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PEDICULARIS RIGGINSIAE (OROBANCHACEAE), A NEW SPECIES FROM AN AREA OF BOTANICAL ENDEMISM IN CENTRAL-COASTAL CALIFORNIA

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ABSTRACT

Pedicularis rigginsiae D.J. Keil (Orobanchaceae) is a described as a new species from the Arroyo de la Cruz area of northwestern San Luis Obispo Co., California, where it occurs with several other localized endemic taxa. It is distinguished from *P. densiflora* by its smaller stature and leaves, much smaller flowers, and pink rather than red or maroon corolla. It differs from *P. dudleyi*, with which it was initially confused, by its narrower leaves with more numerous lateral lobes, straight rather than distally bent galea, and shorter lower corolla lip. It grows in dwarfed maritime chaparral on windswept coastal terraces east of Highway 1.

The publication of *The Vascular Plants of San Luis Obispo County, California* (Hoover 1970) established a base line for botanical studies of the flora of this diverse county. In the intervening years additional taxa have been documented from the county, many representing extensions of the known ranges of native taxa, some regrettably the spread of invasive species, and a few the discovery of taxa new to science. Accompanying this have been revolutions in understanding of phylogenetic relationships, numerous reclassifications and name changes, and a proliferation of electronic resources. These new advances allow more efficient understanding of novel biodiversity. The need for an update of the county flora has long been evident, and I am nearing completion of a revised edition (Keil & Hoover, in prep.). One of the discoveries resulting from this research is the subject of this paper.

A population of a *Pedicularis* (then Scrophulariaceae, now Orobanchaceae), representing a species that had not been documented previously from San Luis Obispo County, was discovered during a series of field trips in the 1980s to the areas near Arroyo de la Cruz on the Hearst Ranch in the northwestern corner of the county. This area is well known for the presence of rare plants, including several endemics: e.g., *Arctostaphylos cruzensis* Roof, *Arctostaphylos hookeri* G. Don subsp. *hearstiorum* (Hoover & Roof) P. Wells, *Bloomeria humilis* Hoover, *Ceanothus maritimus* Hoover, and *C. hearstiorum* Hoover & Roof (Keil & McLeod 1987; Keil 1997). Hoover (1970) described the area as the "Cruzian pocket of endemism," a subset of his Lucian Endemism Area. Based on a 1981 determination by L.R. Heckard of a specimen of this *Pedicularis* (*Riggins 1208*, JEPS82365), Riggins (1983) reported the newly discovered *Pedicularis* as *P. dudleyi* Elmer, a species otherwise known from southern San Mateo County to northern Monterey County, with its southernmost population about 80 km to the northwest of the Arroyo de la Cruz site. Vorobik (1993, 2012), while treating the Arroyo de la Cruz plants under *P. dudleyi*, suggested that they warranted further study and noted differences from their northern relatives. After further investigation I have determined that the Arroyo de la Cruz plants are not *P. dudleyi* and describe them here as a new species, *Pedicularis rigginsiae*, Arroyo de la Cruz lousewort, thus recognizing yet another endemic from the Arroyo de la Cruz area.

PEDICULARIS RIGGINSIAE D.J. Keil, **sp. nov.** (Figs. 1–3). **TYPE: CALIFORNIA.** San Luis Obispo Co.: Mesa S of Arroyo de la Cruz, 1 mi. E of Highway 1, 11.6 mi. N of San Simeon; common where *Arctostaphylos hookeri* subsp. *hearstiorum* grows, ca. 100 m, [35.707°, −121.285°], 11 Apr 1981, *R. Riggins 1208* (holotype: OBI100071 (Fig. 2); isotypes, JEPS82365 + others to be distributed).

Plant 6–30 cm from a stout, sometimes branched root crown. Stems glabrous or short-villous with soft, multicellular hairs. Foliage leaves deep red to green, petioled, mostly basal, the largest, 8–14 cm, blade 1.5–4 cm wide, narrowly elliptic, pinnately divided into (14) 28–38 linear to triangular-ovate lobes, the larger lobes shallowly lobed and sharply dentate or doubly dentate, distalmost lobes reduced to teeth, petioles glabrous or sparsely villous, both blade faces glabrous. Inflorescence a spike, 2–10 cm; bracts reddish green, 9–15 (25) mm, proximally widest, pinnately lobed and sharply toothed, distally dentate or serrate. Calyx 6–9 mm, short-villous with soft multicellular hairs, minutely glandular-puberulent, lobes 5, ± equal; corolla 13–23 mm, club-like, glabrous, tube included in calyx, tube-galea transition indistinct, upper lip forming a hooded, straight galea, 11–13 mm, open in distal 6–9 mm, pink or distally rose-purple, lower corolla lip 2–3.5 mm, white, middle lobe narrower and slightly longer than laterals; anthers 1.7–2.2 mm, anther sac bases acute. Capsule 6–7 mm, ovoid; seeds 2–3 mm, surface netted. Chromosome number: $n = 8$.

