SYSTEMATIC STUDY OF THE GENUS *BAILEYA* (ASTERACEAE: HELENIEAE)

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ABSTRACT

A revisionary treatment of *Baileya* is rendered following the examination of approximately 1,800 herbarium specimens of the genus. Three species are recognized: *B. pauciradiata, B. multiradiata* and *B. pleniradiata.* Descriptions, illustrations, dot-maps, keys to species and complete synonymy are presented. The relationship of *Baileya* to its most closely related genus, *Psilostrophe,* is discussed.

RESUMEN

Se hace una revisión del género *Baileya* mediante el examen de aproximadamente 1800 pliegos de herbario. Se reconocen tres especies: *B. pauciradiata, B. multiradiata* y *B. pleniradiata*. Se ofrecen descripciones, ilustraciones, mapas de distribución, clave de especies y sinonimia completa. Se discuten las relaciones entre *Baileya* y *Psilostrophe* por ser el género más semejante.

KEY WORDS: Asteraceae, *Baileya, Psilostrophe,* taxonomy

Distributed widely in the desert Southwest, *Baileya* is a genus of annual, biennial and short-lived perennial herbs with often showy yellow blossoms that have earned at least one of its species the common name of "Desert Marigold." In reviewing Lieut. Col. William H. Emory's collections of the American Southwest, John Torrey first recognized the genus in print in 1848, which William H. Harvey and Asa Gray had previously described from Thomas Coulter's collections in California in the early 1830s (Emory 1848). The genus was dedicated to Jacob Whitman Bailey of the U.S. Military Academy, renowned for his microscopical investigations and for his research in the "Algae and especially the Diatomaceae (which he was the first to detect in a fossil state in this country)" (Harvey & Gray 1849).

At the time of Torrey's report, Harvey and Gray had already recognized, but not published, three species, which they first fully described in print in 1849: *B. pauciradiata, B. pleniradiata* and *B. multiradiata.* Gray (1884) later recognized only two species, *B. pauciradiata* and *B. multiradiata,* the latter with two varieties, var. *multiradiata* and var. *nudicaulis*. What he had called *B. pleniradiata* he renamed as *B. multiradiata*, and then reduced the larger-headed *B. multiradiata* to varietal status. Subsequent works, such as Coville's (1893), have reinstated the name *pleniradiata* at the varietal if not the specific level. *Baileya pauciradiata,* with its cymose heads and few florets, is clearly the most distinct of the three, and has

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posed no subsequent problems in the taxonomic literature, while *B. pleniradiata* and *B. multiradiata* have continually provoked discussion and are, by many accounts, not readily distinguishable (Kearney & Peebles 1951; Keck 1959). Rydberg (1914) recognized the greatest number of species, six. Brown (1974) in his unpublished dissertation recognized five taxa in three species.

In this paper I have returned to Harvey and Gray's original descriptions in order to call attention to a distinctive feature that Gray himself first recognized, then later ignored. Originally, Harvey and Gray had described *B. pleniradiata* as having mucronate style branches which are lacking in the other two species (cf.

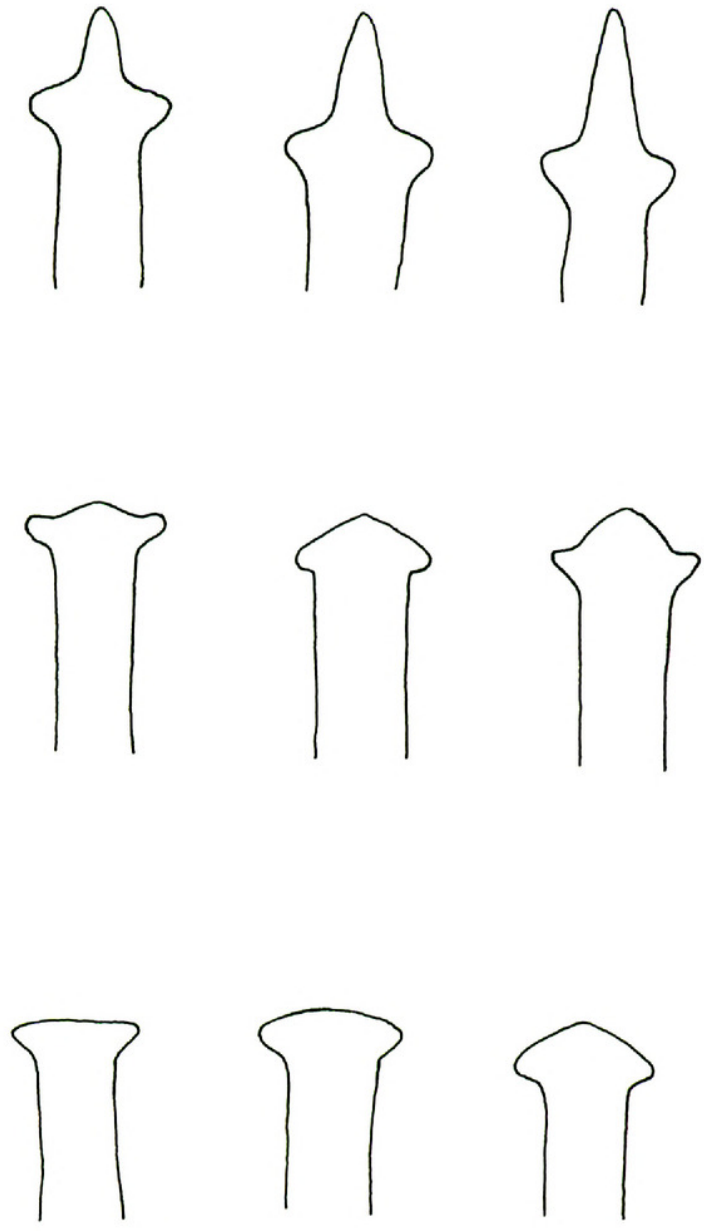

FIG. 1. Outline of style branches (top to bottom) of *Baileya pleniradiata, B. multiradiata,* and *B. pauciradiata.*

Fig. 1). I have found this observation—ignored in all subsequent taxonomic studies—to be a key distinguishing feature between *B. pleniradiata* and *B. multiradiata* . Although the usual distinction between these species is based on the number of ligules and on the peduncle length, these features are unreliable given the difference between the vernal and autumnal forms of *B. multiradiata.* Autumnal forms, with their smaller heads, fewer ligules and shorter peduncles, greatly resemble *B. pleniradiata,* and have caused much confusion in their identification.

In the present study three species are recognized, none of which is thought to have populational units worthy of varietal rank.

CHROMOSOMES

The first chromosome report for the genus was by Carlquist (1956) who reported a number of $2n = 32$. All subsequent workers have found chromosome numbers to be uniformly diploid with $2n = 32$ pairs, with the exception of Watson (1973) who reported a diploid count of $2n = 34$ (Table 1). The latter worker perhaps misinterpreted a pair of B chromosomes, hence the anomolous count. At least Brown and Pinkava (1974) and Brown and Thompkins (1982) have noted the presence of B chromosomes in the genus.

