PHYTOLOGIA

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TAXONOMIC SUMMARY OF *OMALOTHECA* (ASTERACEAE: INULEAE)

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ABSTRACT

The species of the genus *Omalotheca* Cass. are primarily Old World in distribution, but three extend in distribution into northeastern North America. Although the the genus has been included within *Gnaphalium*, its combination of spiciform capitulescences, papillate achenial surfaces and nonmyxogenic achenial hairs exclude it from that genus. A description and taxonomic summary of *Omalotheca* are provided.

KEY WORDS: *Omalotheca, Gnaphalium*, Asteraceae, Inuleae.

A group of species, distributed primarily from Europe to south central Asia, is sometimes segregated from *Gnaphalium* as the genus *Omalotheca* Cass. (*e.g.*, Holub 1976), but there has been no consensus regarding the rank at which it should be treated (*e.g.*, Grierson 1975; Rechinger 1980). The first comparative morphological study to include a broad range of species centered around *Gnaphalium* has been that of Drury (1970), and most subsequent opinions regarding *Omalotheca* are based at least in part on his study. Hilliard & Burtt (1981) discussed some of the characters of *Omalotheca* but did not express a definite opinion regarding its rank.

In Drury's tabular arrangement of results, *Omalotheca* is a subgroup of GROUP I ("gnaphalioid cudweeds"), which is correlatively ranked with GROUP II (primarily *Achyrocline*, but including subgroups) and GROUP III (primarily *Anaphalis*). His arrangement however, provided no hypotheses regarding relationships among the subgroups and his delimitation of "subgroups" appears to have been more accurate than of "groups." As further noted by Hilliard & Burtt (1981), Drury's representation of African species was severely limited and did not include many taxa that Hilliard & Burtt have recognized as segregate genera. The composition of Drury's GROUP I is heterogeneous and the differences that separate the subgroups appear to be at least as significant as those used by Hilliard & Burtt to delimit the numerous genera of southern Africa Gnaphaliinae. *Omalotheca* is clearly set apart from all other entities in Drury's study.

The species of *Omalotheca* are distinguished from other Gnaphaliinae in a combination of features, many of which were recorded by Drury (1970):

herbaceous, rhizomatous and fibrous rooted perennials; leaves narrowly to linearly lanceolate; capitulescence spiciform; heads relatively large; phyllaries with nonfenestrated stereomes; pistillate corollas minutely but evidently papillate punctate; pollen grains relatively large; achenes 1.0-1.5 mm long, the surfaces imbricate-papillate, also with nonmyxogenic hairs 6-12 times longer than wide; and pappus bristles basally eciliate, separate or basally connate and released as a unit. Further, the very large pollen grains and distinctive achenial surfaces in *Omalotheca* were found by Drury elsewhere only in some species of the *Achyrocline* group (those species referred to *Pseudognaphalium* Kirpinczn.) rather than in the gnaphalioid group, and it is likely that the affinities of *Omalotheca* lie with that group. The achenial vestiture of *Omalotheca* removes it from *Gnaphalium* sensu stricto, the species of which have achenes with nonpapillate surfaces and commonly with myxogenic hairs.

Omalotheca is superficially similar to *Gamochaeta* (also placed by Drury in GROUP I) in its spicate capitulescences and (in some species) its connate pappus bristles, but the species of *Gamochaeta* differ in their smaller heads, concave receptacles, filiform corollas, smaller pollen grains, much smaller achenes with nonpapillate surfaces and often with myxogenic achenial hairs and fewer pappus bristles (Nesom 1990a). Further, *Gamochaeta* is strictly a New World genus with its center of diversity primarily in middle elevations of South America.

Euchiton Cass. (*Gnaphalium* sect. *Euchiton* [Cass.] DC.), a group of species from the western to southwestern Pacific region, has also been considered within the boundaries of *Gnaphalium* sensu stricto, but it is very different in habit, capitulescence and details of achenial morphology from *Omalotheca* (Drury 1970).

Of all groups of Gnaphaliinae, *Omalotheca* shows the greatest overall similarity to the two species of *Mexerion* (Nesom 1990b). The Mexican species differ, however, in their nonpapillate achenes with myxogenic duplex trichomes, apically fimbriate pistillate corollas and strictly tubular disc flowers with sterile achenes.

Omalotheca comprises eight species, five endemic to Europe and adjacent Asia, with three primarily Eurasian but also reaching boreal eastern North America. All occur in alpine or high elevation habitats. Chromosome numbers are known for *O. supina* (n=14 pairs) and for *O. sylvatica* and *O. norvegica* (n=28 pairs) (Holub 1976). The genus has been split at the subgeneric and generic levels (Kirpicznikov & Kuprianova 1950; Kirpicznikov 1960), but both Drury (1970) and Hilliard & Burtt (1981) have noted that *Omalotheca*, as a natural group, comprises species of both groups. Holub (1976) separated the infrageneric taxa by the following contrasts:

1. "Inflorescence with 1-10 capitula. Female florets in 1(-2) rows. Achenes obovoid, compressed; pappus-hairs stout, free, falling

separately" .....subg. *Omalotheca*

1. "Inflorescence with 10-150 capitula. Female florets in several rows. Achenes cylindrical; pappus-hairs slender, connate at base, falling as a unit" .....subg. *Gamochaetiopsis*

Additionally, the species of subg. *Gamochaetiopsis* are single stemmed from a short, lateral rhizome, in contrast to the more caespitose growth in the species of subg. *Omalotheca*.

A summary of the taxonomy of *Omalotheca* is presented here, but it does not represent a critical study of species boundaries. All species are based on taxa originally named in *Gnaphalium*.

Omalotheca Cass., Dict. Sci. Nat. 56:218. 1828. Type species: *Omalotheca supina* (L.) DC.

Herbaceous, fibrous rooted perennials, caespitose from a system of numerous, short, slender, ascending, rhizomatous branches or single stemmed from a single, short, lateral, rhizome. Stems densely woolly, erect, unbranched except for very short lateral branches in the lower part of the capitulescence. Leaves entire with flat to very slightly revolute margins, mostly narrowly lanceolate to oblanceolate, bicolored, densely woolly-sericeous beneath, greenish glabrescent above, the basal persistent in a rosette. Capitulescence spiciform or if few flowered, a compact, terminal glomerule, the spike usually continuous but sometimes slightly interrupted in the lower part. Phyllaries hyaline stramineous with a green, baso-medial patch, large and distinctively patterned, the stereome not divided or fenestrated. Pistillate flowers numerous, fertile, the corollas filiform-tubular, definitely lobed at the apex, gradually dilated toward the base, minutely but evidently papillate punctate. Hermaphroditic flowers few, fertile, 3-4 mm long, narrowly tubular but dilated at the throat; anthers tailed; style branches with collecting hairs confined to a blunt, apical patch. Achenes 1.0-1.5 mm long, obovoid to cylindric, the surfaces papillate, also with strigillose, spreading-appressed, duplex, nonmyxogenic hairs, 6-12 times longer than wide. Pappus monomorphic, of numerous, scabrid, basally eciliate, caducous bristles, separate or basally connate in a smooth ring and released as a unit. Base chromosome number, x=14, with diploids and tetraploids reported.

Omalotheca subg. *Omalotheca*

Gnaphalium sect. *Omalotheca* (Cass.) Endl., *Gen. Pl.* 6:447. 1838.

1. *Omalotheca hoppeana* (K. Koch) Schultz-Bip. & F.W. Schulz, *Arch. Fl. J. Bot.* 311. 1861.

Central Europe.

2. *Omalotheca leucopilina* (Boiss.) J. Holub, Folia Geobot. Phytotax. 11:81. 1976.

Turkey.

3. *Omalotheca pichleri* (Murb.) J. Holub, Bot. J. Linn. Soc. 71:271. 1976.

Yugoslavia and Albania.

4. *Omalotheca roeseri* (Boiss. & Heldr.) J. Holub, Bot. J. Linn. Soc. 71:271. 1976.

Greece.

5. *Omalotheca stewartii* (C.B. Clarke) J. Holub, Folia Geobot. Phytotax. 12:429. 1977.

Omalotheca afghanica (Rech. f. & Koie) Holub, *fide* Rechinger, 1980.

Eastern Himalayas in Pakistan and Afghanistan, to Iran and the Caucasus.

6. *Omalotheca supina* (L.) DC., *Prodr.* 6:245. 1838.

Northern Europe and the mountains of central and southern Europe, northern Iran and the Caucasus, also in boreal eastern North America (Gleason & Cronquist 1963; Boivin 1966).

Omalotheca subg. *Gamochaetiopsis* Schultz-Bip. & F.W. Schulz, Arch. Fl. J. Bot. 311. 1861.

Synchaeta Kirpiczn. *in* Kirpiczn. & Kuprian., Acta Inst. Bot. V.F. Komarov, Acad. Sci. U.R.S.S., Ser. 1, 9:33. *Gnaphalium* sect. *Synchaeta* (Kirpiczn.) Kirpiczn., *Flora U.S.S.R.* 25:397. 1959.

7. *Omalotheca norvegica* (Gunn.) Schultz-Bip. & F.W. Schulz, Arch. Fl. J. Bot. 311. 1861.

Europe, also in boreal eastern North America (Gleason & Cronquist 1963; Boivin 1966).

8. *Omalotheca sylvatica* (L.) Schultz-Bip. & F.W. Schulz, Arch. Fl. J. Bot. 311. 1861.

Widespread in Europe, to Siberia and central Asia, Iran, and the Caucasus, also in boreal eastern North America (Gleason & Cronquist 1963; Boivin 1966). According to Grierson (1975), including the following two synonyms:

Omalotheca alpigena (K. Koch) J. Holub, Folia Geobot. Phytotax. 11:81. 1976.

Caucasus region of Russia.

Omalotheca caucasica (Somm. & Lev.) Czerepanov, *Pl. Vasc. U.R.S.S.* 88. 1981.

Caucasus region of Russia.

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Grierson, A.J.C. 1975. *Gnaphalium. Flora of Turkey* 5:97-100.

Hilliard, O.M. & B.L. Burtt. 1981. Some generic concepts in Compositae–Gnaphaliinae. Bot. J. Linn. Soc. 82:181-232.

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Phytologia (April 1990) 68(4):247-254.

MEXERION (ASTERACEAE: INULEAE), A NEW GENUS FROM MÉXICO

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ABSTRACT

A new genus from México is described, **Mexerion**, characterized by a perennial duration, herbaceous habit, fibrous roots, leafy and plantlet tipped stolons, narrowly lanceolate to oblanceolate leaves, very large heads in a spiciform capitulescence, disc flowers with sterile ovaries and nonpapillate achenes with myxogenic hairs and basally fused pappus bristles. The genus comprises two species, **M. sarmentosum** (Klatt) Nesom, *comb. nov.*, from the high volcanic peaks of south central México and **M. mexicanum** Nesom, *sp. nov.*, from the area of high elevation near Cerro Mohinora in southern Chihuahua.

KEY WORDS: México, **Mexerion**, *Gnaphalium*, Inuleae, Asteraceae.

Two closely related species among the Mexican Gnaphaliinae are not clearly associated with any of the species groups that occur in México. One of these is *Gnaphalium sarmentosum*, which is endemic to the high volcanic peaks of central México, the other an undescribed species from southern Chihuahua. Together they are referred to here as the "sarmentosum group." They are characterized by a perennial duration, herbaceous habit, fibrous roots, leafy stolons, narrowly lanceolate to oblanceolate, persistent, basal and cauline leaves, very large heads in a spiciform capitulescence, disc flowers with sterile ovaries, and relatively large, nonpapillate achenes with myxogenic hairs and basally fused pappus bristles.

The two species of the "sarmentosum group" are similar to plants of the genus *Omalotheca* Cass. (particularly sect. *Gamochaetiopsis*) in their habit, capitulescence and basally fused pappus (Nesom 1990a), and I first considered them an endemic American element of that genus. With study of details of floral and fruit characters, however, the Mexican plants prove to be different from *Omalotheca* in a number of significant characters.

The achenial surfaces in the "sarmentosum group" are smooth, lacking the minute but prominent (with compound scope), epidermal papillae characteristic of *Omalotheca*. The trichomes are 3-4 celled Zwillingshaare like those in *Omalotheca*, but they are much shorter (2-3 times longer than wide) and

myxogenic, opening at the tip to release mucilage. The achenial trichomes of *Omalotheca* are 6-12 times longer than wide and not myxogenic. Among Gnaphaliinae native to North or Central America, only *Achyrocline* and the species referable to *Pseudognaphalium* (*sensu* Hilliard & Burtt 1981; Dillon & Nesom, in prep.) have achenes with papillate surfaces similar to those found in *Omalotheca*.

The disc flowers of the "sarmentosum group" have sterile ovaries and the collecting hairs of the style branches extend from tip to base of the branches. In *Omalotheca*, the disc ovaries are fertile and the collecting hairs are restricted to a blunt, apical cluster. In North and Central America, disc flowers with sterile ovaries occur otherwise in native species only in the Mexican/Central American genus *Gnaphaliothamnus* Kirpiczn. (Nesom in prep). This feature is much more common in South American genera (M. Dillon, personal comm.), but in southern Africa, where the Gnaphaliinae is rich in diversity, as well as the Old World in general, sterile disc ovaries are extremely rare (Hilliard & Burtt 1981). It is almost certain, however, that the sterility has developed independently in *Gnaphaliothamnus* and the "sarmentosum group," because, on other grounds, the two appear to be very distantly related. Plants of the former are woody and have much smaller heads with white tipped phyllaries, smaller, red corollas and separate, clavate tipped pappus bristles on the disc flowers. The striking difference in style branch morphology between the "sarmentosum group" and *Omalotheca* should not be weighted heavily apart from the loss of fertility in the disc ovaries, because a similar, correlated loss of stigmatic lines and a greater coverage of collecting hairs occurs on the style branches of plants in the Astereae with "female-sterile" ("pseudohermaphroditic") disc flowers (*e.g.*, in *Baccharis, Diplostephium, Oritrophium* and others).

The leafy, plantlet tipped stolons produced in the "sarmentosum group" are distinctive, particularly since the only species of Gnaphaliinae in North and Central America with a similar habit are *Gnaphalium stolonatum* S.F. Blake of Guatemala, a member of *Gnaphalium* sensu stricto, and species of *Antennaria*. Plants of *Omalotheca* typically have slender rhizomes, but these apparently are always subterranean and are not at all like those in the Mexican species.

Other points of difference between the "sarmentosum group" and *Omalotheca* are found in the corollas. In the former, the pistillate flowers have corollas with merely fimbriate apices and the style branches are completely exserted; the disc corollas are narrowly and evenly tubular. In *Omalotheca*, the pistillate corollas have definite lobes with the style branches mostly included and the disc corollas are dilated at the throat.

Plants of *Gamochaeta* are similar to those of the "sarmentosum group" in their spiciform capitulescences and basally fused pappus bristles (Nesom 1990b), but they differ radically in a number of features, including differently shaped leaves, much smaller flowers and achenes, disc flowers hermaphroditic

and completely fertile, achenes with sessile, 2 celled, myxogenic hairs, and pappus bristles that are more completely fused at the base.

In keys to South American Gnaphaliinae (Cabrera 1961; Dillon & Sagastegui 1986), the Mexican plants key to the vicinity of *Gamochaeta* and *Belloa* because of the basally united pappus bristles. A few species of *Belloa* have spiciform capitulescences and approach the habit of the "sarmentosum group," but the phyllaries are differently patterned, the achenes have papillate myxogenic hairs similar to those of *Gamochaeta* and *Belloa* appears to be restricted to South America.

In summary, the combination of characters of the two species of the "sarmentosum group" place them outside of any genus in the Gnaphaliinae. The plants are very similar in habit and aspect to the primarily Old World genus *Omalotheca* but are excluded from it by critical features of the achenes and flowers. Based on their conservative and consistent mode of occurrence in other genera, these same features suggest that the "sarmentosum group" may be more closely related to American genera than to *Omalotheca*. The two species of the "sarmentosum group" are best treated as a separate genus, proposed here as new.

Mexerion Nesom, *gen. nov.* Type species: *M. sarmentosum.*

> *Omalothecae* Cass. habitu et aspectu similis sed paginis acheniorum non-papillatis sed trichomatibus myxogenis et floribus disci ovariis sterilibus. Differt a *Gnaphalio* capitulis multo majoribus in capitulescentiis spiciformibus, acheniis majoribus, et floribus hermaphroditicis ovariis sterilibus.

Herbaceous, fibrous rooted perennials, single stemmed from a single, short, lateral, rhizome, producing leafy stolons. Stems densely woolly, erect, unbranched except for very short lateral branches in the lower part of the capitulescence. Leaves entire with flat to very slightly revolute margins, mostly narrowly lanceolate to oblanceolate, bicolored, densely woolly-sericeous beneath, greenish glabrescent above, the basal persistent in a rosette. Capitulescence spicate, or if few flowered, a compact, terminal glomerule, the spike usually continuous but sometimes slightly interrupted in the lower part, sometimes borne on a stem barely or not at all protruding from the basal leaves. Heads campanulate, 6-14 mm wide, sessile or short pedicellate. Phyllaries scarious, stramineous but with distinctive lateral bands of pigmentation, with hyaline margins, the longest 7-14 mm long, the stereome green, baso-medial, elliptic to ovate or lanceolate, not divided or fenestrated. Pistillate flowers 40-150, fertile, the corollas filiform-tubular, gradually dilated toward the base, minutely but evidently papillate punctate, apically fimbriate, without definite lobes; style branches completely exserted. Pseudohermaphroditic flowers 5-21, with sterile ovaries, 7-9 mm long, narrowly tubular, the throat not dilated, the apices

purple, eglandular but with a few, appressed, thick hairs; anthers tailed; style branches with collecting hairs from tip to base of branches, without stigmatic lines. Achenes 1.0-1.3 mm long, obovoid to oblong-ellipsoid, somewhat compressed, with a minute but distinct, stipitate carpopodium, the surfaces not papillate but with short, ascending, 3-4 celled, myxogenic twin hairs (Zwillingshaare) 2-3 times longer than wide. Pappus monomorphic, of numerous, barely scabridulous, basally eciliate bristles, basally connate in a smooth ring, easily caducous and released as a unit.

KEY TO THE SPECIES

1. Leaves 1-4 cm long, 3-7 mm wide; heads 10-14 mm wide, 2-12 in a terminal glomerule; pistillate flowers 100-150, pseudohermaphroditic flowers 10-21 ..... *M. sarmentosum*

1′ Leaves 3-7 cm long, 2-3 mm wide; heads 6-9 mm wide, 15-25 in a spiciform capitulescence; pistillate flowers 40-50, pseudohermaphroditic flowers 5-6 ..... *M. mexicanum*

Mexerion mexicanum Nesom, *sp. nov.* (Figure 1). TYPE: MÉXICO. Chihuahua: [Mpio. Guadalupe y Calvo], Sierra Mohinora, about 3 mi S of La Rocha, on grassy pine slope, near and about waterfall (tributary of Río del Soldado), 7000 ft, 18 Oct 1959, *D.S. Correll & H.S. Gentry 23225* (LL).

Mexerion sarmentoso (Klatt) Nesom similis sed foliis longioribus angustioribus et capitulis numerosioribus angustioribus flosculis multo paucioribus differt.

Stems 20-35 cm tall. Leaves strongly bicolored, densely and closely sericeous beneath, green glabrescent above, linear-lanceolate, sessile, ascending, 3-7 cm long, 2-3 mm wide, the cauline little reduced upward. Heads 6-9 mm wide, campanulate-cylindric, 15-25 in a dense, spiciform capitulescence 3-8 cm long with long, bracteal leaves similar to the upper cauline; phyllaries graduated in 5-6 series with the inner 12-14 mm long. Pistillate flowers ca 40-50 in 3-4 series, the corollas 6-7 mm long. Hermaphroditic flowers 5-6, 8-9 mm long. Achenes 1.0-1.3 long. Pappus of 45-50 bristles.

Additional collection examined: MÉXICO. Chihuahua: [Mpio. Guadalupe y Calvo], Sierra Chinatu, San Juan, on rocky open pine slope, 8900 ft, 8 Oct 1959, *Correll & Gentry 22924* (LL).

Mexerion mexicanum differs from *M. sarmentosum* in its longer and narrower leaves and in its narrower, more numerous heads with many fewer flowers. The new species also appears to grow in significantly lower and less alpine or alpine like habitats. The population systems of the two species are separated by more than 1100 kilometers (Figure 2), but both species occupy areas

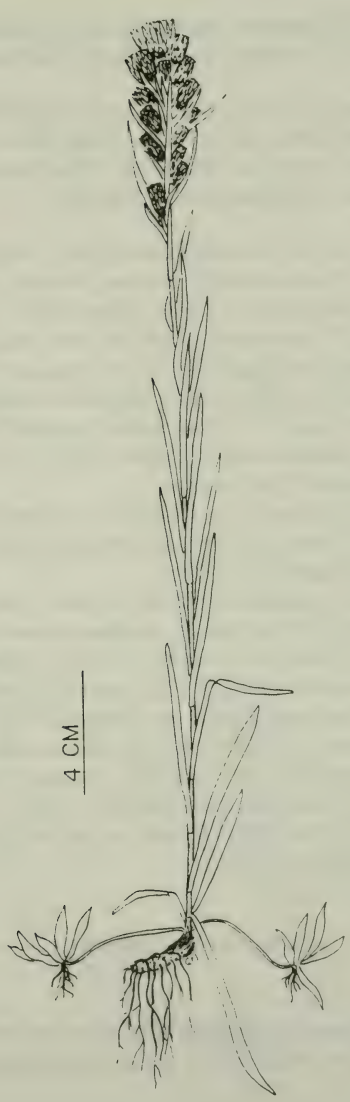

Figure 1. Habit of *Mexerion mexicanum*, from *Correll & Gentry 22924*.

of high elevation. The Chihuahuan plants are in the area of Cerro Mohinora, the highest elevation in the western Sierra Madre (Goldman 1951).

Mexerion sarmentosum (Klatt) Nesom, *comb. nov.* BASIONYM: *Gnaphalium sarmentosum* Klatt, Jahrb. Hamb. Wiss. Anst. 126. 1892. TYPE: MÉXICO. México: about the timberline of the Nevado de Toluca, 6 Sep 1896, *C.G. Pringle 4249* (Isotypes: F-2 sheets!).

Stems 1-15(-30) cm tall or sometimes completely reduced and the plants appearing acaulescent. Leaves strongly bicolored, densely and closely sericeous beneath, green glabrescent above, obovate-oblanceolate to lanceolate, sessile, ascending, 1-4 cm long, 3-7 mm wide, the cauline little reduced upward. Heads 10-14 mm wide, campanulate-cylindric, 2-12 in a compact, terminal glomerule immediately subtended by cauline leaves; phyllaries graduated in 5-7 series with the inner 7-10 mm long. Pistillate flowers ca 100-150 in 4-5 series, the corollas 6-7 mm long. Hermaphroditic flowers 10-21, 7-9 mm long. Achenes 1.0-1.3 mm long. Pappus of 42-48 bristles.

México, volcanic mountains in the states of Veracruz, Puebla and México; alpine meadows, grassy clearings among scattered junipers or pines; (2800-) 3500-4150 m; flowering August-November.

Additional collections examined: MÉXICO. Edo. México: Popocatepetl, Sep 1908, *Purpus 3032* (F); Ixtaccihuatl, meadows above timberline, Oct-Nov 1905, *Purpus 1520* (F); Tlaloc, near summit of mtn., above timberline, 4100-4140 m, 22 Aug 1958, *Beaman 2320* (TEX); Cima del cerro Tlaloc, zona alpina, 26 km SE de Tequexquinahuac, brecha maderara, (30 km ESE de Texcoco); veg. de *Juniperus monticola* y *Berberis schiedeana* con pastizal, 4050 m, 1 Nov 1984, *García P. & González L. 1931* (F,TEX). Puebla: Pico de Orizaba, SW side of mtn. in cañada, grassy meadow, 3860 m, 10 Sep 1958, *Beaman 2514* (F,TEX). Veracruz: ca 10 mi SSE of Perote on road to Cofre de Perote, 3600 m, 2 Oct 1983, *Turner 15348* (TEX).

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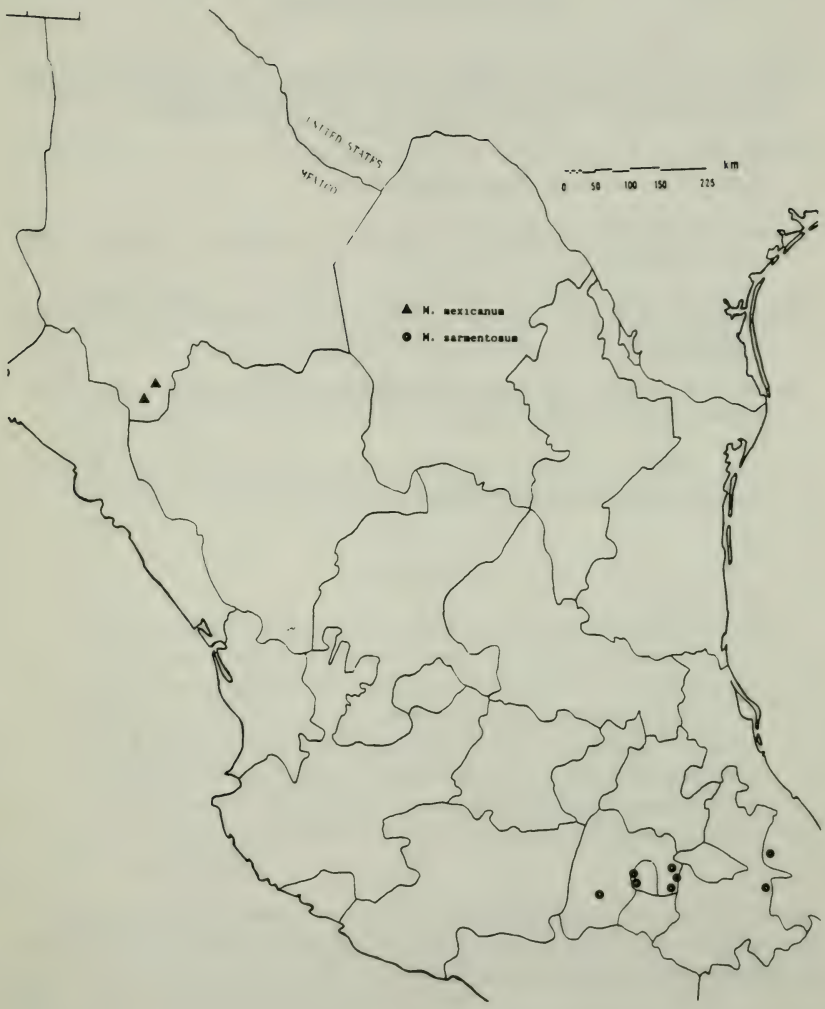

Figure 2. Geographic distribution of the species of *Mexerion*.

