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A NEW SPECIES OF *LOESELIASTRUM* (POLEMONIACEAE) FROM NORTHERN ARIZONA

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ABSTRACT

Loeseliastrum franciscanum R. Crawford, a local endemic known from three populations in the eastern San Francisco volcanic field of Coconino County, northern Arizona is newly described and illustrated here. This species is similar to *L. depressum* (M. E. Jones ex A. Gray) J. M. Porter & L. A. Johnson, but is distinguished by its strongly bilabiate corolla, long exserted stamens, pinnatifid leaves, and mostly tridentate inflorescence bracts. A revised key to *Loeseliastrum* is presented.

Key Words: Endemic, *Loeseliastrum*, northern Arizona, Polemoniaceae, taxonomy.

Loeseliastrum (Brand) Timbrook (Polemoniaceae) is a genus of desert annuals characterized by bilaterally symmetric flowers, terminal compact inflorescences, stamens unequally inserted at the sinuses, and dentate leaves with each lobe possessing a single bristle. The genus is comprised of three species distributed across the Sonoran, Mojave, and Great Basin Deserts. Prior to segregation into *Loeseliastrum* (Timbrook 1986), species were included in *Langloisia* Greene (Brand 1907, Grant 1959). The original circumscription of the genus (Timbrook 1986) included two taxa, *Loeseliastrum matthewsii* (A. Gray) Timbrook and *L. schottii* (Torr.) Timbrook. Recent studies have since transferred *Ipomopsis depressa* M. E. Jones ex A. Gray into the genus (as *Loeseliastrum depressum* [M. E. Jones ex A. Gray] J. M. Porter & L. A. Johnson), based on morphological and molecular data (Porter and Johnson 2000, Porter et al. 2010).

In the spring of 2012 the first author collected specimens of *Loeseliastrum* with blue pollen, elongated inflorescences, and short bristles that represented an undescribed species. The specimens were collected in the Navajo Nation in Hopi Trail Canyon (near Cameron, Arizona) as part of a floristic inventory of the Little Colorado River Gorge. Subsequent searches of specimens in Arizona herbaria revealed two previous collections of this taxon from the vicinity of Wupatki National Monument. Greg Goodwin documented two additional localities in 2014, collecting and photographing the species in situ from sites on the CO Bar Ranch near Grey Mountain, Arizona.

TAXONOMIC TREATMENT

Loeseliastrum franciscanum R. Crawford sp. nov. (Figs. 1–3)—Type: USA, AZ, Coconino Co., Wupatki National Monument, Black Bottom Crater, 35°24′20.5920″N, 111°24′10.8366″W, 1769 m, 6 June 2015, *R. Crawford 1440* (holotype: ASC; isotypes: ASU, ARIZ, DES, BRY, NY, RSA).

Loeseliastrum franciscanum resembles *L. depressum* by sharing stems that freely branch from the base, short terminal bristles on the leaf lobes, small corollas (< 9 mm), and thin membranous rotund valves on the capsule. *Loeseliastrum franciscanum* differs from *L. depressum* by possessing pinnately lobed leaves, mostly tridentate inflorescence bracts, and a strongly bilabiate corolla with long exserted stamens.

