parallel or crossed over each other but occasionally divergent, and sharply reflexed. The lobes of the lower corolla lip are cuneate and tapered to a point. In *D. Bacigalupii,* the upper lobes are broader, widely divergent, and erect or arched backward, but not so prominently as in *D. elegans.* The lobes of the lower lip are broader, rounded, and abruptly pointed. Besides morphological differences, the gametic chromosome number of *D. Bacigalupii,* including plants of the type collection, is n=12, whereas that of *D. elegans* is n=10.

Downingia Bacigalupii occurs from southwestern Idaho westward across southern Oregon, as far north as southern Wasco County east of the Cascade Mountains, and in northeastern California as far south as Lake Tahoe. This range overlaps that of *D. elegans* only in southern Wasco County, Oregon. *D. Bacigalupii* grows in vernal pools, roadside ditches, open areas of mountain meadows and in muddy margins of lakes at sites exposed to bright sunlight.

Type. In heavy soil of a large bowl-shaped depression littered with rocks, 2.7 miles southwest of the California-Oregon border along Ager-Beswick road, Siskiyou County, California, June 24, 1960, *J. H. Weiler* and *A. P. Nelson 60205* (UC-1,199,666).

Other collections. CALIFORNIA. Sierra County: 1 mile south of junction to Calpine, *Bacigalupi 4276.* Plumas County: 11.7 miles north of Sattley, Sierra Valley, *Weiler 59190.* Lassen County: 11.1 miles south of Eagle Lake, *Weiler 59203.* Shasta County: Dickson Flat 3.2 miles south of Shasta-Siskiyou County line, *Weiler 60194.* Modoc County: Pitt River Valley south of Alturas, *Mason & Grant 13414.* OREGON. Josephine County: 3.7 miles north of O'Brien, *Weiler 61319.* Jackson County: 1.5 miles east of Klamath Falls Junction, *Weiler 60177.* Klamath County: Modoc Point, Klamath Lake, *Constance 9682.* Wasco County: 0.9 miles north of Schoolie Ranger Station road on the road to Mount Wilson, *Weiler 61397.* Harney County: 1.2 miles west of Riley, *Weiler 61345.* IDAHO. Owyhee County: 10 miles south of Riddle, *Holmgren 7976.*

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THREE NEW SPECIES RELATED TO MALACOTHRIX CLEVELANDII[1]

William S. Davis and Peter H. Raven

Malacothrix clevelandii A. Gray, a cichoriaceous composite of the southwestern United States and northwestern Mexico, has been regarded as a homogeneous species by all previous authors, including the most recent monographer of the genus, E. W. Williams (Am. Midl. Nat. 58:494-512. 1957). Stebbins *et al.* (Univ. Calif. Publ. Bot. 26:401–430. 1953) reported the gametic chromosome number n=7 for a population of this species from coastal California, whereas the plants they examined from

[1] The authors are indebted to Professors Carl C. Epling, Harlan Lewis, and Henry J. Thompson for their constructive criticism of the manuscript.

Arizona were tetraploid (n=14) and differed morphologically from most California material. Subsequent chromosomal and morphological studies of *M. clevelandii* have shown that, far from being a non-variable species as its lack of synonyms or infraspecific entities might suggest, it is a complex of several closely related entities, for which we propose the taxonomic treatment below.

Malacothrix clevelandii and the related taxa that will be described here are recognized collectively by their erect, inconspicuous heads with the ligules barely exserted; by the presence of one or more persistent pappus setae; and especially by a ring of acute teeth at the summit of the achene. The last-mentioned has proved to be the most useful trait separating them from members of the closely related group of species of which *M. foliosa* A. Gray is a member (fig. 2).

