklebur (N; RLM, RUM) *N 163, 831, 2285*

BERBERIDACEAE

Nandina domestica Thunb., Heavenly Bamboo (I; TUO) *N 1623*

BETULACEAE

Betula nigra L., River Birch (N; RUM) *N 1591, 1730*

BIGNONIACEAE

Campsis radicans (L.) Seem. ex Bureau, Trumpet-creeper (N; RLM, TLM, TUM) *N 89, 671, 945*

Catalpa bignonioides Walter, Southern Cigar-tree (N; TUM, TUO) *N 1800, 2704*

BORAGINACEAE

Buglossoides arvensis (L.) I.M. Johnst., Bugloss (I; TUO) *N 363*

Heliotropium indicum L., Turnsole (N; RLM, TLO, TLW) *N 126, 865, 1893, 1923*

Heliotropium procumbens Mill, Fourspike Heliotrope (I; RLM, TLM, TLO) *N 883, 2188, 2659*

Lithospermum incisum Lehm., Narrowleaf Puccoon (N; TUO) *N 373, 1199, 2647*

Myosotis macrosperma Engelm. var. *macrosperma*, Spring Forget-me-not (N; RUM, TLW) *N 451, 1299, 1532*

Myosotis verna Nutt., Early Scorpion-grass (N; TLW) *N 1300*

Onosmodium bejarense DC. ex A.DC. var. *occidentale* (Mack.) B.L. Turner, Western Marbleseed (N; TUW) *N 1416*

BRASSICACEAE

Brassica rapa L., Turnip (I; TUO) *N 1321*

Capsella bursa-pastoris (L.) Medic, Shephard's Purse (I; TLM, TUO) *N 347, 1228*

Cardamine hirsuta L., Hairy Bittercress (N; TLM) *N 1211*

Cardamine parviflora L. var. *arenicola* (Britton) O.E. Schulz, Sand Bittercress (N; TLM, TUM) *N 384, 1202, 1229*

Draba brachycarpa Nutt. ex T.&G., Shortpod Draba (N; TLM) *N 2469*

Lepidium densiflorum Schrad., Prairie Pepperweed (N; TUO) *N 1503*

Lepidium virginicum L. var. *medium* (Greene) C.L. Hitchc., Virginia Pepperweed (N; TLM) *N 1230*

Lepidium virginicum L. var. *virginicum*, Virginia Pepperweed (N; TLM) *N 51*

Neobeckia aquatica (Eat.) Greene, Water Horseradish (N; AEM) *N 1402*

Rapistrum rugosum (L.) All. (I; TUM, TUO) *N 1323, 2492*

Rorippa sessiliflora (Nutt.) A.S. Hitchc., Stalkless Yellowcress (N; RLM, TLW) *N 444, 1348, 1827, 1929*

BUDDLEJACEAE

Polypremum procumbens L., Juniperleaf (N; RLM, RUM, TUM, TUO) *N 185, 884, 2037, 2145*

CACTACEAE

Opuntia engelmannii Salm-Dyck. var. *linguiformis* (Griffiths) Parfitt & Pinkava, Cowtongue Prickly-pear (N; TLO) *N 2416*

Opuntia humifusa (Raf.) Raf. var. *humifusa*, Eastern Prickly-pear (N; TUM, TUO) *N 1119, 1855*

Opuntia macrorhiza Engelm. var. *macrorhiza*, Plains Prickly-pear (N; TUO) *N 1698*

CAESALPINIACEAE

Cercis canadensis L. var. *canadensis*, Eastern Redbud (N; TLM, TLW, TUM) *N 154, 368, 1529, 2522*

Chamaechrista fasiculata (Michx.) Greene, Prairie Senna (N; TLM, TUO) *N 44, 908, 1029, 1853, 2003*

Gleditsia aquatica Marsh., Water Locust (N; RLM) *N 2711*

Gleditsia triacanthos L., Honey Locust (N; RLM, TLM, TLW, TUM, TUW) *N 194, 584, 1139, 1282, 1949*

Parkinsonia aculeata L., Retama (I; TUO) *N 2632*

Senna obtusifolia (L.) Irwin & Barneby, Sicklepod Senna (I; TLM, TUO) *N 2293, 2405*

Senna occidentalis (L.) Link, Coffee Senna (I; TUO) *N 241, 2406*

CALLITRICHACEAE

Callitriche heterophylla Pursh. (emend. Darby), Larger Water-starwort (N; AFL, RUM, TLW) *N 437, 1257, 1356, 1552*

Callitriche nuttallii Torr., Nuttall Water-starwort (N; RUM, TLW) *N 446, 1267*

Callitriche palustris L., Common Water-starwort (N; RLM, RUM, TLW) *N 1553, 1937, 2539*

Callitriche peploides Nutt., Mat Water-starwort (N; RLM, TLO) *N 2476, 2540*

CAMPANULACEAE

Lobelia appendiculata A. DC., Earflower Lobelia (N; TUO, TUW) *N 658, 1620, 1652, 1722*

Lobelia cardinalis L., Cardinal Flower (N; RLM) *N 859*

Lobelia puberula Michx. var. *pauciflora* Bush, Downy Lobelia (N; TLM) *N 2296*

Lobelia puberula Michx. var. *puberula*, Downy Lobelia (N; TUM) *N 778*

Triodanis perfoliata (L.) Nieuw. var. *biflora* (R. & P.) Bradley, Small Venus' Looking-glass (N; TLM, TUO) *N 54, 518, 1487*

Triodanis perfoliata (L.) Nieuw. var. *perfoliata*, Clasping Venus' Looking-glass (N; TLO, TUO) *N 1426, 1536, 2566*

CAPPARACEAE

Polanisia erosa (Nutt.) Iltis ssp. *erosa*, Large Clammyweed (N; TLO) *N 2155*

CAPRIFOLIACEAE

Lonicera japonica Thunb., Japanese Honeysuckle (I; TLM, TLW, TUM, TUO, TUW) *N 36, 325, 1097, 1126, 1133, 1584*

Lonicera sempervirens L., Scarlet Honeysuckle (N; TLM, TLW, TUM) *N 135, 351, 1497, 2025*

Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli, Elderberry (N; RLM, TLW, TUM) *N 78, 598, 858, 1596, 1647*

Symphoricarpos orbiculatus Moensch, Coralberry (N; TLM, TUM, TUW) *N 43, 1122, 1138*

Viburnum rufidulum Raf., Rusty Blackhaw Viburnum (N; TLM, TLW, TUW) *N 149, 1578, 2072*

CARYOPHYLLACEAE

Arenaria drummondii Shinners, Drummond Sandwort (N; TUM, TUO) *N 546, 1316, 1629* (*Minuartia drummondii* (Shinners) McNeill)

Arenaria patula Michx., Sandwort (N; TLW) *N 1273* (*Minuartia patula* (Michx.) Mattf.)

Arenaria patula Michx. var. *robusta* Steyerm., Sandwort (N; TLM) *N 2577* (*Minuartia muscorum* (Fassett) Rabeler)

Arenaria serpyllifolia L., Thyme-leaved Sandwort (I; TLO, TUO) *N 361, 1195, 1223*

Cerastium brachypetalum Pers., Shortpetal Chickweed (I; TLM) *N 2555*

Cerastium brachypodium (Engelm. & A. Gray) Robins, Shortstalk Chickweed (N; TUO) *N 365*

Cerastium glomeratum Thuill., Mouse-ear (I; TUO) *N 362, 1197*

Loeflingia squarrosa Nutt., Spreading Loeflingia (N; TUM) *N 1856*

Paronychia lindheimeri Engelm ex A. Gray, Lindheimer Nailwort (N; TLM) *N 2421*

Petrorhagia dubia (Raf.) G. Lopez & Romo, Childling Pink (I; TLO, TUM) *N 1463, 1471*

Sagina decumbens (Ell.) T.&G., Trailing Pearlwort (N; RUM, TLM) *N 2470, 2734*

Silene antirrhina L., Sleepy Catchfly (N; TLO, TUO) *N 2571, 2640*

Silene gallica L., Forked Catchfly (I; TUO) *N 513, 1329, 1482*

Stellaria media (L.) Vill., Chickweed (I; TUM, TUW) *N 335, 2449*

CHENOPODIACEAE

Chenopodium ambrosioides L., Epazote (I; RLM, RUM, TLM, TUO) *N 869, 1709, 2157, 2199*

Chenopodium berlandieri Moq., Pitseed Goosefoot (N; TUM) *N 1121*

Chenopodium standleyanum Aellen Standley Goosefoot (N; TUM) *N 2371*

CISTACEAE

Helianthemum georgianum Chapm. , Georgia Sunrose (N; TUM, TUO) *N 1872, 1958, 2621*

Helianthemum rosmarinifolium Pursh., Rosemary Sunrose (N; TLO, TUO) *N 1697, 1707, 2644*

Lechea mucronata Raf., Hairy Pinweed (N; TUM, TUO) *N 181, 700, 1843, 1959*

Lechea san-sabeana (Buckl.) Hodg., San Saba Pinweed (N; TUO) *N 706, 2620*

Lechea tenuifolia Michx., Narrowleaf Pinweed (N; TUM, TUO) *N 705, 1686, 1879, 2069*

CLUSIACEAE

Hypericum drummondii (Grev. & Hook.) T.&G., Drummond St. John's Wort (N; TLM, TUM, TUO) *N 259, 1079, 1107, 2225, 2292*

Hypericum gymnanthum Engelm. & A. Gray, Clasping St. John's Wort (N; TLO) *N 2688*

Hypericum hypericoides (L.) Crantz. ssp. *hypericoides*, St. Andrew's Cross (N; RUM, TLO, TUM, TUO) *N 276, 747, 938, 2224*

Hypericum mutilum L., Dwarf St. John's Wort (N; TLM) *N 2386*

Triadenum walteri (Gmel.) Gl., Marsh St. John's Wort (N; RUM) *N 2079*

CONVOLVULACEAE

Dichondra carolinensis Michx., Ponyfoot (N; TLW, TUO) *N 389, 1555*

Evolvulus sericeus Sw., Silky Evolvulus (N; TUM, TUO) *N 616, 757, 1500*

Ipomoea cordatotriloba Dennst. var. *cordatotriloba*, Bindweed (N; TLO, TUO) *N 280, 607, 955, 1824*

Ipomoea lacunosa L., Pitted Morning-glory (N; RLM, RUM, TLM) *N 851, 948, 2311, 2385*

Ipomoea pandurata (L.) G.F.W. Mey, Bigroot Morning-glory (N; TLM, TUM) *N 2074, 2689*

Jacquemontia tamnifolia (L.) Griseb., Hairy Clustervine (I) *Taubenhaus 2642* (TAES)

CORNACEAE

Cornus drummondii C.A.Mey, Roughleaf Dogwood (N; TLM, TLW) *N 49, 632, 1643*

Cornus florida L., Flowering Dogwood (N; TLW) *N 1331, 2103*

CRASSULACEAE

Crassula aquatica (L.) Schoenl., Water Pygmyweed (N; TLM, TLO, TLW) *N 1427, 1549, 2478*

CUCURBITACEAE

Cucumis melo L., Muskmelon (I; TLM) *N 2384*

Cucurbita pepo L. var. *texana* (Scheele) D. Decker, Texas Gourd (N; RLM) *N 288, 813, 2147*

Melothria pendula L., Melonette (N; RLM, RUM, TLM, TUW) *N 160, 703, 933, 2023, 2291*

CUSCUTACEAE

Cuscuta cuspidata Engelm., Cusp Dodder (N; PAR) *N 1044, 2381*

Cuscuta glomerata Choisy, Cluster Dodder (N; PAR) *N 2201*

Cuscuta obtusiflora Kunth. in H.B.K. var. *glandulosa* Engelm., Red Dodder (N; PAR) *N 134, 2202*

DROSERACEAE

Drosera brevifolia Pursh., Annual Sundew (N;TLO) *N 2473, 2512*

EBENACEAE

Diospyros virginiana L., Virginia Persimmon (N; TLM, TLO, TUO) *N 140, 922, 1455, 1648*

ELATINACEAE

Elatine brachysperma A. Gray, Shortleaf Waterwort (N; TLM, TLW) *N 1288, 1428, 1551*

ERICACEAE

Vaccinium arboreum Marsh., Farkleberry (N; TUM, TUW) *N 100, 211, 557, 1074, 1128, 1705*

EUPHORBIACEAE

Acalypha gracilens A. Gray, Slender Copperleaf (N; RUM, TLM, TUO) *N 991, 2159, 2190*

Acalypha monococca (Engelm. ex A. Gray) L.Mill & Gandhi, One-seed Copperleaf (N; TUM, TUO) *N 265, 704, 788*

Acalypha rhomboidea Raf., Rhomboid Copperleaf (N; RLM) *N 840*

Acalypha virginica L., Virginia Copperleaf (N; RUM, TLO) *N 931, 2158, 2684*

Cnidoscolus texanus (Muell.-Arg.) Small., Texas Bullnettle (N; TLM, TUW) *N 550, 1674*

Croton argyranthemus Michx., Silver Croton (N; TUM) *N 2056*

Croton capitatus Michx., Woolly Croton (N; RLM, TLO) *N 800, 962*

Croton capitatus Michx. var. *lindheimeri* (Engelm. & A. Gray) Muell.-Arg., Woolly Croton (N; TUO) *N 281*

Croton glandulosus L. var. *glandulosus*, Tropic Croton (N; RLM, RUM, TUO) *N 745, 896, 2409, 2452*

Croton glandulosus L. var. *lindheimeri* Muell.-Arg., Lindheimer Croton (N; TUO) *N 2026*

Croton glandulosus L. var. *septentrionalis* Muell.-Arg., Northern Croton (N; TUM) *N 210*

Croton lindheimerianus Scheele var. *lindheimerianus*, Three-seed Croton (N; RLM) *N 799*

Croton monanthogynous Michx., One-seed Croton (N; TLO, TUM) *N 927, 2171, 2283*

Croton texensis (Klotzch.) Muell.-Arg., Texas Croton (N; TUO) *N 1924*

Croton michauxii G.L. Webster, Narrowleaf Croton (N; TUM, TUO) *N 257, 708, 2057, 2304*

Euphorbia bicolor Engelm. & A. Gray, Snow-on the-prairie (N; TUO) *N 787, 2288*

Euphorbia corollata L., Flowering Spurge (N; TUO) *N 2313*

Euphorbia dentata Michx., Toothed Spurge (N; RLM, TLO, TUM, TUO) *N 570, 936, 1948, 2128, 2217*

Euphorbia maculata L., Spotted Spurge (N; RLM, TLO, TUO) *N 204, 798, 952, 2129*

Euphorbia nutans Lag., Eyebane (N; RLM, TLM, TLO, TUO) *N 886, 1025, 1046, 2130, 2243*

Euphorbia prostrata Aiton, Prostrate Spurge (N; TLO, TUM) *N 754, 1821, 2284*

Euphorbia serpens Kunth. in H.B.K., Mat Spurge (N; TLO) *N 2374*

Euphorbia spathulata Lam., Warty Euphorbia (N; TLM, TLO, TUO) *N 1448, 1749, 2581*

Euphorbia tetrapora Engelm., Weak Euphorbia (N; TLO) *N 2514*

Euphorbia texana Boiss., Texas Euphorbia (N; TLO, TUM, TUO) *N 418, 1539, 1900*

Phyllanthus abnormis Baill. var. *abnormis*, Drummond Leaf flower (N; TUO) *N 2407*

Phyllanthus caroliniensis Walter ssp. *caroliniensis*, Carolina Leaf-flower (N; TLM, TUM) *N 2408, 2685*

Phyllanthus pudens L.C. Wheeler, Birdseed Leaf-flower (N; TLM, TLO) *N 2189, 2373*

Ricinus communis L., Castorbean (I; TUO) *N 237*

Sapium sebiferum (L.) Roxb., Chinese Tallowtree (I; RUM) *N 143, 629, 1028, 1125*

Stillingia sylvatica L., Queen's Delight (N; TLO, TUM, TUO) *N 31, 1624, 1794*

Tragia betonicifolia Nutt., Betony Noseburn (N; TLM, TUO) *N 644, 690, 2053*

Tragia brevispica Engelm. & A. Gray, Shortspike Noseburn (N; TLO, TUO, TUW) *N 926, 1415, 2282, 2410*

Tragia ramosa Torr., Catnip Noseburn (N; TUO) *N 2700*

Tragia urticifolia Michx., Nettleleaf Noseburn (N; TUM) *N 2223*

FABACEAE (*sensu stricto*)

Aeschynomene indica L., Joint Vetch (N) *McLeod s.n.* (SHST)

Amorpha fruticosa L., Indigobush (N; RLM) *N 1398*

Apios americana Medik., American Potato-bean (N; RUM) *N 2084, 2680*

Astragalus distortus T.&G. var. *engelmannii* (Sheld.) M.E. Jones, Bentpod Milkvetch (N; TUO) *N 367, 1696*

Astragalus leptocarpus T.&G., Slimpod Milkvetch (N; RUM) *N 2733*

Baptisia alba (L.) Vent var. *macrophylla* (Larisey) Isley, White Wild Indigo (N; RLM, TLO) *N 462, 1838*

Baptisia bracteata Muhl. ex Ell. var. *glabrescens* (Larisey) Isley, Leafy Wild Indigo (N; TLM, TUM) *N 136, 414*

Baptisia nuttalliana Small, Nuttall Wild Indigo (N; TLO, TUO) *N 572, 1478*

Baptisia sphaerocarpa Nutt., Green Wild Indigo (N; TLO, TUM) *N 527, 684*

Centrosema virginianum (L.) Benth., Butterfly Pea (N; TUM, TUW) *N 254, 691*

Clitoria mariana L., Atlantic Butterfly Pea (N; TUW) *N 1909, 2661*

Crotalaria sagittalis L., Arrow Rattlepod (N; TLO, TUO, TUW) *N 650, 694, 1967, 2687*

Dalea compacta Spreng. var. *pubescens* (A. Gray) Barneby, Plains Prairie Clover (N; TUM) *N 1867*

Dalea multiflora (Nutt.) Shinners, Roundhead Prairie Clover (N; TUM, TUO) *N 131, 2050*

Dalea phleoides (T.&G.) Shinners var. *microphylla* (T.&G.) Barneby, Longbract Prairie Clover (N; TUM) *N 250*

Dalea purpurea Vent. var. *purpurea*, Purple Prarie Clover (N) *McLeod s.n.* (TAES)

Dalea villosa (Nutt.) Spreng. var. *grisea* (T.&G.) Shinners, Oklahoma Prairie Clover (N; TUO) *N 2635*

Desmodium canescens (L.) DC., Hoary Tick-clover (N; TUM, TUW) *N 666, 2660*

Desmodium ciliare (Muhl. ex Willd.) DC., Littleleaf Tick-clover (N; TLW, TUM, TUO) *N 997, 2327, 2432*

Desmodium glabellum (Michx.) DC., Tick-clover (N; TLW) *N 2403*

Desmodium paniculatum (L.) DC. var. *paniculatum*, Panicled Tick-clover (N; TLO, TLW) *N 959, 2402*

Desmodium sessilifolium (Torr.) T.&G., Sessileleaf Tick-clover (N; RUM, TUM, TUW) *N 209, 594, 2022*

Desmodium viridiflorum (L.) DC., Velvetleaf Tick-clover (N; TLW) *N 2401*

Erythrina herbacea L., Coralbean (N; TLW, TUM, TUW) *N 530, 1672, 1713*

Galactia regularis (L.) B.S.P., Downy Milkpea (N; TUM, TUO) *N 643, 2648, 2686*

Glottidium vesicarium (Jacq.) Harper, Bagpod Sesbania (N; RUM, TUO) *N 278, 921, 1068, 2320*

Lathryus hirsutus L., Singletary Pea (I; TUO) *N 21, 1607, 2570*

Lathyrus pusillus Ell., Low Pea (N; TLO, TUO) *N 1509, 2557*

Lespedeza cuneata (Dumont) G. Don., Sericea Bushclover (I; TUO) *N 1632*

Lespedeza hirta (L.) Hornem., Hairy Bushclover (N; TLM, TUM) *N 2245, 2676*

Lespedeza repens (L.) W. Bart., Creeping Bushclover (N; RUM, TUO) *N 680, 1088*

Lespedeza striata (Thunb.) Hook & Arn., Japanese Bushclover (I; TLM, TUO) *N 730, 2307*

Lespedeza stuevei Nutt., Stueve Bushclover (N; TLM, TUM, TUO) *N 777, 998, 2052, 2250*

Lespedeza virginica (L.) Britton, Slender Bushclover (N; TUM, TUO) *N 779, 1081, 2249*

Lotus unifoliatus (Hook.) Benth. var. *unifoliatus*, Pursh Deervetch (N; TLO) *N 626, 2638*

Lupinus subcarnosus Hook., Texas Bluebonnet (N; TLO, TUM) *N 406, 1312*

Lupinus texensis Hook., Texas Bluebonnet (N; TUO) *N 1752*

Medicago arabica (L.) Huds., Spotted Medic (I; TLM) *N 1236*

Medicago lupulina L., Black Medic (I; TLO) *N 353*

Medicago orbicularis (L.) Bartal., Button Clover (I; TLO) *N 354, 605*

Medicago polymorpha L., Medic (I; RUM, TLO) *N 1822, 2505*

Medicago sativa L., Alfalfa (I; TUO) *N 1650*

Melilotus indicus (L.) All., Yellow Sweetclover (I; TLO, TUO) *N 1680, 1823*

Melilotus officinalis (L.) Lam., Yellow Sweetclover (I) *Fowler 129* (SHST)

Orbexilum pedunculatum (Mill) Rydb. var. *pedunculatum*, Sampson's Snakeroot (N; TLW) *N 1739*

Orbexilum simplex (Nutt. ex T.&G.) Rydb., Singlestem Snakeroot (N; TUM, TUO) *N 1808, 2006*

Pediomelum hypogaeum (Nutt. ex T.&G.) Rydb. var. *subulatum* (Bush) Grimes, Edible Scurfpea (N; TUM) *N 552, 2732*

Pediomelum rhombifolium (T. & G.) Rydb., Roundleaf Scurfpea (N; TLO, TUM, TUO) *N 1868, 1933, 2608*

Psoralidium tenuiflorum (Pursh.) Rydb., Slimleaf Scurfpea (N) *Clark 415* (TAES)

Pueraria lobata (Willd.) Ohwi, Kudzu (I; TUW) *N 1420*

Rhynchosia latifolia Nutt. ex T.&G., Broadleaf Snoutbean (N; RUM, TUM, TUO, TUW) *N 593, 2049, 2083, 2622*

Robinia hispida L., Bristly Locust (I; TUM) *N 2150*

Robinia pseudo-acacia L., Black Locust (N; TUM, TUO) *N 1242, 1619*

Sesbania drummondii (Rydb.) Cory, Rattlebush (N; RLM, RUM) *N 977, 2165*

Sesbania herbacea (P. Mill) McVaugh, Bequilla (N; RLM, RUM, TLO) *N 974, 1038, 2319*

Sophora affinis T.&G., Eve's Necklace (N; RLM, TLM, TUO) *N 580, 882, 1469, 1902, 2589*

Strophostyles helvula (L.) Ell., Trailing Wildbean (N; RLM, RUM, TUM) *N 95, 683, 878, 2325*

Strophostyles leiosperma (T.&G.) Piper, Slickseed Wildbean (N; TLO, TUO) *N 699, 2008, 2639*

Stylosanthes biflora (L.) B.S.P., Pencilflower (N; TUO) *N 205, 1685, 1711*

Tephrosia onobrychoides Nutt., Multibloom Hoary Pea (N; TUM) *N 79, 2048*

Tephrosia virginiana (L.) Pers., Virginia Hoary Pea (N; TLW) *N 2450*

Trifolium campestre Schreb. in Sturm., Low Hop Clover (I; TLO, TUO) *N 1538, 1805, 2594, 2615*

Trifolium carolinianum Michx., Carolina Clover (N; TLW, TUO, TUM) *N 431, 1274, 1541, 2546*

Trifolium incarnatum L., Crimson Clover (I; TUO) *N 519*

Trifolium polymorphum Poir., Peanut Clover (N; TLW, TUW) *N 1413, 2551*

Trifolium resupinatum L., Persian Clover (I; TLO, TUO) *N 2556, 2601*

Trifolium vesiculosum Savi., Clover (I; TUO) *N 1681, 1758*

Vicia ludoviciana Nutt. ssp. *ludoviciana*, Louisiana Vetch (N; TLM, TLW, TUM) *N 420, 1266, 2575*

Vicia lutea L., Yellow Vetch (I; TUO) *N 1458, 2618, 2630*

Vicia minutiflora Dietr., Small-flowered Vetch (N; RUM, TLM, TLW) *N 397, 1226, 1258*

Vicia sativa L. ssp. *nigra* (L.) Ehrh., Narrow-leaved Vetch (I; RUM, TLO) *N 1193, 2506*

Vicia villosa Roth, Hairy Vetch (I; TUO) *N 1220*

Vicia villosa Roth. var. *glabrescens* Kuch., Hairy Vetch (I; TUO) *N 380*

Vicia villosa Roth. ssp. *varia* (Host.) Corb., Hairy Vetch (I; TUO) *N 1679*

Vigna unguiculata (L.) Walp., Black-eyed Pea (I; TLO) *N 2203*

Wisteria sinensis (Sims) Sweet, Chinese Wisteria (I; TUW) *N 735*

FAGACEAE

Quercus falcata Michx., Southern Red Oak (N; TLO, TUM, TUW) *N 77, 1424, 1738, 1788, 1908*

Quercus lyrata Walter, Overcup Oak (N; RLM, TLM) *N 287, 855, 426, 1644, 1898, 2209*

Quercus macrocarpa Michx., Bur Oak (N; TLM, TLO) *N 201, 2585*

Quercus marilandica Muench., Blackjack Oak (N; TUO, TUW) *N 1494, 1691, 2096, 2139*

Quercus nigra L., Water Oak (N; TLW, TUM, TUO) *N 270, 1219, 1999*

Quercus phellos L., Willow Oak (N; RLM, TLW) *N 421, 1450*

Quercus shumardii Buckl., Shumard Oak (N; RUM) *N 2097*

Quercus stellata Wang. var. *margaretta* (Ashe) Sarg., Sand Post Oak (N; TUM) *N 1787, 1841*

Quercus stellata Wang. var. *paludosa* Sarg., Bottomland Post Oak (N; TLW, TUW) *N 1086, 2131*

Quercus stellata Wang. var. *stellata*, Post Oak (N; TUM) *N 173, 2376*

Quercus virginiana Mill, Live Oak (N; TUO) *N 1812*

FUMARIACEAE

Corydalis micrantha (Engelm.) A. Gray var. *australis* (Chapm.) Shinners, Southern Scrambled Eggs (N; TLW, TUM, TUO) *N 385, 1201, 1278*

GENTIANACEAE

Sabatia campestris Nutt., Prairie Rose-gentian (N; TUO) *N 28, 612, 1714*

GERANIACEAE

Geranium carolinianum L., Carolina Crane's-bill (N; TLO, TUO) *N 458, 1408, 2645*

Geranium dissectum L., Crane's-bill (I; TLO) *N 1446*

HALORAGACEAE

Myriophyllum heterophyllum Michx., Changeleaf Parrot's Feather (N; AFL, ASU) *N 1550, 1936, 2001, 2526*

Myriophyllum pinnatum (Walter) B.S.P., Green Parrot's Feather (N; AFL, ASU) *N 410, 1431, 1896, 2573*

HAMAMELIDACEAE

Liquidambar styraciflua L., Sweet Gum (N; TLW) *N 669, 2524*

HIPPOCASTANACEAE

Aesculus pavia L. var. *pavia*, Red Buckeye (N; TLM) *N 1310*

HYDROPHYLLACEAE

Hydrolea ovata Nutt. ex Choisy., Hairy Hydrolea (N; AEM, RLM, RUM) *N 187, 686, 803, 1101*

Nemophila aphylla (L.) Brumm, Smallflower Nemophila (N; TUW) *N 1245*

Phacelia glabra Nutt., Smooth Phacelia (N; TLM) *N 1227*

Phacelia hirsuta Nutt., Hairy Phacelia (N; TLO) *N 2550*

Phacelia patuliflora (Engelm. & A. Gray) A. Gray, Sand Phacelia (N; TLW) *N 1661*

JUGLANDACEAE

Carya alba (Mill) K.Koch., Mockernut Hickory (N; TLW, TUO) *N 2095, 2627*

Carya aquatica (Michx. f.) Nutt., Water Hickory (N; RLM, RUM) *N 219, 856, 1012, 1886*

Carya illinoinensis (Wang.) K.Koch., Pecan (N; TLM, TLO) *N 200, 902*

Carya texana Buckl., Black Hickory (N; RLM, TUM, TUO) *N 174, 218, 785, 1615*

Juglans nigra L., Black Walnut (N; TLO, TLW) *N 1583, 2094*

KRAMERIACEAE

Krameria lanceolata Torr., Rattany-vine (N; TUM, TUO) *N 710, 1860*

LAMIACEAE

Hedeoma hispida Pursh., Rough Mock Pennyroyal (N; TLO, TUO) *N 1502, 1653, 1688, 2597*

Lamium amplexicaule L., Henbit (N; TLO, TUO) *N 346, 1194*

Lycopus rubellus Moench, Arkansas Bugleweed (N; RLM) *N 844*

Monarda citriodora Cerv. ex Lang. ssp. *citriodora*, Lemon Beebalm (N; TLO, TUO) *N 622, 1817, 2020*

Monarda clinopodioides A. Gray, Basil Beebalm (N; TUO) *N 2602*

Monarda fistulosa L., Wild Bergamot (N; TLM, TLO, TUM) *N 138, 647, 2067, 2287*

Monarda lindheimeri Engelm. & A. Gray ex A. Gray, Lindheimer Bergamot (N; TUM, TUO) *N 76, 1732*

Monarda punctata L. var. *intermedia* (McCl. & Epl.) Waterfall, Spotted Beebalm (N; TLO) *N 37*

Monarda punctata L. var. *lasiodonta* A. Gray, Spotted Beebalm (N; TLW, TUM, TUO) *N 1864, 1930, 1960*

Perilla frutescens (L.) Britton, Beefsteak Plant (I; RLM) *N 2334*

Physostegia angustifolia Fern., Obedient-plant (N; RLM) *N 1828*

Physostegia intermedia (Nutt.) Engelm. & A. Gray, Intermediate Obedient-plant (N; TLM, TLO) *N 1743, 1881, 2580*

Physostegia pulchella Lundell, Obedient-plant (N; TLM, TLO, TUM, TUO) *N 41, 1436, 1638, 2559*

Prunella vulgaris L. var. *vulgaris*, Self heal (I; TLW, TUM) *N 501, 1518*

Prunella vulgaris L. var. *hispida* Benth. Self-heal (I; TUM) *N 87*

Salvia azurea Lam., Blue Sage (N; TUM, TUO) *N 330, 2248, 2418*

Salvia coccinea P.J. Buchoz ex Etlinger, Tropical Scarlet Sage (N; TLW, TUM) *N 678, 767*

Salvia lyrata L., Lyreleaf Sage (N; TLW, TUM) *N 106, 509, 1254*

Scutellaria cardiophylla Engelm. & A. Gray, Heartleaf Skullcap (N; RUM, TLM) *N 153, 679*

Scutellaria drummondii Benth., Drummond Skullcap (N; TLW) *N 1512*

Scutellaria ovata Hill, Tuber Skullcap (N; TUW) *N 1911*

Scutellaria parvula Michx. var. *leonardii* (Epl.) Fern., Skullcap (N; TLO, TUW) *N 1430, 2596*

Scutellaria parvula Mich. var. *parvula*, Skullcap (N; TUM) *N 1961*

Stachys crenata Raf., Shade Betony (N; TLM) *N 2528*

Stachys tenuifolia Willd., Slenderleaf Betony (N; RLM) *N 165*

Teucrium canadense L. var. *canadense*, Germander (N; TLW, TUO) *N 640, 1943*

Trichostema dichotomum L., Forked Bluecurls (N; TLM, TUM) *N 2253, 2289*

LAURACEAE

Sassafras albidum (Nutt.) Nees., Sassafras (N; TLW, TUM, TUW) *N 171, 403, 1419*

LENTIBULARIACEAE

Utricularia gibba L., Cone-spur Bladderwort (N; AFL) *N 2491*

Utricularia radiata Small, Whorled Bladderwort (N; AFL) *N 1969*

LINACEAE

Linum medium (Planch.) Britton var. *texanum* (Planch.) Fern, Texas Flax (N; RUM, TLO, TUO) *N 600, 1744, 2040, 2603*

LYTHRACEAE

Ammannia x *coccinea* Rottb., Purple Toothcup (N; RLM, RUM, TLM) *N 876, 894, 2161, 2193*

Cuphea carthagenensis (Jacq.) J.F. Machr., (N; TUM) *N 2682*

Cuphea glutinosa Chapm. & Schlecht., (I; TUM, TUO) *N 2633, 2681*

Didiplis diandra (Nutt. ex DC.) Wood., Water-purslane (N; ASU) *N 1970*

Lagerstroemia indica L., Crepe Myrtle (I; TLM) *N 631*

Lythrum alatum Pursh. var. *lanceolatum* (Ell.) T.&G., Lanceleaf Loosestrife (N; TLO, TUM, TUO) *N 183, 2110, 2690*

Rotala ramosior (L.) Koehne, Tooth-cup (N; TUM) *N 2677*

MALVACEAE

Callirhoe involucrata (Torr.) A. Gray. var. *involucrata*, Low Wine-cup (N; TLO) *N 32*

Callirhoe involucrata (T.&G.) A. Gray var. *lineariloba* (T.&G.) A. Gray, Low Wine-cup (N; TUO) *N 382, 1495*

Callirhoe papaver (Cav.) A. Gray, Woods Wine-cup (N; TUM, TUO) *N 1719, 1792*

Hibiscus laevis All., Halberd-leaved Hibiscus (N; RUM, TLO) *N 190, 192*

Hibiscus moscheutos L. ssp. *lasiocarpus* (Cav.) O.J. Blanchard, Swamp Rosemallow (N; RLM, TLO) *N 191, 899, 1916*

Hibiscus syriacus L., Rose-of-Sharon (I; TLW) *N 674*

Malvaviscus arboreus Dill ex Cav. var. *drummondii* (T.&G.) Schery, Drummond Turk's-cap (N; RLM, TUM, TUO, TUW) *N 750, 1905, 2120, 2318*

Modiola caroliniana (L.) G. Don., Carolina Modiola (N; TLO, TUO) *N 169, 1407, 1818*

Sida rhombifolia L., Arrowleaf Sida (N; TUM) *N 2085*

Sida spinosa L., Prickly Sida (N; RLM, TLO, TUM) *N 822, 897, 2264*

MELASTOMATACEAE

Rhexia mariana L. var. *mariana*, Meadow Beauty (N; RUM) *N 261*

MELIACEAE

Melia azedarach L., Chinaberry (I; RUM, TUM) *N 99, 681, 1595*

MENISPERMACEAE

Cocculus carolinus (L.) DC., Carolina Snailseed (N; RLM, TLM, TUO) *N 151, 728, 935, 2024*

MIMOSACEAE

Acacia farnesiana (L.) Willd., Huisache (N; TUO) *N 1397, 2137*

Albizia julibrissin Durazz., Mimosa (I; RUM, TLW) *N 161, 628*

Desmanthus illinoensis (Michx.) MacM. ex Robins & Fern., Illinois Bundleflower (N; RUM, TLO, TUO) *N 162, 620, 1834, 2111, 2623*

Mimosa nuttallii (DC.) B.L. Turner, Catclaw Sensitive-briar (N; TLO, TUM) *N 1462, 2106*

Mimosa strigillosa T. & G., Herbaceous Mimosa (N; RLM, TLO) *N 114, 957*

Neptunia lutea (Leavenw.) Benth., Yellow Neptunia (N; TUM, TUO) *N 109, 613, 1692*

Neptunia pubescens Benth. var. *pubescens*, Prairie Neptunia (N; RLM, TUO) *N 909, 1833*

Prosopis glandulosa Torr. var. *glandulosa*, Honey Mesquite (N; TLO, TUM, TUO) *N 93, 524, 762, 1877*

MOLLUGINACEAE

Glinus radiatus (R. & P.) Rohrb., (I; RLM, TLW) *N 1935, 2143*

Mollugo verticillata L., Green Carpetweed (I; RLM, TLM, TUM, TUO) *N 260, 693, 892, 1862, 2197*

MORACEAE

Ficus carica L., Fig (I; TLM) *N 1400*

Maclura pomifera (Raf.) Schneid., Bois D'Arc (N; TLW, TUM) *N 263, 1656*

Morus rubra L., Red Mulberry (N; TLW, TUW) *N 86, 442, 1640, 2093*

MYRICACEAE

Myrica cerifera L., Southern Wax-myrtle (N; RUM, TUM) *N 419, 591, 1085, 1782*

NELUMBONACEAE

Nelumbo lutea (Willd.) Pers., Yellow Lotus (N; AEM) *N 2146*

NYCTAGINACEAE

Mirabilis albida (Walter) Heimerl., White Four-O'Clock (N; TLM, TUM, TUO) *N 46, 273, 994, 1947*

Mirabilis jalapa L., Four-O'Clock (I; TLM) *N 144*

Mirabilis linearis (Pursh.) Heimerl., Linearleaf Four-O'Clock (N; TUM) *N 2169*

Mirabilis nyctaginea (Michx.) MacM., Wild Four-O'Clock (N; TUM) *N 533, 1704*

NYMPHAEACEAE

Nuphar lutea (L.) Sm. ssp. *advena* Kartesz & Gandhi, Spatterdock (N; AFL) *N 1829, 2148*

Nymphaea odorata Aiton ssp. *odorata*, American Waterlily (N; AEM) *N 721*

NYSSACEAE

Nyssa sylvatica Marsh. var. *sylvatica*, Black Tupelo (N; RLM, RUM) *N 1405, 2099, 2399*

OLEACEAE

Forestiera acuminata (Michx.) Poir., Swamp Privet (N; RLM, RUM) *N 400, 447, 2547*

Forestiera ligustrina (Michx.) Poir., Privet Forestiera (N; RLM, RUM, TLW, TUW) *N 289, 743, 1052, 1131, 2047, 2102*

Fraxinus americana L., White Ash (N; TLM, TLW, TUW) *N 376, 377, 2101, 2211*

Fraxinus pennsylvanica Marsh., Red Ash (N; RLM, TUM) *N 234, 435, 2588*

Ligustrum lucidum Aiton f., Wax-leaf Ligustrum (I; TLW) *N 673*

Ligustrum sinense Lour., Chinese Privet (I; TLM, TUM, TUO, TUW) *N 40, 336, 756, 1129, 1621*

ONAGRACEAE

Calylophus berlandieri Spach. ssp. *pinifolius* (A. Gray) Towner, Sundrops (N) *Clark 474* (TAES)

Calyophus serrulatus (Nutt.) Raven, Yellow Sundrops (N; TUM) *N 452*

Gaura brachycarpa Small, Plains Gaura (N; TLO, TUO) *N 523, 1477, 2626*

Gaura longiflora Spach., Kearny Gaura (N; TLO, TUO) *N 267, 2125, 2265*

Gaura sinuata Nutt. ex Ser., Wavyleaf Gaura (N; TLM) *N 562*

Gaura suffulta Engelm. ex A. Gray ssp. *suffulta*, Roadside Gaura (N; TUM) *N 1878*

Ludwigia alternifolia L., Bushy Seedbox (N; RUM, TLM, TUO, TUW) *N 661, 734, 2009, 2043*

Ludwigia decurrens Walter, Primrose-willow (N; AEM, RLM, RUM) *N 841, 972, 2163*

Ludwigia glandulosa Walter ssp. *brachycarpa* (T.&G.) Peng., Torrey Seedbox (N; RUM) *N 2039*

Ludwigia glandulosa Walter ssp. *glandulosa*, Torrey Seedbox (N; RLM, TLO) *N 193, 1883*

Ludwigia palustris (L.) Ell., American Seedbox (N; RLM, RUM, TLO) *N 1554, 1747, 1987, 2038*

Ludwigia peploides (Kunth. in H.B.K.) Raven, Smooth Water-primrose (N; AEM, RUM) *N 212, 1717, 2164, 2595*

Oenothera heterophylla Spach. ssp. *heterophylla*, Varileaf Evening Primrose (N; TLM, TLO, TUO) *N 30, 1968, 2191*

Oenothera laciniata Hill, Cutleaf Evening Primrose (N; TLO, TUM, TUO, TUW) *N 393, 1417, 1816, 1863*

Oenothera linifolia Nutt., Threadleaf Sundrops (N; TUM, TUO) *N 1521, 1718, 2735*

Oenothera spachiana T.&G., Spach Evening Primrose (N; TUO) *N 2610*

Oenothera speciosa Nutt., Showy Evening Primrose (N; TLO, TUO) *N 457, 1480*

OROBANCHACEAE

Orobanche multiflora Nutt., Largeflower Broomrape (N; PAR) *N 520, 1649*

OXALIDACEAE

Oxalis corniculata L., Creeping Woodsorrel (I; TLW) *N 1251*

Oxalis dillenii Jacq., Dillen Woodsorrel (N; TLM) *N 164*

Oxalis rubra St.-Hil., Pink Shamrock (I; TLM) *N 1243*

Oxalis stricta L., Yellow Woodsorrel (N; TUM, TUO) *N 534, 1022*

Oxalis violacea L., Violet Woodsorrel (N; TLM, TUM) *N 1516, 2290*

PAPAVERACEAE

Argemone albiflora Hornem. ssp. *texana* G. Ownbey, White Prickly Poppy (N; TUM) *N 1858*

Argemone polyanthemos (Fedde.) G. Ownbey, White Prickly Poppy (N; TLO) *N 563*

PASSIFLORACEAE

Passiflora incarnata L., Maypop (N; TLO, TUO) *N 29, 662, 2114*

Passiflora lutea L., Yellow Passionflower (N; TLW, TUO, TUW) *N 272, 725, 1676, 2419*

