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ERYTHRANTHE SERPENTINICOLA (PHRYMACEAE), A NEW SERPENTINE-ENDEMIC SPECIES FROM SAN LUIS OBISPO COUNTY, CALIFORNIA

DAVID J. KEIL
Professor Emeritus
Biological Sciences Department
California Polytechnic State University
San Luis Obispo, California 93407
dkeil@calpoly.edu

ABSTRACT

Erythranthe serpentinicola D.J. Keil, **sp. nov.** (Phrymaceae), is described from areas of serpentine soil in west-central San Luis Obispo Co., California. It is a member of *Erythranthe* sect. *Simiolus* and is disjunct from *E. pardalis*, a species of the Sierra Nevada foothills, to which it is most similar and perhaps most closely related. Both *E. serpentinicola* and *E. pardalis* are slender annuals with relatively small flowers. Calyces of both species are often dotted with dark red spots, and both are puberulent with delicate gland-tipped trichomes. Both occur primarily on serpentine soils. *Erythranthe serpentinicola* differs from *E. pardalis* in having usually sessile distal cauline leaves, a dense puberulence of fine, spreading glandless trichomes in addition to the gland-tipped trichomes, generally shorter fruiting pedicels, puberulent rather than glabrous styles that are longer exserted than those of *E. pardalis*, and longer corollas that are exserted to a greater extent beyond the calyx.

In the spring of 1979, I collected a yellow-flowered monkeyflower from a serpentine area in the Irish Hills above San Luis Obispo (*Keil 13058*). The Irish Hills are the western half of the San Luis Range, a ridge of the South Coast Range separated from the Santa Lucia Range by the Los Osos and San Luis Valleys. My attempt to identify the plant led me to the polymorphic *Mimulus guttatus* DC. complex, where with some doubt I determined the plant to be *M. nasutus* Greene. Some years later (date not recorded) Dr. David Thompson pencil-annotated a sheet of this collection (OBI138330) as *M. guttatus*.

Based on morphology and molecular phylogenetic data Barker et al. (2012) revised the generic circumscription of *Mimulus*, resurrecting the formerly monospecific genus *Erythranthe* Spach and greatly expanding it to encompass numerous species previously classified in *Mimulus*, including the members of the *M. guttatus* complex. In an accompanying paper Nesom (2012) critically examined *Erythranthe* sect. *Simiolus* (Greene) Nesom, including the *M. guttatus* complex. Nesom restricted the application of the name *Erythranthe guttata* (DC.) Nesom [=*Mimulus guttatus*] to a more homogeneous set of plants and recognized numerous entities that had formerly been treated as races or forms of *M. guttatus* as distinct species of *Erythranthe*. As I examined and sought to understand Nesom's revised monkeyflower taxonomy, I noted that he had cited a duplicate of *Keil 13058* (TEX) as *Erythranthe arenicola* (Pennell) Nesom, one of the segregate species.

In preparation of the manuscript for the second edition of the Vascular Plants of San Luis Obispo County, California (Keil and Hoover in prep.), I attempted to test Nesom's revised taxonomy of this complex with monkeyflowers that I encountered in my field work. I quickly realized that *Mimulus guttatus*, as I had been applying it, encompassed several readily distinguishable entities. I struggled, however, with the concept of *Erythranthe arenicola*, which seemed to encompass disparate elements. During my field work I encountered two additional populations similar to the one represented by *Keil 13058*. Both were also found on soils derived from serpentine substrates in the vicinity of San Luis Obispo. Despite my misgivings I tentatively determined them to be *E. arenicola*.

After examining additional material, Nesom (2019) reevaluated *E. arenicola* and determined that it is actually a depauperate form of a more widespread species, *E. grandis* (Greene) Nesom, that is restricted to sandy, coastal sites in Monterey Co., California. He made no mention of the plant I had collected from an upland serpentine habitat in San Luis Obispo Co. In subsequent correspondence Dr. Nesom acknowledged that he had been mistaken and that the San Luis Obispo Co. plants are not at all the same as those from Monterey Co. He instead noted that they are similar to but not the same as *E. pardalis* (Pennell) Nesom of the Sierra Nevada foothills. Both the San Luis Obispo plants and *E. pardalis* are apparently restricted to serpentine substrates. Further investigation of photos and herbarium material revealed several features by which these plants differ. I therefore am recognizing the San Luis Obispo County plants as a new, serpentine-endemic species.