The taxa of the *M. clevelandii* group can be distinguished by means of the following key:

Achenes less than 1.7 mm. in length, fusiform, with 5 of the 15 ribs more prominent than the rest; involucre less than 8 mm. high; persistent pappus seta 1

Achenes brown or straw-colored; cauline leaves often toothed; plants usually unbranched below; mean pollen diameter 25μ; gametic chromosome number, n=7 . . . . . *M. clevelandii*

Achenes dark purplish-brown, rarely paler; margins of cauline leaves entire; plants often well-branched from the base; mean pollen diameter 30μ; gametic chromosome number, n=14 . . . . . *M. similis*

Achenes more than 1.7 mm. in length, subcylindrical, grey-brown to straw-colored; with 15 equally prominent ribs; involucre more than 8 mm. high; persistent pappus setae 1 or 2

Persistent pappus setae usually 2, the upper portion of the achene smooth; margins of the basal leaves irregularly and doubly dentate; mean pollen diameter 25μ . . . . . *M. sonorae*

Persistent pappus seta usually 1, the upper portion of the achene with ribs; margins of the basal leaves dentate; mean pollen diameter 30μ . *M. stebbinsii*

Pollen diameter was found to be useful for distinguishing taxa of the *M. clevelandii* complex, and, in addition, provided a clue to the level of polyploidy in two of them. Pollen samples were taken from herbarium sheets of *M. clevelandii, M. similis, M. sonorae,* and *M. stebbinsii,* and the size of mature grains was measured with an ocular micrometer. The mean standard deviation and range of the sample from each species are shown in Table 1. The mean of the pollen sample from *M. similis* (n=14) was compared with the mean of the pollen sample from *M. clevelandii* (n=7) by use of Student's *t*-test, and the results show a highly significant difference between the mean pollen sizes. On the other hand, the pollen of *M. clevelandii* and *M. sonorae* was closely similar in size, as was that of *M. similis* and *M. stebbinsii* (Table 1). Since in addition the pollen from *M. similis* and *M. stebbinsii* was mostly tetra-aperturate while that from *M. sonorae* and *M. clevelandii* was predominantly tri-aperturate, we believe that *M. sonorae* is probably diploid, and that *M. stebbinsii* is probably tetraploid.

TABLE 1. DIAMETERS OF POLLEN GRAINS OF SPECIES OF MALACOTHRIX.

SPECIES	NUMBER OF PLANTS	SAMPLE SIZE[1]	RANGE (μ)	MEAN (μ)	STANDARD DEVIATION (μ)
M. clevelandii	29	394	21–31	25	1.8
M. similis	13	347	23–38	30	2.3
M. sonorae	10	260	20–29	25	1.3
M. stebbinsii	49	794	24–36	30	2.1

[1] Pollen from one plant from each locality, 20–50 grains per plant. A plant from the type collection was included in each case. Data obtained from herbarium specimens.

DESCRIPTIONS OF THE SPECIES

MALACOTHRIX CLEVELANDII A. Gray, Bot. Calif. 1:433, 1876 (fig. 1, 2a).

Annual herb 5–60 cm. tall, with a single stem or, more rarely, numerous stems from the base; basal leaves linear to narrowly lanceolate, dentate, pinnatifid or lobed, the rachis oblong or wider near the base; cauline leaves often toothed; heads cylindrical to narrowly campanulate, 10–160 (median, 36), 4–8 mm. high, 2–5 mm. broad, 19–67–flowered; ligules yellow; pollen grains 21–31μ (mean=25μ) in diameter; achenes truncate-fusiform, 1.4–1.8 mm. long, 0.22–0.38 mm. wide, slightly curved, brown to straw-colored, finely 15–ribbed, with 5 ribs more prominent than the rest, the achene pentagonal in transverse section, its apex flared, bordered by a ring of 14–17 white-scarious teeth, of which the basal portions extend above the achene lip, the teeth often irregularly cleft, outwardly curved, lance-deltoid, the persistent seta 1. Gametic chromosome number, n=7.

Type. San Diego, California, *Cleveland* (GH; isotype, K).