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HYMENOCALLIS PIMANA (AMARYLLIDACEAE): A NEW SPECIES FROM NORTHWESTERN MÉXICO

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ABSTRACT

Hymenocallis pimana Laferrière (Amaryllidaceae) is described as a new species from the States of Chihuahua and Sonora, México. It is distinguished from the closely related *H. graminifolia* Greenm. by larger size, longer floral bracts (44-82 mm long), a slightly longer perigone tube (5-10 cm long) and a longer style (11-18 cm long). It is distinguished from *H. sonorensis* Standl. and *H. durangoensis* T. Howard by a larger staminal cup (25-40 mm high and 25-50 mm broad) and narrower leaves (5-11 mm wide).

KEY WORDS: *Hymenocallis*, Amaryllidaceae, México, Chihuahua, Sonora.

RESUMEN

Hymenocallis pimana Laferrière (Amaryllidáceas) se describe como nueva especie de los Estados de Chihuahua y Sonora, México. Se distingue de su congénero más cercano *H. graminifolia* Greenm. por su tamaño más grande, sus brácteas florales más largas (44-82 mm de largo), su tubo del perigonio más largo (5-10 cm de largo), y su estilo más largo (11-18 cm de largo). Se distingue de *H. sonorensis* Standl. y *H. durangoensis* T. Howard por su copa estaminal más grande (25-40 mm de altura y 25-50 mm de ancha), y por sus hojas mas angostas (5-11 mm de ancho).

The genus *Hymenocallis* is a group of approximately 70 species in the Amaryllidaceae, native to the warm regions of the Western Hemisphere. It is a rapidly evolving genus with new species being described rather frequently (Flory 1976, 1977; Raina & Khoshoo 1971).

The Sierra Madre Occidental of the Mexican states of Chihuahua and Sonora is home to a previously undescribed species of this genus. The plant was discussed as "*Hymenocallis* #5" by Bauml (1979) but the plant was not

formally named at that time since no living material and very little herbarium material was then available. I have recently had an opportunity to observe hundreds of living plants in the field, and to collect additional material. The results of this work establish consistent differences between this and previously known species. The plant is therefore described as a new species.

Hymenocallis pimana Laferrière, *sp. nov.* TYPE: MÉXICO. Chihuahua: Mpio. Temósachic, Nabogame, in grassy field near village, 1800 m, 28° 30′N, 108° 30′W, 23 Jun 1988, *Laferrière 1456* (HOLOTYPE: ARIZ; Isotypes: CHAP,ENCB,GH,MEXU,MO,TEX,UC,US). PARATYPES: MÉXICO. Chihuahua: Nabogame, in fruit, 12 Jul 1988, *Laferrière 1508* (ARIZ,CHAP,MEXU); Nabogame, seedlings, 22 Oct 1988, *Laferrière 2168* (ARIZ); Yepachi, in grassy cow pasture, 28° 25′N, 180° 20′W, 15 Jul 1988, *Laferrière 1515* (ARIZ); banks of Río Yepachi, 5 km S of Nabogame, 6 Jul 1988, *Laferrière 1492* (ARIZ); Mesa de Basaseachic, Río Mayo headwaters, 5 Jul 1936, *LeSueur 571* (ARIZ!,F,GH,MO,TEX). Sonora: Maycoba, 14 Jul 1988, *Laferrière 1514* (ARIZ).

Herba perennis, glabra. Radices carnosae, albae. Bulbus 20-65 mm longus, 15-45 mm latus, cum pseudocollo subterraneo 20-90 mm alto. Folia 4-8, ensiformia, interdum gradatim attenuatae infra, 10-60 cm longa, 5-11 mm lata. Scapi 1-2(-3), ancipites, 8-40 cm alti. Bracteae externae subulatae, scariosae, hyalinae, 44-72 (-82) mm longae. Inflorescentia capitata cum floribus (1-)2-6(-8), sessilibus, fragrantibus, erectis; perigonii tubus viridis, 5-10 cm longus; tepala alba, persistentia, effusa, 55-90 mm longa, 1.0-3.5 mm lata; poculum staminale infundibulare, album, 25-50 mm latum ad apicem, 25-40 mm longum, cum base viride leviter decrescente et dentibus 1-6 mm longis et 1-4 mm latis; filamenta 15-40 mm longa, alba infra, viridia superne; antherae luteae, versatiles, introrsae, 11-17 mm longae; stylus exsertus, 11-18 cm longus, viridis superne, albus infra, obtusangule trigonus, interdum spiralis superne; stigma viridis, capitatum, trilobatum; ovarium viridis, triangularis, trilocularis; septa lutea rumpentes ante maturationem; ovula 2-5 in quoque loculum, alba; placentatio axialis ad basalis. Capsula viridis, loculicida. Semina 1-15, viridia, laevia, elliptica ad clavata, germinantia mox post casum et producentia bulbus 2-5 cm longus et 6-12 mm latum.

Herb, perennial, geophytic, glabrous. Roots fleshy, white. Bulbs 20-65 mm high, 15-45 mm broad, with a subterranean neck 20-90 mm high; bulb tunic light brown. Leaves 4-8, ensiform, sometimes very gradually attenuate below, bright green to slightly glaucous, 10-60 cm long, 5-11 mm broad. Scapes 1-2 (-3), ancipitous, 8-40 cm tall. Outer floral bracts subulate, scarious, hyaline, 44-72(-82) mm long. Inflorescence capitate; flowers (1-)2-6(-8), sessile, fragrant,

erect; perigone tube green, 5-10 cm long; tepals white, persistent, spreading, 55-90 mm long, 1.0-3.5 mm wide; staminal cup funnelform, white, 25-50 mm broad at apex, 25-40 mm high, with slightly tapering green base and teeth 1-6 mm long and 1-4 mm broad; filaments inserted between teeth, 15-40 mm long, white below, green above; anthers yellow, versatile, introrse, 11-17 mm long; style exserted, 11-18 cm long, green above, white below, obtusely triangular in cross section, sometimes twisted helically above; stigma green, capitate, 3 lobed; ovary green, triangular, 3 loculate; septa yellow, rupturing before maturity; ovules 2-5 per locule, white; placentation axial to basal. Capsule green, loculicidal. Seeds 1-15, green, smooth, elliptical to clavate, 5-10 mm in diameter, germinating soon after falling and producing a bulb 2-5 cm long and 6-12 mm wide.

Additional specimens cited by Bauml (1979): MÉXICO. Chihuahua: Yepachi, 7 Jul 1970, *Pennington 26* (TEX); Tosanachic, 2000 m, 20 Jun 1947, *Hewitt 217* (GH). Sonora: Sierra Madre, 1891, *Lumholtz Exp. s.n.* (GH); Maicobita [Maycovita], ca 3 km from Maycoba, 1500 m, Jul 1968, *Pennington 183* (TEX).

The plant is named "*pimana*" in honor of the Mountain Pima who detoxified and ate the bulbs of this plant until the early part of this century (Laferrière & Perry, in prep.). The plant is found in sunny locations in fields and along streams, often in the vicinity of past or present human habitation. It forms large colonies of several thousand individuals and hence is extremely conspicuous at anthesis. The size of the type population was estimated at approximately 70-80,000 individuals. Flower buds are formed underground, and the anthers are already yellow before the buds break through the soil surface. This enables the plant to be one of the first species to flower at the start of the rainy season in June or July. Leaves appear simultaneously with the flowers.

The species is assignable to the Mexicana alliance of subgenus *Hymenocallis* (Traub 1962). It is distinguished from the closely related *H. graminifolia* Greenm. by larger size, longer floral bracts, longer perigone tube and longer style (Greenman 1903; Sealy 1954; Bauml 1979), and from *H. sonorensis* Standl. and *H. durangoensis* T. Howard by its broader leaves and larger staminal cup (Standley 1937; Shreve & Wiggins 1964; Bauml 1979). A key separating these four taxa is as follows:

1. Staminal cup 15-25 mm high and 15-26 mm broad; leaves (8.5-)10-23(-30) mm broad 2

    2. Perigone tubes (6.5-)7-13 cm long; style 11.8-20.3 cm long; lowland Sonora, Sinaloa and Nayarit below 1500 m *Hymenocallis sonorensis*

    2′ Perigone tubes (3.3-)4-5.4(-7) cm long; style 7.9-12 cm long; Durango *Hymenocallis durangoensis*

1′ Staminal cup 25-40 mm high and 25-50 mm broad; leaves 4-11 mm broad 3

3. Scapes 8-40 cm tall; flowers (1-)2-6(-8); floral bracts 44-82 mm long; perigone tube 5-10 cm long; style 11-18 cm long; montane Chihuahua and Sonora above 1500 m ..... *Hymenocallis pimana*

3′ Scapes 6-16 cm tall; flowers 1-2(-4); floral bracts 25-40 mm long; perigone tube 3-5 cm long; style 9.8-12 cm long; central Morelos ..... *Hymenocallis graminifolia*

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MISCELLANEOUS NOTES ON NEOTROPICAL FLORA XVIII. NEW SPECIES IN THE HUMIRIACEAE

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ABSTRACT

Four new species of Humiriaceae are described: **Schistostemon fernandezii** J. Cuatrec. and **Humiriastrum ottohuberi** J. Cuatrec. from the Venezuelan Guayana and **Vantanea morii** J. Cuatrec. and **Vantanea bahiaensis** J. Cuatrec. from Brazil.

KEY WORDS: Humiriaceae, *Humiriastrum, Schistostemon, Vantanea*, Brazil, Venezuela.

In the process of working on the Humiriaceae for the Flora of the Venezuelan Guayana, in preparation by the Missouri Botanical Garden, and through the study of a great number of Brazilian specimens recently received at US for identification, four new species were detected. Their descriptions are here provided.

Humiriastrum ottohuberi J. Cuatrec., *sp. nov.* TYPUS: VENEZUELA. Amazonas: Río Casiquiare, arriba de Solano, 100 m alt, tree 8 m tall, trunk about 50 cm diam., flowers green, leaves coriaceous dark green above, 8 Apr 1970, *Julian A. Steyermark & George Bunting 102442* (HOLOTYPE: US; Isotype: US).

Arbor mediocris. Rami juveniles resinosi et dense minuteque hirsutuli. Folia alterna breviter pseudopetiolata. Lamina adaxialiter atroviridis, tenuiter coriacea sed rigida, late elliptica vel obovato-elliptica, utrinque obtusa, apice vulgo subite obtuse apiculato, basi subite cuneata pseudo-petiolata, 4-7 x 2.5-4.8 cm, apiculo (3-5 mm) excluso, margine integra vel obsolete subcrenata, costa adaxialiter sicut petiolo minute hirtula, in vetusta glabrata, superficie occulo nudo utrinque laevis enerviaque, sed nervis secundariis patulis 1 mm inter se distantibus sub lente saepe subtilissime notatis, et abaxialiter epidermo minutissime papillato glanduloso signato. Pseudo-petiolus 1-3 mm longus.

Inflorescentiae cymoso-paniculatae, dichasialiter et monochasialiter ramificatae, 3-6 cm longae, axillares quam folia breviores; pedunculi 1-2 cm longi; rami articulati saepe ancipitati sicut pedunculi minutissime denseque erecto-pilosi subvelutini; ramusculi ultimi cymas breves subglomeratas floribus sessilibus vel subsessilibus ferentes. Bracteae persistentes, ovatae obtusiusculae vel proximales triangulares, 0.5-1 mm longae, sparse minuteque pilosae, margo ciliatae, base ramos ramulosque amplectentes.

Alabastra sessilia vel subsessilia 2 mm longa ovata obtusa, sparse minuteque hirtula. Calyx quincuncialis circa 1.3 mm longis sepalis 5, basi coalitis, parte libera orbiculari crassiuscula extus glabra resinoso-punctata, margine minute ciliata 0.8 mm longa lataque. Petala 5, oblonga 3-3.2 x 1.4 mm crassiuscula margine anguste membranacea, distaliter paulo attenuata apice obtuso, vel subacuto, basi subite contracta 0.6-0.7 mm lata, adaxialiter glabra laevia, abaxialiter epidermide glandulata, sursum hirtula pilis minutis semipatulis acutis albis antrorsis. Stamina 20: decem longiora circa 2 mm longa, cum decem 0.5 mm breviora alternantia, filamentis glabris complanatis distaliter acutis, base in tubo coalitis. Antherae 0.8 mm longae, connectivo crasso acuminato, thecis albis ellipticis basale affixis 0.2 mm. Discus crasse membranaceus cylindraceo-cupularis argute dentatus, 0.7 mm altus ovarium cingens. Ovarium depresso-globosum, laeve glabrum, 5-tabicatum, 5 cavitatis uniovulatis, tantum 3-2 ovulis oblongo-ellipticis 0.5-0.6 mm longis evolutis. Stylus crassiusculus brevis 0.6 mm. Stigma capitato-stellata radiis albis glutinosis.

Fructus drupaceus ellipsoideus vel subrotundatis 3 x 2.5 cm, exocarpio crasso, endocarpio lignoso anfractuoso cavernoso, cavitatis resiniferis, in specimine forsans inmaturus.

Another collection: VENEZUELA. Amazonas: Depto. Río Negro, selvas pluviales de rebalse del Bajo Pasimoni entre la boca y Laguna Buridajao, 19 Apr 1985, *Stergios, Aymard & Nico 8327* (US).

This new species differs from *Humiriastrum colombianum, H. excelsum* and *H. glaziovii*, mainly by the shape of the thinly leathery leaves which are abruptly obtuse-apiculate, as well as by the very minute hirtellous indument of the branchlets and by the persistence of the bracts. The name is dedicated to Dr. Otto Huber, who recently has contributed considerably to the knowledge of the distribution and ecology of the Humiriaceae in the Venezuelan Guayana with rich collections and sound annotations.

Schistostemon fernandezii J. Cuatrec., *sp. nov.* TYPUS: VENEZUELA. Bolívar: Gran Sabana, South of Urimán (4-9 km), margin of Laguna Ca-

paura, 440 m. alt., Arbol 4.5 m, estambres ocres, Mar 86, *Angel Fernández 2276* (HOLOTYPE: US; Isotypes: VEN,MY).

Arbor ad 4 m alta. Rami foliati terminales teretes nitidi, hirtuli pilis minutissimis unicellularibus acutis patulis. Folia alterna petiolata. Petiolus 3-6 mm longus crassiusculus glaber adaxialiter planus, abaxialiter rotundus, basi breviter incrassati-pulvinatus. Lamina rigide coriacea, ovato-elliptica vel elliptica apice attenuata vulgo 0.5-1 mm cuspidata acutaque, basi rotundata vel breviter obtuseque angustata, 5-10 x 3-5.8 cm plus apiculo 0.5-1 cm longo, margine integerrima; superficie glabra, adaxialiter nitida laevis brunnescenti-viridis, costa ampla plana vel paulo elevata nervis secundariis 7-8 utroque latere parce prominulis cum venulis discoloribus (luteolis) laxi-reticulatis, abaxialiter costa prominenti reliquis nervis venulisque leniter notatis vel obsoletis.

Inflorescentiae axillares 1.5-3 cm longae, conferte cymosae paniculatae, pedunculo (axis) robusto ancipitato ad 6 mm longo vel brevissimo, ramis monochasialiter raro dichasialiter ramificatis robustis brevibus intricatis, omnibus sicut axe dense hirtulis pilis minutis rigidis acutis patentibus. Bracteae persistentes, deltoides semiamplectentes acutae vel subacutae 1-0.5 mm longae.

Alabastra maturitate viridula late-oblonga obtusiuscula vel apice subacuto, 3 x 1.5 mm, minutissime hirtula. Flores per anthesin 7-8 mm diam. Calyx quincuncialis sepalis orbicularibus 1-1.2 mm longis 1.3-1.5 mm latis, basi breviter in annulum coalitis, praeter marginem minute ciliolatum glaberrimis, sed epidermo resinoso. Petala 5, rigide carnosula oblonga acutiuscula, 3-3.3 x 1.2 mm, abaxialiter hirtula pilis minutis unicellularibus antrorsis vel patulis albis. Stamina 20, filamentis complanatis basi in tubo circa 1 mm longo coalitis; 5 filamenta oppositisepala longiora, 3 mm longa, apice breviter trifurcata et triantherifera, unumquidque cum anthera centrali 0.8 mm longa connectivo crasso obtusissimo castaneo thecis duobus ellipticis luteis lateraliter ad basem affixis, et 2 antheris lateralibus brevibus, 0.3 mm, fortasse sterilibus; 5 filamenta oppositipetala paulo breviora, 2.5 mm longa monantherifera antheris latis quam praecedentibus fertilibus similiter; 10 filamenta minora interposita, 2 mm longa, cum antheris singulis 0.5-0.6 mm longis perfecte fertilibus. Grana pollinica glutinose glomerata alba. Discus cylindricus, 0.8 mm altus, 20-acuti-dentatus, ovarium cingentem, in 5 squamas faciliter fragmentabilis. Ovarium globosum 1.5 m altum glabrum saepe 3 ovulis oblongis 0.6 mm longis inter fibras et cavas resinosas. Stylus brevis robustus glaber 0.3 mm longus. Stigma plano-capitata et 5-stellata radiis valde glutinosis.

Fructus drupaceus 2.4-2.8 x 1.9-2 cm, ellipsoideus, oliviformis superficie laevissima nitida viridi-olivacea; exocarpium 1 mm crassum; endocarpium lignosum ellipsoideum 2.6 x 2.1 cm fere laeve moderatissime sinuatum, extus 5-sulcatum sulcis angustissimis ad apicem latioribus parce foveolatis, interiore saepe semina unica oblonga in cavitate 10 x 4.5 mm, reliqua parte ubique cavitatis rotundatis inaequalibus resiniferis vel vacuis instructa.

Other collection: VENEZUELA. Bolívar: Expedition to Auyan-tepui, near Guayaraca above Valle de Camarata, 1000 m, Rocky edge of escarpment, Shrub 1-2 m, sprawling, leaves deep green above, yellow green below, fruit not edible, broadly oblong, 3 x 2.5 cm (probably immature), 8 May 1964, *J. Steyermark 94197* (US,NY).

This species is closely related to *Schistostemon auyantepuiense* from which it differs by the brownish-green, rigid leaves with nerves loosely reticulate above and almost smooth abaxially, and by the smaller flowers, their petals being 3-3.3 mm long. The young branchlets are hirtellous. *Schistostemon auyantepuiense* has leaves dark green, prominently minute reticulate on both sides, the petals are 4-4.5 mm long and the young branchlets glabrous (not pilose as written in the original description).

Vantanea bahiaensis J. Cuatrec., *sp. nov.* TYPUS: BRAZIL. Bahía: Municipio Belmonte, Itapebí, beira da estrada, Árvore com 8 m de altura, folha discolor, flores com calice amarelo-esverdeado, petas amarelo-esverdeado, frutos imaturos verdes, 1 Ago 1981, *A.M. de Carvalho & José Gatti 484* (HOLOTYPE: NY; Isotype: US). PARATYPES: BRAZIL. Bahía: Belmonte km 1, a 10 do ramal (de cima) p/Mogiquiçaba, mata litoranea, arvor de 8 m alt, flores esverdeadas, anteras amarelas, 17 Abr 1975, *T.S. Santos 2983* (US); Prado, árvore 6 m alt, flor crema, anteras amarelas, 21 Jan 1974, *T.S. Santos 2737* (US).

Arbor parva ad 10 m alta. Rami ramusculique glabri. Folia alterna coriacea firma petiolata glabra. Lamina obovata apice late-rotundata, vel obtusa, basim angustato-cuneata, (4.5-)6-9 x (3.4-)4-6.4 mm, margine integra, adaxialiter nervis parum visibilis, abaxialiter costa prominenti, nervis secundariis parallelis prominulis 10-12 utroque latere prope marginem arcuatis anastomosatisque, saepe nervis brevioribus minus signatus parallelis cum praecedentibus alternatis, venis minoribus prominulis laxe reticulatis plus minusve notatis. Petiolus gracilis basi parce incrassatus 10-16 mm longus.

Inflorescentiae terminales vel subterminales saepe floribundae cymoso-paniculatae corymbiformes, 6-10 cm longae, 6-10 cm expansae, interdum 2-3 subterminales synflorescentia valde floribunda

ad 20 cm lata instructae. Ramificatio monochasialis interdum dichasialis in angulo acuto, ad modum articulata. Rami ramusculi pedicellique dense minuteque hirtuli, minute tomentoso-velutini. Ramuli distales saepe breves glomerulos paucifloros formantes. Pedicelli crassi 0.5-1.5 mm cum floribus adnati. Bracteae oblongae ca 0.6 mm longae parce attenuatae obtusae jam deciduae.

Alabastra 4-5 mm longa pyramidata subacuta glabra vel subglabra. Pedicelli brevi crassi ca 1 mm, ad florem adnati. Flores per anthesin ca 10-12 mm diam albi. Calyx quincuncialis; sepala 1-1.2 mm alta, 1.5-2 mm lata basi coalita, apice late rotundata, dorso incrassata saepe 1(-3) glandulis munita, glabra vel subglabra margine minutissime ciliata. Petala 4-5.8 x 2.1-2.3 mm, crassiuscula oblonga sursum gradatim attenuata apice subacuto margine uno latere membranacea, basi ungui ovato vel quadrato 0.7-1 mm longo latoque, aestivatione contorta, abaxialiter dorso sparsis minutis pilis adpressis vel pilis minutis crassiusculis resiniferis patulis. Stamina saepe 30-40, interdum 26; filamenta 3.5-3.8 mm longa cum altera breviora 2.5-3.2 mm alta alternantia, complanata distaliter filiformia basi in annulum 0.7-1 mm altum crassiusculum coalita glabra. Antherae 0.8 mm longae dorsaliter circa basim affixae, connectivo ovato-acuminato acuto, thecis duobus ellipticis bilocularibus 0.5-0.6 mm longis laterale affixis, longitudinalibus dehiscentibus. Discus intrastaminalis crassus crenato-acutidentatus glaber cupulariformis basim ovarium cingens, 1 mm altum. Ovarium rotundatum 1.8-2 mm diam argute striatum supra depressum sed ad centrum conicum, dense minuteque tomentoso-velutinum, 5-septatum, loculis biovulatis, ovulis superpositis oblongis, 0.6-0.7 mm longis. Stylus brevis, 1-1.5 mm longus, crassiusculus inferne hirtellus, distale glaber. Stigma capitatum breviter lobatum lobis planis obtusis erectis glutinosis.

Fructus drupaceus ellipsoideus utrinque obtusus, 22 x 18-19 mm, exocarpio brunnescenti minute velutino coriaceo ruguloso resinoso ca 1 mm crasso. Endocarpium ellipticum obtusum 20-21 x 16-17 mm, brunnescenti-luteolum sinuato-rugulosum compactissime lignosum, 1-3 cellis monospermis seminibus oblongis, 5 valvis oblongis longitudinale bene signatis ca 17-18 mm longis, 4-5 mm latis.

Additional collections: BRAZIL. Bahía: Itabuna, km 80 between Betanha and Canavieiros, tree 4 m, fruits, 13 Jul 1964, *N.T. Silva 58410* (US); Ilhéus, km 22 de S. Luzia a Canavieiras, árvore 8 m, fl. branca, anteras amarelas, restinga alta, 27 Apr 1972, *Santos 2290* (US); Mun. Canavieiras a 22 km W, mata perturbada de piaçava, árvore 9 m x 5 cm frutos verdes, 13 Jul 1978, *Santos & Silva 3287* (US); Ramal da Fez, Campo Lucio, arborezinha 3 m, fl.

botoes, fr. verdes, 4 Jun 1981, *Hage & Santos 906* (US); Rodovia Camacan, restinga, arbusto 2 m, fl. brancas, estamos amarelos, 11 Apr 1965, *Belém & Magalhaes 748* (US); Restinga, arb 2-3 m, fl. brancas, est. amar., fr. verdes, 28 Jun 1966, *Belém & Pinheiro 2418* (US); Municipio de Marau, rod. BR 030, Ubaita/Marau, restinga e campos naturais, árvore 10 m x 40 cm, 12-13 Jun 1979, *Mori, Carvalho, et al. 11983* (US); Municip. Belmonte, direc. Itapebí, Río Ubú, ramal km 30, mata solo arenoso, arvorezinha 5 m x 10 cm, fl. esverdeadas, fr. verdes, 18 May 1979, *Silva, Ribeiro & Brito 403* (NY,US); Mata costera, arbusto 3 m, fl. brancas, cálice verde, fr. verdes, 30 Jan 1967, *Belém & Pinheiro 3215* (US); Ramal para Mogiquiçaba, Itapeibí-Belmonte, mata higrofila Sul Bahiana, mata raleada por extractores de piaçava, solo arenoso, 100 m alt, 9 Jul 1980, *Silva & Brito 960* (US); Restinga, arbusto, fl. cremes, estames amarelos, fr. verdes, 6 Jul 1966, *Belém & Pinheiro 2496* (NY).