CHEMICAL STUDIES

Seaman (1982) in his comprehensive study of the sesquiterpene lactones of the Asteraceae has summarized most of the published material dealing with the secondary chemistry of *Baileya.* A few additional compounds are reported by Einck et al. (1978). All three species of *Baileya* have been examined for their sesquiterpene lactones with the following results:

B. multiradiata	*B. pleniradiata*	*B. pauciradiata*
baileyolin	baileyolin	
baileyin	baileyin	
fastigilin A		
fastigilin B		
fastigilin C	fastigilin C	
		hymenoratin
hymenoxon		
multigilin		
multistatin		
multiradiatin		
		odoratin
	paucin	paucin
	pleniradin	
	plenolin	
radiatin	radiatin	

Table 1: Chromosome reports for *Baileya*.

Species	Reference	Chromosome no. (2n)
B. pauciradiata	Raven & Kyhos (1961)	32
"	Pinkava et al (1972)	32
"	Strother (1976)	32
"	Keil (1981)	32
B. multiradiata	Carlquist (1956)	32
"	Raven & Kyhos (1961)	32
"	Powell & Turner (1963)	32
"	DeJong (1966)	32
"	Grashoff et al (1972)	32
"	Pinkava et al (1972)	32
"	Watson (1973)	34
"	Brown & Pinkava (1974)	32 + (0–4B)
"	Reveal & Spellenberg (1976)	32
"	Keil (1979)	32
"	Weedin & Powell (1980)	32
"	Brown & Thompkins (1982)	32 + (1–2B)
"	Strother (1983)	32
"	Ward (1984)	32
B. pleniradiata	Raven & Kyhos (1961)	32
"	Turner et al. (1961)[1]	32
"	Watson (1973)	32
"	Keil (1979)	32
"	Brown & Thompkins (1982)	32

[1]Specimen cited is from Coahuila, Mexico. From the above study, it is highly probable that this sheet represents *B. multiradiata*.

It can be seen from the above that *B. multiradiata* and *B. pleniradiata* are chemically similar based upon several shared compounds, whereas *B. pauciradiata* is relatively more remote, expressing but a couple of sesquiterpene compounds, one of these, paucin, shared with *B. pleniradiata.* All of these are C-8 lactonized helenanolids, which are relatively common in the tribe Helenieae (Seaman 1982, p. 205), although the various genera appear to sequester their own particular kinds of compounds. Thus, most of the above-listed compounds are unique to *Baileya,* but the sesquiterpene lactone, fastigilin C, also occurs in *Gaillardia fastigiata* Greene and *Hymenoxys acaulis* (Pursh) Parker, while the glucosidic derivative, paucin, has been reported from several species of *Hymenoxys.*

In addition to sesquiterpene lactones, the roots of *Baileya multiradiata* have been examined (Bohlmann et al. 1976) and found to contain a sulfoxid, a chemical type that is relatively common in the tribes Helenieae and Heliantheae.

Finally, it should be noted that K.J. Kim and B. Turner (unpubl.) have made a restriction site analysis of the chloroplast DNA of *Baileya* and closely related

genera. Their preliminary data suggest that *Baileya* nestles neatly in the tribe Helenieae somewhere near *Psilostrophe* and *Bahia*, but details of this relationship are yet to be worked out.

ECONOMIC ATTRIBUTES

Baileya multiradiata is an attractive and bountiful wild flower over a large part of the desert Southwest. It has been touted as a promising plant for landscaping, and research on its nursery production has begun (Cotter et al. 1980, 1982).

It is also reportedly toxic to livestock, especially to sheep and goats, where losses as high as 25% have been reported on overgrazed rangeland in Texas (Hill et al. 1979, 1980). Cattle and horses, however, seem to be unaffected, or at least poisoning of these animals has gone unreported. The chemical agent responsible is believed to be hymenoxon, a sesquiterpene lactone originally found in the genus *Hymenoxys*, where it is also toxic.

Both *Baileya multiradiata* and *B. pleniradiata* produce an antineoplastic pseudoguaianolide, radiatin, which might prove useful in cancer therapy (Einck et al. 1978). In addition, the antibiotic sesquiterpene lactone, baileyolin, from *B. multiradiata* inhibits tumor formation (Dominguez et al. 1977). *Baileya pauciradiata* also possesses cytotoxic sesquiterpene lactones, namely odoratin and paucin (Hoffmann et al. 1978).

Finally, it should be noted that the poorly known Desert Marigold Moth, *Schinia minima* (Grote), appears to be endemic on *Baileya multiradiata*, using the heads of this species for its larval development. Little is known about the life history of this noctuid moth, but the closely related species, *Schinia pallicincta* Smith, occupies mostly sand dunes of southern California and uses *Baileya pauciradiata* as a primary feeding source (Myles & Binder 1990).

GENERIC RELATIONSHIPS

Most recent workers have positioned *Baileya* in the tribe Helenieae, subtribe Gaillardiinae (=subtribe Heleniinae). Bentham (1873, p. 519), however, thought that *Baileya* was "nearer to some Old World *Chrysanthema* [Anthemideae] than to any American genus." Hoffmann (1894) was the first to recognize the close relationship of *Baileya* and *Psilostrophe*, positioning these two genera, along with the anomalous *Whitneya*, in the subtribe Riddellinae (after *Riddellia*, which is a synonym of the earlier *Psilostrophe*). Rydberg (1914) followed Hoffmann's treatment. Turner and Powell (1977) positioned *Baileya* and *Psilostrophe* as the only members of their subtribe Psilostrophinae, relegating *Whitneya* to or near the tribe Senecioneae.

Robinson (1981), in his comprehensive treatment of the tribe Heliantheae (including the tribe Helenieae) positioned *Baileya* (and *Psilostrophe*) in an expanded subtribe Gaillardiinae (including 13 genera). Unfortunately, he did not

attempt to relate the genera among themselves, merely listing these alphabetically.

After examination of various genera that have been suggested as closely related to *Baileya*, I conclude (as have most other workers, except Bentham, cited above) that *Psilostrophe* is closest. The comparative head and floral morphology of these two genera are illustrated in Fig. 2. As indicated in Table 2, *Baileya* and *Psilostrophe*