Paratypes. San Luis Obispo Co.: Mesa S of Arroyo de la Cruz, 1 mi E of Hwy 1, 11.6 mi N of San Simeon, common where *Arctostaphylos hookeri* subsp. *hearstiorum* grows, ca. 100 m, [35.707°, −121.285°], 16 Mar 1980, *Riggins 1195* (JEPS82364); ca. 1 mi E of California Rte. 1 on Hearst Ranch, wind-swept coastal hills and canyon area, most shrubs on windward slopes severely wind-pruned forming prostrate mats or a dwarf shrubland, soil heavily compacted, recently moist, scattered among prostrate branches of *Arctostaphylos hearstiorum* on windswept hilltop, 18 May 1980, *Keil 14011* with McLeod, Luckow, Vanderwier, et al. (OBI100073); N of San Simeon in vicinity of Arroyo de la Cruz, along ridge system just S of the arroyo, windswept coastal hills with severely wind-pruned shrubs and trees, local in low-growing chaparral shrubs, galea pink, 30 Jan 1982, *Keil 15678* with Roberts and Raiche (OBI100072); between Cinnabar Hill and Oak Knoll, S of Arroyo de la Cruz, windswept patch of dwarf maritime chaparral, apparently hemiparasitic on *Adenostoma fasciculatum*, 11 Feb 2002, *Keil 29742* with Cox, Sage, and Sage (OBI100074); Santa Lucia Mountains, Arroyo de la Cruz, Cinnabar Hill, mixed chaparral, probably on *Adenostoma*, w/*Ceanothus hearstiorum, C. maritimus, Arctostaphylos cruzensis, A. hearstiorum, A. tomentosa*, 155 m, 35.7141°, −121.2797°, 16 Mar 1985, *Hrusa, Griffiths, & Ragan 3600* (CDA20789).

During the study of this species, several specimens of *Pedicularis rigginsiae* were sent to a collaborator who failed to return all of the loaned specimens. At this point these specimens are considered to be missing. These included a specimen I had originally annotated as the holotype of the new species (*Riggins 1208*, OBI80783) plus several annotated as paratypes (*Riggins 1195*, OBI80782; *Keil et al. 14011*, OBI75134; *Keil et al. 15678*, OBI32234; *Keil and Meridith 18124*, OBI45429). The specimen here designated as the holotype (*Riggins 1208*, OBI100071, Fig. 2) is a duplicate of the specimen I originally annotated as holotype; if the latter is rediscovered it must be considered an isotype. Three of these specimens (*Riggins 1195*, OBI80782; *Keil et al. 14011*, OBI75134; *Keil et al. 15678*, OBI32234) are duplicates of specimens cited above as paratypes, and if rediscovered they should be treated as paratypes as well. The last missing specimen, if rediscovered, should also be treated as a paratype: San Luis Obispo Co.: Ridge system S of Arroyo de la Cruz; windswept coastal hills; ridge tops and windward slopes with severely wind-dwarfed shrubs and trees; locally common in fringes of chaparral with chamise and dwarf manzanitas, 14 Apr 1984, *Keil 18124* with Meredith (OBI45429).

Figure 1. Inflorescence of *Pedicularis rigginsiae* (photograph by Rhonda Riggins).

Figure 2. Holotype of *Pedicularis rigginsiae* (*Riggins 1208*, OBI100071).

Figure 3. Habit of *Pedicularis rigginsiae*. Leaves of *Arctostaphylos hookeri* subsp. *hearstiorum*, the putative host, on right. Photo by Rhonda Riggins.

Figure 4. Habitat of *Pedicularis rigginsiae*. Coastal terrace grassland south of Arroyo de la Cruz with mounds of wind-pruned maritime chaparral and coastal live oak woodland in background. Large grass-like clumps are *Carex obispoensis*. Photo by David Keil.

Etymology and common name. The specific epithet honors Dr. Rhonda Riggins, Professor Emeritus at California Polytechnic State University, San Luis Obispo, and student of annual *Lupinus*, who first reported the Arroyo de la Cruz lousewort. I recommend "Arroyo de la Cruz lousewort" as the common name for *Pedicularis rigginsiae*.

Location and ecology. The Arroyo de la Cruz endemic area is in the northwestern part of San Luis Obispo County in the central-coastal part of California, situated between the shoreline and the Santa Lucia Range north of San Simeon. The part of the endemic area to the west of Highway 1 was transferred to state ownership in 2005, but the Hearst Corporation retained possession of the area east of the highway where *Pedicularis rigginsiae* grows. The Hearst Ranch portion of the endemic area is part of an active cattle ranch with a conservation easement in place. Public access is restricted by the Hearst Corporation. To date the only documented occurrences of *P. rigginsiae* are from an area directly to the south of Arroyo de la Cruz and about a mile east of Highway 1, but nearby areas of similar habitat have not been thoroughly explored.