Vantanea bahiaensis seems to be restricted to, but widespread in the state of Bahía, Brazil. It can be easily distinguished by the shape and size of the rather thinly coriaceous, glabrous leaf blades, with secondary nerves marked below, and petioles 10-15 mm long. In addition, it is characterized by the subglabrous petals 4-5.8 mm long, with short, very minute hairs, by the 30-40 stamens, by the striate ovary, shortly velutinous-tomentous, and the size of the fruit, perfectly elliptic, rounded at both ends, with thin exocarp and with endocarp of the same shape. The synflorescences are terminal or subterminal, and densely and shortly hirtulous.

Vantanea morii J. Cuatrec., *sp. nov.* TYPUS: BRAZIL. Bahía: Mun. Andarai, velha estrada entre Andarai e Mucugê via Igatu, a 2 km ao Sur de Igatu, 800 m alt., Campo rupestre, arbusto escandente prostrado emcima de pedras, 23 Dez 1979, *S.A. Mori & F.P. Benton 13181* (HOLOTYPE: US; Isotype: NY).

Arbuscula interdum scandens, valde ramosa ramis terminalibus striatis glabris. Folia alterna coriacea rigida brunnescenti-viridia breviter petiolata glabraque. Petiolus 2-5 mm longus. Lamina rotundato-elliptica vel elliptica apice rotundata, basi late obtusa subite breviterque cuneata, margine integra, 5-7.5 x 3.2-4.7 cm, costa supra impressa, abaxialiter firma elevata, nervis secundariis utrinque circa 10 utroque latere patentibus, 45-60° divergentibus, filiformibus sed prominentibus prope marginem arcuatis anastomosatisque, nervis brevioribus parallelis alternantibus saepe praesentibus, venis tertiariis venulisque paulo prominulis laxissime reticulatis utrinque quoque bene notatis. Superficie laminorum utrinque lucida densisimeque impresse resinoso-glandulata punctata, interdum insuper abaxialiter minute glanduloso-papillata. Inflorescentiae cymosae thyrsoideo-paniculatae, 4-6 cm longae et latae,

ramis alternis laxe patentibus vel subpatulis crassiusculis rigidis striolatis, minute hirtulo-puberulis, terminalibus flores subsessiles glomeratos ferentibus. Pedicelli crassiusculi saepe 1 mm longi. Bracteae late semirotundatae 1-0.5 mm longae, 1 mm latae amplectentes minute hirtulae jam deciduae. Calyx praefloratione quincuncialis. Sepala 5 rotundata basi in annulum coalita, 0.8 mm longa, 1.2 mm lata, glabra sed margine minutissime ciliata, abaxialiter minute immersi-glandulata. Petala 5 oblonga sursum attenuata obtusa, 4 mm longa, proximaliter 1.6 mm lata, crassiuscula glabra alba. Filamenta complanata uniseriata 21-26 breviter (0.5 mm) basi coalita, longiora 2.8-3 mm longa cum breviora 2.2 mm longa alternantia antherae 0.7-0.8 mm longa connectivo crassiusculo acuto, thecis duobus bilocularibus ellipticis albidus 0.4-0.5 mm longis, locis 2, longitudinalibus dehiscentibus. Discus intrastaminalis glaber squamis crassiusculis 22, acutis in cylindrum 0.9-1 mm altum acutidentatum ovarium cingentem adnatis. Ovarium glabrum pyriforme 1.5 mm longum 5-septatum, cellis biovulatis cum ovulis superpositis. Stylus robustus 0.6-0.7 mm longus. Stigma capitatum breviter 5-lobatum lobis glutinosis.

Drupa subglobosa ca 17 x 16 mm in sicco, exocarpio laevi 1 mm crasso. Endocarpium lignosum 15 x 14 mm, subrotundum sublaeve 5 cavitatis monospermis, 5 valvis subaequilongis longitudinalibus, ca 3.5 mm latis instructis. Semina oblonga 6 x 2.5 mm.

Other specimen: BRAZIL. Bahía: Mun. Andarai, velha estrada entre Andarai e Mucugê via Igatu, com entrada km 7 entre os kms 2 e 8 deste desvio, afloramento de rocas, 900 m, arvorezinha 3 m altura, flores em botoes verdes, 12 Jan 1983, *L.A. Matos Silva, Elton M.C. Leme, et al. 1613* (US).

Vantanea morii is characterized by the leaves rather small, moderately coriaceous, rigid, obtusely elliptic, often almost round, with a very short petiole, by the branchlets glabrous and those of the inflorescences minutely patent-hirtous, and by the small flowers with petals and ovary glabrous. The most distinctive character of this species is the low number of stamens, 21 to 26, all flat and in one row like in other genera of the family. The genus *Vantanea* is known for its numerous stamens, from 50 to 150, or more, with usually filiform filaments; only occasionally in some flowers of a few species of the genus have been counted fewer stamens, down to 30. Although the flowers of *V. morii* resemble those of *Humiriastrum*, the bilocular thecae of the anthers, the biovular cells of the ovary and the structure of the endocarp with the typical long germinal valves, indicate placement of the species in *Vantanea*.

The species is named for Dr. Scott Mori, who collected the type species and called attention to the singular floral structure of his collection.

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NOMENCLATURAL CHANGES IN PORTULACACEAE

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ABSTRACT

Species of *Calyptridium, Calandrinia, Claytonia, Lewisia* and *Talinum* are recombined under *Cistanthe*. The nomenclatural changes reflect new morphological and cladistic data on Portulacaceae.

KEY WORDS: *Cistanthe, Calyptridium, Spraguea, Calandrinia, Lewisia, Claytonia, Talinum*, Portulacaceae, taxonomy.

Critical re-examination of Carolin's (1987) cladistic analysis of Portulacaceae and corroboration with leaf morphological data (Hershkovitz 1990), support the segregation of *Cistanthe* Spach from *Calandrinia* H.B.K. The latter study also indicates that *Calyptridium* Nuttall (including *Spraguea* Torrey), cannot be excluded from *Cistanthe* on phylogenetic, and perhaps even phenetic, criteria. Therefore, these segregate taxa are here regarded as comprising a distinct section within *Cistanthe*, and the species recognized by Hinton (1975) are recombined as follows:

Cistanthe Spach sect. **Calyptridium** (Nuttall *in* Torrey & A. Gray) Hershkovitz, *stat. nov.* BASIONYM: *Calyptridium* Nuttall *in* Torrey & A. Gray, *Fl. N. Amer.* 1(2):198. 1838. TYPE: *Calyptridium monandrum* Nuttall *in* Torrey & A. Gray, *Fl. N. Amer.* 1(2):198. 1838.

Spraguea Torrey, *Pl. Frémont.* (Smithsonian Contr. Knowl. 6[2] [err., 5(1)]):4. 1853. TYPE: *Spraguea umbellata* Torrey, *Pl. Frémont.* (Smithsonian Contr. Knowl. 6[2] [err., 5(1)]):4. 1853.

Included species:

Cistanthe monandra (Nuttall *in* Torrey & A. Gray) Hershkovitz, *comb. nov.* BASIONYM: *Calyptridium monandrum* Nuttall *in* Torrey & A. Gray, *Fl. N. Amer.* 1(2):198. 1838.

Cistanthe monosperma (E. Greene) Hershkovitz, *comb. nov.* BASIONYM: *Calyptridium monospermum* E. Greene, Erythea 3:63. 1895.

Cistanthe parryi (A. Gray) Hershkovitz, *comb. nov.* BASIONYM: *Calyptridium parryi* A. Gray, Proc. Amer. Acad. Arts 22:285. 1887.

Cistanthe pulchella (Eastwood) Hershkovitz, *comb. nov.* BASIONYM: *Spraguea pulchella* Eastwood, Bull. Torrey Bot. Club 29:79. 1902.

Cistanthe pygmaea (Parish *ex* Rydberg) Hershkovitz, *comb. nov.* BASIONYM: *Calyptridium pygmaeum* Parish *ex* Rydberg, *N. Amer. Fl.* 21:320. 1932.

Cistanthe quadripetala (S. Watson) Hershkovitz, *comb. nov.* BASIONYM: *Calyptridium quadripetalum* S. Watson, Proc. Amer. Acad. Arts 20:356. 1885.

Cistanthe rosea (S. Watson) Hershkovitz, *comb. nov.* BASIONYM: *Calyptridium roseum* S. Watson, *Botany* (fortieth parallel) 44. 1871.

Cistanthe umbellata (Torrey) Hershkovitz, *comb. nov.* BASIONYM: *Spraguea umbellata* Torrey, *Pl. Frémont.* (Smithsonian Contr. Knowl. 6[2] [err., 5(1)]):4. 1853.

Followup on Hohn's (1975) studies of *Lewisia* and corroboration with leaf data (Hershkovitz 1990), indicate that plants referred to "*Lewisia tweedyi*," also belong to a separate section of *Cistanthe*. This species had been assigned to the monotypic *Lewisia* subg. *Strophiolum*. The name *Strophiolum* is retained as the sectional name in *Cistanthe*, although it is misleading, because other members of *Cistanthe* are strophiolate.

Cistanthe Spach sect. **Strophiolum** (B. Mathew) Hershkovitz, *comb. nov.* BASIONYM: *Lewisia* subg. *Strophiolum* B. Mathew, *The Genus Lewisia* 139. 1989. LECTOTYPE (here designated): *Calandrinia tweedyi* A. Gray, Proc. Amer. Acad. Arts 22:277. 1887.

Included species:

Cistanthe tweedyi (A. Gray) Hershkovitz, *comb. nov.* BASIONYM: *Calandrinia tweedyi* A. Gray, Proc. Amer. Acad. Arts 22:277. 1887. ≡ *Lewisia tweedyi* (A. Gray) B.L. Robinson *in* A. Gray, *Syn. Fl. N. Amer.* 1(1):268. 1897.

The remaining sections of *Cistanthe* are established herein, following the circumscriptions proposed by Carolin, later modified by Hershkovitz (1990 and in prep.). New combinations for the type species are provided as necessary. The taxonomy of most South American species of *Cistanthe* remains chaotic (Hershkovitz 1990), hence their transfer from *Calandrinia* is delayed (Hershkovitz in prep.). The remaining North American species, however, are sufficiently distinct to be recombined under their assigned sections below:

Cistanthe Spach sect. **Amarantoideae** (Reiche) Carolin *ex* Hershkovitz, *comb. nov.* BASIONYM: *Calandrinia* sect. *Amarantoideae* Reiche, Ber. Deutsch Bot. Ges. 15:501. 1897. LECTOTYPE (here designated): *Calandrinia salsoloides* Barnéoud *in* Gay, *Fl. Chil. (Hist. Fisica y Politica de Chile, Botanica)* 2:502. 1847.

Included species:

Cistanthe salsoloides (Barnéoud *in* Gay) Carolin *ex* Hershkovitz, *comb. nov.* BASIONYM: *Calandrinia salsoloides* Barnéoud *in* Gay, *Fl. Chil. (Hist. Fisica y Politica de Chile, Botanica)* 2:502. 1847.

Cistanthe ambigua (S. Watson) Carolin *ex* Hershkovitz, *comb. nov.* BASIONYM: *Claytonia ambigua* S. Watson, Proc. Amer. Acad. Arts 17:365. 1882.

Cistanthe Spach sect. *Cistanthe* BASIONYM: *Cistanthe* Spach, *Hist. Nat. Veg. Phan.* 5:229. 1836. LECTOTYPE (here designated): *Calandrinia grandiflora* Lindley, Bot. Reg. t. 1194. 1828.

Calandrinia sect. *Cistanthe* (Spach) Reiche, Ber. Deutsch Bot. Ges. 15:501. 1897.

Included species:

Cistanthe grandiflora (Lindley) Carolin *ex* Hershkovitz, *comb. nov.* BASIONYM: *Calandrinia grandiflora* Lindley, Bot. Reg. t. 1194. 1828. ≡ *Cistanthe anceps* Spach *nom. illeg.*

Cistanthe guadalupensis (Dudley) Carolin *ex* Hershkovitz, *comb. nov.* BASIONYM: *Talinum guadalupense* Dudley *in* D. Jordan, *The Fur Seals and Fur-Seal Islands of the Northern Pacific Ocean* 3:282. 1899.

Cistanthe maritima (Nuttall *in* Torrey & A. Gray) Carolin *ex* Hershkovitz, *comb. nov.* BASIONYM: *Calandrinia maritima* Nuttall *in* Torrey & A. Gray, *Fl. N. Amer.* 1(2):197. 1838.

Cistanthe Spach sect. **Philippiamra** (Kuntze) Hershkovitz, *comb. nov.* BASIONYM: *Philippiamra* Kuntze, *Rev. Gen. Pl.* 1:58. 1891. LECTOTYPE (here designated): *Silvaea celosioides* Philippi, *Fl. Atacam.* 22. 1860.

Cistanthe celosioides (Philippi) Carolin *ex* Hershkovitz, *comb. nov.* BASIONYM: *Silvaea celosioides* Philippi, *Fl. Atacam.* 22. 1860.

The recognition of *Cistanthe guadalupense* represents a formal correction of the misplacement of this species by Dudley (1899), whose erroneous assignment of the species to *Talinum* has persisted for many decades.

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VASCULAR FLORA OF TWO WEST LOUISIANA PITCHER PLANT BOGS

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ABSTRACT

The floristic composition and soil characteristics of two west Louisiana pitcher plant bogs are described.

KEY WORDS: Pitcher plant bogs, Louisiana, floristics, *Sarracenia*.

INTRODUCTION

In a previous paper we described the floristic composition of two west Louisiana pitcher plant bogs (MacRoberts & MacRoberts 1988). In the present paper we describe the floristic composition of another two west Louisiana pitcher plant bogs. The reason for undertaking these studies is given in our previous paper: almost nothing has been published about bogs west of the Mississippi delta although a start was made over three decades ago by Rowell (1949) and Kral (1955).

STUDY SITES

Fixit and Woodcock bogs are located in the Kisatchie District of the Kisatchie National Forest, Natchitoches Parish, about 7 km ENE of Lotus at the headwaters of the Bayou L'Ivrogne drainage system, at about 90 m above sea level. They are approximately 0.5 km apart. Fixit measures approximately 0.4 ha and Woodcock about 0.8 ha.

The two bogs are relatively flat with a slight slope and are open with a few scattered pines and shrubs. They are surrounded by elements of upland Longleaf Pine forest at their upper slopes and abut riparian woodland at their lower edges. They occur on fine, slow draining sandy loam that is kept damp through the year by seeps at their upper margins. *Sphagnum* is present in both bogs but is not abundant. The climate is described in our previous paper. Both sites have been variously damaged by logging.

Table 1. Soil Characteristics.

			Exchangeable ions (ppm)			
Site/Sample		pH	P	K	Ca	Mg	OM%
Fixit	1	5.0	5	31	100	24	0.7
	2	4.7	3	28	80	16	0.5
Woodcock	1	4.7	2	32	100	49	0.5
	2	4.9	2	37	80	24	1.1

METHODS

We visited the bogs at two week intervals from April through October 1989. Voucher specimens for each of 55 reported species were collected. Rare or easily identifiable plants were not collected. We follow MacRoberts (1984; 1989) for scientific nomenclature. Two soil samples from the upper 15 cm of each bog were analyzed by A & L Agricultural Laboratories, Memphis, Tennessee.

RESULTS

Table 1 gives soil information for both bogs.

Table 2 lists the species found at the two bogs. Double asterisk indicates presence at Woodcock bog only, single asterisk indicates occurrence at Fixit bog only, and absence of a symbol indicates presence at both bogs.

Table 2. List of Taxa Present at Fixit and Woodcock Bogs

DENNSTAEDTICEAE - *Pteridium aquilinum* (L.) Kuhn.
LYCOPODIACEAE - *Lycopodium alopecuroides* L., *L. appressum* (Chapm.) Lloyd & Underw., *L. carolinianum* L.
OSMUNDACEAE - *Osmunda cinnamomea* L., *O. regalis* L.
PINACEAE - *Pinus palustris* P. Mill., *P. taeda* L.
AMARYLLIDACEAE - *Hypoxis rigida* Chapm.
BURMANNIACEAE - *Burmannia capitata* (Walt.) Mart.
CYPERACEAE - *Carex glaucescens* Ell., *Eleocharis microcarpa* Torr.*, *Eleocharis tuberculosa* (Michx.) Roem. & Schult., *Fuirena squarrosa* Michx., *Rhynchospora globularis* (Chapm.) Small var. *globularis*, *R. glomerata* (L.) Vahl.*, *R. gracilenta* A. Gray, *R. oligantha* A. Gray, *R. plumosa* Ell., *Scleria reticularis* Michx., *S. triglomerata* Michx.**
ERIOCAULACEAE - *Eriocaulon decangulare* L., *Lachnocaulon anceps* (Walt.) Morong.
JUNCACEAE - *Juncus scirpoides* Lam., *J. trigonocarpus* Steud.
LILIACEAE - *Aletris aurea* Walt., *Smilax laurifolia* L.

Table 2 (continued)

ORCHIDACEAE - *Calopogon tuberosus* (L.) B.S.P., *Platanthera ciliaris* (L.) Lindl., *Platanthera integra* (Nutt.) Gray *ex* Beck*, *Pogonia ophioglossoides* (L.) Juss., *Spiranthes cernua* (L.) L.C. Rich.
POACEAE - *Andropogon ternarius* Michx., *Anthaenantia rufa* (Ell.) Schultes, *Dichanthelium acuminatum* (Sw.) Gould & Clark, *D. scabriusculum* (Ell.) Gould & Clark*, *D. scoparium* (Lam.) Gould*. *Muhlenbergia expansa* (Poir.) Trin.**. *Panicum rigidulum* Bosc *ex* Nees, *Panicum verrucosum* Muhl.*, *Panicum virgatum* L., *Paspalum laeve* Michx.*, *Schizachyrium scoparium* (Michx.) Nash.
XYRIDACEAE - *Xyris ambigua* Beyr. *ex* Kunth, *X. baldwiniana* Schultes, *X. caroliniana* Walt.*, *X. difformis* Chapm., *X. drummondii* Malme, *X. torta* Smith.*
ACERACEAE - *Acer rubrum* L.
ANACARDIACEAE - *Rhus copallina* L., *Toxicodendron vernix* (L.) Kuntze.
APIACEAE - *Eryngium integrifolium* Walt., *Oxypolis rigidor* (L.) Raf., *Ptilimnium capillaceum* (Michx.) Raf.
AQUIFOLIACEAE - *Ilex opaca* Ait.*, *I. vomitoria* Ait.
ASTERACEAE - *Aster ericoides* L.. *Chaptalia tomentosa* Vent., *Coreopsis linifolia* Nutt., *Eupatorium fistulosum* Barratt** *E. leucolepis* (DC.) T. & G., *E. rotundifolium* L., *Helianthus angustifolius* L., *Liatris pycnostachya* Michx., *Marshallia tenuifolia* Raf.
BETULACEAE - *Alnus serrulata* (Ait.) Willd.
CAMPANULACEAE - *Lobelia puberula* Michx.**, *L. reverchonii* B.L. Turner.
CAPRIFOLIACEAE - *Viburnum nudum* L.
CLUSIACEAE - *Hypericum fasciculatum* Lam., *H. setosum* L., *H. stans* (Michx.) Adams & Robson.
DROSERACEAE - *Drosera brevifolia* Pursh, *D. capillaris* Poir.
ERICACEAE - *Rhododendron canescens* (Michx.) Sw.**, *Vaccinium corymbosum* L.
FABACEAE - *Tephrosia onobrychoides* Nutt.
GENTIANACEAE - *Bartonia paniculata* (Michx.) Muhl., *Sabatia gentianoides* Ell.
HAMAMELIDACEAE - *Liquidambar styraciflua* L.
LAURACEAE - *Persea borbonia* (L.) Spreng.
LENTIBULARIACEAE - *Pinguicula pumila* Michx., *Utricularia cornuta* Michx., *U. juncea* Vahl, *U. subalata* L.
LINACEAE - *Linum medium* (Planch.) Britt.
LOGANIACEAE - *Cynoctonum sessilifolium* (Walt.) St. Hil., *Gelsemium sempervirens* (L.) St. Hil.

Table 2 (continued)

MAGNOLIACEAE - *Magnolia virginiana* L.
MELASTOMATACEAE - *Rhexia mariana* L. var. *mariana*, *R. petiolata* Walt.
MYRICACEAE - *Myrica cerifera* L., *M. heterophylla* Raf.
ONAGRACEAE - *Ludwigia alternifolia* L., *L. hirtella* Raf.
POLYGALACEAE - *Polygala cruciata* L., *P. incarnata* L.**, *P. mariana* P. Mill., *P. nana* (Michx.) DC., *P. ramosa* Ell.
ROSACEAE - *Aronia arbutifolia* (L.) Pers., *Rubus louisianus* Berger.
RUBIACEAE - *Diodia virginiana* L.
SARRACENIACEAE - *Sarracenia alata* Wood.
SCROPHULARIACEAE - *Agalinis obtusifolia* Raf., *Gratiola pilosa* Michx.
VIOLACEAE - *Viola primulifolia* L.

DISCUSSION

The soils of these two bogs are similar and they in turn are similar to Middle Branch and Strange Road bogs, the sites in Natchitoches Parish described in MacRoberts & MacRoberts (1988). All four bogs are similar to east Texas bogs described by Nixon & Ward (1986).

We recorded 108 taxa for Fixit and Woodcock bogs, representing 71 genera and 41 families. Fixit had 102 taxa and Woodcock, 98 taxa. Strange Road bog and Middle Branch bog had 98 and 106 taxa, respectively.[1] The average number of taxa for the four Natchitoches Parish bogs is 101, which is almost identical to that of the six east Texas bogs studied by Nixon & Ward (1986) which averaged 103 taxa, with a range of 88 to 116. The four Louisiana bogs are also similar in floristic composition to those described for east Texas and contain 90 percent of the 48 species listed by Nixon & Ward (see discussion in MacRoberts & MacRoberts 1988).

Sorensen's index of similarity (see Nixon & Ward 1986) shows that the Natchitoches Parish bogs are similar to each other in number of taxa: Strange Road/Middle Branch (64), Strange Road/Woodcock (74), Strange Road/Fixit (77), Middle Branch/Woodcock (71), Middle Branch/Fixit (73) and Fixit/Woodcock (92). Clearly, Fixit and Woodcock are essentially identical.

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[1] We take this opportunity to correct mistakes in our 1988 paper. *Rhynchospora microcarpa* is *R. globularis* (Chapm.) Small, and is present at both Middle Branch and Strange Road bogs. *Lachnocaulon minus* does not occur at either site. *Lachnocaulon anceps* occurs at both Middle Branch and Strange Road, and *L. digynum* occurs at Strange Road (MacRoberts 1989). *Anthaenantia villosa* is misidentified *A. rufa* (Ell.) Schultes. *Rhododendron oblongifolium* (Small) Millais occurs at Strange Road bog. These modifications raise the total number of taxa we report at Strange Road to 98 but do not alter the number given for Middle Branch.

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CYTOLOGICAL AND BIOCHEMICAL STUDY OF CO-OCCURING DIPLOID, TETRAPLOID AND HEXAPLOID INDIVIDUALS OF *SETARIA VERTICILLATA* (L.) BEAUV. (POACEAE)

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ABSTRACT

Three nearly distinct morphotypes with chromosome numbers of $n = 9$, 18 and 27 were encountered in *Setaria verticillata* (L.) Beauv., collected from the plains of Punjab, India. Morphological and cytological observations were supplemented with data from biochemical studies to assess genetic divergence and to understand the relationships between morphotypes. The three cytotypes exhibited constant variations in several biochemical characters. Some of these were directly related to ploidy level. The cytological behaviour of tetraploids parallels that of an allotetraploid, while that of hexaploids compares well with that of an autoallopolyploid. These observations were further substantiated with information from phenolic compounds and albumin patterns. Phenolic compounds, albumin, globulin and isozyme patterns were highly specific within cytotypes.

KEY WORDS: Angiosperms, Poaceae, *Setaria verticillata*, chemotaxonomy, soluble proteins, free amino acids, starch content, nucleic acids, ascorbic acid, lipids, phenolics, albumins, globulins, isozymes.

Setaria verticillata (L.) Beauv., a member of the tribe Paniceae of the Poaceae, is widely distributed in a variety of habitats on the plains of northwest India. The present study from the plains of Punjab, revealed the presence of three distinct morphological forms which were propagated by seed in the botanical garden under uniform nursery conditions. The garden grown plants compared well to those of the natural populations, suggesting genetic differentiation between the populations. Cytological analysis of the morphotypes growing in nature, as well as those maintained in the botanical garden, showed

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them to be cytotypes at diploid, tetraploid and hexaploid levels with $n = 9$, 18 and 27 respectively (Figure 1). It was considered desirable to supplement the observations on morphological and cytological characters, with data from biochemical studies, in order to assess the degree of genetic divergence and to highlight interrelationships between these taxa.

Material and Methods

The plants for the present study were collected from areas in and around seven major localities on the plains of Punjab (Table 1, Figure 2). Chromosome numbers were ascertained from young inflorescences by the usual acetocarmine technique. Voucher specimens are preserved in the Herbarium, Punjab Agricultural University, Ludhiana (PAU). The diploid, tetraploid and hexaploid taxa did not show any preference for a particular type of habitat but rather existed in a haphazard manner. The relative proportion of the prevailing cytotypes at the investigated sites is presented in Table 1. The morphological features marking these cytotypes from each of the seven localities were maintained under uniform nursery conditions in the botanical garden. A preliminary survey of biochemical characteristics suggested that differentiation in biochemical features paralleled that in morphological features. Ten plants of each cytotype were collected at random from garden grown plants for biochemical analysis. Where leaves were utilized for such studies, they were collected from the tip of erect culms just at the time of emergence of the inflorescence.