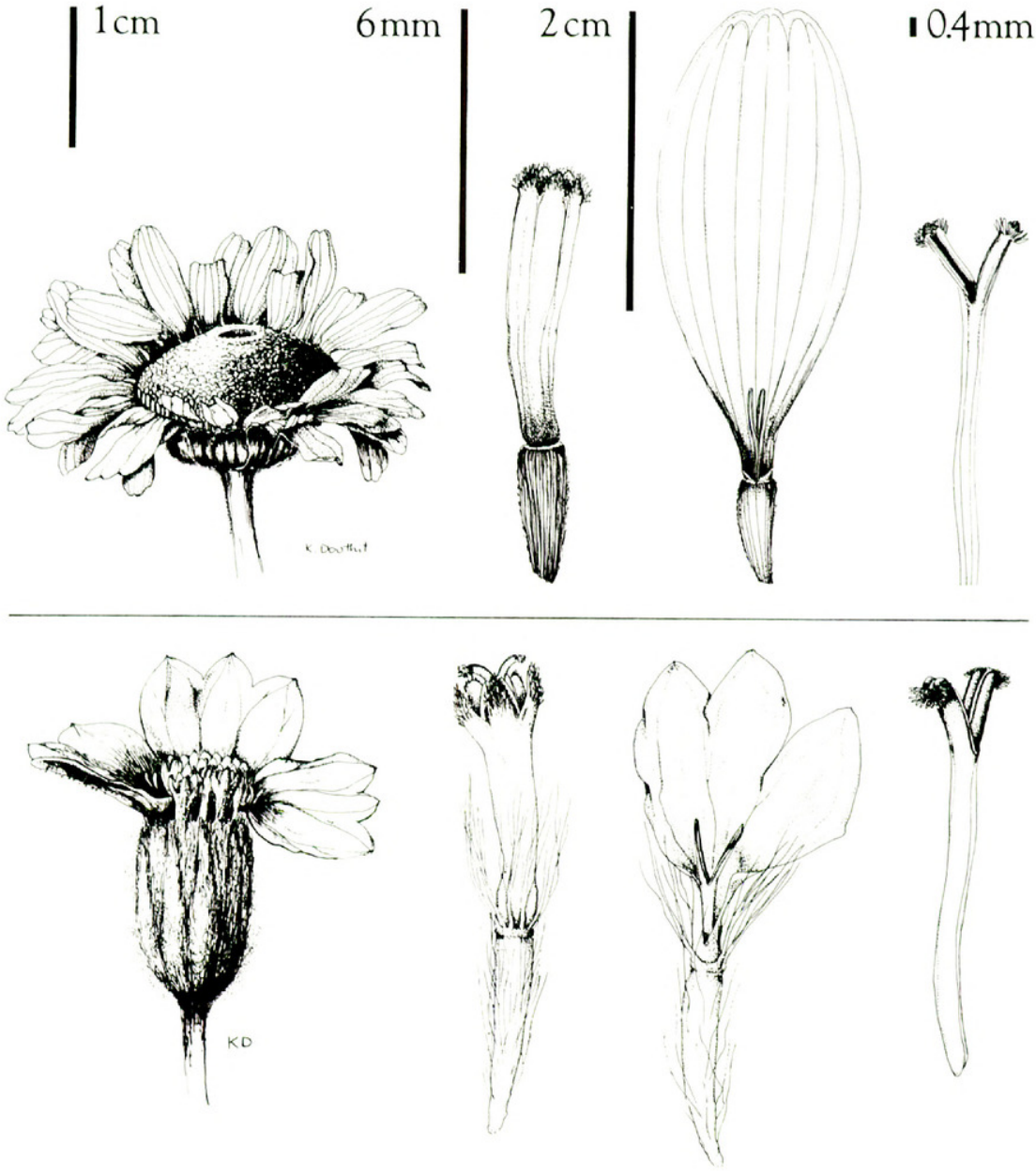

Fig. 2. Head and floral parts of *Baileya multiradiata (Warnock 13530)*, upper series, and *Psilostrophe gnaphalodes (McVaugh 8224)*, lower series. Left to right: heads; disk florets; ray florets; style branches (drawings by K. Douthit).

TABLE 2: Comparison of *Baileya* spp. with those of *Psilostrophe*.

B. multiradiata	*B. pleniradiata*	*B. pauciradiata*	*Psilostrophe*
1. Leaves			
mostly basal	mostly cauline	mostly cauline	mostly cauline
twice pinnatifid	once pinnatifid	simple	simple
2. Heads			
mostly single	mostly single	mostly cymose	mostly cymose
hemispheric	hemispheric	campanulate	cylindric
3. Ray florets			
30–55/head	20–40/head	5–7/head	3–11/head
4. Disk florets			
100+/head	40–50/head	10–20/head	5–20/head
5. Style branches (Apices)			
rounded to truncate	conical	rounded to truncate	truncate
6. Pappus			
absent	absent	absent	scales

[1] Specimen cited is from Coahuila, Mexico. From the above study, it is highly probable that this sheet represents *B. multiradiata*.

share many characters especially through *B. pauciradiata*, the most distinctive species within *Baileya*. The two genera have the same base chromosome number ($x = 16$), share similar sesquiterpene lactones, and occupy similar habitats in the same region of the desert Southwest. The principal morphological difference between *Baileya* and *Psilostrophe* is that of pappus: absent in the former but composed of well-developed hyaline scales in the latter. Nevertheless, abortive scarious pappus scales occasionally occur on achenes of *Baileya pleniradiata* (cf. *Ferris 7918* TEX, *Clawson s.n.* LL), which suggests that this atavism was characteristic of *Baileya* in its primitive state.

My view of the relationships within *Baileya* to those of *Psilostrophe* are indicated in Fig. 3. Clearly *Baileya multiradiata* is most closely related to *B. pleniradiata*, the latter more nearly approaching *B. pauciradiata* through reduction of the ray and disk florets, and in having less dissected, more uniformly distributed cauline leaves. *Baileya pauciradiata* appears to link *Baileya* to *Psilostrophe* itself, which appears to be at the base of a reduction series in which the involucres, receptacles, and florets are all reduced in size, shape, and numbers, respectively. Of course, the evolutionary trend suggested here can be read, with equal validity, in the reverse: the ancestral condition being a *Psilostrophe* -like species with relatively small involucres, few florets, and evenly distributed, nearly simple leaves, the achenes with well developed pappus scales. The morphological evolution of *Baileya* from

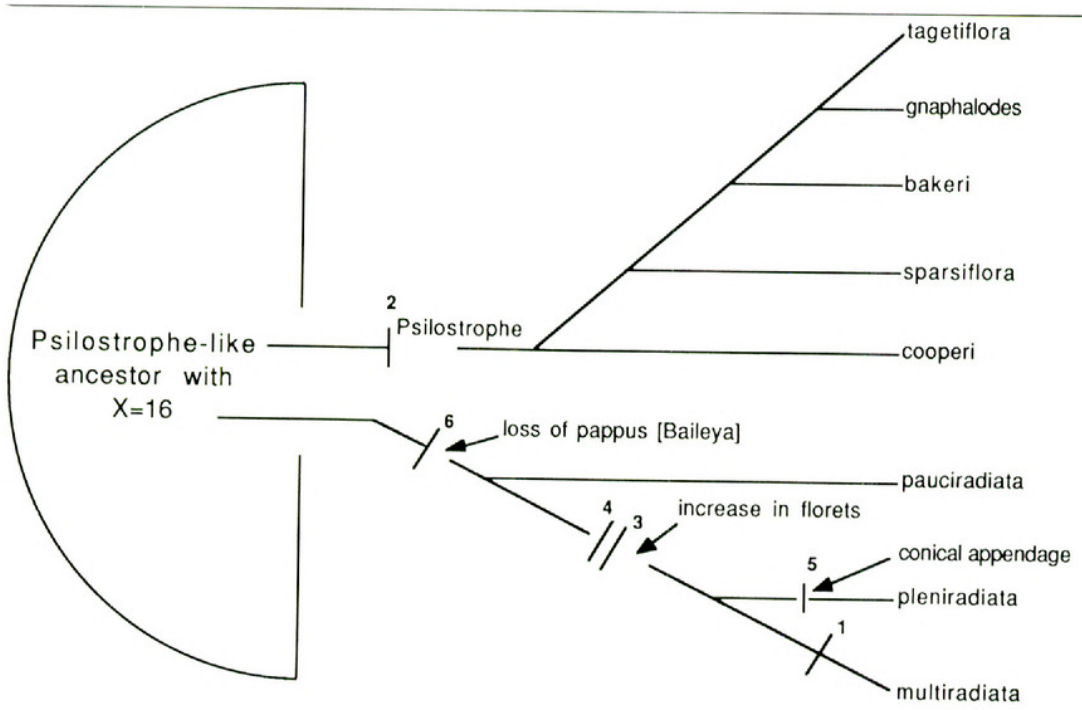

Fig. 3. Hypothetical phyletic relationships in *Baileya* and *Psilostrophe*. Numbers refer to characters given in Table 2.

this ancestral complex would merely require multiplication in floret number, increasing dissection of leaves, and loss of pappus.