ERYTHRANTHE SERPENTINICOLA D.J. Keil, **sp. nov. TYPE: USA. California.** San Luis Obispo Co.: Irish Hills Natural Reserve, serpentine springs area on slope above Froom Creek Trail, a short distance E of junction with Poppy Trail, locally common on moist soil with *Chorizanthe breweri* and *Cirsium fontinale* var. *obispoense* on exposed sites around spring, also observed nearby on lower Poppy Trail in moist trail margins, corolla golden yellow, lower lip with red spots, 35.25259°, -120.71381°, 205 m, 22 Apr 2019, *D.J. Keil 35581* (holotype: OBI147660 [Fig. 1]; 4 isotypes to be distributed).

Similar to *Erythranthe pardalis* in its serpentine habitat, annual duration, small flowers, spotted calyces, and vestiture of delicate, gland-tipped trichomes but different in its sessile distal cauline leaves, a dense puberulence of glandless trichomes in addition to the gland-tipped ones, shorter fruiting pedicels, puberulent rather than glabrous, longer-exserted styles, and longer, longer-exserted corollas.

Additional specimens examined. California. San Luis Obispo Co.: Upper Prefumo Canyon Road, grassy area with scattered patches of chaparral, locally abundant on rock outcrop, flowers yellow with red dots, [35.255251°, -120.760226°], [360 m], 29 Apr 1979, *Keil 13058* (OBI [Fig. 2], SBBG, TEX); Laguna Lake Park, San Luis Obispo, serpentine hillside near bog thistle exclosure, local in moist soil, scattered elsewhere, *Erythranthe microphylla* growing nearby, corolla yellow, lower lip with red spots, 35.267147°, -120.683066°, 60 m, 5 May 2017, *Keil 34609* (OBI [Fig. 3], +2 duplicates to be distributed); Irish Hills Natural Reserve, serpentine springs area on slope above Froom Creek Trail, a short distance E of jct with Poppy Trail, locally common on moist soil with *Chorizanthe breweri*, also observed nearby on lower Poppy Trail in moist trail margins, 35.25259°, -120.71381°, 205 m, 17 March 2019, *Keil 35496* (OBI [Fig. 4]).

Annual, 7–40 cm, slender; herbage sparsely to densely puberulent, at least distally, with variable mixture of short, fine, spreading, glandless hairs and delicate gland-tipped hairs, proximally ± glabrous. Stems cylindric, erect or with decumbent bases, simple or branched from proximal to medial nodes. Leaves mostly cauline, basal usually absent at flowering, cauline short-petioled or distal sessile, distalmost sometimes ± connate, blades broadly ovate to ± circular, palmately 3–5-veined, margin entire or shallowly dentate-serrate. Flowers ± evenly distributed from proximal to distal nodes. Fruiting pedicels 10–25 mm. Calyx in flower 5–11 mm, cylindric-campanulate, usually reddened, often with dark-purple spots, in fruit 9–14 mm, ellipsoid to ovoid with throat closed, distal lobe prolonged, straight or moderately downcurved. Corolla 12–20 mm, yellow, throat and lower lip red-dotted, lower lip villous medially, tube-throat funnelform, 7–10(–15) mm, exserted 1–4 mm beyond calyx rim, limb expanded 8–12 mm (when pressed). Anther pairs at slightly different levels; style minutely puberulent, stigma positioned slightly beyond distal anther pair. Capsule ± 5–8 mm, borne on a short gynophore, included within calyx (Figs. 3–6).

Etymology. The epithet serpentinicola is derived from the Latin serpentinus (serpentine rock) and -cola (inhabitant), referring to plants inhabiting soils derived from serpentine rock (Stearn 1966).

Suggested common name. Irish Hills monkeyflower.

Distribution, habitat, and abundance. *Erythranthe serpentinicola* is documented only from three sites in the western South Coast Range in west-central San Luis Obispo Co., California. Two