Representative specimens.[2] CALIFORNIA. Tehama County: 5 miles west of Paskenta, *Baker 12581*. Glenn County: 9 miles east of Alder Springs, *Heller 11452*. Colusa County: upper Sand Creek, *Hoover 3212*. Lake County: Scotts Valley, *Tracy 1646*. Contra Costa County: Mitchell Canyon, Mount Diablo, *Bowerman 1415*. Santa Clara County: Seeboy Ridge, Mount Hamilton Range, *Sharsmith 3270*. San Benito County: Pinnacles, *Howell 12933*. Monterey County: King City, *K. Brandegee* in 1893. San Luis Obispo County: 8 miles east of Santa Margarita, *Ferris & Rossbach 9440*. Santa Barbara County: Painted Cave Ranch, *Eastwood 120*. Kern County: Kern River, *Peirson 8835*. Ventura County: Kinchers, Ojai Valley, *Pettibone & Hubby* in 1896. Los Angeles County: east fork of Santa Anita Canyon, *Howell 3778*. San Bernardino County: Cajon Pass, *S. B. Parish 4868*. Riverside County: Santa Rosa Mountains, *Munz 15087*. San Diego County: Buckman Springs, *Fosberg 8486*. Tuolumne County: above Indian Creek, *Williamson 80*. Mariposa County, Sherlocks, *Congdon* in 1897. Calaveras County: Mokelumne Hill, *Blaisdell*. Amador County:

[2] The following herbaria have been consulted, and for this privilege the writers are grateful to the curators of the institutions concerned: University of Arizona, British Museum (Natural History), California Academy of Sciences, University of California (Berkeley), University of California (Los Angeles), Pomona College, Rancho Santa Ana Botanic Garden (where vouchers for our chromosome counts are deposited), Royal Botanic Gardens, Kew, and Stanford University.