Brown (1974) attempted several intergeneric crosses between *Baileya* and *Psilostrophe* without success. Unfortunately, he did not attempt an intergeneric cross with the most likely candidate for hybridization, *B. pauciradiata*, in his work.

TAXONOMY

Baileya Harvey & Gray ex Torr.

Erect, annual, biennial or short-lived perennial herbs. Stems floccose-woolly. Leaves alternate, forming a basal rosette or not; basal or rosette leaves usually petiolate; stem leaves usually epetiolate; blades simple to deeply pinnately pinnatifid, linear-lanceolate to broadly ovate in outline, pubescent like the stems. Heads radiate and solitary or cymose, usually on long peduncles. Involucres campanulate to hemispheric; bracts 2-seriate, subequal. Receptacle plane to convex, alveolate, epaleate. Ray florets pistillate, fertile, the ligules yellow. Disk florets perfect, fertile; corollas yellow, the tube shorter than the throat, the lobes 5. Anthers with ovate appendages. Style branches with truncate to acute apices.

Achenes narrowly obpyramidal, weakly ribbed or striate, epappose (rarely with a few scales).

TYPE SPECIES: *Baileya multiradiata* Harv. & Gray ex Torr.

KEY TO THE SPECIES OF *BAILEYA*

1. Heads loosely cymose at tips of branches; ray florets 5–7 ..... 1. *B. pauciradiata*
1. Heads mostly solitary at tips of branches; ray florets 20–55
   2. Apices of style branches truncate to slightly rounded; peduncles in vernal forms 10–30 cm long ..... 2. *B. multiradiata*
   2. Apices of style branches acute to strongly acute; peduncles 10 cm long or less ..... 3. *B. pleniradiata*

1. Baileya pauciradiata Harvey & A. Gray ex A. Gray, Mem. Amer. Acad. II, 4:105. 1849. TYPE: U.S.A. CALIFORNIA: 1832(?), *Thomas Coulter 312* (HOLOTYPE: GH!; ISOTYPE: NY!). *Coulter* reportedly collected in the area of Yuma, Arizona during 1832 (McVaugh 1943).

Winter annual, biennial or short-lived perennial, mostly 20–75 cm high. Basal rosette, if present, not persistent; basal leaves mostly 5–12 cm long, 0.5–1.0 cm wide; petioles often indistinct; blades entire to pinnately lobed, linear-oblanceolate to oblanceolate in outline. Stem leaves mostly entire and linear and often not reduced upwards. Heads cymose, on peduncles 2–5 cm long. Involucres campanulate, mostly 5–8 mm high, about as wide, floccose tomentose, the bracts mostly 8–13. Ray florets mostly 5–7; ligules elliptic to ovate, mostly 5–8 mm long, 4–6 mm wide, shallowly to indistinctly 3-toothed at apex. Disk florets mostly 10–20; corollas yellow, pubescent, 2.5–3.0 mm long, the tube ca 0.4 mm long, the lobes pubescent, ca 0.25 mm long. Style branches truncate. Achenes ca 3 mm long, multi-striate, glandular-pubescent. Chromosome number, $2n = 32$.

General range: Southwestern Arizona (Yuma Co.), southeastern California (Mojave and Colorado deserts), and adjacent Sonora and Baja California (Figs. 4, 5).

Habitat: dry, sandy deserts; elevation mostly 60–660 m.

Flowering: March to May.

The most distinct of the three species, *B. pauciradiata* has the most limited range and is, perhaps, the least abundant. It has been found growing with or near *B. pleniradiata*: 10.4 mi NE of Peñasco, Sonora, 27 Feb 1958, *Raven 11681* (GH). However, no evidence of hybrids has been noted. Brown (1974) supported the genetic isolation of the species from the other taxa by demonstrating complete barriers to gene exchange. He maintained that "all interspecific crossing attempts with *B. pauciradiata* were unsuccessful."

Representative Specimens: **UNITED STATES. ARIZONA. Yuma Co.**: 9 mi NE of Mohawk, 2 Apr 1973, *Holmgren 6636* (NY). **CALIFORNIA. Imperial Co.**: 20 mi E of Brawley, 25 Mar 1973, *Holmgren 6520* (NY). **Riverside Co.**: 5.6 mi SE of Thousand Palms, 18 Apr 1955, *Ingram, Arnott, Chisaki 631* (ARIZ, RM, RSA). **San Bernadino Co.**: 3 mi SW of Kelso, 1 May 1941, *Wolf 10245*