Total soluble proteins, starch and soluble sugars were estimated by the methods of Lowry, *et al.* (1951), McCready, *et al.* (1950), Loewus (1952 [for total soluble sugars]) and Shallenberger & Moores (1957 [for chromatographic studies]), respectively. Determination of free amino acids was done by the methods of Lee & Takahashi (1966; [total free amino acid content]) and Consden, *et al.* (1944 [for chromatographic studies]). The estimations of total lipids and ascorbic acid were made by the methods of Folsch, *et al.* (1957) and Aberg (1958) respectively. For the study of phenolic patterns, the method of Frost, *et al.* (1975) was used. The quantitative estimation of nucleic acids (DNA and RNA), was made as per methods of Burton (1956) and Ogur & Rosen (1950), respectively. The method of Davis (1964) was employed for polyacrylamide gel electrophoresis. Staining of proteins, esterase and peroxidase isozymes was done by the method of Weber & Osborne (1969), Tripathi, *et al.* (1983) and Kuhns & Fretz (1978) respectively.

Figure 1. Map showing the relative proportion of 2X, 4X and 6X individuals at each of the seven localities sampled in Punjab.

Table 1. Actual collection sites with vouchers listed. Numbers in parentheses represent sample sizes.

Amritsar Site (Chheharta)

diploids (8)	(4501,4502,4504,4509,4510,4517,4520,4523)
tetraploids (9)	(4503,4505,4506,4507,4514,4515,4521,4522,4524)
hexaploids (7)	(4508,4511,4512,4513,4516,4518,4519)

Kapurthala Site (Khojewala)

diploids (8)	(4553,4557,4558,4559,4562,4563,4569,4570)
tetraploids (5)	(4550,4555,4556,4565,4573)
hexaploids (11)	(4551,4552,4554,4560,4561,4564,4566,4567,4568, 4571, 4572)

Hoshiarpur Site (Nasrala)

diploids (10)	(4527,4528,4529,4532,4533,4539,4542,4543,4545, 4547)
tetraploids (6)	(4530,4534,4535,4537,4541,4546)
hexaploids (8)	(4525,4526,4531,4536,4538,4540,4544,4548)

Jalandhar Site (Dhagri)

diploids (6)	(4575,4579,4582,4586,4588,4598)
tetraploids (10)	(4576,4577,4583,4584,4585,4589,4590,4591,4593, 4594)
hexaploids (8)	(4578,4580,4581,4587,4592,4595,4596,4597)

Ludhiana Site (Dhandari Kalan)

diploids (7)	(4601,4610,4611,4614,4617,4621,4623)
tetraploids (4)	(4600,4605,4609,4612)
hexaploids (13)	(4602,4603,4604,4606,4607,4608,4613,4615,4616, 4618, 4619,4620,4622)

Table 1 continued.

Chandigarh Site (Mani Majra)

diploids (8)	(4627,4628,4629,4632,4636,4637,4641,4646)
tetraploids (7)	(4631,4634,4635,4640,4643,4644,4647)
hexaploids (9)	(4625,4626,4630,4633,4638,4639,4642,4645,4648)

Patiala Site (Rajpura)

diploids (10)	(4650,4651,4653,4659,4660,4662,4668,4669,4670, 4671)
tetraploids (8)	(4652,4654,4655,4656,4665,4666,4667,4673)
hexaploids (6)	(4657,4658,4661,4663,4664,4671)

Results and Discussion

The course of meiosis was perfectly normal in diploid and tetraploid forms. Meiotic irregularities of high order were found in the hexaploid taxa. During Metaphase I (M_I) of the hexaploids, univalents and multivalents were found, along with bivalents in some pollen mother cells (PMCs). Laggards were also recorded at Anaphase I (A_I). These aberrations affected the pollen fertility adversely to the degree where only 78% of the pollen grains were determined to be normal. Gupta & Singh (1977), who examined eighteen species of this genus, did not discover diploid taxa in this species. Plant height was observed to increase with increase in ploidy level (Table 2). Increase in internodal length contributed significantly to this increase in plant height. Internodal colour, coupled with plant height proved useful in the identification of cytotypes in the field (Table 2). Of the many leaf characteristics and inflorescence traits that were observed to be directly related with ploidy level, stomatal and pollen grain size proved highly discriminatory (Table 2). Stomatal frequency per unit area, however, decreased with progressively higher levels of ploidy (Table 2). Similar observations were earlier recorded by Sachdeva & Bhatia (1979) and Sachdeva & Kals (1981) in *Cynodon dactylon* and *Dactyloctenium aegyptium* respectively. So much is the constancy and reliability of these characters that they can unambiguously be employed to identify the cytotypes, even when spikes are not at a favourable stage for undertaking meiotic studies.

Biochemical evaluation of the cytotypes revealed considerable intraspecific variation. Variations in DNA, RNA, ascorbic acid, lipids and total soluble proteins were observed to be related to ploidy level (Table 3). Whereas amounts

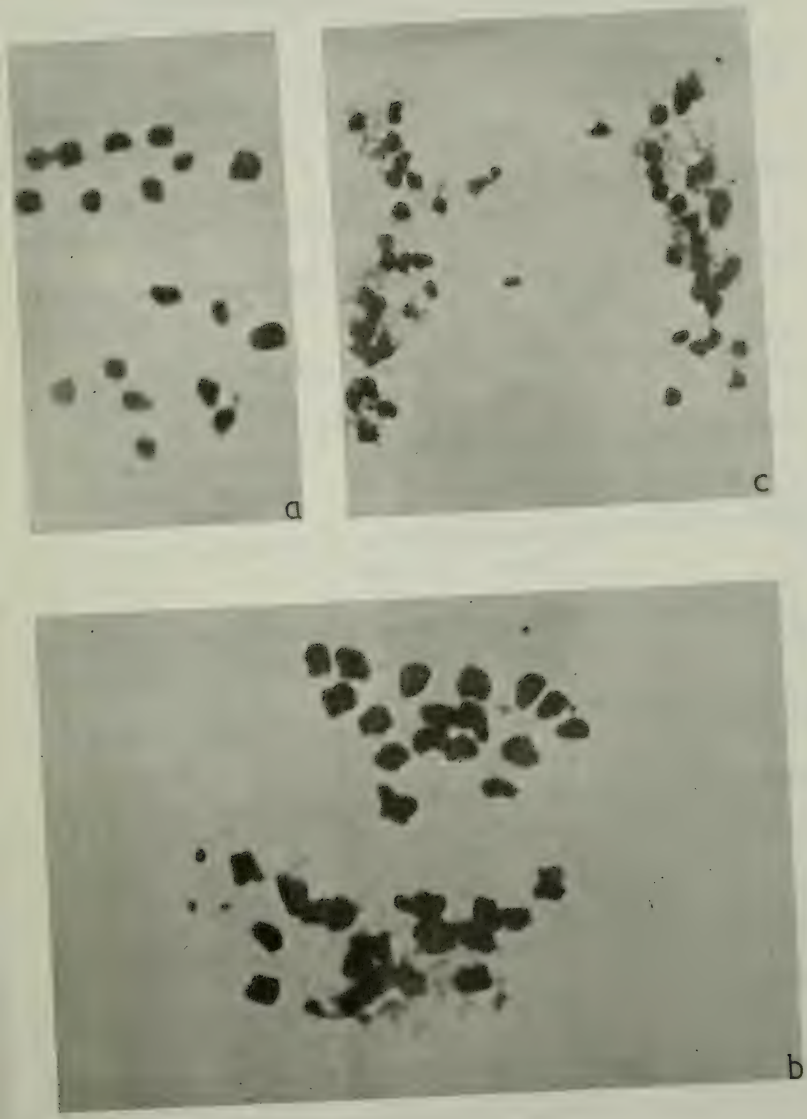

Figure 2. Photomicrographs of meiotic stages of the three cytotypes (all X 1500); a. $n = 9$ at late Anaphase I; b. $n = 18$ at Metaphase II; c. $n = 27$ at Anaphase I.

Table 2. Comparison of some morphological characters in three cytotypes of *Setaria verticillata* (L.) Beauv. ± denotes standard deviation.

Characters		Diploid (n=9)	Tetraploid (n=18)	Hexaploid (n=27)
Vegetative Traits				
Plant height (cm)	Range	12.0-28.0	35.0-60.0	62.0-90.5
	Mean	18.0±3.4	45.2±9.9	78.0±9.2
Internode length (cm)	Range	1.5-3.5	5.5-7.0	6.5-9.0
	Mean	2.6±0.7	6.2±0.7	7.9±1.0
Internode colour		greenish yellow	light green	deep green
Number of leaves per culm	Range	8.0-16.0	8.0-16.0	12.0-17.0
	Mean	14.2±2.5	14.5±2.1	15.0±1.5
Leaf blade length (cm)	Range	6.6-9.2	7.4-15.0	14.0-22.0
	Mean	7.9±1.0	12.5±2.9	17.9±2.8
Leaf blade width (cm)	Range	8.5-15.0	10.0-18.0	14.5-21.9
	Mean	10.5±1.0	13.9±1.8	17.5±2.5
Leaf sheath length (cm)	Range	3.5-4.3	6.3-14.2	6.5-10.0
	Mean	4.4±0.5	10.3±0.7	8.0±0.2
Stomatal frequency (per mm^2)	Mean	52.9±2.2	41.2±1.7	32.9±1.5
Stomata size (μm)	Mean	23.0 x 22.6	26.9 x 25.6	35.2 x 27.8
Floral traits				
Number of spikes per inflorescence	Range	3.0-5.0	4.0-7.0	6.0-8.0
	Mean	3.8±1.5	4.9±0.9	7.2±0.8
Spike length (cm)	Range	2.2-4.4	6.6-9.2	10.3-14.8
	Mean	3.5±0.5	7.9±1.0	12.5±0.7
Spikelet length (mm)	Range	1.1-1.2	1.5-1.9	2.1-2.5
	Mean	0.9±0.1	1.7±0.2	2.2±0.2
Fertile pollen size (μm)	Mean	26.4 x 25.1	34.2 x 32.7	47.2 x 45.0
Pollen fertility	Mean	100%	100%	78%

Table 3. Comparison of different biochemical parameters in three cytotypes of *Setaria verticillata* (L.) Beauv. Values shown are mean ± standard error.

Characters	Diploid (n=9)	Tetraploid (n=18)	Hexaploid (n=27)
Total soluble protein (mg protein/g leaf fresh weight)	6.44±0.06	5.52±0.05	4.84±0.01
Total free amino acid (mg amino acid/g leaf dry weight)	14.4±0.08	13.1±0.02	14.8±0.04
Starch content (mg starch/g leaf dry weight)	81.6±0.32	87.0±0.32	49.5±0.68
Total soluble sugar (mg sugar/g leaf dry weight)	4.6±0.12	3.3±0.08	3.31±0.15
RNA (mg RNA/g leaf dry weight)	6.43±0.17	10.59±0.08	11.19±0.14
DNA (mg DNA/g leaf dry weight)	2.62±0.01	5.19±0.14	9.56±0.09
Ascorbic acid (mg ascorbic acid/100 g leaf fresh weight)	30.8±1.4	35.3±0.9	40.5±1.7
Total lipids (%)	5.9	6.5	7.2

of DNA, RNA, ascorbic acid and lipids increased with increase in ploidy level, the soluble protein content registered a continuous decrease with increase in chromosome number (Table 3). Kumar (1987) had observed a similar increase in DNA and RNA contents that was directly related with ploidy level in *Cynodon dactylon*. However, he reported no such linear relationship in soluble proteins. Starch content was observed to be highest in the tetraploids, followed by diploids and hexaploids (Table 3). Considerable quantitative variations in free amino acids were noticed. The diploids were quite rich in γ - amino butyric acid and β - alanine. The tetraploids revealed much higher levels of cysteic acid and cysteine. The hexaploids exhibited greater amounts of aspartic acid, glutamic acid and glutamine, glycine and serine, alanine, proline, valine and methionine, and phenylalanine (Table 4).

The three cytotypes also varied considerably in sucrose, glucose and fructose content. As invertase is known to catalyze the hydrolysis of sucrose to

Table 4. Amino acid composition (mg amino acid/g dry leaf weight) in three cytotypes of *Setaria verticillata* (L.) Beauv.

Characters	Diploid	Tetraploid	Hexaploid
	(n=9)	(n=18)	(n=27)
Cysteic acid + Cysteine	0.32	0.54	0.40
Aspartic acid	0.78	0.80	0.86
Glutamic acid + Glutamine	1.20	1.28	1.40
γ-Amino butyric acid	0.85	0.20	0.20
β-Alanine	0.75	0.40	0.40
Glycine + Serine	1.17	1.15	1.26
Asparagine	0.57	0.35	0.40
Threonine	0.29	0.40	0.20
Alanine	0.56	0.90	1.06
Tyrosine	0.48	0.39	0.40
Hydroxyproline	0.06	0.03	0.02
Histidine	-	-	-
Lysine	-	-	-
Arginine	0.37	0.37	0.30
Proline	0.26	0.57	0.71
Valine	0.67	0.78	0.91
Tyrosine	-	-	-
Phenylalanine	0.54	0.54	0.62
Leucine + Isoleucine	0.95	0.98	1.00

Table 5. Sucrose, glucose and fructose contents, and invertase activity in three cytotypes of *Setaria verticillata* (L.) Beauv.

Characters	Diploid (n=9)	Tetraploid (n=18)	Hexaploid (n=27)
Sucrose (mg sucrose/g dry leaf weight)	2.12	1.42	2.37
Glucose (mg glucose/g dry leaf weight)	6.51	4.03	7.37
Fructose (mg fructose/g dry leaf weight)	3.51	8.03	3.42
Invertase activity (μg of glucose + fructose produced/mg of protein/hr)	112	183	125

hexoses, and play a key role in growth by controlling sucrose storage and utilization (Ricardo & Rees 1970; MacLachlan, *et al.* 1970; Shukla, *et al.* 1973), the activity of this enzyme was also assayed. The activity was observed to be much higher in hexaploids which exhibited comparatively much higher combined levels of glucose and fructose (Table 5).

Phenolic compound chromatographic patterns were observed to be of great assistance in identifying the different cytotypes. Although identification of compounds is considered significant in studies such as this, it was not possible to identify the compounds producing the spots on the chromatograms. However, much useful information can be gathered from unidentified chromatographic spots (Alston & Turner 1963; Grant 1968; Dass, *et al.* 1976). Twelve spots were observed in diploid cytotypes. Tetraploids and hexaploids exhibited fourteen spots each. Although as many as nine spots were common to all three cytological races, each of the cytotypes exhibited cytotype specific spots (Figure 3). Spots 11 and 12 were confined to diploids only. Spots 13 and 14 were present only in tetraploids. Hexaploids were distinguishable from others by the cytotype specific spot 18. Spot number 10 was found only in diploids and hexaploids, whereas tetraploids and hexaploids were observed to share spot numbers 15, 16 and 17.

Electrophoretic banding patterns of albumins and globulins showed that these proteins could unambiguously be employed for identification of cytotypes (Figure 4). Most of the albumin bands depicted by diploids were also observed in tetraploids. The hexaploids, apart from containing albumin bands from diploids and tetraploids, revealed a characteristic band in zone D. Globulin patterns likewise were cytotype specific. The peroxidase and esterase isozyme

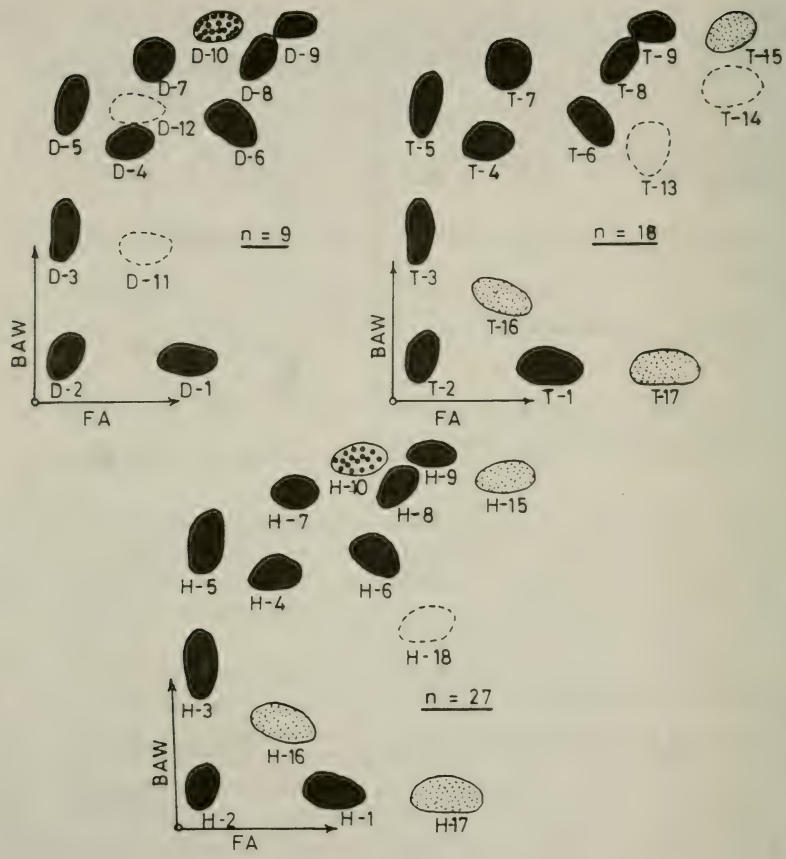

Figure 3. Chromatographic patterns of phenolic molecules in diploid (n = 9), tetraploid (n = 18) and hexaploid (n = 27) taxa. Spots with broken lines indicate the characteristic spots of the cytotypes. Color of spots, uv/uv + NH_3: D-1, T-1, H-1 - Y/FY; D-2, T-2, H-2 - GY/GY; D-3, T-3, H-3 - LBlW/LYG; D-4, T-4, H-4 - B/BY; D-5, T-5, H-5 - P/P; D-6, T-6, H-6 - LY/FY; D-7, T-7, H-7 - Y/GY; D-8, T-8, H-8 - Y/Y; D-9, T-9, H-9 - V/FV; D-10, H-10 - GBl/DuBl; D-11 - YG/YG; D-12 - LY/YG; T-13 - Bl/FBl; T-14 - P/P; T-15, H-15 - LY/FY; T-16, H-16 - LBl/FBl; T-17, H-17 - Y/Y; H-18 - Y/Y. F = Fluorescent; L = Light; Y = Yellow; G = Green; Bl = Blue; W = White; B = Brown; P = Purple; Du = Dull; V = Violet.

patterns were also highly taxon specific (Figure 5). The differences observed in peroxidase and esterase paralleled differences previously observed in cultivars of *Zea mays* L. (Cardy & Kannenberg 1982), *Cenchrus* (Nicholson, *et al.* 1985) and *Agropyron junceum* (Moustakas, *et al.* 1986).

Taken together, the cytological behaviour, phenolic patterns, and electrophoretic profiles of albumin and globulin revealed some interesting correlations. Tetraploids invariably exhibited bivalents and absence of quadrivalents. This suggests that this cytotype is not an autotetraploid or segmental allotetraploid. The meiotic behaviour of hexaploids resembles that of an autoallopolyploid. These observations are further substantiated by data derived from phenolic compound and albumin patterns. Phenolic chromatographs and albumin patterns in diploids and tetraploids are different, conforming to the likely alloploid nature (Murray & Williams 1976) of the tetraploids. Hexaploids reveal a sum total of patterns exhibited by diploids and tetraploids, suggesting the possibility that hexaploids in nature might have originated through crosses between unreduced gametes of diploid and tetraploid taxa. However, globulin patterns were not observed to support the idea of hexaploid origin by fusion of unreduced gametes from diploids and tetraploids. Though globulins were taxon specific, they did not show additive patterns. Bala (1988), while working with varieties of *Setaria italica*, noticed that although albumin and globulin patterns were highly discriminatory, they were not especially useful in providing phylogenetic insights. On the other hand, the evolutionary usefulness of cytological and phenolic data is well established. Thus, the hypothesis that hexaploids originated through fusion of unreduced gametes from diploids and tetraploids is not entirely untenable.

The present investigation has revealed considerable morphological, cytological and biochemical variability among the three cytotypes of *Setaria verticillata* examined. How such taxa might be treated so that the presence and nature of the encountered variations is also reflected by their names is not considered here. The concepts involved in addressing this question (that of nomenclature for variants such as those seen in this study) are considered in some detail by Harborne & Turner (1984) in their chapter on the Application of Chemistry at the Intraspecific Level. It seems clear that cytogeographical, chemogeographical and morphogeographical patterns may be exceedingly complex and need not fit neat patterns, nor lend themselves to easily conceived formal nomenclatural units.

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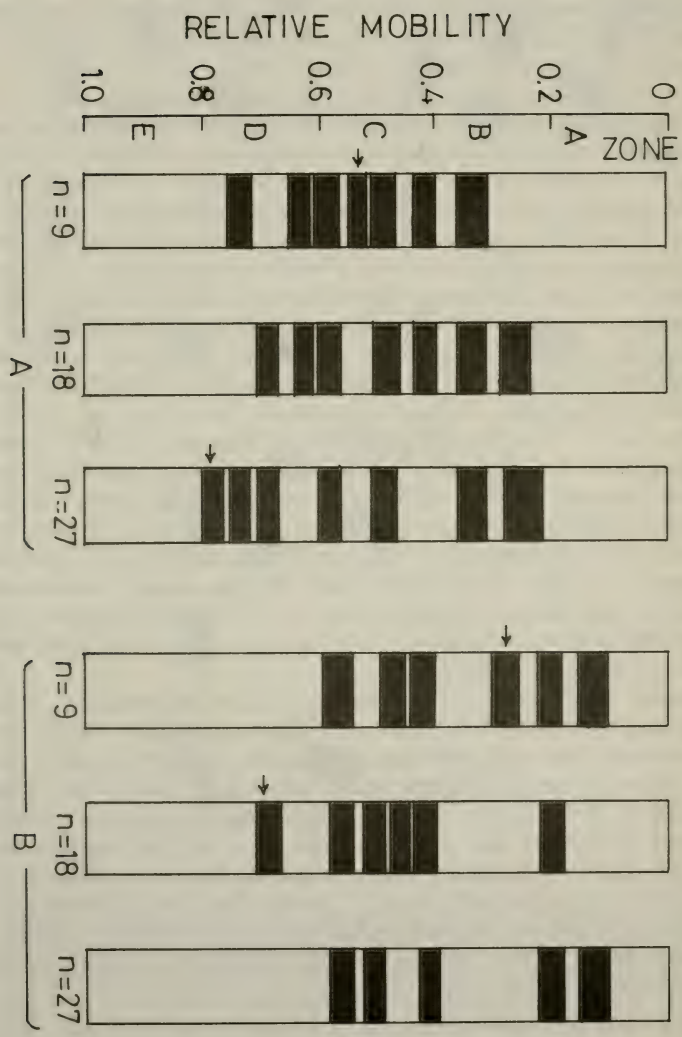

Figure 4. Zymograms of Albumin (A) and Globulin (B) patterns in the three cytotypes.

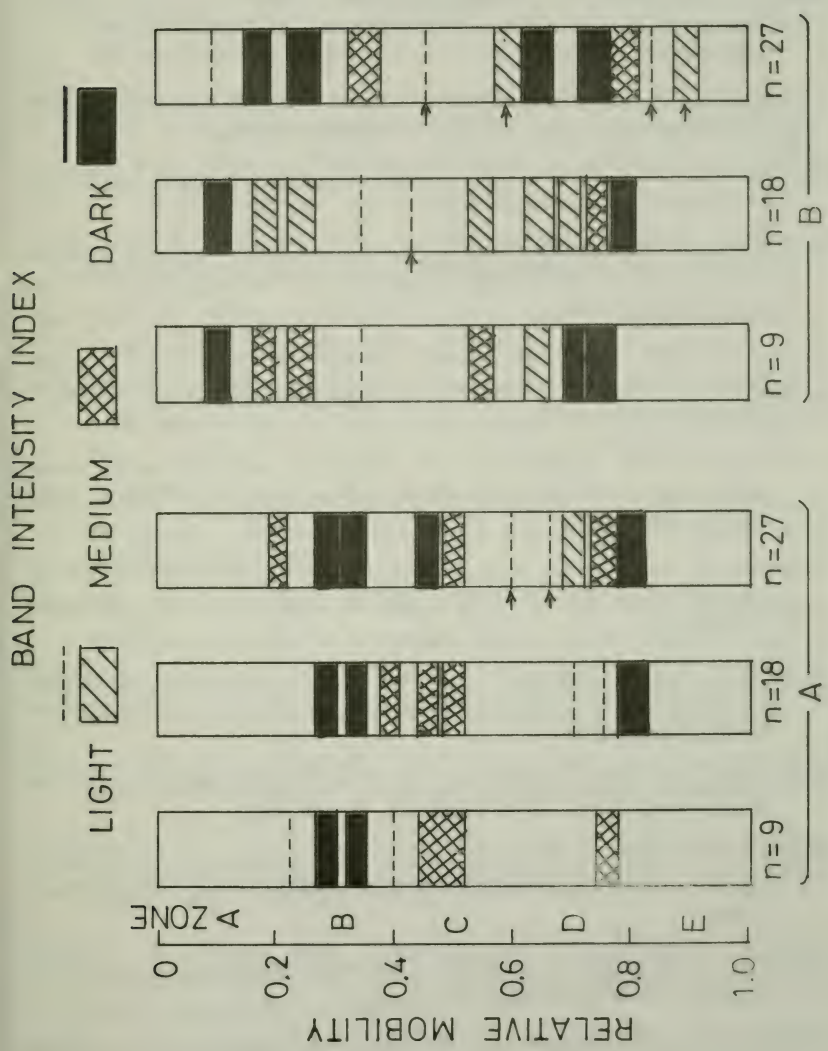

Figure 5. Zymograms of Esterase (A) and Peroxidase (B) isozyme patterns in [illegible] cytotypes.