PHYTOLACCACEAE

Phytolacca americana L., Pokeweed (N; RUM, TUO, TUW) *N 145, 729, 1659*

Rivina humilis L., Rougeplant (N; TUM) *N 2144*

PLANTAGINACEAE

Plantago aristata Michx., Bottlebrush Plantain (N; TLO, TUO) *N 35, 1609, 1693*

Plantago heterophylla Nutt., Simplespike Plantain (N; TUO) *N 1517*

Plantago hookeriana Fisch. & C.A. Mey., Hooker Plantain (N; TLW) *N 1334*

Plantago patagonica Jacq., Bristlebract Plantain (N; TUM) *N 561*

Plantago rhodosperma Dcne., Redseed Plantain (N; TLM) *N 2529*

Plantago virginica L., Paleseed Plantain (N; TLM, TUM) *N 45, 441, 538*

Plantago wrightiana Dcne., Wright Plantain (N; TUO, TUW) *N 649, 2617*

PLATANACEAE

Platanus occidentalis L., American Sycamore (N; RUM, TLW) *N 893, 1586*

POLEMONIACEAE

Ipomopsis rubra (L.) Wherry, Standing Cypress (N; TUO) *N 186*

Phlox cuspidata Scheele var. *cuspidata*, Pointed Phlox (N; TUO) *N 344, 348, 1499*

Phlox drummondii Hook. var. *peregrina* Shinners, Drummond Phlox (N; TUO) *N 158, 2560*

Phlox pilosa L., Downy Phlox (N; TUM) *N 1492*

POLYGALACEAE

Polygala incarnata L., Pink Milkwort (N; TLO) *N 573*

Polygala polygama Walter, Bitter Milkwort (N; TLO, TUO) *N 1716, 1737, 2607, 2655*

Polygala verticillata L., Whorled Milkwort (N; TUO) *N 732*

POLYGONACEAE

Brunnichia ovata (Walter) Shinners, Buckwheat Vine (N; RLM, TLO) *N 116, 223, 956, 2127*

Eriogonum longifolium Nutt., Longleaf Wild Buckwheat (N; TUM) *N 2220, 2272*

Polygonum hydropiperoides Michx., Swamp Smartweed (N; RLM, RUM, TLO, TUO) *N 692, 968, 1611, 1851*

Polygonum lapathifolium L., Curltop Smartweed (N; TLO, TLW) *N 1922, 2200*

Polygonum pensylvanicum L., Pennsylvania Smartweed (N; RLM, TLO) *N 295, 969, 2336*

Polygonum persicaria L., Lady's Thumb (I; RLM) *N 821*

Polygonum punctatum Ell., Water Smartweed (N; RLM, TLO) *N 296, 843, 2335*

Polygonum ramosissimum Michx., Bushy Knotweed (N; RLM) *N 2333*

Polygonum setaceum Baldw., Smartweed (N; AEM) *N 189*

Rumex chrysocarpus Moris, Pale Dock (N; TUO) *N 1772, 2268*

Rumex crispus L., Curly Dock (I; TLO) *N 1241, 1897*

Rumex hastatulus Baldw., Heart Sorrel (N; TUM, TUO) *N 24, 537, 1472*

Rumex pulcher L., Fiddle Dock (I; TLM, TLO, TUO) *N 68, 578, 1566*

Rumex verticillatus L., Swamp Dock (N; RLM) *N 113*

PORTULACACEAE

Claytonia virginica L., Spring Beauty (N; TUO) *N 343, 1198*

Portulaca oleracea L., Common Purslane (I; TLO) *N 951*

Portulaca pilosa L., Chisme (N; TUO) *N 2179, 2309*

Portulaca umbraticola H.B.K., Wingpod Portulaca (N; TUM, TUO) *N 2222, 2240*

Talinum parviflorum Nutt., Prairie Flameflower (N; TUO) *N 711*

PRIMULACEAE

Anagallis arvensis L., Scarlet Pimpernel (I; TUO) *N 22*

Centunculus minimus L., Chaffweed (I; TLM, TLO, TLW, TUM) *N 1261, 1328, 1548, 1755, 2477* (*Anagallis minima* (L.) E.H.L. Krause)

Samolus valerandi L. ssp. *parviflorus* (Raf.) Hultén, Thinleaf Brookweed (N; TLW) *N 1921*

RANUNCULACEAE

Anemone berlandieri Pritzel, Tenpetal Anemone (N; TUO) *N 357, 2501*

Anemone caroliniana Walter, Carolina Anemone (N; TLW, TUO) *N 390, 392, 2500*

Clematis pitcheri T.&G. var. *pitcheri*, Pitcher Clematis (N; RLM, TUM) *N 585, 802, 932, 2118*

Clematis reticulata Walter, Netleaf Clematis (N; RLM, TUM) *N 1885, 2140*

Delphinium carolinianum Walter ssp. *vimineum* (D.Don) Warnock, Carolina Larkspur (N; TLO, TUO) *N 38, 510, 1210*

Delphinium carolinianum Walter ssp. *virescens* (Nutt.) R.E. Brooks, Plains Larkspur (N) *Clark 362* (TAES)

Myosurus minimus L., Tiny Mousetail (N; RLM, TUO) *N 405, 2532*

Ranunculus fascicularis Muhl. ex Bigel., Tufted Buttercup (N; TLO, TLW) *N 391, 1931, 2513*

Ranunculus hispidus Michx. var. *nitidus* (Chapm.) T. Duncan, Bristly Buttercup (N; TLW) *N 1250*

Ranunculus laxicaulis (T.&G.) Darby, Small Buttercup (N; TLW) *N 1249, 1475*

Ranunculus muricatus L., Roughseed Buttercup (I; RUM) *N 2502*

Ranunculus parviflorus L., Sticktight Buttercup (I; RLM, TLM, TLW, TUM, TUO) *N 411, 1421, 1545, 1831, 2487*

Ranunculus pusillus Poir., Weak Buttercup (N; RLM, RUM, TUM, TUO) *N 412, 540, 1531, 2533*

Ranunculus sardous Crantz., Buttercup (I; RUM, TLM, TUO) *N 65, 345, 395*

Ranunculus sceleratus L., Blister Buttercup (N; RUM) *N 1984*

Thalictrum dasycarpum Fisch. & Ave.-Lall., Purple Meadow-rue (N) *Cory 54579* (LL)

RHAMNACEAE

Berchemia scandens (Hill) K.Koch., Rattanvine (N; TLM, TLW, TUM, TUW) *N 42, 667, 1064, 1537*

Rhamnus caroliniana Walter, Carolina Buckthorn (N; TLW) *N 2070, 2136, 2738*

ROSACEAE

Crataegus marshallii Eggl., Parsley Hawthorn (N; TLW, TUM) *N 264, 1140, 1324, 1522, 2454*

Crataegus spathulata Michx., Littlehip Hawthorn (N; TLW) *N 1297*

Crataegus viridis L., Green Hawthorn (N; RLM, TLW, TUO) *N 402, 427, 895, 1296, 2537*

Geum canadense Jacq. var. *camporum* (Rydb.) Fern, White Avens (N; RUM, TUW) *N 50, 1411*

Geum canadense Jacq. var. *texanum* Fernald & Weath., White Avens (N; TLW) *N 1559*

Prunus angustifolia Marsh, Chickasaw Plum (N; TUM) *N 386*

Prunus caroliniana (P.Mill) Aiton, Cherry-laurel (N; RLM) *N 1196, 2342*

Prunus gracilis Engelm. & A.Gray, Oklahoma Plum (N; TUO, TUW) *N 398, 1200*

Prunus mexicana S.Wats., Mexican Plum (N; TLW, TUM, TUO, TUW) *N 358, 375, 1504, 2015, 2274*

Prunus persica (L.) Batsch., Peach (I; TUM) *N 751*

Prunus serotina Ehrh. var. *serotina*, Black Cherry (N; TLW, TUM) *N 1464, 2104*

Pyracantha coccinea M.J.Roem., Scarlet Firethorn (I; TUM, TUO) *N 752, 1120*

Pyrus calleryana Decne., Callery Pear (I; TUM) *N 758, 759, 760*

Pyrus communis L., Common Pear (I; TUM) *N 2493*

Rosa carolina L., Carolina Rose (N; TUM) *N 2151*

Rosa multiflora Thunb. ex Murr., Japanese Rose (I; TUO) *N 1467, 1636*

Rubus aboriginum Rydb., Blackberry (N; TLW, TUO) *N 1761, 1814*

Rubus argutus Link., Blackberry (N; RUM) *N 2737*

Rubus flagellaris Willd., Northern Blackberry (N; TLM, TLW) *N 1260, 2604*

Rubus trivialis Michx., Dewberry (N; TUO) *N 350, 1214*

Spiraea prunifolia Siebold. & Zucc., Bridal-wreath Spiraea (I; TLM) *N 1938*

RUBIACEAE

Cephalanthus occidentalis L., Buttonbush (N; AEM, RLM, RUM) *N 159, 592, 871, 1041, 1626*

Diodia teres Walter, Rough Buttonweed (N; TUM, TUO) *N 202, 253, 712, 770, 1869, 2260*

Diodia virginiana L., Virginia Buttonweed (N; RLM, RUM, TLM, TLO) *N 611, 689, 872, 2194*

Galium aparine L., Velcro Plant (N; RUM, TLM, TLO) *N 464, 1576, 2508*

Galium circaezans Michx., Woods Bedstraw (N; TUW) *N 1445, 2662*

Galium obtusum Bigel., Bluntleaf Bedstraw (N; RUM) *N 1973*

Galium pilosum Aiton, Hairy Bedstraw (N; TLW, TUM, TUO) *N 664, 707, 1508, 1754, 2021, 2135, 2553*

Galium tinctorium (L.) Scop., Dye Bedstraw (I; TLM, TLW, TUM, TUO) *N 417, 545, 1264, 1533, 2527, 2554*

Galium virgatum Nutt., Southwest Bedstraw (N; TUO) *N 1683*

Hedyotis nigricans (Lam.) Fosb., Prairie Bluets (N; TJO) *N 717*

Houstonia micrantha (Shinners) Terrell, White Bluets (N; TLM, TUO) *N 1231, 2471, 2498*

Houstonia pusilla Schopf., Small Bluets (N; TLW, TUO) *N 1221, 1277*

Houstonia rosea (Raf.) Terrell, Rose Bluets (N; TLM) *N 338, 2472*

Mitchella repens L., Partridge-berry (N; TLW) *N 1753, 2078*

Oldenlandia boscii (DC.) Chapm. (N; RLM, RUM) *N 1974, 2036, 2338*

Oldenlandia uniflora L. (N; RLM) *N 2339*

Sherardia arvensis L., Field-madder (I; TLM, TUO) *N 333, 1224*

Spermacoce glabra Michx., Smooth Buttonweed (N; RLM, RUM, TLO) *N 195, 283, 1917, 2340*

RUTACEAE

Poncirus trifoliolata (L.) Raf., Bitter Orange (I;TLW) *N 1735*

Zanthoxylum clava-herculis L., Hercules-club (N; TUM, TUO) *N 262, 641, 724, 1459*

SALICACEAE

Populus deltoides Marsh., Eastern Cottonwood (N; TUM) *N 1460*

Salix nigra Marsh., Black Willow (N; RLM, RUM, TLO) *N 459, 1483, 1736*

SAPINDACEAE

Cardiospermum halicacabum L., Balloonvine (I; RLM, TLO) *N 196, 835, 934*

Sapindus saponaria L. var. *drummondii* (Hook. & Arn.) L. Benson, Western Soapberry (N; RLM, RUM, TLM) *N 1011, 2117, 2355*

SAPOTACEAE

Sideroxylon lanuginosum Michx. ssp. *albicans* (Sarg.) Kartesz & Gandhi, Gum Bumelia (N; TUO) *N 761, 2138*

Sideroxylon lanuginosum Michx. ssp. *oblongifolium* (Nutt.) T.D. Penn., Gum Bumelia (N; TLW, TUM) *N 176, 1333, 1844, 2105*

SAURURACEAE

Saururus cernuus L., Lizard-tail (N; RLM) *N 124, 2000*

SAXIFRAGACEAE

Lepuropetalon spathulatum (Muhl.) Ell., Petite plant (N; TLO) *N 2482, 2511*

Penthorum sedoides L., Ditch-Stonecrop (N; RUM, TLM) *N 222, 2187, 2411*

Saxifraga texana Buckl., Texas Saxifrage (N; TLO, TUO) *N 2465, 2480*

SCROPHULARIACEAE

Agalinis fasciculata (Ell.) Raf., Beach Gerardia (N; TUO) *N 791*

Agalinis heterophylla (Nutt.) Small ex Britton, Prairie Gerardia (N; TLO, TUO) *N 904, 958, 2324*

Agalinis purpurea (L.) Penn., Purple Gerardia (N) *Jones & Jones 433* (TAES)

Aureolaria grandiflora (Benth.) Penn. var. *grandiflora*, Bigflower Oakleech (N; TLM) *N 2665*

Bacopa monnieri (L.) Penn., Coastal Water-hyssop (N; RUM) *N 723*

Bacopa rotundifolia (Michx.) Wettst., Disc Water-hyssop (N; RLM) *N 2142*

Castilleja indivisa Engelm., Texas Indian Paint brush (N; TUO) *N 381, 1317*

Gratiola flava Leavenw., Golden Hedge-hyssop (N; TLM) *N 2466*

Gratiola neglecta Torr., Yellowseed Hedge-hyssop (N; RLM, RUM, TLM, TUO) *N 544, 826, 1513, 2534*

Gratiola virginiana L., Virginia Hedge-hyssop (N; RLM, TLW, TUO) *N 445, 1279, 2535, 2548*

Leucospora multifida (Michx.) Nutt., Narrowleaf Conobea (N; RLM) *N 891*

Linaria canadensis (L.) Dum. var. *canadensis*, Oldfield Toadflax (N; TLM) *N 1235*

Linaria canadensis (L.) Dum. var. *texana* (Scheele.) Penn., Texas Toadflax (N; TUM, TUO) *N 438, 1530*

Lindernia dubia (L.) Penn. var. *anagallidea* (Michx.) Cooperrider, Clasping False Pimpernel (N; RLM, RUM, TLW) *N 1932, 1972, 2736*

Mecardonia acuminata (Walter) Small, Sawtooth Water-hyssop (N; TLM) *N 2383*

Mecardonia procumbens (P. Mill) Small, Prostrate Water-hyssop (N; TLW) *N 2549*

Penstemon australis Small ssp. *laxiflorus* (Penn.) Bennett, Southern Beardtongue (N; TUM) *N 179, 500, 1465*

Verbascum thapsus L., Common Mullein (I; TUO) *N 1906*

Veronica agrestis L., Wayside Speedwell (I; TLO) *N 1192*

Veronica arvensis L., Common Speedwell (I; TLM) *N 1212, 1234*

Veronica peregrina L. ssp. *peregrina*, Purslane Speedwell (N; TLM, TLW) *N 1233, 1281*

Veronica peregrina L. ssp. *xalapensis* (Kunth. in H.B.K.) Penn., Purslane Speedwell (N; TLW) *N 450*

SIMAROUBACEAE

Ailanthus altissima (Mill) Swingle, Tree of Heaven (I; TUO) *N 790*

SOLANACEAE

Datura wrightii Regel., Jimsonweed (N; TUM, TUO) *N 2175, 2300*

Physalis cinerascens (Dun.) A.S. Hitchc. var. *cinerascens*, Beach Groundcherry (N; TUO) *N 274, 903, 1061*

Physalis heterophylla Nees. var. *heterophylla*, Clammy Groundcherry (N; TUM, TUO) *N 532, 1774, 2609*

Physalis pubescens L. var. *pubescens*, Downy Groundcherry (N; TLM, TUO) *N 1403, 2192*

Physalis pubescens L. var. *integrifolia* (Dun.) Waterfall, Downy Groundcherry (N; RLM, RUM) *N 796, 2162*

Solanum capsicastrum Link., False Jerusalem-cherry (I; TUW) *N 1731, 2055*

Solanum carolinense L., Carolina Horse-nettle (N; TLM, TLO, TLW, TUO) *N 606, 930, 1673, 1954, 2195*

Solanum dimidiatum Raf., Western Horse-nettle (N; TUO) *N 1618, 2149*

Solanum elaeagnifolium Cav., Silverleaf Horse-nettle (N; TLM, TUM) *N 139, 2232*

Solanum esculentum Mill var. *cerasiforme* (Dun.) A. Gray, Cherry Tomato (I; TUO) *N 2698*

Solanum ptycanthum Dun. ex DC., American Nightshade (N; RUM, TLO, TUM, TUW) *N 1955, 1760, 1914, 2176*

Solanum rostratum Dun., Buffalo-bur (N; TUO) *N 2178*

Solanum triquetrum Cav., Texas Nightshade (N; TUW) *N 701*

SPHENOCLEACEAE

Sphenoclea zeylanica Gaertn., Chicken-spike (I; RLM) *N 2141*

TILIACEAE

Tilia americana L. var. *americana*, American Basswood (N; RLM, RUM) *N 1592, 1646*

Tilia americana L. var. *caroliniana*, Carolina Basswood (N; TLM, TLW) *N 152, 627, 2080*

ULMACEAE

Celtis laevigata Willd., Sugar Hackberry (N; TLM, TUM) *N 369, 465, 755*

Planera aquatica (Walter) J.F. Gmel., Water Elm (N; RLM) *N 443, 1645*

Ulmus alata Michx., Winged Elm (N; TUM, TUW) *N 331, 378, 1209*

Ulmus americana L., American Elm (N; TLM, TLW, TUO) *N 332, 349, 2092, 2523*

Ulmus crassifolia Nutt., Cedar Elm (N; RLM, TLW, TUM, TUO) *N 898, 929, 2343, 2375*

URTICACEAE

Boehmeria cylindrica (L.) Sw., False Nettle (N; RLM, RUM) *N 870, 2091*

Parietaria pensylvanica Muhl. ex Willd. var. *obtusa* (Rydb. ex Small) Shinners, Pellitory (N; TUO) *N 1406*

Parietaria pensylvanica Muhl. ex Willd. var. *pensylvanica*, Pennsylvania Pellitory (N; RLM, RUM, TLW) *N 57, 440, 1253, 2504*

Urtica chamaedryoides Pursh., Heart leaf Nettle (N; RLM, TLW) *N 342, 439, 601*

VALERIANACEAE

Valerianella florifera Shinners, Cornsalad (N; TUO) *N 1561*

Valerianella radiata (L.) Dufr., Cornsalad (N; TLM, TLO, TLW, TUM, TUO) *N 364, 416, 461, 1269, 1303*

VERBENACEAE

Callicarpa americana L., American Beautyberry (N; TLM, TUM) *N 156, 920*

Lantana camara L., West-Indian Lantana (I; TUM) *N 765*

Lantana urticoides Hayek, Lantana (N; TUM) *N 2152*

Phyla lanceolata (Michx.) Greene, Lanceleaf Frogfruit (N; RLM, RUM, TLO) *N 128, 687, 966, 1820, 1975*

Phyla nodiflora (L.) Greene var. *nodiflora*, Common Frogfruit (N; TLM, TUM) *N 137, 2273*

Verbena bipinnatifida Nutt., Dakota Vervain (N) *Huss 91* (TAES) (*Glandularia bipinnatifida* (Nutt.) Nutt.)

Verbena brasiliensis Vell., Brazilian Vervain (I; TLO, TUO) *N 85, 1213, 1635, 1819, 1976*

Verbena canadensis (L.) Britton, Rose Vervain (N; TUO) *N 1404* (*Glandularia canadensis* (L.) Nutt.)

Verbena officinalis L. ssp. *halei* (Small.) Barber, Slender Vervain (N; TLO, TUO) *N 74, 925, 1493, 2126*

Verbena scabra Vahl, Harsh Vervain (N; RUM) *N 2221*

Verbena stricta Vent., Hoary Vervain (N) *Albers 33014* (TEX)

Verbena urticifolia L. var. *urticifolia*, White Vervain (N; TLM) *N 1940*

Verbena xutha Lehm., Gulf Vervain (N; TLO, TUO) *N 198, 2112, 2619*

VIOLACEAE

Viola bicolor Pursh., Field Pansy (N; TLM, TUO) *N 366, 1216, 2467*

Viola palmata L., Violet (N; TLW, TUM) *N 1204, 2468*

Viola sororia Willd. var. *missouriensis* (Greene) McKinney, Missouri Violet (N; RUM, TLM, TUM) *N 337, 396, 1207*

Viola sororia Willd. var. *sororia*, Sister Violet (N; RLM) *N 975*

VISCACEAE

Phoradendron tomentosum (DC.) Engelm. ex A. Gray, Mistletoe (N;PAR) *N 1115, 1136, 1141, 1205*

VITACEAE

Ampelopsis arborea (L.) Koehne., Peppervine (N; RUM, TLM, TUM) *N 88, 633, 748*

Ampelopsis cordata Michx., Heartleaf Peppervine (N; RLM, RUM) *N 1941, 2312*

Cissus incisa (Nutt.) Des Moul., Ivy Treebine (N; RLM, TUM) *N 749, 919, 1857*

Parthenocissus quinquefolia (L.) Planch., Virginia Creeper (N;TLM, TLW, TUM) *N 155, 1111, 1298, 1573*

Vitis aestivalis Michx. var. *lincecumii* (Buckl.) Munson, Summer Grape (N;TUM) *N 1777*

Vitis cinerea (Engelm. in A. Gray) Engelm. ex Millard., Sweet Grape (N; RUM, TLW, TUM) *N 231, 1489, 2649*

Vitis mustangensis Buckl., Mustang Grape (N;TLM, TLO, TUM) *N 175, 625, 2177*

Vitis palmata Vahl, Catbird Grape (N; RLM, TLM) *N 117, 1830*

Vitis riparia Michx., Frost Grape (N; RLM) *N 1918*

Vitis rotundifolia Michx. var. *rotundifolia*, Muscadine Grape (N; RLM, TUM, TUW) *N 230, 1335, 1666, 1790*

MAGNOLIOPHYTA: LILIOPSIDA

AGAVACEAE

Manfreda virginica (L.) Rose, Rattlesnake Master (N;TUM) *N 2107*

Yucca arkansana Trel., Arkansas Yucca (N;TUO) *N 1616*

Yucca louisianensis Trel., Louisiana Yucca (N;TUO) *N 2565*

Yucca treculeana Carr., Spanish Dagger (N;TUM) *N 213*

ALISMATACEAE

Echinodorus cordifolius (L.) Griseb., Burhead (N; RLM, TLW) *N 1894, 1928*

Sagittaria graminea Michx. ssp. *graminea* Grassy Arrowhead (N; AEM, RLM) *N 424, 688, 1479*

Sagittaria platyphylla Engelm., Delta Arrowhead (N; AEM, RUM) *N 224, 1985*

ARACEAE

Arisaema dracontium (L.) Schott., Green Dragon (N;TLM, TLW, TUW) *N 142, 1414, 1572*

ARECACEAE

Sabal minor (Jacq.) Pers., Small Palmetto (N;RLM, TLW) *N 110, 677*

BROMELIACEAE

Tillandsia recurvata L., Ball-moss (N; EPI) *N 282, 2170*

Tillandsia usneoides (L.) L., Spanish-moss (N; EPI) *N 111, 586, 807, 1034, 1496*

CANNACEAE

Canna x generalis L.H. Bailey, Canna (I;TLW) *N 676*

COMMELINACEAE

Commelina diffusa Burm. f. var. *diffusa*, Spreading Dayflower (N;TLO, TUW) *N 970, 2663*

Commelina erecta L. var. *angustifolia* (Michx.) Fern., Narrowleaf Dayflower (N;TUM, TUO) *N 256, 1729, 1865*

Commelina erecta L. var. *erecta*, Erect Dayflower (N;TLO) *N 971*

Commelina virginica L., Virginia Dayflower (N; RLM, TLW, TUO) *N 853, 1594, 1980, 2344*

Tradescantia hirsutiflora Bush, Hairyflower Spiderwort (N;TLM, TLW) *N 1603, 2486*

Tradescantia ohiensis Raf., Ohio Spiderwort (N; RLM, TLO, TLW, TUW) *N 355, 1435, 1654, 1832*

Tradescantia reverchonii Bush, Reverschon Spiderwort (N) *MacQueen 58* (TAMU)

Tradescantia subacaulis Bush., Stemless Spiderwort (N;TLM, TUM) *N 413, 2586*

CYPERACEAE

Carex albicans Willd. ex Spreng var. *australis* (Bailey) J. Rettig, Sedge (N;TLW) *N 2517*

Carex arkansana Bailey, Arkansas Sedge (N;TUO) *N 2544*

Carex austrina (Small) K. Mack., Southern Sedge (N; RUM) *N 1966*

Carex bulbostylis Dew., Sedge (N;TUW) *N 1437*

Carex bushii Mack., Bush Sedge (N;TUO) *N 2629*

Carex caroliniana Schwein., Carolina Sedge (N; RLM) *N 1337*

Carex cherokeensis Schwein., Cherokee Sedge (N; RUM, TLO, TLW, TUO) *N 1191, 1286, 1770, 2541*

Carex complanata T.&H., Sedge (N; RLM) *N 407, 1338*

Carex corrugata Fern., Corrugated Sedge (N; RUM) *N 1771*

Carex crus-corvi Schuttlw. ex Kuntze., Crowfoot Sedge (N; RLM, TLM) *N 428, 1307, 1344*

Carex emoryi Dew., Emory Sedge (N;RUM) *N 2516*

Carex flaccosperma K. Mack., Thinfruit Sedge (N; RLM, TLM, TLW) *N 549, 1283, 1342, 1534*

Carex frankii Kunth., Franks Sedge (N; RUM, TLW) *N 1951, 1993*

Carex hyalina Boott., Whitesheath Sedge (N; TUW) *N 1439*

Carex hyalinolepis Steud., Thinscale Sedge (N; TLW) *N 1292, 1562*

Carex leavenworthii Dew., Narrowleaf Sedge (N; RLM) *N 408*

Carex longii Mack., Longs Sedge (N; TLW) *N 1569*

Carex louisianica Bailey, Louisiana Sedge (N; TLW) *N 1285*

Carex lupulina Muhl., Hop Sedge (N; RLM, RUM, TLW) *N 848, 1742, 1991, 2600*

Carex oxylepis T. & H., Sharpscale Sedge (N; TLW) *N 1287*

Carex retroflexa Muhl., Reflexed Sedge (N; RLM) *N 2590*

Carex tetrastachya G. Scheele, Sedge (N; RLM, TUM) *N 1880, 2591*

Carex texensis (Torr.) L.H. Bailey, Texas Sedge (N; TLW) *N 1291*

Carex triangularis Boeckl., Sedge (N; RLM) *N 409*

Carex vulpinoidea Michx., Fox Sedge (N; RLM) *N 1343*

Cyperus acuminatus T. & H., Taperleaf Flatsedge (N; AEM) *N 119, 713*

Cyperus articulatus L., Jointed Flatsedge (N; TLO) *N 609*

Cyperus croceus Vahl, Baldwin Flatsedge (N; TUM, TUO) *N 780, 2703*

Cyperus echinatus (L.) A. Wood, Globe Flatsedge (N; TUM) *N 2434*

Cyperus erythrorhizos Muhl., Redroot Flatsedge (N; RLM) *N 812, 2349*

Cyperus esculentus L. var. *esculentus*, Yellow Nutsedge (N; TUM) *N 2457*

Cyperus haspan L., Sheathed Flatsedge (N; RUM) *N 714*

Cyperus odoratus L. var. *squarrosus* Jones, Wippf, & Carter, Fragrant Flatsedge (N) *Jones & Jones 404* (TAES)

Cyperus polystachos Rottb., Flatsedge (N; RLM) *N 809*

Cyperus pseudovegetus Steud., Flatsedge (N; TLM, TUO) *N 571, 1095*

Cyperus reflexus Vahl, Bentawn Flatsedge (N; TUM) *N 2458*

Cyperus retrorsus A. Chapm., Flatsedge (N; TUM, TUO) *N 258, 695*

Cyperus retroflexus Buckl. var. *retroflexus*, Oneflower Flatsedge (N) *Duncan s.n.* (TAES), *MacQueen 73* (TAMU)

Cyperus rotundus L., Nutgrass (I; RLM, TUO) *N 1884, 2267*

Cyperus strigosus L., False Nutgrass (N; TUO) *N 2134*

Cyperus virens Michx., Green Flatsedge (N; TLO) *N 1036*

Eleocharis fallax Weath., Spikerush (N) *Kessler 5839* (SHST)

Eleocharis lanceolata Fern., Lanceleaf Spikerush (N) *Herrick 120* (TAMU)

Eleocharis microcarpa Torr., Smallseed Spikerush (N; RLM) *N 1341*

Eleocharis montevidensis Kunth., Sand Spikerush (N; AEM, RUM, TLM) *N 423, 1305, 1565, 1986*

Eleocharis obtusa (Willd.) Shult., Blunt Spikerush (N; AEM) *N 1476*

Eleocharis palustris (L.) Romer & J.A. Shultes, Largespike Spikerush (N; RLM) *N 1887*

Eleocharis quadrangulata (Michx.) R.&S., Squarestem Spikerush (N; AEM) *N 685*

Fimbristylis autumnalis (L.) R. & S., Slender Fimbry (N; RLM, RUM) *N 252, 811*

Fimbristylis vahlii (Lam.) Link., Vahl Fimbry (N; RLM) *N 236, 808, 2353*

Fuirena squarrosa Michx., Hairy Umbrellagrass (N; RUM) *N 226*

Isolepis carinata Hook. & Arn. ex Torr., Small Bulrush (N; RLM, TLM, TUO) *N 541, 1340, 1485*

Isolepis molesta (M.C. Johnst.) S.G. Smith, Small Bulrush (N; TLM) *N 542, 1304*

Kyllinga odorata Vahl, Fragrant Flatsedge (N; RUM, TLO) *N 574, 2326*

Rhynchospora caduca Ell., Anglestem Beakrush (N; RLM) *N 240*

Rhynchospora corniculata (Lam.) A. Gray, Horned Beakrush (N; AEM) *N 1946*

Rhynchospora globularis (Chapm.) Small var. *recognita* Gale, Beakrush (N; RLM) *N 125*

Rhynchospora glomerata (L.) Vahl, Cluster Beakrush (N; TLW) *N 1451, 1547*

Rhynchospora macrostachya Torr., Tall Beakrush (N; AEM, RUM) *N 115, 1473*

Schoenoplectus californicus (C. Meyer) J. Sojak., Giant Bulrush (N; AEM) *N 722*

Scirpus cyperinus (L.) Kunth., Woolgrass Bulrush (N) *Kessler 5849, 5866* (SHST)

Scleria ciliata Michx., Fringed Nutrush (N; RUM) *N 1625*

Scleria oligantha Michx., Littlehead Nutrush (N; TUW) *N 1444*

DIOSCOREACEAE

Dioscorea villosa L., Atlantic Yam (N; TLW, TUW) *N 1301, 1658, 1907, 2657*

IRIDACEAE

Alophia drummondii (Graham) Foster, Purple Pleatleaf (N; TLO) *N 2678*

Gladiolus italicus Mill, Corn-flag (I; TUO) *N 2741*

Iris hexagona Walter var. *flexicaulis* (Small) Foster, Dixie Iris (N; TLM, TUO) *N 1311, 2481, 2574*

Iris pallida Lam., Bearded Iris (I; TUM) *N 768*

Sisyrinchium albidum Raf., White Blue-eyed Grass (N; TUM) *N 556*

Sisyrinchium exile Bickn., Yellow Blue-eyed Grass (N; TLW, TUO, TUW) *N 1268, 1433, 1600*

Sisyrinchium langloisii Greene, Pale Blue-eyed Grass (N; TUO) *N 1602*

Sisyrinchium minus Engelm. & A. Gray, Least Blue eyed Grass (N; TUO) *N 1601*

Sisyrinchium pruinosum Bickn., Dotted Blue-eyed Grass (N; TLO, TUO) *N 468, 1454*

Sisyrinchium rosulatum Bickn., Spreading Blue-eyed Grass (I; TLO, TUM, TUO) *N 567, 1703, 2664*

JUNCACEAE

Juncus acuminatus Michx., Knotleaf Rush (N; TUW) *N 1440*

Juncus acuminatus Michx. f. *sphaerocephalus* Herm., Knotleaf Rush (N; RUM) *N 1637*

Juncus brachycarpus Engelm., Whiteroot Rush (N; RUM) *N 1728*

Juncus bufonius L., Toad Rush (N) *Gould 8560* (TAES)

Juncus capitatus Weigel., Capped Rush (N; TUO) *N 2499*

Juncus debilis A. Gray, Weak Rush (N; RUM) *N 1981*

Juncus dichotomous Ell., Forked Rush (N; TLM, TUO) *N 1217, 1308*

Juncus diffusissimus Buckl., Slimpod Rush (N; AEM, TLM) *N 47, 589*

Juncus dudleyi Wieg., Dudley Rush (N; RLM, TUW) *N 433, 1443*

Juncus effusus L. var. *solutus* Fern. & Weig., Common Rush (N; AEM, ASU, RLM) *N 247, 432, 1114, 1560*

Juncus interior Wieg., Inland Rush (N; RUM, TLW) *N 1962, 1992*

Juncus marginatus Rostk., Grassleaf Rush (N; TLM, TLO, TUO) *N 26, 575, 2643*

Juncus repens Michx., Creeping Rush (N; ASU) *N 1971*

Juncus scirpoides Lam., Needlepod Rush (N; RUM) *N 1103*

Juncus tenuis Willd., Slender Rush (N; RUM) *N 58*

Juncus validus Coville. var. *validus*, Roundhead Rush (N; AEM, RLM, TLW, TUM) *N 122, 1270, 1701, 1780, 1944*

Luzula bulbosa (Wood.) Rydb., Bulb Woodrush (N; TLM, TLO) *N 2479, 2519*

LEMNACEAE

Lemna minima Phil., Duckweed (N; AFL) *N 1042*

Spirodela polyrhiza (L.) Schleid., Duck-meat (N; AFL) *N 2365*

Spirodela punctata (Meyer) Thomps., Duck-meat (I; AFL) *N 1043, 2489*

Wolffia columbiana Karst., Water-meal (N; AFL) *N 2490*

LILIACEAE

Allium canadense L. var. *canadense*, Wild Onion (N; TLM, TLO, TUW) *N 460, 1434, 1589, 2579*

Allium canadense L. var. *mobilense* (Regel.) M. Ownbey, Wild Onion (N; TLM, TUM, TUO) *N 404, 502, 1725, 2576*

Asparagus officinalis L., Asparagus (I; TUO) *N 1811*

Cooperia drummondii Herb., Cebolleta (N; TUO) *N 271*

Cooperia pedunculata Herb., Giant Rainlily (N; TUO) *N 2173*

Crinum americanum L., Swamp-lily (N; TUO) *N 1639*

Erythronium albidum Nutt., White Fawn-lily (N; TLW) *N 2510*

Habranthus tubispathus (L'Her) Traub, Copper Rainlily (I; TUO) *N 206, 2172*

Hemerocallis fulva L., Daylily (I; TLW, TUM) *N 675, 766*

Hippeastrum bifidum (Herb.) Bak., Oxblood Lily (I; TUM) *N 2244*

Hymenocallis caroliniana (L.) Herb., Carolina Spiderlily (N; AEM, TLW) *N 1641, 2538*

Hymenocallis eulae Shinners, Late Spiderlily (N; TUM, TUO) *N 1875, 2255, 2377*

Hymenocallis liriosme (Raf.) Shinners, Spiderlily (N; AEM) *N 1313*

Hypoxis hirsuta (L.) Cov., Hairy Goldstar-grass (N; TUM) *N 415, 1461*

Liriope spicata Lour., Creeping Lilyturf (I; TLW) *N 672*

Narcissus jonquilla L., Jonquil (I; TUO) *N 2525*

Nothoscordum bivalve (L.) Britton, Crow-poison (N; TLM, TUO) *N 334, 910*

Zigadenus nuttallii A.Gray, Nutall Deathcamas (N; TUM) *N 1325*

MARANTACEAE

Thalia dealbata Roscoe, Powdery Thalia (N; AEM) *N 132, 2572*

NAJADACEAE

Najas guadalupensis (Spreng.) Magnus, Southern Naiad (N; AFL) *N 682*

ORCHIDACEAE

Corallorhiza wisteriana Conrad., Wister Coralroot (N; TUW) *N 1456*

Spiranthes cernua (L.) Rich var. *cernua*, Nodding Ladies' Tresses (N; TLM, TUM, TUO) *N 1000, 1024, 1063, 1117, 2422*

Spiranthes gracilis (Bigel.) Beck var. *gracilis*, Slender Ladies' Tresses (N; TUO) *N 1005, 1062*

Spiranthes parksii Correll, Navasota Ladies' Tresses (N) *Nixon 15571* (ASTC), *Parker 1858* (BRIT)

Spiranthes praecox (Walter) Wats., Grass-leaved Ladies' Tresses (N; TUW) *N 1671*

Spiranthes tuberosa Raf., Gray's Ladies' Tresses (N; TLM) *N 2670*

Spiranthes vernalis Engelm. & A. Gray, Spring Ladies' Tresses (N; RUM, TLO, TUO) *N 604, 608, 1804, 2606*

POACEAE

Agrostis elliottiana Schult., Elliot Bentgrass (N; TUM) *N 1354*

Agrostis hyemalis (Walter) B.S.P., Winter Bentgrass (N; TLM, TLW, TUO) *N 55, 1410, 1526, 1762*

Aira caryophyllea L., Hairgrass (I; TUO) *N 1535, 1687*

Alopecurus carolinianus Walter, Carolina Foxtail (N; TLM, TLW, TLO) *N 64, 1409, 1558*

Andropogon glomeratus (Walter) B.S.P., Bushy Bluestem (N; RLM) *N 976*

Andropogon ternarius Michx., Splitbeard Bluestem (N; TUM, TUO) *N 1009, 1023, 1092, 1109*

Andropogon virginicus L., Broomsedge Bluestem (N; RUM, TUO) *N 2035, 2464*

Aristida desmantha Trin. & Rupr., Curly Threeawn (N; TUO) *N 1008*

Aristida longespica Poir. var. *geniculata* (Raf.) Fern, Plains Threeawn (N; TLM) *N 2444*

Aristida longespica Poir. var. *longespica*, Slimspike Threeawn (N; TUO) *N 1075*

Aristida oligantha Michx., Oldfield Threeawn (N; TUM, TUO) *N 914, 2346, 2442*

Arundinaria gigantea (Walter) Muhl., Giant Cane (N; RLM, TLW) *N 833, 1399, 1588*

Arundo donax L., Giant Reed (I; TUO) *N 880, 881*

Avena fatua L. var. *fatua*, Wild Oats (I; TLO, TUO) *N 455, 1393*

Avena fatua L. var. *sativa* (L.) Hausskn., Common Oats (I; TLO) *N 167*

Bothriochloa ischaemum (L.) Keng. var. *songarica* (Fisch. & Mey.) Cel. & Harl., King Ranch Bluestem (I; TUM, TUO) *N 789, 1108, 1525, 2276*

Bothriochloa laguriodes (DC.) Herter ssp. *torreyana* (Steud.) Allred & Gould, Silver Bluestem (N; TUM, TUO) *N 105, 1007, 1093*

Bothriochloa longipaniculata (Gould) Allred & Gould, Longspike Silver Bluestem (N; TUM, TUO) *N 917, 1094, 2275*

Bouteloua curtipendula (Michx.) Torr. var. *curtipendula*, Sideoats Grama (N; TUO) *N 696*

Briza minor L., Little Quaking Grass (I; TLO, TLW, TUO) *N 517, 1332, 1449*

Bromus catharticus M.A.Vahl, Rescuegrass (I; RUM, TUM, TUO) *N 516, 1352, 1394, 2507*

Bromus japonicus Thunb., Japanese Brome (I; TUO) *N 1726, 2005*

Bromus pubescens Muhl. ex Willd., Brome (N) *Nixon 4712* (ASTC)

Bromus secalinus L., Rye Brome (I; TLM, TUO) *N 67, 1677, 1763*

Buchloe dactyloides (Nutt.) Engelm., Buffalograss (N; TLO) *N 579, 1889*

Cenchrus spinifex A. Cav., Sandbur (N; TUM, TUO) *N 249, 737, 2016, 2270, 2397*

Chasmanthium latifolium (Michx.) Yates, Broadleaf Woodoats (N; RLM, RUM) *N 112, 795, 1765*

Chasmanthium laxum (L.) Yates var. *laxum*, Woodoats (N; RLM, TLW) *N 228, 2400*

Chasmanthium laxum (L.) Yates var. *sessiliflorum* (Poir.) Wipff & S.D. Jones, Narrowleaf Woodoats (N; TLW, TUW) *N 2075, 2658*

Chloris canterai Arech., Windmillgrass (I; TUO) *N 2124*

Chloris verticillata Nutt., Tumble Windmillgrass (N; TUM) *N 2259*

Chloris virgata Sw., Showy Windmillgrass (N; TLM) *N 1015*

Chloris x *subdolichostachya* Mueller, Shortspike Windmillgrass (N; TUM, TUO) *N 1105, 2122*

Cynodon dactylon (L.) Pers., Bermuda Grass (I; TUM, TUO) *N 913, 1033, 1327*

Dactyloctenium aegyptium (L.) Willd., Durban Crowfootgrass (I; RLM, TUO) *N 849, 912, 2310*

Dichanthelium aciculare (Poir.) Gould & Clark var. *aciculare*, Rosettegrass (N; TLO, TUO) *N 996, 1978*

Dichanthelium acuminatum (Sw.) Gould & Clark var. *acuminatum*, Woolly Rosettegrass (N; RUM, TUO, TUW) *N 71, 716, 1422, 1766*

Dichanthelium acuminatum (Sw.) Gould & Clark var. *lindheimeri* (Nash) Gould, Lindheimer Rosettegrass (N; RLM, RUM, TUW) *N 746, 875, 2708*

Dichanthelium clandestinum (L.) Gould, Deertongue Rosettegrass (N; TUW) *N 2709*

Dichanthelium commutatum (Schult.) Gould, Variable Rosettegrass (N; TLM, TLW, TUW) *N 1289, 1429, 1524, 2077, 2518*