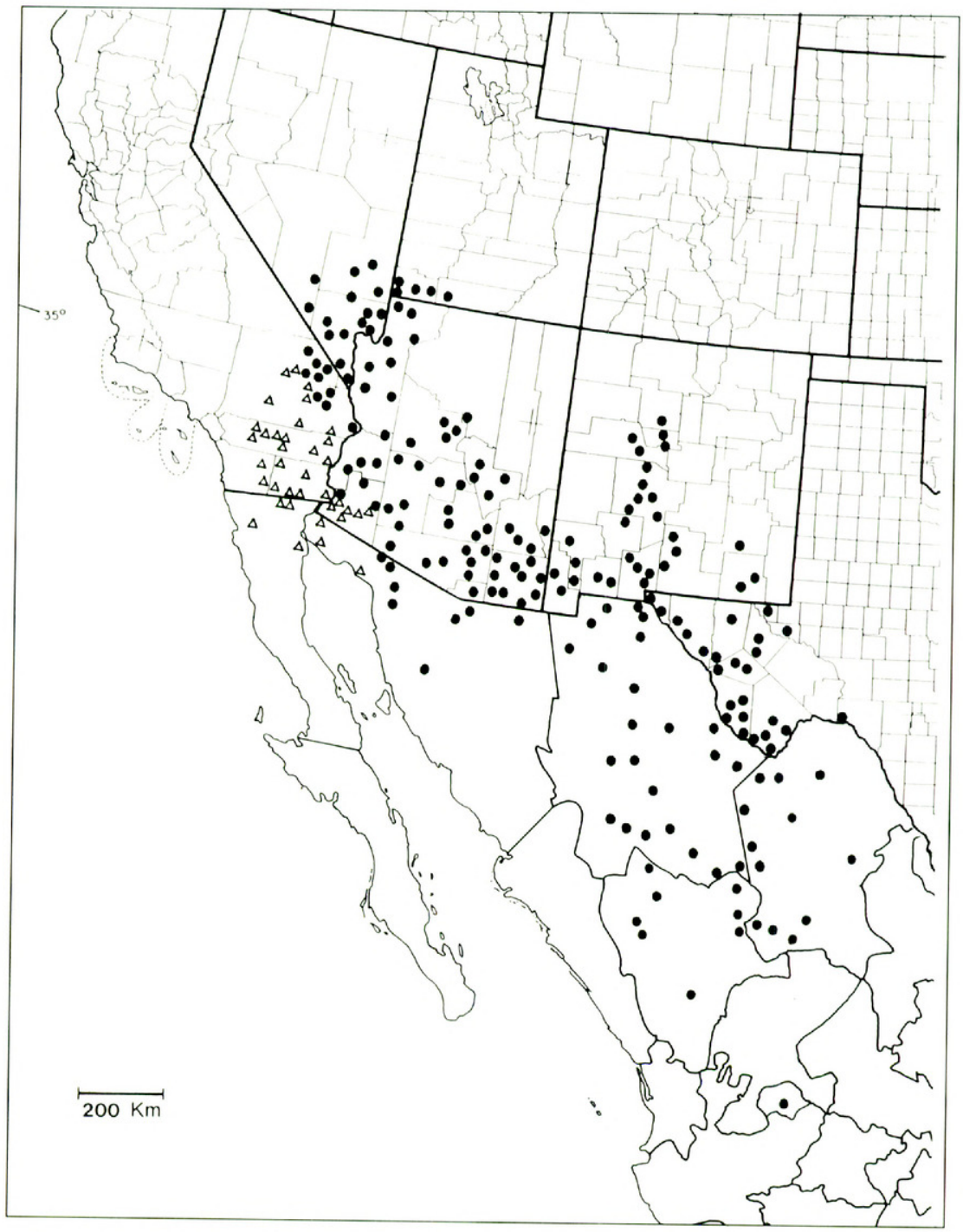

Fig. 4. Documented distribution of *Baileya multiradiata* (dots) and *B. pauciradiata* (triangles).

(LL, NY, RSA). **San Diego Co.:** Borrego Springs, 24 Apr 1976, *Moldenke 30646* (ARIZ, LL).

MEXICO. Baja California: Sierra de Juarez, E of Laguna Salada, 13 Mar 1988, *Charton 1393* (TEX, RSA); 15 mi W of Mexicali, 16 Mar 1960, *Wiggins 15737* (ARIZ, TEX). **Sonora:** 0.5 mi E of El Golfo de Santa Clara, 13 Mar 1975, *Felger 75-81* (ARIZ); 12.3 mi N of Puerto Peñasco, 21 Dec 1961, *Breedlove 1393* (TEX).

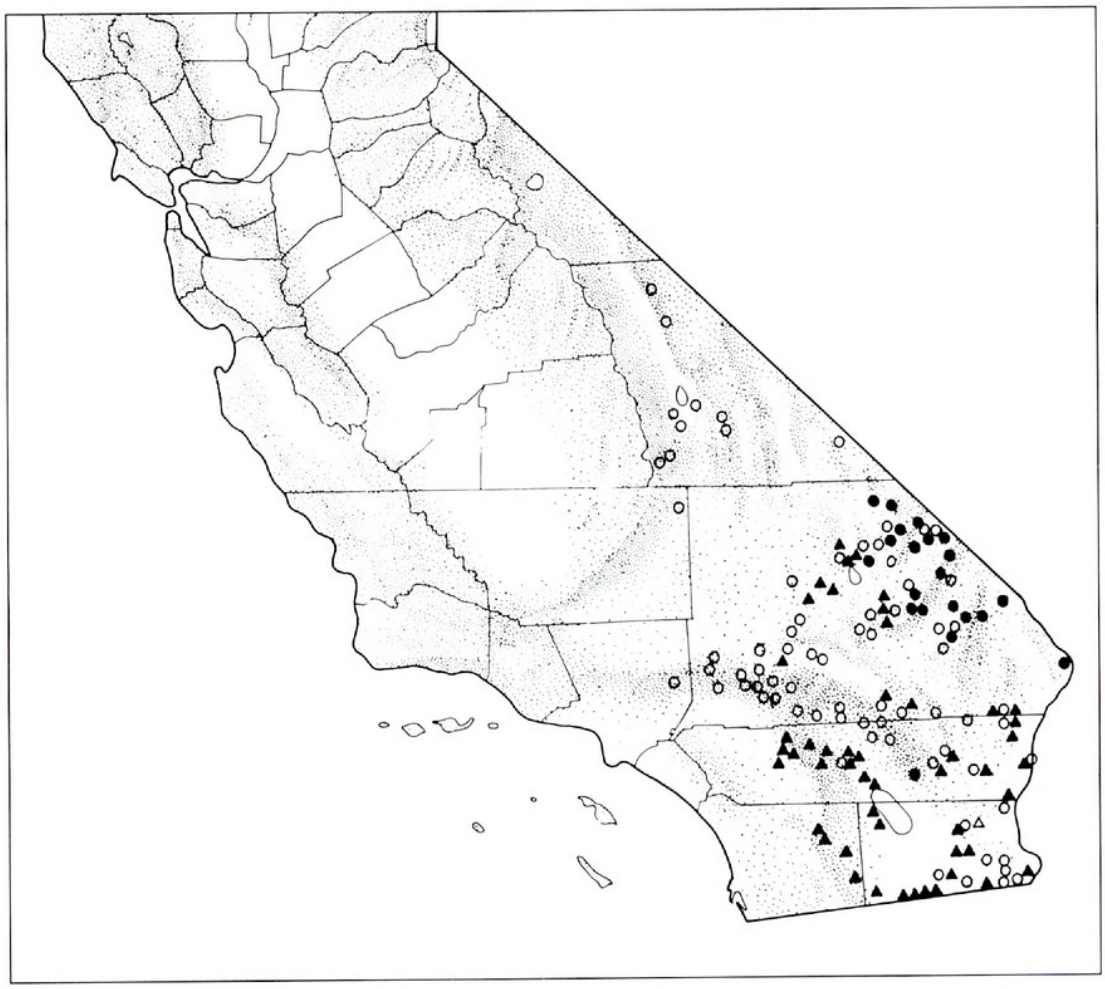

Fig. 5. Documented distribution of *Baileya* in California: *B. multiradiata* (closed circles); *B. pauciradiata* (triangles); *B. pleniradiata* (open circles).

2. **Baileya multiradiata** Harvey & A. Gray ex Torr., In Emory, Not. Milit. Reconn. 144. 1848. TYPE: U.S.A. CALIFORNIA: 1832(?), *Thomas Coulter 326* (LECTOTYPE: GH!). Originally lectotypified by Roy Brown, Jun 1973, but formalized here in accordance with the International Code of Botanical Nomenclature (ICBN). *Baileya pleniradiata* var. *multiradiata* (Harvey & A. Gray) Kearney, Trans. New York Acad. Sci. 14:42. 1894.

Baileya multiradiata var. *nudicaulis* A. Gray, Syn. Fl. N. Amer. 1(2):318. 1884. TYPE: U.S.A. NEW MEXICO: Oct 1846, *Wislizenus 7* (LECTOTYPE: GH!; ISOLECTOTYPE: NY!). Lectotypified here; collection data obtained from isolectotype, NY.

Baileya thurberi Rydb., N. Amer. Fl. 34:10. 1914. TYPE: U.S.A. TEXAS: "along the Pecos [River]," Nov 1850, *Thurber 132* (HOLOTYPE: NY!; ISOTYPES: GH!, NY!). *Baileya multiradiata* var. *thurberi* (Rydb.) Kittell, Fl. Arizona & N. Mex., 457. 1941.