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NEW RECORDS AND A NEW SPECIES OF *CRATAEGUS* (ROSACEAE) IN TEXAS

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ABSTRACT

Study of *Crataegus* during the last 4 years has revealed a number of interesting records. *Crataegus stevensiana* Sarg., previously known only from Oklahoma and Kansas, is reported from north and central Texas, and is added to the Texas flora. *Crataegus dallasiana* Sarg., a Texas endemic previously known only from historic collections from Dallas County, is newly reported from Ellis County. **Crataegus turnerorum** Enquist, *sp. nov.*, is described and reported from 7 counties in central and west Texas.

KEY WORDS: Floristics, taxonomy, Texas, *Crataegus*, Rosaceae.

INTRODUCTION

Crataegus is deservedly known as a difficult and problematic genus. The difficulty is compounded by the many collections which omit such important data as the color of the predehiscent anthers. In addition, hybrids and unusual forms tend to be over represented in collections, causing a distortion in the perception of their quantitative distribution.

Careful collecting, as suggested by Kruschke (1955), with repeated visits to numbered trees in order to collect both flowering and fruiting specimens from the same tree, is the desired approach. Probable hybrids and unusual forms are still found, but their frequency and significance is much reduced.

Referring to those characters he found most useful in defining species of *Crataegus*, Palmer (1925) stated, "In these tables the color of the anthers, number of stamens, glabrous or pubescent character of corymbs at flowering time and general shape of the leaves were adopted for most of the groups, in the order named." The color of the predehiscent anthers is probably the most important character used in making species (or varietal) determinations, but such data is usually missing from specimen labels. Even when the color is noted, caution is necessary. Dehiscent anthers all appear yellow due to the pollen within.

This writer agrees with the order of importance assigned to those characters listed by Palmer in 1925, with the reservation, of course, that anther color alone is an insufficient distinction for the description of a new species. Those collections of flowering material made by the author and cited in this paper all note the color of the unopened anther.

CRATAEGUS STEVENSIANA, NEW TO TEXAS

Crataegus stevensiana Sargent, J. Arnold Arb., 4:99. 1923. TYPE: U.S.A. Kansas: Wilson Co., Neodesha, 19 Sep 1922, *E.J. Palmer 21562* (HOLOTYPE: GH!). *Crataegus reverchonii* Sargent var. *stevensiana* (Sarg.) Palmer, Brittonia 5:482. 1946.

Specimens examined: U.S.A. Kansas: Wilson Co.: Neodesha, 5 May 1922, *E.J. Palmer 21158* (GH); 22 May 1922, *E.J. Palmer 21374* (GH); Neodesha, thickets, rocky hills, 19 Sep 1922, *E.J. Palmer 22042* (GH); Neodesha, thickets, limestone hills, 6 Nov 1924, *E.J. Palmer 26825* (GH).

Oklahoma: Greer Co.: granite, occasional along creek in mountains, 7 Oct 1913, *G.W. Stevens 2891* (GH). Kiowa Co.: Snyder, slopes of granite hills, 18 Jul 1917, *E.J. Palmer 12586* (GH); Snyder, slopes of granite hills, 26 Oct 1917, *E.J. Palmer 13075* (GH). Logan Co.: Orlando, along small stream, 25 Jul 1940, *B.F. Kiltz K-623* (GH). Seminole Co.: Asher, dry hills, 10 Apr 1936, *Delzie Demaree 11974* (GH).

Texas: Comanche Co.: Sweetwater Creek north of Sidney, tree # 424, 3 Aug 1989, *Enquist 1470* (GH,MO,SMU,TAES,TEX,US). Dallas Co.: Dallas, common on prairie, 27 Apr 1900, *J. Reverchon 454* (GH). Gillespie Co.: East side of Hwy. 87, 8.5 miles south of intersection with Hwy. 290 in Fredricksburg, tree # 362, 26 Apr 1989, *Enquist 953* (GH,MO,SMU,TAES,TEX,US); East side of Hwy. 87, 8.5 miles south of intersection with Hwy. 290 in Fredricksburg, tree # 362, 22 Jun 1989, *Enquist 1430* (GH,MO,SMU,TAES,TEX,US); West side of Hwy. 87, 8.7 miles south of intersection with Hwy. 290 in Fredricksburg, tree # 361, 22 Jun 1989, *Enquist 1439* (GH,MO,SMU,TAES,TEX,US); 0.5 mi east of South Grape Creek on Hwy. 290, south side, in Post Oak woods, tree # 410, 22 Jun 1989, *Enquist 1425* (GH,MO,SMU,TAES,TEX,US); 0.5 mi east of South Grape Creek on Hwy. 290, south side, in Post Oak woods, tree # 410, 8 Oct 1989, *Enquist 1567* (GH,MO,SMU,TAES,TEX). Hill Co.: 2 miles north of Carl's Corner on west side of I-35, tree # 350, 22 Apr 1989, *Enquist 819* (GH,MO,SMU,TAES,TEX,US); 2 miles north of Carl's Corner on west side of I-35, tree # 350, 18 Jun 1989, *Enquist 1398* (GH,MO,SMU,TAES,TEX,US); 2 miles north of Carl's Corner on west side of I-35, tree # 350, 15 Oct 1989, *Enquist 1587* (GH,SMU,TAES,TEX). Jack Co.: No locality data, 12 Jun 1924, *B.C. Tharp 3029* (GH). Mason Co.: 1.6 miles south of intersection of 1851 and 1222, west side, along Sandy Creek, Edmiston property, tree # 372, 27 Apr 1989, *Enquist 1068* (GH,MO,SMU,TAES,TEX,US);

Spy Rock, along intermittent creek, tree # 371, 27 Apr 1989, *Enquist 1058* (GH,MO,SMU,TAES,TEX,US). McCulloch Co.: West side of Hwy. 71 at roadside park south of San Saba River, tree # 370, 27 Apr 1989, *Enquist 1047* (GH,MO,SMU,TAES,TEX,US); West side of Hwy. 71 at roadside park south of San Saba River, tree # 370, 23 Sep 1989, *Enquist 1552* (GH,MO,SMU,TAES, TEX,US); East side of Hwy. 71 at roadside park south of the San Saba River, tree # 473, 8 Aug 1989, *Enquist 1578* (GH,MO,SMU,TAES,TEX,US). Mills Co.: On 2005, north of Merrell Creek crossing, in Shin Oak thicket at edge of valley, west side of road, tree # 382, 2 May 1989, *Enquist 1108* (GH,MO,SMU,TAES,TEX,US).

DISCUSSION

In the course of observing *Crataegus* in the field, a particular morphological type was seen to appear in several widely separated localities. It was realized that this was a species that was not listed as a member of the Texas flora, and indeed, was no longer listed anywhere as a species.

Originally described and given species status by Sargent (1923), *Crataegus stevensiana* was relegated to varietal rank by Palmer (1946). As previously noted, Palmer listed, in 1925, those characters he found most useful in defining species of *Crataegus*. However, by 1946 Palmer had undergone a change in opinion, as evidenced by his placing in synonymy or combining several species with different stamen number and anther color. As a result of his reclassification, *C. reverchonii* Sarg. (1903), came to include three varieties, the typical variety with 10-15 reddish purple anthers, var. *stevensiana* (Sarg.) Palmer (with 10 yellow anthers), and var. *discolor* (Sarg.) Palmer (with 20 white anthers). These combinations correctly indicate a genetic interrelationship that can be seen in a few characteristics of some leaves. However, in this writer's opinion, each entity is sufficiently distinct in other characters (including stamen number and anther color) to justify species status.

Herbarium material from GH indicates some confusion existed as to the boundaries of *Crataegus reverchonii*. One sheet (Texas: Dallas Co: Dallas, common on prairie, 27 Apr 1900, *J. Reverchon 454*), labeled *C. reverchonii* but almost certainly *C. stevensiana*, bears a note stating "This is the round-leaved hawthorn of the Dallas area." Perhaps as a result, another sheet (Texas: Jack Co., *Tharp 3029*) correctly identified as *C. stevensiana* originally, was relabeled *C. reverchonii* by Palmer.

The confusion has remained to this day. In Correll & Johnston (1970), *Crataegus reverchonii* is described as having "stamens 10-15; anthers [?] pinkish-red" (brackets and question mark in the original). Vines (1960), treated the taxon as *C. reverchonii* var. *stevensiana* but he gave it a separate description and somewhat coequal status with *C. reverchonii*. In *Flora of the Great Plains* (1986), it is listed simply as a synonym of *C. crus-galli* L.

The confusion results from trying to fit two distinct species into one species description. Misidentifications have ignored significant differences in both stamen and leaf morphology. *Crataegus reverchonii* is distinguished by its stamen number (10-15) and anther color (purple). Its leaves, both on first year shoots and fruiting stems, are orbicular to broadly obovate, with roughly 50-90 per cent of the leaves orbicular. The calyx tube and pedicels are sparsely pubescent. *Crataegus stevensiana* is distinguished by its stamen number (10) and anther color (yellow). The vast majority of its leaves are obovate to narrowly obovate, with only a few orbicular leaves at the tip of first year growth. The calyx tube and pedicels are completely glabrous. In addition, the thorns are often malformed, with a characteristic crook in the last 1-3 centimeters of the tip.

Since their ranges coincide, and given the ability of hawthorns to hybridize, it would not be surprising to find forms intermediate between the two species. Such plants, however, have not been seen thus far. This writer believes that Sargent's original descriptions were substantially correct and that *Crataegus reverchonii* Sarg. and *C. stevensiana* Sarg. are best considered closely related but separate species.

CRATAEGUS DALLASIANA, REDISCOVERED

Crataegus dallasiana Sargent, *Trees and Shrubs* 1:59, pl. 30. 1903. Probable syntype (*fide* D. Boufford): U.S.A. Texas: Dallas County, Dallas, April & July 1900 (?), *J. Reverchon 279* (GH photocopy!).

Additional specimens examined: U.S.A. Texas: Dallas Co.: Dallas, Luck's (?) Mill, 3 Apr 1901, *J. Reverchon 2633* (GH,MO); Dallas, Luck's (?) Mill, 6 Aug 1901, *J. Reverchon 2662* (GH); Eagle Ford, 3 Apr 1902, *J. Reverchon 2633* (MO). Ellis Co.: Waxahachie, I-35 at South Prong Creek crossing, 200 yards north of bridge, east side, on fence in R.O.W., tree # 300, 3 Apr 1988, *Enquist 385* (TEX); Waxahachie, I-35 at South Prong Creek crossing, 200 yards north of bridge, east side, on fence in R.O.W., tree # 300, 23 Mar 1989, *Enquist 502* (GH,SMU,TEX); Waxahachie, I-35 at South Prong Creek crossing, 200 yards north of bridge, east side, on fence in R.O.W., tree # 300, 29 Mar 1989, *Enquist 594* (GH,SMU,TAES,TEX); Waxahachie, I-35 at South Prong Creek crossing, 200 yards north of bridge, east side, on fence in R.O.W., tree # 300, 6 Apr 1989, *Enquist 661* (GH,SMU,TEX); Waxahachie, I-35 at South Prong Creek crossing, 200 yards north of bridge, east side, on fence in R.O.W., tree # 300, 18 Jun 1988, *Enquist 1377* (GH,MO,SMU,TAES,TEX,US); Waxahachie, I-35 at South Prong Creek crossing, 100 yards south of bridge, about 200 yards west of Hwy., tree # 321, 29 Mar 1989, *Enquist 600* (TEX); Waxahachie, I-35 at South Prong Creek crossing, 100 yards south of bridge, about 200 yards west of Hwy., tree # 321, 6 Apr 1989, *Enquist 662* (GH,SMU,TAES,TEX); Waxahachie, I-35 at South Prong Creek crossing, 100 yards south of bridge, about

200 yards west of Hwy., tree # 321, 18 Jun 1989, *Enquist 1373* (GH,MO,SMU, TAES,TEX,US); Milford, I-35 at Richland Creek, south of bridge, 70 yards west of Hwy., between Coastal Bermuda field and old borrow pit, tree # 322, 29 Mar 1989, *Enquist 601* (TEX); Milford, I-35 at Richland Creek, south of bridge, 70 yards west of Hwy., between Coastal Bermuda field and old borrow pit, tree # 322, 6 Apr 1989, *Enquist 655* (SMU,TAES,TEX); Milford, I-35 at Richland Creek, south of bridge, 70 yards west of Hwy., between Coastal Bermuda field and old borrow pit, tree # 322, 22 Apr 1989, *Enquist 802* (GH,MO,SMU,TAES,TEX,US); Milford, I-35 at Richland Creek, south of bridge, 70 yards west of Hwy., between Coastal Bermuda field and old borrow pit, tree # 322, 18 Jun 1989, *Enquist 1387* (GH,MO,SMU,TAES,TEX,US); Milford, I-35 at Richland Creek, south side of creek, west of Hwy. about 200 yards, just west of old low water crossing, tree # 431, 5 Aug 1989, *Enquist 1480* (GH,MO,SMU,TAES,TEX,US).

DISCUSSION

Crataegus dallasiana Sarg. has been known only from Dallas County, Texas, from historic collections by Reverchon. On April 3, 1988, this species was rediscovered along a creek near Waxahachie, Texas.

The taxonomic status of *Crataegus dallasiana* has been in question. In Correll & Johnston (1970), it is listed as a synonym under *C. brazoria* Sarg. (1901). In Vines (1960), the two taxa were listed separately, each being accorded species status. Sargent felt they were distinct, and in the type description of the species provided the following comment regarding *C. dallasiana* -"Closely related to *C. brazoria* Sarg., of the Collina group, and a native of the lower Brazos River, Texas. *Crataegus dallasiana* differs from that species in the form and texture of the leaves, and in the dull red not canary-yellow early-ripening fruit, and in the color of the bark."

Visits to the area of *Crataegus brazoria*'s type locality, in Brazoria County on the Texas Gulf coast, have not yet produced an indisputably authentic specimen of that taxon. *Crataegus brazoria* may be either a distinct relict species or a product of hybridization. Specimens found in this area are attributable to *C. mollis* Scheele, *C. texana* Buckley and *C. viburnifolia* Sarg. As described, *C. brazoria* has 20 stamens, dark red (purple) anthers, and large yellow fruit. *Crataegus viburnifolia* has 20 stamens, white anthers, and large yellow fruit. *Crataegus texana* has 20 stamens, dark red (purple) anthers, and large red fruit. Obviously, a theoretical *viburnifolia-texana* hybrid would be similar to *C. brazoria*. Since *C. brazoria* was described from a single tree, the possibility must be recognized that it is simply one hybrid member of a *mollis-texana-viburnifolia* complex. Further collecting in the area of the type locality of *C. brazoria* will be necessary.

In view of this, and considering the clear identity of *Crataegus dallasiana*

and its relatively well defined distribution in north Texas, treatment of the latter as a distinct species is justified.

Sargent's type description of *Crataegus dallasiana* is incorrect in its assertion that the fruit ripen in midsummer. The first tree found flowered profusely, but a visit in early August, 1988, revealed no fruit. This was an indication of extremely poor fruit-set, not early ripening. The same tree successfully produced ripe, dull-red fruit in late October and early November of 1989. The fruit were 8-10 mm in diameter and matched the type description in all characters.

CRATAEGUS TURNERORUM, SP. NOV.

Crataegus turnerorum Enquist, *sp. nov.*, Figure 1. TYPE: UNITED STATES. Texas: Menard Co., 23 Sep 1989, *Enquist 1555* (HOLOTYPE: TEX; Isotypes: GH,MO,SMU,TAES,US).

> Frutices vel arbores parvae 1.5-4.5 m altae. Folia ovata vel elliptica 2.5-5.5(-8.0) cm longa 1.5-4.0(-5.5) cm lata, marginibus 2-serratis lobis 2-4 binatis. Flores 1.5-2.0 cm diametro; sepala 3-4 mm longa acuminata; stamina 10-15 antheris purpureis; styli 3(-4). Fructus 1.0-1.4 cm lati, depressi-sphaerici.

Shrub to small tree, 1.5-4.5 m high. Stems straight to slightly zigzag, glabrous and lustrous, bearing a few scattered pale lenticels; light brown tinged with green in first and second years, becoming light ash gray; thorns slender (to stout), straight to slightly curved, black, 2-5.5 cm long. Leaves ovate to elliptic, glabrous, acute, basally cuneate to broadly cuneate, 2.5-5.5(-8) cm long, 1.5-4(-5.5) cm wide, with 2-4 pairs of short lobes, margin doubly serrate, petioles 0.3-1 cm long, stipules linear and bearing stalked glands, stipules on first year growth often lunate. On unfolding, leaves slightly pubescent, mainly along base of midrib and base of primary veins. Flowers opening in mid April, 1.5-2 cm in diameter, in a 3-12 flowered corymbose panicle with glabrous pedicels. Sepals 3-4 mm long, abruptly narrowed, entire to sparsely serrate, often with stalked glands, adaxially pubescent. Petals orbicular to elliptic, 0.5-1 cm long. Stamens 10-15, anthers deep purple. Styles 3(-4), with ring of tomentum at base. Fruit slightly flattened, 1-1.4 cm wide, 0.8-1.3 cm deep, nutlets potentially 5, usually maturing 3(-4), 5-7 mm long, dorsally ribbed.

Additional specimens examined: U.S.A. Texas: Crockett Co.: Ozona, Apr 1924, *Cory s.n.* (TAES). Jeff Davis Co.: Musquiz Canyon, tree # 390, 6 May 1989, *Enquist 1144* (GH,MO,SMU,TAES,TEX). Mason Co.: 1.6 miles south of intersection of highways 1851 and 1222, west side, along Sandy Creek, Edmiston property, tree # 373, 27 Apr 1989, *Enquist 1076* (GH,MO,SMU,TAES, TEX). Menard Co.: Menard, Rocky bluffs, 10 May 1917, *E.J. Palmer 11853* (GH); Menard, Rocky river banks, 10 May 1917, *E.J. Palmer 11862* (GH);

Ft McKavett, low water crossing of San Saba River, tree # 375, 2 Nov 1986, *Enquist 233* (TEX,SMU); Ft. McKavett, low water crossing of San Saba River, tree # 375, 18 Apr 1989, *Enquist 740* (GH,SMU,TAES,TEX); Ft. McKavett, low water crossing of San Saba River, tree # 375, 27 Apr 1989, *Enquist 1005* (GH,MO,SMU,TAES,TEX,US); Ft. McKavett, low water crossing of San Saba River, tree # 375, 23 Sep 1989, *Enquist 1549* (GH,MO,SMU,TAES,TEX,US); Menard, 4 miles south on Hwy. 83, east side of road, tree # 345, 18 Apr 1989, *Enquist 771* (GH,SMU,TAES,TEX); Menard, 4 miles south on Hwy. 83, east side of road, tree # 345, 23 Sep 1989, *Enquist 1554* (GH,MO,SMU,TAES,TEX, US); Menard, crossing of 190 and Scalp Creek, tree # 343, 20 Apr 1986, *Enquist 202* (GH,TAES,TEX); Menard, crossing of 190 and Scalp Creek, tree # 343, 1 Jul 1986, *Enquist 216* (TEX); Menard, crossing of 190 and Scalp Creek, tree # 343, 12 Apr 1989, *Enquist 709* (TEX); Menard, crossing of 190 and Scalp Creek, tree # 343, 18 Apr 1989, *Enquist 757* (GH,MO,SMU,TAES,TEX,US); Menard, crossing of 190 and Scalp Creek, tree # 343, 23 Sep 1989, *Enquist 1555* (GH,MO,SMU,TAES,TEX,US); Menard, Chapman draw, tree #344, 10 Apr 1986, *Enquist 201* (TEX); Menard, Chapman draw, tree #344, 18 Apr 1989, *Enquist 762* (GH,MO,SMU,TAES,TEX,US); Menard, Chapman draw, tree #344, 23 Sep 1989, *Enquist 1551* (GH,MO,SMU,TAES,TEX); Menard, shin oak thickets on hillside 0.5 miles west of Scalp Creek on Hwy. 190, tree # 340, 18 Apr 1989, *Enquist 748* (GH,MO,SMU,TAES,TEX); 1.8 miles east of entrance to Clark Ranch, tree # 368, 10 Apr 1986, *Enquist 200* (TAES,TEX); 1.8 miles east of entrance to Clark Ranch, tree # 368, 27 Apr 1989, *Enquist 1023* (GH,MO,SMU,TAES,TEX,US). Schleicher Co.: County road crossing of Middle Prong of the San Saba River, 3.2 miles west of intersection with Hwy. 864, tree # 367, 27 Apr 1989, *Enquist 996* (GH,MO,SMU,TAES,TEX); County road crossing of the Middle Prong of the San Saba River, 3.2 miles west of intersection with Hwy. 864, tree # 339, 23 Sep 1989, *Enquist 1548* (GH,MO,SMU,TAES,TEX,US). Sutton Co.: 30 miles SW of Sonora, 4 Apr 1933, *Cory 5505* (TAES); Crossing of Granger Draw Road and Dry Devil's River, tree # 338, 19 Apr 1989, *Enquist 728* (SMU,TAES,TEX); Crossing of Granger Draw Road and Dry Devil's River, tree # 338, 23 Sep 1989, *Enquist 1556* (GH,MO,SMU,TAES,TEX,US); Old Aldwell Ranch, along Dry Devil's River, tree # 336, 19 Apr 1989, *Enquist 717* (GH,MO,SMU,TAES,TEX); Old Aldwell Ranch, along Dry Devil's River, tree # 336, 23 Sep 1989, *Enquist 1547* (GH,MO,SMU,TAES,TEX,US). Val Verde Co.: Taylor Crossing on Devil's River, tree # 335, 19 Apr 1989, *Enquist 710* (GH,MO,SMU,TAES,TEX); Taylor Crossing on Devil's River, tree # 335, 23 Sep 1989, *Enquist 1546* (GH,MO,SMU,TAES,TEX,US).

In the course of field studies, this writer came across a hawthorn that could not be identified. At that time it was apparent that it was either a new record for Texas or a new species. Additional study since then has convinced me it is a new species.

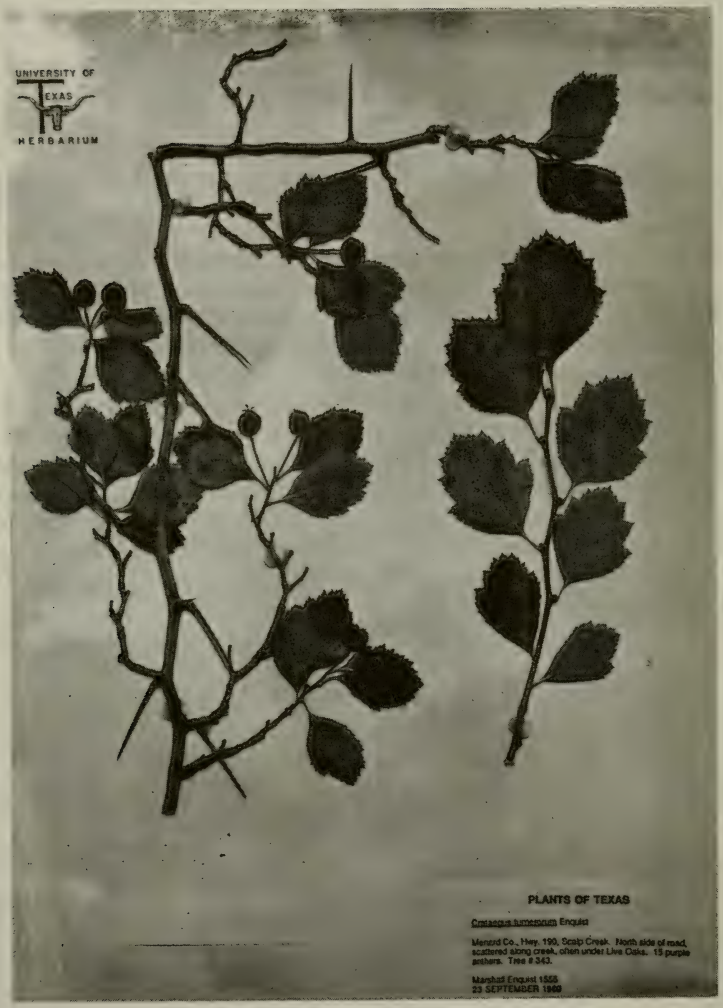

Figure 1. Type specimen of *Crataegus turnerorum* Enquist.

The earliest collections of this taxon known to me were made by Palmer in 1917. One sheet was mistakenly attributed by Sargent to *Crataegus uvaldensis* Sarg. (1922) in his type description of that species– "Menard County, low woods on the San Saba River, Menard, *E.J. Palmer, no. 11889* (sterile branches only), May 12, 1917." Two other sheets (10 May 1917, *E.J. Palmer 11853* and *11862*) are simply labeled *Crataegus* with the words "*crus-galli*" written to one side in parentheses. They also bear the penciled notation "*C. glabriuscula*" and, until now, were included in those folders. Both sheets hold branches that are in excellent fruit and are without doubt *C. turnerorum.* The Tracy Herbarium (TAES) has two collections of *C. turnerorum* made by Cory in 1924 and 1933 but labeled *C. crus-galli* L. and *C. tracyi* Ashe respectively.

The closest relatives of *Crataegus turnerorum* are found in New Mexico. A comparison of the type description of *C. turnerorum* with the type description of *C. wootoniana* Eggles. (1907) reveals that a number of their characters are similar (leaf shape and size, lobing, serration, lack of pubescence; stipule shape; sepal shape, serration and pubescence) and seemingly differ only in degree. However, study of the type of *C. wootoniana* (U.S.A. New Mexico: Socorro Co. 23 Aug 1903, *O.B. Metcalfe 584* [Isotype: NMC!]) demonstrates that the two species are distinguished by numerous small differences. *Crataegus wootoniana* has a more truncate leaf blade that is often as wide as it is long, and long petioles which are not winged. It also has 5-10(8) purple or light purple anthers and fruit that is longer than wide. *Crataegus turnerorum* has a more cuneate leaf blade that is significantly longer than wide and short petioles that are slightly winged. It has 10-15(13-15) purple anthers and fruit that is wider than long. *Crataegus erythropoda* Ashe is another possible relative of *C. turnerorum.*

Crataegus turnerorum can be found growing along a few streams and streambeds of the Edwards Plateau and Llano Uplift, usually in the shade of *Quercus fusiformis* Small. It is also found on dry hillsides among thickets of *Quercus sinuata* Walt. var. *breviloba* (Torr.) C.H. Mull. One collection is from Musquiz Creek, in Musquiz Canyon of the Davis Mountains, where it is found associated with *Crataegus tracyi* Ashe.