Dichanthelium dichotomum (L.) Gould var. *dichotomum*, Rosettegrass (N; TUM) *N 539*

Dichanthelium oligosanthes (Schult.) Gould var. *oligosanthes*, Rosettegrass (N; TUM) *N 553*

Dichanthelium oligosanthes (Schult.) Gould var. *scribnerianum* (Nash) Gould, Scribners Rosettegrass (N; TUM, TUO, TUW) *N 25, 1850, 2707*

Dichanthelium ravenelii (Lamson-Scribn.) Gould, Rosettegrass (N; TLM) *N 2673*

Dichanthelium scoparium (Lam.) Gould, Velvet Rosettegrass (N; RUM, TUM, TUO) *N 227, 508, 1773, 1778, 1903*

Dichanthelium sphaerocarpon (Ell.) Gould & Clark var. *sphaerocarpon*, Roundseed Rosettegrass (N; TLW) *N 1294, 1505*

Digitaria cognata (Schult.) Pilger ssp. *cognata*, Fall Witchgrass (N; TUO) *N 1057, 1617*

Digitaria sanguinalis (L.) Scop., Hairy Crabgrass (I; TLO, TUM, TUO) *N 2019, 2123, 2212, 2261*

Digitaria villosa (Walter) Pers., Shaggy Crabgrass (N; TUM) *N 782*

Digitaria violascens Link., Violet Crabgrass (I) *Wells 36* (TAES)

Echinochloa colonum (L.) Link., Junglerice (I; AEM) *N 2460*

Echinochloa crusgallii (L.) Beauv. var. *crusgallii*, Barnyard Grass (I; AEM, RLM, RUM) *N 816, 2032, 2082, 2167*

Echinochloa muricata (Beauv.) Fern., Barnyard Grass (N) *Newman 18* (TAES)

Echinochloa walteri (Pursh) Heller, Barnyard Grass (N; AEM, RLM, TUO) *N 290, 2214, 2347*

Eleusine indica (L.) Gaertn., Goosegrass (I; TUO) *N 2121*

Elymus canadensis L. var. *canadensis*, Canada Wildrye (N; TUM, TUO) *N 107, 618, 1733*

Elymus virginicus L., Virginia Wildrye (N; TLO, TLW, TUO) *N 1840, 1920, 2018*

Eragrostis curtipedicillata Buckl., Gummy Lovegrass (N; TUM) *N 2280*

Eragrostis hirsuta (Michx.) Nees, Bigtop Lovegrass (N; TUM) *N 2186*

Eragrostis hypnoides (Lam.) B.S.P., Teal Lovegrass (N; RLM) *N 235*

Eragrostis intermedia A.S. Hitchc. var. *intermedia*, Plains Lovegrass (N; TUM) *N 1099, 2237*

Eragrostis reptans (Michx.) Nees, Creeping Lovegrass (N; RLM) *N 887, 1939, 2354, 2592*

Eragrostis secundiflora Presl. ssp. *oxylepis* (Torr.) S.D. Koch, Red Lovegrass (N; TUM, TUO) *N 246, 697, 2263, 2305, 2433*

Eragrostis spectabilis (Pursh.) Steud., Purple Lovegrass (N; RLM, TUM) *N 771, 2352, 2438*

Eriochloa sericea (Scheele) Munro ex Vasey, Texas Cupgrass (N) *Nixon 4737* (ASTC)

Eustachys retusa (Lag.) Kunth., Windmillgrass (N; TUO) *N 1963*

Festuca subverticillata (Pers.) E.B. Alexeev, Nodding Fescue (N; TUO) *N 1585*

Glyceria septentrionalis Hitchc. var. *septentrionalis*, Eastern Mannagrass (N; AEM) *N 1945*

Gymnopogon ambiguus (Michx.) B.S.P., Bearded Skeletongrass (N) *Wells 45* (TAES)

Hordeum leporinum Link., Hare Barley (I; TLO) *N 1442*

Hordeum pusillum Nutt., Little Barley (N; TUO) *N 1396*

Leersia lenticularis Michx., Catchfly Grass (N; RLM) *N 866, 978, 2348*

Leersia virginica Willd., Whitegrass (N; RLM, RUM) *N 817, 2674*

Lolium perenne L., Perennial Ryegrass (N; TLM, TLO, TUO) *N 454, 1237, 1395*

Melica mutica Walter, Twoflower Melic (N; RUM, TLW) *N 148, 1259*

Muhlenbergia capillaris (Lam.) Trin., Hairyawn Muhly (N; TUM) *N 1098, 2440*

Muhlenbergia schreberi Gmel., Nimblewill (N) *Rich & Briley 1713* (ASTC)

Nassella leucotricha (Trin. & Rupr.) Pohl., Texas Wintergrass (N; TLO, TLW) *N 453, 1490*

Oplismenus hirtellus (L.) Beauv., Basketgrass (I; TLM, TLW) *N 1593, 2303, 2398*

Panicum anceps Michx., Beaked Panicum (N; TUM) *N 2235, 2441*

Panicum brachyanthum Steud., Pimple Panicum (N; TLM, TUM) *N 2252, 2302*

Panicum dichotomiflorum Michx., Fall Panicum (N; RLM, TLW) *N 888, 2459*

Panicum diffusum Sw., Spreading Panicum (N) *Waller & Lonard 1973* (TAES)

Panicum gymnocarpon Ell., Savannah Panicum (N; RLM) *N 850*

Panicum hallii Vasey var. *hallii*, Halls Panicum (N) *Wells 65* (TAES)

Panicum hians Ell., Gaping Panicum (N; RLM, TLM, TUO) *N 120, 543, 818, 1055*

Panicum rigidulum Nees, Redtop Panicum (N; RLM, TLW) *N 297, 819, 890, 1892, 1994*

Panicum virgatum L., Switchgrass (N; RLM, TUO) *N 889, 1089, 2712*

Paspalidium geminatum (Forssk.) Stapf. var. *geminatum*, Paspalidium (N; RUM) *N 2030*

Paspalum dilatatum Poir., Dallisgrass (I; TUM) *N 1786*

Paspalum floridanum Michx. var. *glabratum* Engelm. ex Vasey, Florida Paspalum (N; TUM, TUO) *N 715, 1032, 2437*

Paspalum fluitans (Ell.) Kunth., Water Paspalum (N; RLM, RUM) *N 863, 2166, 2350* (*P. repens* Bergius var. *fluitans* (Ell.) Wipff & S.D. Jones

Paspalum laeve Michx., Field Paspalum (N) *Newman 2* (TAES)

Paspalum notatum Flugge var. *notatum*, Bahiagrass (I; TUM, TUO) *N 245, 1849*

Paspalum notatum Flugge var. *saurae* Parodi, Bahiagrass (I; TLM) *N 634*

Paspalum plicatulum Michx., Brownseed Paspalum (N; TUM, TUO) *N 69, 1950, 2004, 2258, 2628*

Paspalum pubiflorum Rupr. ex Fourn., Hairyseed Paspalum (N) *Nixon 7604* (TAES)

Paspalum setaceum Michx. var. *setaceum*, Thin Paspalum (N; TUO) *N 1708*

Paspalum setaceum Michx. var. *stramineum* (Nash.) D. Banks, Thin Paspalum (N; TUO) *N 1848*

Paspalum urvillei Steud., Vaseygrass (I; TLO, TUO) *N 286, 1815, 2461*

Phalaris caroliniana Walter, Carolina Canarygrass (N; TLM, TLO, TUM) *N 60, 507, 1425*

Piptochaetium avenaceum (L.) Parodi, Blackseed Needlegrass (N; RLM, TLM, TLW, TUM) *N 555, 1293, 1345, 1580*

Poa annua L., Annual Bluegrass (I; TLW) *N 2739*

Poa autumnalis Muhl. ex Ell., Autumn Bluegrass (N; TUO) *N 1567*

Poa chapmaniana Lamson.-Scribn., Chapman Bluegrass (N; TUM) *N 434*

Polypogon monspeliensis (L.) Desf., Rabbitfoot Polypogon (I; RUM) *N 1977*

Saccharum baldwinii Spreng., (N; RUM) *N 2345*

Schizachyrium scoparium (Michx.) Nash var. *divergens* (Hack.) Gould, Little Bluestem (N; TUM, TUO) *N 1058, 2306*

Schizachyrium scoparium (Michx.) Nash var. *scoparium* (C.E. Hubb.) Gould, Little Bluestem (N; TUM, TUO) *N 993, 2238*

Secale cereale L., Rye (I; TUM) *N 103*

Setaria parviflora (Poir.) Kerguel., Bristlegrass (N; RLM, TLO, TUM, TUO) *N 197, 285, 623, 1627, 2213, 2278*

Sorghastrum nutans (L.) Nash, Yellow Indiangrass (N; TUM, TUO) *N 1090, 1106, 2435*

Sorghum halepense (L.) Pers., Johnsongrass (I; RUM, TUM, TUO) *N 108, 1734, 2033*

Sphenopholis interrupta (Buckl.) Lamson-Scribn., Wedgescale (N; TUO) *N 1689*

Sphenopholis obtusata (Michx.) Lamson-Scribn. var. *major* (Torr.) Erdman, Wedgescale (N; TLM, TLW, TUO) *N 1255, 1306, 1564*

Sphenopholis obtusata (Michx.) Lamson-Scribn. var. *obtusata*, Prairie Wedgescale (N; TUO) *N 1488*

Sporobolus compositus (Poir.) Merr. var. *macer* (Trin.) Kartesz & Gandhi, Dropseed (N; TUM, TUO) *N 1059, 2439*

Sporobolus coromandelianus (Retz.) Kunth, Dropseed (N; TUO) *N 2174*

Sporobolus cryptandrus (Torr.) A. Gray, Sand Dropseed (N; TUM) *N 2279*

Sporobolus indicus (L.) R. Br., Smutgrass (N; TUM, TUO) *N 1330, 1523, 2462*

Stenotaphrum secundatum (Walter) Kuntze, St. Augustine Grass (I; RUM, TLO) *N 763, 2641*

Tridens flavus (L.) A.S. Hitchc. var. *chapmanii* (Small) Shinners, Chapman Tridens (N; RLM, TUM) *N 783, 804*

Tridens flavus (L.) A.S. Hitchc. var. *flavus*, Purpletop (N; TUM, TUO) *N 2301, 2436*

Tridens strictus (Nutt.) Nash, Longspike Tridens (N; TUM, TUO) *N 916, 1060, 2257*

Tripsacum dactyloides (L.) L., Eastern Gamagrass (N; TLM, TLO, TUO) *N 150, 645, 2132*

Triticum aestivum L., Wheat (I; TUM) *N 102*

Urochloa platyphylla (Munro ex Wright) R.D.Web., Broadleaved Signalgrass (N; TUM, TUO) *N 2271, 2372, 2679*

Urochloa texana (S. Buckl.) R.D. Webster, Texas Signalgrass (N; TUM, TUO) *N 915, 1124*

Vulpia myuros (L.) K.C. Gmel. var. *myuros*, Rattail Sixweeks Grass (I; TLO, TLW) *N 1470, 1667*

Vulpia octoflora (Walter) Rydb. var. *octoflora*, Common Sixweeks Grass (N; TLM, TUM, TUO) *N 554, 1507, 1546, 2587*

Vulpia sciurea (Nutt.) Henr., Squirrel Sixweeks Grass (N; TUO) *N 2563*

Zea mays L., Corn (I; TLO) *N 2207*

Zizaniopsis miliacea (Michx.) Doell. & Asch., Southern Wildrice (N; RLM, RUM) *N 220, 1890*

PONTEDERIACEAE

Pontederia cordata L., Pickerelweed (N; AEM) *N 188*

POTAMOGETONACEAE

Eichhornia crassipes (Mart.) Solms, Water Hyacinth (I) *Murray 34* (TAMU), *Griffith 28* (TAMU)

Potamogeton diversifolius Raf. var. *diversifolius*, Waterthread Pondweed (N; AFL) *N 1983, 1481, 2446*

SMILACACEAE

Smilax bona-nox L., Cat-briar (N; RLM, TUM, TUW) *N 123, 1053, 1127, 2071, 2455*

Smilax glauca Walter, Saw-briar (N; TLW, TUM) *N 1769, 1791*

Smilax glauca Walter var. *leucophylla* Blake, Saw-briar (N; TUM) *N 232*

Smilax smallii Morong, Green-briar (N; TLW, TUM) *N 340, 560, 1768, 2068*

Smilax tamnoides L., Hellfetter (N; RLM, TLW) *N 873, 2115, 2404*

TYPHACEAE

Typha domingensis Pers., Cattail (N; AEM) *N 97, 590, 1037, 1628, 1982*

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BOOK NOTICE

GRADY L. WEBSTER and CONRAD J. BAHRE (editors). 2001. **Changing Plant Life of *La Frontera*.** (ISBN 0-8263-2239-5, hbk.). University of New Mexico Press, 1720 Lomas Boulevard NE, Albuquerque, NM, 87131-1591, U.S.A. $60.00, hbk., 272 pages, 41 halftones, 6 maps, 8 1/2" × 11".

Table of Contents.—List of Figures; List of Tables; Foreword. *Frederick Gehlbach*

This book is a result of the *Changing Vegetation and Flora of the U.S./Mexico Boundary Region* symposium held at the American Institute of Biological Sciences to honor the late Forrest Shreve, a pioneer desert ecologist. Contributions and collaborations come from biologists, environmentalists, and climatologists from both sides of *La Frontera* to present a new agenda for the study of the strikingly diverse shrub and grassland ecosystems of the U.S./Mexico border. Covering cross border changes in vegetation stemming from the disparate land use practices in the region, fire histories, pollen studies, repeat aerial and ground photographic analyses, botanical surveys, biogeography, and paleoecology, this text is nothing less than exhaustive. Everyone interested in the vegetation of the U.S./Mexico border should have this book on his or her shelf.—*Kevin D. Janni, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A., kjanni@brit.org.*

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CONSIDERACIONES SOBRE EL ORIGEN DE LA FLORA ARVENSE Y RUDERAL DEL ESTADO DE QUERÉTARO, MÉXICO

José Aurelio Colmenero Robles

Coordinación General de Posgrado e Investigación
Instituto Politécnico Nacional
Apartado Postal 75-187
Col. Lindavista, 07300, MÉXICO, D.F.

Concepción Rodríguez Jiménez and Fernández Nava Rafael

Departamento de Botánica
Escuela Nacional de Ciencias Biológicas
Instituto Politécnico Nacional
Col. Santo Tomás, Apartado Postal 17-564
11410 MÉXICO, D.F.

RESUMEN

Se efectuó un estudio del origen de la flora arvense y ruderal presente en el estado de Querétaro, México. Una de las principales causas de la distribución es la ubicación geográfica del estado, paso obligado hacia las regiones norte y sur del país. Otro factor implicado fueron las actividades agropecuarias practicadas por los grupos nativos (chichimecas y otomíes), modificadas posteriormente por la inmigración europea, con la introducción de cultivos y de diversas especies de maleza.

Se registraron 347 especies, 211 géneros y 47 familias de las regiones agrícolas del estado; destacan por el número de taxa las familias Compositae (81 spp.), Gramineae (61 spp.), Euphorbiaceae (22 spp.), Leguminosae (17 spp.), Solanaceae (16 spp.), Malvaceae (12 spp.), Cruciferae (12 spp.) y Convolvulaceae (10 spp.) de las que el 66% fueron recolectadas en terrenos de cultivo y el 14% en la vegetación ruderal. Se listan 125 especies consideradas nativas, la mayoría de las cuales pertenecen a las familias: Compositae, Gramineae, Solanaceae, Euphorbiaceae, Caryophylllaceae y Cucurbitaceae; además de las 57 de origen norteamericano, hay 57 de América tropical, 29 europeas, 23 sudamericanas, 20 euroasiáticas, 16 asiáticas, 8 caribeñas, 8 africanas, 2 de la región de Oceanía y 2 de Centroamérica.

ABSTRACT

The origin of weeds and ruderal species from Queretaro, Mexico was studied. One of the principal causes for the distribution of weeds of diverse origin is the location of the state, through which much north-south travel was focused. Another factor was the agricultural practices of native people (chichimecas y otomíes), later modified by European immigrants, with the introduction of new crops and diverse weedy associates.

We recorded 347 species, 211 genera, and 47 families. The families with largest number of taxa are Compositae (81 spp), Gramineae (61 spp.), Euphorbiaceae (22 spp.), Leguminosae (17 spp.), Solanaceae (16 spp.), Malvaceae (12 spp.), Cruciferae (12 spp.) and Convolvulaceae (10 spp.) of which 66% were collected in field crops and 14% in ruderal vegetation. There are 125 species considered native, most of them belong to the families: Compositae, Gramineae, Solanaceae, Euphorbiaceae, Caryophyllaceae and Cucurbitaceae. In addition to 57 from North America, there were 57 from Tropical America, 29 from Europe, 23 from South America, 23 from European-Asiatic, 16 from Asia, 8 from Caribbean, 8 from Africa, 2 from Oceania, and 2 from Central America.

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INTRODUCCION

El estudio de las especies de maleza en México se ha incrementado considerablemente en los últimos años, llamando la atención el aumento de trabajos registrados en este campo de la Biología. Estas plantas presentan dos propiedades fundamentales: resistencia a situaciones adversas y agresividad, que les permiten causar serios daños a los cultivos agrícolas: incrementando el costo de producción y disminuyendo los rendimientos. Cumplen sin embargo funciones ecológicas importantes al ser consideradas pioneras o colonizadoras en áreas con vegetación alterada o en proceso de sucesión, donde con sus sistemas radiculares, a veces muy extensos, retienen el suelo y evitan el riesgo de erosión, proveen de néctar y polen a insectos melíferos, sirven como fertilizantes y contribuyen a la formación del suelo (Villarreal 1983).

Caracterizar a las plantas arvenses o ruderales no es fácil, sin embargo, se considera que todas presentan: **1.**-Alta producción de semillas con elevada tasa de germinación y desarrollo en distintas condiciones ambientales. **2.**-Crecimiento acelerado desde la etapa juvenil hasta la floración. **3.**-Autocompatibilidad o autofertilización, pero no siempre son autógamas o apomícticas. **4.**-Diversos mecanismos de dispersión a distancias cortas y/o largas mediante estructuras morfológicas presentes en sus frutos y semillas. **5.**-Alto grado de reproducción vegetativa (Baker 1974; Espinosa y Sarukhán 1997).

Reciben estas plantas diversos nombres comunes, tales como: malas hierbas, plantas indeseables, yuyos, plantas arvenses o agrestales y en náhuatl son reconocidas como acahuales, jehuites o jihuites (Villegas 1970).

Desde el punto de vista ecológico se reconocen dos grandes grupos, las plantas arvenses, que se encuentran ligadas a los cultivos y las plantas ruderales, que son propias de poblados, lotes baldíos y múltiples vías de comunicación (Rzedowski y Rzedowski 1957; Rzedowski 1978).

ANTECEDENTES

Las especies de arvenses y ruderales de la República Mexicana varían de una región a otra, en función de los distintos factores ambientales de cada sitio, quedando su abundancia sujeta a las actividades antropógenas (Rzedowski 1978).

Por lo que se refiere al origen de las arvenses mexicanas diversos autores han hecho mención de la procedencia de un buen número de ellas en estudios realizados para varias regiones del país (Rodríguez 1967; Villegas 1970; Agundis y Rodríguez 1978; Villarreal 1983; Nava 1991; Rzedowski 1993; Rzedowski y Rzedowski 1993; Vibrans 1998a); lo mismo que para las plantas ruderales (Rapoport et al. 1983; Vibrans 1996, 1998b). El análisis de los datos recabados ha llevado a concluir que en este grupo de plantas prevalece cuantitativamente la maleza autóctona (Rzedowski 1978, 1991; Bye 1993). El arribo de plantas introducidas de origen europeo y asiático se realiza en los siglos del XVI al XVIII, con motivo de la colonización española y el intercambio comercial que se efectuó de manera inmediata. Entre los géneros con especies introducidas en este período destacan: *Asphodelus, Brassica, Conium, Eruca, Fumaria, Melilotus, Sisymbrium, Sonchus, Taraxacum* y *Verbascum*. En cuanto al componente de origen africano se registran a la fecha alrededor de 42 taxa para el país, sobresaliendo los géneros *Bryophyllum, Chloris, Cynodon, Eleusine* y *Eragrostis* (Rzedowski & Rzedowski 1990). En la actualidad se cuenta con nuevos registros de exóticas introducidas en nuestro país, algunos ejemplos de ellos son *Amaranthus muricatus* (Moq.) Gillies ex Hicken, *Bellis perennis* L., *Chenopodium giganteum* D. Don, *Digitaria wallichiana* (Wight & Arnold) Stapf, *Guizotia abyssinica* (L.f.) Cass. y *Hypochoeris radicata* L. (Vibrans 1998b).

La presencia de algunas gramíneas exóticas está estrechamente relacionada con la introducción de la ganadería a nuestro país. Los primeros hatos ganaderos, provenientes de las Islas de Cuba y la Española a cargo de Nuño Guzmán llegaron en 1527 a Pánuco, Veracruz. Este hecho promovió la formación de tres regiones ganaderas en la Nueva España: la de Pánuco, la de Llanos de Almería (hoy las tierras bajas de Misantla, Vega de Alatorre y Nautla) y la de Papaloapan. Este acontecimiento favoreció también el arribo de diversas especies forrajeras para la alimentación del ganado y a su vez la paulatina transformación de los ecosistemas del trópico húmedo. Alrededor de 1870 se registra por primera vez el pasto guinea o privilegio (*Panicum maximum* Jacq.) en las tierras del norte de México y se piensa que éste fue utilizado como cama para los esclavos africanos transportados masivamente hacia América (Challenger 1998).

Las principales gramíneas forrajeras de origen africano presentes en México son: el zacate Rhodes (*Chloris gayana* Kunth), del sur y este de ese continente; el pasto estrella gigante (*Cynodon plectostachyus* (K. Schum.) Pilg.), del oriente; *Dichanthium annulatum* (Forssk.) Stapf., del norte; el zacate pangola (*Digitaria decumbens* Stent), del sur; el zacate kikuyu (*Pennisetum clandestinum* Hochst. ex Chiov.), de Africa central y oriental. Otras especies como el zacate elefante (*Pennisetum purpureum* Schumach.), el pasto natal o pasto rosado (*Rynchelytrum repens* (Willd.) C.E. Hubb) y el zacate Johnson (*Sorghum halepense* (L.) Pers.) este último nativo del área mediterránea y posiblemente de ascendencia africana (Rzedowski & Rzedowski 1990). Al parecer muchas de estas especies se cultivan en nuestro territorio desde el primer tercio del siglo XX, como forraje para el ganado cebú (Barrera 1996). De acuerdo con Dávila y Sánchez (1996), existen alrededor de 49 géneros de gramíneas introducidos a la fecha, la mayoría de sus representantes se consideran malezoides.

Otros factores que favorecieron el desarrollo de especies exóticas en el Altiplano durante épocas pasadas fueron la tala de los bosques para su utilización como madera y combustible y la introducción de ganado cuyo sobrepastoreo sobre la vegetación nativa, promovió la distribución de especies como *Urtica dioica* L., algunas otras de *Plantago* y del trébol blanco, *Trifolium repens* L., plantas que se extendieron muy rápidamente, de tal manera que los aztecas llamaron a esta última "ocoxichtli de castilla," nuevamente de acuerdo a la apreciación de Challenger (1998).

Los estudios sobre el inventario y el conocimiento de las plantas arvenses y ruderales para el estado de Querétaro son relativamente escasos, se inician en los años de 1983-1984 con Agundis, O. y colaboradores quienes elaboran el primer inventario florístico de arvenses para la zona centro del estado, registrando un total de 234 especies en 14 cultivos principales (inédito).

De acuerdo con Fernández et al. (1993), existe además de la zona agrícola, un área ganadera de gran importancia para el estado, que no registraba ningún trabajo que permitiera conocer las plantas malezoides que crecían en ella, por lo que se abocaron a realizar este inventario para el noreste de Querétaro (Arroyo Seco, Jalpan, Landa de Matamoros y Pinal de Amoles). Los resultados establecieron que existía una cantidad considerable de arvenses, alrededor de 172 especies, como consecuencia del intensivo uso del suelo en esta región.

Zepeda (1996), emprende el estudio de las especies de malezas presentes en los cultivos de maíz y de sorgo en el Centro-Sur de Querétaro. Sus resultados indican la presencia de 21 familias y 53 taxa, destacando las familias Gramineae (16 spp.) y Compositae (10 spp.).

Suárez y Serrano (1997), en su publicación "Principales malezas (arvenses) en el campo queretano," citan 14 especies con su respectiva descripción, imagen fotográfica e indicando los cultivos donde prosperan. Finalmente, Villaseñor y Espinosa (1998), enlistan un número considerable de taxa para Querétaro.

AREA DE ESTUDIO

Querétaro se ubica en la Región Central de la República Mexicana entre los paralelos 20°01'16" y 21°35'38" de latitud norte y los meridianos 99°00'46" y 100°35'46", está limitado por 5 estados: San Luis Potosí al Norte y Noroeste, Hidalgo al Este, Guanajuato al Oeste y Suroeste, Estado de México y Michoacán al Sureste y Sur respectivamente (INEGI 1986).

Querétaro ha sido por siglos un estado agrícola, aunque en la actualidad la industria, ha cobrado mayor importancia, pero a pesar de esto, la agricultura y la ganadería forman parte de la columna vertebral de su economía; existen más de 30 cultivos, destacando por la magnitud de la superficie sembrada maíz, trigo, alfalfa, frijol, sorgo, jitomate, lenteja, chile verde, cebada, cebolla y ajo entre otros (Ramírez 1995).

La distribución de las áreas agrícolas se establece de acuerdo al criterio de Holt (1970) en 3 Distritos: Norte, Centro y Sur, incluyendo algunos datos de las características físicas del ambiente tomados de INEGI (1986), así como los tipos de vegetación considerados por Zamudio et al. (1992) (Fig. 1).

Distrito Norte

Queda comprendido en la Provincia Sierra Madre Oriental, de forma particular dentro de la Subprovincia Carso Cárstico; el clima que predomina corresponde a los cálidos (Aw) y templados (A)C(w_0-w_2), razón por lo cual se presenta de norte a sur un gradiente térmico de cálido a frío, con precipitaciones de 770-1050 mm de lluvia promedio anual y temperaturas promedio anual de 18-20° C; la conformación geológica está constituida por rocas sedimentarias, calizas y lutitas; los suelos predominantes son de los tipos litosoles, luvisoles crómicos, luvisoles órticos y rendzinas; la actividad agrícola tiende a ser de temporal con cultivos de ciclo anual y pequeñas áreas dedicadas a la fruticultura; los tipos de vegetación que se presentan en las regiones serranas son: Bosque de *Pinus*, Bosque de *Abies*, Bosque Mesófilo de Montaña, Bosque Tropical Caducifolio y Matorral Submontano. Comprende los municipios de Pinal de Amoles, Arroyo Seco, Jalpan y Landa de Matamoros.

Distrito Centro

Está inserto en la provincia Mesa del Centro, de forma particular en las subprovincias de las Sierras y Llanuras del Norte de Guanajuato y en una sección de la Provincia del Eje Neovolcánico. Los tipos de clima corresponde a los semisecos (BS_1) y los secos (BS_0), la cantidad de lluvia es alrededor de los 370-630 mm de precipitación promedio anual y la temperatura oscila entre los 20-25° C; geológicamente predominan rocas ígneas, basaltos y otras de carácter sedimentario; los tipos de suelos se identifican como litosoles, luvisoles crómicos, regosoles eútricos, feozem háplico y feozem crómico; en cuanto a la agricultura tiende a ser variada, se caracteriza por ser la región del cultivo de vid, aguacate, mango y pequeñas áreas de cultivos de ciclo anual; los tipos de vegetación que sobresalen entre las cañadas, laderas y elevaciones orográficas de mediano tamaño son: Bosque de *Quercus*, Bosque de *Juniperus*, Encinar Arbustivo, Matorral Rosetófilo y Matorral Micrófilo. Su extensión incluye los municipios de Cadereyta, Ezequiel Montes, Peñamiller, San Joaquín y Tolimán.

Distrito Sur

Se ubica en lo que se conoce como Provincia del Eje Neovolcánico y en una sección pequeña de la Subprovincia Mil Cumbres. Los tipos de climas principales son los secos (BS_0), semisecos (BS_1) y templados (Cw_2), la cantidad de lluvia promedio anual se sitúa entre los gradientes de los 400-860 mm, con temperaturas promedio anual de 18-25° C; las unidades geológicas comprenden: basaltos, tobas, calizas, brechas volcánicas y aluviones; entre los tipos de suelos sobresalen principalmente el vertisol pélico (muy ricos en materia orgánica) y el feozem háplico; destaca la agricultura de riego de dos ciclos (primavera e invierno); los tipos de vegetación para esta sección son el Bosque de *Pinus cembroides*, el Bosque de *Quercus*, el Matorral Crasicaule y el Pastizal. Está conformado por los municipios de Amealco, Colón, Villa Corregidora,

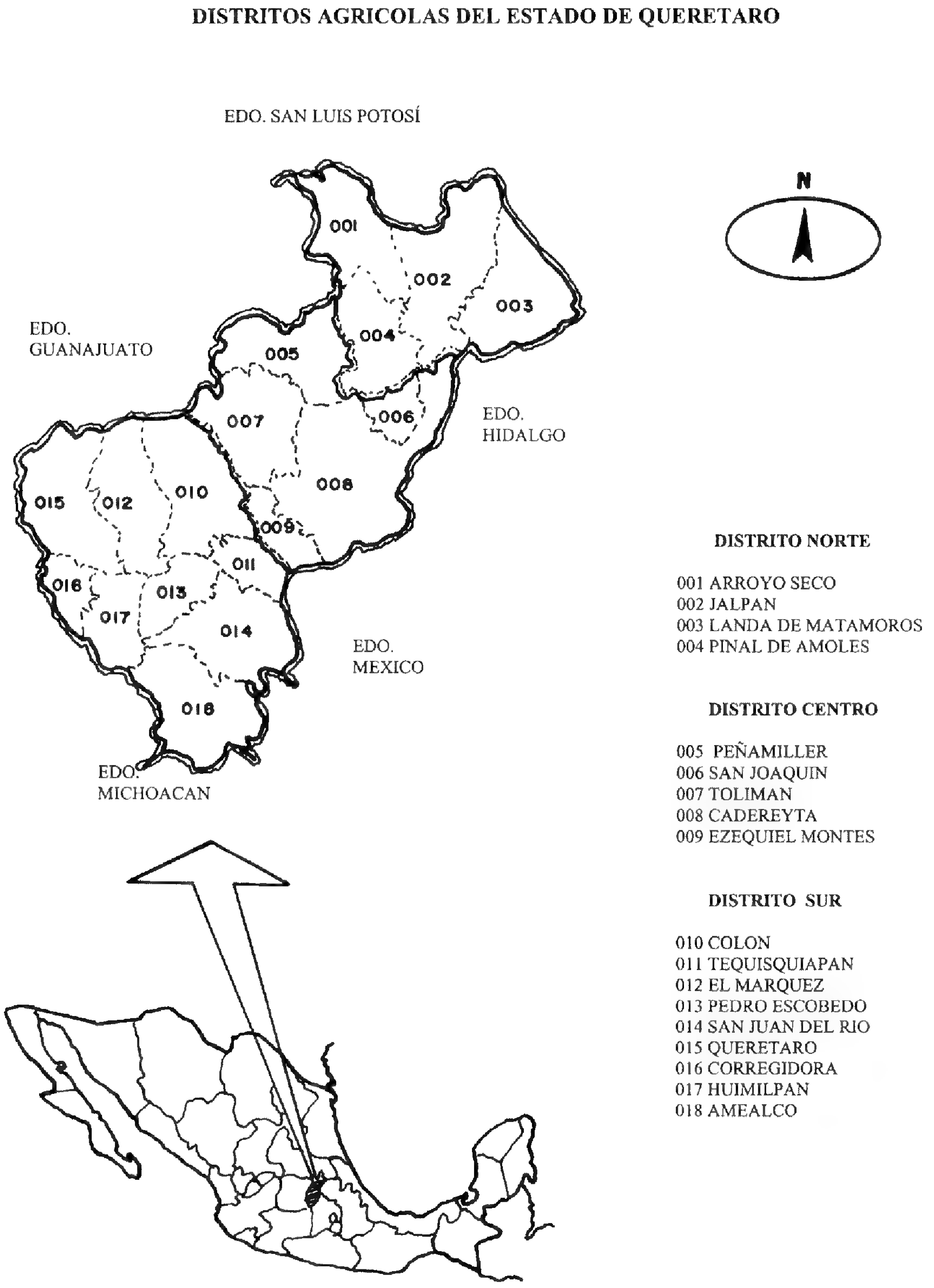

Fig. 1. Ubicación del área de estudio.

Huimilpan, El Marqués, Pedro Escobedo, Querétaro, San Juan del Río y Tequisquiapan.

METODOLOGIA

Para llevar a cabo la presente investigación se realizó trabajo de campo en dos etapas (1982 a 1983 y de 1992 a 1993) colectando material en las diferentes regiones y áreas agrícolas de Querétaro, el que se encuentra depositado en el Herbario ENCB; de manera complementaria se revisaron ejemplares de maleza del Instituto Nacional de Investigaciones Agrícolas, SARH, actualmente Instituto Nacional de Investigaciones Forestales y Agropecuarias (INIFAP) y se consultaron distintas fuentes bibliográficas relacionadas con la presencia de maleza en este estado (Zepeda, A. op. cit.; Suárez y Serrano op. cit.) y flora regional (Argüelles et al. 1991). Para la designación del lugar de procedencia de las especies, fue necesario consultar diversas obras (Marzocca 1976; Rzedowski 1978; Holm et al. 1977; Boelcke 1986), trabajos florísticos o grupos específicos (Rodríguez op. cit.; Rollins 1981; Villarreal op. cit.; Fryxell 1988; Nava op. cit.; McDonald 1991; Rzedowski 1993; Lira et al. 1998), labor que resultó compleja, debido a los diferentes criterios y múltiples confusiones que se aprecian entre los autores. Los conceptos designados en cuanto al origen se especifican al principio de listado florístico (Tabla 1).

RESULTADOS Y DISCUSION

Se registraron para el estado 347 especies que se comportan como arvenses o ruderales comprendidas en 211 géneros y 47 familias, un centenar menos que las especies de arvenses reconocidas para el Valle de México (Espinosa y Sarukhán 1997) y un número inferior al reconocido para Querétaro por Villaseñor y Espinosa (1998). El criterio de estos últimos autores es muy amplio ya que consideran dentro del grupo a las arvenses, ruderales y las especies secundarias que dan origen a las "acahualeras"(Rzedowski 1978).

Destacan por el número de taxa registrados las familias Compositae (81), Gramineae (61), Euphorbiaceae (22), Leguminosae (17), Solanaceae (16), Malvaceae (12), Cruciferae (12) y Convolvulaceae (10), que en conjunto representan el 66% de las especies colectadas en terrenos de cultivo y áreas circunvecinas, el resto (116 especies) queda comprendido en 39 familias (Fig. 2).

Al igual que en otros trabajos relacionados con el estudio de la flora arvense (Rodríguez op. cit.; Rzedowski op. cit.; Zepeda op. cit.; Suárez y Serrano op. cit.), las compuestas y las gramíneas ocupan el primer lugar en importancia, seguidas por las euforbiáceas y leguminosas que también se perfilan como grupos importantes en el estado.

De los grupos de plantas cuya presencia se ve favorecida por la actividad del hombre, las ruderales estrictas en Querétaro ocupan sólo el 15%, quedando

Tabla 1. Listado florístico de las plantas arvenses y ruderales del estado de Querétaro, México indicando lugar de origen.

CONCEPTOS

NATIVAS (NT)= endémicas al territorio mexicano; **NORTEAMERICANAS (NA)=** tienen su origen en la parte que comprende los paises de Canadá, Estados Unidos y la región Norte y centro de México; **CENTROAMERICANAS (CA)=** implica el área desde el Sur y Sureste de México hasta el Norte y NW de Colombia; **CARIBEÑAS (CB)=** se considera la porción Sur de Texas y la Península de La Florida, parte de la Costa del Golfo de México, Islas del Caribe, parte de la región atlántica costera de Centro América hasta el delta del Río Orinoco de los paises de Colombia y Venezuela; **SUDAMERICANAS (SA)=** al Norte y NW de Colombia hasta la Argentina y Chile; **AMERICANAS TROPICALES (AT)=** comprende las porciones principalmente bajas cálido-húmedas de México, Centro y Sudamérica; **EUROPEAS (EU)=** incluye la Península Ibérica, Islandia, Península de Escandinavia hasta los Montes Urales (Rusia) y parte de Turquía; **EUROASIÁTICAS (EA)=** esta región abarca el área central entre Europa y Asia; **ASIÁTICAS (AS)=** se inicia desde la Península de Arabia, hasta el Cáucaso y Siberia, así como la sección Sur de Asia (Bangladesh, China, Vietnam); **AFRICANAS (AF)=** se sitúan en la porción Norte de África, Egipto hasta el Sur del Cabo de Buena Esperanza, también la Isla Socotora y el Golfo de Guinea; **OCEANÍA (OC)=** es el área de Australia, Nueva Guinea, Nueva Zelanda y Tasmania, así como la gran cantidad de Islas en la Polinesia.