Baileya australis Rydb., N. Amer. Fl. 34:11. 1914. TYPE: MEXICO. DURANGO: Santiago Papasquiaro, Apr–Aug 1896, *Palmer 50* (HOLOTYPE: NY!; ISOTYPES: GH!, POM!).

Winter annual, biennial or short-lived perennial, mostly 20–100 cm high. Basal (rosette) leaves mostly 3–10 cm long, 1–5 cm wide; petioles 1–4 cm long; blades pedately to pinnately parted, ovate in outline, rarely not. Stem leaves in vernal forms much reduced; autumnal forms often leafy throughout and stem leaves not much reduced. Heads solitary, on peduncles 10–30 cm long (vernal forms), often less on autumnal forms. Involucres hemispheric (vernal forms), mostly 5–10 mm high, 10–25 mm wide, floccose tomentose, the bracts mostly 21–34. Ray florets (vernal forms) mostly 34–55; ligules linear-oblanceolate, mostly 10–20 mm long, ca 5 mm wide, moderately to deeply 3-toothed at apex. Disk florets (vernal forms) 100+; corollas yellow, pubescent, ca 4 mm long, the tube ca 1 mm long, the lobes pubescent, ca 0.25 mm long. Style branches with truncate to slightly rounded apices. Achenes ca 4 mm long, multistriate, glandular-pubescent. Chromosome number, $2n = 32$.

General range: from California (San Bernadino Co.) to western Texas; from southwestern Utah and southern Nevada south to Mexico as far as Aguascalientes (Figs. 4, 5).

Habitat: very common on both stony slopes and sandy plains and mesas; elevation mostly 100–2,000 m.

Flowering: primarily March to November, depending on rains.

Baileya multiradiata has by far the widest range and is the most abundant and usually the earliest blooming of the three species. The large-headed vernal form is particularly attractive; this, together with its long flowering season and its drought tolerance, have given the plant recognition in horticultural circles where it is usually known as the Desert Marigold. The autumnal blossoms greatly resemble *B. pleniradiata* both in the number of rays and in the length of peduncles, which has caused much confusion in the distinction between these two species. The shape of the style apex (Fig. 1) is often necessary to distinguish between fall-blooming specimens.

Rydberg's *B. australis* appears to be merely a very robust form of *B. multiradiata* and I could find no truly distinct feature that would justify its status as a populational entity, although Brown (1974) recognized it at the varietal level (unpublished), emphasizing its supposedly "sparsely leafy" stems and weakly-ribbed, glabrous achenes. I could find no correlation between these characters, singly or in combination, that would align with geography. Robust forms occur sporadically throughout the southern range of *B. multiradiata.*

Brown likewise recognized var. *thurberi* on the basis of leafy stems arising from a perennial base, which, he maintained, distinguished it from var. *multiradiata* which had principally basal leaves and presumably was not perennial. In my opinion var. *thurberi* in its typical form is merely a perennating or autumnal form of a highly variable *B. multiradiata* and does not correlate with geography in any way. *McVaugh 7793* (TEX) and *Correll 32203* (LL), for instance, clearly evince the characters of Brown's var. *multiradiata*, but were found in Brewster Co., Texas,

several hundred miles southeast of the range that Brown gives to this variety and well within the range of his concept of var. *thurberi.* It is noteworthy that Brown apparently did not do field work in the eastern part of the range of *B. multiradiata,* at least to judge from specimens cited from his dissertation. While Brown admitted to a degree of intergradation between the two varieties, I am suggesting that his var. *thurberi* is merely a perennating form of *B. multiradiata* and that such forms occur throughout the range of the species, as I have repeatedly noted in the field.

Carl B. Wolf noted on the label of his *B. multiradiata* (*7000* NY): "This species seems to be restricted to stony slopes, while *B. pleniradiata* prefers the fine soil of the flats. There is no mixing in this region either in distribution or characters." Cronquist's herbarium labels on specimens at NY also note that the two species show no mixing of morphological characters from sympatric populations in southern Nevada. With regard to hybridization, Brown (1974) demonstrated that the two species, *B. multiradiata* and *B. pleniradiata,* are highly interfertile in synthetic crosses, though he also noted the partial infertility of the F1 hybrids.

Representative specimens: UNITED STATES. ARIZONA. **Cochise Co.**: 10 mi NE of Douglas, 19 Jun 1930, *Goodman & Hitchcock 1230* (GH, LL, NY, RM). **Coconino Co.**: near Sedona, 27 Apr 1963, *Beach s.n.* (RSA). **Gila Co.**: Sierra Ancha Mts, 4 Sep 1946, *Gould & Hudson 3870* (ARIZ, LL). **Graham Co.**: 12 mi S of Gernonimo, 27 Apr 1969, *Douglas 75* (ARIZ). **Greenlee Co.**: near Clifton, 1 Nov 1880, *Greene s.n.* (NY). **Maricopa Co.**: 4 mi S of Salt River on Jackrabbit-Rainbow Valley Rd, Apr 1973, *Sundell 269* (ARIZ). **Mohave Co.**: 9 mi E of Kingman, 17 Jun 1965, *Crutchfield 237* (LL, NY). **Pima Co.**: 8 mi SSW of Robles Junction (Three Points), 7 Apr 1973, *Holmgren 6696* (NY, RM). **Pinal Co.**: ca 20 mi W of Casa Grande City, 22 Mar 1935, *Nelson 1264* (NY, RM). **Santa Cruz Co.**: Patagonia, 30 Mar 1916, *Hill 25895* (RM). **Yavapai Co.**: 9 mi NE of Cottonwood, 8 May 1989, *Brooks 19222* (NY, RM). **Yuma Co.**: NE of Yuma, 6 mi N of Gila River, 20 Mar 1974, *Booth A-114* (ARIZ). CALIFORNIA. **Riverside Co.**: end of Hayfield Rd, S of Hwy 10, 28 Mar 1969, *Young P430* (POM). **San Bernadino Co.**: near Bonanza King Mine, Providence Mtns, 21–24 May 1920, *Munz, Johnston & Harwood 4108* (GH, NY, POM, RM). NEVADA. **Clark Co.**: Charleston Mtns, Old Kyle Canyon, 12 May 1938, *Clokey 8175* (ARIZ, GH, LL, NY, POM, RM, TEX). **Lincoln Co.**: Meadow Valley Wash, Calientis [sic], 28 Apr 1902, *Goodding 648* (GH, POM, RM). **Nye Co.**: 1.9 mi S of Hwy 95 on Rt 16, 4 Apr 1978, *Williams 78-13* (NY). NEW MEXICO. **Bernalillo Co.**: E edge of Albuquerque, 20 May 1973, *Saufferer 185* (NY, TEX). **Chaves Co.**: 11 mi NE of Roswell, 23 Aug 1942, *Waterfall 4299* (ARIZ, GH). **Doña Ana Co.**: 2 mi S of Rincon, 9 Jun 1965, *Crutchfield 166* (LL, NY). **Eddy Co.**: 12 mi NW of Carlsbad, 13 Aug 1942, *Waterfall 3710(a)* (ARIZ, GH). **Grant Co.**: 18 mi NW of Silver City, 10 May 1903, *Metcalfe 61* (ARIZ, GH, NY, POM, RM). **Hidalgo Co.**: 5 mi S of intersection Hwy 80 and IH 10 on 80, 30 May 1967, *Mears 1594* (TEX). **Luna Co.**: ca 2 mi E of Gage, 22 Mar 1972, *Hartman 3213* (LL). **Otero Co.**: near Three Rivers, 16 Aug 1941, *Wiltbank 328* (LL, RM). **Sandoval Co.**: Cañada Nervio near Las Lagunitas Ranch, 30 Jun 1970, *Bohrer 1305* (ARIZ). **Sierra Co.**: 24 mi N of Hot Springs [Truth or Consequences], 15 Oct 1948, *Dunn 5412* (TEX). **Socorro Co.**: Socorro, 27 may 1931, *Nelson 11462* (GH, RM). **Valencia Co.**: E of Old Laguna, 28 Jul 1933, *Degener 4887* (NY). TEXAS. **Brewster Co.**: ca 5 mi N of Study Butte, 14 Sep 1991, *Turner 7* (TEX). Culberson Co.: ca 8 mi S of Van Horn, 7 Aug 1945, *Lundell 7* (LL). **El Paso Co.**: 1 mi N intersection of Hwys 62 and 180, 27 Aug 1989, *Mayfield 62* (TEX). **Hudspeth Co.**: 12 mi W of Sierra Blanca, 17 Jun 1943, *Waterfall 4579* (ARIZ, NY, TEX). **Jeff Davis Co.**: 1 mi NW of Valentine, 6 Sep 1955, *Warnock 13530* (LL). **Loving Co.**: 5 mi W of Winkler-Loving