Annual herbs, 2.5–17 cm tall, freely branching from the base, stems one to many, prostrate to erect, purple to green, sparsely to densely hirtellous with a mix of eglandular and gland-tipped hairs and longer flattened multicellular hairs (0.1–1 mm), more dense distally. Leaves basal and cauline, 5–20 × 0.1–7 mm wide, alternate, sessile to subsessile, entire to pinnately 3–5 lobed or toothed, each lobe or tooth with a single short terminal bristle, blades sparsely short hispid, with a mix of short eglandular and gland-tipped hairs and longer flattened multicellular trichomes. Inflorescence subcapitate, elongating in fruit, subtending bracts 2.5–10 mm long, divided distally into 3–5 teeth, ciliate below teeth; flowers 5–25, 5.8–7.5 mm long; calyx 2.9–4 mm long, accrescent, to 3–6 mm in fruit, lobes acuminate and scarious margined, sometimes with maroon streaks, subequal, bristle-tipped, glandular pubescent and with flattened multicellular hairs (0.1–1 mm), the wide intercostal hyaline membrane remaining intact throughout development; corolla white, funnelform, tube 2–3 mm long, limb bilabiate, upper lip 3-lobed, 2–3.5 mm long, with one or two yellow spots at the base of each lobe, usually outlined by lavender arches, the lower lip 2-lobed, 2–2.5 mm long, markings often faint or absent, lobes rounded to apiculate, sinuses unequal; stamens 5, ± equal, filaments 3.5–5 mm long, unequally attached at sinuses, strongly exserted and curved, anthers blue or white, pollen blue; style 3–4 mm long, exserted, stigma lobes 0.3 mm long. Fruit a capsule, 3-lobed in cross-section, 3–4 mm long, dehiscent at maturity via apical valves, the valves rotund, apiculate, translucent; seeds 7–12 per capsule, 1.3–1.8 mm long, olive to brown, reticulate and rugulose.

FIG. 1. Holotype (ASC1120555).

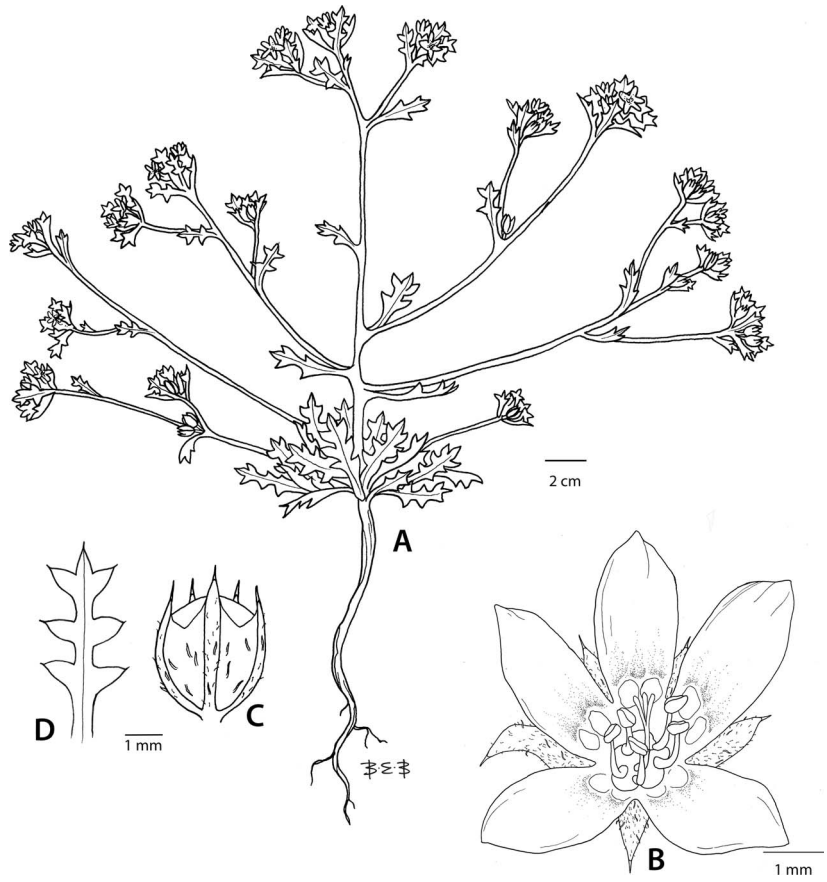

FIG. 2. Illustration of *Loeseliastrum franciscanum* from holotype (ASC1120555). A. Habit. B. Flower. C. Fruit. D. Leaf.