populations (separated by 2.6 miles (4.2 km)) are documented from the northeastern portion of the Irish Hills. The type locality is located in the immediate vicinity of a serpentine spring in Froom Creek Canyon in San Luis Obispo's Irish Hills Natural Area. The site is surrounded by dense chaparral dominated by *Adenostoma fasciculatum*, *Arctostaphylos obispoensis*, *Ceanothus cuneatus* var. *ramulosus*, *Pickeringia montana* var. *montana*, *Quercus durata* var. *durata*, and *Salvia mellifera*. Moist soil around the spring was occupied by *Castilleja minor* var. *spiralis*, *Cirsium fontinale* var. *obispoensis*, and *Salix breweri*. Immediate associates of *E. serpentinicola* included *Allium lacunosum* var. *lacunosum*, *Chorizanthe breweri*, seedlings of the *Cirsium*, *Cryptantha clevelandii*, *Epilobium minutum*, and *Eschscholzia californica*. The second Irish Hills population occupies an upland site located on private land bordering upper Prefumo Canyon Road. The habitat is an open, grassy slope with patches of chaparral. *Erythranthe serpentinicola* was locally abundant around and on serpentine outcrops. The third population occurs about two miles (3.2 km) northeast of the type locality in San Luis Obispo's Laguna Lake Park and Open Space. It is situated on the lower southeastern flank of Cerro San Luis Obispo, which is one of the Morros, a chain of nine volcanic hills and mountains in western San Luis Obispo County. The site is a southwest-facing serpentine grassland with springs featuring *Cirsium fontinale* var. *obispoensis*. *Erythranthe microphylla* (Benth.) Nesom grows in moist soil with the thistles. *Erythranthe serpentinicola* was scattered in shallow soil on the grassy slope.

Soils derived from serpentine parent material are island-like in their occurrence in San Luis Obispo County. Because of their unusual chemistry—high Mg^{++}, low CA^{++} and the presence of toxic metals (e.g., Cr, Hg)—these soils are challenging substrates for plant growth. Various species have evolved features that enable them to grow on serpentine-derived soils. Plants wholly or largely endemic to serpentine soils occur in various combinations on the patches of serpentine in the San Luis Obispo area. Fifteen of these (starred) occur near populations of *Erythranthe serpentinicola*: **Allium lacunosum* var. *lacunosum*, *Aquilegia eximia*, **Arctostaphylos obispoensis*, **Astragalus curtipes*, **Calochortus obispoensis*, **Carex obispoensis*, **Chorizanthe aphanantha*, **C. breweri*, **C. palmeri*, **Cirsium fontinale* var. *obispoense*, *Dudleya abramsii* subsp. *bettinae*, **D. abramsii* subsp. *murina*, *Hesperocyparis sargentii*, **Layia jonesii*, **Lomatium parvifolium*, **Monardella palmeri*, **Quercus durata* var. *durata*, **Salix breweri*, *Sidalcea hickmanii* subsp. *anomala*, and *Zeltnera muehlenbergii*. The type locality of *E. serpentinicola* is close to that of the recently described *Chorizanthe aphanantha* (Nelson et al. 2019). Indeed *C. aphanantha* was found growing on trail margins within a few meters of *E. serpentinicola*.

Phenology. *Erythranthe serpentinicola* is a spring-flowering annual, and germination is dependent on adequate winter precipitation. Flowering specimens have been collected from 17 March to 9 May. Flowering is expected to extend from about the beginning of March until late May depending on seasonal precipitation patterns.

Conservation assessment. *Erythranthe serpentinicola* is documented at present from just the three populations represented by the specimens cited above. Kristen Nelson (pers. comm.) has observed a fourth population near an abandoned chromite mine in the Irish Hills Natural Reserve, but no specimens currently document this occurrence. It is likely that additional populations occur in serpentine soils in the San Luis Obispo area. The two most widely separated documented populations are about 4.4 miles (7.1 km) apart. Two of the known populations occur in open space areas owned and managed by the City of San Luis Obispo. The third is on private ranch land. The total areal extent of the populations is unknown but is unlikely to exceed a few acres. Potential threats include foot traffic, grazing, fire, and (for the site on private land) changes in land usage. Recognition of *E. serpentinicola* as a rare and potentially endangered species seems warranted; I recommend it be considered by the California Native Plant Society for California Rare Plant Rank 1B.1. When evaluated using IUCN (2000) Red List criteria, *E. serpentinicola* qualifies as Endangered (EN) – High risk of extinction in the wild, based on extent of occurrence estimated to be less than ~100 km^2.

Figure 1. Holotype of *Erythranthe serpentinicola, Keil 35581* (OBI147660).

Figure 2. Paratype of *Erythranthe serpentinicola*, *Keil 13058* (OBI138330).

Figure 3. Paratype of *Erythranthe serpentinicola, Keil 34609* (OBI147662).