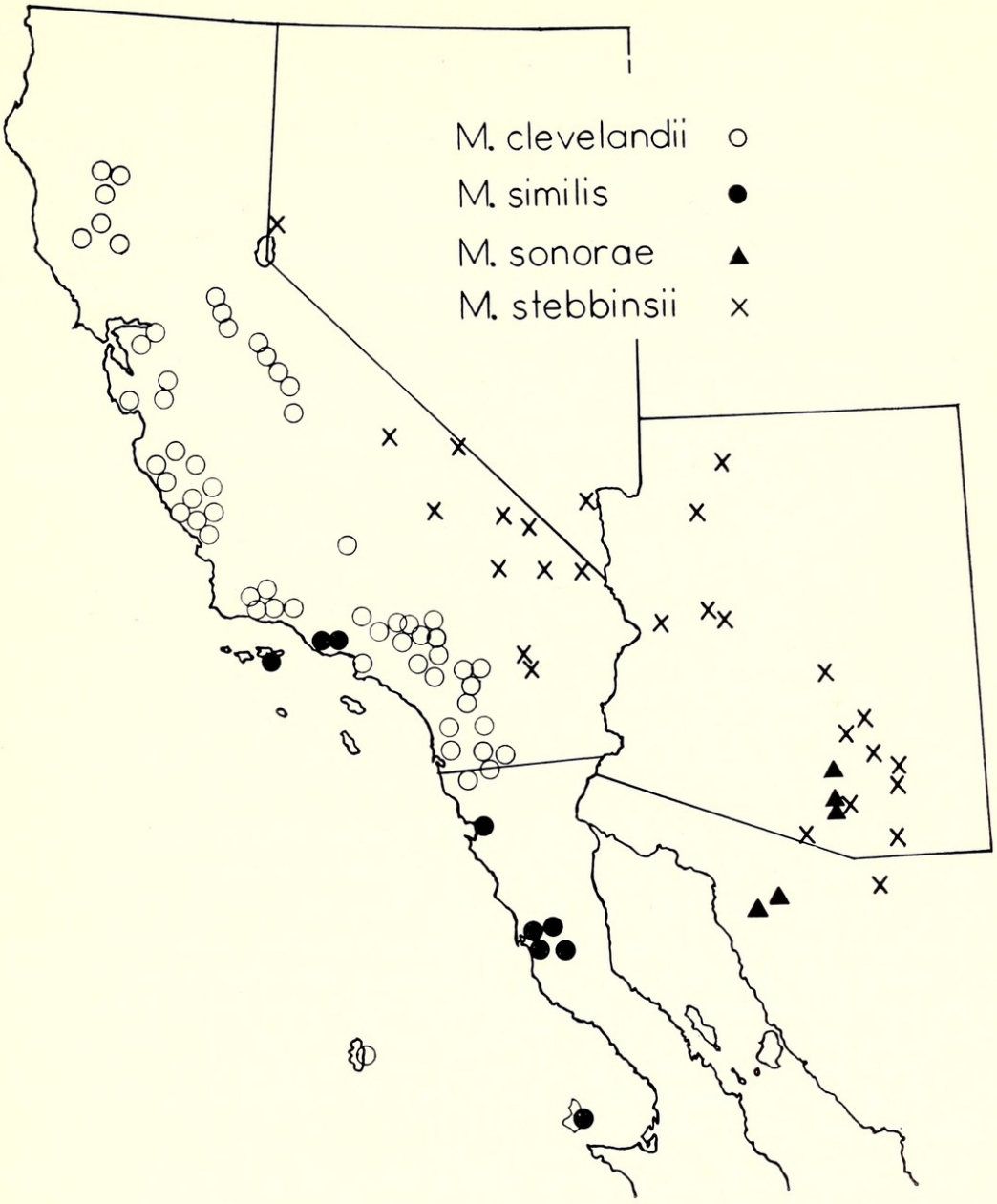

FIG. 1. Distribution of *Malacothrix clevelandii* and allied species in the southwestern United States and northwestern Mexico.

Drytown, *Hansen 401*. BAJA CALIFORNIA, MEXICO. Guadalupe Island, *Palmer 51;* 13 miles southeast of Tecate, *Munz 9520*.

As shown by the specimens cited above and by figure 1, this species occurs on the coastward slopes of the mountains of California and northernmost Baja California. Its occurrence on Guadalupe Island should be confirmed by additional material and by determination of chromosome number. In addition to the report of Stebbins *et al.* of a chromosome number of 2n=14 from the Sharsmith collection cited above from Santa Clara County, we have obtained this number in a collection from the Santa Monica Mountains, Los Angeles County, California (*Raven &*

Thompson 15034) and the gametic number of n=7 in a collection from the San Jacinto Mountains, Riverside County, California (*Davis 99*).

Malacothrix similis sp. nov. (fig. 1, 2c). Herba annua; foliis ad radices linearo-lanceolatis, integris, dentatis, lobatis, vel pinnatifidis; capitulis anguste campanulatis, 6–10 mm. longis, 3–6 mm. latis, floribus 32–73; corollis flavis; achaeniis truncato-fusiformis, 1.4–1.7 mm. longis, subflexuosis, maximam partem purpureo-brunneis interdum stramineis, subtiliter 15-costatis, 5 costis prominulis, 5-angulatis in sectione transversa, parte superiore late dilata, ab annulo setarum circa 18 scabriosarum circumdata; seta perstata 1.

Annual herb 5–32 cm. tall, usually branched from the base, the stems 1–11; basal leaves linear-lanceolate, entire, dentate, lobed, or pinnatifid, the rachis oblong; cauline leaves subentire; heads narrowly campanulate, 5–50 (median, 14), 6–10 mm. high, 3–6 mm. broad, 32–73 flowered; ligules yellow; pollen grains 23–38μ in diameter (mean=30μ); achenes truncate-fusiform, 1.4–1.7 mm. long, 0.26–0.31 mm. wide, slightly curved, dark purplish-brown, sometimes straw-colored, finely 15-ribbed, with 5 ribs more prominent, the achenes pentagonal in transverse section, the apex flared, bordered by a ring of about 18 white-scarious irregular teeth, of which the basal portions extend above the achene lip, the teeth curved outward, lance-deltoid, the persistent seta 1. Gametic chromosome number, n=14.

Type. With *Idria, Yucca, Salvia,* and *Solanum hindsianum,* 16.0 kilometers southeast of El Rosario, Baja California, Mexico, altitude 210 meters, 18 April 1958, *Raven, Mathias & Turner 12475* (RSA).