Crataegus turnerorum Enquist is named for Dr. Billie Turner and his wife Gayle. Dr. Turner has extended every possible assistance to this writer in his study of *Crataegus.* For this, I am deeply grateful.

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STUDIES IN THE SYSTEMATICS OF MEXICAN AND TEXAN *GRINDELIA* (ASTERACEAE: ASTEREAE)

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ABSTRACT

Four new species of *Grindelia* are described from México, **G. hintoniorum** Nesom, **G. macvaughii** Nesom, **G. turneri** Nesom and **G. vetimontis** Nesom. Three varieties are recognized within *G. microcephala* DC.: var. *microcephala*, var. *adenodonta* Steyerm. and var. *pusilla* Steyerm. *Grindelia microcephala* var. *montana* Steyerm. is elevated in rank to **G. oaxacana** Nesom, *nom. et stat. nov. Grindelia nuda* Alph. Wood is recognized as a species separate from *G. squarrosa* (Pursh) Dunal and *G. aphanactis* Rydb. is considered to be conspecific with *G. nuda*, reduced in rank to **G. nuda** var. **aphanactis** (Rydb.) Nesom, *comb. et stat. nov. Grindelia oxylepis* E. Greene var. *eligulata* Steyerm. is raised to specific rank as **G. eligulata** (Steyerm.) Nesom, *comb. et stat. nov. Grindelia neomexicana* Woot. & Standl. (*G. scabra* E. Greene var. *neomexicana* [Woot. & Standl.] Steyerm.) is treated as **G. arizonica** A. Gray var. **neomexicana** (Woot. & Standl.) Nesom, *comb. nov.* and the concept of *G. arizonica* is further broadened by including populations from México and Texas. *Grindelia greenei* Steyerm. is treated as **G. lanceolata** Nutt. var. **greenei** (Steyerm.) Nesom, *comb. et stat. nov.* Four varieties are recognized within *G. inuloides* Willd.: var. *glandulosa* (Greenm.) Steyerm., var. **hirtella** (Robinson & Greenm.) Nesom, *comb. nov.*, var. *inuloides* and var. **latamplexa** Nesom, *var. nov.* The identities and geographic distributions of *G. scabra* E. Greene, *G. havardii* Steyerm., *G. nelsonii* Steyerm. and *G. subdecurrens* DC. are clarified.

KEY WORDS: *Grindelia*, Asteraceae, Astereae, Texas, México.

The North American species of *Grindelia* were the subject of a monographic treatment by Steyermark (1934), who provided many valuable insights regarding the group, particularly with regard to nomenclature and types. The genus has remained poorly understood however, and plants are difficult to identify using Steyermark's keys and descriptions. Further, at the time of his

study, available specimens could give only a very general idea of the geographic range of the species recognized. The present study, undertaken in connection with forthcoming taxonomic treatments of the Asteraceae for México and for Texas (Turner & Nesom, in prep.), attempts to clarify a number of problems that have remained. The following taxonomic evaluations and clarifications, nomenclatural adjustments, and descriptions of new taxa should be helpful in providing at least a firmer base for future investigations of the genus.

I. THE *GRINDELIA NUDA-APHANACTIS* COMPLEX

A population system of eradiate plants (*Grindelia squarrosa* [Pursh] Dunal var. *nuda* [Alph. Wood] A. Gray ≡ *G. nuda* Alph. Wood) occurs in north central Texas and adjacent New Mexico through southeastern Colorado and southwestern Kansas (Map 1). Radiate *G. squarrosa*, including the typical variety and several intergrading varieties, occupies a large geographic area from Montana and North Dakota southward to Texas and New Mexico. Variety *nuda* and typical *G. squarrosa* are largely allopatric, but radiate plants are scattered in the range of the eradiate populations. 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.

In view of their remarkable difference in achene morphology and their partial sympatry, which is suggestive of some degree of genetic isolation, I believe that *G. squarrosa* and *G. nuda* are appropriately regarded as separate species. The monomorphic achenes of *G. nuda* suggest that its relationships lie with *G. oxylepis* E. Greene, *G. arizonica* A. Gray, and other species with similar achenes. The Mexican species known to have dimorphic achenes are relatively few in number. Their geographic distributions are shown in Map 2 (*G. microcephala DC.*), Map 3 (*G. lanceolata* Nutt.) and Map 4 (the related pair *G. tenella* Steyerm. and *G. grandiflora* Hook.).

Another relatively large population system of eradiate plants that has been regarded as a separate species, *Grindelia aphanactis* Rydb., forms with *G. nuda*, a complex that is best treated as a single species. The two taxa are morphologically very similar, of essentially continuous geographic range and intergrading over a large area where they meet. *Grindelia aphanactis* and *G. nuda* have been separated only by differences of degree, the most prominent difference being the relatively narrower leaf shape of *G. aphanactis*. Steyermark (1934: p. 492) added that "From narrow-leaved forms of *G. squarrosa* var. *nuda*, such as f. *angustior*, *G. aphanactis* may be distinguished by its more

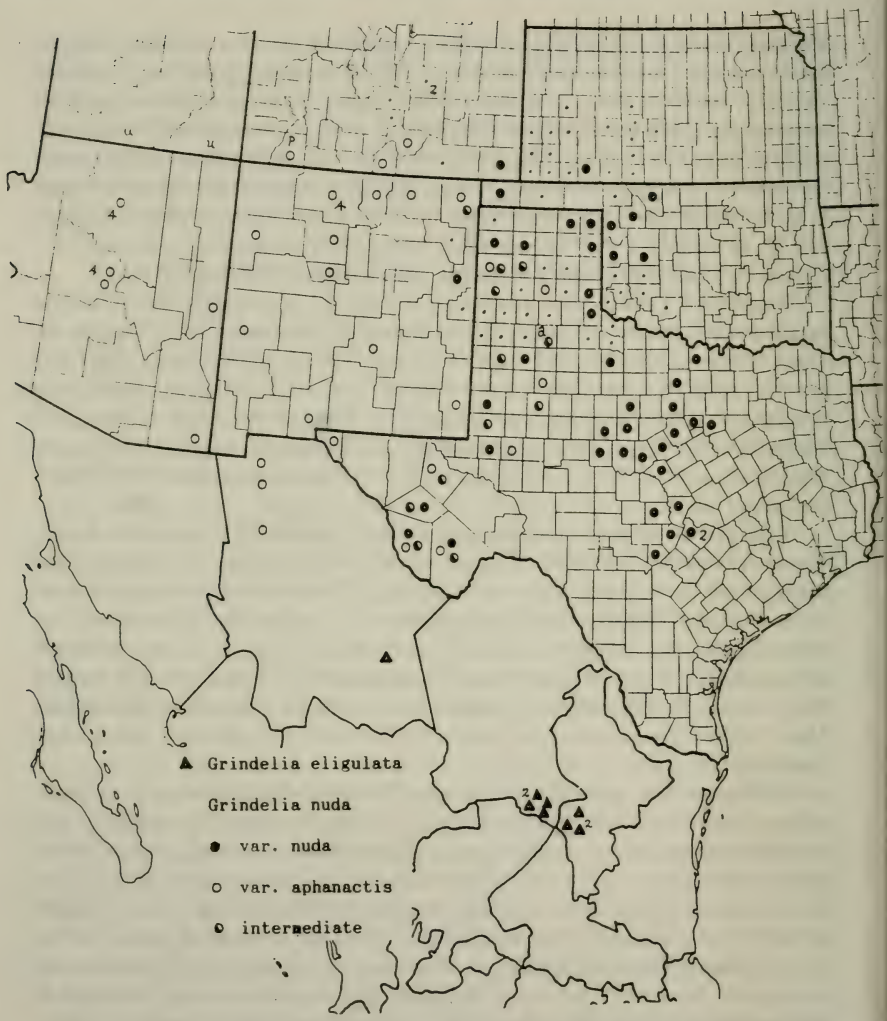
markedly serrulate or setulose-serrulate pappus awns, more strongly reflexed involucral bracts, more deeply ribbed or furrowed achenes, and less regularly crenulate-serrulate leaf margins." With respect to these criteria noted by Steyermark, I find no consistent difference in pappus awns (strongly scabrous-ciliolate awns can be found in typical populations of both taxa) or in the position and morphology of the phyllaries, which are variably spreading-reflexed. In their typical appearances, on either side of the zone of intermediacy, *G. nuda* and *G. aphanactis* can be distinguished only by leaf morphology, although achenes of *G. aphanactis* have a tendency to become more deeply furrowed.

Steyermark (1934) cited specimens of both *G. aphanactis* and *Grindelia squarrosa* var. *nuda* from west Texas; Correll & Johnston (1970) also recognized the occurrence of both taxa in Texas. Martin & Hutchins (1981) recognized both taxa from eastern New Mexico, as did Harrington (1954) from southeastern Colorado. In contrast, in the *Atlas of the Flora of the Great Plains* (Great Plains Flora Assoc. 1977), *G. aphanactis* apparently was not considered apart from var. *nuda*, since only the latter was mapped from those states.

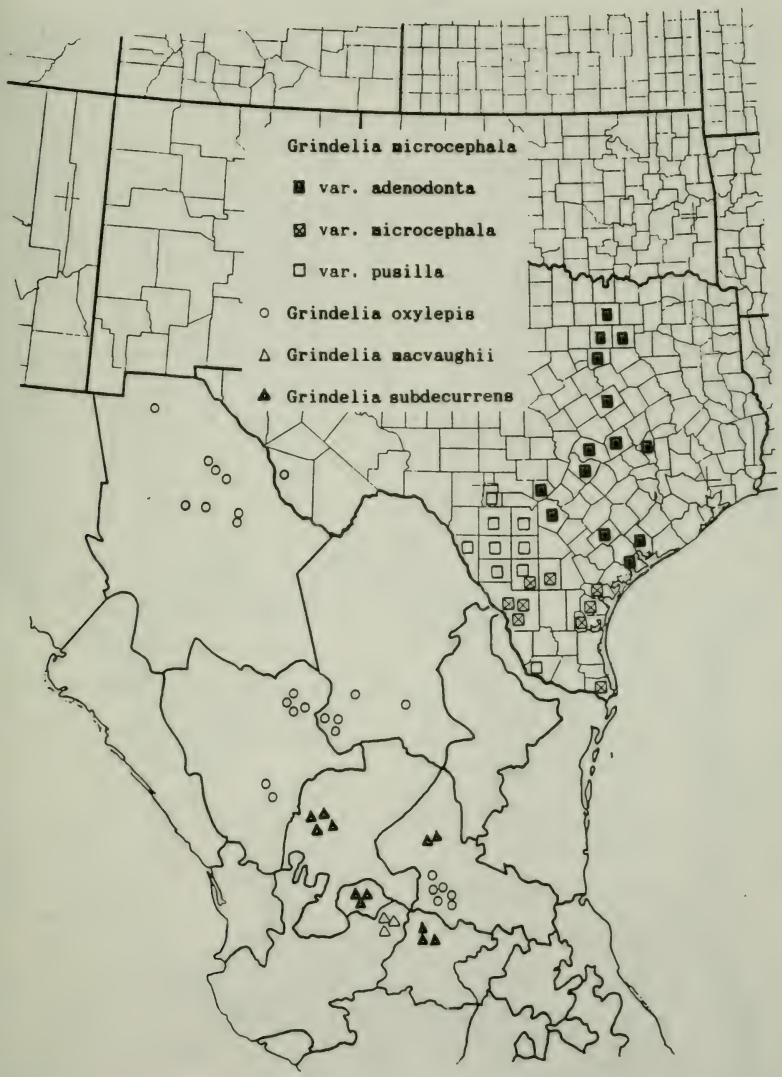
Typical *Grindelia nuda* occurs from central Texas north into western Kansas and southeastern Colorado. Typical *G. aphanactis* occurs in Arizona, New Mexico, and in southern Utah and Colorado. The plants of several collections from western Chihuahua have short spinulose (vs. glandular) foliar teeth but otherwise are like the species. There is a relatively wide area of morphological intermediacy between *G. nuda* and *G. aphanactis* in west Texas and eastern New Mexico. Steyermark's var. *nuda* forma *angustior* is also from this region. Map 1 shows the geographical range of the whole complex and the area of intermediacy.

Chromosome counts reported in the *Grindelia nuda-aphanactis* complex do not resolve the taxonomic problems, although the variability suggests that a further knowledge of chromosome numbers might contribute to a solution. Several populations of var. *aphanactis* from Arizona and northern New Mexico are tetraploid (Raven, *et al.* 1960; Dunford 1970; Kovanda 1972; Pinkava & Keil 1977; Schaack 1983), but a diploid has been reported from El Paso Co., Colorado (Semple 1985, as *G. squarrosa* var. *nuda*). Both diploids and tetraploids have been reported from typical var. *nuda* (n=12, Whitaker & Steyermark 1935, neither locality nor voucher cited; n=6, Turner & Ellison 1960). The localities of these counts are plotted on Map 1.

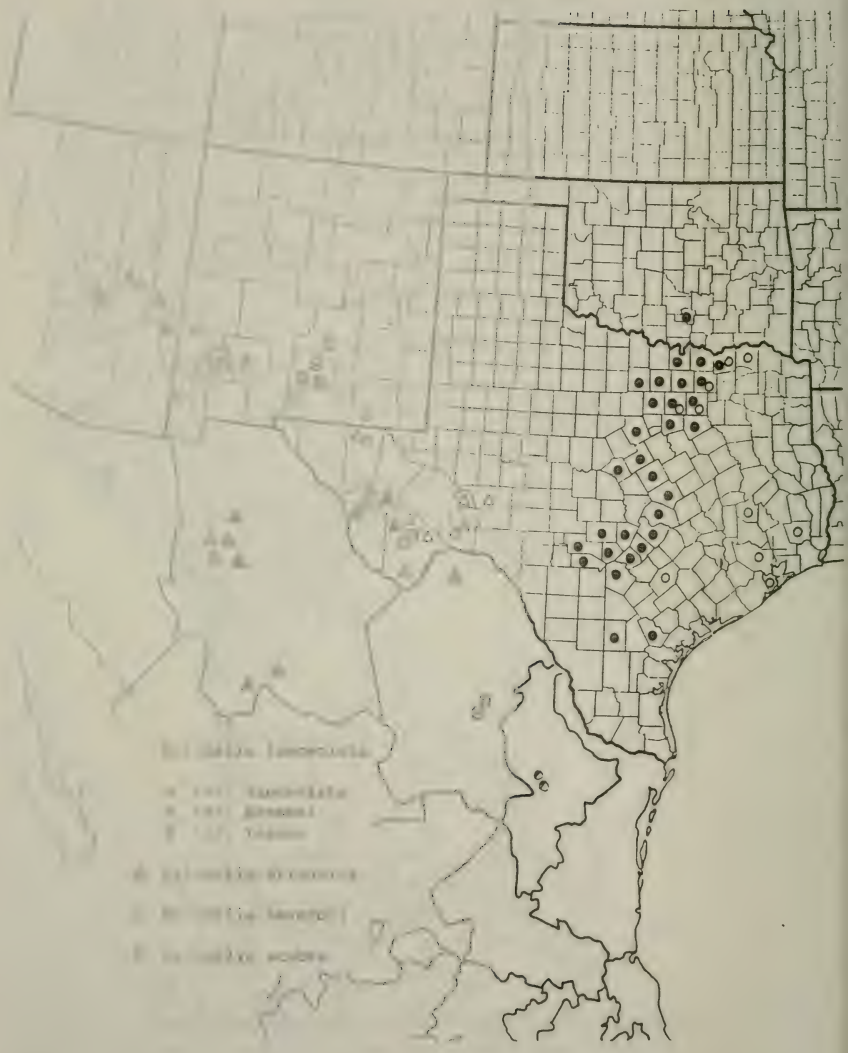
Grindelia nuda comprises two varieties, separated in their typical forms by the following couplet. The descriptions of each have been drawn from a range of plants outside of the area of intermediacy, where the identification of many of the intermediates is arbitrary.



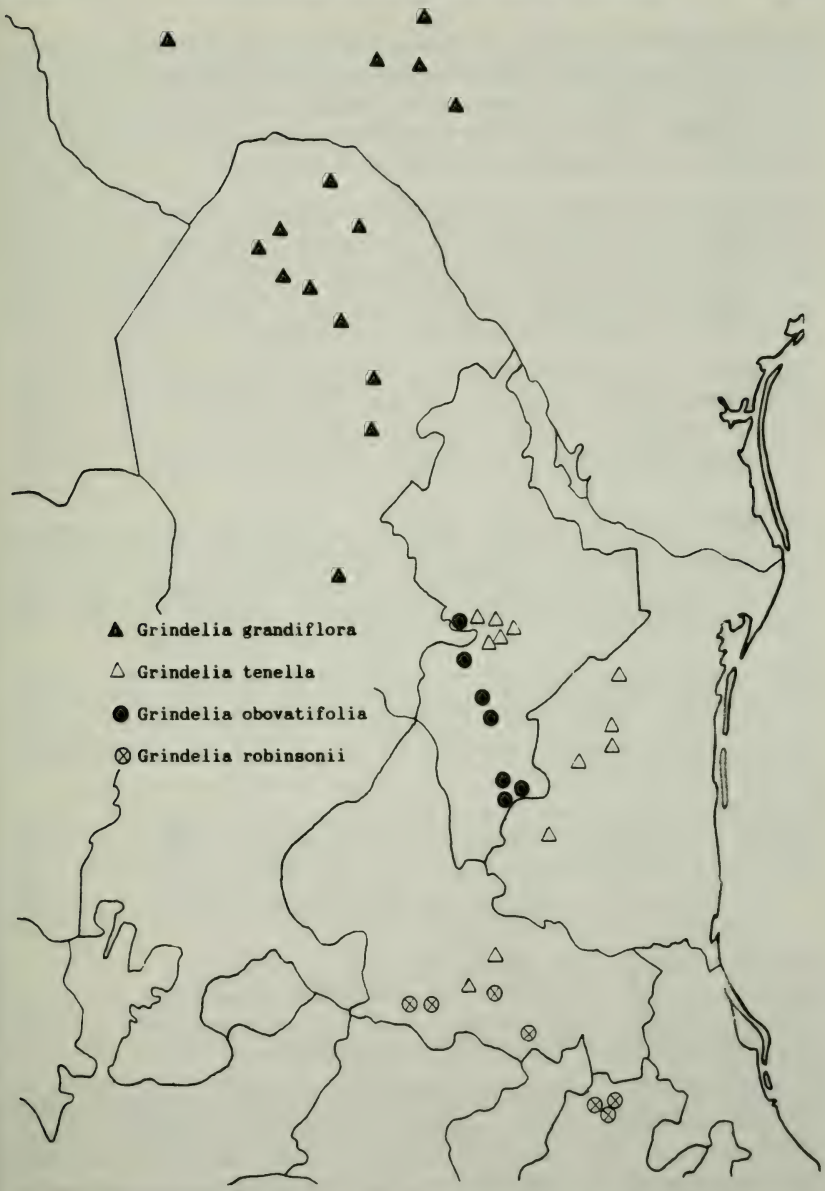
Map 1. Geographical range of *Grindelia eligulata* and *Grindelia nuda* sensu lato, showing var. *nuda* and var. *aphanactis*. The map is constructed from specimens in LL-TEX and SMU. The northern margins of the range are adjusted somewhat by records from the *Atlas of the Flora of the Great Plains* (Great Plains Flora Assoc. 1977), these shown as small dots. Records from Welsh (1983) are marked as "u"; the location of the type collection of *G. pinnatifida* Woot. & Standl. is marked "p"; the locality of forma *angustior* is marked "a". Localities of diploid chromosome counts are marked "2"; those of tetraploid counts are marked "4".



Map 2. Geographical range of *Grindelia microcephala* and its varieties and the radiate species of the *G. oxylepis* group.



Map 3. Geographical range of *Grindelia scabra, G. arizonica, G. havardii* and the Texas and Mexican components of *G. lanceolata*. The range of *G. lanceolata* var. *lanceolata* extends northward and eastward. The entire range of *G. lanceolata* var. *lanceolata* is not shown.



Map 4. Geographical range of the species pairs *Grindelia tenella*-*G. grandiflora* (dimorphic achenes) and *G. obovatifolia*-*G. robinsonii* (monomorphic achenes). The distributions of *G. microcephala*, *G. scabra* and *G. lanceolata*, which also have dimorphic achenes, are shown on Map 2 and Map 3.

1. Stems green; largest midcauline leaves 13-35 mm long, 6-19 mm wide, 1.5-2.5(-4.0) times longer than wide, margins with (4-)5-8 pairs of teeth per cm, apices blunt to obtuse or less commonly acute; disc corollas 4.5-6.0 mm long; achenes 1.6-3.0 mm long, smooth to longitudinally striate or shallowly furrowed at maturity ..... var. *nuda*

1′ Stems green or commonly reddish; largest midcauline leaves (10-)15-65 mm long, (2-)4-13 mm wide, 4-8(-10) times longer than wide, margins with 2-5(-7) pairs of teeth per cm, rarely nearly entire or with narrow, shallow lobes, apices acute; disc corollas 5.0-5.5(-6.0) mm long; achenes 2.0-3.0 mm long, often deeply furrowed at full maturity ..... var. *aphanactis*

Grindelia nuda Alph. Wood, Bot. Gaz. (Crawfordsville) 3:49. 1878. TYPE: UNITED STATES. [State?]. "Indian territory," 1875-77, *T.E. Wilcox s.n.* (TYPE: not seen). *Grindelia squarrosa* (Pursh) Dunal var. *nuda* (Alph. Wood) A. Gray, *Syn. Fl. N. Amer.* 1(2):118. 1884.

Grindelia nuda Alph. Wood var. **aphanactis** (Rydb.) Nesom, *comb. et stat. nov.* BASIONYM: *Grindelia aphanactis* Rydb., Bull. Torrey Bot. Club 31:647. 1904. TYPE: UNITED STATES. Colorado: [La Plata Co.], Durango, 21 Jul 1898, *C.F. Baker, F.S. Earle & S.M. Tracy 526* (HOLOTYPE: RM; Isotypes: F,GH,MO!,MINN,NY,POM).

Grindelia pinnatifida Woot. & Standl., Contr. U.S. Natl. Herb. 16:178. 1913. TYPE: UNITED STATES. New Mexico: [Rio Arriba Co.], open slopes about Chama, 9 Jul 1911, *P.C. Standley 6606* (HOLOTYPE: US!).

Grindelia squarrosa (Pursh) Dunal var. *nuda* (Alph. Wood) A. Gray forma *angustior* Steyerm., Ann. Missouri Bot. Gard. 21:481. 1934. TYPE: UNITED STATES. Texas: Floyd Co., 16 mi E of Sockney on Quitaque road, 23 Aug 1921, *Ferris & Duncan 3391* (HOLOTYPE: MO!; Isotypes: CAS,NY).

II. THE *GRINDELIA OXYLEPIS* GROUP

The eradiate species of the *Grindelia oxylepis* group.

Steyermark's key (1934) separated the eradiate *Grindelia oxylepis* E. Greene var. *eligulata* Steyerm. from *G. nuda* and *G. aphanactis* by its slightly reflexed-squarrose (vs. strongly reflexed-squarrose) phyllaries, but var. *eligulata* also has achenes deeply cut with transverse and longitudinal furrows so that the surfaces appear pebbly (or "rugose," as they are often described). The distinctive achenes are similar to those found in typical, radiate *G. oxylepis* E. Greene, and I believe Steyermark was correct in aligning the eradiate plants

more closely with it than with other eradiate taxa from further north. The var. *eligulata* comprises plants of a geographically discrete population system primarily in southeastern Coahuila and adjacent Nuevo León, México (Map 1). Numerous chromosome counts of this taxon have all been diploid (Turner, Beaman & Rock 1960; Powell & Turner 1963; Pinkava & Keil 1977; Dunford 1986).

Compared to var. *eligulata*, the radiate plants of the *Grindelia oxylepis* group are much more widespread (Map 2) and include two previously undescribed taxa. I believe that the taxonomy of this whole group is rendered more comprehensible by recognizing the eradiate plants as a separate species. Retaining them at varietal rank might be reasonably defended, because they are obviously closely related to *G. oxylepis*, but so also are *G. subdecurrens* DC. and the other species proposed below as new. In my opinion, recognizing all four taxa of the *G. oxylepis* group as varieties of a single species would broaden the species to a degree that would also require consideration of the closely related *G. arizonica* A. Gray as yet another variety.

Grindelia eligulata (Steyerm.) Nesom, *comb. et stat. nov.* BASIONYM: *Grindelia oxylepis* E. Greene var. *eligulata* Steyerm., Ann. Missouri Bot. Gard. 21:490. 1934. TYPE: MÉXICO. Coahuila: Saltillo, Sep 1898, *E. Palmer 316* (HOLOTYPE: GH; Isotypes: MO-2 sheets!,NY,UC,US).

Only two eradiate species of *Grindelia* occur in México. In addition to their allopatric geographic ranges, the two can be distinguished by the following key.

1. Stems usually branching from the base; achenes rugose with longitudinal and transverse furrows; pappus awns smooth edged ..... *G. eligulata*

1′ Stems usually single from the base; achenes longitudinally furrowed; pappus awns scabrous-ciliolate ..... *G. nuda*

The radiate species of the *Grindelia oxylepis* group.

