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**MENTZELIA PECTINATA VAR. CHRYSOPETALA (LOASACEAE),
A YELLOW-PETALED RACE FROM WEST-CENTRAL CALIFORNIA**

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ABSTRACT

Mentzelia pectinata Kellogg var. *chrysopetala* Keil & Brokaw, **var. nov.**, is a yellow-petaled race of the otherwise orange-petaled *M. pectinata*, a species endemic to central California. The yellow- and orange-petaled varieties are largely allopatric, with var. *chrysopetala* nearly restricted to San Luis Obispo County, whereas var. *pectinata* extends eastward into the dry hills and mountains around the southern end of the San Joaquin Valley, including eastern portions of San Luis Obispo County. Petals of var. *chrysopetala* are golden yellow, usually with orange bases, unlike the petals of var. *pectinata*, which are coppery orange with red-orange bases. We designate a neotype for *M. pectinata* because original material, which presumably was in CAS, apparently is no longer extant; the holotype was probably destroyed in the 1906 San Francisco earthquake and fire.

Mentzelia pectinata Kellogg is an annual species endemic to the southern part of California's San Joaquin Valley and the surrounding hills and mountains of the South Coast Range, Transverse Range, and foothills of the southern Sierra Nevada. In spring growing seasons with abundant rainfall, these plants often form large populations, and the mass displays of their flowers form conspicuous splashes of color across the landscape. The species exhibits two strikingly different flower color forms. Plants from a large part of its range have coppery-orange petals with red-orange bases. Plants from the southern Diablo Range through central San Luis Obispo County and south-central Monterey County have golden yellow petals, usually with orange bases.

Taxonomic treatments of these plants have varied. Kellogg (1863) originally described *Mentzelia pectinata* with "flowers of a shining golden color, with a lustrous metallic hue. shading from a deep, vivid orange to a burnt carmine center." Jepson (1925, 1936) treated *M. pectinata* as part of a broadly defined *M. gracilentata* Torr. & A.Gray, describing the petals of the species as "yellow with orange base." Munz (1959) recognized *M. pectinata* and described the petals as "orange above, coppery-red toward base." Hoover (1970) treated the orange-flowered plants as *M. pectinata* and the yellow-flowered plants as *M. gracilentata*. He noted that that flower color appears to be the only reliable differentiation between the two kinds of plants, but that they are distinct ecologically, geographically, and apparently genetically. Brokaw (2016) distinguished diploid *M. pectinata* from tetraploid *M. gracilentata* using several characters, including (1) orange petals (in most collections of *M. pectinata*, absent in *M. gracilentata*), (2) bracts with white bases (in most collections of *M. gracilentata*, absent in *M. pectinata*), and (3) elevation/habitat (*M. pectinata* occurs at lower elevations than *M. gracilentata* where the ranges overlap in San Luis Obispo County).

Zavortink (1966), in an unpublished dissertation, provided evidence from a biosystematic investigation that the yellow-flowered and orange-flowered plants are two races of a single diploid species: "Hybrids between the two morphological races of *Mentzelia pectinata* showed some slight pairing irregularity in a few instances, but little or no reduction in fertility as indicated by pollen analyses and seed set." This contrasted with the results of her controlled crossing experiments that showed that interspecific crosses between *M. pectinata* and the tetraploid *M. gracilentia* were unsuccessful or that interspecific triploid hybrids had much reduced fertility. But she made no mention of heritability of flower color. She also found that populations of the yellow-flowered race often included a small proportion of orange-flowered individuals that varied from 30:1 yellow- to orange-flowered individuals in years with ample precipitation to fewer than 100:1 in drier years. Zavortink also commented that "variation within *Mentzelia pectinata* is clinal. In the northwest portion of the range the individuals have small yellow flowers (petals 8–14 mm long) with retuse petal tips and large seeds (1.4 mm long and 1.2 mm wide), 20–25 seeds per capsule. In the southwest section of the range the other extreme of the cline has larger flowers with deep orange petals (12–20 mm long) with mucronate tips and small seeds (1.2 mm long and 1.0 mm wide), 30–38 seeds per capsule." However, Zavortink presented no data that demonstrated this to be clinal variation. In her study she did not recognize any infraspecific taxa.