Specimens examined. CALIFORNIA. Santa Barbara County: Santa Cruz Island, *T. S. Brandegee* in 1888. Ventura County: Hueneme, *Peirson 5772*; Hueneme Beach, *Munz 9390*. BAJA CALIFORNIA, MEXICO. South Todos Santos Island, *Moran 2804;* San Quintín, *Bacigalupi 3020, Epling & Stewart* in 1936, *Raven et al. 12355;* Rosario wash, *Wiggins 5427;* 3.5 miles east of Rancho San José, *Wiggins 9783;* Arroyo el Agua Marga, *Wiggins 9935, 9935B;* El Rancho Viejo, *T. S. Brandegee* in 1889; Cedros Island, *Anthony 434, Palmer 762.*

The chromosome number of *M. similis* has been determined as n=14 at meiosis in microsporocytes of the type collection. This species is variable and puzzling, separable only with difficulty from *M. clevelandii,* but measurements of the pollen from the collections cited consistently have fallen within the tetraploid-size range. Furthermore, with the exception of two outlying stations in California, this species occupies a coherent area in Baja California south of the range of the diploid *M. clevelandii.* Much of the difficulty with respect to the delimiting of *M. similis* is due to the three collections from California. The dune habitat at Hueneme Beach (Ventura County), however, would be highly anomalous for *M. clevelandii,* and the collections cited are morphologically distinguishable from that species. Plants of *M. similis* from similar beach and coastal plain habitats in Baja California have smaller and darker achenes than the Hueneme collections. Additional collections and chromosome number determinations from Hueneme Beach and from Santa Cruz Island, the