ESPECIES	ORIGEN										
	NT	NA	CA	CB	SA	AT	EU	EA	AS	AF	OC
EQUISETACEAE											
Equisetum hyemale L. subsp. *affine* (Engelm.) Calder & R.L.Taylor		X									
POLYPODIACEAE											
Pteridium aquilinum (L.) var. *pubescens* Underw.		X									
AIZOACEAE											
Mollugo verticillata L.						X					
ACANTHACEAE											
Elytraria imbricata (Vahl) Pers.						X					
AMARANTHACEAE											
Amaranthus hybridus L.		X									
Amaranthus palmeri S. Watson		X									
Gomphrena decumbens Jacq.				X							
Gomphrena pringlei Coult.& Fisher	X										
ASCLEPIADACEAE											
Asclepias curassavica L.						X					
Sarcostema cynanchoides Decne. subsp. *hartwegii* (Vail) R.W. Holm		X									
BORAGINACEAE											
Heliotropium angiospermum Murray						X					
CAMPANULACEAE											
Diastatea micrantha (Kunth) McVaugh					X						
Diastatea ternera (A. Gray) McVaugh	X										
Lobelia fenestralis Cav.	X										

ESPECIES	ORIGEN										
	NT	NA	CA	CB	SA	AT	EU	EA	AS	AF	OC
CAPPARIDACEAE											
Cleome aculeata L.						X					
CARYOPHYLLACEAE											
Drymaria arenarioides Willd.	X										
Drymaria glandulosa Bartl.	X										
Drymaria laxiflora Benth.	X										
Spergula arvensis L.							X				
Stellaria cuspidata Willd.	X										
CHENOPODIACEAE											
Atriplex suberecta Verd.											X
Chenopodiun album L.								X			
Chenopodium ambrosioides L.	X										
Chenopodium graveolens Willd.	X										
Chenopodium mexicanum Moq.	X										
Chenopodium murale L.								X			
COMMELINACEAE											
Commelina diffusa Burm. f.									X		
Commelina erecta L.									X		
Commelina tuberosa L.									X		
Tinantia erecta (Jacq.) Schltdl.						X					
Tradescantia crassifolia Cav.	X										
Tripogandra purpurascens (Schauer) Handlos subsp. *purpurascens*	X										
COMPOSITAE											
Achillea millefolium L.							X				
Aldama dentata La Llave & Lex.	X										
Ambrosia cordifolia (A. Gray) W.W. Payne		X									
Ambrosia psilostachya DC.		X									
Aphanostephus ramosissimus DC.		X									
Artemisia ludoviciana Nutt. subsp. *mexicana* (Willd.) Keck		X									
Aster spinosus Benth.	X										
Aster subulatus Michx.		X									
Baccharis salicifolia (Ruiz & Pav.) Pers.					X						
Bidens aurea (Aiton) Sherff		X									
Bidens bicolor Greenm.		X									
Bidens bigelovii A. Gray	X										
Bidens odorata Cav.			X								
Bidens pilosa L.						X					
Bidens serrulata (Poir) Desf.	X										
Calyptocarpus vialis Less.	X										
Cirsium rhaphilepis (Hemsl.) Petr.	X										
Conyza bonariensis (L.) Cronquist					X						
Conyza canadensis (L.) Cronquist		X									
Conyza coronopifolia Kunth					X						

ESPECIES	ORIGEN										
	NT	NA	CA	CB	SA	AT	EU	EA	AS	AF	OC
Conyza sophiifolia Kunth		X									
Cosmos bipinnatus Cav.	X										
Cotula australis (Sieb.) Hook. f.											X
Dugesia mexicana (A. Gray) A. Gray	X										
Dyssodia papposa (Vent.) Hitchc.		X									
Dyssodia pinnata (Cav.) B.L. Rob. var. *pinnata*	X										
Dyssodia porophyllum (Cav.) Cav.	X										
Eclipta postrata (L.) L.									X		
Erechtites hieracifolia (L.) Raf. var. *cacaloides* (Fish.) Griseb.	X										
Erygeron karvinskianus DC.	X										
Eupatorium ododarum L.	X										
Flaveria trinervia (Spreng.) C. Mohr	X										
Florestina pedata Cass.	X										
Florestina tripteris DC.		X									
Galinsoga parviflora Cav.	X										
Galinsoga quadriradiata Ruiz & Pav.	X										
Gnaphalium americanum Mill.	X										
Grindelia subdecurrens DC.	X										
Helenium mexicanum Kunth	X										
Heliopsis annua Hemsl.	X										
Heterosperma pinnatum Cav.		X									
Heterotheca inuloides Cass. var. *inuloides*	X										
Jaegeria hirta (Lag.) Less.				X							
Lactuca graminifolia Michx.		X									
Lactuca serriola L.								X			
Leontodon taraxacoides (Vill.) Mérat							X				
Melampodium bibracteatum S. Watson	X										
Melampodium divaricatum (Rich.) DC.	X										
Melampodium perfoliatum (Cav.) Kunth	X										
Melampodium sericeum Lag.	X										
Parthenium bipinnatifidum (Ort.) Rollins	X										
Picris echioides L.							X				
Pinaropappus roseus (Less.) Less. var. *roseus*	X										
Piqueria trinervia Cav.	X										
Porophyllum linaria (Cav.) DC.	X										
Pseudelephantopus spicatus (Juss.) Rohr				X							
Psilactis brevilingulata Sch. Bip.	X										
Sabazia humilis (Kunth) Cass.	X										
Sanvitalia procumbens Lam.	X										
Schkuhria pinnata (Lam.) Kuntze var. *virgata* (La Llave ex Lex.) Heiser	X										
Sigesbeckia agrestis Poepp. & Endl.			X								
Simsia amplexicaulis (Cav.) Pers.	X										
Simsia foetida (Cav.) S.F. Blake var. *foetida*	X										

ESPECIES	ORIGEN										
	NT	NA	CA	CB	SA	AT	EU	EA	AS	AF	OC
Sonchus asper (L.) Hill							X				
Sonchus oleraceus L.							X				
Spilanthes oppositifolia (Lam.) D'Arcy					X						
Stevia serrata Cav.	X										
Stevia viscida Kunth	X										
Tagetes filifolia Lag.	X										
Tagetes lucida Cav.	X										
Tagetes lunulata Ort.	X										
Tagetes micrantha Cav.		X									
Taraxacum officinale Weber							X				
Tithonia tubiformis (Jacq.) Cass.	X										
Tridax coronopifolia (Kunth) Hemsl.	X										
Tridax trilobata (Cav.) Hemsl.	X										
Verbesina encelioides (Cav.) Benth. & Hook.						X					
Viguiera dentata (Cav.) Spreng.		X									
Xanthium strumarium L. var. *canadense* (Mill.) Torr. & A. Gray		X									
Zaluzania triloba (Ort.) Pers.	X										
Zinnia peruviana (L.) L.					X						
CONVOLVULACEAE											
Convolvulus arvensis L.							X				
Dichondra sericea Sw.						X					
Ipomoea hederifolia L.						X					
Ipomoea indica (Burm.) Merr.						X					
Ipomoea neei (Spreng.) O'Donell						X					
Ipomoea purpurea (L.) Roth						X					
Ipomoea stans Cav.	X										
Ipomoea trifida (Kunth) G. Don						X					
Ipomoea triloba L.				X							
Merremia umbellata (L.) Hallier f.				X							
CRASSULACEAE											
Bryophyllum pinnatum (Lam.) Kurz										X	
CRUCIFERAE											
Brassica rapa L.							X				
Brassica nigra (L.) Koch								X			
Capsella bursa pastoris (L.) Medik.							X				
Descurainia pinnata (Walter) Britton		X									
Descurainia virletii (Fourn.) O.E. Schulz	X										
Eruca sativa Mill.								X			
Erysimum asperum (Nutt.) DC.		X									
Lepidium virginicum L. var. *pubescens* (Greene) Hitchc.		X									
Lesquerella argentea (Schauer) S. Watson	X										
Raphanus raphanistrum L.								X			
Rapistrum rugosum (L.) All.							X				
Sisymbrium irio L.							X				

ESPECIES	ORIGEN										
	NT	NA	CA	CB	SA	AT	EU	EA	AS	AF	OC
CUCURBITACEAE											
Cucurbita foetidissima Kunth		X									
Cyclantera dissecta (Torr. & A. Gray) Arn.		X									
Cyclanthera ribiflora (Schltdl.) Cogn.				X							
Echinopepon milleflorus Naudin	X										
Momordica charantia L.										X	
Sicyos deppei G. Don	X										
Sicyos laciniatus L.	X										
Sicyos parviflorus Willd.	X										
CYPERACEAE											
Bulbostylis funckii (Steud.) C.B. Clarke						X					
Bulbostylis juncoides (Vahl) Kük.						X					
Cyperus esculentus L.								X			
Cyperus manimae Kunth						X					
Cyperus odoratus L.						X					
Cyperus seslerioides Kunth						X					
Cyperus surinamensis Rottb.					X						
Eleocharis acicularis (L.) Roem. & Schult.								X			
Eleocharis geniculata (L.) Roem. & Schult.				X							
EUPHORBIACEAE											
Acalypha indica L. var. *mexicana* (Müll.Arg.) Pax & K. Hoffm.	X										
Acalypha infesta Popp. & Endl.					X						
Acalypha ostryifolia Ridd.		X									
Acalypha setosa A. Rich.						X					
Alchornea latifolia Sw.						X					
Croton dioicus Cav.		X									
Euphorbia albomarginata Torr.& A. Gray		X									
Euphorbia dentata Michx.		X									
Euphorbia francoana Boiss.	X										
Euphorbia glomerifera (Millsp.) Wheeler						X					
Euphorbia heterophylla L.						X					
Euphorbia hirta L.						X					
Euphorbia hyssopifolia L.						X					
Eupborbia nutans Lag.						X					
Euphorbia peplus L.								X			
Euphorbia prostrata Aiton						X					
Euphorbia villifera Scheele	X										
Euphorbia serpens Kunth						X					
Euphorbia stictospora Engelm.	X										
Euphorbia thymifolia L.	X										
Ricinus communis L.										X	
Tragia nepetifolia Cav.					X						
GERANIACEAE											
Erodium cicutarium (L.) L'Hér.								X			
Geranium seemannii Peyr.	X										

ESPECIES	ORIGEN										
	NT	NA	CA	CB	SA	AT	EU	EA	AS	AF	OC
GRAMINEAE											
Agrostis semiverticillata (Forssk.) C. Chr.								X			
Andropogon condensatus Kunth						X					
Aristida adscensionis L.					X						
Avena fatua L.							X				
Bouteloua barbata Lag.	X										
Bouteloua curtipendula (Michx.) Torr.	X										
Bouteloua hirsuta Lag.		X									
Bothriochloa saccharoides Sw. var. *torreyana* (Steud.) Gould		X									
Brachiaria meziana Hitchc.	X										
Brachiaria plantaginea (Link.) Hitchc.	X										
Bromus catharticus Vahl					X						
Buchloë dactyloides (Nutt.) Engelm.		X									
Cenchrus echinatus L.	X										
Cenchrus incertus M.A. Curtis	X										
Cenchrus myosuroides Kunth						X					
Cenchrus pilosus Kunth						X					
Chloris rufescens Lag.						X					
Chloris virgata Sw.						X					
Cynodon dactylon (L.) Pers.										X	
Digitaria ciliaris (Retz.) Koeler									X		
Digitaria insularis (L.) Fedde						X					
Digitaria ternata (A. Rich.) Stapf										X	
Echinochloa colonum (L.) Link									X		
Echinochloa crus-galli (L.) P. Beauv.									X		
Echinochloa crus-pavonis (Kunth) Schult.					X						
Echinochloa oplismenoides (Kunth) Chase						X					
Eleusine indica (L.) Gaertn.									X		
Eleusine multiflora Hochst.										X	
Eragrostis barrelieri Daveau							X				
Eragrostis cilianensis (All.) Vignolo							X				
Eragrostis glomerata (Walter) L.H. Dewey		X									
Eragrostis intermedia Hitchc.		X									
Eragrostis lugens Nees						X					
Eragrostis mexicana (Hornem.) Link	X										
Eragrostis pectinacea (Michx.) Nees		X									
Eragrostis pilosa (L.) P. Beauv.									X		
Eriochloa acuminata (C. Presl.) Kunth	X										
Heteropogon contortus (L.) P. Beauv.									X		
Hilaria cenchroides Kunth	X										
Lasiacis ruscifolia (Kunth) Hitchc.						X					
Leptochloa dubia (Kunth) Nees	X										
Lolium multiflorum Lam.								X			
Lycurus phleoides Kunth var. *phleoides*		X									
Muhlenbergia rigida (Kunth) Trin.		X									

ESPECIES	ORIGEN										
	NT	NA	CA	CB	SA	AT	EU	EA	AS	AF	OC
Oplismenus compositus (L.) P. Beauv.									X		
Panicum decolorans Kunth	X										
Panicum fasciculatum Sw.						X					
Panicum miliaceum L.								X			
Panicum obtusum Kunth	X										
Panicum vaseyanum Scribn.	X										
Paspalum distichum L.						X					
Pennisetum purpureum Schumach.										X	
Poa annua L.							X				
Polypogon monspeliensis (L.) Desf.							X				
Rynchelytrum repens (Willd.) C.E. Hubb.										X	
Setaria geniculata (Lam.) P. Beauv.	X										
Setaria grisebachii E. Fourn.		X									
Setaria lutescens (Weigel) C.E. Hubb							X				
Setaria verticillata (L.) P. Beauv.							X				
Sorghum bicolor (L.) Moench									X		
Sorghum halepense (L.) Pers.									X		
GUTTIFERAE											
Hypericum philonotis Cham. & Schltdl	X										
HYDROPHYLLACEAE											
Nama dichotomum (Ruiz & Pav.) Choisy var. *dichotomum*								X			
IRIDACEAE											
Sisyrinchium schaffneri S. Watson	X										
LABIATAE											
Marrubium vulgare L.							X				
Molucella laevis L.									X		
Salvia hirsuta Jacq.	X										
Salvia reflexa Hornem.	X										
Salvia tiliifolia Vahl	X										
Stachys agraria Cham. & Schltdl.	X										
LEGUMINOSAE											
Astragalus nuttallianus DC.		X									
Crotalaria pumila Ort.						X					
Dalea cliffortiana Willd.						X					
Dalea leporina (Aiton) Bullock						X					
Dalea prostrata Ort.	X										
Desmodium procumbens (Mill.) Hitchc.						X					
Desmodium sericophyllum Schltdl.						X					
Hoffmannseggia glauca (Ort.) Eifert	X										
Medicago lupulina L.							X				
Medicago polymorpha L. var. *vulgaris* (Benth.) Shinners										X	
Melilotus albus Desr.							X				
Melilotus indicus (L.) All.							X				
Phaseolus heterophyllus Willd.	X										
Senna uniflora (Mill.) Irwin & Barneby						X					

ESPECIES	ORIGEN										
	NT	NA	CA	CB	SA	AT	EU	EA	AS	AF	OC
Trifolium goniocarpum Lojac	X										
Trifolium repens L.								X			
Vicia americana Muhl. ex Willd. var. *americana*		X									
LILIACEAE											
Allium glandulosum Link & Otto		X									
Nothoscordum gracile (Aiton) Stearn						X					
LYTHRACEAE											
Cuphea aequipetala Cav.	X										
Cuphea carthagenesis (Jacq.) Macbr.					X						
Lythrum album Kunth	X										
MALVACEAE											
Anoda cristata (L.) Schltdl.	X										
Anoda thurberi A. Gray		X									
Herissantia crispa (L.) Brizicky					X						
Malva parviflora L.								X			
Malvastrum americanum (L.) Torr.						X					
Malvastrum coromandelianum (L.) Garcke					X						
Modiola caroliniana (L.) G. Don					X						
Sida abutifolia Mill.					X						
Sida rhombifolia L.									X		
Sida spinosa L.		X									
Sphaeralcea angustifolia (Cav.) G. Don						X					
Urocarpidium limense (L.) Krapov.					X						
MARTYNIACEAE											
Proboscidea louisianica (Mill.) Thell. subsp. *fragrans* (Lindl.) Bretting		X									
NYCTAGINACEAE											
Allionia incarnata L.						X					
Boerhavia coccinea Mill.	X										
Mirabilis jalapa L.	X										
ONAGRACEAE											
Gaura coccinea Pursh	X										
Lopezia racemosa Cav.	X										
Ludwigia octovalvis (Jacq.) Raven					X						
Oenothera pubescens Willd.		X									
Oenothera rosea L'Her	X										
Oenothera tetraptera Cav.	X										
OXALIDACEAE											
Oxalis corniculata L. subsp. *albicans* (Kunth) Lourteig			X								
Oxalis decaphylla Kunth		X									
Oxalis latifolia Kunth	X										
PAPAVERACEAE											
Argemone mexicana L.				X							
Argemone ochroleuca Sweet subsp. *ochroleuca*	X										

ESPECIES	ORIGEN										
	NT	NA	CA	CB	SA	AT	EU	EA	AS	AF	OC
PLANTAGINACEAE											
Plantago lanceolata L.							X				
Plantago linearis var. *mexicana* (Link) Pilg.	X										
Plantago major L.							X				
POLYGONACEAE											
Polygonum aviculare L.								X			
Polygonum mexicanum Small		X									
Polygonum punctatum Ell.		X									
Polygonum segetum Kunth	X										
Rumex acetosella L.								X			
Rumex conglomeratum Murr.								X			
Rumex crispus L.							X				
Rumex obtusifolius L.								X			
PORTULACACEAE											
Calandrinia micrantha Schltdl.		X									
Portulaca oleracea L.							X				
PRIMULACEAE											
Anagallis arvensis L.								X			
RESEDACEAE											
Reseda luteola L.							X				
ROSACEAE											
Alchemilla aphanoides var. *subalpestris* (Rose) L.M. Perry	X										
RUBIACEAE											
Bouvardia ternifolia (Cav.) Schltdl.	X										
Crusea diversifolia (Kunth) W.R. Anderson	X										
Spermacoce tenuior L.						X					
SCROPHULARIACEAE											
Bacopa procumbens (Mill.) Greenm.					X						
Castilleja arvensis Cham. & Schltdl.	X										
Veronica peregrina L. subsp. *xalapensis* (Kunth) Pennell			X								
SOLANACEAE											
Datura discolor Bernh.						X					
Datura innoxia Mill						X					
Datura stramonium L.	X										
Jaltomata procumbens (Cav.) J.L. Gentry	X										
Nicotiana glauca Graham					X						
Nicotiana trigonophylla Dunal		X									
Petunia parviflora Juss.		X									
Physalis aequata Jacq.	X										
Physalis philadelphica Lam.		X									
Physalis solanaceous (Schltdl.) Axelius	X										
Physalis viscosa L.					X						
Solanum americanum Mill.		X									
Solanum elaeagnifolium Cav.					X						
Solanum mozinianum Dunal	X										

ESPECIES	ORIGEN										
	NT	NA	CA	CB	SA	AT	EU	EA	AS	AF	OC
Solanum nigrescens M. Martens & Galeotti	X										
Solanum rostratum Dunal	X										
STERCULIACEAE											
Melochia pyramidata L.						X					
UMBELLIFERAE											
Apium leptophyllum (Pers.) F. Muell.						X					
Eryngium comosum F. Delaroche	X										
Eryngium serratum Cav.	X										
Rhodosciadium tolucense (Kunth) Matthias	X										
VERBENACEAE											
Bouchea prismatica (L.) Kuntze						X					
Lippia nodiflora (L.) Michx.		X									
Verbena bipinnatifida Nutt.		X									
Verbena gracilis Desf.	X										
Verbena menthaefolia Benth.	X										
VIOLACEAE											
Hybanthus attenuatus (Humb. & Bonpl.) Schulze-Menz							X				
ZYGOPHYLLACEAE											
Kalstroemia rosei Rydb.	X										
Tribulus terrestris L.							X				

el 85% restante en la categoría de arvenses; existiendo algunas como: *Anoda cristata, Aster subulatus, Bouteloua hirsuta, Euphorbia heterophylla, Galinsoga parviflora, Jaltomata procumbens, Lobelia fenestralis, Malva parviflora, Malvastrum coromandelianum, Modiola caroliniana, Sida spinosa, Melampodium divaricatum, Physalis viscosa, Tithonia tubiformis, Trifolium repens* y *Zinnia peruviana* que se ubican tanto en zonas perturbadas como en terrenos de cultivo.

Por otra parte, existe una aparente regionalización de un grupo de 61 taxa, para cada uno de los 3 Distritos. En el Norte se encuentran 26 taxa entre los que destacan: *Achillea millefolium, Alchornea latifolia, Andropogon condensatum, Bryophyllum pinnatum, Convolvulus arvensis, Cotula australis, Croton dioicus, Digitaria insularis, Dichondra sericea, Elytraria imbricata, Erysimum asperum, Euphorbia hirta, Heliotropium angiospermum, Hybanthus attenuatus, Ipomoea hederifolia, Jaegeria hirta, Lasciasis ruscifolia, Merremia umbellata, Oplismenus compositus, Pennisetum purpureum, Pseudelephantopus spicatus, Pteridium aquilinum* var. *pubescens, Rhodosciadium toluscense, Setaria geniculata, Stellaria cuspidata* y *Solanum nigrescens*.

En el Centro solo se localizan 11 taxa: *Artemisia ludoviciana* ssp. *mexicana, Datura discolor, Eragrostis barrelieri, Eragrostis lugens, Eruca sativa, Euphorbia*

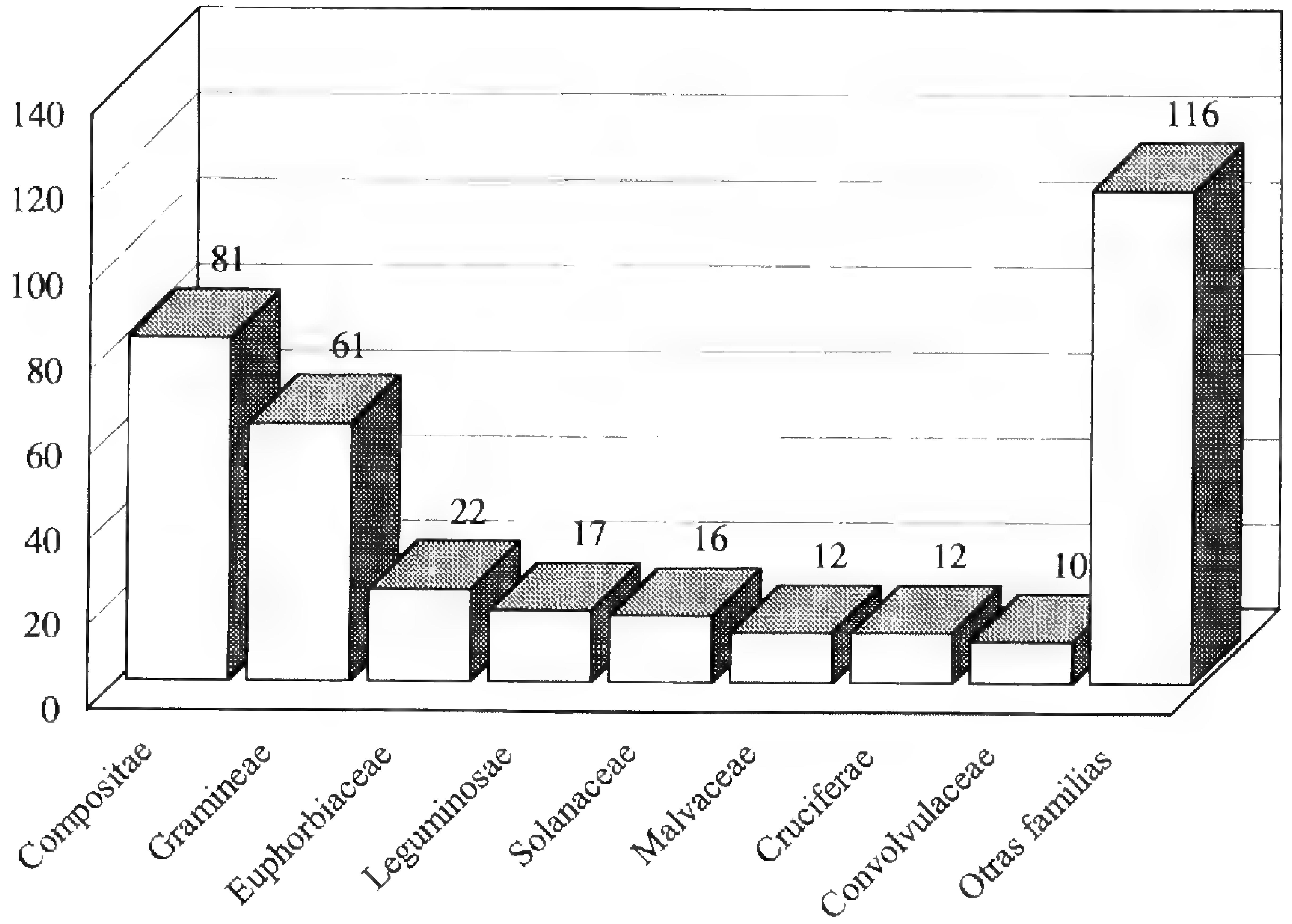

Fig. 2. Representación del número de especies de la flora arvense y ruderal para el estado de Querétaro.

thymifolia, Lactuca graminifolia, Mollugo verticilata, Nothoscordum gracile, Sabazia humilis y *Tagetes micrantha.*

Los 24 taxa del Sur son: *Agrostis semiverticillata, Boerhavia coccinea, Cenchrus myosuroides, Cenchrus pilosus, Cyperus odoratus, Chenopodium mexicanum, Chenopodium murale, Descurainia pinnata, Diastatea micrantha, Eleocharis acicularis, Erechtites hieracifolia* var. *cacaloides, Euphorbia albomarginata, Euphorbia glomerifera, Gnaphalium americanum, Ipomoea indica, Lactuca serriola, Malvastrum americanum, Oenothera pubescens, Oenothera tetraptera, Petunia parviflora, Polygonum mexicanum, Polygonum monspeliensis, Rumex acetosella* y *Simsia foetida* var. *foetida.*

En la tabla 2, se pueden observar los datos cuantitativos de los taxa con distribución restringida por Distrito agrícola: en el Norte, estos corresponden al 7.49% del total, en el Centro al 3.17% y en el Sur al 6.91%. Solo cerca del 18% de los taxa registrados para el estado presentan cierta exclusividad regional. El 82% (286 taxa) restante, se encuentra distribuido en estos 3 Distritos de manera indistinta.

Por lo que se refiere al lugar de procedencia de las especies, el mayor número de taxa son nativos (125) y entre los introducidos se registraron en el estado los siguientes: 57 norteamericanos, 57 de América tropical, 29 europeos, 23

Tabla 2.-Número y porcentaje de especies arvenses y ruderales con distribución restringida por Distritos agrícolas y su relación con el número total de especies malezoides para el estado de Querétaro.

Distrito Agrícola	Relación de número taxa por Distrito Agrícola/número de taxa totales	Porcentaje
Norte	26/347	7.49
Centro	11/347	3.17
Sur	24/347	6.91
Total	**61/347**	**17.57**

sudamericanos, 20 euroasiáticos, 16 asiáticos, 8 caribeños, 8 africanos, 2 de la región de Oceanía y 2 centroamericanos (Fig. 3).

El porcentaje de especies de nativas es importante (36%), aunque la suma de las especies introducidas es mayor (ca. 64%), lo que contrasta con el hecho que la maleza autóctona es la que prevalece en el país (Rzedowski 1978, 1991)

Por la ubicación geográfica del estado de Querétaro, una pequeña proporción de su superficie se encuentra dentro de la región árida y templada de la llamada Altiplanicie Mexicana o Mesa del Centro, razón por la cual se favorece la distribución de elementos de origen norteamericano y la presencia de endemismos, algunos de ellos en la categoría tanto de arvense como ruderal.

Las principales familias con taxa endémicos de México y presentes para este estado son: Compositae (45 spp.), Gramineae (14 spp.), Solanaceae (7 spp.), Euphorbiaceae (5 spp.), Caryophyllaceae (4 spp.), Cucurbitaceae (4 spp.); Labiatae (4 spp.), Leguminosae (4 spp.), Onagraceae (4 spp.), Chenopodiaceae (3 spp.), Umbelliferae (3 spp.) y Commelinaceae (2 spp.) (Tabla 1). En función del número de elementos florísticos endémicos de la familia Compositae para México, Turner y Nesom (1998) han señalado que tienen su origen *in situ* dentro de la Altiplanicie Mexicana y el Eje Neovolcánico Transversal.

El mayor número de taxa introducidos registrados para Querétaro, quizá se explica por la ubicación geográfica del estado, paso obligado hacia las regiones norte y sur, así como del Pacífico al centro del país, su presencia probablemente se puede remontar al intercambio comercial de granos y especias con Asia, iniciado en 1565, por la ruta naviera entre los Puertos de Acapulco (estado de Guerrero) y Manila, Filipinas (King 1966). Otro factor que pudo influir en estos eventos, se relaciona con la intensa actividad minera existente durante el Virreinato español (siglos XVII y XVIII), ya que favoreció los asentamientos humanos, previamente iniciados por los chichimecas y otomíes y como consecuencia de esta nueva actividad aumentaron los espacios para el cultivo, para la actividad ganadera y para las diversas actividades antrópicas que en el estado se han realizado a lo largo de algunos cientos de años, por lo que varios

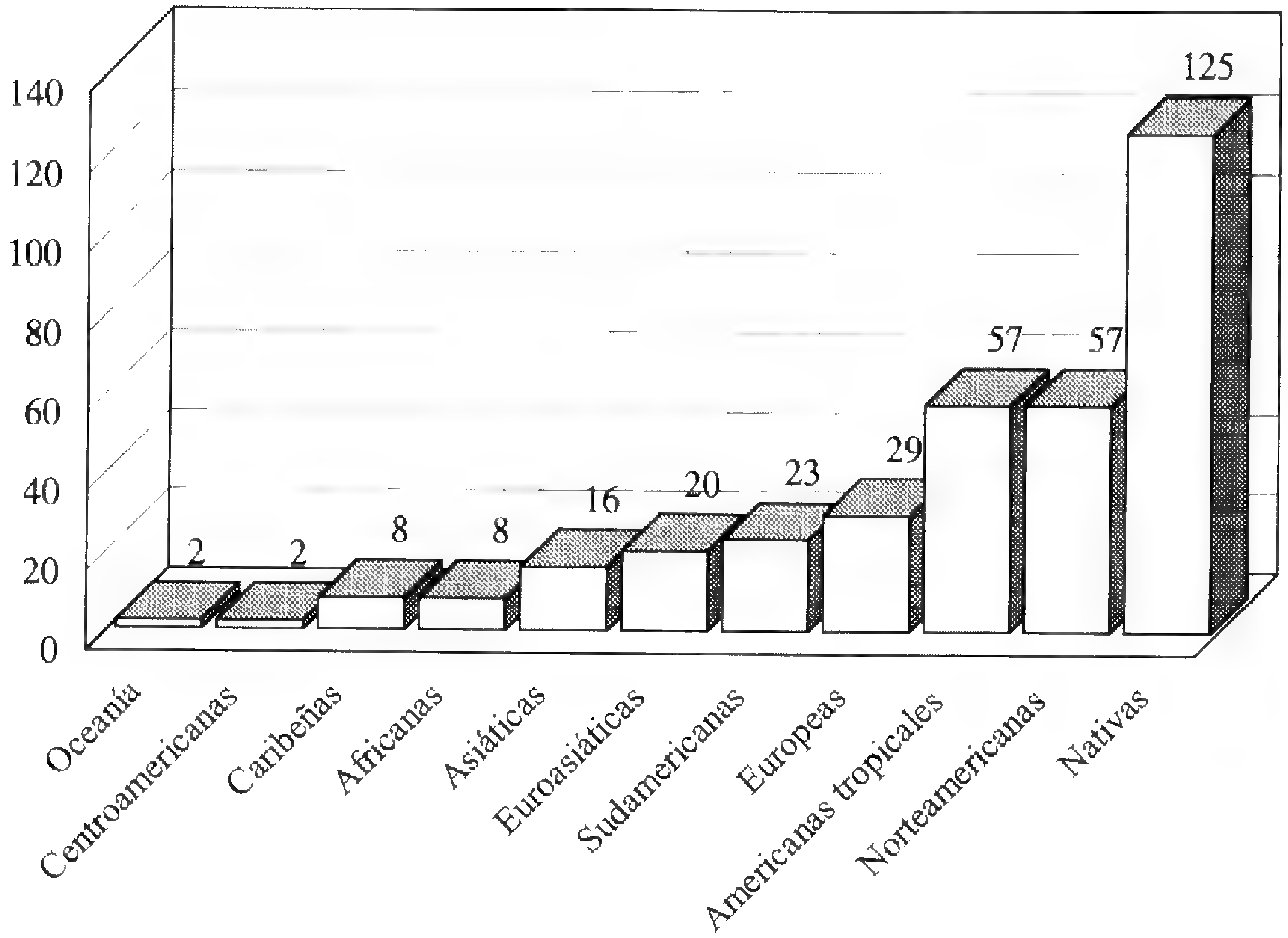

Fig. 3. Representación del número de especies de la flora arvense y ruderal, por región de procedencia, para el estado de Querétaro.

taxa de la familia Gramineae pudieron ingresar y adquirir la posición de forrajeras silvestres (*Cynodon dactylon*, *Lycurus phleoides*) y más tarde el carácter de cultivadas como *Sorghum bicolor* y *Sorghum halepense* (ésta última convertida en una agresiva arvense), motivo por el que esta familia, contiene un buen porcentaje de elementos introducidos. Por otra parte, la apertura de la carretera panamericana en el período postrevolucionario, así como la construcción de caminos en los Valles Centrales de la entidad, permitieron a su vez el tráfico contínuo y la dispersión de varias especies hacia las regiones norte y occidente, así como en sentido inverso. Este pudiera ser el caso para las familias Cyperaceae, Convolvulaceae, Malvaceae y Polygonaceae, que aportan un número de taxa de otras regiones. A su vez se favoreció la llegada de elementos tropicales y caribeños, con posible vía de la Planicie Costera del Golfo de México, hacia la parte norte del estado (municipios de Landa de Matamoros y Jalpan).

El éxito de las especies malezoides provenientes de otras áreas como la euroasiática, en comparación con las del Nuevo Mundo, se explica por la estrecha similitud ecológica y agrícola, existente entre ambas regiones (tierras de clima templado y sin barreras orográficas notables). Esto favoreció la introducción y naturalización de una buena cantidad de especies con características particulares que les permitieran adaptarse perfectamente al arribar a las zonas templadas de América, donde ya existía una agricultura sumamente avanzada.

Otro de los múltiples factores que favorecieron el desarrollo de especies exóticas en nuestro país, fue el manejo particular del suelo agrícola con típicas prácticas del Viejo Mundo, permitiendo el establecimiento de plantas ruderales de esa región, en los distintos nichos ecológicos donde se implantó un nuevo cultivo (sin competencia alguna), dando lugar a que algunas ruderales exóticas presentaran ciclos de vida sincrónicos con las actividades agrícolas, comportandose entonces como arvenses.

¿Que se prevee en el futuro? El crecimiento y la industrialización de las zonas agrícolas centro y sur del estado, pueden modificar la presencia de las especies actualmente consideradas como malezas y favorecer la introducción de otras que tengan las características adecuadas para adaptarse al tráfico y perturbación antrópica, circunstancias que en la región norte no se ha reflejado y donde seguramente la representación de este tipo de plantas seguirá sin cambio considerable o bien muchas de estas ruderales podrían empezar a comportarse como especies arvenses.

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BOOK NOTICES

PIERS VITEBSKY. 2001. **Shamanism.** (ISBN 0-8061-3328-7, pbk.). University of Oklahoma Press, 4100 28th Avenue N.W., Norman, OK 73069-8218, U.S.A. (Orders: www.ou.edu/oupress, 405-364-5978 fax). $12.95, pbk., 128 pp., 250 color and b&w illustrations, 25 maps, 5 1/2" × 8".

Table of Contents.—Introduction
- 1) The Shamanic Worldview
- 2) Regional Traditions
- 3) Becoming a Shaman
- 4) Shamans and Clients
- 5) Understanding Shamans
- 6) Documentary Reference

Bibliography, Index, Photo Credits, and Acknowledgements

This is a fine introductory text on Shamanism worldwide. Including a detailed region-by-region survey of shamanism with full color maps, covering both spiritual and psychological aspects, and the relevance of shamanism to Western culture this book admirably considers the subject from all angles and disciplines. From the back cover: "The shaman occupies a key role as a healer, mediating between the world of the living and the world of the spirits, and is a potent figure in alternative medicine. *Shamanism*, a richly illustrated guide, looks at both historic and present-day manifestations." I would recommend this book for anthropology classes in Religion and/or Shamanism. It is reasonably priced, well-written, and comprehensive.—*Kevin D. Janni, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A., kjanni@brit.org.*

B. LEROY DAVIDSON. 2001. **Lewisias.** 2000. (ISBN 0-88192-447-4, hbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $34.95, hbk. 238 pp., 68 color photos, 20 color plates, 13 line drawings.

This is a book about flowers and pretty ones at that. Yes, the genus *Lewisia* commemorates Meriwether Lewis (1774–1809). *Lewisia* belongs to the purslane family, Portulacaceae. "A genus of succulent plants numbering approximately twenty species, *Lewisia* has been adopted as a favorite by rock gardeners throughout the world." If you want to have an impressive collection of lewisia photos in habitats and gardens and text to go along with it then this is book. "*Lewisias* is that rare book that seamlessly blends various disciplines and perspectives to create a holistic picture of a botanical treasure: it is part field guide, horticultural guidebook, memoir, history, and art book." Thirteen line drawings by artist Micheal Moshier are included.—*Barney Lipscomb, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

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VINES OF A TEMPERATE STATE: STILL UNDERCOLLECTED?

Alexander Krings

Herbarium, Department of Botany
North Carolina State University
Raleigh, NC 27695-7612, U.S.A.
Alexander_Krings@ncsu.edu

ABSTRACT

Over the past decades, there has been a steady effort to contribute to our knowledge of herbaceous and woody vines (lianas)—a habit previously largely neglected in both botanical and ecological studies. This study sought to evaluate to what extent progress has been made in our floristic understanding of lianas and vines in a state hosting the highest number of herbarium specimens per square mile in the southeastern United States—North Carolina. To analyze the state of our floristic understanding, baseline and updated county species lists of lianas and vines were developed based on literature review and herbarium survey. To compare liana and vine species richness by ecophysiological province, an index of species similarity was calculated. The Piedmont and Coastal Plain host the largest absolute number of vine taxa in North Carolina, as well as the largest mean richness per county. The higher Piedmont mean richness may be due in part to geographic position and overlapping distributions from adjacent provinces. However, reasons for the particularly high species richness of individual counties and the significant variation in county to county species richness remain unclear. Macro-climate, as well as diversity in topography and associated microclimate may be factors. However, the three most species rich counties also happen to host the three largest herbaria in the state, suggesting the potential influence of historically larger collecting programs. Other non-biological factors potentially involved include distance to site and accessibility.

RESUMEN

En las décadas pasadas, ha habido un esfuerzo constante para contribuir a nuestro conocimiento de las lianas herbáceas y leñosas—un hábito previamente muy descuidado tanto en los estudios botánicos como ecológicos. Este estudio pretendió evaluar en que medida se ha progresado en nuestro conocimiento florístico de las lianas en un estado que alberga el mayor número de especimenes de herbario por milla cuadrada del sureste de Estados Unidos—Carolina del Norte. Para analizar el estado de nuestro conocimiento florístico, se desarrollaron listados de especies por condado, básicos y puestos al día, de lianas basados en revisiones bibliográficas y de herbarios. Para comparar la riqueza de especies de lianas por provincia ecofisiológica, se calculó un índice de similitud de especies. El pie de monte y la llanura costera tienen el mayor número absoluto de lianas de Carolina del Norte, así como la mayor riqueza media por condado. La alta riqueza media del pie de monte puede deberse en parte a la posición geográfica y a las distribuciones solapadas de las provincias adyacentes. Sin embargo, las razones para la riqueza en especies particularmente alta de condados individuales y la variación significativa de condado a condado no quedan claras. El macroclima, así como la diversidad en topografía y el microclima asociado pueden ser factores. Sin embargo, los tres condados más ricos en especies tienen también los tres herbarios mayores del estado, lo que sugiere la influencia potencial de los programas de colecta históricamente más amplios. Otros factores no biológicos potencialmente implicados incluyen la distancia al lugar y la accesibilidad.

An important aspect of recent studies of vines has been the exploration of the underlying causes determining and limiting the distribution of species and

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individuals (Bell et al. 1988; Molina-Freaner & Tinoco-Ojanguren 1997; Castellanos et al. 1999). Understanding factors controlling vine distributions is of interest in understanding broader patterns of vine species richness. Several factors, such as soil moisture (Bell et al. 1988; Collins & Wein 1993), availability of small diameter supports (Putz & Chai 1987), distribution and spatial arrangement of supports (Putz & Chai 1997), as well as preferences for light microenvironments within host canopies (Castellanos et al. 1999), have been found important, but further study is warranted before a synthesis can be obtained. Although lianas and vines have been previously largely neglected in both botanical and ecological studies (Jacobs 1976; Putz 1984; Gentry 1991; Collins & Wein 1993), there has been a steady effort over the past decades to contribute to our floristic knowledge base of this important group. Gentry (1991, 1995) reviewed the floristics of lianas as determined from a series of 0.1 ha plots mostly located in Neotropical lowlands or Andean montane sites. Work by Grubb et al. (1963), Putz (1983, 1984), Collins and Wein (1993), Burnham (1997), and Krings (2000a, 2000b, 2001), among others (see Putz & Mooney 1991), has also contributed to our understanding of New World lianas and vines. This study sought to evaluate to what extent progress has been made in our floristic understanding of lianas and vines in temperate North Carolina. With the highest number of herbarium specimens per square mile in the southeastern United States (Funk & Morin 2000), North Carolina presents an interesting situation for evaluating the status of collections of this historically undercollected group.

METHODS

To analyze the state of our floristic understanding, baseline county species lists of herbaceous and woody vines [hereafter collectively "vines"] were developed based on Radford et al. (1968). Separate, updated species lists were then developed based on literature review (Kessler 1956; Gupton 1960; Morgan 1962; Sears 1966; Blair 1967; Tucker 1967; Bruton 1968; Hartshorn 1968; Sawyer 1968; Michael 1969; Pittillo et al. 1969; Pultorak 1969; Wells 1970; Jones 1971; Pittillo et al. 1972; Jones 1973; Taggart 1973; Taylor 1974; Racine & Hardin 1975; Smith 1977; Lacey 1979; Corda 1982; Skean 1982; Rohrer 1983; Sieren 1983; Mayes 1984; Bradshaw 1987; Pittillo & Brown 1988; Matthews & Mellichamp 1989; Palmer 1990; Ingle 1993; Floyd 1997; Strickland 2000), as well as herbarium searches at NCSC and NCU. All climbing, woody and herbaceous taxa known from North Carolina are included. Prostrate, mat-forming taxa, such as *Mitchella repens* L. (Rubiaceae), are excluded.

To compare vine species richness by ecophysiological province, an index of species similarity was calculated based on a modification of Sørensen (1948). As area has been shown to significantly influence species richness (White et al. 1984; Kohn & Walsh 1994), the Sørensen index is most precise when two communities of the exact same size are compared (e.g., using fixed area transects). When communities of different sizes are compared a modified index can be calculated:

$$\text{(Eq. 1) Index of similarity (area-weighted)} = \frac{C/\log \text{area}_A + C/\log \text{area}_B}{A/\log \text{area}_A + B/\log \text{area}_B} * 100,$$

where C is the number of species shared between two respective sites, and A and B are the numbers of species present at each respective site. Although not as precise, non-modified Sørensen indices have been used between communities of different sizes (see Sklenář & Jørgensen 1999) but should be interpreted cautiously for revealing broad trends in similarity.

RESULTS

Including escaped and persisting taxa, the North Carolina vine flora currently comprises 155 species in 31 families.

Over the period of 1968–2001, the largest percentage of new North Carolina county vine species presence records came from the Mountain and transitional Mountain-Piedmont counties (Table 1). Except for Wilkes County (no change), all Mountain counties showed an increase in the number of vines known from 1968 to 2001. County records of Piedmont, Piedmont-Coastal Plain transition, and Coastal Plain counties, increased only a third or less (by percent) of Mountain record increases (Table 1). Nine of the 31 Piedmont counties showed negative changes in the number of vines known over the period. Nine Coastal Plain counties also showed negative change over the period. Negative change resulted from changes in taxonomy or resolution of formerly mis-applied names. No change in the number of species known occurred in 20 of the 100 counties of North Carolina. Thus, 38% of all counties displayed either a negative change or no change in the number of species of vines known in 2001 vs. 1968.

Based on the updated 2001 data, Piedmont counties host a significantly higher mean number of species ($x = 40.7$) than do Mountain counties ($t = 5.140$, $p < 0.0005$) or Coastal Plain counties ($t = 4.283$, $p < 0.0005$). Coastal Plain counties also host a significantly higher mean number of species ($x = 37.1$) than Mountain counties ($x = 35.5$; $t = 1.785$, $p < 0.025$). The Piedmont and Coastal Plain host the largest absolute number of vine taxa in North Carolina (Table 2), as well as the largest mean richness per county.

DISCUSSION

The higher Piedmont mean vine species richness may be due in part to geographic position. Piedmont counties host a larger percentage of vines overlapping in distribution from adjacent provinces than Mountain or Coastal Plain counties. However, reasons for the particularly high richness of several, scattered counties remain unclear (Fig. 1).

TABLE 1. Changes in liana and vine species totals known per county in North Carolina 1968–2001.

	Avg. no. of spp. per county (1968)*	Avg. no. of spp. per county (2001 update)	Change in spp. nos. 1968–2001	Percent change in spp. nos. 1968–2001
Mountain counties (N=20)	30.7	35.5	+ 4.8	+ 15.6
Mountain-Piedmont transition counties (N=5)**	29.2	35.0	+ 5.8	+ 19.9
Piedmont counties (N=31)	38.6	40.7	+ 2.1	+ 5.4
Piedmont-Coastal Plain transition counties(N=3)***	43.0	45.0	+ 2.0	+ 4.7
Coastal Plain counties (N=41)	35.8	37.1	+ 1.3	+ 3.7

* Based on Radford et al. (1968).
** Alexander, Burke, Polk, Rutherford, and Surry counties.
*** Lee, Moore, and Richmond counties.

TABLE 2. Matrix of Sørensen's indices of similarity (area-weighted) for the vine flora of North Carolina by physiographic province. Diagonals indicate total number of liana and vine species and, in parentheses, number and percentage of included, introduced liana and vine species.