Brokaw (2009) and Brokaw and Hufford (2010a, 2010b) investigated phylogenetic relationships within *Mentzelia* sect. *Trachyphytum*. Yellow-flowered and orange-flowered populations of *M. pectinata* were recovered as a monophyletic lineage closely allied to *M. congesta* Torr. & A. Gray (Brokaw & Hufford 2010a), whereas *M. gracilentia* was hypothesized to be an allopolyploid hybrid of *M. pectinata* and *M. congesta* (Brokaw & Hufford 2010b). A yellow-flowered population of *M. pectinata* evidenced past nuclear introgression with *M. congesta* (Brokaw & Hufford 2010a), and all sampled populations of *M. gracilentia* possessed nuclear DNA from *M. congesta*, suggesting that the yellow phenotype could be promoted by genetic contributions from *M. congesta*.

In both editions of *The Jepson Manual* (Prigge 1993; Brokaw, Schenk, & Prigge 2012), *Mentzelia pectinata* was treated as a species with orange to yellow petals with red to orange bases, but the geographic pattern to this variation was not discussed. We think it is important to address this issue before publication of the second edition of the *Vascular Plants of San Luis Obispo County, California* (Keil & Hoover in prep.). We believe that the yellow-flowered and orange-flowered races of *M. pectinata* are worthy of formal taxonomic recognition. In so doing, we acknowledge their close relationship as evidenced by their interfertility and close phylogenetic relationship. They are readily distinguishable and have allopatric distributions. We have chosen to recognize them as varieties rather than subspecies because the rank of variety has been more frequently used in *Mentzelia* than has subspecies. We consider the use of variety and subspecies to be equivalent in practice, though we recognize their nomenclatural independence and hierarchical relationship (Turland et al. 2018).

MENTZELIA PECTINATA Kellogg var. **CHRYSOPETALA** D.J. Keil & Brokaw, **var. nov.** (Figs. 1, 2).

TYPE: California. San Luis Obispo Co: Shell Creek Road, 1.5 mi N of Highway 58, 35.478693°, -120.329352° (WGS84), 410 m, steep roadcut next to road, above valley of Shell Creek, foothill woodland, 4 Apr 2016, *D.J. Keil 33903* with Kathleen Keil (holotype: OBI; isotypes to be distributed).

Flowers of *Mentzelia pectinata* var. *chrysopetala* are readily recognizable in having golden-yellow petals, usually with orange bases (Fig. 2), in contrast to those of var. *pectinata*, which have coppery-orange petals with red-orange bases (Fig. 3).

Annual, 6–60 cm tall. Stems erect or ascending, simple proximal to inflorescence or branched from proximal and/or distal nodes, puberulent with fine, spreading, minutely glochidiate trichomes, epidermis pale, sometimes exfoliating in age. Leaves basal and cauline, basal sometimes absent at flowering; proximal leaves petioled, distal sessile, blades 1–10 cm long, 1–35 mm wide, linear to

oblong-lanceolate to lanceolate in outline or distal sometimes ovate, margins shallowly to deeply pinnately lobed, often to near narrow rachis, with numerous triangular to linear-oblong lobes or sometimes coarsely and shallowly few-lobed or -toothed with wide rachis and proximally widened teeth or lobes, rarely distal entire; abaxial face finely puberulent to pilose with slender, erect, glochidiate trichomes, midrib and sometimes surface hispid to hirsute with scattered, coarse, pustulate-based, glochidiate trichomes; adaxial face and margins hispid-hirsute with pustulate-based, glochidiate trichomes and sometimes puberulent with more slender trichomes as well. Flowers in cymose clusters (solitary) at tips of main stem and branches; bracts leaf-like, green throughout, pinnately or sub-palmately lobed or toothed (entire), terminal lobe or tooth prolonged. Ovary 5–10 mm in flower, narrowly cylindrical or slightly expanded distally, finely pilose and densely puberulent with spreading glochidiate trichomes; sepals 6–10 mm long, narrowly to broadly lanceolate, acuminate, abaxially hispid-hirsute and finely puberulent; petals 8–18 mm long, obovate, emarginate to rounded or mucronate, golden yellow (rarely coppery orange), usually proximally orange, occasionally unmarked at base, on dry specimens fading to dull tan with darker veins; anthers and filaments pale yellow; styles and stigmas pale yellow.