Paratypes: USA, NAVAJO NATION: Hopi Trail Canyon, 35°56′34.8144″N, 111°28′46.0232″W, 1323 m, 28 May 2012, *R. Crawford 481* (ASC, NAVA); same location, 28 April 2013, *R. Crawford 911* (ASC, NAVA, ARIZ, UVSC, SJNM); USA, ARIZONA, Coconino Co.: Wupatki National Monument, 12 May 1939, *D. Jones 21* (ARIZ); Wupatki National Monument, Black Bottom Crater, 35°24′19.8036″N, 111°24′13.2512″W, 768 m, 9 June 2005, *K. Christie 629* (ASC); same location, 09 May 2013, *R. Crawford 976* (ASC, ASU, UNLV, UT, BRY, RENO-V, UCR); CO Bar Ranch, 35°40.117′N, 111°31.047′W, 1585 m, 10 May 2014, *G. Goodwin 4527* (ASC, US); CO Bar Ranch, 35°41.450′N, 111°32.164′W, 1554 m, 25 Aug 2014, *G. Goodwin 4602* (ASC).

ETYMOLOGY

Loeseliastrum franciscanum is named for its endemism to the eastern San Francisco Volcanic Field.

TAXONOMIC RELATIONSHIPS

We compared specimens of *L. franciscanum* to the collections available in the Deaver Herbarium (ASC), which included four specimens of *L. depressum* from California and Nevada; 11 specimens of *L. schottii* (Torr.) Timbrook from Arizona, California, and Nevada, and five specimens of *L. matthewsii* (A. Gray) Timbrook from California (Appendix 1, Table 1). In addition, we examined digital images of type specimens for each species available at JSTOR Global Plants (https://plants.jstor. org/). The pinnatifid leaves, divided corolla, strong bilateral symmetry with long, exserted, recurved filaments suggests that *L. franciscanum* is morphologically similar to *L. matthewsii* and *L. schottii*. However, the combined suite of habit, floral, fruit, and vegetative characters support a closer relationship to *L. depressum* (Table 1). Both *L. franciscanum* and *L. depressum* can possess blue pollen (though not exclusively blue for *L. depressum*), hyaline calyx membranes that are wider than the ribs and remain intact throughout fruit development, thin translucent rotund valves, and large rugulose seeds. *Loeseliastrum franciscanum* and *L. depressum* share several vegetative traits including stems that freely branch from the base, bristles that are shorter than the leaf lobes, and cauline leaves with margins entire or 1–5 lobes. The calyx of *L. schottii* and *L. matthewsii* has a thin hyaline membrane that shatters early in fruit

FIG. 3. Field photographs of *Loeseliastrum franciscanum*. A. Typical corolla, with yellow spots outlined with lavender arches at base of lobes. B. Atypical appearance of corolla lacking defining lavender arches. C. Habit freely branching from the base. D. Habitat at CO Bar Ranch, a gentle slope with moderate disturbance and clay soil derived from Moenkopi Formation. Photographs A, C, D by Greg Goodwin; photograph B by Rich Crawford.

TABLE 1. Comparison of morphological and ecological traits between *Loeseliastrum* species.