In the view held here, the *Grindelia oxylepis* group includes three radiate species, which are characterized as a group by their completely glabrous vestiture, prominently punctate phyllary apices, tubular, slightly and gradually widened (vs. abruptly ampliate) disc corollas, and monomorphic, subquadrate, sculptured achenes with smooth edged awns. *Grindelia subdecurrens* and a previously undescribed species comprise, for the most part, the plants regarded by McVaugh (1984) as *G. oxylepis*.

Grindelia oxylepis E. Greene, Pittonia 4:42. 1899. TYPE: MÉXICO. Chihuahua: Wet places, plains near Chihuahua, 17 Sep 1886, *C.G. Pringle 748* (HOLOTYPE: US; Isotypes: GH,MICH,MINN,MO!,NY,PH,RM, UC).

Grindelia oxylepis E. Greene forma *capitella* Steyerm., Ann. Missouri Bot. Gard. 21:490. 1934. TYPE: MÉXICO. Durango: Mapimi, 21-23 Oct 1898, *E. Palmer 520* (HOLOTYPE: GH; Isotypes: MO!,NY, US). This differs from typical plants only in its smaller heads.

Grindelia oxylepis is a relatively well defined species. The primary problem with its morphological integrity is that the leaves in some populations of northern Chihuahua are spinulose tipped, intergrading with gland tipped forms. I suspect this may reflect introgression from *G. arizonica*, but field work will probably be necessary to sort this out.

Grindelia subdecurrens DC., *Prodr.* 5:315. 1836. TYPE: MÉXICO. Guanajuato: Villalpando, 1829, *Mendez s.n.* (HOLOTYPE: G-DC fiche!; Isotype: GH!).

Grindelia subdecurrens is recognized as a taprooted perennial, apparently always with several, often thin stems branching from the base. The stems and leaves are completely glabrous except for minutely scabrous leaf margins, and the leaves have punctate surfaces and blunt, glandular teeth, though usually not as strongly glandular as those in *G. oxylepis*. The achenes are smooth until the last moments of ontogeny when longitudinal furrows appear, and they produce smooth edged pappus awns. In its monomorphic, longitudinally furrowed achenes, *G. subdecurrens* is similar to *G. arizonica* although its relationship appears to lie most closely with *G. oxylepis*.

The name *Grindelia subdecurrens* commonly has been used as the identification for many Mexican plants, including many of *G. inuloides* Willd. *s. str.* Steyermark (1934) and McVaugh (1984) both have recognized *G. subdecurrens* as distinct, although their concepts of the species were different.

Grindelia macvaughii Nesom, *sp. nov.* TYPE: MÉXICO. Jalisco: 15.9 km E of Agua El Obispo (W of Lagos de Moreno) on Hwy 80; beside and in ditch on NW side of road, 1770 m, 20 Aug 1979, *M.E. Lane 2594* (HOLOTYPE: TEX!; Isotypes: MEXU,TEX!).

Grindelia oxylepi E. Greene similis sed duratione longiore et foliis longioribus paginis non punctatis et dentibus acutis non glandiferis differt.

Annuals or biennials, 3-9 dm tall, completely glabrous except for scabrous leaf margins. Leaves narrowly oblong to oblanceolate or lanceolate, clasping, not decurrent, 2.0-3.5 cm long at midstem, 4-7 mm wide, reduced near the heads, not punctate, with 9-15 pairs of strongly spinulose or sharp indurated, eglandular teeth. Heads 12-17 mm wide, on short peduncles; phyllaries strongly graduated in length, the inner 7-9 mm long, white indurated

except at the very tip, the outer with loose, erect to spreading or reflexing, herbaceous punctate apices. Ray flowers 15-20. Disc corollas 5-6 mm long, not sharply ampliate. Achenes 2.5-3.5 mm long, subquadrate, with prominent transverse incisions and broad, shallow, longitudinal furrows; pappus awns smooth, nearly as long as the disc corollas.

Endemic to northeast Jalisco in the area around Lagos de Moreno; clay soil, ditches, grasslands, pastures, with desert shrubs, including *Acacia* and *Artemisia*; 1800-1900 m; Aug-Oct.

Additional collections examined: MÉXICO. Jalisco: about 11 mi SE of Lagos de Moreno, near hwy to León, 1900 m, 7 Sep 1952, *McVaugh 12820* (F,SMU); 11 mi SE of Lagos de Moreno, 16 Aug 1957, *Waterfall 13869* (SMU).

Grindelia macvaughii differs from *G. oxylepis* primarily in its longer leaves with nonpunctate surfaces and sharp, eglandular teeth. The three radiate species of the *Grindelia oxylepis* complex can be distinguished by the following key.

1. Annuals, usually single stemmed from the base; leaves mostly 8-15(-25) mm long, 3-5 mm wide, 2.0-2.5(-5) times longer than wide; achenes deeply sculptured at early maturity ..... *G. oxylepis*

1′ Annuals, biennials or short lived perennials, with several stems from the base; leaves mostly 15-40 mm long, 3-8 mm wide, 4-7 times longer than wide; achenes smooth or sculptured at early maturity .....(2)

   2. Perennials; leaf surfaces punctate; foliar teeth mostly glandular; ray flowers 20-30; achenes smooth at early maturity, developing longitudinal furrows at late maturity ..... *G. subdecurrens*

   2′ Annuals or biennials; leaf surfaces nonpunctate; foliar teeth definitely spinulose, not at all glandular; ray flowers 15-20; achenes usually prominently sculptured even at early maturity, with prominent transverse incisions and longitudinal furrows . *G. macvaughii*

A new species peripherally related to *Grindelia oxylepis*.

Grindelia turneri Nesom, *sp. nov.* TYPE: MÉXICO. Nuevo León: Mpio. Galeana, between San Pablo and Tanquecillos, 0.5 mi S of San Pablo, on the road between San Rafael Jc. and Galeana, fallow fields in valley, pines on high slopes of valley margins, 2320 m, 27 Aug 1989, *G. Nesom 7189* with J. Norris (HOLOTYPE: TEX; Isotypes: ANSM,COLO,ENCB,F, GH,KANU,MEXU,MO,NY,RM,US,WAT,WIS).

Grindelia oxylepi Greene similis sed duratione perenni, ramificatione basali, paginis foliorum minute puberulis non-punctatis, et aristis pappi quam corollis discii longioribus differt.

Perennials from thick, woody taproots, with numerous, basally decumbent-ascending branches arising from the crown. Stems 13-33 cm tall, glabrous or with a few, minute hairs. Basal leaves usually not persistent, lower to mid-cauline with blunt, gland tipped teeth, not punctate, glabrous, sometimes minutely scabrous near the margins or commonly with scattered puberulous hairs, clasping, oblong to oblong-lanceolate, mostly 15-45 mm long, 4-9 mm wide, slightly reduced in size upwards. Heads 14-20 mm wide, solitary on leafy peduncles; phyllaries lanceolate, subequal in length, the inner 3-4 series erect, 7-10 mm long, the outer spreading but not reflexed, whitish indurated on the basal 1/2-2/3, the apex herbaceous punctate; receptacles alveolate. Ray flowers 18-28, the corollas 12-18 mm long. Disc corollas 4.8-5.2 mm long, abruptly ampliate above the tube. Achenes 2.1-3.0 mm long, monomorphic, slightly flattened to 3 angled, smooth or with short, shallow, transverse incisions at late maturity; pappus awns 2, smooth edged, 1-2 mm longer than the disc corollas.

Endemic to Nuevo León in an area NNW of Galeana; valley bottoms in deep soil and surrounding, rocky, gypsum-limestone hillsides, areas of desert scrub to pine or pine-yucca woods; 1900-2550 m; (May-)August-October(-November).

Additional collections examined: MÉXICO. Nuevo León: Mpio. Galeana: road to 18 de Marzo, 8.7 mi E of jct with Hwy 57 [at San Rafael], 5 Aug 1983, *Freeman & Wetter 2056* (TEX,WIS-2 sheets); 8 mi E of San Rafael on road to 18 de Marzo, 4.4 mi E of La Boca, 22 Oct 1982, *Grimes 2278* (TEX); Tanquecillos, 11 May 1980, *Hinton, et al. 17760* (TEX); E of San Rafael, 5.6 mi ESE of San Pablo, 30 Nov 1986, *Nesom 5281* (MEXU,TEX); ca 2 mi W of San Pablo, overlooking the town, open, grassy slopes at edge of pine woods, 2300 m, 27 Aug 1989, *Nesom 7184* (ANSM,KANU,MEXU,MO,NY,RM,TEX,WIS); ca 2 mi S of Tanquecillos on road toward Galeana, open, sloping area of shaly limestone with scattered pines, 2450 m, 27 Aug 1989, *Nesom 7192* (MEXU,TEX); 20.6 mi N of San Roberto Jct on Hwy 57, 12 Oct 1984, *Sundberg 3131* (TEX,WIS).

Most of the collections of *Grindelia turneri* have been made within and on the low sides of the large valley that situates the towns of San Pablo and Tanquecillos, Nuevo León (Map 6). One collection (*Sundberg 3131*) is from the north edge of the large gypseous valley of Entronque San Rafael and San Roberto. The species is named for Dr. B.L. Turner, whose study of the systematics of Mexican Compositae within nearly all tribes has been of great influence.

The perennial duration and "bowl-shaped" habit of *Grindelia turneri* are similar to those of the northern plants of *G. inuloides*, which occurs on mountainsides overlooking the valley of San Pablo to the south. The glabrous stems, punctate phyllary apices, and wrinkled achenes, however, are features more similar to *G. oxylepis* E. Greene. In contrast to *G. oxylepis*, the leaves

of *G. turneri* are not punctate and often produce minute, eglandular hairs or glands (vs. punctate and completely glabrous in *G. oxylepis*). Further, plants of *G. oxylepis* are annual, usually with strictly erect stems that arise singly from the base. *Grindelia turneri* is distinctive among Mexican species in its pappus awns that extend 1-2 mm above the disc corollas.

III. *GRINDELIA NELSONII*

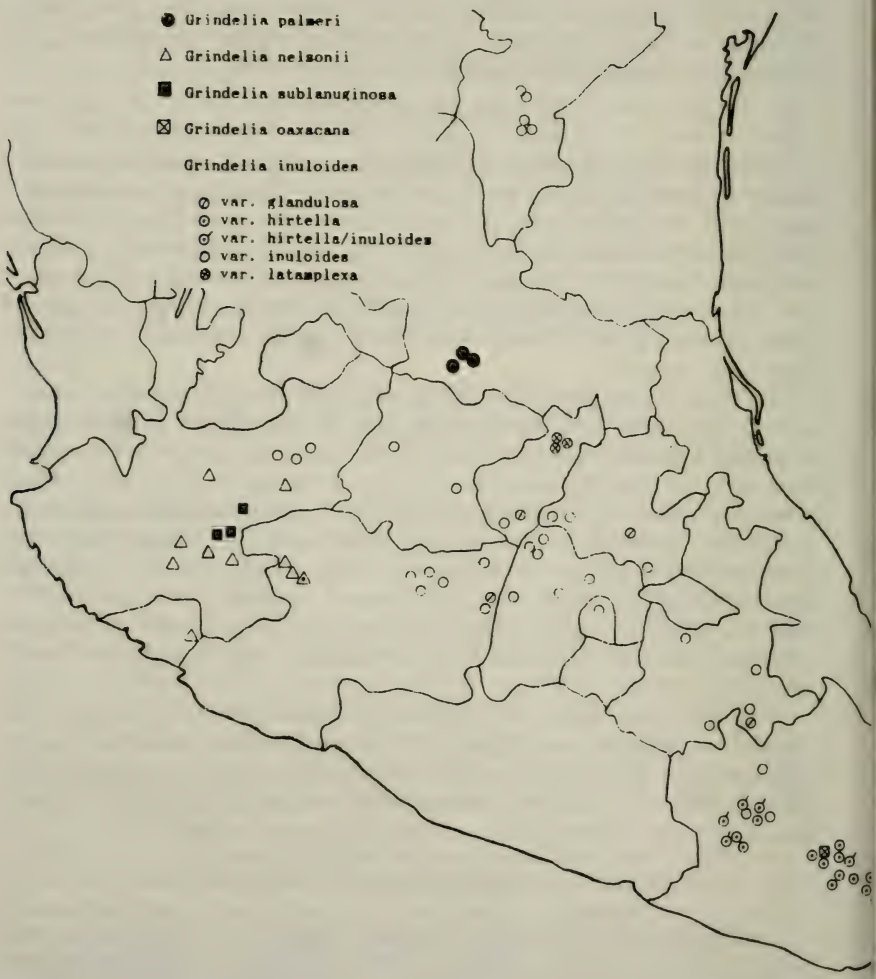
Grindelia nelsonii Steyerm. is restricted to southeastern Jalisco and immediately adjacent Michoacán and Colima (Map 5). The plants are characterized by tall stems (0.4-2.0 m) and are distinctive in bearing numerous heads in corymbs. The leaves are nearly glabrous with gland tipped teeth and have bases decurrent for 2-5(-10) mm. The outer phyllaries are long and very narrow. These plants were identified by McVaugh (1984) as *G. subdecurrens*, to which they appear to be closely related, although the relationship may be as close to *G. oxylepis*.

The type collection of *Grindelia nelsonii* (Isotype: GH!) was made at the eastern edge of the range of the species (Map 5) and appears to be aberrant in several significant respects. The cauline leaves are barely to not at all decurrent, and while the upper leaves have gland tipped teeth, the teeth of the lower ones are sharp pointed and subspinulose. In these features the plants are more like *G. inuloides*. In contrast, the glabrate leaves, gland tipped teeth and corymbose capitulescence are distinctive, and firmly align the type collection with the population system of similar plants to the west. Even if genes of *G. inuloides* were represented through hybridization or introgression in the type collection, the basis of the identity of *G. nelsonii* is firmly enough established through the type.

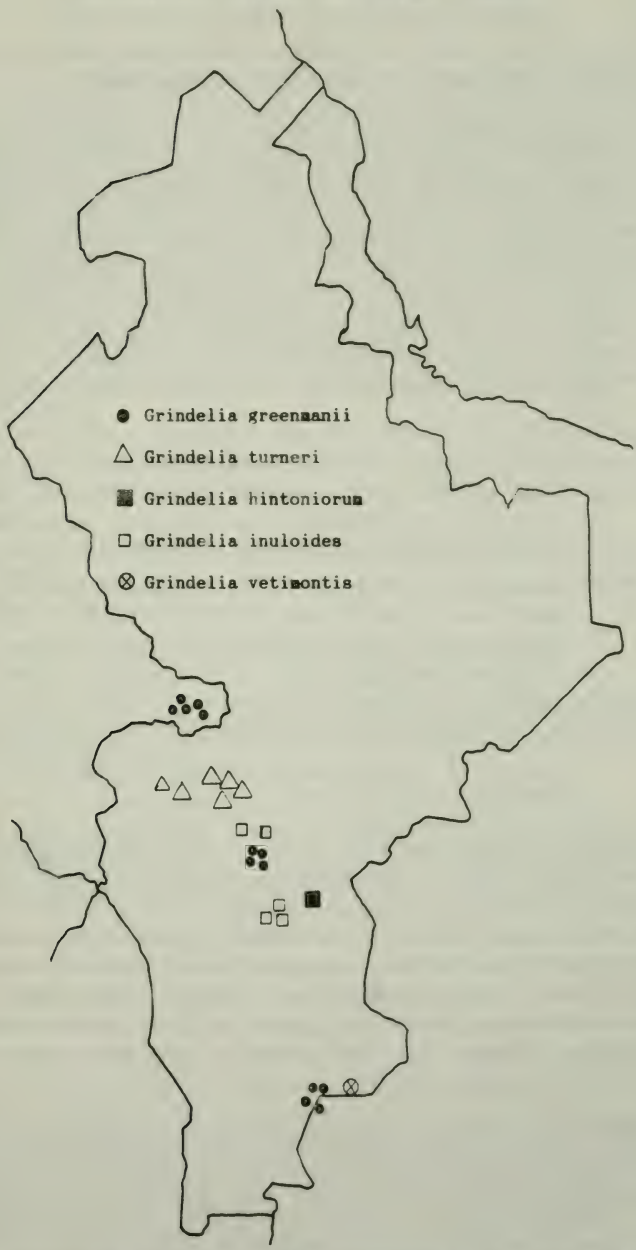
The only other species of *Grindelia* that occurs within the range of *G. nelsonii* is *G. sublanuginosa* Steyerm., which is a distinctive species but known only from a few collections around the northern and southern margins of Lake Chapala (Map 5). Plants of *G. sublanuginosa* have densely villous and stipitate glandular stems, solitary heads, and deeply sculptured achenes.

IV. THE *GRINDELIA ARIZONICA* COMPLEX

In this treatment, *Grindelia arizonica* A. Gray is viewed as a species that comprises three apparently disjunct population systems and that extends from southeastern Arizona through southwestern New Mexico, trans-Pecos Texas, and into Chihuahua and Coahuila, México (Map 3). It is distinguished by its glabrous, often reddish stems, glabrous leaves (except for the scabrous margins) with spinulose teeth, monomorphic achenes with longitudinal furrows at maturity, and pappus awns with ciliolate-scabrous margins. It is closely related to *G. oxylepis*, with which it shares strongly punctate phyllary apices and monomorphic achenes. *Grindelia havardii* Steyerm. also is closely similar



Map 5. Geographical range of *Grindelia inuloides, G. oaxacana, G. palmeri, G. nelsonii* and *G. sublanuginosa.* The type locality of *G. nelsonii* is shown by an open triangle enclosing a dot.



Map 6. Geographical range of *Grindelia vetimontis*, *G. turneri*, *G. hintoniorum*, *G. greenmanii* and *G. inuloides* in Nuevo León, Coahuila and Tamaulipas.

but has a longer duration and hirtellous leaf surfaces. Both of the latter differ from *G. arizonica* in their gland tipped foliar teeth.

Grindelia arizonica A. Gray, Proc. Amer. Acad. Arts 17:208. 1882. TYPE: UNITED STATES. Arizona: [Apache Co.], "southern Arizona," Black River, *Rothrock 796* (HOLOTYPE: GH!; Isotype: GH!). In Gray's 1882 publication of this name, he noted that it was "as yet unpublished (to which belongs *G. microcephala*, Rothrock in Wheeler Rep. 141)" ([Vol. VI.–Botany 141. 1878]). In Wheeler's report, Rothrock had presented a description and citation of his own collection *796*, which he identified as *G. microcephala* DC. Two years later (*Syn. Fl. N. Amer.* 1[2]:118. 1884) Gray cited his 1882 publication of *G. arizonica* as the origin of its name. In both references, Gray noted that the species occurs in northern México.

Grindelia arizonica A. Gray var. *dentata* Steyerm., Ann. Missouri Bot. Gard. 21:508. 1934. TYPE: UNITED STATES. New Mexico: Grant Co., Bear Mountain, near Silver City, 19 Sep 1903, *Metcalfe 744* (HOLOTYPE: US; Isotypes: GH,MINN,MO!,ND,NY,RM).

Grindelia arizonica A. Gray var. *microphylla* Steyerm., Ann. Missouri Bot. Gard. 21:508. 1934. TYPE: UNITED STATES. Arizona: [Greenlee Co.,] 10 mi N of Clifton, San Francisco River, 7 Sep 1902, *Davidson 736* (HOLOTYPE: GH!; Isotypes: CAS,PH,RM).

Grindelia setulifera Woot. & Standl., Contr. U.S. Natl. Herb. 16:179. 1913. TYPE: UNITED STATES. New Mexico: [Catron Co.,] high summits of the Mogollon Mountains, Sep 1881, *H.H. Rusby 206* (HOLOTYPE: US!).

Grindelia neomexicana Woot. & Standl. has been distinguished from *G. arizonica* by its linear (vs. subulate) outer phyllaries that are erect to slightly spreading (vs. spreading to slightly reflexed). Many of the New Mexico plants have much longer phyllaries than those of Arizona and the rest of the range, although both taxa have been recognized in both states (Kearney & Peebles 1951; Martin & Hutchins 1981) in an overlapping distribution. These New Mexico populations, primarily in Catron and Grant counties, are distinctive enough for continued taxonomic recognition, but I propose that they be reduced in rank to form part of *G. arizonica*.

Grindelia arizonica A. Gray var. **neomexicana** (Woot. & Standl.) Nesom, *comb. nov.* BASIONYM: *Grindelia neomexicana* Woot. & Standl., Contr. U.S. Natl. Herb. 16:178. 1913. TYPE: UNITED STATES. New Mexico: [Grant Co.,] mountains N of Santa Rita, 23 Aug 1900, *Wooton s.n.* (HOLOTYPE: US!). *Grindelia scabra* E. Greene var. *neomexicana* (Woot. & Standl.) Steyerm., Ann. Missouri Bot. Gard. 21:510. 1934.

The plants in México and trans-Pecos Texas are also differentiated, but they are here maintained simply as *Grindelia arizonica* (var. *arizonica*), since the overlapping variability in this species does not justify further taxonomic fragmentation. The Chihuahuan plants of *Grindelia arizonica* have narrow leaves like those in Arizona, outer phyllaries intermediate in length (between var. *arizonica* s. str. and var. *neomexicana*), and only slightly scabrous pappus awns. The Texan plants are more like the New Mexican ones in their wider leaves and prominently scabrous-ciliolate awns, but the outer phyllaries are also intermediate in length. In Arizona the trend toward reduction of the outer phyllaries culminates in a race from the Sierra Ancha (Gila Co.) that have very strongly graduated phyllaries as well as pappus awns that are smooth edged or nearly so.

Grindelia arizonica is essentially allopatric (Map 3) and not intergrading with *G. scabra* E. Greene, of which it has been considered a variety (as var. *neomexicana*). See discussions below of both *G. scabra* and *G. havardii* for further comments.

Grindelia arizonica var. *stenophylla* Steyerm. occurs in Colorado and northeastern New Mexico and appears to be more closely related to *G. decumbens* E. Greene than to *G. arizonica*.

V. THE IDENTITY OF *GRINDELIA HAVARDII*

Judging from recent annotation of specimens in LL-TEX as *Grindelia havardii* Steyerm., there have been varying interpretations of its identity. It is, however, a distinctive taxon.

Grindelia havardii Steyermark, Ann. Missouri Bot. Gard. 21:474. 1934. TYPE: UNITED STATES. Texas: Culberson Co., Guadalupe Mts., dry, gravely wash near mouth of McKittrick Canyon, 2000 m, 23 Jul 1931, *Moore & Steyermark 3607* (HOLOTYPE: MO; Isotype: TEX!).

Perennials, less commonly biennial, 0.6-1.5 m tall. Stems glabrous or sparsely hispidulous. Leaves ovate-lanceolate, slightly coriaceous, rarely punctate, with a tight, slightly raised reticulum of veins, often noticeably 3(-5) veined, coarsely serrate with gland tipped teeth but the apex with a short, indurated, spinulose apiculum, at least the lower with scabrous margins and often with scabrous-hispidulous lamina, the hairs sometimes minutely gland tipped. Heads on short, naked or bracteate peduncles; outer phyllaries with teretish, herbaceous punctate, loose, often spreading-reflexing apices, with the outermost usually reflexing, the inner 3 nerved on the distal half. Achenes monomorphic, 2.2-2.5 mm long, nearly smooth or with shallow, longitudinal furrows; pappus awns smooth edged.

Trans-Pecos Texas and Eddy Co., New Mexico; open sites, rocky slopes of limestone, less commonly alluvium; ca 1300-2000 m; June-September (-October).

Grindelia havardii has been considered to be similar and closely related to *G. lanceolata* Nutt. *Grindelia lanceolata*, however, always has spinulose foliar teeth and dimorphic achenes and it is geographically distant from *G. havardii*. The latter has blunt, gland tipped foliar teeth, monomorphic achenes, and is endemic to trans-Pecos Texas and adjacent New Mexico. The achenes of *G. havardii* are similar to those of *G. arizonica*, and in view of their putative hybridization, discussed below, I believe these two species probably are closely related.

The geographic range of *Grindelia arizonica*, which has spinulose foliar teeth, linear, erect phyllaries, and scabrous-ciliolate pappus awns, is more or less contiguous with that of *G. havardii* in Jeff Davis and Brewster counties (Map 3), although it appears to be more or less restricted to the igneous substrates to the southwest of the limestone area typical of *G. havardii*. Where their ranges abut, apparent intermediates occur between the two. Even there, however, the foliar teeth tend to be either mostly spinulose or glandular and the pappus awns smooth or ciliolate, and I have separated the two taxa on that basis. The foliar teeth of some of these putative intermediates are glandular on the proximal portion of the margins and sharp spinulose above.

The most strongly perennial forms of *Grindelia havardii* occur in Culberson Co., Texas. In the eastern part of the range, plants have more slender taproots, longer, more reflexing phyllaries and plants of one collection from Terrell Co. (*Raven & Gregory 19196*, SMU) have glandular but also slightly spinulose teeth.

VI. THE IDENTITY OF *GRINDELIA SCABRA*

Grindelia scabra E. Greene, Bull. Torrey Bot. Club 25:120. 1898. LECTOTYPE (designated here): UNITED STATES. New Mexico: Otero Co., White Mts., 6300 ft, 21 Aug 1897, *E.O. Wooton 224* (US!). Greene also cited *Wooton 372* (US).

Annual or biennial, from a taproot distinctly thickened at the stem/root junction. Stems sparsely to densely villous, eglandular. Leaves oblong to oblong-lanceolate with a rounded to slightly cordate base, clasping, sessile or on a short stipitate petiole, the margins serrate with 10-15 pairs of short spinulose teeth, the lamina sparsely hispidulous-pilose with short hairs, nonpunctate, eglandular or the Texas plants with minute, sessile resin glands. Heads 16-20 mm wide, immediately subtended by leaf like bracts; phyllaries glabrous, lanceolate-triangular, erect or the outer spreading, the innermost 10-11 mm long, all except the inner with a spinulose apex, with 3-5 longitudinal veins often prominent on at least the distal half. Achenes apparently somewhat dimorphic, the outer mostly smooth and 3 angled, the inner compressed, with slightly raised, longitudinal nerves; pappus awns minutely ciliolate-scabrous.