Figure 4. Paratype of *Erythranthe serpentinicola, Keil 35496* (OBI147661).

Figure 5. Habit and serpentine gravel habitat of *Erythranthe serpentinicola*, from type locality.

Figure 6. Flowers and distal bracts of *Erythranthe serpentinicola*, from type locality.

Figure 7. Flowers and distal bracts of *Erythranthe serpentinicola*, from type locality.

Relationships. *Erythranthe serpentinicola* is a member of *Erythranthe* sect. *Simiolus* and is similar to *E. pardalis* (Pennell) Nesom, a species largely restricted to serpentine soils of the Sierra Nevada foothills. *Mimulus pardalis* Pennell was recognized as a distinct species by Pennell (1951) but was subsumed within *M. guttatus* sensu lato or not mentioned at all in subsequent floras (Munz & Keck 1959; Thompson 1993, 2012). Nesom (2012) resurrected this species as *Erythranthe pardalis* and synonymized *M. cupriphilus* Macnair with it. Fraga (2018), Rabeler et al. (2019), and Nesom and Fraga (2019) accepted *Erythranthe* as a genus distinct from *Mimulus* and recognized *E. pardalis* as a distinct species.

Both *Erythranthe serpentinicola* and *E. pardalis* are slender annuals with relatively small flowers. Calyces of both species are often dotted with dark red spots, and both have an indument of delicate gland-tipped trichomes. Both occur primarily on serpentine soils, though *E. pardalis* is also known from copper mine tailings, and one population in Tehama County was collected from a basaltic substrate. Leaves of *E. pardalis* are usually short-petioled more or less throughout, whereas distal leaves of *E. serpentinicola* are usually sessile, and the bract-like distalmost leaves may be connate. Herbage of *E. serpentinicola* is at least distally densely puberulent with fine, spreading glandless trichomes in addition to the gland-tipped trichomes. Pedicels of *E. pardalis* may elongate to as much as 60 mm in fruit whereas those of *E. serpentinicola* reach a maximum of 25 mm and often are shorter. Styles of *E. serpentinicola* are sparsely puberulent and are longer exserted than those of *E. pardalis*, and their corollas are longer, and further exserted beyond the calyx. The two species are strongly disjunct, with *E. pardalis* occurring in the Sierra Nevada foothills from Tehama Co. to Tuolumne Co. whereas *E. serpentinicola* is restricted to a small area of the southern South Coast Range in San Luis Obispo Co. Whether the similarities of *E. serpentinicola* and *E. pardalis* are a result of common ancestry or are independently derived has not been determined.

Several other species of *Erythranthe* occur on soils derived from serpentine parent materials. I have collected annual *E. microphylla* and perennials *E. grandis* and *E. guttata* from serpentine soils in the vicinity where *E. serpentinicola* occurs, but none of these is restricted to these soils. In addition to *E. pardalis* and *E. serpentinicola*, species of *Erythranthe* wholly or in part restricted to serpentine include annuals *E. glaucescens* (Greene) Nesom, *E. percaulis* Nesom, *E. trinitiensis* Nesom, and *E. nudata* (Curran ex Greene) Nesom, and perennials *E. linearifolia* (A.L. Grant) Nesom & Fraga, and *E. willisii* Nesom. At least some of these species have independently adapted to serpentine substrates, but perhaps some share a common adaptive history.

The partitioning of Phrymaceae that resulted in the segregation of *Erythranthe* as a genus separate from *Mimulus* remains controversial (Lowry et al. 2019; Nesom et al. 2019). Numerous biosystematic studies have been published for taxa treated as the *Mimulus guttatus* complex, and some authors continue to use the name *M. guttatus* with a traditional broad species concept (e.g., Popovic & Lowry 2020). On the other hand editors and authors of various floras have adopted the revised generic concepts for Phrymaceae (e.g., Fraga 2018; Rabeler et al. 2019; Nesom & Fraga 2019). Unfortunately epithets published in one genus (e.g., *Erythranthe*) do not automatically transfer to the other (*Mimulus*). This issue with the competing generic and species concepts sometimes deprives users of monkeyflower taxonomy the flexibility to adopt taxonomic circumscriptions without having to formally propose new combinations (e.g., Keil 2019). So in proposing *Erythranthe serpentinicola* as a species new to science I recognize that it may be overlooked or disregarded by those whose favored genus is *Mimulus* and whose concept of *Mimulus guttatus* is broad and inclusive.

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