	Mountains	Piedmont	Coastal Plain
Mountains	**89** (20; 22.5%)	–	–
Piedmont	75.16	**111** (35; 31.5%)	–
Coastal Plain	65.03	82.13	**118** (36; 30.5%)

Note: Transitional counties of overlapping physiographic provinces are not considered in the table. These counties are Alexander, Burke, Lee, Moore, Polk, Richmond, Rutherford, and Surry.

It is possible that richness in some counties, particularly in the eastern Piedmont, may be linked to macro-climate, as well as diversity in topography and associated microclimate. For example, Hardin and Cooper (1967) suggested that eastern Piedmont communities (especially in Durham, Orange, and Wake counties) are particularly rich in plant taxa (of all habits) due to a significant mountain and mountain disjunct element in their flora. Citing growing season and precipitation data, Hardin and Cooper (1967) provide indirect support for their hypothesis that this component of the flora is largely remnant from Pleistocene times and persists in cooler microsites. Topographically more highly dissected than the western Piedmont, the eastern Piedmont may provide a higher number of sites amenable to the occurrence of montane elements (Hardin & Cooper 1967), although further studies are needed.

Although Hardin and Cooper (1967) discount montane disjunction patterns as an artifact of sampling, the same may not yet be defendable for the distribution of vine taxa. As Connor and Simberloff (1978) have explored, in some

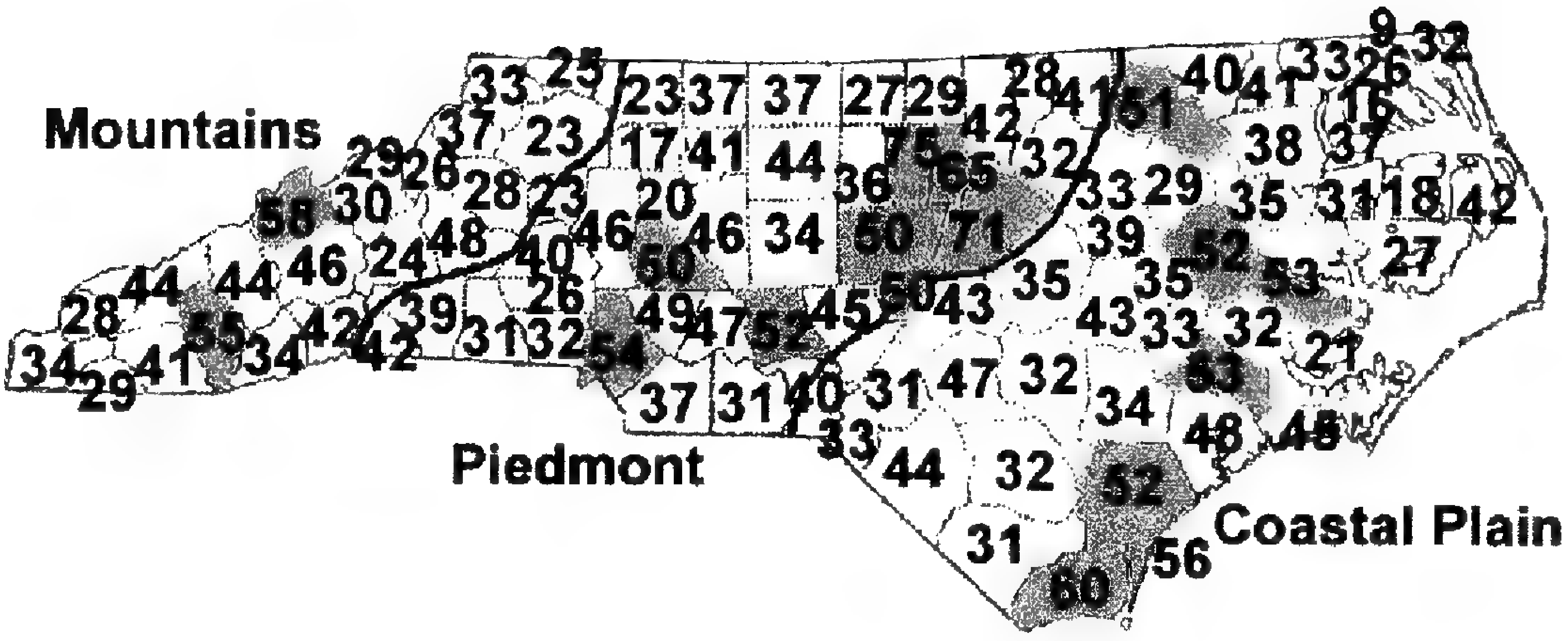

Fig. 1. Liana and vine species richness in North Carolina by county (based on Radford et al. (1968) and updated through literature review and search of herbarium collections of NCSC and NCU). Counties with 50 or more species are shaded gray.

instances collection effort may be a greater indicator of species richness and similarity among communities than biological factors. Based on our present knowledge, county to county vine species richness varies so generously within North Carolina provinces (Fig. 1) that an analysis of variance (ANOVA) found no significant difference by province in county species richness ($F_{0.05;\ 2,\ 91} = 1.355 < F_{crit}\ 3.098$; $p > 0.26$). Such variation is unexpected based on distinct differences in the climates and soils of the state's three provinces (Robinson 1979) and suggests non-biological causal factors. Potentially the result of historically larger collecting programs, the three most species rich counties also happen to host the three largest herbaria in the state (DUKE, NCU, and NCSC) (Fig. 1). Distance to the study site from the residence of researchers could likely influence the number of visits and hence the completeness of inventories. Accessibility and topography could also play a limiting role. Combined with less than 5.5% growth in county records for 75% of the potentially most speciose North Carolina counties (i.e., Piedmont and Coastal Plain counties) over the past thirty-three years (Table 1), the encountered county to county species richness variation indicates that, at least geographically, vines still remain largely undercollected for much of North Carolina.

ACKNOWLEDGMENTS

I thank the ILL department of the North Carolina State University libraries for help with obtaining materials not owned by the University and NCU for access to its collections.

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BOOK REVIEW

JILL NOKES. 2001. **How to Grow Native Plants in Texas and the Southwest. Second Edition.** (ISBN 0-292-75573-2, hbk.). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. (Orders: http://www.utexas.edu/utpress, 512-471-4032). $60.00 hbk., 566 pp., 30 watercolor plates, line drawings by Kathryn Miller Brown, 6" × 9".

This is a bible when it comes to propagating the native flora in the Southwest. This second edition is a beautiful example of an author's passion for, knowledge of, and expertise in native plants. The first edition that was published in 1986 has acted as the foremost guide for nurserymen, scientists and laymen trying to grow species of plants that are native in the temperate climate of Texas and the Southwest.

The first edition was written as a graduate thesis when the author was a student at Texas A&M. It contains an interesting analysis of the benefits for using native plants in the landscape verses the typical, exotic, high maintenance nursery stock. When the first edition was published the native plant movement was just beginning to be popular; however, at that time there was little supporting literature on the subject. In the 15 years past a very healthy amount of supporting literature has been published.

In the second edition, the author addresses the common notions that the general public has about native plants. Those being that they are shabby, ill behaved and second rate compared to the typical, traditional landscapes. She talks about the obliteration of the native flora in this country due to unknowing land developers. The author also describes how people think that a native landscape is a "zero-scape." This misconception has led to apathy in using native plants since people do not realize that a native plant garden can be lush, evergreen, and formal. A very good point made by the author is how important the basic design is to a more natural and less formal garden. Another idea offered is the importance of educating the public in choosing adapted, resource-efficient plants. She brings up the water concerns that have come about recently and how public places can be key factors in making the public aware about using water-efficient plants.

The second edition has been significantly expanded as far as the number of species addressed, approximately 75 new along with the original 350 trees, shrubs and woody vines. Some of these species are from the subtropical southern part of Texas; a region apparently left out of the first edition. Other revised sections of the book are those that give the user precise instructions on gathering and storing seed, seed germination, planting, vegetative propagation and transplanting. The bulk of the book consists of the propagation techniques for the genera and species. Both editions are well illustrated but the new edition includes photographs showing working examples of nursery methods that are described in the text. One of the best parts of the work is the group of beautiful watercolor plates that illustrate the characteristics of 30 species.

Both editions came about with the help and encouragement of numerous experts some of whom have past away since the first edition. The author says she has acted as a bridge between the younger generation of horticulturists and the elder generation by bringing together their knowledge in this publication. New techniques in horticulture that have boosted older methods have led to an increased availability of these plants from the nursery trade.

This book is not only a guide for greenhouse and nursery workers but also a field guide for anyone wanting to identify a plant that has been found in the wild that could be considered for ornamental applications. This publication sets high standards for horticulturalists for many years to come.—*Justin Allison, FNA Administrative Assistant, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

A NEW SYNONYM FOR *ERAGROSTIS PILGERI* (POACEAE: ERAGROSTIDEAE)

J. José Alegría Olivera and Arturo Granda Paucar

Departamento de Biología, Herbario (MOL)
Universidad Nacional Agraria La Molina
Apartado 456, Lima, PERÚ
gmn@lycos.com and a.granda@lycos.com

ABSTRACT

The identity of *Eragrostis ancashensis* P.M. Peterson, Refulio & Tovar, a Peruvian endemic, is discussed; the name is considered to be a synonym of *Eragrostis pilgeri* Fedde. Lectotypes are also designated for the names of some synonyms of *E. pilgeri*, whose holotypes at B were destroyed in 1943. Further remarks about the identity of two paratypes of *E. ancashensis* (*Ferreyra 14577* and *14594*) are included.

RESUMEN

Se discute la identidad de *Eragrostis ancashensis* P.M. Peterson, Refulio & Tovar, una especie endémica de Perú. El nombre se considera sinónimo de *Eragrostis pilgeri* Fedde. Se designan también lectotipos para los nombres de algunos sinónimos de *E. pilgeri*, cuyos holotipos depositados en B fueron destruidos en 1943. Se hace un comentario adicional sobre la identidad de dos paratipos de *E. ancashensis* (*Ferreyra 14577 y 14594*).

Eragrostis Wolf (Chloridoideae: Eragrostideae) is a genus with about 350 species distributed in the tropical and subtropical regions throughout the world (Clayton & Renvoize 1986). In Peru, the genus is represented by 22 species according to Tovar's (1993) treatment, although Davidse and Brako (1993) recognize the existence of 29 entities, which grow mainly in open fields, in dry and sandy soils of the Andes at altitudes between 0 and 4000 meters. Far from being well understood, Peruvian species of *Eragrostis* require a modern treatment making use of more reliable taxonomic characters such as degree of development of secondary branches, disarticulation of the spikelet, length of glumes in relation to the contiguous lemma, and the number of stamens. Using these reliable characters in any future revision of the genus will reflect a clearer picture of new taxa remaining to be discovered, new records, and nomenclatural changes. Likewise, anatomical characters have been demonstrated to be taxonomically significant for infrageneric levels in *Eragrostis* (Van den Borre & Watson 1994).

Eragrostis ancashensis P.M. Peterson, Refulio & Tovar, a Peruvian endemic known only from the Andes of the Cordillera Blanca (Department of Ancash), was recently described by Peterson et al. (2000) on the basis of collections with diagnostic characteristics such as dark-green and plumbeous-spotted spikelets with a ciliate, flattened rachilla. When discussing the relationships of their new entity, the authors pointed out, on the one hand, the possibly close relationship

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with *Eragrostis magna* Hitchcock, and on the other, a certain similarity with *Eragrostis macrothyrsa* Hack. Curiously, a detailed examination of the holotype, isoparatypes and the original illustration of *E. ancashensis* does not reveal its genuine alliance with *E. magna* as Peterson et al. (2000) mentioned, since these specimens as well as their figure 1, exhibit a particular set of features, viz. inflorescence with spreading or patent branches, reflexed pedicels, ovate spikelets 3.0–6.1 mm long, glumes equalling or exceeding the contiguous lemma, tenacious rachilla with hairs up to 1.5 mm long, 3–8 florets per spikelet, and ovate lemmas, which clearly distinguish these plants from Hitchcock's entity and which, on the contrary, show an undeniably closer similarity to another well known member of the genus also endemic to Peru, *Eragrostis pilgeri* Fedde. Indeed, when examining the lectotype and additional collections of *E. pilgeri* and comparing them with the material on which *E. ancashensis* was founded, it is impossible in our opinion to find the slightest difference in any way that allows any specific separation between the two species. Glands—which have not been previously reported for *E. pilgeri*—are usually present on the sheaths, pedicels, glumes, lemmas, and paleas of *E. pilgeri*; they are very conspicuous in *Weberbauer 2746* (type of *E. andicola* var. *robustior*). Moreover, it is important to point out the remarkable overlap in distribution of both species, mainly confined to the Department of Ancash (northern Peru), which reinforces our argument. The similarities of *E. pilgeri* were not taken into account by Peterson et al. in the discussion of their new species, *E. ancashensis*.

The preceding evidence—in our opinion—leaves no doubt on the conspecificity of *E. ancashensis* P.M. Peterson, Refulio & Tovar and *E. pilgeri* Fedde and the consequent synonymy of the two names. The following list provides complete and updated synonymy for *Eragrostis pilgeri*.

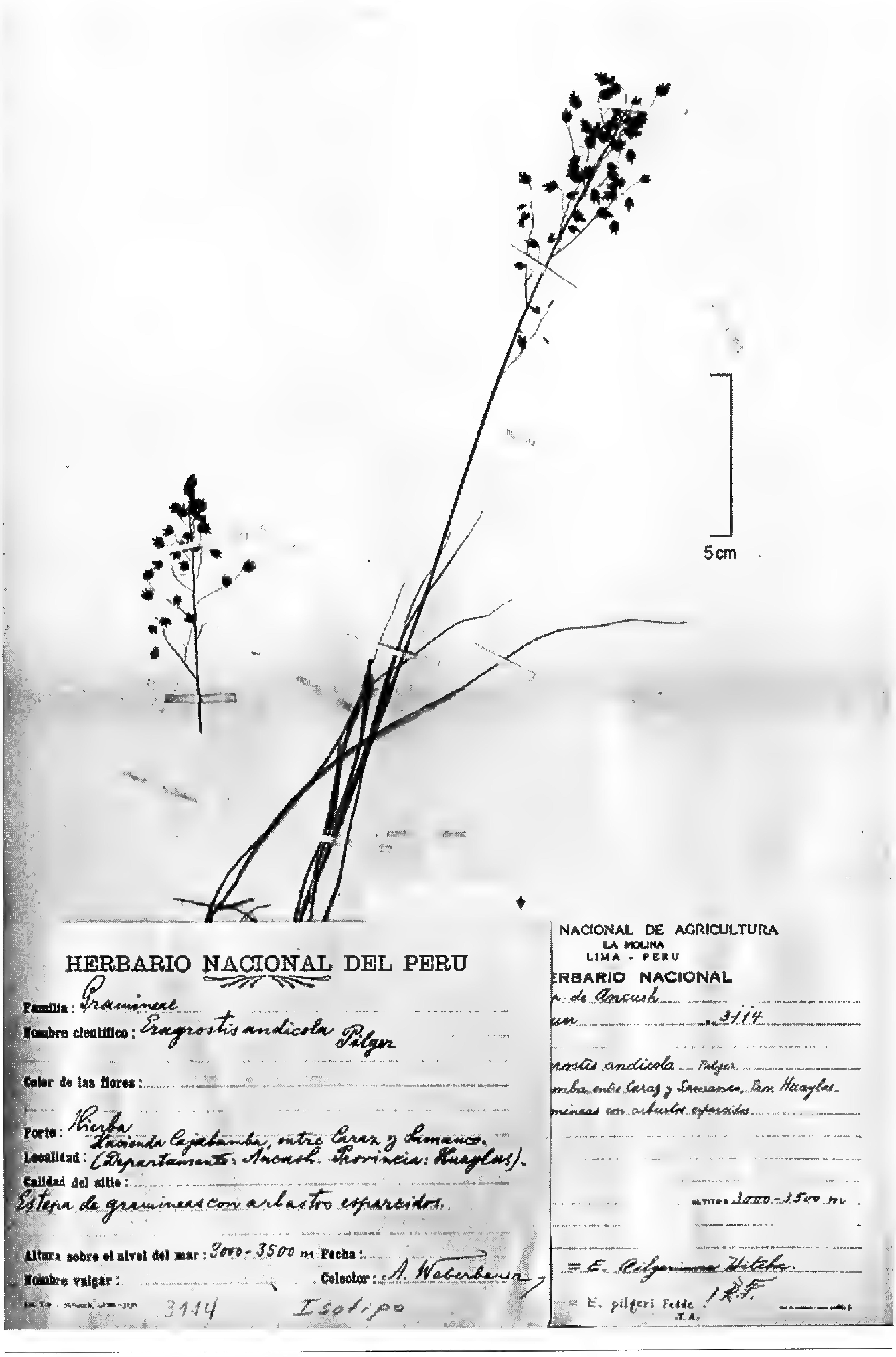
Eragrostis pilgeri Fedde, Just's Bot. Jahresber. 34:18, pl. 3. 1908. Based on *Eragrostis andicola* Pilger, Bot. Jahrb. Engler 37:377. 1906. Non *E. andicola* Fries, 1905. TYPE: PERU: DEPT. ANCACHS: inter Samanco et Caraz, infra Hacienda Cajabamba; in formatione ± aperta, praecipue gramina intermixtis fruticibus gerente, 3000-3500 ms.m., *Weberbauer 3114*, florens mense Majo 1903 (HOLOTYPE: B-destroyed; LECTOTYPE, here designated: MOL!, **Fig. 1**; ISOLECTOTYPES: fragments at BAA!, US).

Eragrostis andicola forma *humilior* Pilger, Bot. Jahrb. Engler 37:377. 1906. TYPE: PERU: DEPT. ANCACHS: inter Samanco et Caraz, infra Hacienda Cajabamba; in formatione aperta, 3700 ms.m., *Weberbauer 3036*, florens mense Majo 1903 (HOLOTYPE: B-destroyed; LECTOTYPE, here designated: MOL!).

Eragrostis andicola var. *robustior* Pilger, Bot. Jahrb. Engler 37:377. 1906. TYPE: PERU: DEPT. ANCACHS: in prov. Cajatambo, infra Ocros, in formatione aperta, fruticibus et plantis herbaceis mixta, 3000–3200 ms.m., *Weberbauer 2746* (HOLOTYPE: B-destroyed; LECTOTYPE, here designated: MOL!; ISOLECTOTYPE: fragment at US).

Eragrostis carazensis Pilger, Bot. Jahrb. Engler 56:Beibl. 123:27. 1920. TYPE: PERU: DEPT. ANCACHS: Caraz, offene Formation bei 2200–2500 m ü. M., *Weberbauer 2999*, Mai 1903 (HOLOTYPE: B-destroyed; LECTOTYPE, here designated: MOL!; ISOLECTOTYPES: fragments at BAA!, US).

Eragrostis pilgeriana A. Hitchcock, Contr. U.S. Natl. Herb. 24:342. 1927. Based on *E. andicola* Pilger.



HERBARIO NACIONAL DEL PERU

Familia: Gramineae

Nombre científico: Eragrostis andicola Pilger

Color de las flores:

Porte: Hierba

Localidad: Hacienda Cajabamba, entre Caraz y Simanco. (Departamento: Ancash. Provincia: Huaylas).

Calidad del sitio: Estepa de gramineas con arbustos esparcidos.

Altura sobre el nivel del mar: 3000 - 3500 m Fecha:

Nombre vulgar: Colector: A. Weberbauer

3114 Isotipo

NACIONAL DE AGRICULTURA
LA MOLINA
LIMA - PERU
ERBARIO NACIONAL

p. de Ancash

um 3114

rostis andicola Pilger

mba, entre Caraz y Simanco, Prov. Huaylas.

mineas con arbustos esparcidos

altitud 3000 - 3500 m

= E. Pilgeriana Hitchc.

= E. pilgeri Fedde ! R.F.
T.A.

Fig. 1. Lectotype of *Eragrostis pilgeri* Fedde (*Weberbauer 3114*, MOL).

> *Eragrostis ancashensis* P.M. Peterson, Refulio & Tovar, Sida 19:66. 2000. TYPE: PERU: DEPT. ANCASH. Provincia Recuay: Cordillera Blanca, approximately 20 km E of Raquia on Route 02-014 on roads towards Huaraz, along roadside and steep rocky slopes with shrubby Asteraceae, *Lupinus*, *Vicia* and *Commelina*, 3000 m, 20 Mar 1997, *P.M. Peterson & N. Refulio Rodríguez 13793* (HOLOTYPE: USM!; ISOTYPES: K, MO, NY, RSA, TAES, UC, US, WIS).

Lastly, we refer to the paratypes of *E. ancashensis Ferreyra 14577* and *14594*, which we had the opportunity to check. Here, the characteristics so dissimilar in appearance to *E. pilgeri* and consequently to *E. ancashensis* sensu Peterson et al.—namely taller culms (70–95 cm tall), longer and wider inflorescence (20–37 cm long x 12–16 cm wide) with longer branches (up to 14 cm long), longer spikelets (8–15 mm long) which are oblong to narrowly oblong rather than ovate, shorter glumes which are shorter than the contiguous lemma, rachilla with shorter and fewer hairs, more florets per spikelet [(8–)12–20], etc.—could well belong to another member of the genus with completely different relationships.

Thus, a remarkable affinity with *E. bahiensis* Schrader ex Schultes, a species not known from Peru (Davidse & Brako 1993) could rather be established. This species shares some features with the collections of Ferreyra, e.g., plant size, inflorescence size, spikelet size and shape, length of glumes in relation to the contiguous lemma, tenacity of rachilla, number of florets per spikelet, and lemma shape (ovate). Nevertheless, *E. bahiensis* differs by possessing shorter glumes (1.0–1.5 vs 2.0–2.5 mm long), shorter lemmas (1.5–2.0 vs 2.5—3.0 mm long), and a glabrous rachilla (Hitchcock 1951; Renvoize 1998).

We agree with Peterson et al. (2000) that the collections of Ferreyra could have some relationship with *Eragrostis magna*. With this species, they share some characteristics such as spikelet shape and rachilla pilosity. However, *E. magna* differs by having ascending panicle branches, shorter spikelets (7–10 mm long), a deciduous rachilla disarticulating between the florets, and fewer florets per spikelet (7–10) (Hitchcock 1927).

On the other hand, it is possible that such peculiar collections represent quite old stages of *E. pilgeri* because the features they possess have been observed in the latter species with relative frequency by one of us (J.A.) despite not having been reported by previous authors (Hitchcock 1927; Standley 1936; Tovar 1993). In this respect, it is worth remarking the high index of variability noticed in different populations of *E. pilgeri* for characters such as size of plant, degree of pubescence on blades and sheaths, presence of glands on sheaths and spikelets (pedicels, glumes, lemmas, and paleas), degree of panicle development, size and shape of the spikelet, degree of pubescence of rachilla, number of florets per spikelet, which could have compelled Tovar (1993) to place *E. carazensis* into the synonymy of *E. pilgeri*.

Finally, it is possible that these two paratypes belong to a species remaining to be named; however, in our opinion, only a careful examination of a greater number of future collections of these plants will make it possible to determine the consistency and taxonomic validity of the characteristics mentioned. Before such time, any decision that seeks to clarify the situation of the specimens *Ferreyra 14577* and *14594* would be questionable to us.

Additional material examined: *Eragrostis pilgeri*: **PERU**. **Dept. Ancash. Provincia Bolognesi:** entre Chasquitambo y Conococha, 3000–3200 m, 24 May 1962, *Ferreyra 14476* (USM); Mishahuayunca, cerro al frente de Ocros, 3400 m, 8 Jul 1974, *Cerrate 6190* (USM); Rumpuquio cerro al S de Ocros, 3500 m, 27 Abr 1977, *Cerrate et al. 6510* (USM); camino a Bellavista, 3200 m, 29 Abr 1977, *Cerrate 6580* (USM). **Provincia Huaraz:** 10 km by road from Cachabamba (77°51'W, 9°27'S), 2870 m, 6–8 Jun 1985, *Smith & Buddensiek 10872* (USM). **Provincia Huaylas:** encima de Huaylas, 2700–2800 m, 3 Jun 1962, *Ferreyra 14606* (USM); Huascarán National Park, Auquispuquio area of ruins (77°58'W, 8°50'S), 3800–3900 m, 7 Apr 1986, *Smith et al. 11959* (USM).

Eragrostis ancashensis: **PERU. Dept. Ancash. Provincia Corongo:** 7 km NW of Yupan on road to Bambas, 3220 m, 26 Mar 1997, *Peterson & Refulio 13915* (USM, isoparatype); 7 km NW of Bambas, 2710 m, 26 Mar 1997, *Peterson & Refulio 13919* (USM, isoparatype). **Provincia Huaylas:** entre Caraz y Huallanca, 2200–2300 m, 2 Jun 1962, *Ferreyra 14577* (USM, paratype); entre Huaylas y el Callejón, 2400–2500 m, 3 Jun 1962, *Ferreyra 14594* (USM, paratype).

ACKNOWLEDGMENTS

The authors wish to express their gratefulness to Zulma Rúgolo (SI) for reviewing the first draft of the manuscript and mailing Pilger's protologues; Gabriel Rua for sending images of the types at BAA; Werner Greuter and Mia Ehn Salter for providing information about the types housed at B and S, respectively; and Nancy Refulio (USM) for supplying part of the literature. Appreciation is extended to the staff of USM and MOL for allowing access to the collections. We are also indebted to Kelly Allred and Paul Peterson for their reviews of the manuscript, and Barney Lipscomb without whose support the present paper could not have been published.

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BOOK REVIEW

William Dubbin. 2001. **Soils.** (ISBN 0-565-09148-4, pbk.). Iowa State University Press, 2121 South State Street, Ames, IA 50014, U.S.A. (Orders: 800-862-6657, 515-292-015—distributed for the Natural History Museum, London). $19.95, 110 pp, 97 color photos, 19 b/w photos, 10 drawings, 1 color map, 8 1/4" × 9 1/4".

Contents.—Preface; The author; Soils—the nuts and bolts; Soil taxonomy and geography; Soil biology; Soil fertility; Soil use and misuse; What lies ahead?; Glossary; Index; Further information.

As stated in the preface, "The soils that cover the Earth's surface determine, to a large extent, the prosperity of those who depend on them for the production of food and fibre. ... More recent examples of soils degradation emphasize the strong link between soil quality and human welfare. Sustained prosperity therefore depends on a thorough understanding of soils coupled with sound management practices."

This small volume is a good beginning for gaining such an understanding and appreciation for this "indispensable natural resource." The book provides a brief, yet understandable and well-illustrated introduction to a complex subject. It does not attempt to go into great depth about the details of soil science. Rather, it gives a basic presentation of the field that is accessible, informative, and interesting to the intelligent lay person. For example, the introductory chapter, "Soils—the nuts and bolts," covers a variety of important basics such as soil formation, parent materials, soil minerals, mineral weathering, soil texture, organic matter, porosity, and water in soils.

The chapter on "Soil taxonomy and geography" is particularly helpful. Currently, there are two main hierarchical classification systems of the world's soils. One system (referred to as UNESCO FAO) was developed by the United Nations Educational, Scientific and Cultural Organization (UNESCO) jointly with the Food and Agriculture Organization (FAO), while the other, called *Soil Taxonomy*, was developed by "a team of international scientists and the U.S. Department of Agriculture." Clear descriptions and photographs of the 12 orders of the *Soil Taxonomy* system, and a table comparing this system with the UNESCO FAO classification, bring satisfying clarity to what can sometimes be a confusing array of names. The numerous excellent color photographs are particularly helpful in visualizing the various soils being discussed in the text.

As someone living on the Blackland Prairie of Texas, whose soils have been devastated by years of misuse and now increasing development, it was very pleasing to see a whole chapter, "Soil use and misuse," devoted to issues of soil conservation. Concise but informative discussions of erosion, the buildup of salts in soils, and soil pollution highlight important issues in soil management and conservation. Also, such special focus topics as "Salinity 'down under' (Australia)," "Bioremediation—nature's chimney-sweep," and "Famine in Africa" give real world examples and a human face to soil conservation. In addition, conservation is a theme incorporated throughout the book—for example, there is a special section on eutrophication ("Too much of a good thing—eutrophication") in the chapter on "Soil fertility."

In several sections I had the feeling I wanted more—additional information and details. That's probably a positive thing. As many teachers will attest, if you can interest a student so they want to learn more on their own, you've won half the battle. Indeed, the book only intends to be an understandable introduction to a large and complex discipline, and it clearly succeeds in that goal. It is a brief yet helpful overview of the field and should provide increased understanding to a wide audience. Individuals wishing more in-depth knowledge will appreciate a page at the end of the book with a list of more detailed soil science references as well as a number of web site addresses.—*George M. Diggs, Jr., Dept. of Biology, Austin College, Sherman, TX 75090, and Botanical Research Institute of Texas, Fort Worth, TX 76102, gdiggs@austinc.edu.*

SCLERIA LACUSTRIS (CYPERACEAE), AN AQUATIC AND WETLAND SEDGE INTRODUCED TO FLORIDA

Colette C. Jacono

United States Geological Survey (USGS)
7920 NW 71st St.
Gainesville, FL 32653, U.S.A.

ABSTRACT

A non-native species of *Scleria*, *S. lacustris* is reported from six counties and three major hydrologic regions in Florida. Biogeography and habitat in Florida are addressed. A description, key features and illustration are presented.

RESUMEN

Se presenta aquí la presencia de una especie exótica del género *Scleria*, *S. lacustris*, de seis condados y de tres regiones hidrológicas de Florida. Se hacen anotaciones sobre su biogeografía y hábitat en Florida. Se presenta una descripción con características clave junto con una ilustración.

A robust, annual member of its genus, *Scleria lacustris* C. Wright is being found with increasing frequency in freshwater marshes of peninsular Florida. This noteworthy species is native to scattered regions of the Neotropics and Africa (Core 1936; Hennessy 1985). Adventive populations have been documented in six counties located in the headwaters of three major USGS hydrologic regions: the Upper St. Johns River, the Kissimmee River, and the Big Cypress Swamp drainages.

Scleria lacustris was first reported in 1998 based on a 1989 specimen from a Lee County wetland in the upper reaches of the Big Cypress Swamp drainage (Wunderlin 1998; Tobe et al. 1998). In 1990 it was documented at a wetland eight km east and noted as the dominant plant (M. Roessler, pers. comm.) Not recognized at the time was a 1988 specimen from Jane Green Swamp, a conservation marsh in the St. John's Water Management District, Brevard County in eastern Florida. The Brevard County specimen had been misidentified as *Scleria vaginata* Steudel. In 1999 *S. lacustris* was documented in the Kissimmee River drainage of central Florida in Polk County at the Disney Wilderness Preserve (DWP) and at London Creek, two km west of DWP boundaries. The following year additional stations were found within DWP (Polk and Osceola Counties), and east of DWP on South Florida Water Management District conservation lands. Since 2000, collections have been made from St. Johns River Water Management District marshes in Indian River County and from the lower Kissimmee drainage in Okeechobee County. These latest stations lie south of the earliest locale (Brevard County) where recollection has also been made (Fig. 1).

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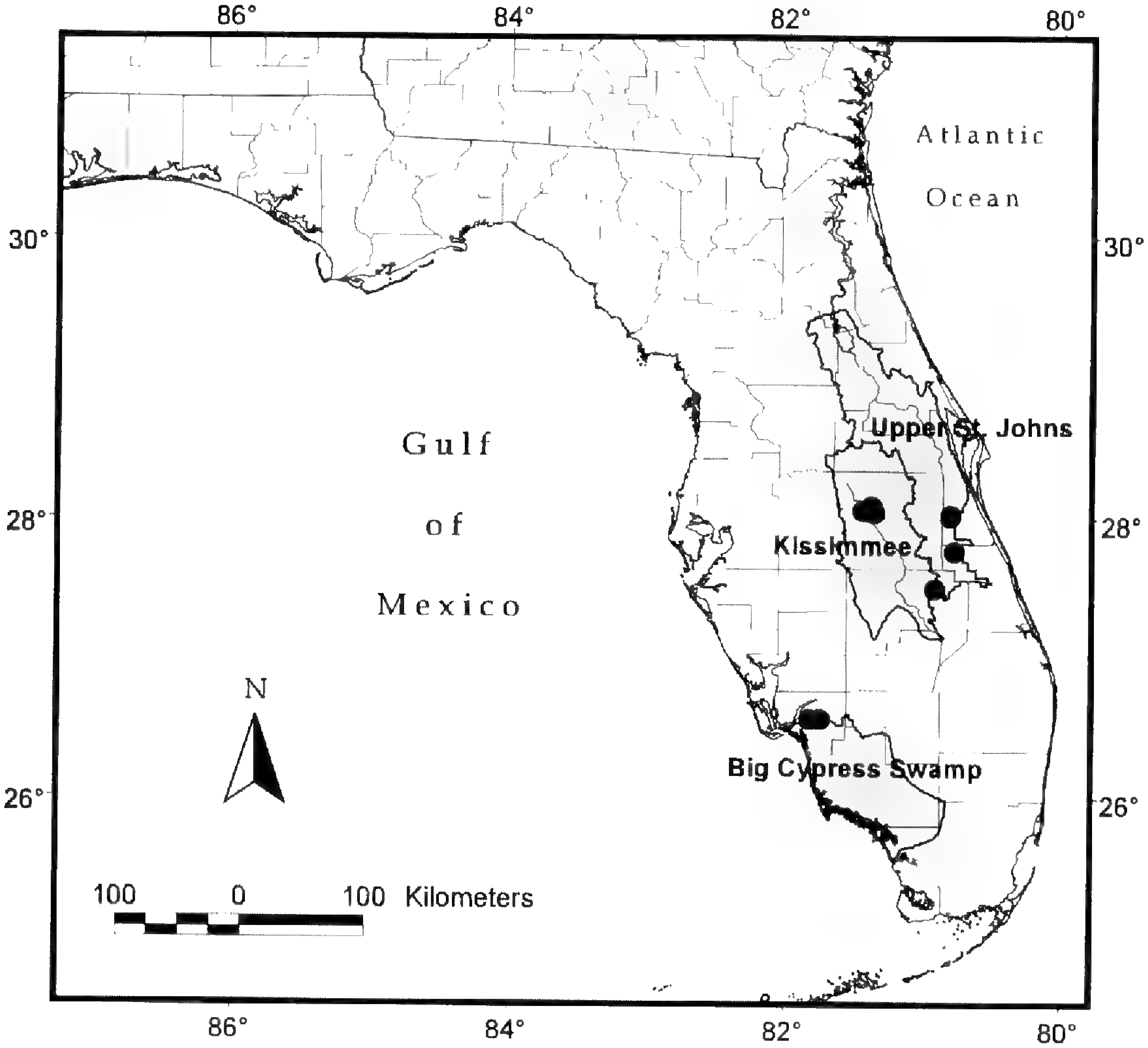

Fig. 1. Geographic distribution of *Scleria lacustris* in Florida. Collection sites are indicated by dots. USGS hydrologic regions are shaded in gray and delineated with bold lines. From left to right they represent drainages of the Big Cypress Swamp, the Kissimmee River, and the Upper St. Johns River.

Scleria stands apart from other genera in the Cyperaceae for its unisexual flowers and prominent, white, bone-like achenes (Kessler 1987). The genus is distributed primarily in tropical and warm-temperate regions. Kessler (1987) recognized and described ten North American species of *Scleria*, placing emphasis on the sculpturing of achenes and pubescence on the achenes, scales, bracts, leaves, and culms. Camelbeke and Goetghebeur (1999) used the ligule as a diagnostic character in *Scleria* and presented a key to the five ligulated Neotropical species so far known. In the Americas, the Neotropical *S. lacustris* was most recently treated by Core (1936). Hennessy (1985) most recently detailed the species from Africa.

Scleria lacustris lacks a genuine ligule, but does have a sheath-top extension called a contraligule (Camelbeke & Goetghebeur 1999; Fig. 2c.). The contraligule for this species has a membranous margin, which Core (1936) described but failed to accurately account for in his key. All Florida specimens exhibit this margin; a scarious, tongue-shaped appendage, 2–5 mm long, at the top of the contraligule. It is also apparent in a digital image, *Wright s.n.* (NY) (NYBG 2001).

Core (1936) believed *Scleria lacustris* to be endemic to the type locality of Cuba; only three specimens from two locales were available on which to base his description. Fairey (1972) discovered that the original notes for Core (1936) described leaves as "6 mm to 1.6 cm wide." This differs from "1–6 mm wide," an error that appeared in the published monograph (Core 1936). Florida plants, 61 to about 230 cm in height, stand two to three times taller than specimens from Cuba. Also the leaf width is broader, 11–25 mm wide. Consistently larger material was collected in the St. Johns drainage where plants grew emergent from water. These plants were taller, with solitary culms, long panicles (to 21 cm) and adventitious roots up to 44 cm above the culm base. In these respects plants from the St. Johns drainage bore a greater resemblance to *S. lacustris* described from aquatic habitats in Africa (Hennessy 1985; Robinson 1966; Nelmes 1955). African plants originally described as *S. aquatica* Cherm. are considered conspecific with *S. lacustris* (Nelmes 1955; Hennessy 1985; Fairey 1972). The African entity as a whole is infrequently distributed in six countries across tropical Africa and in Madagascar (Hennessy 1985).

Fairey (1972) examined both Neotropical and African specimens of *Scleria lacustris* and found African plants taller and more robust, with larger, better-developed panicles. He noted leaves on African specimens as acute and those on Neotropical plants as obtuse. Core (1936) described Cuban plants with obtuse leaves. In Florida, the leaves of *S. lacustris* are acute; they gradually taper to a point. Fairey (1972) attributed differences between Neotropical and African representatives of *S. lacustris* to their wide geographical separation.

In the Neotropics, *Scleria lacustris* is now known to range far beyond Cuba. Camelbeke confirmed specimens from Costa Rica, Cuba, Jamaica, Guyana, Suriname, French Guiana, Brazil and Paraguay, but within this wide distribution still regards *S. lacustris* as "a very rare species" (K. Camelbeke, pers. comm.).

In Florida, *Scleria lacustris* exists as an annual species, recurring by seed in locally abundant populations. Seedlings emerge in late spring. Flowering occurs August to September and achenes remain on standing plants September through December. By February plants in the St. Johns drainage were collapsed with bases and roots withered. Persisting structures are absent in Florida, although *S. lacustris* may perenniate in Africa (Nelmes 1955; Fairey 1972, Hennessy 1985).

Throughout its Florida range, *Scleria lacustris* resides in seasonal marshes in or near former wet cattle pasture. The mechanisms of introduction and dispersal are not known. According to Hennessy (1985), the achenes sink in water, yet, one hundred achenes collected from the ground in May remained buoyant in the laboratory for several days. Achenes floating through ditches and washed along lakeshores may explain spread in some regions. However, water flow cannot account for widely scattered populations in more isolated sites, suggesting dispersal by birds or other animals as an additional mechanism of introduction.

In marshes of the Upper St. Johns River drainage, *Scleria lacustris* is encountered as scattered patches approximately five m^2 to several hectares in size on slight rises in peat substrate. Plants are observed in drier years and may require recession of standing water for seedling recruitment. However, mature specimens collected in late season are commonly found growing in water to one m (L. & J. Harrison, pers. comm.). Drier conditions existed at DWP in the Kissimmee River drainage, where *S. lacustris* was observed during 2000 at approximately 20 stations (C. Campbell, pers. comm.). At that time colonies reaching 1.8 ha were found at marshes, ditches, and lakefronts remaining dry after several years of extreme drought. Hennessy (1985) suggested that the annual habit, uncommon in the subgenus *Scleria*, serves as a drought-escape mechanism in tropical regions that experience seasonal drought. The increasing occurrence of *S. lacustris* in Florida marshes could be related to changing hydrologic conditions.

Scleria lacustris can be recognized in the field by its large size, thick three-sided culms and broadly linear, plicate leaves. Terminal panicles may extend over 1–2 meter in height and are open and conspicuous when achenes mature. Plants are extremely scabrous, especially leaf margins, midribs, rachis and bracts. The harsh texture results from minute prickles, developed as barbed outgrowths of silica deposited in the epidermal cells (Metcalfe 1971). Seedlings are bright green, with purple tinged basal sheaths, red roots and tapering, plicate leaves.

The hypogynium, a hardened pad at the base of the achene, is an important taxonomic feature in *Scleria*. Wunderlin's (1998) key, in addressing Florida, distinguishes *S. lacustris* from North American species and groups *S. lacustris* with *S. triglomerata* in having a smooth-surfaced achene and a hypogynium without tubercles. Wunderlin (1998) separated *S. lacustris* from *S. triglomerata* by noting the broad, crusty hypogynium and the narrower leaves of *S. triglomerata* versus the narrow, smooth hypogynium and the wider leaves of *S. lacustris*.

Kessler (1987) noted the achene body of *S. triglomerata* as ovoid-globose, and pointed to the resulting circular base of the achene as a key element. The achene body of *S. lacustris* appears more ovoid-ellipsoid and its achene base more triangular. Addition of these elements after line 3 in the key of Kessler (1987) is as follows:

1. Achene body smooth or with longitudinal ridges ____ (2)
1. Achene body rough, reticulate or with transverse ridges.
   2. Base of achene circular to obtusely triangular, with a hypogynium ____ (3)
   2. Base of achene triangular without a hypogynium.

3. Tubercles present between achene and hypogynium ______________ **Scleria oligantha**
3. Tubercles absent between achene and hypogynium ______________________ (4)
    4. Hypogynium broad, granular- or papillose- crusty; base of achene circular; leaves less than 1 cm wide ______________________ **Scleria triglomerata**
    4. Hypogynium narrow, smooth; base of achene obscurely triangular; leaves greater than 1 cm wide ______________________ **Scleria lacustris**

The following description of *Scleria lacustris* in Florida, adapted from Core (1936), is based on all specimens reviewed and six unvouchered plants from Indian River County.

Scleria lacustris C. Wright in Sauvalle, Anales Acad. Ci. Med. Habana 8:152. 1871. (**Fig. 2**) TYPE: CUBA: Wright *s.n.* (LECTOTYPE: K; designated by E.A. Robinson, Kew Bull. 18:517-519. 1966).