border, 10 Jul 1965, *Stuessy 177* (TEX). **Presidio Co.:** 9.3 mi S of Shafter, 24 Jul 1973, *Henrickson 11266* (LL). **Reeves Co.:** 29 mi N of Pecos, 1 Jul 1958, *Correll & Johnston 19075* (LL, NY). **Val Verde Co.:** Pecos River Canyon below high bridge, 14 Jun 1931, *Tharp 8885* (TEX). **Ward Co.:** 6 mi S of Peyote, 17 Jun 1970, *Powell 1893* (TEX). UTAH. **Kane Co.:** 10 mi NW of Kanab, 27 Apr 1968, *Valentine 27* (POM). **Washington Co.:** St. George, 22 Apr 1942, *Gould 1618* (ARIZ, GH, NY, POM).

MEXICO. Aguascalientes: 5 mi E of Aguascalientes, 9 Aug 1958, *McVaugh 16707* (NY); near Aguascalientes, 9 Oct 1903, *Rose & Painter 7748* (GH). **Chihuahua:** 2–3 mi W of Parral, 18 Aug 1967, *Stuessy 1018* (LL, NY, RM, TEX); 13 mi W of Chihuahua, 20 Aug 1939, *White 2458* (ARIZ, GH, LL). **Coahuila:** 3 m SW of Torreon, 10 Jul 1944, *Fisher 44126* (GH, NY); 3 km S of El Tule, 15 Jun 1941, *Stewart 535* (GH, LL). **Durango:** 3.5 km W of La Soledad, 19 Mar 1983, *Diaz 105* (NY, TEX); 17 km WSW of Ciudad Lerdo, 26 Jul 1982, *Diggs & Nee 3113* (NY, TEX). **Sonora:** 39 mi N of Hermosillo, 12 Sep 1941, *Wiggins & Rollins 472* (ARIZ, GH, NY); 3 mi E of Agua Prieta, 7 Aug 1941, *White 3823* (ARIZ, GH, LL).

3. **Baileya pleniradiata** Harvey & A. Gray ex A. Gray, Mem. Amer. Acad. II, 4:105. 1849. TYPE: U.S.A. CALIFORNIA: 1832(?), *Thomas Coulter 312* (LECTOTYPE: TCD; Fragment LECTOTYPE: GH!). *Baileya multiradiata* var. *pleniradiata* (Harvey & A. Gray) Coville, Contr. U.S. Natl. Herb. 4:133. 1893.

Baileya nervosa M.E. Jones, Contr. W. Bot. 8:34. 1898. TYPE: U.S.A. CALIFORNIA. **Inyo. Co.:** Darwin Mesa, Argus Mountians, 5,000 ft, 11 May 1897, *Jones s.n.* (HOLOTYPE: POM!; ISOTYPE: NY!).

Baileya pleniradiata var. *perennis* A. Nels., Bot. Gaz. (Crawfordsville) 47:431. 1909. TYPE: U.S.A. NEVADA. **Clark Co.:** Moapa, 8 Apr 1905, *Goodding 2176* (HOLOTYPE: RM!; ISOTYPES: GH!, NY!). *Baileya perennis* (A. Nels.) Rydb., N. Amer. Fl. 34:10. 1914. *Baileya multiradiata* var. *perennis* (A. Nels.) Kittell, Fl. Arizona & N. Mex. 457. 1941.

The only collection of this taxon at GH is a fragment from the head which is contained within a packet bearing the Coulter collection number 312; the fragment was presumably sent to GH at the request of Gray, as the packet bears a notation that this was obtained from Dublin (TCD) where the Coulter collections are housed. Brown (Jun 1973) by annotation selected this as the lectotype (but see comments regarding ICBN above), since it was the only material of the taxon to be examined by Gray at the time of his descriptions. Examination of the several disk florets in the packet show the style branches to be acute, as to be expected in *B. pleniradiata*. Coulter's number 312, while written on the packet itself, is also the number assigned to the type of *B. pauciradiata*. Apparently, Coulter, or someone, assigned the same number to a mixed collection. Since both *B. pleniradiata* and *B. pauciradiata* occur together or near each other in southern California, it is likely that he collected both of these taxa, assigning them the same number.

Winter annual, biennial or short-lived perennial, mostly 15–45 cm high. Basal rosette, if present, not persistent; basal leaves mostly 2–7 cm long, 0.5–2.5 cm wide; petioles 1–3 cm long; blades entire to pinnately lobed, oblanceolate in outline. Stem leaves gradually reduced upwards. Heads solitary, on peduncles 3–12 cm long. Involucres hemispheric, mostly 5–8 mm high, 7–12 mm wide, floccose tomentose, the bracts mostly 21–34. Ray florets mostly 20–40; ligules

elliptic to obovate, mostly 7–10 mm long, 4–7 mm wide, shallowly 3–toothed at apex. Disk florets mostly 40–50; corollas yellow, pubescent, ca 3 mm long, the tube ca 0.3 mm long, the lobes pubescent, ca 0.25 mm long. Style branches acute. Achenes ca 3 mm long, multi-striate, glandular-pubescent. Chromosome number, $2n = 32$.

General range: Somewhat less common than *B. multiradiata* and with a much more restricted range, extending east from Los Angeles Co., California to south-central Arizona, and extending south from Inyo Co., California, southern Nevada, and southwestern Utah to northern Baja California and Sonora, Mexico (Figs. 5, 6).

Habitat: common on sandy plains and mesas; elevation mostly 100 – 2,000 m.