Because this species has not been previously recorded from Texas or México, the following specimens are cited.

UNITED STATES. Texas: Brewster Co., Gage Estate, Del Norte Mts., infrequent in deep limestone canyon on east side of Mt. Ord, 5000 ft, 14 Jul 1947, *Warnock 6466* (SMU).

MÉXICO. Coahuila: Monclova, [Sierra de Gloria,] 20 Jul 1939, *Marsh 1845* (F,TEX); Monclova, [Sierra de Gloria,] 3 Aug 1939, *Marsh 1883* (F,TEX).

Grindelia scabra is similar to *G. microcephala* DC. of Texas in its leafy bracteate heads and villous stems. It does not appear to be more closely related to *G. arizonica*, which has been treated as a variety (as *G. scabra* var. *neomexicana*, see discussion of *G. arizonica* above), than to *G. microcephala*. *Grindelia microcephala* differs from *G. scabra* in its blunt, gland tipped foliar teeth, smaller heads, enervate inner phyllaries and smooth edged pappus awns. *Grindelia arizonica* differs in its glabrous stems and leaves, heads without large, subtending, foliar bracts and monomorphic achenes with longitudinal furrows.

The leaves of the Mexican plants of *Grindelia scabra* are slightly stipitate on petioles 1-2 mm long. While this appears to be an unusual feature, it can also be seen, though rarely, in related species, where a decurrent leaf base appears to be slightly separated from the stem. Although the plants of the Mexican collections lack roots and mature achenes, they appear best placed in this species, at least until further collections can be made. The lectotype has narrowly linear outer phyllaries but otherwise is typical for the species.

VII. VARIATION IN *GRINDELIA MICROCEPHALA*

As presented here, *Grindelia microcephala* comprises three distinct population systems, each recognized as a separate variety. The plants are annuals with sparsely to moderately but closely villous stems. The leaves have blunt, gland tipped teeth and the heads are small (8-12 mm wide), immediately subtended by relatively unreduced cauline leaves. The phyllaries are enervate, with green, nonpunctate, spreading-erect apices. The achenes are dimorphic, with morphology variable among the varieties and producing smooth edged pappus awns.

Grindelia microcephala apparently is endemic to Texas. Although it has been collected very near the Mexican border at several localities (Map 2), no stations from México are known. Three remarkably distinct varieties occur, each occupying a relatively restricted geographic range, almost completely allopatric with the other varieties. Although heads with mature fruits are required to distinguish them with certainty, there appear to be but few collections that might be identified as intermediates.

1. Leaves often with conspicuous sessile or stipitate resin glands, sometimes punctate-resinous; outer achenes deeply and sharply cut with transverse

furrows, the inner abortive or fertile, flat and many nerved; southwest Edwards Plateau; March-May ..... var. *pusilla*

1′ Leaves usually punctate-resinous, rarely with sessile or minutely stipitate and inconspicuous resin glands; outer achenes smooth, longitudinally furrowed, or slightly roughened rugose, the inner achenes abortive and undeveloped or fertile, flat, and many nerved ..... (2)

2. Outer achenes roughened rugose, not at all transversely incised, at least some of the inner achenes fertile, strongly flattened and as long as or longer than the outer, with numerous, whitish, longitudinal nerves; Blackland Prairie region of Texas; June-September ..... var. *adenodonta*

2′ Outer achenes smooth, plump and rounded, to 3 sided with a few, rounded, longitudinal furrows, commonly with short, shallow, transverse incisions, the inner achenes completely abortive; Rio Grande plains; (November-)March-June(-August) ..... var. *microcephala*

Grindelia microcephala DC. var. *microcephala.*

Grindelia microcephala DC. var. *microcephala. Grindelia microcephala* DC., *Prodr.* 5:315. 1836. TYPE: UNITED STATES. Texas: 1832, *Berlandier 2057* (HOLOTYPE: G-DC, fiche!; Isotypes: GH,MO!,NY). *Grindelia inuloides* Willd. var. *microcephala* (DC.) A. Gray, *Syn. Fl. N. Amer.* 1(2):117. 1884.

Steyermark (1934: p. 467) cited "*Berlandier 647* (*2057*)" as the type of *Grindelia microcephala* (Texas, "in campis prope Rio Frio, Juli 1829 and Juli 1829" - - GH the holotype, with isotypes MO,NY). The smaller number (647) is a "distribution number" by Berlandier for the larger one (2057). The collection data in DeCandolle's description, in contrast, cited only Texas, without specific locality, 1832, *Berlandier 2057.* Because there is a specimen in G-DC (fiche!) that exactly matches DeCandolle's published data, it must be assumed to be the holotype. Further, DeCandolle's notes on this specimen leave little doubt regarding its identity: "Flores disci steriles in specim. meo videntur. Achaenia radii matura grossa calva." Thus, the collection almost certainly must have been made from lower parts of the Frio River in McMullen County, where plants with such features occur and through which Berlandier passed in his travels (Muller & Muller 1980).

Variety *microcephala* appears to be most closely related to var. *pusilla*, as evidenced by its abortive inner ovaries, the slight transverse incisions on the mature achenes and its flowering that begins in early spring.

Grindelia microcephala DC. var. *pusilla* Steyerm.

Grindelia microcephala DC. var. *pusilla* Steyerm., Ann. Missouri Bot. Gard. 21:467. 1934. TYPE: UNITED STATES. Texas: [Frio or LaSalle Co.,] between the Frio and Nueces Rivers, on the road to Laredo, 27-28 Jan 1880, *E. Palmer 469* (HOLOTYPE: GH; Isotypes: MO!,NY,US).

Grindelia microcephala DC. var. *adenodonta* Steyerm. forma *angustior* Steyerm., Ann. Missouri Bot. Gard. 21:469. 1934. TYPE: UNITED STATES. Texas: Uvalde Co., near Uvalde, rocky, open ground along small stream, 28 Apr 1928, *E.J. Palmer 33590* (HOLOTYPE: MO!; Isotypes: LL!,NY).

Grindelia microcephala DC. var. *adenodonta* Steyerm.

Grindelia microcephala DC. var. *adenodonta* Steyerm., Ann. Missouri Bot. Gard. 21:467. 1934. TYPE: UNITED STATES. Texas: [Fayette Co.,] 39 mi W of San Felipe, Jul-Aug 1844, *Lindheimer 255* (HOLOTYPE: MO!; Isotypes: GH,PH,UC).

The status of *Grindelia microcephala* D.C. var. *montana* Steyerm.

The collection described by Steyermark as *Grindelia microcephala* var. *montana* is similar to *G. microcephala* in its heads immediately subtended by relatively unreduced cauline leaves. In contrast, besides its extremely wide geographic disjunction and different habitat, the Oaxacan taxon differs from *G. microcephala* in its much taller and densely stipitate glandular stems, nonglandular foliar teeth, and strongly 3-5 nerved phyllaries. It appears to be a distinct species and is here formally elevated in rank.

Grindelia oaxacana Nesom, *nom. nov.* Based on: *Grindelia microcephala* DC. var. *montana* Steyerm., Ann. Missouri Bot. Gard. 21:470. 1934; *non Grindelia montana* Phil., 1894. TYPE: MÉXICO. Oaxaca: Mts. San Juan del Estado, 7500 ft, 13 Aug 1894, *L.C. Smith 135* (HOLOTYPE: GH!).

Plants at least 40 cm tall. apparently much taller, duration unknown. Stems densely stipitate glandular, the glands orange resinous, mixed with nonglandular, villous hairs. Leaves oblong-ovate, 2-5 cm long, 8-20 mm wide, mostly even sized upwards, the surfaces minutely glandular, the teeth blunt, neither glandular nor spinulose. Heads 16-22 mm wide, immediately subtended by cauline leaves little reduced in size; phyllaries glabrous to slightly sessile glandular, oblong-obovate, abruptly narrowed to a strongly reflexed apex, the middle 2.5-2.8 mm wide, 5 nerved. Rays 16-22, 14-16 mm long. Disc corollas 5 mm long. Mature achenes not observed; pappus awns smooth edged.

Known only from the type collection.

This species is distinctive in its large leaves and heads immediately subtended by relatively unreduced cauline leaves. *Grindelia sublanuginosa* Steyerm., from Jalisco, is similar in some respects, but *G. oaxacana* differs by its taller stems that are much more densely stipitate glandular and not densely villous, leaves larger and relatively broader, and phyllaries strongly nerved, the outer abruptly narrowed to a reflexing apex. Populations of *Grindelia inuloides*, the only other species of *Grindelia* in Oaxaca, also occur in the central part of the state, but are much more common than *G. oaxacana* (Map 5). The latter has stems taller, villous and eglandular to very slightly and minutely glandular, leaves smaller with the upper strongly reduced and phyllaries enervate or barely nervate.

VIII. THE STATUS OF *GRINDELIA GREENEI*

The Mexican taxon *Grindelia greenei* is best treated as a variety of *G. lanceolata* Nutt.

Grindelia lanceolata Nutt. var. **greenei** (Steyerm.) Nesom, *comb. et stat. nov. Grindelia greenei* Steyerm., Ann. Missouri Bot. Gard. 21:517. 1934. TYPE: MÉXICO. Nuevo León: vicinity of Monterrey, 1924, *C.R. Orcutt 1204* (HOLOTYPE: US!).

Additional collections examined: MÉXICO. Nuevo León. Monterrey, "foot Chipi[n]que," 9 Oct 1937, *Kenoyer 300* (F,MO); Monterrey, 1924, *Orcutt 1249* (US).

The plants of the type collection of *Grindelia greenei* apparently were far disjunct from the main range of *G. lanceolata* (Map 3). Only the type collection and two others of this taxon, both from Monterrey or its vicinity, are known from México, and the current urban expansion of that city makes it improbable that the original population has survived. The broadly ovate-elliptic leaves of the Mexican plants, consistently among the collections examined, are different from those of both var. *lanceolata* and var. *texana* (Scheele) Shinners, and they have somewhat smaller, more regular teeth. The phyllaries are only weakly graduated to subequal in length, most like those of var. *lanceolata*. In their perennial duration, glabrous vestiture, punctate leaves with stoutly spinulose teeth and dimorphic achenes, the plants of *G. greenei* clearly belong with *G. lanceolata*.

Perhaps the largest amount of variability in *Grindelia lanceolata* occurs in the extreme southern portion of its range. Steyermark (1934: p. 517) described *G. littoralis* Steyerm. as an "endemic of the Galveston Bay region ...intermediate between *G. lanceolata* and *G. texana*" with more closely appressed and incurved foliar teeth and with pappus awns with "several projections" rather than "entire or subentire." With many more collections from

around Galveston now at hand, however, I agree with Johnston (1970) that *G. littoralis* cannot be separated from *G. lanceolata*.

IX. THE *GRINDELIA INULOIDES* S. STR. COMPLEX

As noted below, *Grindelia inuloides* Willd. is an extremely variable species. It is recognized by its taprooted habit, nonpunctate leaves with sharp pointed, nonglandular teeth (glandular in one variety), stem pubescence at least sparsely villous, heads mostly solitary, phyllaries variable in morphology but never with punctate apices and monomorphic achenes with smooth or weakly sculptured surfaces.

Grindelia inuloides Willd.

Annuals, biennials, or perennials from taproots, most commonly single stemmed from the base but often with several ascending branches from the crown. Stems 2-7(-10) dm tall, very sparsely villous to glabrate, eglandular or sometimes glandular. Lower and midcauline leaves oblong-obovate to oblong-lanceolate or lanceolate, 25-50 mm long, 3-10 mm wide, 5-9 times longer than wide, clasping, decurrent 0(-3) mm, reduced in size upwards and becoming triangular-lanceolate to linear, minutely and sparsely appressed puberulent, not punctate. Heads 12-20 mm wide, solitary; phyllaries 8-11 mm long, equal to subequal or strongly graduated in length, sparsely puberulous to glabrate, not punctate or nervate, the lower portion usually strongly white indurated. Ray flowers 23-50, the corollas 12-18 mm long. Disc corollas 4.0-5.0 mm long, abruptly ampliate above the tube. Achenes monomorphic, slightly flattened to 3 angled, smooth or with distinct transverse incisions near the top; pappus awns 2-5(-6), smooth edged.

KEY TO THE VARIETIES

1. At least the upper stems, leaves, and phyllaries densely and prominently stipitate glandular ..... (2)

1′ Stems and phyllaries eglandular or with minute, nearly sessile, barely perceptible glands ..... (3)

2. Leaves slightly auriculate but sessile or nearly so at the base, upper cauline leaves strongly reduced in size from midstem; phyllaries white indurated and enervate at the base ..... var. *glandulosa*

2′ Leaves thin whitish and strongly clasping at the very base, upper cauline leaves little reduced in size from midstem; phyllaries herbaceous and 3 nerved at the base ..... var. *latamplexa*

3. Stems moderately to densely villous; foliar teeth glandular and blunt at the apex; phyllaries strongly graduated, the inner erect, 6-8 mm long, the outer strongly reflexed; achenes with deep, transverse furrows at maturity ..... var. *hirtella*

3. Stems very sparsely villous; foliar teeth indurated and sharp pointed at the apex; phyllaries subequal or weakly graduated, all more or less erect, 8-11 mm long; achenes smooth to weakly sculptured ..... var. *inuloides*

Grindelia inuloides Willd. var. *glandulosa* (Greenm.) Steyerm.

Grindelia inuloides Willd. var. *glandulosa* (Greenm.) Steyerm., Ann. Missouri Bot. Gard. 21:456. 1934. TYPE: MÉXICO. Hidalgo: Sierra de Pachuca, 13 Aug 1898, *C.G. Pringle 6962* (HOLOTYPE: GH!; Isotypes: MO!,US). *Grindelia glandulosa* Greenm., Proc. Amer. Acad. Arts 34:575. 1899.

Hidalgo, Puebla, Michoacán, scattered in areas of high elevation; meadows, near pine, fir, or spruce; 2400-3050 m; June-October.

In its most representative form, var. *glandulosa* is very distinctive. The glandular vestiture is dense, with very few eglandular hairs present. Lightly glandular plants, however, can be found among those of var. *hirtella* as well as scattered through the eastern range of var. *inuloides*.

Grindelia inuloides Willd. var. *hirtella* (Robinson & Greenm.) Nesom

Grindelia inuloides Willd. var. **hirtella** (Robinson & Greenm.) Nesom, *comb. nov.* BASIONYM: *Grindelia squarrosa* (Pursh) Dun. var. *hirtella* Robinson & Greenm., Amer. J. Sci. 50:153. 1895. TYPE: MÉXICO. Oaxaca: hills, Las Sedas, 6000 ft, 16 Aug 1894, *C.G. Pringle 4805* (HOLOTYPE: US; Isotype: MO!).

Central to northwest Oaxaca; calcareous slopes, fields, roadsides; ca 1200-1800 m; January-September.

Grindelia inuloides var. *hirtella* is characterized by villous stem pubescence, blunt, glandular, foliar teeth, strongly reflexed outer phyllaries with a glandular groove on the distal adaxial surface and sculptured achenes. It is similar in aspect to var *inuloides*, which differs in smooth achenes, sharp pointed, nonglandular foliar teeth and erect, more herbaceous phyllaries.

Grindelia inuloides var. *hirtella* is extremely distinctive when found in its characteristic morphology. The difference between it and var. *inuloides* is greater than between a number of other closely related Mexican taxa recognized as distinct species. Particularly in northern Oaxaca (Map 5), however, the intermediates are too numerous over a wide area to allow the two taxa to be maintained as separate species.

Grindelia inuloides Willd. var. *inuloides*

Grindelia inuloides Willd., Ges. Naturf. Freunde Berlin Mag. 1:261. 1807. TYPE: MÉXICO. Grown in Europe from seeds sent from México by Sesse (B, photo-MO!). According to Steyermark (1934), the leaves of the type have "margins with close sharp serrulations," which indicates that it was collected north of Oaxaca, primarily the range of var. *hirtella*.

Grindelia angustifolia Kunth, Nov. Gen. & Sp. 4 [folio]:245. 1818; 4 [quarto]:309. 1820. TYPE: MÉXICO. Michoacán: Prope Valladolid de Michoacán et Pazcuaro, *Humboldt & Bonpland s.n.* (HOLOTYPE: P fiche!). See Steyermark (1934) for additional synonyms.

Northern Jalisco, Guanajuato, Michoacán, Querétaro, Hidalgo, México, Puebla and northern Oaxaca; cultivated areas, pine-oak woods; 1800-2250 m; (June-)July-October.

As I have treated it, *Grindelia inuloides* is the most variable of all the Mexican species. Even within var. *inuloides*, a great deal of variability remains and almost certainly will form the basis for segregation of additional taxa in the future. For example, a distinctive form with the upper cauline leaves reduced to a long series of linear-filiform peduncular bracts occurs from Zitácuaro to Morelia, Michoacán. These plants also have very strongly graduated phyllaries. Plants with basal branching and very broad, lacerate-ciliate phyllaries are found in México, southern Hidalgo and Puebla. Plants with strongly decurrent leaves appear to be relatively common in Puebla. The plants in northeastern Jalisco have more strongly scabrous foliar margins and longer ligules than elsewhere in the range of the species.

Grindelia inuloides Willd. var. *latamplexa* Nesom

Grindelia inuloides Willd. var. **latamplexa** Nesom, *var. nov.* TYPE: MÉXICO. Querétaro: 2.7 km SW of Pinal de Amoles on Hwy 120, 1.7 km NE of the SARH forestry fire station, 27 Dec 1980, *J.M. Canne 1941* with D.W. Woodland (HOLOTYPE: F!).

Grindelia inuloidi Willd. var. *glandulosae* (Greenm.) Steyerm. similis sed basibus foliorum valde amplectentibus, foliis caulium superorum non deminutis, et phyllariis nervatis herbaceis differt.

Taprooted annuals or biennials, with stems, leaves and phyllaries densely stipitate glandular. Stems 25-40 cm tall, dark purple, glandular and moderately to densely villous, with 2-4 branches on the upper half. Basal leaves persistent, 10-15 cm long, with a basally dilated, multinerved petiole; cauline leaves 3-6 cm long, only slightly reduced in size upwards, the base broadly

clasping, whitish, with 3-5 veins entering in parallel from the stem and continuing independently and more or less palmately into the blade, the teeth sharp pointed, not glandular, the lamina glandular and hirtellous to sparsely short pilose. Heads 15-20 mm wide; phyllaries relatively evenly herbaceous, all series erect and of nearly even length, narrowly triangular, 3 nerved at least on the lower portion. Ray flowers 25-50. Achenes apparently monomorphic, mature morphology not observed; pappus awns smooth edged.

Querétaro, in the vicinity of Pinal de Amoles; roadsides, banks, in both oak and pine woods; 2300-2400 m; November-February(-probably later).

Additional collections examined: MÉXICO. Querétaro. 1.5 mi W of Pinal de Amoles, 11 Nov 1976, *Turner 76-13* (LL); 6.5 mi S of Pinal de Amoles along Hwy 120, 16 Jan 1977, *Urbatsch & Pridgeon 3038* (LL).

The three collections of these distinctive plants have all come from the immediate vicinity of Pinal de Amoles, Querétaro, on the northern periphery of the range of the species (Map 5). They are recognized by their densely glandular vestiture, villous stems, cauline leaves with broadly clasping, multinerved bases and herbaceous, narrowly triangular, even length, basally 3 nerved phyllaries. The cauline leaves are relatively unreduced in size upwards, with some of them immediately subtending the heads as foliar bracts. These plants may deserve specific rank, but the features that characterize them can be found, although not coherently, through the range of var. *inuloides*.

The populations of *Grindelia inuloides* in northeastern México

Although they are restricted in distribution and far disjunct from the primary range of the species (Maps 5 and 6), there is very little to distinguish the plants of *Grindelia inuloides* in Nuevo León from those of var. *inuloides* in south central México. The northern plants are consistently perennial with shorter, decumbent-ascending stems, but similar sized plants with a similar habit occur in the south as well. They tend to have slightly smaller heads and the inner and outer series of phyllaries exhibit the same extreme variability in graduation of length as seen in the more southern plants.

While true *Grindelia inuloides* can be recognized among these northern forms, there is a closely related taxon from that area that I believe warrants formal recognition as a species.

Grindelia hintoniorum Nesom, *sp. nov.* TYPE: MÉXICO. Nuevo León: Mpio. Galeana , E of Pablillo, oak woods, 1940 m, 15 May 1984, *Hinton, et al. 18666* (HOLOTYPE: TEX!; Isotypes: NY!,WIS!,others to be distributed - MEXU?).

Grindelia inuloidi Willd. similis sed caulibus brevioribus, vestimento dense stipitati-glanduloso, et foliis decurrentibus differt.

Perennial herbs with many ascending-decumbent unbranched stems 5-15 cm long from the base, apparently taprooted. Stems, leaves and phyllaries densely stipitate glandular from top to bottom of plant, the stems also sparsely to very sparsely villous-hirsute, leaves and phyllaries mostly without eglandular hairs except along the veins and margins. Basal leaves spatulate-oblanceolate, lower and midcauline oblong-oblanceolate, 10-22 mm long, 4-6 mm wide, clasping, decurrent for 0.5-2.0 mm, with 10-22 pairs of sharp indurated but not aristate teeth, strongly reduced to linear, leafy bracts just beneath the heads. Heads 10-12 mm wide, solitary, phyllaries evenly and narrowly triangular-lanceolate, white indurated at the base, gradually becoming herbaceous upwards, in 5-6 weakly graduated to subequal series, the innermost 7-8 mm long, mostly erect, with loose or spreading, minutely aristate apices. Ray flowers 19-34, the corollas 9-11 mm long. Disc corollas 4.5-5.0 mm long, abruptly ampliate above the tube. Mature achenes not seen; pappus awns 2, smooth edged, equal or slightly longer than the disc corollas.

Grindelia hintoniorum is known from a single remarkable collection. On the three sheets cited, it is represented by a large number (ca 35) of stems broken off at the base. All are densely stipitate glandular from top to bottom. In the small size of its stems, leaves, heads and ligules, *G. hintoniorum* is most similar to and probably most closely related to forms of *G. inuloides* from Nuevo León. A number of collections of the latter from the area of Pablillo, however, are typical for the species and show nothing of the densely stipitate glandular vestiture displayed by all plants of *G. hintoniorum* (Map 6).

Other species related to *Grindelia inuloides*

Grindelia greenmanii Steyerm., the common, high elevation species of Coahuila and Nuevo León (Map 6), appears to be only distantly related to the other species of northeastern México but more closely to the *G. inuloides* complex *s. lat.* It has densely stipitate glandular vegetative parts, very large leaves and heads, and herbaceous, subequal phyllaries. Rather than a taproot, it produces thick, lateral rhizomes.

Grindelia palmeri Steyerm., a relatively narrow endemic of the mountains east of Cd. San Luis Potosí (Map 5), has been identified as *G. inuloides*. It differs from *G. inuloides* in its more crowded cauline leaves that are only slightly reduced upwards and that are oblong with rounded apices and blunt, gland tipped teeth. This species does not appear to be as highly morphologically differentiated from *G. inuloides* as *G. inuloides* var. *hirtella*, but *G. palmeri* is allopatric with *G. inuloides* and no intermediates between them have been seen.

X. A NEW SPECIES OF *GRINDELIA* FROM NUEVO LEÓN

Grindelia vetimontis Nesom, *sp. nov.* TYPE: MÉXICO. Nuevo León: Mpio. Zaragoza, Cerro del Viejo, 15 mi W of Dulces Nombres, rocky slopes in open pine forest, 3330 m, 18 Aug 1948, *F.G. Meyer & D.J. Rogers 2988* (HOLOTYPE: MO!; Isotype: F!).

Grindelia greenmanii Steyerm. similis rhizomatibus, foliis glandulosis, et acheniis monomorphis laevibus valde compressis sed differt caulibus eglandulosis, foliis superis caulinis ovati-oblongis non deminutis, capitulis minoribus, et phyllariis externis 3-5 nervibus induratis ad bases.

Perennials from a thick rhizome. Stems 3-5 dm tall, sparsely to moderately villous, eglandular or very sparsely glandular just below the heads. Leaves densely invested with minute, sessile or barely stipitate resin glands, intermixed with sparse villous-hirtellous hairs; basal leaves persistent, elliptic-oblanceolate, the cauline ovate-oblong, clasping but not basally ampliate, 15-30 mm long 10-12 mm wide, relatively even sized and of constant shape upwards, the teeth eglandular, sharp pointed, indurated at the tip but not spinulose. Heads 15-18 mm wide, immediately subtended by several, large, leaf like bracts; phyllaries ovate-lanceolate, conspicuously 3-5 nerved, with the lower 2/3-3/4 white indurated, the outer gradually tapered to a herbaceous, spreading-reflexing tip, the inner sharply constricted at the very apex. Ray flowers 22-24. Disc corollas 5 mm long. Achenes monomorphic, obovate, 2.8-3.2 mm long, strongly compressed with 2 lateral nerves, the walls smooth or with several, faint, longitudinal nerves; pappus awns 1-2, very slender, smooth edged.

Known only from the type collection (Map 6).

Grindelia vetimontis is similar to *G. greenmanii, G. obovatifolia* and *G. robinsonii* in its rhizomatous habit, foliar teeth with sharp, indurated points and very slender pappus awns. It is similar to the first and probably most closely related to it in its glandular leaves, and monomorphic, smooth and strongly compressed achenes, but different in its eglandular stems, differently shaped and unreduced upper cauline leaves, smaller heads, and nervate, basally white indurated outer phyllaries. It is similar to the latter two in its leaf shape and nervate phyllaries, but different in its prominent foliar capitular bracts, broader phyllaries that are apically more abruptly acute and monomorphic (vs. dimorphic) achenes.

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