Common names.—Wright's Nut-rush, Cañuella, Little Cane

Robust, annual herb 0.6–2.3 m tall. *Rhizome* absent. *Roots* stout and fibrous, at base and submersed nodes of culm, red-brown. *Culms* erect, solitary to several, often with 1–2 undeveloped basal tillers, 8–24 mm thick near base to 5–13 mm thick aerially, triquetrous with angles retrorsely scabrous. *Leaf blades* 41–90 cm long, 11–25 mm wide, acute, plicate, transverse section inversely W-shaped, glabrous, margins and midribs scabrous; sheaths scarcely winged, loose, closed, tinged with purple streaks, sheath hairs strigose to hispid, white and sparkling; ligule absent; contraligule rounded, 3–12 mm long, 6–17 mm wide at base, the margin with a scarious appendage, appendage triangular to tongue shaped, 2–5 mm long. *Inflorescence* open paniculate, the branches ascending to spreading, rigid, antrorsely scabrous, axillary and terminal, terminal inflorescence 19–48 cm long; lower bract of inflorescence foliaceous, 9–30 cm long, 5–1.6 mm wide, bractlets to 48 mm long, < 1 mm wide, antrorsely scabrous, awl shaped from broadened base, base margined with dark bristles. *Spikelets* both bisexual and male. *Staminate spikelets*, 4–5 mm long, 0.8–1.2 mm wide, scales lanceolate, mucronate, maroon to dark purple, flower with 3 stamens. *Gynecandrous spikelets* common, 4.5–6.5 mm long, pistillate scales 3–4.5 mm long, 2.4–4 mm wide, broadly ovate, abruptly acuminate, ciliolate on the margin, maroon to dark purple. *Androgynous spikelets* less common. *Achene* 3–4 × 2.3–2.5 mm, ovoid- ellipsoid, faintly three sided, base obscurely triangular, smooth, shining, white to mottled gray or tan, equaling or exceeding the scales. *Hypogynium* small, depressed 0.5–<1 mm, obtusely triangular to three lobed, the margin entire, narrow, 0.1–0.2 mm high, tan to brown.

Voucher specimens: **U.S.A. FLORIDA. Brevard Co.:** Rare, growing in water, Jane Green Swamp, W. of Lake Hell'n Blazes, near W property boundary, about 14 mi WSW of Melbourne, ca. 28°02'N, 80°48'W, 6 Oct 1988, *G.B. Hall s.n.* (FLAS!), duplicate specimen originally determined as *Scleria vaginata* Steudel.; Jane Green Swamp, St. Johns Water Management District; UTM 3099747.5 N, 518595.9 W, abundant at this station, growing in 14 cm of water, freshwater marsh with *Rhynchospora inundata, Cyperus articulatus, Pontederia cordata, Sagittaria lancifolia, Panicum hemitomon, Polygonum punctatum, Leersia hexandra, Cyperus haspan,* 21 Oct 2000, *J. Harrison & L. Harrison 259 with K. Snyder* (FLAS!).

Fig. 2. *Scleria lacustris* C. Wright drawn from *Harrison & Harrison 259* by Laura Line. A. Achene, profile and base with hypogynium. B. Habit. C. Portion of culm showing leaf, sheath and contraligule. D. Spikelets.

Indian River Co.: Blue Cypress Marsh, ca. 600 m E of northern section of Blue Cypress Lake, Nov 2000, *G. Nichols s.n.* (FLAS!); Blue Cypress Marsh, ca. 600 m E of northern section of Blue Cypress Lake, 27°41.869'N, 80°41.659'W withered plants with *Eleocharis*, 10 Feb 2001, *C.C. Jacono 204 with G. Nichols* (FLAS!); Blue Cypress Marsh, 27° 41.869' N, 80° 41.659' W, immature plants 150 cm high growing in 76 cm of water, 16 Aug 2001, *G. Nichols s.n.* (FLAS!). **Lee Co.:** ca. 10 mi SE of Ft. Myers, herbaceous wetland, 27 Nov 1989, *W. Cox s.n.* (USF); ca. 10 mi SE of Ft. Myers, herbaceous wetland, 16 Dec 1989, *W.*

Cox s.n. (USF; FLAS!); wet prairie along Griffin Dr., 0.5 mi N of Gateway Blvd., in the Gateway Community, Nov 1990, *M. Roessler s.n.* (FTG, scanned image seen; USF), specimen originally determined as *Scleria triglomerata* Michx. **Okeechobee Co.:** Approx. 5 mi W of US 441 on SR 724, approx. 50 m from wetland edge, 19 Sep 2000, *C. Lane s.n.* (FLAS!). **Osceola Co.:** Disney Wilderness Preserve, HU3T4, along transect in HU, cypress dome community, 40–50 plants, *C. Campbell s.n.* 16 Oct 2000 (dwp!). **Polk Co.:** London Creek, Tract A. Oct 1999, *C. MacGregor s.n.* (USF!); Disney Wilderness Preserve, N side of Lake Hatchineha, ditch of N side lakefront road, water depth 45 cm, colony 9 m diameter, P. Royston, 8 Nov 1999 (PIHG!); Disney Wilderness Preserve, HUT, Aug 2000, *C. Campbell s.n.* (dwp!); just W of Dead River on Johnson Island, McKinney Tract, T28S R30E Sec.13, open marsh with *Sagittaria lancifolia* and *Sacciolepis striata*, 12 Oct 2000, *B. Hansen 12,894 with R. P. Wunderlin & C. MacGregor* (USF!); Disney Wilderness Preserve, N side of Lake Hatchineha, S of the T off old marsh front road, seedlings 11–13 cm tall with empty pericarp attached, 7 May 2001, *C.C. Jacono 266 w/ V. Ramey, C. Campbell and K. Yeuell* (FLAS!); Disney Wilderness Preserve, N side of Lake Hatchineha, S of the T off old marsh front road, mature plant cultivated from seedling collected 7 May 2001, 11 Sep 2001, *C.C. Jacono 309* (FLAS!).

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SOUTH AMERICAN SKULLCAP (*SCUTELLARIA RACEMOSA*: LAMIACEAE) IN THE SOUTHEASTERN UNITED STATES

Alexander Krings
Herbarium, Department of Botany
North Carolina State University
Raleigh, NC 27695-7612, U.S.A.
Alexander_Krings@ncsu.edu

Joseph C. Neal
Department of Horticultural Science
North Carolina State University
Raleigh, NC 27695-7609, U.S.A.
Joe_Neal@ncsu.edu

ABSTRACT

Although previously reported from scattered localities, studies of the habitats and distribution in the United States of the South American native *Scutellaria racemosa* Pers. are lacking. To analyze trends in the spread of *S. racemosa* throughout the southeast we studied 82 specimens from 16 herbaria. Collections taken from roadsides, lawns or golf courses, and nurseries or horticultural plantings accounted for about 76% of specimens examined. Establishment is facilitated by vegetative reproduction via rhizomes and a capacity to produce flowers and fruits throughout the year. Patterns of distribution are likely a result of human activity such as transport of contaminated nursery stock or sod, as well as seed spread on right-of-way mowing equipment.

RESUMEN

Aunque citada de varias localidades, no hay estudios de los hábitats y la distribución en los Estados Unidos de la especie suramericana *Scutellaria racemosa* Pers. Para analizar tendencias en el movimiento de *S. racemosa* en el sudeste de los Estados Unidos, estudiamos 82 especímenes de 16 herbarios. Recolecciones de bordes de carreteras, céspedes o campos de golf, y viveros o plantaciones horticulturales, justifican el 76% de los especímenes examinados. El establecimiento está facilitado por la reproducción vegetativa por rizomas y la capacidad para producir flores y frutos durante todo el año. La distribución es probablemente el resultado de actividades humanas, incluyendo el transporte de plantas de vivero o suelo contaminado, así como semillas diseminadas por cortacéspedes.

Native to South and Central America (Leonard 1927; Epling 1942), *Scutellaria racemosa* Pers. (South American skullcap, Lamiaceae) was first reported from North America in 1973 (Kral 1973) and subsequently reported from sporadic collections in the southeastern United States (e.g., Godfrey & Wooten 1981; Tobe et al. 1998). Following observation of encroachment of a population into nursery pots and nearby natural areas in Chatham County, North Carolina (Krings & Neal 2001), we grew concerned over the potential of this species to become invasive in our state. Although previously noted from the southeast primarily in floras, checklists, and noteworthy addition articles (e.g., Kral 1973, 1981; Godfrey & Wooten 1981; Allen 1983; Jones & Coile 1988; Tobe et al. 1998), scant information concerning the invasion of habitats and overall distribution in the United States has been published. In this study we sought to more carefully examine the distribution and habitat of the species in the southeastern United

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States. Specifically, our objectives were to: (1) compile an up-to-date atlas of *S. racemosa* in the southeastern United States, (2) compile and analyze habitat and phenology data, and (3) analyze any trends in the spread of *S. racemosa* throughout the southeast.

METHODS

The distribution and habitat of *Scutellaria racemosa* in the southeastern United States was compiled based on study of vouchered herbarium specimens, guided by previous literature citations (e.g., Penland 1924; Radford et al. 1968; Kral 1973, 1981; Godfrey & Wooten 1981; Allen 1983; Jones & Coile 1988; Tobe et al. 1998; Wunderlin & Hansen 2000). Eighty-two collections were analyzed—comprising the totality of *S. racemosa* holdings in the following herbaria: AUA, DUKE, GA, GH, FLAS, FSU, LSU, MO, NCU, NCSC, NO, NY, UNA, USCH, USF, TEX. Habitat and phenology data were taken from mounted specimens. In addition, field surveys were undertaken by Krings in east Texas and southeast South Carolina.

RESULTS

An updated distribution of *S. racemosa* is provided in Figure 1, d. New county records are reported from FL, GA, LA, SC, and TX and herbaria interested in updating their records may wish to consult the list of exsiccatae (Appendix A). The species remains unreported from Mississippi, although, based on its known distribution along Interstate 10 and habitat preference, it is extremely likely to occur—especially in the southern counties of Pearl River, Hancock, Stone, Harrison, George, and Jackson. It is also likely occur in other Texas counties, particularly Harris, Chambers, Jefferson, Orange.

Scutellaria racemosa has been collected in the southeastern United States in fruit and flower in every month of the year and in a variety of habitats ranging from wet, roadside ditches to lawns and orange groves (Fig. 2). The largest number of collections (40%) were taken from roadside ditches, embankments, or right-of-ways. Collections from lawns or golf courses constituted approximately 19% of all collections. Collections from nurseries or horticultural plantings constituted nearly 18%. The species has also been sporadically collected from pine forest, hayfields, and disturbed sites. Soils ranged from sandy to muck and sites from low to high maintenance (e.g., mowed turf)—suggesting a potential to infest varied environs and tolerance of site management activities such as mulching and mowing.

DISCUSSION

An obligate wetland species (Reed 1988), *S. racemosa* has already shown itself a potential weed of irrigated landscapes, such as lawns and golf courses (Fig. 2). Although first reported from Baldwin Co., Alabama (8 Jun 1971, *Kral 43084*,

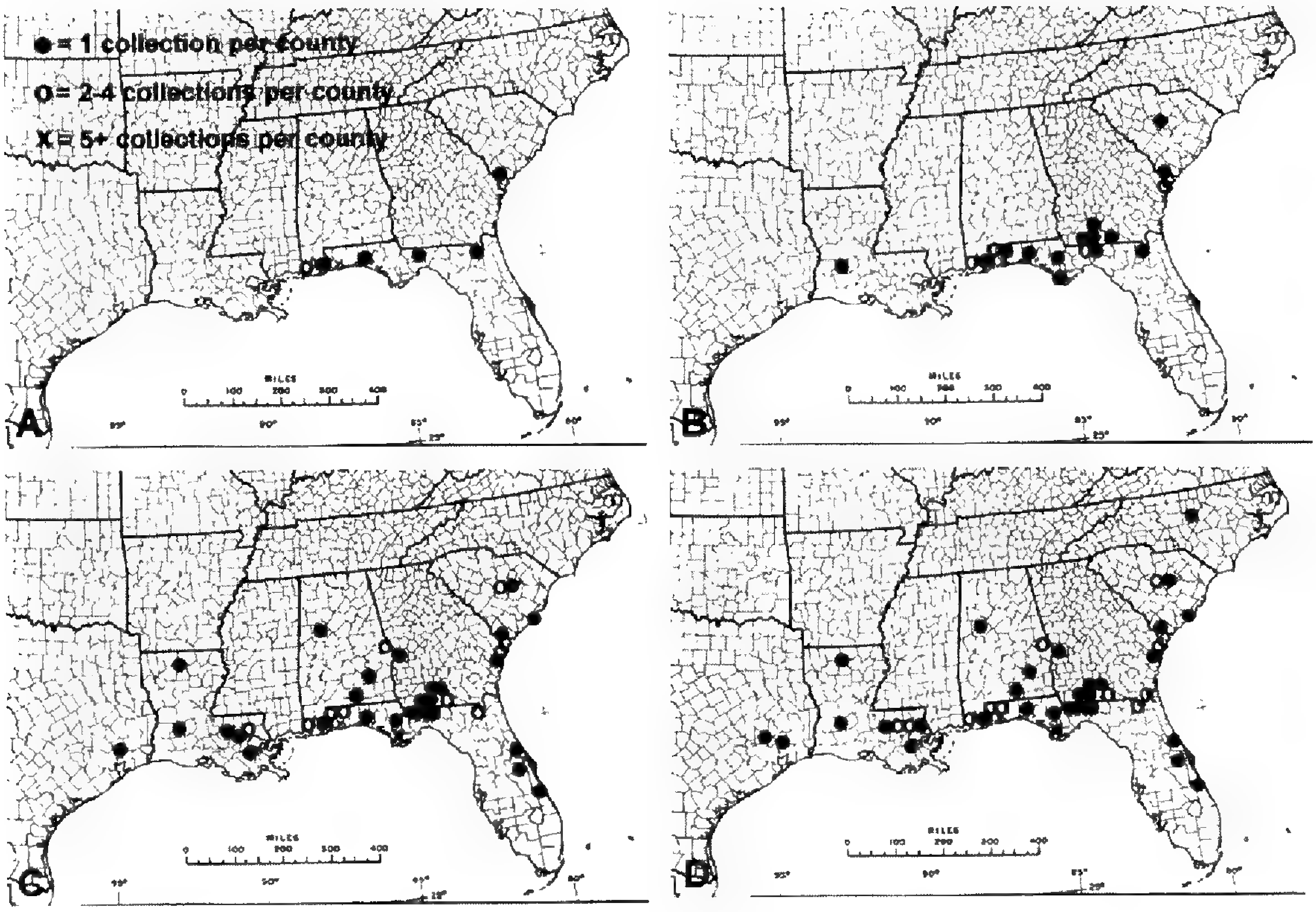

Fig. 1. **Distribution of *Scutellaria racemosa* Pers. (Lamiaceae) in the southeastern United States from its earliest collection in 1965 (Mobile Co., Alabama) to present: A, 1965–1975; B, 1976–1985; C, 1986–1995; D, 1996–2000.**

AUA, FLAS, GA, NCU, UNA, USF) by Kral (1973), the earliest North American collection appears to be from neighboring Mobile Co. (10 Apr 1965, *Deramus D378*, UNA). The method of initial introduction is unknown, although it is likely that the species was introduced accidentally with horticultural plants shipped from Central or South America. Although the species is known from coastal Mexico (Epling 1942), an overland introduction does not seem plausible given the complete lack of collections from southeastern, coastal Texas and the lack of any Louisiana collections before 1982. In the ten years following the initial 1965 collection in Alabama, further collections had been made in Florida and as far north as South Carolina (Fig. 1, a). A comparison of Fig. 1 to roadmaps of the southeastern US reveals a close agreement between occurrence records and major by-ways (e.g., I-10, Hwy 17). Although occurrence patterns may be biased somewhat by the ease of roadside collection, the small number of collections from relatively isolated wetlands remains surprising – especially given the recent effort to study and delineate wetlands in the southeastern United States. Although unknown, it is not likely that seeds were dispersed so rapidly over such distances by natural means (e.g., through the highly mobile avifauna). It is more likely that dispersal was achieved as a consequence to human activity, such as transport in sod, nursery crops, or right-of-way mowing equipment. As

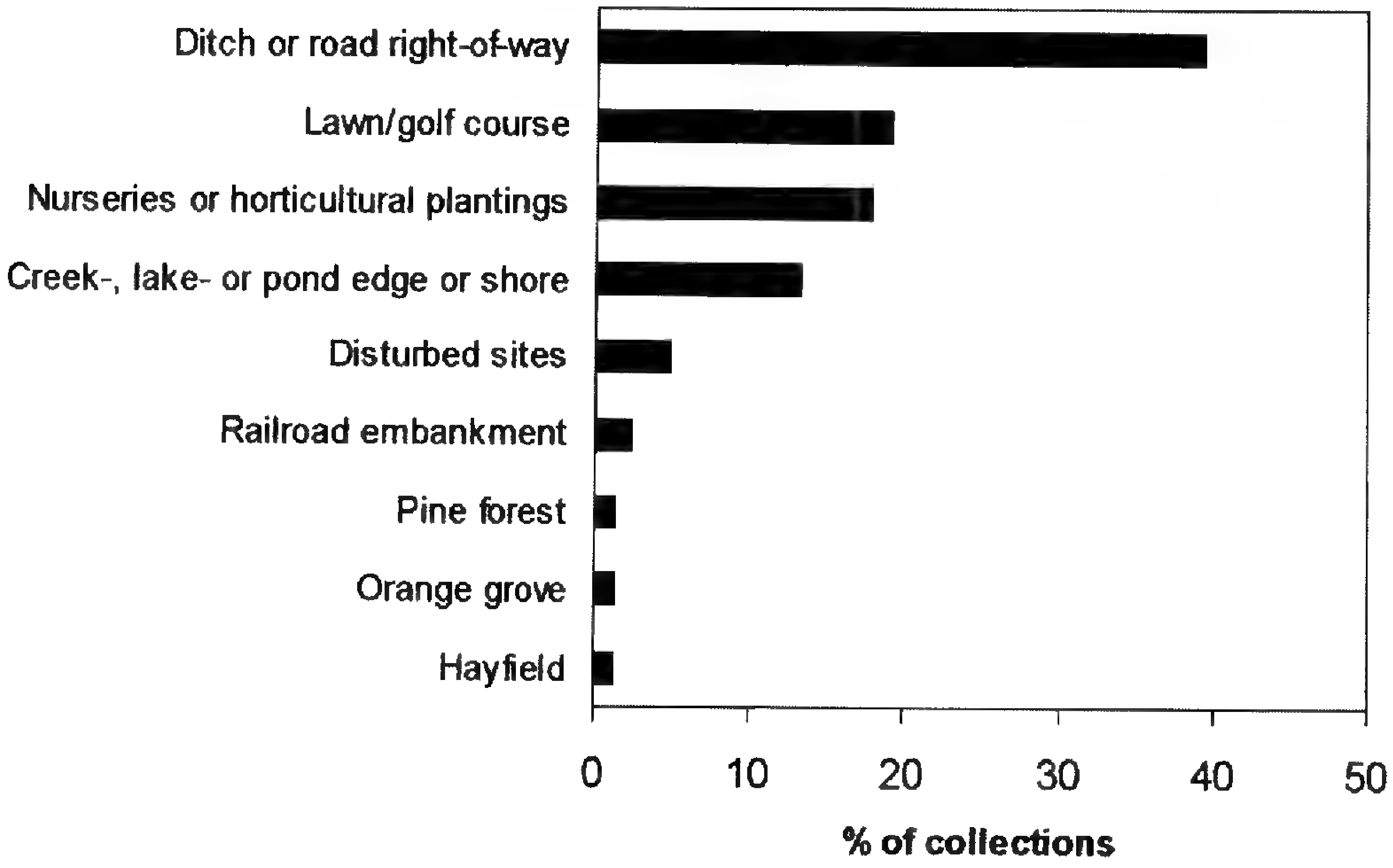

Fig. 2. Habitat class as percentage of collections of *Scutellaria racemosa* Pers. in the southeastern United States.

shown in Fig 2, about 18% of herbaria collections came from nurseries, horticultural plantings, or root balls of nursery crops. The collections from lawns and golf courses (19%), as well as lake or pond shores (13%), also potentially originated from populations established either from the root balls of introduced landscape plants or through the movement of sod. Dispersal based on transport of nursery stock has been previously implicated in the movement of other annual and perennial, rhizomatous weeds in the eastern United States, including *Fatoua villosa* (Thunb.) Nakai (Massey 1975) and *Artemisia vulgaris* L. (Uva et al. 1997).

Encroachment into natural landscapes by *S. racemosa* seems to be limited by degree of human movement and soil moisture. However, the apparent ease and speed of establishment along wet, roadside ditches is of concern as these populations can serve as persistent sources for slower, yet repeated advances into more natural settings. Establishment is facilitated by vegetative reproduction via rhizomes and a capacity to produce flowers and fruits throughout the year. The recently documented North Carolina population (Krings & Neal 2001) was clearly spreading into nursery pots from established plants growing alongside ground tarpons, by sending rhizomes into pots through holes in the bases and tarpons.

In the thirty-five years since its first collection in Alabama, *S. racemosa* has spread into seven states and is to be expected in an eighth—Mississippi. In tropical America, the species is known from Vera Cruz to Valdivia (Epling 1942) and reported from grassy hillsides to damp thickets and stream banks (Leonard

1927). Based on its zonobiomic distribution in South America (Leonard 1927; Epling 1942; Walter 1985), it should subsist at least as far north as Baltimore, Maryland. The potential area of expansion in North America extends from the southern tip of Florida to southern Maryland, westward to western and northern Arkansas, and southward into east Texas. To combat this introduced weed, future studies are needed to evaluate (1) the population biology of *S. racemosa* and its effect on native, wetland vegetation, and (2) the extent of nursery crop infestation.

APPENDIX A

List of exsiccatae of *Scutellaria racemosa* Pers. in the southeastern U.S.

U.S.A. ALABAMA. Baldwin Co.: Sandy gravelly railroad embankment through *Hypericum* pond just N of jct I-10 on Ala. 59 and 6 mi S Stapleton, abundant, 8 Jun 1971, *Kral 43084* (AUA, FLAS, GA, MO, NCU, UNA, USF). **Covington Co.:** LBW Junior College on US Hwy 84 in Andalusia, growing around the edge of the lake on the golf course, full sun, sandy wet soil, T4N, R16E, Sec. 15, 21 Apr 1994, *Diamond 9070* (AUA); Sandy loam of shoulder bypass US 29/84, N side of Andalusia, common in shadier sites, 2 Apr 2000, *Kral 89387* (USCH). **Lee Co.:** In sandy soil in filtered sun under an azalea plant in a flower bed in the Presidents front lawn on the Auburn University Campus, several plants present, all on the root ball of the azalea, 8 Jul 1986, *Diamond 2613* (AUA); Auburn University campus in the Presidents lawn, in a flower bed with azaleas and spreading into the lawn, common weed in the lawn, in full sun and sandy soil, 25 May 1987, *Diamond 3245* (GA); Auburn University campus in the Presidents lawn, in a flower bed with azaleas and spreading into the lawn, common weed in the lawn, in full sun and sandy soil, 25 May 1987, *Diamond 3246* (NCU). **Mobile Co.:** Bienville Blvd, near water tower, sunny, grassy, mod. Moist, infreq. herb., 10 Apr 1965, *Deramus D378* (UNA); Bienville Blvd, near E end, sunny, moist, infrequent, 30 Apr 1967, *Deramus D1063* (GH, UNA). **Pike Co.:** Troy State University Campus, Lake Lagoona, edge of the lake, full sun, wet muck soil, common, T10N, R21E, Sec. 33, 11 May 1993, *Diamond 8615* (AUA). **Tuscaloosa Co.:** Common component of lawn, front (W side) of Biology Bldg, adjacent to Hackberry Lane, Univ. Alabama campus, Tuscaloosa, T/R/S: T21SR10W24, 12 May 1987, *Burckhalter 991* (UNA).

FLORIDA. Baker Co.: Plants trailing, banks of drainage ditch in nursery plots, approximately 4 mi S of MacClenny on Fla 121, 16 May 1975, *Heppner s.n.* (FLAS); 2 mi S of US 90 on CR 123, on left at end of CR 123, in hayfield, common, cows will not graze, 28 Apr 1992, *Harvey s.n.* (FLAS). **Calhoun Co.:** Locally abundant on spoil bank across floodplain, right-of-way paralleling highway bridge over Chipola River, S of Blountstown, 21 Jun 1982, *Godfrey 79877* (FSU). **Escambia Co.:** Pensacola, common, sandy loam soil, low moist weedy grassy place, alongside fence of Main St. sewage treatment plant, E side of Donelson St., N of Main St., 4 Apr 1976, *Burkhalter 3669* (FLAS); Pensacola, S of Cedar St., E of Commendencia St., near railroad tracks, soil dark, rich, common in the Pensacola area, particularly so in low moist sites, 12 Jul 1981, *Burkhalter 7819* (FSU); Frequent, lawn weed, Tom Lane Drive, Pensacola, 20 Apr 1989, *Dunavin s.n.* (FLAS). **Gadsden Co.:** Frequent among grasses and sedges of right of way along highway 90 at Lanier Rd, 3 mi SE of Little River bridge, SW1/4 Sec 30, T2N, R2W, 13 May 1987, *Anderson 10507* (FSU). **Gulf Co.:** Mat-forming, in grassy lawn-like place, roadside park, just by Westarm Creek, N edge of Wewahitchka, 24 Apr 1978, *Godfrey 76327* (FSU, GA); On moist slope above cypress pond along Rte. 22, ca. 1.5 mi W of Wewahitchka, flowers pink, 4 May 1982, *Correll & Correll 53923* (NY, USF); N side SR 386, 2.95 mi W from jct with SR 71 (Wewa), damp, peaty sands in roadside ditch adjacent to disturbed pine flatwoods, 6 Jun 1987, *Gholson with Godfrey & Baker 11830* (FLAS, GA); Shallow, broad ditch at edge of fallow field, by Fla. Rd 386, 3 mi from its jct with Fla. Rt 71 S of Wewahitchka, slender plants growing extremely densely, 6 Jun 1987, *Godfrey*

82413 with Gholson & Baker (FSU, GA); Weedy, amongst grasses and sedges in wet roadside depression along Rte 22 (N side), 3.4 mi W of Wewahitchka and Rte 71, 28 May 1991, *Anderson 13425* (FSU). **Indian River Co.:** SW of Feldsmere, orange grove, S7 T31S R37E, 2 Nov 1988, *Mears s.n.* (FLAS, MO, USF). **Jefferson Co.:** Several weedy patches among flowers planted on W side of Jefferson County courthouse, downtown Monticello, 16 Jun 1980, *Nelson 1631* (FSU). **Leon Co.:** In peaty mucky soil, small clearing of cypress swamp, shores of Lake Munson at the Public Boat Landing, plants also extending into a small lawn-mowed area adjacent, 22 April 1974, *Godfrey 73437* (FLAS, FSU, NCU, USF); Small plant (with blueberry bush planted at 3237 Sharer Road last summer) actively spreading into lawn, N side of Tallahassee, 26 Mar 1976, *Anderson 4129* (FSU, NCU, USCH, USF); Small clumps of herbs along hurricane fence behind Florida High School, Tallahassee, 26 Oct 1977, *Nelson 949* (FSU, GA); Plants essentially past flowering; frequently seen along ditch margin just W of Tully Gym, FSU campus, this ditch overflowers its banks nearly every time it rains, 1 Aug 1981, *Nelson 1940* (NCU); In enriched soil of vegetable garden, Tallahassee, 29 Apr 1982, *Godfrey 79702* (MO); Shrubbery bed on the N side of W Tennessee St., North Florida Education Credit Union, 1 Apr 1983, *Leonard 8113* (FSU); Frequent in muddy soil [...] around edge of Lake Ella, just E of N. Monroe St. in Tallahassee, 20 May 1985, *Anderson 8085* (FSU); Common in lawn of low, shaded area along Pensacola St. just W of Dupree St. in Tallahassee, 11 Jun 1986, *Anderson 9535* (FSU); Frequent amongst weedy growth along Sugar Creek near (edge of shopping mall) near Sharer Rd, just N of Hwy 27 in Tallahassee, 13 Apr 1990, *Anderson 12620* (FSU); Lake Jackson in Sunset Park off Old Bainbridge Rd, on a wet bank at the edge of a marsh at the lake, 21 Oct 1992, *Godfrey 84438* (A, NY); In sand of sparse lawn bordering Blountstown Hwy between Tennesee St. and Pensacola St. in Tallahassee, 4 Apr 1995, *Anderson 15412* (FSU, USCH); Elinor Klapp Phipps Park (W of Meridian Rd, N of Tallahassee, T2N, R1W, Sec 35), frequent in disturbed sites bordering open fields of Lake Jackson at edge of hardwoods, S of marker 7, 23 Apr 1996, *Anderson 16264* (FSU). **Nassau Co.:** White Oak Plantation bordering on the St. Mary's River ca. 10 mi NW of Yulee, near Animal Science Building and the nearby ditches, ditch and shady roadbank, 25 Oct 1997, *Wilbur 69802 & Moore* (DUKE); White Oak Plantation bordering on the St. Mary's River ca. 10 mi NW of Yulee, borrow pit along Short-Cut Road near the Perimeter Road in the SW corner, highly disturbed area, erect herb, only clump seen, 28 Oct 1997, *Wilbur 69972 & Moore* (DUKE); White Oak Plantation bordering on the St. Mary's River ca. 10 mi NW of Yulee, in the woods behind the Animal Science Building and along a sandy drainage ditch, 25 Apr 1998, *Wilbur 70456* (DUKE, GA); White Oak Plantation bordering on the St. Mary's River ca. 10 mi NW of Yulee, ditch along the E side of the road that encircles the Necroscopy-Biodiversity Building, abundant in shallow ditch, 25 Apr 1998, *Wilbur 70482 & Wilbur* (DUKE, GA); White Oak Plantation bordering on the St. Mary's River ca. 10 mi NW of Yulee, disturbed sites near the Necroscopy Building and the slopes W of the road on the western side E of Spare Lake, 25 Apr 1998, *Wilbur 70517* (DUKE); White Oak Plantation bordering on the St. Mary's River ca. 10 mi NW of Yulee, borrow pit near the South Boundary, abundant, 29 Apr 1998, *Wilbur 70716 & Wilbur* (DUKE, USCH). **Orange Co.:** Soil wet, organic, common, weed in fernery at 2810 Union St., Zellwood, 23 Jun 1990, *Boone s.n.* (FLAS). **Santa Rosa Co.:** Wayside Park, S side I-10, E side Escambia Bay, near Pensacola, sandy-loam soil, which was probably hauled in, 16 Sep 1977, *Gholson 6681* (FSU); Milton, between bowling alley and Odom Fiberglass (2944 Avalon Blvd) on Santa Monica St., E at end of road near Avalon Blvd, in landscape, frequent, invasive, this plant is vigorous, spreads easily, competes with shrub plantings, 14 Jun 1994, *Hockett s.n.* (FLAS). **Volusia Co.:** Weedy patch within *Canna* planting, median of Willow Run Dr, Port Orange, 27 Nov 1987, *Nelson 6273 with Wnek* (USCH). **Walton Co.:** Among shrubbery, 4 mi S of Freeport, 25 May 1971, *Davis 15823* (FLAS).

GEORGIA. **Chatham Co.:** Top of bank on drainage ditch in open low flats of Savannah River, just E of Savannah, 22 Apr 1978, *Duncan 30489* (GA); Dense colonies in depressions, Hunter Nursery, Old Louisville Rd, uncommon, 20 Sep 1979, *Duncan 30622* (GA). **Colquitt Co.:** Moist bank of roadside ditch, 6 mi S of Moultrie, by US Rt 319, 30 Apr 1978, *Godfrey 76344* (FSU). **Cook Co.:** 1 mi W of I 75 on S.R. 37, growing on roadside between pavement and wet ditch, 14 May 1991, *Mears s.n.* (USF).

Grady Co.: In alluvial mud of ditch, at roadside at Barnett's Creek, by US Rt 84, E of Cairo, 28 Apr 1980, *Godfrey 77747* (FSU); Roadside embankment, along US #84, ca. 5 mi E of Cairo, 11 Apr 1994, *Henderson 94-76* (MO); Low roadside, along GA #111, ca. 1 mi S of Reno, 20 Aug 1994, *Henderson 94-850* (MO). **Liberty Co.:** Ft. Stewart Military Reservation, Training Area D-3, Grid Coor. 385278, 100m SE of jct FS 38 and FS 40, loamy soil on bank of Mill Creek (channelized), locally common, 25 Aug 1992, *Carter 10403 & Lusk* (GA). **Lowndes Co.:** Weedy area along Two Mile Creek in McKey Park between N. Patterson and N. Oak Streets in Valdosta. Coastal Plain Province, 15 May 1980, *Faircloth 8455* (FSU, GA, NCU); US Hwy 84, 2.1 mi E of the Brooks Co. line, on the S side of the road, roadside, abundant, moist sandy ditch in full sun, 22 May 1988, *Diamond 4801* (AUA). **Muscogee Co.:** Columbus, 6219 Windsor Dr, Bermuda grass lawn, full sun, sandy loam soil, 2 Oct 1987, *Brantley s.n.* (GA). **Sumter Co.:** Locally fairly common on ditchbank on W side of Brady Rd, just N of jct Bone Rd, ca 3 (air) mi SE of Americus, Sumter Co., elev. ca 350 ft., main soil herecas is Irvington sandy loam (now moist to wet), near fencerow of chinaberry, opposite cow pasture and farm pond, Repl. 6 (Pollen Sample No. 111), 2 May 1997, *Norris 6829* (GA). **Thomas Co.:** In shallow water of drainage ditch at side of road and just outside of fence of pasture, just inside city limits of Thomasville (to W), by US Rte 84, 13 Apr 1984, *Godfrey 81178 with Gholson* (FSU).

LOUISIANA. **Allen Parish:** Infrequent in pine forest off US 165, ca. 2 mi N of Oberlin, 6 May 1982, *Allen 11947* (FSU). **East Baton Rouge Parish:** Along Christian St. at Hollydale Town Houses and at Perkins Road and I-10 overpass in Baton Rouge, 5 Nov 1993, *Thomas 138578* (NY). **Lincoln Parish:** Ditchbank at a nursery on the S side of US Hwy 80, 1.2 mi E of Louisiana Hwy 33, just outside the eastern edge of Ruston city limits, sandy loam, common, 28 Apr 1988, *Boyd & Boyd 3095* (LSU). **Livingston Parish:** Roadside ditch along eastbound I.H. 12, 2.3 mi W of LA 43 exit, W of Hammond, 3 May 1989, *Urbatsch 5445 with Cox* (LSU); common along roadside of local rd at jct with I-12, Satsuma, LA, 16 Sep 1996, *Montz 8323* (LSU); common in rear of yard at 25088 Hwy 42, Holden, LA, ca. 3 mi W of junction of Hwy 42 and Hwy 43, 2 Jul 1998, *Montz 8894* (NO). **Ouachita Parish:** Large population between edge of road and end of culvert on first canal N of the entrance to Chennault Park E of Monroe, 29 May 1997, *Thomas 154251 with Gabel* (GA, NO, NY, USCH). **Saint Charles Parish:** Bonnet Carre Spillway, rare only 3 plants noted and 2 collected, N of Hwy 61 near E guide levee at old Recreation facility, 9 Dec 1995, *Montz 8098* (LSU). **Saint Tammany Parish:** Interstate 12 at the E bound rest area near Covington at the Tchefuncte River, 13 May 1999, *Alford 1967 with McDaniel* (DUKE). **Tangipahoa Parish:** Southeastern Louisiana State University campus, common along Columbus Dr near University Center, Hammond, LA, 9 Apr 1994, *Montz 6607* (LSU, NO); Southeastern Louisiana University campus, locally common only in this area near Physical Plant & Services Shops along N Oak St., Hammond, LA, 28 Jan 1995, *Montz 7338* (LSU, NO); Southeastern Louisiana University campus, infrequent at Horticulture Complex along N Oak St., Hammond, LA, 8 Apr 1997, *Montz 8607* (LSU, NO).

NORTH CAROLINA. Chatham Co.: Specimen from potted plant collected 4 Dec 1998 from 2925 NC Hwy 751 and grown in North Carolina State University greenhouse by Joseph Neal, 1 Dec 2000, *Krings & Neal 365* (NCSC); 2925 NC Hwy 751; From fertilized pots of shrubs kept in enclosed greenhouse space and receiving regular irrigation, 6 Dec 2000, *Krings & Neal 366* (BHO, NCSC, USCH).

SOUTH CAROLINA. Charleston Co.: Jenkins Nursery, Rt. 17-S, Charleston, submitted by Joanna Hubbard for ID (Dept. Horticulture, Clemson University), weed in boxwood pots and established in ditches and nursery, first seen 3 years ago, probably came in from Florida, 2 Feb 1989, *Hill 20176* (GH, MO, NY, USF). **Jasper Co.:** Ditch near US 17A, Savannah Wildlife Refuge, 1 mi NW of SC 170 jct, 20 Apr 1974, *Radford 46268* (FLAS, FSU, GA, GH, NCU, NY, USCH, USF). **Richland Co.:** Moist lawn, 6221 Monticello Road, Columbia, Aug 1977, *Rayner 1013* (USCH); Blossom St. side of Hardees, opposite Coliseum, Columbia, fairly abundant, sprawling and/or intertwined within branches of low shrubbery, 10 Dec 1992, *Nelson 13693* (USCH); Commonly matted and tangled together in some abundance on wet, grassy ground, 1900'WSW of Paton Stadium, 1st Brigade Training Site (Black Lions), ca. 5 mi E of downtown Columbia, elev. 225', 11 Jun 1999, *Nelson 20591* (USCH). **Sumter Co.:** Shaw Air

Force Base, Sumter, very abundant and tangled together on wet sandy ground with *Cyperus sesquiflorus* at edge of northernmost of three golf course ponds, along causeway end of the pond, 20 July 1994, *Nelson 15753* (GH, USCH).

TEXAS. Liberty Co.: Wet ditch along Hwy 321 105 ca. 3 mi E of Cleveland, 23 May 1987, *Brown 11136* (TEX). **Montgomery Co.:** New Covey, in wet ditch immediately across from entrance to Lake Houston State Park, 9 Dec 2000, *Krings 371* (NCSC, TEX, TAMU).

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BOOK REVIEW

MARY F. IRISH. 2000. **Gardening in the Desert: A Guide to Plant Selection & Care.** (ISBN 0-8165-2057-7, pbk.). The University of Arizona Press, 355 S. Euclid Ave, Suite 103, Tucson, AZ 85719. (Orders: www.uapress.arizona.edu, 520-621-1441, 520-621-8899 fax). $17.95, 210 pp, 20 halftones, 6" × 9".

Gardening in the Desert is an excellent book for anyone interested in desert gardening. It provides a starting point for anyone who has never encountered some of the unique challenges of desert gardening and landscaping. This book could not be more timely for an area of the United States that has experience rapid population growth followed by a significant increase in demand on natural resources. Water is at a premium in low desert environments and utilizing plants adapted to dry habitats should be near the top of desert inhabitants' conservation priorities.

The book is divided into 11 chapters, beginning with conditions of desert gardening. This first chapter addresses the seasons of the low deserts of the Southwest, soil content and texture, as well as annual precipitation and water supplementation in desert gardens. Subsequent chapters are arranged according to general growth form: trees, desert palms, shrubs, perennials, wildflowers and other annuals, vines, cacti, agaves, other succulents, and distinctive desert plants. Each chapter begins with pertinent information on the growth form. The chapter on wildflowers and other annuals, for example, opens with recommendations on propagating annuals, suggests soil amendments and advises on proper seed collection. After a short introduction, each chapter lists a myriad of suggested species to include in your garden. Each plant that is listed includes common and Latin names, a short description of the plant including height, flower color and phenology, information on water and soil requirements, as well as pruning advice for woody plants and other perennials. In the woody plants chapter, proper placement of tall or vigorous growth forms is also stressed.

Several chapters in particular would be useful to novice desert gardeners. The chapter on cacti seems especially practical. Within the chapter is information on how to properly transplant cacti, how and when to water cacti, and how to avoid frost damage in susceptible species. Numerous examples of native *Opuntia* are mentioned in the book, but sadly the author mentions only *Mammillaria* and *Coryphantha* in passing and has no specific suggestions for planting. This is unfortunate since members of these two genera are aesthetically pleasing and lack the glochidia which make *Opuntia* gardening potentially painful. The chapter on agaves is noteworthy because a short horticultural history is provided to enlighten the reader on their ethnobotanical heritage. In the last chapter, the author discusses unusual plants that do not readily fit into a general growth form. These include ocotillos, hesperaloes, and yuccas, among others. A preventative approach to pest and disease control is stressed throughout the book, thus decreasing the need for toxic pesticides.

Although twenty figures provided in this book, they are black and white. The black and white photos of different garden settings do little justice to the plants that thrive in desert environments. Color figures would have greatly enhanced the book and would have provided further evidence of the natural beauty of these dry landscapes. Although the author stresses the importance of choosing garden plants wisely, it cannot be overstated that great care should be taken when planting exotic species. Many non-natives from Africa, Australia, and the Mediterranean, including *Senna artemesiodes* and *Dimorphotheca sinuata* mentioned in the book, can become pests in a matter of a few growing seasons and these escapees diminish habitat for the native flora. There are numerous native choices that should be considered first before planting exotics in any desert garden.

All in all, this is a valuable book for anyone interested in desert gardening and landscape practices. Irish's anecdotal writing style makes reading this book both educational and entertaining. The book provides her experience and opinions regarding desert gardening and these words of wisdom would be most useful to amateur and master gardeners alike. It would make a suitable addition to any desert gardener's library.—*Amy Trauth Nare, Fort Worth, TX, U.S.A., amy trauth@yahoo.com.*

CAESALPINIA BONDUC (FABACEAE) NEW TO LOUISIANA

William G. Vermillion

U.S. Fish and Wildlife Service
646 Cajundome Blvd., Suite 400
Lafayette, LA 70506, U.S.A.