	L. franciscanum	*L. depressum*	*L. schottii*	*L. matthewsii*
Stems	2–25 cm	2–12 cm	2–12 cm	3–15 cm
Lobes on largest leaves	Absent or poorly developed proximally, well-developed and numerous distally	Absent or poorly developed, when present concentrated distally	Well-developed throughout, equally spaced	Well-developed throughout, equally spaced
Lobe-to-bristle l engtth	Leaf lobe > leaf bristle	Leaf lobe > leaf bristle	Leaf lobe < leaf bristle	Leaf lobe < leaf bristle
Inflorescence	Axillary and terminal, much elongated in fruit	Axillary and terminal, slightly elongated in fruit	Compact, terminal, not elongated in fruit	Compact, terminal, not elongated in fruit
Inflorescence bracts	3–5 distal teeth	Mostly entire or 1–2 very small teeth	3–5 distal teeth	3–5 distal teeth
Calyx	Hyaline membrane wider than ribs, remaining intact throughout fruit development	Hyaline membrane wider than ribs, remaining intact throughout fruit development	Hyaline membrane narrower than ribs, rupturing early in fruit development	Hyaline membrane narrower than ribs, rupturing early in fruit development
Calyx lobes	Bristles < 1 mm	Bristles < 1 mm	Bristles > 1.5 mm	Bristles > 1.5 mm
Corolla	4.3–7 mm, strongly bilabiate	5–8 mm, weakly bilabiate	8–15 mm, strongly bilabiate	11–21 mm, strongly bilabiate
Corolla, upper lip	2–3 mm	1–2 mm	3–7 mm	5–11 mm
Anthers	Long-exserted	Included	Long-exserted	Long-exserted
Pollen	Blue	Blue, yellow, or white	Yellow	Yellow
Capsule valves	Fully disarticulating tardily, thin, translucent, rotund	Fully disarticulating tardily, thin, translucent, rotund	Fully disarticulating at maturity, walls thick, opaque, lanceolate	Fully disarticulating at maturity, walls thick, opaque, lanceolate
Seeds	1.3–1.8 mm rugulose and finely textured	1.2–1.4 mm rugulose and reticulate	1 mm, flattened to rounded faces, finely textured	1 mm, flattened to rounded faces, finely textured
Distribution	Southern Colorado Plateau	Southwest Great Basin Desert, Northern Mojave	Southwest Great Basin Desert, Mojave and Sonoran Deserts	Mojave and lower Sonoran Desert
Flowering period	April–August	May–November	March–June	March–July

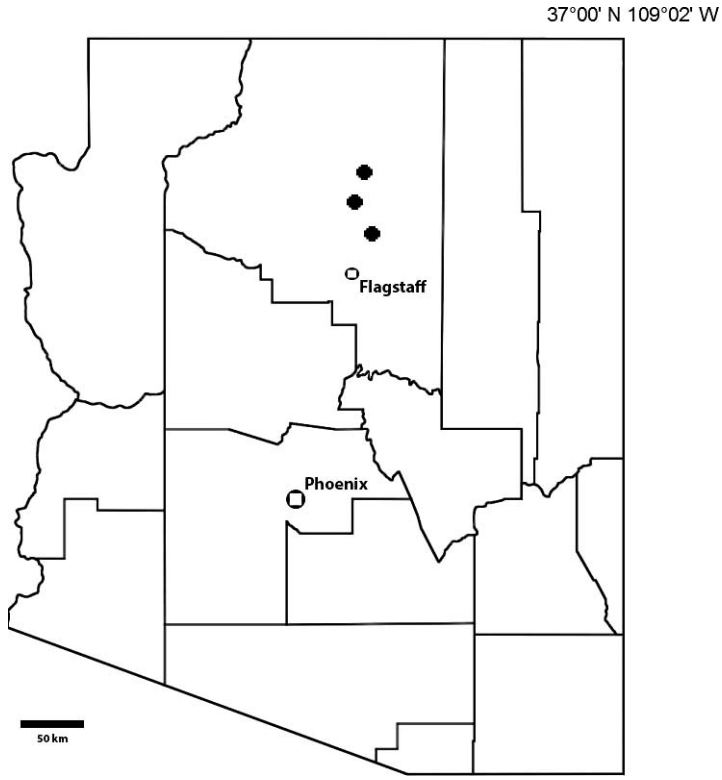

FIG. 4. Distribution map of *Loeseliastrum franciscanum* (Coconino County, AZ). Black circles indicate populations.

development and their lanceolate fruit valves are thick and opaque. *Loeseliastrum schottii* and *L. matthewsii* have divaricately branched stems with eglandular trichomes, long bristles on leaf lobes, and pinnatifid leaves with 5–9(–11) lobes.