Paratypes. California. Monterey Co.: hills, western edge of Hames Valley, [35.891998°, -120.933236°], 11 Apr 1958, *Hardham 3016* (SBBG); hills, western edge of Hames Valley, Bradley-Jolon Rd., [35.891998°, -120.933236°], flowers yellow with red at base of petals, 7 Apr 1959, *Hardham 4201* (CAS, JEPS, RSA, SBBG). San Luis Obispo Co.: Upper reaches of Commatti Cyn, 1.6 mi N of direct road from La Panza to Creston, 16 May 1955, *Bacigalupi 5139* with Robbins and Harrison (CAS, OBI, UC); Shell Creek Road near Hwy 58, 35.478599°, 120.329302°, 9 May 2006, *Brokaw 212* (ACU, WS); Paso Robles River Road along Salinas River S of Creston Road, 35.624285°, 120.680431°, 9 May 2006, *Brokaw 213* (ACU, WS); Fernandez Creek on La Panza-Shandon Road, [35.458034°, -120.333600°], 30 Mar 1947, *Hoover 6834* (CAS, OBI); Cottonwood Pass, near summit, [35.780242° -120.207089°], 2 Apr 1949, *Hoover 7577* (CAS, OBI); between San Juan River and Carrizo Plain, 11 Apr 1949, *Hoover 7586* (CAS, OBI); just E of San Juan River on road from La Panza to Simmler, 21 Apr 1949, *Hoover 7608* (CAS, OBI); between San Juan River and Carrizo Plain, [35.359°, -120.0711°], 20 Apr 1952, *Hoover 8149* (CAS, OBI, UC); between San Juan River and Carrizo Plain on Hwy 58, [35.382262°, -120.121242°], 5 Apr 1967, *Hoover 10358* (CAS, OBI); Shell Creek Road, ca 1/2 mi N of jct with California Rte 58, 9 Apr 1995, *Keil 24782* with K. Keil (OBI); Shell Creek Road, ca 1/2 mi N of jct with California Rte 58, 35.46411°, -120.33005°, 15 Apr 1995, *Keil 24900* with K. Keil (OBI); Shell Creek Road N of Hwy 58 where road cuts against base of hill, vicinity of 35.4790°, -120.3282°, 20 Apr 2001, *Keil 29339* with K. Keil (OBI); between San Juan River and Carrizo Plain, Hwy 58, just E to ca. 0.25 miles E of San Juan Creek bridge, S side of highway, 35.386951°, -120.146136°, 11/12 Apr 2008, *Keil 30499* with Andreano, Walgren, and Sims (OBI, UC); Shell Creek Road N of Hwy 58, 35.47895°, -120.329285°, 7 Apr 2012, *Keil 31246* (OBI, SD); Shell Creek Road, 2 mi from jct with Hwy 58, 18 Apr 1981, *Luckow 665* (OBI); Red Eagle Mine, 1 mi E, 12 mi S of Shandon [35.472564°, -120.378998°], 5 May 1952, *McMillan 103* (CAS, OBI[2]). Coordinates in brackets were estimated from label data.

Etymology. The specific epithet is a compound derived from Greek roots: *chrysos* - gold + *petalon* - petal, describing the golden-yellow petals (Fig. 1) that distinguish the newly-described variety.

Common names. We recommend Obispo Blazing Star as the common name for *Mentzelia pectinata* var. *chrysopectala*. The common name San Joaquin Blazing Star is already in use for *Mentzelia pectinata* (e.g., Calflora 2020) and we recommend that it be restricted to var. *pectinata*.



Figure 1. Holotype of *Mentzelia pectinata* var. *chrysopetala*.