A recent collection of *Caesalpinia bonduc* (L.) Roxb., a sea bean, from a coastal barrier island in Lafourche Parish, southeastern Louisiana, is apparently the first record for the state. On 27 April 2001, material of *C. bonduc* was collected on the western end of East Timbalier Island, a barrier island bordering Timbalier Bay. The plant was growing adjacent to an interior canal bordered by a low levee of rocks (riprap). At the time of collection the plants had mature dehiscing fruits, with gray seeds, but no flowers. Identification of the plant was verified by comparison with specimens from Florida at LAF. I also saw the species at another location in lower Lafourche Parish on 5 April 2001, but no specimen collected. The plant was on a canal bank approximately 0.6 miles east of Louisiana Highway 1, ca. 1.4 miles south-south east of the La. Hwy. 1 bridge over Bayou Lafourche at Leeville, and ca. 1 mile northeast of the heliport located between La. Hwy. 1 and Bayou Lafourche, south of the Leeville bridge. The latitude and longitude, recorded with a hand-held global positioning unit, is latitude 29º13'36.87, longitude 90º12'08.77 (Fig. 1).

The species is not shown for Louisiana by Isely (1990), Thomas and Allen (1998), or the USDA, NRCS database (2001). Prior to its find in Louisiana, it was known in North America north of Mexico only from central and southern peninsular Florida (Wunderlin 1998). It ranges widely around the tropics and subtropics of the world. A voucher specimen has been deposited at LAF, with a duplicate at NLU.

Voucher specimen: **LOUISIANA. Lafourche Parish:** Sprawling over riprap bordering canal on interior of west end of East Timbalier Island, a coastal barrier island, forming a somewhat elongate colony ca. 10 m long, 27 Apr 2001, *Vermillion s.n.* (LAF, NLU).

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Fig. 1. *Caesalpinia bonduc* locations in Lafourche Parish, Louisiana.

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HOUSTONIA LONGIFOLIA (RUBIACEAE): NEWLY DOCUMENTED FOR THE FLORA OF TEXAS

Jason R. Singhurst
Wildlife Diversity Program
Texas Parks and Wildlife Department
Austin, TX 78704, U.S.A.
Jason.singhurst@tpwd.state.tx.us

W.C. Holmes
Department of Biology
Baylor University
Waco, Texas 76798-7388, U.S.A.
walter_holmes@baylor.edu

ABSTRACT

Houstonia longifolia Gaertn. (Rubiaceae) is reported as new to Texas.

RESUMEN

Houstonia longifolia Gaertn. (Rubiaceae) se cita como nueva de Texas.

Houstonia longifolia Gaertn. var. *tenuifolia* (Nutt.) A. Wood was included in the checklist of the vascular plants of Texas by Jones et al. (1997). Its inclusion appears based upon the citation by Hatch et al. (1990) of *Hedyotis nuttalliana* Fosberg as occurring in the Pineywoods, Gulf Prairies and Marshes, Cross Timbers and Prairies, and Edwards Plateau vegetational areas of the state. In a monograph of the genus, Terrell (1996) treats both *Houstonia longifolia* var. *tenuifolia* (Nutt.) A. Wood and *Hedyotis nuttalliana* as synonyms of *Houstonia longifolia*. He further comments (p. 67) that *Houstonia longifolia* is "quite variable and wide ranging, and by far the most difficult species in the genus." Ultimately he concludes that the only reasonable taxonomic solution is not to recognize varieties or subspecies. Instead, Terrell recognizes "population groups." The "Ozark-Ouachita Group" of *Houstonia longifolia* is known from southeast Oklahoma and southwest Arkansas, barely 20 km north of Texas. The "Tenuifolia Group" (formerly *H. longifolia* var. *tenuifolia*) is restricted, according to Terrell, to west Florida and central Alabama northeastward to Virginia and West Virginia.

The plant referred to by Jones et al. (1997) and Hatch et al. (1990) is, under Terrell's (1996) classification, *Houstonia longifolia*, however, this species has not previously been found in Texas (Terrell 1996). At this time the identity of the plant or plants referred to by Hatch et al. (1990) and Jones et al. (1997) is not clear, but is most likely *Stenaria nigricans* (Lam.) Terrell var. *nigricans* a species widely distributed in Texas. The collection is the first validation of *Houstonia longifolia* from Texas.

Specimens cited: **TEXAS. Red River Co.:** W side of Tanyard Creek, 0.6 mi NE of Woodland Cemetery, 1.2 mi NE of Woodland at jct. of Hwy 195 and Hwy 410, 19 May 1999, *Singhurst 7902* (BAYLU, TEX, US).

The specimens were collected from a thinly wooded hardwood forest dominated

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by *Quercus alba* L., *Q. shumardii* Buckl., *Q. muhlenbergii* Englem. (Fagaceae), *Carya tomentosa* (Poir.) Nutt. (Juglandaceae), and a few scattered trees of *Acer saccharinum* L. (Aceraceae). The site is characterized by an 8–20% slope with a sparceness of vegetation. Isolated clumps of *Houstonia longifolia* were growing on a steep bluff overhang above Tanyard Creek and among sandstone outcrops on the slope.

Houstonia longifolia is a perennial, sometimes with a basal rosette during flowering, and a height of up to 45 cm. Other than *H. purpurea*, all east Texas *Houstonia* species are annual, lack basal rosettes at flowering, and are of considerably shorter height (up to 15 cm, but generally less than 10 cm). *Houstonia purpurea*, known in Texas only from Newton Co. (Terrell 1996), while similar to *H. longifolia*, is distinguished by it broader median cauline leaves. A similar species is *Houstonia ouachitana* (E.B.Smith) Terrell of southwest Arkansas and southeast Oklahoma. That species is distinguished by the densely pilose hairs on the inner surfaces of the corolla. These hairs are 0.5–1.2(–1.8) mm, while the inner corolla surfaces of *Houstonia longifolia* are glabrous or with hairs less than 0.5 mm long (Terrell 1996).

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NEW RECORDS IN *PSEUDOGNAPHALIUM* (ASTERACEAE: GNAPHALIEAE) FOR THE UNITED STATES

G.L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, TX 76102-4060, U.S.A.

ABSTRACT

State and national distribution records are reported for species of *Pseudognaphalium*. New for the U.S.A. are *P. jaliscense* (Arizona, California, Colorado, New Mexico, and Texas) and *P. attenuatum* (Hawaii). *Pseudognaphalium arizonicum* is first reported for Texas, and the nearly cosmopolitan weed *P. luteoalbum* is reported for Texas and New Mexico. An early collection for *P. stramineum* in New York, apparently as a waif in Manhattan, is cited. A brief characterization is provided for each species, specimens are cited, and a lectotype is chosen for *P. jaliscense*. A record of the occurrence of *P. helleri* in Indiana is incorrect, based on a collection of *P. macounii*.

RESUMEN

Se citan los registros de distribución estatal y nacional de las especies de *Pseudognaphalium*. Son nuevas para U.S.A. *P. jaliscense* (Arizona, California, Colorado, Nuevo México, y Texas) y *P. attenuatum* (Hawaii). *Pseudognaphalium arizonicum* es citado por primera vez para Texas, y la mala hierba casi cosmopolita *P. luteoalbum* se cita para Texas y Nuevo México. Se cita una colección previa de *P. stramineum* en Nueva York, aparentemente como abandonada en Manhattan. Se ofrece una breve caracterización de cada especie, se citan especímenes, y se escoge un lectotipo para *P. jaliscense*. Una cita de la presencia de *P. helleri* en Indiana es incorrecta, y está basada en una colecta de *P. macounii*.

In connection with taxonomic studies of Gnaphalieae of Central America, Mexico, and the United States, various new distribution records have come to light for the United States. First reports for *Pseudognaphalium* species are documented here.

Pseudognaphalium arizonicum (A. Gray) A. Anderb., Opera Bot. 104:147. 1991. *Gnaphalium arizonicum* A. Gray, Proc. Amer. Acad. Arts 19:3. 1883. TYPE: UNITED STATES. ARIZONA. [Cochise Co.], Huachuca Mts., "near Fort Huachuca, along exsiccated beds of streams," [1882,] *J.G. Lemmon 2547* (probable type: GH!).

Plants annual to short-lived perennial herbs from a slender, lignescent taproot. *Stems* 2–5 cm tall, loosely but densely woolly-tomentose, the hairs from thick, viscid-appearing, persistent bases, commonly with reddish or purplish crosswalls or segments, eglandular. *Leaves* ascending, linear-oblanceolate to linear-lanceolate, 2–6 cm long, 3–7 mm wide, prominently decurrent, not basally ampliate, tomentose above and beneath, weakly or not at all bicolored, vestiture like the stems. *Capitulescence* diffuse-corymboid or of only a few tight clusters. *Capitula* 4.5–5 mm high; phyllaries usually brownish to tawny, rarely slightly rosy, shiny, narrowly triangular-acute, subequal. *Pistillate florets* (25–)30–49(–67 in southwestern Mexico). *Bisexual florets* (1–)3–6(–10 in southwestern Mexico). *Cypselae* longitudinally ridged, densely and minutely papillate.

Specimens examined. **UNITED STATES. TEXAS. Brewster Co.:** Chisos Mts.: Boot Creek area, 8 Sep 1933, *Wolff 4609* (BRIT); Emory Peak, 14 Aug 1931, *Mueller 32020* (GH, TEX); Boot Spring, 22 Aug 1931, *Mueller 8208 09* (GH); Big Bend Natl. Park, N branch of Cattail Canyon, igneous soil, 6500 ft, 7 Oct 1967, *Warnock 21281* (SRSC); along trail to South Rim above Boot Springs, 6500 ft, sparse in igneous soil, 10 Sep 1950, *Warnock 9788* (SRSC). **Jeff Davis Co.:** Davis Mts.: Mt. Livermore, 29 Sep 1935, *Hinckley s.n.* (GH, TEX); 6.8 mi N on road to Davis Mountain Resort on Tomahawk Trail, which starts at Hwy 166, 11.0 mi W of Hwy 17, 15 Sep 1991, *Sherman, Noyes, and Brant 194* (MO); upper spring in Madera Canyon on Mt. Livermore, 7500 ft, 11 Sep 1947, *Warnock and Hinckley 7408* (SRSC). **No county specified:** "expedition from western Texas to El Paso, New Mexico," May–Oct 1849, *Wright 398* (GH) and *Wright 395[1053]* (GH).

Pseudognaphalium arizonicum is widespread in Mexico (from Chiapas northward through Veracruz and Michoacan to Nuevo Leon and Chihuahua) and has been previously known in the U.S.A. only from Arizona (Cochise, Pima, and Pinal counties). It has been collected in a wide range of habitats, from agricultural land to oak and pine woodlands above 1600 meters elevation. It is superficially similar in its narrow, non-bicolorous leaves to *Pseudognaphalium stramineum* (Kunth) A. Anderb., but the latter has mostly non-decurrent leaves, light yellowish, ovate to obovate phyllaries, and (75–)160–200 pistillate florets and (9–)16–28 bisexual florets.

Pseudognaphalium attenuatum (DC.) A. Anderb., Opera Bot. 104:147. 1991. *Gnaphalium attenuatum* DC., Prodr. 6:228. 1838. TYPE: MEXICO: "In Mexico circa Tampico de Tamaulipas," *Berlandier 70* (G-DC fiche!).

Plants annual herbs, taprooted. *Stems* 4–15 dm tall, persistently and closely white-tomentose, eglandular. *Leaves* narrowly elliptic to lanceolate, (3–)4–9(–12) cm long, 5–10(–13) mm wide, usually long-tapering on both ends, sessile, not at all clasping or decurrent, strongly bicolored, glabrescent above and often shiny, eglandular but often appearing roughened with persistent, thick, gland-like trichome bases. *Capitulescences* compactly to diffusely corymboid to rounded-paniculate. *Capitula* 5–6 mm high; phyllaries tawny-whitish, very rarely pinkish. *Pistillate florets* 35–41 (Michoacan westward) or 49–59 (Edo. Mexico, Veracruz, and southward). *Bisexual florets* 2–4 (Michoacan westward) or 5–8 (Edo. Mexico, Veracruz, and southward). *Cypselae* with 4–8 shallow, longitudinal ridges, not papillate.

Specimens examined. **UNITED STATES. HAWAII.** [**Hawaii Co.:**] near Kohala Blvd., makai of Belt Road, Kahuku, Kau, ubiquitous at 1500 ft in small, sterile kipuka, 10 Jan 1981, *O. & I. Degener 35,082* (GH, MO, SMU, TEX).

Pseudognaphalium attenuatum is widespread in the southern half of Mexico and through most of Central America; it also occurs in the West Indies (at least in Cuba, Puerto Rico, and Jamaica). Over this range, it occurs at elevations of

60–2200 meters in fields, secondary vegetation, woodlands of oak, oak-pine, and pine, and sometimes in subtropical forests. *Pseudognaphalium* in Hawaii has previously been reported only as *P. sandwicensium* (Gaud.) A. Anderb. (Wagner et al. 1990; Wagner et al. 1997).

Pseudognaphalium jaliscense (Greenm.) A. Anderb., Opera Bot. 104:147. 1991. *Gnaphalium jaliscense* Greenm., Proc. Amer. Acad. Arts 39:96. 1903. TYPE: MEXICO. JALISCO: Gravelly soil near Guadalajara, 9 Aug 1902, *C.G. Pringle 8628* (LECTOTYPE, designated here: GH!; ISOLECTOTYPES: CAS, F!, LL!, MO!, NY, PH!). Greenman also cited *Palmer 256* (GH!, US!) from near Guadalajara, Jalisco.

Plants annual or biennial herbs, taprooted. *Stems* 3–7 dm tall, unbranched until the capitulescence, densely and persistently loosely woolly-tomentose-sericeous, eglandular to sparsely glandular. *Leaves* narrowly lanceolate to nearly linear, 3–10 cm × 3–6 mm, not auriculate-clasping, decurrent 4–8 mm, concolorous, closely sericeous-tomentose on both surfaces, the hairs arising from a thickened, gland-like base, sessile-glandular but the glandularity obscured by the dense vestiture. *Capitulescences* diffuse-corymboid or of a few tight clusters. *Capitula* 5–6 mm high; phyllaries opaque-white, strongly graduated, the apex keeled-apiculate. *Pistillate florets* (80– in U.S.A.)(100–)138–180. *Bisexual florets* (9– in U.S.A.)(12–)14–22(–30). *Cypselae* weakly 4(–6)-ridged, minutely but prominently papillate.

Specimens examined. UNITED STATES. **ARIZONA**. **Cochise Co.:** Huachuca Mts., plain near Ft. Huachuca, 23 Oct 1926, *Peebles et al. 34484* [or 3484 fide ARIZ sheet] (ARIZ, LL); Chiricahua Mts., Sep 1882, *Lemmon s.n.* (US, WIS). **Gila Co.:** Pine, 7000 ft, 15 Aug 1937, *Darrow s.n.* (ARIZ- 2 sheets). **Graham Co.:** eastern foothills of the Galiuro Mts., ca 3.5 mi from end of High Springs Rd, and on foot into hills; oak-pine-juniper woodland with grassy areas and patches of manzanita-dominated chaparral, 30 Sep 1989, *Keil 21259* (ASU). **Navajo Co.:** Navajo Co., along Hwy 60 at Forestdale, 16 Aug 1966, *Caldwell 66262* (ARIZ); immediately W of Forestdale, pine-juniper-oak woods, 6200 ft, 29 Aug 1971, *Bohrer 1536b* (ARIZ); 1 mi NE of Forestdale Trading Post, 6000 ft, ponderosa zone, 19 Sep 1975, *Pinkava, Keil, and Lehto L19023* (ASU). **Pima Co.:** Santa Catalina Mts., 14 Apr 1881, *Pringle 311* (GH); Rozemont, Santa Rita Mountains, 2 Sep 1905, *Thornber s.n.* (ARIZ). **Santa Cruz Co.:** Sonoita, 6 Sep 1940, *Benson 10422* (LL, MO); The Bog Hole, Meadow Valley, headwaters of the Santa Cruz River, 1530-1540 m, 26 Aug 1976, *Van Devender and McCarten s.n.* (ARIZ). **CALIFORNIA. Del Norte Co.:** Hazelview Summit in Crescent City, Grants Pass Road, 24 Jul 1928, *Kildale 5813* (LL). **Marin Co.:** Tomales Point, 5 mi from Inverness, grassy coastal slopes, 300 ft, 23 Jul 1939, *Gould 852* (SMU). **Mendocino Co.:** near Point Arena Light, coastal prairie, 27 Jul 1949, *Whitehouse 21713* (SMU). **COLORADO. Jefferson Co.:** Clear Creek Junction, dry open soil, 1590 m, 11 Sep 1920, *Clokey 3943* (US). **NEW MEXICO. Grant Co.:** hills around the copper mines, [near Santa Rita, ca. 1–5 Aug], 1851, *Wright 1283* (GH); Pinos Altos Mts., 8 Sep 1880, *Greene s.n.* (US); Santa Rita del Cobre, 24 Sep 1880, *Greene 460* (GH). **Lincoln Co.:** Lincoln Natl. Forest, Smokey Bear R.D., FR 120, grama-juniper flat, 6900 ft, 10 Sep 1990, *Pase 3575* (NMC); White Mts., 25 Aug 1907, *Wooton and Standley s.n.* (NMC); White Mts., Gilmore Ranch, 11 Aug 1897, *Wooton s.n.* (NMC). **Mora Co.**: Watrous, 27 Aug 1926, *Arsene and Benedict 17488* (LL); Rio de las Casas, 28 Jul 1927, *Arsene 19159* (LL); Canyon Colorado Equid Sanctuary, 24 mi NE of Wagon Mound, open plain, 6020 ft, 27 Sep 1990, *Smith 158* (NMC). **San Miguel Co.:** Vicinity of Las Vegas (8 mi SE), 1950 m, 2 Sep 1926, *Arsene 17373* (MO); Las Vegas, 2 Oct 1926, *Arsene 17875* (LL). **No county specified:** N. Mex., 1851–1852, *Wright 1283* (GH) and *Wright 1284* (GH), mounted on the same sheet. **TEXAS.**

Brewster Co.: Glass Mts., Iron Mountain, 20 Aug 1940, *Warnock W219* (ARIZ, SRSC, TEX); Glass Mts., abundant locally in upper Green Valley, 18 Sep 1940, *Warnock W218* (GH). **Jeff Davis Co.:** Davis Mts., Chitense Spring, 7 Sep 1918, *Young s.n.* (GH, MO).

Pseudognaphalium jaliscense is relatively common from southwestern to northern Mexico (Nayarit, Jalisco, Sonora, Chihuahua, Coahuila, and Nuevo León) into localities in the southwestern United States. In Mexico, it has been collected along roadsides or in disturbed sites, meadows or openings in pine or oak woods. It is recognized by its annual duration, long, narrow leaves with non-clasping, short-decurrent bases and barely bicolored, persistently tomentose-floccose surfaces, large capitula with relatively thick, white, dull-opaque phyllaries, and large numbers of pistillate and bisexual florets. The slightly atypical lower limits for pistillate and bisexual florets reflect counts from several of the U.S.A. collections, but in other features, these plants are correctly identified as *P. jaliscense*.

Pseudognaphalium luteoalbum (L.) Hilliard & Burtt, J. Linn. Soc., Bot. 82:206. 1981. *Gnaphalium luteoalbum* L., Sp. Pl. 2:851. 1753. LECTOYPE (Hilliard & Burtt 1981): Without data, *Herb. van Royen s.n.* (LECTOTYPE: L 900.286-294).

Plants annual, taprooted or fibrous-rooted. *Stems* erect to basally decumbent-ascending, 15–40 cm, simple or with several branches from the base, loosely but persistently white-tomentose, eglandular. *Leaves* basal and cauline, basal narrowly obovate to subspatulate, 1–3(–6) cm × 2–8 mm, becoming smaller upwards and oblanceolate to narrowly oblong or linear, basally rounded to abruptly tapered, subclasping, short-decurrent or not, densely gray-tomentose, often glabrescent adaxially, eglandular. *Capitulescences* usually one to a few tight terminal clusters 1–2.5 cm wide. *Capitula* broadly campanulate, 3–4 mm; phyllaries ovate, silver-gray to yellowish, translucent, glabrous. *Pistillate florets* 140–160. *Bisexual florets* 5–10, red-tipped. *Cypselae* weakly ridged, epidermal surfaces minutely papillate; pappus bristles weakly coherent in an easily fragmented basal ring. $2n = 14$.

Specimens examined. **UNITED STATES. NEW MEXICO. Hidalgo Co.:** Little Hatchet Mts., Playas, S side of town near city buildings in area where water from lawns flows into desert, 4450 ft, alluvial fan of mts., watered area, 31 Aug 1997, *Worthington 27009* (SRSC identified by Worthington as "*Pseudognaphalium* cf. *luteoalbum*" and confirmed as that species by annotation by Turner in 1998). **TEXAS. Kimble Co.:** ca. 2 mi N of IH 10 along Segovia Exit, along perennial creek just N of Johnson Draw, 7 Apr 1999, *Turner 99 83* (SRSC). **El Paso Co.:** Franklin Mts., 1.2 air mi NE from the top of North Franklin Mtn., 0.4 mi NW from Indian Spring, 4900 ft., canyon draining E, granite rock, along flow from spring (seep areas), 23 Apr 1995, *Worthington 24696* (SRSC). **Parker Co.:** Weatherford, Stuart's Nursery on Hwy 180, in pots, spreading to nursery, 24 Jun 2001, *O'Kennon 14991* (BAYLU, BRIT, OKL, TEX).

Pseudognaphalium luteoalbum is previously known in the U.S.A. from Florida, New York, and several western states (California, Nevada, Arizona, Utah, Oregon, and Washington) (Kartesz 1999). It apparently is native to Eurasia and is a nearly cosmopolitan weed, known from Europe, North America (including Mexico), Africa, central and southeast Asia, Australia, New Zealand, and other Pacific regions. It is similar to *P. stramineum* in its annual duration, loosely tomentose vestiture, concolorous, subclasping leaves, and capitula in small tight glomerules mostly 1–2 cm wide at the stem tips but differs in the following contrasts.

1. Florets red-tipped, these tips visible through the translucent phyllaries; capitula 3–4 mm high; bisexual florets 5–10; leaves subclasping, usually slightly rounded at the base, not decurrent ________ **P. luteoalbum**
1. Florets evenly yellowish, not red-tipped; capitula 4–6 mm high; bisexual florets 8–20 in western U.S.A. (19–28 in Mexico); leaves subclasping but not basally rounded, sometimes decurrent 1–2 mm ________ **P. stramineum**

Pseudognaphalium stramineum (Kunth) A. Anderberg, Opera Bot. 104:148. 1991 (15 January); non (Kunth) W.A. Weber 1991 (10 June). *Gnaphalium stramineum* Kunth, Nov. Gen. & Sp. 4 [folio]:66. 1818. TYPE: MEXICO. HIDALGO: Between Morán and Omitlán, [no date], *Humboldt and Bonpland s.n.* (HOLOTYPE: P fiche!).

Gnaphalium chilense Sprengel, Syst. 3:480. 1826.

Plants annual or biennial, taprooted. *Stems* 3–6(–8) dm, simple or several from the base, erect to basally ascending, loosely tomentose, eglandular. *Leaves* linear to narrowly lanceolate, oblanceolate, or oblong, 2–8(–9.5) cm × 2–5(–10) mm, gradually reduced upward, subclasping but not basally ampliate, sometimes slightly decurrrent, concolorous, loosely but persistently gray-tomentose on both surfaces, eglandular. *Capitulescences* 1-few tight terminal clusters 1.5–3 (–4) cm wide. *Capitula* subglobose, 4–6 mm; phyllaries ovate to obovate, hyaline and somewhat translucent, commonly distinctly yellowish with age. *Pistillate florets* 160–200. *Bisexual florets* 8–28, yellowish. *Cypselae* weakly ridged, minutely papillate; pappus bristles separate, not basally coherent. $2n = 28$.

Specimen examined. **UNITED STATES. NEW YORK:** [Manhattan,] ballast filling, at northern terminus of 8th Avenue, N.Y., Jul 1879, *Addison Brown s.n.* (GH).

Pseudognaphalium stramineum perhaps is broadly native from South America through Central America and Mexico to many states of the western United States and British Columbia. In the eastern U.S., it apparently is adventive on the Atlantic coastal plain of Virginia, North Carolina, and South Carolina, where it occurs in sandy fields, flowering May through August. The collection from New York represents a waif, as *P. stramineum* has never been reported by any floristic account of the northeastern United States.

Pseudognaphalium helleri in Indiana

Pseudognaphalium helleri (Britt.) A. Anderb. was reported/ mapped to occur in Indiana by Mahler (1975). This apparently was based on the identification of a GH specimen, annotated by C.A. Weatherford and Wm. F. Mahler as that species:

UNITED STATES. INDIANA. Lagrange Co.: 2 Sep 1923, *Deam 52927* (GH).

This plant, however, has distinctly decurrent leaves and is *Pseudognaphalium* *macounii* (Greene) Kartesz, which is abundant in Indiana. Other collections of *P. macounii* from Lagrange County also are housed at GH.

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ARTHRAXON (POACEAE: ANDROPOGONEAE) NEW TO SOUTH AMERICA

L.J. Dorr

Department of Systematic Biology (Botany), MRC-166
National Museum of Natural History,
Smithsonian Institution
Washington, DC 20560-0166, U.S.A.
dorr.laurence@nmnh.si.edu

S. Miguel Niño

BioCentro
UNELLEZ, Mesa de Cavacas
Portuguesa, VENEZUELA 3323
smiguel@cantv.net

ABSTRACT

Arthraxon hispidus, native to the Old World and adventive in Hawaii, North America, Central America, and the Caribbean, is reported for the first time from South America. The records are from the Andes of Venezuela. Information also is provided on the earliest dates that this species is documented to have appeared in different countries in the New World.

RESUMEN

Arthraxon hispidus, nativa del viejo mundo y adventicia en Hawaii, Norte América, Centro América y el Caribe, se cita por primera vez en Sur América. Los registros son de los Andes de Venezuela. Además se suministra información adicional documentada sobre las fechas más remotas de aparición de esta especie en diferentes países del nuevo mundo.

One of us (SMN) recently collected *Arthraxon hispidus* (Thunb.) Makino var. *hispidus* in Guaramacal National Park in the Andes of Venezuela and a search for additional material revealed that at least two other collections were made nearby in 1986 and 1990 (see voucher specimens). These are the first collections of the genus *Arthraxon* P. Beauv. (Poaceae: Andropogoneae) from South America. The species, *A. hispidus*, which is native to Asia, Africa, and Australia, was previously known to be adventive in Hawaii, North America, Central America, and the Caribbean (van Welzen 1981). *Arthraxon hispidus* thus is now known to occur on all continents except Europe and Antarctica.

The earliest record we can find of *Arthraxon hispidus* in the New World is a collection made in the Japanese Garden on the Centennial Grounds of Fairmount Park, Philadelphia in 1877 (*Burk* s.n., US). The species next was found on ship's ballast in Philadelphia in 1878 (*Scribner* s.n., US) and on ballast in Portland, Oregon about 1901 (*Suksdorf* 5316, US). The label data on a 1903 collection from South Carolina stated that the plant was introduced at Clemson College with seed from Japan (*Newman* s.n., US) and there is a specimen indicating that *A. hispidus* was cultivated by the U.S.D.A. at Arlington Experimental Farm in Virginia by 1906 (*Tidestrom* s.n., US). These herbarium records support the inference that there were multiple introductions of this species into the United States. Irrespective of the source or sources of these introductions, additional specimens in the United States National Herbarium (US) indicate that *A. hispidus* was fairly widely but locally established in North America by the 1920s. When Kiger (1971) evaluated the status of this species in the United States he noted that while the distribution of the species showed only a slight change in the previous 20 years, *A. hispidus* was becoming more firmly established within that range. Subsequent reports (Newbold 1979; Cusick 1986; Brown & Schultz 1991; USDA, NRCS, 2001) reveal that *A. hispidus* is spreading further west and north in the United States and merits concern as an invasive weed.

In tropical America, *Arthraxon hispidus* first appeared in the Caribbean. The earliest collection we can locate was made in Guadeloupe in 1892 (*Duss 2712*, US). The species then was found in Jamaica in 1903 (*Underwood 1195*, NY). A century later it does not seem to have spread to any other island in the Caribbean (Nash 1912; Hitchcock 1936; Adams 1972; Fournet 1978; Gould 1979; all records cited as either the synonym *A. quartinianus* (A. Rich.) Nash or *A. hispidus* var. *quartinianus* (A. Rich.) Roberty). In Central America the first record of *A. hispidus* is a collection (*Weatherwax 171*, US) made in Guatemala in 1932. In 1945 the species was first collected in Mexico, in adjacent Chiapas state (*Hernandez Xolocotzi X-412*, US). *Arthraxon hispidus* was subsequently first recorded in El Salvador by 1960 (Weberling & Lagos cited in Berendsohn & Araniva de González, 1991). In the 1960s it also first appeared in Honduras (*Molina R. 18516*, US), Costa Rica (*Pohl & Davidse 11257*, US), and Nicaragua (*Molina R. 22890*, NY). By 1980, the range of *A. hispidus* had expanded northward in Mexico to include at least one locality in the state of Michoacán (Carvajal Hernández, 1980; cited as *A. quartinianus*) and more recently one in the state of Colima (*Sanders et al. 10373*, MO).

Another species of *Arthraxon*, *A. castratus* (Griff.) V. Naray. ex Bor, was collected in Puerto Rico in 1981 (Hatch 1982). This species appears to be less aggressive than *A. hispidus*, not otherwise being known outside its native range in Asia. Both van Welzen (1981) and Hatch (1982) provided keys that can be used to distinguish the two species of *Arthraxon* that occur as adventives in the New World.

Voucher specimens. **UNITED STATES. Oregon. Multnomah Co.:** raised from young plants collected on ballast at Portland, 22 Jan 1901, *W.N. Suksdorf 5316* (US). **Pennsylvania. Philadelphia Co.:** Japanese Garden, at Centennial Grounds, Phil^{a}, 1877, *I. Burk s.n.* (US); On ship's ballast, Philadelphia, 1878, *F.L. Scribner s.n.* (US). **South Carolina. Pickens Co.:** Clemson College, introduced with seed from Japan, Oct 1903, *C.L. Newman s.n.* (US). **Virginia. Arlington Co.:** cult. Arlington farm, Aug 1906, *I. Tidestrom s.n.* (US). **MEXICO. Chiapas:** from Finca Liquidambar to El Triunfo, ca. 1100–1850 m, 9 Nov 1945, *E. Hernández Xolocotzi X-412* (US). **Colima:** Comala, Rancho El Jabali, 22 km (airline) NNW of Colima (19°26'54"N, 103°4142"W), 1300 m, 7 Jan 1991, *A.C. Sanders et al. 10373* (MO). **GUATEMALA. Quezaltenango:** along rr. in mountains near Santa María, 25 Mar 1932, *P. Weatherwax 171* (US). **HONDURAS. Morazán:** between El Edén and El Rancho, mountain Canta Gallo, 1600 m, 1 Nov 1966, *A. Molina R. 18516* (NY, US). **COSTA RICA. Alajuela:** 4.5 km S of Zarcero, 1670 m, 15 Oct 1968, *R.W. Pohl & G. Davidse 11257* (US). **NICARAGUA. Matagalpa:** vic. El Porvenir, 4 km E of Santa María de

Ostuma, 30 Oct 1968, *A. Molina R. 22890* (NY). **JAMAICA.** Cinchona, 8 Feb 1903, *L.M. Underwood 1195* (NY). **GUADELOUPE.** Environs de Bagatelle, 24 Feb 1892, *Père A. Duss 2712* (NY, US). **VENEZUELA. Portuguesa:** Mpio. Guanare. Caserío "La Montaña" a 4 km NW de Cordoba (approx. 10°24'N, 69°52'W), 1000 m, 11 Dec 1986, *G. Aymard 5109* (PORT). Carretera Chabasquén a Córdoba (9°25'N, 69°55'W), 1200–1500 m, 19 Sep 1990, *G. Aymard et al. 8845* (MO, PORT). **Trujillo:** Mpio. Boconó. Parque Nacional Guaramacal, bosque a los alrededores de la Laguna de Aguas Negras, cerca de Batatal (9°18,382N, 70°10,515W), 1900 m, 23 Sep 2000, *M. Niño et al. 1351* (PORT, US).

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BOOK REVIEW

CORAL G. GUEST. 2001. **Painting Flowers in Watercolour, A Naturalistic Approach.** (ISBN 0-88192-509-8, pbk.), Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. Published in association with The Royal Botanic Gardens, Kew. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $19.95, pbk., 128 pp., 78 color illustrations, 43 color figures, 6 b/w figures, 11 line drawings.

You've heard the expression, *"Gee, I wish I could paint like that!"* or *"Where did you learn to draw like that?"* To many, art is often considered a gift, but it is a gift one must work for. This is why many latent artists never make that first step. They may feel the task too daunting. For those who have always wanted to try painting and in particular, botanical painting, this instructional and inspirational book is the place to start. In *Painting Flowers in Watercolour*, Coral Guest has simplified and organized her techniques so that anyone, whatever their level of expertise, can benefit.

Coral G. Guest is a full-time botanical artist who conducts courses on naturalistic botanical painting for the Royal Botanic Gardens, Kew, and at a number of other venues. Her work has been shown internationally and she has received numerous awards, including a gold metal from the Royal Horticultural Society. She frequently lectures and has written for various magazines.

Coral's techniques in watercolor are impeccably classical and she has painstakingly laid out instructions in a step-by-step way with copious full color visuals and illustrations. Her naturalistic approach helps the novice paint in a systematic but creative way, helping one develop not only technique, but observational skills as well.

Painting Flowers in Watercolour is quite impressive from the get-go with an honorable Foreword by Dr. Shirley Sherwood, noted connoisseur and collector of some of the finest contemporary botanical art in private hands. Dr. Sherwood has collected and commissioned quite a few of Coral's works, in particular, *Lilium longiflorum* which is included as part of the instructional lesson of the book.

The book is divided into two parts. The chapters of Part I are: Equipment, Materials, Plant Material, Work in Progress, The Workspace, The Properties of Watercolour, Watercolour Wash Techniques, Dry Brush Techniques, The Colour Palette, Mixing Greens, The Neutral Tint Mixture, Colour Assessment, Drawing, Composition, The Thumbnail Sketch, Light and the Tonal Sketch, The Colour Study Method.

Part I describes: 1) specific techniques essential to creation of the color and texture of plant surfaces which emphasizes the importance of observational drawing. 2) the purists method of working with transparent watercolor, which utilizes the whiteness of the paper to achieve highlights and pale tints, rather than using white watercolor or opaque white watercolor (gouache). Part II is devoted to: 1) observation of individual flowers in a systematic procedure, applying the methods and techniques described in Part I. 2) specific issues, such as highlight on leaves and various surface textures, are analyzed as they occur. Plants featured are: *Lilium longiflorum, Anemone coronaria, Delphinium, Fritillaria imperialis, Canna, Camellia japonica, Tulipa, Strelitzia reginae*. The last part of the book is devoted to: *Botanical Terms, Bibliography, Suppliers directory* and *Index*.

From this humble artist's point of view, I find it one of the best instructional books on flower painting to date and is finely printed and well designed. I do have a few criticisms, however. There are the odd 'typos' here and there—those kind of pesky typographic errors that the computer's spell check doesn't catch. That is minor stuff of course. More problematic is in the inconsistency of including page numbers within the text when referencing a visual. Occasionally, it is a bit tedious trying to find referenced illustrations and figures without page numbers. Adding a page number as reference to ALL the described visuals in the text would have made a quicker reference for the reader, especially in some of the more involved instructions.—*Linny Heagy, Linny/Designer, Illustrator, Arlington, TX, a0005835@airmail.net*

ANAGALLIS ARVENSIS SUBSP. *FOEMINA* (PRIMULACEAE) NEW TO LOUISIANA

Charles M. Allen, Sara Thames, Phillip Paul

Department of Biology
University of Louisiana at Monroe
Monroe, LA 71209, U.S.A.

Selena Dawn Newman

USDA/NRCS
3737 Government Street
Alexandria, LA 71302, U.S.A.

On a recent outing with the Louisiana Native Plant Society, a blue flowered "scarlet pimpernel" (*Anagallis arvensis* L.) was observed on Fort Polk in Vernon Parish. A search of the literature revealed that scarlet pimpernel can be blue flowered (Correll & Johnston 1970; Diggs et al. 1999; Fernald 1950; Radford et al. 1968). Some of the blue flowered plants are only a color variant while others are separated as subsp. *foemina* (P. Mill.) Schinz & Thellung (Blamey & Grey-Wilson 1989). The leaves of our plants were lanceolate and narrower than the common and scarlet flowered var. *arvensis*. The blue petals were narrower than those of var. *arvensis* and were toothed but glabrous along the margins. Thus, our collection corresponds to subsp. *foemina*, as identified in Blamey and Grey-Wilson (1989). The common name is usually poorman's weathervane or weatherglass. The name is suggested by the closing of the flowers with cloudy conditions associated with inclement weather (Diggs et al. 1999; Fernald 1950). Synonymy for this subspecies includes *A. foemina* P. Mill (Blamey & Grey-Wilson 1989) and *A. arvensis* var. *caerulea* (Schreb.) Gren. & Godr. (Fernald 1950). The plants are annual/biennial and introduced from Europe. Prior to this report, the United States distribution included California, Colorado, Iowa, Kentucky, Maine, Ohio, Pennsylvania, and Vermont (USDA, NRCS 2001).

Voucher specimen: **LOUISIANA. Vernon Parish:** roadside shoulder of LA 467, western border of Fort Polk, ca 4 mi ESE of Leesville Section 34 T2N R8W, 31 Mar 2001, *Allen, Thames, Paul, and Newman 18437* (NLU).

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ALTERNANTHERA SESSILIS (AMARANTHACEAE) NEW TO ARKANSAS

Christopher S. Reid and David X Williams

University of Arkansas Herbarium
Biomass Research Center, Rm. 141
Fayetteville, AR 72701, U.S.A.

Fieldwork for the Arkansas Vascular Flora Project has resulted in the discovery of *Alternanthera sessilis* (L.) R. Br. ex DC. (chaff-weed, sessile joyweed) in Arkansas. This species was collected in Arkansas and Prairie counties, which lie in the Mississippi Alluvial Plain Natural Division of the state. Both occurrences were located in the White River watershed. *Alternanthera sessilis* is not reported for the state by Smith (1988, 1994). It is recorded in five parishes in northeast Louisiana, including East Carroll Parish, which borders Chicot County, Arkansas (Thomas & Allen 1996).

Alternanthera sessilis has a pantropical distribution (Buckingham 1996) and appears on the United States Federal Noxious Weed List (Coile 1996). Further fieldwork is necessary to document the range of this species in Arkansas and to determine its status in the state.

Voucher Specimens: **ARKANSAS. Arkansas Co.:** Abundant on either side of a small backwater inlet (Johnson Bay) on the White River, NE1/4 S13 T2S R3W, growing on mud, associated with *Eragrostis glomerata, Heliotropium procumbens, Leucospora multifida, Rorippa palustris* and *Fimbristylis vahlii*, 8 Aug 2000, *Reid & Williams 1358* (UARK). **Prairie Co.:** Rare on mud around boat ramp at NE access to Peckerwood Lake, NE1/4 S27 T1N R5W, ca 2 mi SSE of Tollville, 8 Oct 2000, *Reid 1965* (UARK).

ACKNOWLEDGMENTS

We wish to thank Kenneth R. Robertson (ILLS) for verifying the identification of duplicate specimens. We would also like to thank the curators of the following herbaria for checking their collections for Arkansas specimens of *A. sessilis*: BRIT, MO, NLU, STAR, and UAM.

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BOOK NOTICES

FREDERICK J. SIMOONS. 1998. **Plants of Life, Plants of Death.** (ISBN 0-299-15904-3, pbk.). University of Wisconsin Press, 2537 Daniels Street, Madison, WI 53718, U.S.A. $34.95, pbk., 568 pp., 1 map, 43 b/w photos, 6" × 9".

Synthesizing evidence from the fields of geography, botany, religion, medicine, folklore, and anthropology, author Frederick J. Simoons has produced a groundbreaking volume that covers plant use shaped by two primary human concerns: life and death. Whether he is debunking the theories of Pythagoras's ban of fava beans or bringing to light the Hindu use of the holy basil plant tulsi, the author has compiled an erudite volume that is both exceptionally written and well researched. Geographically this tome covers the regions from Europe through the Near East to India and China. The author covers subjects such as ritual purity, fertility, good health, impurity, sickness, ill fate, and death in his quest to decipher the historical and ethnographic data on plants of life and death. This edition is profusely illustrated and comes with a bibliography and general index. I would recommend this book to those of us interested in Old World ethnobotany and the perception and use of plants in religious and medical contexts.—*Kevin D. Janni, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A., kjanni@brit.org.*

N.M. NAYAR and T.A. MORE. 1998. **Cucurbits.** (ISBN 1-57808-003-7, hbk.). Science Publishers, Inc., P.O. Box 699, May Street, Enfield, NH 03748, 603-632-7377, 603-632-5611 fax). $75.00, 340 pp.

The Cucurbitaceae or gourd family is what this book is all about. Cucurbits are "of considerable economic importance as a source of vegetables, fruits, edible seeds rich in oil and proteins, edible and industrial seed oils, domestic utensils and drugs." This is a comprehensive book with 17 chapters that cover everything from taxonomy, morphology, embryology, physiology and biochemistry, and production aspects related to improvement and cultivation, plant protection, and to seed production of cucurbits. -*Barney Lipscomb, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

BOOK ANNOUNCEMENT

ROBERT D. DORN. 2001. **Vascular Plants of Wyoming. Third Edition. Illustrations by Jane L. Dorn.** Mountain West Publishing, Cheyenne, Wyoming. Rocky Mountain Herbarium, Department of Botany, University of Wyoming, Laramie, WY 82071-3165, U.S.A., http://www.rmh.uwyo.edu. (Orders: Copies sell for $20.00, shipping included in USA; Wyoming orders add sales tax for your county [4% - $.80, 5% - $1.00, 6% - $1.20]). 412 pp.