PHENOLOGY

Loeseliastrum franciscanum flowers from April to August, and is in fruit from May to September.

DISTRIBUTION AND ECOLOGY

Loeseliastrum franciscanum is geographically closest to *L. schottii* populations at Lake Pleasant in Yavapai Co. (*E. Lehto L19750*, ASU83931) (SEINet) about 180 km SSW of the type locality. The nearest collection of *L. depressum* is 380 km west of Wupatki National Monument in San Bernardino County, CA in the eastern Mojave Desert (*J. André 19830*, UCR243799) (SEINet). Habitat features and population size vary among *L. franciscanum* sites. The most productive site in terms of numbers of individuals is the type locality near Black Bottom Crater between Sunset Crater and Wupatki National Monuments. At Black Bottom Crater, *L. franciscanum* grows in open pinyon-juniper woodlands on gentle slopes in clay soil mixed with cinder pebbles and larger basalt rocks. In 2013 and 2014, a relatively large number of individuals (>100) were observed growing in ca. 4 hectare area. The species was not detected in adjacent woodlands and scrublands where soils have a thick cinder pebble surface. At CO Bar Ranch, 31 km NW of the type locality, three sites occur less than 3 km apart with fewer than 70 individuals. Here, *L. franciscanum* grows on fine soils derived from eroded Moenkopi Formation in Great Basin Desert Grassland with moderate to heavy disturbance from livestock (Fig. 3). In Hopi Trail Canyon (Navajo Nation), fewer than 50 individuals were detected in fine sediments that accumulated behind large rocks or debris in the wash bottom. A survey of the uplands immediately adjacent to the wash did not yield any additional plants. Consistent features among sites include a narrow elevation range between 1340 and 1780 m, soils consisting of silt or clay, and close proximity to cinder cones.

The limited number of collections, small populations and lack of detection until now indicate that *L. franciscanum* is endemic to the eastern San Francisco volcanic field. Documented locations occur within a 35 km radius of CO Bar Ranch (Fig. 4). The region surrounding Sunset Crater is known for several local endemics including *Phacelia serrata* J. W. Voss, *Eremothera gouldii* (P. H. Raven) W. L. Wagner & Hoch, *Penstemon clutei* A. Nelson, and *Mentzelia*

collomiae Christy (Christy 2008). These species are restricted to the very young soils produced by Sunset Crater and other recent eruptions (Christy 2008). In contrast, *Loeseliastrum franciscanum* occurs on soils that range in age from young quaternary alluvial deposits in Hopi Trail Canyon to the much older Jurassic aged Moenkopi Formation. To better understand the conservation status, degree of endemism, and reasons for endemism, additional surveys for *L. franciscanum* are needed. These surveys should focus on regions to the east and south of the type locality, specifically Canyon Diablo, Meteor Crater, the Sunset Mountains near Winslow, and the cinder hills around Dilkon. These locations are similar in climate, vegetation, geology, elevation, and topography to known locations. This species is expected to occur within the boundaries of Sunset Crater and Wupatki National Monuments.

Key to Loeseliastrum species
Modified from Timbrook (1986)

1. Leaf bristles shorter than leaf lobes; calyx lobe much narrower than intercostal hyaline membrane; capsule valves rotund and translucent
   2. Corolla strongly bilabiate, upper lip >2 mm; stamens strongly exserted . . . . . *L. franciscanum*
   2′. Corolla weakly bilabiate, upper lip <2 mm, stamens included. . . . . *L. depressum*
1′. Leaf bristles equal to or longer than leaf lobes; calyx lobe wider than intercostal hyaline membrane; capsule valves lanceolate and opaque
   3. Corolla 11–21 mm, longest filaments equal to or longer than the upper lip . . . . . *L. matthewsii*
   3′. Corolla 8–15 mm, longest filaments shorter than the upper lip . . . . . *L. schottii*