Figure 2. *Mentzelia pectinata* var. *chrysopetala*. A. Close-up of flowers showing adaxial faces of petals. B. Close-up of inflorescence showing bracts and abaxial faces of sepals and petals.



Figure 3. *Mentzelia pectinata* var. *pectinata*. A. Close-up of flowers. B. Close-up of inflorescence showing bracts and abaxial faces of sepals and petals.



Figure 4. Neotype of *Mentzelia pectinata* Kellogg.

Morphology, ecology, and geography. The ranges of var. *chrysopetala* and var. *pectinata* are essentially allopatric. Hoover (1970) described the range and flower color of var. *chrysopetala* [as *M. gracilentata*]: "In crumbling shale gravel, calcareous clays, or calcareous sandy loams, usually on steep slopes, frequent from Cottonwood Pass to near Creston and Caliente Mt., but absent from Temblor Range. The yellow petals often, but not always, have an orange base." These populations occur largely in the drier portions of the foothill woodland-chaparral zones of the southern South Coast Range.

This contrasts with Hoover's description of the range [in San Luis Obispo County] and flower color of *Mentzelia pectinata* [here treated as *M. pectinata* var. *pectinata*]: "Gypseous clay soils, Temblor Range, Caliente Range, and hills bordering Cuyama Valley. The plants usually grow on slopes which are otherwise nearly barren, and in a year of good rainfall are abundant and showy. The petals are vivid orange, always with a copper red base. The nature of the relationship between this species and *M. gracilentata* is an unsolved enigma. Flower color seems to be the only difference which is completely reliable; yet the two kinds of plants are completely distinct ecologically, geographically, and apparently genetically. Even in the Caliente Range, which is the only known area where they occur relatively near each other, there are no mixed colonies, intergrades as to flower color, evident hybrids, or any sort of evidence of interfertility. Unfortunately, it is usually impossible to determine the flower color from herbarium specimens."

Hoover's last observation is indeed a problem for dealing with specimens lacking flower color data on the labels. Because determining the identity of historic populations that lack flower color data is not possible, the varietal identity of some outlying populations is uncertain. *Mentzelia pectinata* var. *chrysopetala* is nearly endemic to San Luis Obispo County. Two collections document its occurrence in the hills bordering the western edge of the Hames Valley in southern Monterey County. Hoover documented it from the Cottonwood Pass area in the northeastern corner of San Luis Obispo County, and it likely occurs in nearby areas of Kern, Kings, and Monterey counties. A collection from the hills southwest of Kettleman City in Kings County (*Reveal 4380*, CAS, RSA) lacks flower color data and cannot be determined to variety. Specimens from the Annette-Choice Valley area along the San Luis Obispo-Kern Co. line to Cholame similarly lack flower color data.

Hoover did not cite any specimens of *Mentzelia gracilentata* [*M. pectinata* var. *chrysopetala*] from the Caliente Range, and none of his collections from the Caliente Range bear the name *M. gracilentata*. We have not observed any populations or located any specimens of var. *chrysopetala* that would verify its presence in that range.

Zavortink (1966) commented in some detail on geographical and seasonal patterns of variation in *Mentzelia pectinata*:

Variation within *Mentzelia pectinata* is clinal. In the northwest portion of the range the individuals have small yellow flowers (petals 8–14 mm long) with retuse petal tips and large seeds (1.4 mm long and 1.2 mm wide), 20–25 seeds per capsule. In the southwest section of the range the other extreme of the cline has larger flowers with deep orange petals (12–20 mm long) with mucronate tips and small seeds (1.2 mm long and 1.0 mm wide), 30–38 seeds per capsule. In the northwest the populations are generally associated with *Quercus lobata* and occur on fine, white shale soils. To the southeast the populations occur on heavier brown clay soils mainly in grassland communities. Most populations are intermediate representing various combinations of the morphological extremes, and in general occur on the finer white or light gray soils. In intermediate populations with both orange and yellow flowered individuals present, it appears that the orange flowered plants are abundant only in years of adequate rainfall, more scarce in drier years, and completely absent in years of extreme drought (Zavortink 1966, p. 75).