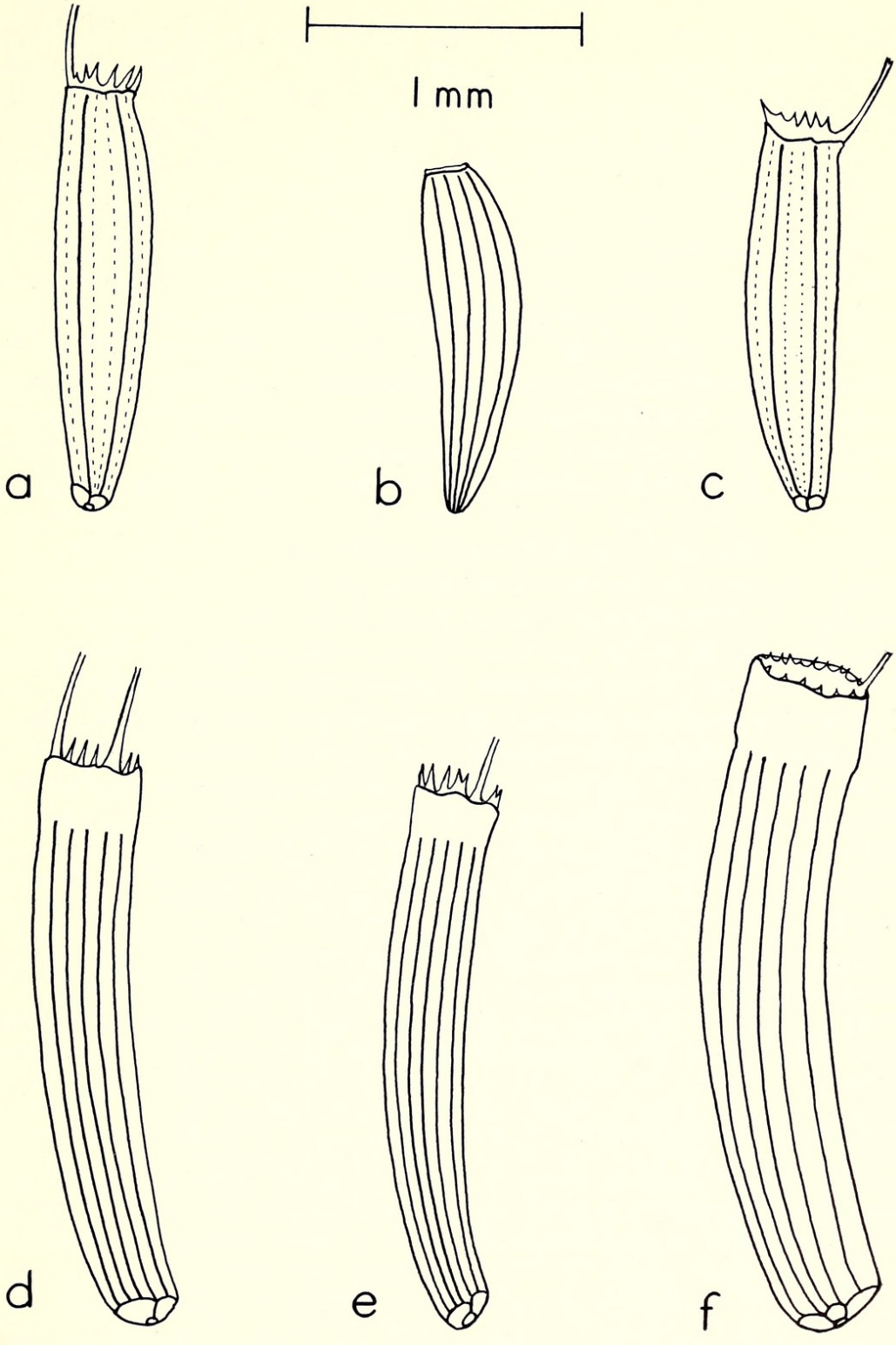

FIG. 2. Mature achenes of species of *Malacothrix*: a. *M. clevelandii;* b. *M. foliosa;* c. *M. similis;* d. *M. sonorae;* e. *M. stebbinsii;* f. *M. fendleri.*

other California station, are much to be desired. In both cases the pollen measurements are consistent with the range of size expected for the tetraploid. We suggest that an understanding of relationships in the complex

depends on a more thorough knowledge of *M. foliosa* and related species which inhabit the islands off the coast of California and Baja California, and which may have participated in the alloploid origin of the populations we have named *M. similis*. Measurements of the pollen of different collections of the *M. foliosa* complex suggest that it contains both diploids and tetraploids.

Malacothrix sonorae sp. nov. (fig. 1, 2d). Herba annua; foliis ad radices lanceolatis vel oblanceolatis, inaequaliter pinnatifidis; capitulis campanulatis, 6–9 mm. longis, 4–6.6 mm. latis, floribus 30–61; corollis flavis; achaeniis columnaris 1.7–2.00 mm. longis ad basim attenuatis, subflexuosis, praesertim fuscis nunc stramineis, subtiliter aequaliterque 15–costatis, in sectione transversa rotundis, parte superiore dilata, achaenii parte superiore ad 0.2–0.3 mm. nullomodo costata, ab annula setarum 16–18 scabriosarum circumdata; setis perstatis 2, per occasionem 1, raro 3 vel 4.

Annual herb 10–35 cm. tall, usually unbranched at the base but occasionally with up to 9 stems; basal leaves lanceolate to oblanceolate, irregularly and doubly dentate, the rachis broadest near the apex, narrowed below; heads campanulate, 5–109 (median, 10), 6–9 mm. high, 4–6.6 mm. broad, 30–61-flowered; ligules yellow; pollen grains 20–29 μ in diameter (mean=25 μ); achenes cylindrical (1.6–) 1.7–2.0 mm. long, attenuate toward the base, slightly curved, grey-brown to straw-colored, finely 15-ribbed, all the ribs equal, the achene round in transverse section, the apex slightly expanded, the upper 0.2–0.3 mm. of the achene not ribbed, bordered by a ring of 16–18 white-scarious teeth, of which the basal portions do not extend above the achene lip, the teeth pectinate, straight, acicular, the persistent setae 2, occasionally 1, rarely 3 or 4.

Type. Tucson Mountains, altitude 2600 feet, Pima County, Arizona, 24 April 1903, *Thornber 362* (ARIZ 59,491; istoypes, DS, POM, UC).