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Appendix 1

Additional Specimens Examined

Loeseliastrum depressum: USA, CALIFORNIA, **Inyo Co.**: 0.6 mi N 70 degrees E of Deep Springs College, 6 August 1983, *J. D. Morefield 1627a* (ASC). NEVADA, **Nye Co.**: Railroad Valley, 4.1 road miles E of highway 375 on the Nyala road, then 0.7 road miles N, 19 May 2005, *A. Tiehm 14859* (ASC); Amargosa Valley about 10 miles west of Lathrop Wells, 22 April 2010, *G. Rink 9121a* (ASC97339); **Mineral Co.**: Terrill Mountains, 7.3 road miles ENE of highway 95 on the more southern road to Rawhide, 8 June 2005, *A. Tiehm 14984* (ASC). UTAH, **Millard Co.**: Deseret, 16 June 1880, *M. E. Jones 1772* (isotype, P00640940 digital image via JSTOR Global Plants).

Loeseliastrum matthewsii: USA, CALIFORNIA, **Inyo Co.**: Camp Independence, 1877, *W. Matthews s.n.* (syntype, GH91178 digital image via JSTOR Global Plants); **Kern Co.**: Northwest of Rosemond, 6 June 2011, *G. Rink 10599* (ASC102645); **Riverside Co.**: Desert flats north of Blythe, east of the McCoy Mountains, 3 March 2011, *G. Rink 10388* (ASC98038); proposed Palo Verde power plant about 15 mi southwest of Blythe, 29 April 2011, *G. Rink 10496* (ASC98132); **San Bernardino Co.**: Mojave Desert, about 35 miles east of Barstow, north of I-40 near the railroad tracks near Pisgah Substation, sandy, 6 May 2010, *G. Rink 9243* (ASC97540); Johnson Valley, about 1 mile south of Galway Dry Lake, 26 March 2014, *G. Rink 12440* (ASC107440).

Loeseliastrum schottii: USA, ARIZONA, **La Paz Co.**: Shea Rd., E of Parker on sand dunes S of road, 28 March 1998, *H. D. Hammond 11352* (ASC64010); **Mojave Co.**: In bottom of Silver Creek Wash, 22 March 1997, *K. Beck s.n.* (ASC62977); 2 miles outside Topoc along old route US 66, 8 April 2001, *J. L. Toney 15* (ASC73125); E of mile marker 7 on White Hills Highway, 1 mi S on Skipper Boulevard, downslope from Prince Albert Mine, 5 April 2008, *D. Peppin 12* (ASC94553); North of Golden Shores and just south of the power plant, east of highway 95, 19 March 2013, *G. Goodwin 4063* (ASC103639); **Yavapai Co.**: Castle Creek Road, 0.1 mi north of intersection of Castle Creek Rd and road to Black Canyon Freeway, just west of Lake Pleasant Regional Park, 31 March 1976, *E. Lehto L19750* (ASU83931 digital image via SEINet). CALIFORNIA, **Inyo Co.**: 2.3 mi N 70 degrees E of Antelope Springs in Deep Springs Valley along Birch Creek, 28 May 1984, *J. D. Morefield 1974c* (ASC); **San Bernardino Co.**: Essex Rest Area, ca. 45 miles W of Needles on I-40, 31 May 1980, *J. R. Kierstead 84* (ASC); Johnson Valley, about 1 mile south of Galway Dry Lake, 26 March 2014, *G. Rink 12439* (ASC).

NEVADA, **Clark Co.**: Valley east of Sheep Mountain, east of Jean, 4 April 2009, *G. Rink 8525* (ASC93732); several miles south of Jean, 8 April 2009, G. Rink 8550 (ASC93752); Terrill Mountains, 7.3 road miles ENE of Highway 95 on the more southern road to Rawhide, 8 June 2005, *A. Tiehm 14985* (ASC). UNKNOWN COUNTRY, Colorado Desert, Sonora, *A. C. V. Schott, s.n.* (isotype, GH91181 digital image via JSTOR Global Plants).