One example [of fluctuation in population size] is that of *M. pectinata* in which the proportions of orange to yellow flowered individuals vary in a given year depending on the yearly rainfall conditions. In May, 1963 sufficient moisture had been received in the Cammatti Valley in San Luis Obispo County to support flourishing populations of many annual and perennial species. Species of *Mentzelia*, *Amsinckia*, *Salvia*, *Clarkia*, *Delphinium*, *Lupinus*, and of other genera formed extensive populations. *Mentzelia pectinata* was present in great abundance, covering the hillsides with thousands of individuals, and the yellow flowered plants were present in a ratio of 30:1 yellow to orange flowered individuals. In May, 1964 the Cammatti Valley population was less extensive both in number of individuals and in area, with yellow flowered individuals far outnumbering orange flowered plants by 100:1. May, 1965 showed a great change in the area, with all species much reduced in number and showing evidence of drier conditions with smaller, more depauperate-appearing individuals, more widely scattered than in previous years. The population of *M. pectinata* consisted of almost all yellow flowered plants. After much searching, only 2 orange flowered individuals could be found, and the population size was drastically reduced to between 200–300 individuals, many small and with few flowers (Zavortink 1966, pp. 20–21).

We have observed the presence of orange-flowered individuals in only a single population of var. *chrysopetala*, in which yellow-flowered plants were far more numerous, conforming to Zavortink's observations.

Left for future studies are the reportedly clinal variation in morphological features and the rare occurrence of orange-flowered individuals within populations of the yellow-flowered race. It should also be noted that other species in sect. *Trachyphytum*, including *Mentzelia veatchiana* Kellogg, also have both orange and yellow-flowered phenotypes but with less clearly delineated geographic races (Brokaw 2016). Does flower color affect pollinator selection? Do the yellow-flowered and the infrequent orange-flowered plants in mixed populations interbreed? How is flower color inherited?

Neotypification of *Mentzelia pectinata*. Kellogg (1863) described *Mentzelia pectinata* based on a plant "found by Mrs. Hutchings on the mountains above Visalia." Mrs. Hutchings was Elvira (Sproat) Hutchings, the wife of James Mason Hutchings, who was prominent in exploring and promoting the Sierra Nevada, especially the Yosemite area (National Park Service 2015). No specimen of *Mentzelia* collected by Mrs. Hutchings has been located in the herbarium of the California Academy of Sciences (CAS) or elsewhere. If Kellogg deposited a specimen of *Mentzelia pectinata*, it likely was destroyed in the 1906 earthquake and fire, which ravaged most of the CAS plant collection.

The options for typification of *Mentzelia pectinata* are either to designate a neotype or to select as lectotype the illustration that accompanied Kellogg's original description. Our preference in designation of a specimen as neotype would be a collection well representative of the species made in the area where Mrs. Hutchings found the plant. Unfortunately our search of specimen records from this area (CCH2 2020) did not locate any *Mentzelia pectinata* specimens that fit these criteria. The type location is to the north of any collection known to us of *M. pectinata* in the Sierra Nevada. Although the illustration published as Figure 9 by Kellogg (1863) might serve as lectotype of *M. pectinata*, it does not illustrate in sufficient detail the features of the species that differentiate it from related species of *Mentzelia*. We therefore designate as neotype a collection that adequately represents the features of *M. pectinata* var. *pectinata*.

Mentzelia pectinata Kellogg, Proc. Calif. Acad. Sci. 3: 40. 1863. **TYPE: California.** Tulare Co.: "Found by Mrs. Hutchings on the mountains above Visalia," not dated (holotype, CAS?; specimen not located, probably destroyed in the 1906 San Francisco earthquake and fire). **Neotype** (here designated): **California.** San Luis Obispo Co.: Panorama Hills, near the Temblor Range, Carrizo Plain, on loose open soil with *Caulanthus*, annual, petals deep orange

with coppery base, 762 m, [35.182190°, -119.721648°], 27 Mar 1965, *D. Wilken 130* (OBI132149; isoneotypes, CSLA005776, UCR0037482).

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