Specimens examined. ARIZONA. Pima County: north base of Silver Bell Mountains, *Benson 10716;* Rosemont, *Thornber* in 1907; Sabino Canyon, Santa Catalina Mountains, *Thornber* in 1903; Tucson Mountains, *Thornber 428,* in 1903. Pinal County: between Oracle and Mammoth, *Gentry 6081.* SONORA, MEXICO. Distrito de Altar: Passo San Emeterio, *Keck 4135A;* 4 miles west of Caborca, *Keck 4040.*

The size and number of apertures of its pollen suggest that this distinctive and rather local species may be diploid (n=7), but we have not yet been able to obtain living material from which to make chromosome counts. In achene shape (fig. 1d, a, f) it is intermediate between *M. clevelandii* and *M. fendleri* A. Gray (fig. 2), the latter a diploid[3] species with long-exserted ligules that occurs east of the range of the *Malacothrix clevelandii* complex. The range of *M. sonorae* likewise lies between that of the other two diploids.

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[3] We have made two new gametic chromosome counts of *M. fendleri,* n=7, from the following collections: 1.9 miles north of Chambers, Apache County, Arizona, *Raven 13026;* 5 miles northeast of Bates Well, Pima County, Arizona, *Raven 11699.* Stebbins *et al.* (*op. cit.*) reported the same number for a collection from New Mexico.

We have derived the specific epithet, "sonorae," from the Sonoran Desert in which the range of this taxon lies.

Malacothrix stebbinsii sp. nov. (fig. 1, 2e). Herba annua; foliis ad radices lanceolatis vel oblanceolatis, dentatis, raro pinnatifidis; capitulis campanulatis, 7–10 mm. longis, 3.5–8 mm. latis, floribus 19–70; corollis flavis, raro albis; achaeniis fusiformo-columnaris, 1.7–2.3 mm. longis, ad basim subattenuatis, raro flexuosis, nunc cinearo-fuscis nunc stramineis, subtiliter aequaliterque 15-costatis, in sectione transversa rotundis, parte superiore subdilata, achaenii parte superiore ad 0.14–0.20 mm. non costata, ab annulo setarum 14–17 scabriosarum circumdata; setis perstatis 1, per occasionem 2.

Annual herb 6–60 cm. tall, usually unbranched at the base but occasionally with up to 9 stems; basal leaves lanceolate to oblanceolate, dentate, more rarely pinnatifid, the rachis often narrowed near the base; heads campanulate, 5–66 (median, 20), 7–10 mm. high, 3.5–8 mm. broad, 19–70-flowered; ligules yellow, rarely white; pollen grains 24–36 μ in diameter (mean=30 μ); achenes narrowly fusiform-columnar, tapering slightly to the base, 1.7–2.3 mm. long, 0.3–0.45 mm. wide, rarely curved, grey-brown to straw-colored, finely 15-ribbed, all the ribs equal, the achene round in transverse section, the apex slightly flared, the upper 0.14–0.20 mm. of the achene not ribbed, bordered by a ring of 14–17 white-scarious teeth, of which the basal portions rarely extend above the achene lip, the teeth rarely and irregularly cleft, straight, lance-linear; the persistent setae 1, rarely 2.

Type. Abundant in shade of a large rock, moist soil, Mendoza Canyon, Coyote Mountains, Pima County, Arizona, altitude 3,800 feet, 22 April 1945, *K. F. Parker 5815* (ARIZ 32,709; isotype, UC).