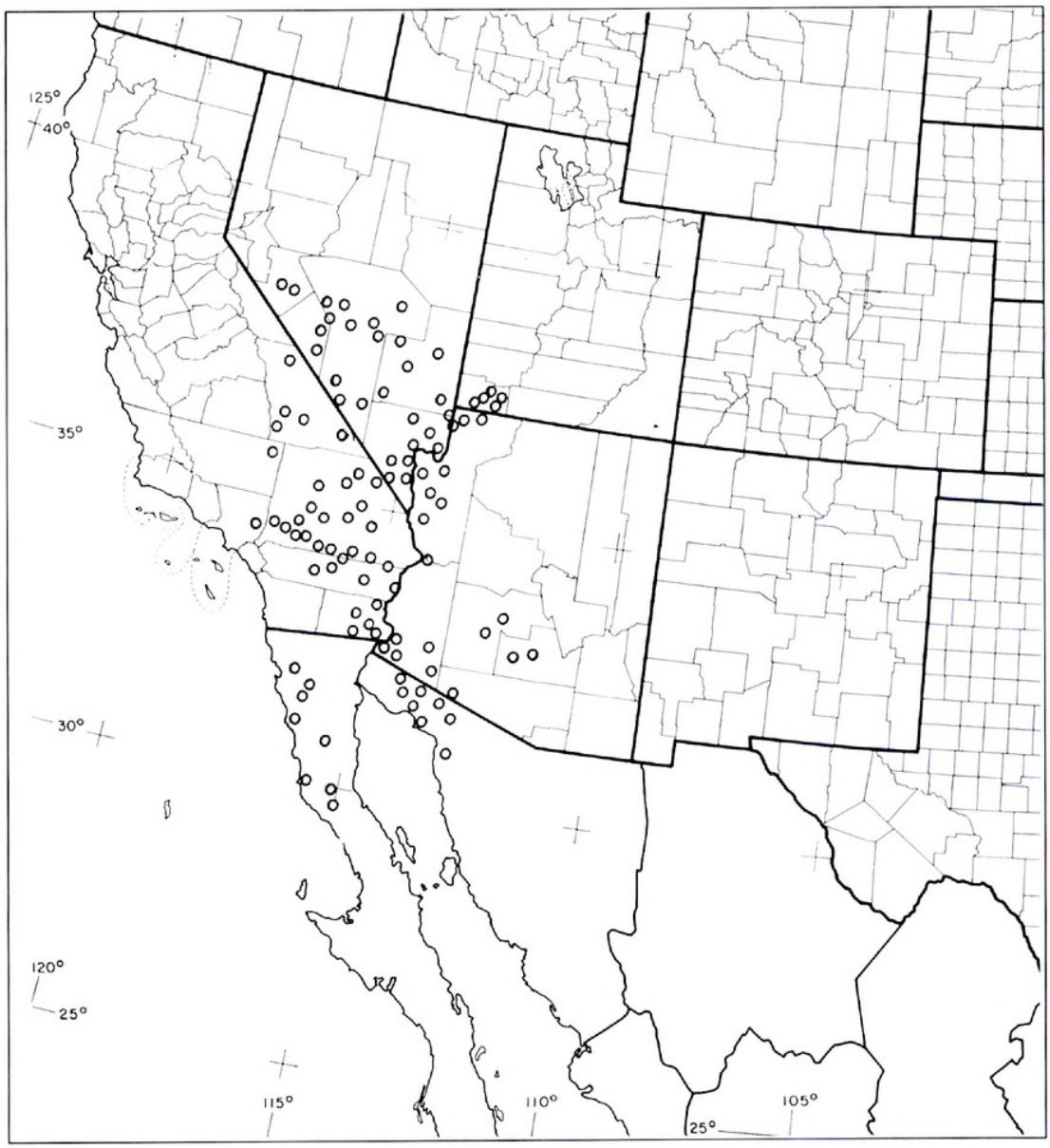

Fig. 6. Documented distribution of *Baileya pleniradiata*.

Flowering: March to November, depending on rains.

Baileya pleniradiata is superficially similar to *B. multiradiata* and autumnal forms of the latter have often been misidentified as the former, as noted under the discussion following *B. multiradiata*. The two species occasionally occur growing together or in close proximity, but hybrids have not been noted. Style appendages readily allow distinction between these (Fig. 1).

Baileya pleniradiata occasionally occurs with or near *B. pauciradiata*, at least in Mexico, to judge from the collections of *Raven 11682* (GH: 10.4 mi NE of Peñasco, Sonora). Nevertheless, natural hybrids between these have not been recorded, nor were synthetic crosses successful (Brown 1974).

Representative specimens: UNITED STATES. ARIZONA. **Maricopa Co.**: Sierra Estrella Regional Park, 29 Apr 1973, *Sundell 270* (ARIZ, NY, POM). **Mohave Co.**: Littlefield, 12 Jul 1959, *Demaree 41322* (ARIZ, NY, RSA). **Pima Co.**: Quitobaquito, 14 Apr 1963, *Felger 7681* (ARIZ). **Pinal Co.**: near Sacaton, 8 Apr 1927, *Peebles & Harrison 3874* (ARIZ, LL). **Yuma Co.**: ca 7 mi N of Dome, 24 Mar 1970, *Hitchcock 25762* (NY, RM, TEX). CALIFORNIA. **Imperial Co.**: 0.5 mi N of Hwy 80 on rd to Blythe, 20 Mar 1958, *Balls & Everett 22893* (RM, RSA). **Inyo Co.**: Darwin Mesa near Darwin, 11 Jun 1930, *Ferris 7918* (ARIZ, GH, NY, RM, RSA, TEX). **Kern Co.**: Naval Weapons Center, China Lake, 27 Apr 1969, *Brierly s.n.* (GH). **Los Angeles Co.**: 30 mi W of Victorville, 27 Apr 1926, *Mason 3064* (GH). **Riverside Co.**: 8 mi NE of Desert Center, 27 Mar 1941, *Wiggins 9684* (GH, NY, RM, RSA). **San Bernadino Co.**: 2 mi W of Valley Wells, 15 May 1935, *Wolf 6861* (ARIZ, GH, RM, RSA). NEVADA. **Clark Co.**: E of Wilson's Ranch [ca 20 mi NNW of Jean], 22 May 1940, *Clokey 8619* (ARIZ, GH, LL, NY, POM, RM, TEX). **Esmeralda Co.**: 18.3 mi NW of Goldfield, 5 May 1981, *Tiehm 6363* (NY, RM, RSA). **Lincoln Co.**: 11 mi S of Adaven, 1 Jul 1966, *Holmgren 2786* (NY, RSA, TEX). **Mineral Co.**: 5 mi W of Luning, 18 Jun 1945, *Maguire & Holmgren 25511a* (GH, NY). **Nye Co.**: 13 mi NW of Tonopah, 31 May 1980, *White & Neese 155* (NY, RM). UTAH. **Washington Co.**: ca 6 mi NW of St. George, 6 May 1964, *Conquist 9939* (NY, RSA, TEX).

MEXICO. **Baja California**: 10 mi W of El Marmol, 6 Mar 1930, *Wiggins 4376* (GH, LL, NY, POM, TEX); Valle de la Trinidad, 16 Mar 1936, *Harbison s.n.* (POM, RM, RSA). **Sonora**: ca 7 mi N of Puerto Peñasco, 25 Jun 1985, *Felger 85-784* (ARIZ, TEX); 56 km W of Sonoyta, 14 Jul 1971, *Gibson & Gibson 2016* (LL, NY, RSA).

This study is based in large part upon the examination of approximately 1,800 sheets from seven herbaria as follows: ARIZ (253), GH (259), LL (119), NY (416), POM-RSA (449), RM (162), TEX (142). I am grateful to the Directors and Curators of each for the loan of material.

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