Please make checks payable to the Rocky Mountain Herbarium. Questions, contact Ronald L. Hartman, Curator, Rocky Mountain Herbarium: rhartman@uwyo.edu; 307-766-2236; fax 307-766-2851.

VASCULAR PLANTS NEW TO KENTUCKY

J. Richard Abbott

Marie Selby Botanical Gardens
811 South Palm Ave.
Sarasota, FL, 34236-7726 U.S.A.
galearis@yahoo.com

Ralph L. Thompson & Rudy A. Gelis

Herbarium, Biology Department
Berea College
College P.O. 2121
Berea, KY, 40404 U.S.A.
ralph_thompson@berea.edu

ABSTRACT

Fourteen species of vascular plants are reported new to the state of Kentucky, U.S.A. Five of these are European weeds: *Anthoxanthum aristatum*, *Aphanes microcarpa*, *Erysimum hieraciifolium*, *Lathyrus tuberosus*, and *Vicia tetrasperma*. The other nine are native species known from adjacent states and were, thus, not entirely unexpected: *Acalypha deamii*, *Carex austrocaroliniana*, *Centunculus minimus*, *Elymus wiegandii*, *Equisetum × ferrissii*, *Leucothoe fontanesiana*, *Lupinus perennis*, *Polygonum cilinode*, and *Silene nivea*.

RESUMEN

Se presentan 14 especies de plantas vasculares que fueron descubiertas como nuevas para el estado de Kentucky, EE.UU. Cinco de éstas son malezas de Europa: *Anthoxanthum aristatum*, *Aphanes microcarpa*, *Erysimum hieraciifolium*, *Lathyrus tuberosus*, y *Vicia tetrasperma*. Las otras nueve son especies nativas ya conocidas de los estados de alrededor y, por eso, no fueron totalmente inesperadas: *Acalypha deamii*, *Carex austrocaroliniana*, *Centunculus minimus*, *Elymus wiegandii*, *Equisetum × ferrissii*, *Leucothoe fontanesiana*, *Lupinus perennis*, *Polygonum cilinode*, y *Silene nivea*.

DISCUSSION

A recent dissertation (Medley 1993) and a recent book (Browne & Athey 1992) provided lists of the vascular flora of Kentucky and are the comparative basis for our records. We report the following species to make knowledge of their presence available not only to other in-state workers but also to the botanical community at large. Gleason and Cronquist (1991) was used for distributional information outside Kentucky and is the main source of the nomenclature used here. Taxa not present in Gleason and Cronquist were found in Radford et al. (1968). All specimens are deposited at the Berea College Herbarium [BEREA].

Acalypha deamii (Weath.) Ahles (Euphorbiaceae)—Reported in mesic sites from southern Indiana and Ohio to Tennessee and Arkansas. Levin (1999) did not report this species from Kentucky.

Madison Co.: Fort Boonesborough State Park, SW of junction of KY 627 and the Kentucky River, upper riverbank, rare; associates: *Campanula americana*, *Commelina virginica*, *Lobelia siphilitica*, *Stachys* spp., *Teucrium canadense*; 26 Sep 1992, *Abbott 4464*. Verified by John Thieret [KNK].

Anthoxanthum aristatum Boiss. (Poaceae]—Native to Europe; introduced throughout the northeastern United States.

Trigg Co.: Land Between The Lakes, Elk-Bison Prairie, entranceway and the Trace Road, locally frequent; associates: *Andropogon virginicus, Bromus japonicus, Carex hirsutella, Chamaecrista fasciculata, Hedyotis canadensis, Lespedeza cuneata, L. striata, Panicum lanuginosum, Smilax glauca, Solidago canadensis, Tripsacum dactyloides, Vulpia octoflora*; 27 Jun 1998, *Thompson 98-282*. Verified by John Thieret [KNK].

Aphanes microcarpa (Boiss. & Reuter) Rothm. (Rosaceae)—Native to southern Europe. In United States from Long Island to Alabama.

Madison Co.: Fort Boonesborough State Park, SW of junction of KY 627 and the Kentucky River, mowed yard in campground, rare, only one population seen; associates: *Medicago lupulina, Plantago* spp., *Poa* spp., *Trifolium* spp., *Veronica* spp.; 21 May 1994, *Abbott 6898*.

Carex austrocaroliniana Bailey (Cyperaceae)—A southern Appalachian endemic (Radford et al. 1968). First found in Kentucky in Laurel County by Thompson (Campbell et al. 1994), and now known to be found in other southeastern counties.

Laurel Co.: Rock Creek Research Natural Area, ca 30 km S of London off KY 1193 and 2 km W on F.S. 131, mixed mesophytic forest ravine at Rock Creek and Rockcastle River, occasional; associate: *Carex laxiflora*; 21 Apr 1985, *Thompson 85-64*. Verified by Rob Naczi [KNK].

Centunculus minimus L. [= *Anagallis minima* (L.) Krause] (Primulaceae)—An irregularly cosmopolitan species, especially in warmer areas. Reported from Kentucky, without explanation, by Radford et al. (1968). Medley (1993) cited an 1840, *Short s.n.*, Muhlenberg Co. collection at Philadelphia [PH], and he also stated that the specimen should be verified. David Hewitt [PH] was kind enough to send us a digital scan of the specimen, which is indeed this species and was reportedly common around Greenville in Muhlenberg Co. in western Kentucky. Our collection represents the first known population in Kentucky in over 150 years and its first documentation in east-central Kentucky.

Madison Co.: A wet ditch on the E side of northbound I-75 at KY 21 (Exit 77); associates: *Daucus carota, Rhexia virginica, Samolus floribundus*; 17 Jun 1995, *Thompson 95-374*. Verified by John Thieret [KNK].

Elymus wiegandii Fern. (Poaceae)—In northeastern North America and scattered to the west.

Lewis Co.: Manchester Island #1 (27 acres), in the Ohio River at mile 396, 1.3 mi E of Trinity Station, forested wetland [*Acer saccharinum-Populus-Platanus*], damp transition zone between forest and old field, near middle of island, rare; associates: *Boehmeria cylindrica, Laportea canadensis, Leersia virginica, Muhlenbergia frondosa, Polygonum virginianum*; 29 Jul 1995, *Gelis M1-753*.

Equisetum × ferrissii Clute (Equisetaceae)—According to the distribution maps in Hauke (1993), this sterile hybrid is more widespread in North America than *E. laevigatum* A. Braun, the parent it most closely resembles. Medley (1993) cited literature reports for *E. laevigatum* in Kentucky, but he said no voucher specimens are known.

Laurel Co.: Along Laurel River downstream of Laurel River Dam spillway (Whitley County line), sandy banks scattered among rocks and boulders, infrequent; associates: *Andropogon gerardii, Carex* *scabrata, Phlox maculata, Physostegia virginiana, Rhododendron arborescens, Rudbeckia laciniata, Selaginella apoda, Spiraea virginiana, Thalictrum mirabile, Trautvetteria caroliniensis*; 1 Aug 1993, *Abbott 5970*. **Whitley Co.:** The above population was rediscovered across the narrow river, a few hundred feet downstream from the powerplant dam off the end of County Road 1193; handheld GPS coordinates 36' 57' 41"N 84° 16' 31" W [NAD 83 projection system]; 17 Jul 2001, *Abbott 14477*. This time strobili were present, which yielded spores that were misshapen and colorless, thus confirming the identity.

Erysimum hieraciifolium L. (Brassicaceae)—Native to Europe; naturalized in Canada, Michigan, and Wisconsin.

Laurel Co.: NNW of Hazelpatch, scattered along railroad tracks N of junction with C.R. 760 and S of Shetland Trace, E of the Little Rockcastle River, in gravel along railroad adjacent to mesic woods; 23 Jun 1993, *Abbott 5530*; London, just E of U.S. 25 on C.R. 1006 (toward Levi Jackson Wilderness Road State Park), then S along railroad tracks, along gravel embankment; associates: *Camelina microcarpa, Plantago aristata, Poa pratensis, Triodanis perfoliata, Tragopogon* sp.; 19 Jun 1994, *Abbott 6979*. Verified by John Thieret [KNK].

Lathyrus tuberosus L. (Fabaceae)—Native to Europe and western Asia. Known from a few areas in the United States, mostly in the north. Isely (1990) reported this species from Tennessee.

Madison Co.: Berea College Campus; S of the music building, in unmowed field adjacent to the NW end of the athletic fields, locally abundant sprawling vine, no record of it having been planted; 2 Jun 1992, *Abbott 2374*.

Leucothoe fontanesiana (Steud.) Sleumer (Ericaceae)—Native to the southeastern United States.

Madison Co.: Lower Dogfoot Springs, Berea College Forest, 1.6 mi S of Bighill (at junction of KY 21 and U.S. 421), and 0.2 mi S of Grant House entrance, in a NNW mesic mixed hardwood-hemlock ravine transversed by Grant House Creek, infrequent, several shrubs; associates: *Acer saccharum, Aesculus octandra, Cercis canadensis, Cornus florida, Lindera benzoin, Liriodendron tulipifera, Tilia americana, Toxicodendron radicans, Tsuga canadensis*; 12 Jul 1995, *Thompson 95-407*. This population was first found in 1982 by David D. Taylor [*#1943*, BEREA]. Later in the 1990s, this population was buried and extirpated during road construction on U.S. 421, but some shrubs were transplanted to the nearby Upper Dogfoot Springs. Some skeptics had claimed that this population may have just been persisting from cultivation by some 19th century settler, despite the lack of homesite remnants. Recently, however, a second population was brought to our attention by Ben Begley, increasing the likelihood that this species is naturally in Kentucky and has just been overlooked. **Harlan Co.:** Pine Mountain Settlement School, Pine Mountain, 3.1 mi SSE from Big Laurel on KY 221 at junction with KY 510, 2.2 mi E of Letcher Co., and 9.5 mi ESE from US 421, in a *Fagus grandifolia* and *Tsuga canadensis* stand with *Actaea alba, Hexastylis arifolia, Laportea canadensis, Polystichum acrostichoides, Rhododendron maximum, Thelypteris noveboracensis*, and *Tiarella cordifolia*; 5 May 2001, *Thompson 01-51*.

Lupinus perennis L. (Fabaceae)—Widely native in the eastern United States. Isely (1990) reported this species to the north, east, and south of Kentucky.

Rockcastle Co.: Horselick Surface-mined Area, 1.8 mi S of KY 1955 off Daugherty Road, open bench, rare; associates: *Cardamine hirsuta, Trifolium pratense, T. repens, Veronica arvensis*; 14 Jun 1987, *Thompson 87-735*.

Polygonum cilinode Michx. (Polygonaceae)—Native to northeastern North America and south, in the mountains, to North Carolina.

Lewis Co.: Manchester Island #2 (115 acres), in the Ohio River at mile 396, 1.3 mi E of Trinity Station, old field [*Rubus-Sambucus-Vitis*], E rim of island head, trailing down from upper terrace, rare; associates: *Erigeron philadelphicus, Ipomoea pandurata, Rudbeckia laciniata, Urtica dioica, Verbesina alternifolia, Vernonia gigantea*; 21 Jul 1995, *Gelis M2-522*.

Silene nivea (Nutt.) Otth. (Caryophyllaceae)—Widespread in the northeastern United States.

Lewis Co.: Manchester Island #1 (27 acres), in the Ohio River at mile 396, 1.3 mi E of Trinity Station, late old field [*Rubus-Sambucus-Acer negundo-Rosa-Vitis*], between old field at island head and shaded forest bottomland, infrequent; associates: *Impatiens pallida, Phalaris arundinacea, Stellaria aquatica, Urtica dioica, Verbesina alternifolia*; 24 Jun 1995, *Gelis M1-389*. Verified by John Thieret [KNK].

Vicia tetrasperma (L.) Moench. (Fabaceae)—Native of Eurasia and introduced at scattered stations in the eastern United States to Texas. Isely (1990) reported this species as occurring primarily on the coastal plain, but he also said that it was probably present in every southeastern state.

Madison Co.: Berea College Forest, Red Lick Reservoir, exposed south side of dam, lower slope, near cattail marsh, rare, one small population of 20–25 individuals; associates: *Melilotus alba, Trifolium repens*; 19 Jun 1996, *Gelis 393*.

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BOOK REVIEWS

DAN GRAUR and WEN-HSIUNG LI. 2000. **Fundamentals of Molecular Evolution, Second edition.** (ISBN 0-87893-266-6, pbk.). Sinauer Associates, Inc., PO Box 407, 23 Plumtree Road, Sunderland, MA 01375 U.S.A. (Orders: Internet: publish@sinauer.com, www.sinauer.com, 413-549-1118 fax). $48.95, pbk., 482 pp., 7" × 9".

Having been trained in biosystematics and comparative secondary chemistry, I feel a bit like the driver of an old 70s model car who has just been left behind in the dust of a new sporty model, the molecular systematics model, that is. Hence, I approached reviewing this book from the standpoint of whether it could bring me up to date in my understanding of molecular biology and how the data are applied to systematics.

After reading this book, I do feel more comfortable discussing introns, reverse transcription, transposons, and so on. In that sense, the book succeeded in passing the test of teaching me. However, the explanations in some sections took several readings. This was particularly true for concepts that, introduced early in the book, were the basis for models or for more complex concepts later in the book (e.g., replication of leading vs. lagging strands; Holliday structures and heteroduplexes; calculation of mutation and/or substitution rates).

Not only the title but also the tenor of the introduction suggest that the book assumes the reader has a basic understanding of molecular biology and genetics. Presumably, the main goal of this book is to familiarize graduate students and tangential professionals to be able to read and understand the primary literature and to provide them with the tools for learning research techniques. However, it is not a "cookbook" of techniques in molecular systematics and population genetics. Unfortunately, the book also tries to be a primer to the beginner. In attempting to cover so many basic topics, the primer part becomes shallow and inaccurate. For example, the first chapter begins with an explanation of DNA. In the second paragraph, the four bases are equated with nucleotides:

Each chain is a linear polynucleotide consisting of four kinds of nucleotides. There are two purines, adenine (A) and guanine (G), and two pyrimidines, thymine (T) and cytosine (C).

Before the term "base" is explained, the concept of canonical base pairs is presented.

This brings up another weakness. There is no glossary. Certain words are boldface in both the text and index. These words are considered to be "defined" where first presented in the text. Often, this definition must be gleaned from context only.

Writers of conceptually oriented books need to be careful to present assumptions that underlie the various concepts; for the most part, these authors have succeeded. However, they were not always aware of their assumptions, especially of their bias of the supremacy of molecular methods over more "traditional" ones, as is evident on page 3:

"... the introduction of molecular methods has undoubtedly put evolution on a much more solid footing, and has turned it into a science in which relevant parameters are measured, counted, or computed from empirical data, and theories are tested against objective reality.

Such statements reveal that the authors really do not understand that molecular data faces many of the same limitations (indeed more severe limitations in the case of homoplasious base differences) as does organismal data when both data types are subjected to algorithms of population genetics and cladistics. Likewise, the authors seem (to me) to be making the assumption that the genome contains all necessary information for controlling all developmental pathways differentiating taxa, whereas recent research is also pointing to the proteinome and maternal inheritance as major factors, as well.

As explained in the introduction, the book focuses on instructing in two major areas: 1) molecular evolution as hypotheses of phylogeny and character transformations; and 2) molecular evolution as hypotheses of cause and effect of differences among organisms. The topics related to the two major areas are presented in eight rather long chapters.

Chapter One, where basic terms and concepts are introduced, suffers many of the problems already mentioned.

Chapter Two introduces concepts of population genetics, especially rates of gene substitution under differing assumptions and conditions. The connection between populational studies and nucleotide substitutional differences among species and higher groups is poorly developed. The ongoing controversy between the hypotheses of the neo-Darwinian selectionists and neutral mutation advocates is well covered.

In **Chapter Three**, the authors outlined the evolutionary assumptions made in comparing nucleotide sequences among individual organisms and taxa. Methods for aligning sequences, from visual inspection to computer algorithms, are covered.

Based on these assumptions, **Chapter Four** shows how sequence comparisons are used to draw conclusions about the mechanisms and rates of nucleotide substitution. Because some sites and regions show greater differences than do other regions, an important part of the chapter examines mechanisms that might explain these nonrandom biases.

For the systematist, **Chapter Five** contains the most meat the use of nucleotide sequence data to construct hypothetical phylogenies. Not only does it introduce the vocabulary of phylogenetics, but also covers theoretical problems, as well. Presentation of distance measures and the mathematics for UPGMA (unweighted pair group method with arithmetic means) of distance measures, transformed distance methods (true parsimony), neighbors-relation and neighbor-joining methods, and minimum spanning trees figures prominently in the chapter. I think the book could have been improved if the authors had given (in appendices) step-by-step examples to work through by hand for these different methods. Because the math of computerized parsimony algorithms (exhaustive and heuristic searches and tree comparisons) and maximum likelihood is very complicated, only the description of these methods is given. Also included are rooting methods, estimating divergence time, and tree reliability assessments (e.g., bootstrap). Several examples from recent studies were provided (human-ape; cetaceans; angiosperm origins; tree-of-life) to compare the strengths of the various analytical methods.

Looking beyond point mutations, **Chapter Six** examines duplication and modification of gene segments, especially pseudogenes, alternative pathways for producing new functions, and the lack of independent evolution of duplicated segments within species (so-called concerted evolution). The concept of evolution by "jumping genes," i.e., insertion or deletion of transposable elements, including both transposition and retroposition, is covered in **Chapter Seven.** Here the authors give a rather complete account of retrosequences, retroviruses, retroposons, and related sequences. I found the detailed explanations of LINEs and SINEs (long and short interspersed repetitive elements) to be helpful. Lateral gene transfer among unrelated species is an associated concept of special interest: can it account for discontinuity in the taxonomic distribution of isolated genetic sequences?

Chapter Eight relates attempts to account for traditional chromosomal differences at the molecular level. That is, what happens to the genome after polyploidization, what is heterochromatin, and why are there vast differences in sizes of genomes of diverse organism? Also two appendices provide additional background for those unfamiliar with 1) the geologic column, geologic history, and current species diversity; and 2) mathematical probabilities.

For the goals the authors have set for themselves, I would give the book a grade of "B." If other books that do a better job are not available in this niche, then, for the taxonomist needing a better understanding of molecular systematics, it is worth the investment.—*Roger W. Sanders, Associate Collections Manager, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A., rsanders@brit.org.*

JOHN J. WIENS (Editor). 2000. **Phylogenetic Analysis of Morphological Data.** (ISBN 1-56098-841-X, hbk.; 1-56098-816-9, pbk.). Smithsonian Institution Press, PO Box 960, Herndon, VA 20172-0960 U.S.A. (Orders: MLitts@sipress.si.edu, 1-800-782-4612; 202-287-3738 x343). $49.95 hbk., 26.95, pbk., 220 pp., tables and numerous figures, 6" × 9".

What ever happened to morphology-based systematics? A perusal of titles of such traditional journals as *Systematic Botany* reveals that studies employing morphological data have been replaced largely by those focusing on molecular. If that has you feeling depressed, a quick read-through of this book will have you pumped up about the future of morphological studies.

A symposium, "Morphological Data in Phylogenetic Analysis: Recent Progress and Unresolved Problems," at the 1996 annual meeting of the Society of Systematic Biologists gave birth to this collection of papers. The symposium's title clearly reflects the theme of the book—no hand wringing over the demise of morphology as a science. Instead, the controversy is mentioned in the first contribution (**Chapter 1**, "Molecules Versus Morphology in Systematics") as a means of placing morphological analyses in the perspective of the current state of systematics and providing a context for the rest of the papers. The senior author, David M. Hillis (with John Wiens as junior author), is a prominent advocate of using both morphological and molecular data in systematics. Hence, a reasoned argument is made that the best studies take advantage of the strengths and avoid the weaknesses of both morphological and molecular data. Moreover, graduate training in systematics should generate researchers who have a command of both methods.

In **Chapter 2**, "Character Selection and the Methodology of Morphological Phylogenetics," Steven Poe and John Wiens begin the study of morphological data sets in earnest. In trying to answer the question of how systematists decide on the set of characters they actually include in cladistic studies, the authors surveyed 23 journals between 1987 and 1997 for research papers that explicitly state criteria for character inclusion. Only about 20 percent of the papers gave any criteria, which can be categorized as: 1) excessive variation in terminal taxa, 2) variation continuous and/or character quantitative, 3) missing data, 4) too much homoplasy in character, and 5) polarity unknown. They point out that rejection of characters generally was based on assumptions rather than on empirical evidence. After analyzing each of the criteria, they recommend excluding characters only after one has objective evidence to support rejection.

Chapter 5 ("Coding Morphological Variation within Species and Higher Taxa for Phylogenetic Analysis") actually follows in logical sequence after Chapter 2. However, because its sole author is John Wiens, its placement probably reflects modesty. The first part of the paper focuses on variation within species. Using simulations of an artificial (i.e., "known") phylogeny and congruence analyses of a real data set, he compared the effect of eight different coding methods under parsimony algorithms to that of continuous data under maximum likelihood, as well as under all combinations of three different clustering methods (UPGMA, neighbor-joining, Fitch Margoliash) with two distance measures (Nei's, Cavalli-Sforza & Edwards's). The results were surprising. The most highly resolved, and potentially most accurate, cladograms resulted from parsimony of continuous characters coded as frequencies and from the non-parsimony methods. Lowest resolution came from excluding all polymorphic characters (i.e., the standard practice of phylogenetics) and from coding the character as missing or equivocal for two or more states. Various coding methods to include data from polymorphic characters (whole species scored apomorphic for any occurrence in the species; species scored according to modal condition; polymorphic condition scored as a state intermediate or alternative to fixed apomorphy) performed at intermediate levels. Wiens therefore concludes that analytical information is lost when polymorphic characters are excluded or not allowed to contribute to tree construction. Wiens also examined the various methods of coding character states in higher taxa with variation among species. In those cases, he recommends using species as terminals in the analyses rather than coding higher taxa or excluding characters.

The remaining five chapters examine different areas of morphological research in which advances are occurring—morphometrics, ontogeny, hybridization, stratigraphy of fossils, and adaptation.

I find the study of morphometrics (both intraspecific and interspecific variation) to be fascinating and was pleased by Zelditch, Swiderski, and Fink's article (**Chapter 3**, "Discovering Phylogenetic Characters in Morphometric Data). They do a superb job of explaining the field and summarizing its state as practiced today. If one is not familiar with morphometrics, this article would make a good introduction for entering the literature.

Paula Mabee (**Chapter 4**, "The Usefulness of Ontogeny in Interpreting Morphological Characters) summarizes the state of affairs with ontogenetic characters in phylogenetic reconstruction. She reviews the recent history of the role of ontogeny in cladistics, criticizing unjustified uses (especially in pattern cladisitcs) with recent empirical studies. She also recommends ways of coding ontogeny as characters. However, ontogeny has not proved useful for polarizing or ordering characters or establishing homology. There must first be a better understanding of morphogenesis.

In **Chapter 6** (Hybridization and Phylogenetics: Special Insights from Morphology), Lucinda McDade reviews the state of dealing with hybrids in this context. In particular she discusses the meaning of hybrid intermediacy, how it can be recognized, and the expected placement of hybrids in cladistic analyses. She makes a very good case that new computer algorithms are needed to perform hybrid reticulations in addition to species' cladogenesis.

John Huelsenbeck and Bruce Rannala's treatment of fossil evidence (**Chapter 7**, "Using Stratigraphic Information in Phylogenetics") is enlightening but rather tedious, except for someone interested in maximum-likelihood mathematics. They provide the historical setting for the new interest (since about 1985) of using fossil data for phylogenetics. Rather than focusing on using morphological characters of fossils, they are concerned most with using the stratigraphic occurrences to evaluate or choose among alternative cladograms. Apparently, maximum likelihood statistics have become an important factor in such studies, and they devote a major portion of their article to the topic.

In **Chapter 8** (Logical Problems Associated with Including and Excluding Characters During Tree Reconstruction and Their Implications for the Study of Morphological Character Evolution), Kevin de Queiroz is concerned about circular reasoning. That is, can interpretations about adaptations be related to characters that were included in the tree-building analysis? Despite the importance of avoiding circular reasoning, I found de Queiroz's treatment rather tedious. He spends considerable time building a philosophical basis for evaluating circularity, and more time on the potential circularity of including the data versus excluding the data. He seems to build a straw man of the practice of excluding data to replace it with the superior method of including data. In frustration before reaching his conclusion, I thought to myself, "Why not just do both and compare the effects on the tree?"—to later discover de Queiroz arriving at that same conclusion. Was he actually leading me down that path or did he get there himself by accident?

All in all, the papers are consistently well written and edited. This appears to be an important contribution to the systematic literature and concisely summarizes the advances of and challenges for morphological systematics. I recommend it to anyone wanting to catch up on the cutting edge of morphology or needing encouragement to continue using "out-dated" characters. Perhaps it should be required reading of molecular phylogenetics who have not been trained to recognize the apex of a leaf or the skull of a mammal.—*Roger W. Sanders, Associate Collections Manager, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A., rsanders@brit.org.*

BOOKS RECEIVED

Systematics/Monographs/Floras/Guides

JOHN M. GILLETT, NORMAN L. TAYLOR, and MICHAEL COLLINS (edited by Michael Collins). 2001. **The World of Clovers.** (ISBN 0-8138-2986-0, hbk.). Iowa State University Press, 2121 South State Street, Ames, IA 50014-8300, www.isupress.com, 800-862-6657, 515-292-0155, 515-292-3348 fax). $144.95 hbk. (includes CD-ROM), $99.95 (CD-ROM only), 488 pp, illustrated, 6" × 9".

IRWIN M. BRODO, SYLVIA DURAN SHARNOFF, and STEPHEN SHARNOFF. 2001. **Lichens of North America.** (ISBN 0-300-08249-5, hbk.). Yale University Press, 302 Temple Street, P.O. Box 209040, New Haven CT 06520-9040, U.S.A. (Orders: www.yale.edu/yup, 203-432-0960, 203-432-0948 fax). $69.95, hbk., 795 pp., 939 color photos, maps, 9 1/2" × 11".

JIM COOTES. 2001. **Orchids of the Philippines.** (ISBN 0-88192-516-0, hbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $49.95, hbk., 232 pp., 339 color photos, 1 diagram, 1 map, 7 1/2" × 10".

Ethnobotanical/Economic/Medicinal/Useful Plants/Toxic

CHARLES R. HART, TAM GARLAND, A. CATHERINE BARR, BRUCE CARPENTER, and JOHN C. REAGOR. 2000. **Toxic Plants of Texas. Integrated Management Strategies to Prevent Livestock Losses.** (no ISBN listed, TAES B-6105 12/00). Texas Agricultural Extension Service, P.O. Box 1209, Bryan, TX 77806, U.S.A. (Orders: http://texaserc.tamu.edu, 888-900-2577, 979-862-1566 fax). $20.00, spiral bound, 247 pp., color photos, 5 1/2" × 8 1/2".

GEORGE E. BURROWS and RONALD J. TYRL. 2001. **Toxic Plants of North America.** (ISBN 0-8138-2266-1, hbk.). Iowa State University Press, 2121 South State Street, Ames, IA 50014-8300, U.S.A. (Orders: www.isupress.com, 800-862-6657, 515-292-0155, 515-292-3348 fax). $174.95 hbk., 1350 pp, illustrated, 8 1/2" × 11".

HANS ZOEBELEIN (editor). 2001. **Dictionary of Renewable Resources. Second, Revised and Enlarged Edition.** (ISBN 3-527-30114-3, hbk.). Wiley-VCH Verlag GmbH, D-69469 Weinheim, Germany (Orders: John Wiley & Sons, Inc., One Wiley Drive, Somerset, NJ 08875, 732-302-2300 fax). Price not listed, 408 pp., 6 3/4" × 9 1/2".

JAMES LANG. 2001. **Notes of a Potato Watcher.** (ISBN: 1-58544-154-6, pbk.). Texas A&M University, 4354 TAMU, College Station, TX 77843-4354, www.tamu.edu/upress, 979-458-3982, 979-847-8752 fax). $24.95, 388 pp, 8 color, 9 b/w photos, 5 line drawings, 8 tables, bibliography, index, 6" × 9".

Botany/Molecular

MOHAMMAD PESSARAKLI (editor). 2002. **Handbook of Plant and Crop Physiology. Second Edition, Revised, and Expanded.** (ISBN 0-8247-0546-7, hbk.). Marcel Dekker, Inc. Cimarron Road, P.O. Box 5005, Monticello, NY 12701-5185, U.S.A. (Orders: www.dekker.com, 212-696-9000, 212-685-4540 fax). $225.00, 973 pp., figures, 7" × 10".

Ecology/Conservation/Landscape Ecology

CLARK C. GIBSON, MARGARET A. MCKEAN, and ELINOR OSTROM (editors). 2000. **People and Forests. Communities, Institutions, and Governance.** (ISBN 0-262-57137-4, pbk.). The MIT Press, 5 Cambridge Center, Cambridge, MA 02142-1493, U.S.A. (Orders: http://mitpress.mit.edu, mitpress-orders@mit.edu, 800-356-0343). $21.00, pbk., 274 pp., 22 illustrations, 6" × 9".

MILO I. HARPSTEAD, THOMAS J. SAURER, and WILLIAM F. BENNETT. 2001. **Soil Science Simplified. Fourth Edition.** (ISBN 0-8138-2942-9, hbk.). Iowa State University Press, A Blackwell Science Company, 2121 South State Street, Ames, IA 50014-8300, U.S.A. (Orders: www.isupress.com, 800-862-6657, 515-292-0155, 515-292-3348 fax). $42.95 hbk., 268 pp, illustrated, 6" × 9".

Horticulture/Gardening

DIANA GRENFELL. 2001. **The Gardener's Guide to Growing Hostas.** (ISBN 0-88192-518-7, pbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $19.95, pbk., 160 pp., 74 color photos, 5 line drawings, 7" × 9 1/2".

GEOFF STEBBINGS. 2001. **The Gardener's Guide to Growing Irises.** (ISBN 0-88192-388-5, pbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $19.95, pbk., 160 pp., 74 color photos, 3 line drawings, 7" × 9 1/2".

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ALLAN M. ARMITAGE. 2001. **Armitage's Manual of Annuals, Biennals, and Half-Hardy Perennials.** (ISBN 0-88192-505-5, hbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $39.95, hbk., 604 pp., 125 color photos, 107 line drawings, 1 map, 75 tables, 6" × 9".

PAT HALLIDAY. 2001. **The Illustrated Rhododendron. Their Classification Portrayed Through the Artwork of Curtis's Botanical Magazine.** (ISBN 0-88192-510-1, hbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $69.95, hbk., 274 pp., 120 color illustrations, 4 line drawings, 8 1/4" × 11 3/4".

EMILY S. SIEGERIST. 2001. **Bulbophyllums and Their Allies. A Grower's Guide.** (ISBN 0-88192-506-3, hbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $34.95, hbk., 284 pp., 77 color photos, 6" × 9".

MARY TOOMEY and EVERETT LEEDS (photograhy editor Charles Chesshire). 2001. **An Illustrated Encyclopedia of Clematis.** (ISBN 0-88192-508-X, hbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $59.95, hbk., 428 pp., 652 color photos, 5 b/w illustrations, 19 line drawings, 2 maps, 8 1/2" × 11".

BARBARA JOE HOSHIZAKI and ROBBIN C. MORAN. 2001. **Fern Grower's Manual. Revised and Expanded Edition.** (ISBN 0-88192-495-4, hbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $59.95, hbk., 624 pp., 50 color photos, 165 b/w photos, 826 line drawings, 8 1/2" × 11".

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STEPHEN ANDERTON. 2001. **Urban Sanctuaries. Peaceful Havens for the City Gardener.** (ISBN 0-88192-502-0, hbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-

327-5680, 503-227-2878, 503-227-3070 fax). $29.95, hbk., 144 pp., 148 color photos, 4 color plans, 4 b/w plans, 8 1/2" × 11".

Biographical

MARGARET LYNN BROWN. 2001. **The Wild East. A Biography of the Great Smoky Mountains.** (ISBN 0-8130-2093-X, hbk.). University Press of Florida, 15 NW 15th Street, Gainesville, FL 32611-2079, U.S.A. (Orders: www.upf.com). $55.00, hbk., $24.95, pbk., 479 pp., 68 b&w photos, notes, bibliography, index, 6" × 9".

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ABSTRACT

Every paper no matter the length should include both an English and Spanish, or another major language abstract.

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Use the collector's last name and number or (s.n.) and underline. Abbreviate the months of the year by the first three letters of the month without a period. Example: Texas. Jeff Davis Co.: 1 mi W of Fort Davis, 3 Jan 1972, Smith 118 (BRIT).

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Please present ALL figures as a unified, single sequence of figures. A scale should be in or on the illustration or photograph; reduction will automatically reduce the scale and subject proportionately. In halftones, sharp glossy photographs with good contrast are necessary for good reproduction. Please mount illustrative material (halftones, line drawings, etc.) on flexible paper so that may be mounted and on a high-speed drum scanner. You may also submit graphic materials in electronic format. Please consult the editor for proper graphics format (tif, jpeg, gif., bmp, etc.). Color figures can be used and an additional cost maybe charged. Color figures reproduced best from a color transparency. Please submit color prints for reviewing purposes.

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Barrie, F.R., C.E. Jarvis, and J.L. Reveal. 1992a. The need to change Article 8.3 of the Code. Taxon 41:508–512.

Ricketson, J. and J. Pipoly. 1997. A synopsis of the genus *Gentlea* (Myrsinaceae) and a key to the genera of Myrsinaceae in Mesoamerica. Sida 17:697–707.

Crawford, D.J. 1983. Phylogenetic and systematic inferences from electrophoretic studies. In: S.D. Tanksley and T.J. Orton, eds. Isozymes in plant genetics and breeding, Part A. Elsevier, Amsterdam. Pp. 257–287.

Sivinski, R.C. and K. Lightfoot (eds.). 1995. Inventory of rare and endangered plants of New Mexico. New Mexico Forestry and Resources Conservation Division. Energy, Minerals and Natural Resources Department. Misc. Pub. No. 4.

ABBREVIATIONS

When the following abbreviations are used the period is omitted. Distance: mm, dm, cm, m, km, ft, mi; directions (in caps): S, N, E, W, months: first 3 letters only, Jan, Feb, etc. Example: Potter Co.: 2 km W of Dot, 5 Jun 1971, Smith 118 (SMU).

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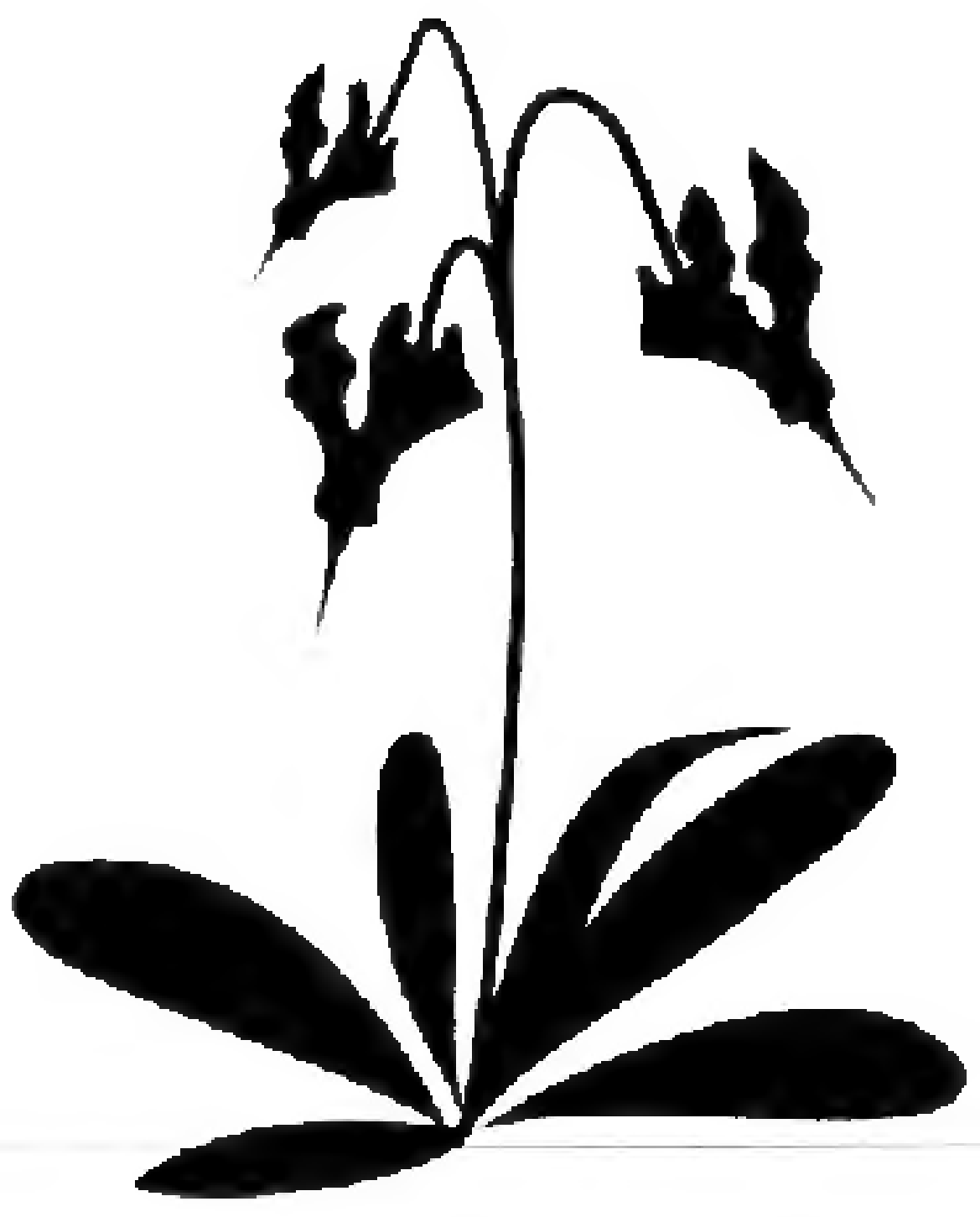

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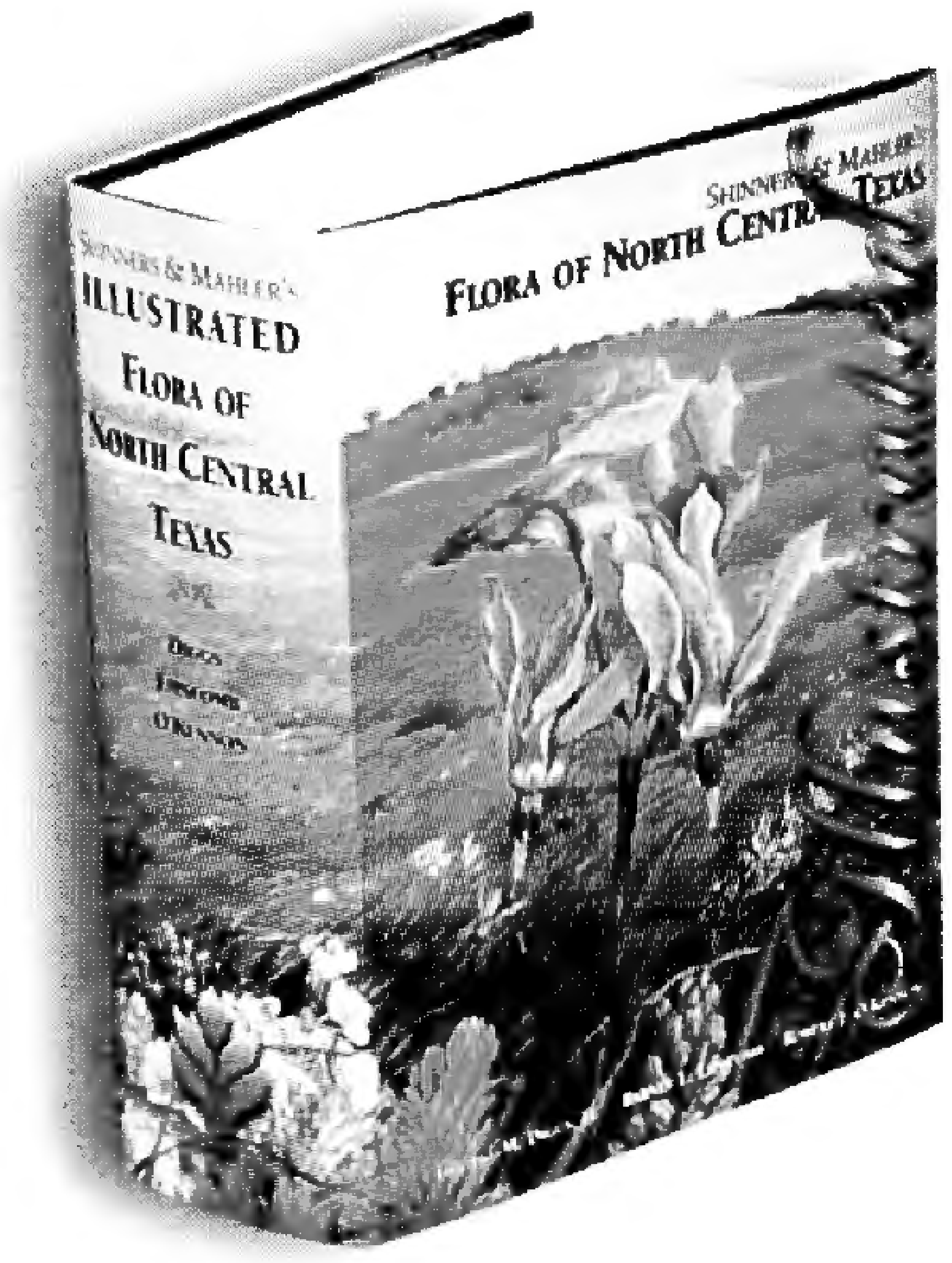

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