Representative specimens. NEVADA. Washoe County: hills west of Reno, *Hillman* in 1893. Clark County: Nelson, *Jones* in 1907. CALIFORNIA. Inyo County: Titus Canyon, *Eastwood & Howell 7786;* 4 miles east of Aberdeen, *Kerr 630*; 2 miles east of Bradbury Wells, *Howell* in 1928; Slate Range, *Alexander & Kellogg 1135*. San Bernardino County: Turtle Mountains, *Munz & Harwood 3505;* Quail Springs, Little San Bernardino Mountains, *Munz & Johnson 5227*; south base of Old Dad-Granite Mountain Range, *Wolf 10092*; Kingston Mountains, *Wolf 10456*. Riverside County: Murray Canyon, *Peirson 2715*; 12 miles southwest of Twentynine Palms, *Alexander & Kellogg 2129*. San Diego County, Palm Canyon, Borrego Valley, *Wolf 8451*; San Felipe Hill, *Jones* in 1906. ARIZONA. Mohave County: Yucca, *Jones* in 1884; Chemehuevis, *Jones* in 1903; Diamond Creek Canyon, *Wilson* in 1893. Yavapai County: Burro Creek, *Crooks & Darrow* in 1938; Skull Valley, *Jones* in 1903. Gila County: Pine Creek, near Roosevelt, *Peebles et al. 5227;* Mazatzal Mountains, *Eastwood* in 1929, *17163*. Pinal County: near Oracle, *Peebles 6844;* between Superior and Miami, *A. & R. A. Nelson 1900;* Galuro Mountains, 12 miles above Mammoth, *Gentry 6051*. Pima County: Baboquivari Peak, *Goodding 4649;* Florita Canyon, *Knipe* in 1938; Oracle Camp, Santa Catalina Mountains, *Simon 224;* Sabino Canyon, Santa Catalina Mountains, *Thornber* in 1905, in 1913. Santa Cruz County: Stone Cabin Canyon, Santa Rita Mountains, *Thornber 5543*. SONORA, MEXICO. 4 miles south of Imuris, *Abrams 13202*.

Pollen of this species is consistently larger than in *M. clevelandii* and *M. sonorae,* both of which are diploids, and, like that of the tetraploid

M. similis, is mostly tetra-aperturate. We believe that the count reported by Stebbins *et al* (*op. cit.*) of 2n=28 for "*Malacothrix clevelandii*" from Tucson, Arizona (for which we can find no voucher) probably refers to *M. stebbinsii*. From a consideration of morphology we believe that *M. stebbinsii* may be an allotetraploid between *M. clevelandii* and *M. sonorae*. Stebbins and his associates postulated that it might be an allotetraploid between *M. clevelandii* and *M. fendleri,* but they were not aware of the probably diploid *M. sonorae*. As we have mentioned above, *M. sonorae* is nearly intermediate between *M. clevelandii* and *M. fendleri,* both morphologically and geographically.

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DOCUMENTED CHROMOSOME NUMBERS OF PLANTS

(See Madroño 9:257–258. 1948)

Species	Number	Counted by	Collection	Locality
Portulacaceae				
Montia **perfoliata* (Willd.) Howell	n = 6	P. Raven LA[1]	*H. & M. Lewis* in 1956, LA	Mather, Tuolumne County, California
	n = 12	H. Lewis LA	*H. Lewis* in 1955 LA	Mather, Tuolumne County, California
	n = 18	P. Raven LA	*H. Lewis* in 1956 LA	La Panza Range, San Luis Obispo County
	n = 18	P. Raven LA	*H. Lewis* in 1956 LA	San Juan Canyon, San Luis Obispo County, California
	n = 18	P. Raven LA	*H. Lewis* in 1956 LA	Temblor Grade, Kern County, Calif.
sibirica (L.) Howell	n = 12	W. H. Lewis ASTC	*W. H. Lewis 5367* SMU	Near Sechelt, British Columbia, Canada
Ranunculaceae				
Delphinium virescens Nutt.	n = 8	R. C. Jackson KANU	*McGregor 14282* KANU	Douglas County, Kansas
Trautvetteria grandis Nutt.	n = 8	R. Ornduff DUKE	*Ornduff 6262* UC	Multorpor Mountain, Clackamas County, Oregon
Magnoliaceae				
Michelia **fuscata* Blume	n = 19	P. Raven LA	*Raven 14026* UC	Cultivated, Los Angeles, Calif.
Saxifragaceae				
Bolandra oregana S. Wats.	n = 7	R. Ornduff DUKE	*Ornduff 6240* UC	Elowah Falls, McCord Creek, Multnomah County, Oregon