Topography of the Arroyo de la Cruz endemic area is a stairstep-like series of Pleistocene coastal terraces. Flat-topped or gently sloping terrace surfaces have been dissected by coastal stream-courses, arroyos, and gullies. Soils on the terraces are clay-rich, at least in part derived from highly weathered ultramafic parent materials. Coarser substrates are exposed on steeper slopes and on eroded surfaces. Salt-bearing northwesterly coastal winds sweep across the terraces, and trees and shrubs in exposed areas are generally dwarfed and wind-pruned, sometimes to only a few cm above the ground. In a memorable scene from one of the windswept terraces, I observed flowers of *Calochortus albus* (fairy lantern) hanging above the prostrate canopy of a mature *Quercus agrifolia* (coast live oak)! Grasslands occupy much of the exposed terraces, with a diversity of annual and perennial wildflowers growing among native and Mediterranean grasses. Although some terrace areas were cultivated fields in the past and consequently have a high proportion of introduced species, large areas have never been plowed and support a rich native flora. Interfingering with the grasslands are areas of dwarfed maritime chaparral (Fig. 4) that include endemic or near-endemic shrubs such as *Arctostaphylos cruzensis*, *A. hookeri* subsp. *hearstiorum*, *Ceanothus maritimus*, and *C. hearstiorum*, and more widespread taxa such as *Arctostaphylos tomentosa* subsp. *tomentosa* and *Adenostoma fasciculatum*. *Ceanothus maritimus* extends into the grasslands in places as a prostrate shrubby understory beneath the grasses. It is within the dwarf chaparral and its ecotone with grasslands that *Pedicularis rigginsiae* occurs. I suspect, based on observed associations, that *P. rigginsiae* establishes root connections with both *Arctostaphylos hookeri* subsp. *hearstiorum* and *Adenostoma fasciculatum*, but attachments to the putative hosts have not been documented.

Relationships. Two other species of *Pedicularis* occur in California's South Coast Ranges: *P. dudleyi* and *P. densiflora* Hook. Phylogenetic analyses by Robart et al. (2015) indicate that *P. dudleyi* and *P. densiflora* are closely related, and the two appear as sister taxa in their phylogenies.

Monfils and Prather (2007) distinguished *Pedicularis aurantiaca* (E.F. Sprague) Monfils & Prather as a close relative of *P. densiflora* that occurs in the Sierra Nevada, Cascade, and eastern Klamath Ranges, but not in the western Klamath and Coast Ranges where *P. densiflora* grows. Robart et al. (2015) did not include *P. aurantiaca* in their analyses; their DNA source for *P. densiflora* was a specimen collected in Marin County in the North Coast Range. Vorobik (2012) did not treat *P. aurantiaca* in her Jepson Manual treatment of *Pedicularis*, but synonymized its basionym, *P. densiflora* subsp. *aurantiaca* E.F. Sprague in the 1993 edition of the manual.

Chuang and Heckard (1992) indicate that most *Pedicularis* species are diploids with $n = 8$. Keil in Riggins (1983) reported a chromosome count of $n = 8$ for *P. rigginsiae* [as *P. dudleyi*]. Spellenberg (1971), Carr (1972), and Chuang and Heckard (1992) reported counts of $n = 8$ for *P. densiflora* from Trinity, Napa, and Marin counties, respectively. Chuang and Heckard's chromosome voucher is a duplicate of the specimen from which Robart et al. (2015) obtained their DNA sample for *P. densiflora*. Carr (1972) reported a count of $n = 8$ for a San Mateo County population of *P. dudleyi*. No counts have been reported for *P. aurantiaca*.

Table 1. Comparison of features of *Pedicularis* species in California's South Coast Range.

	Pedicularis rigginsiae	***Pedicularis dudleyi***	***Pedicularis densiflora***
Stature	6–30 cm	10–20 cm	6–55 cm
Vestiture	Stems glabrous or villous; leaves glabrous; bracts glabrous; calyx minutely villous	Stems villous; leaves glabrous or villous on one or both faces; bracts abaxially villous; calyx villous	Stems glabrous to densely villous; leaves abaxially glabrous, puberulent, or villous, adaxially glabrous; bracts glabrous or margins and abaxial face villous; calyx glabrous or villous
Length of largest leaf	8–14 cm	15–25 cm	10–30 cm
Width of largest leaf blade	1.5–4 cm	4–6 cm	4–8(15) cm
Number of lateral lobes of largest leaves (distalmost reduced to teeth)	(14) 28–38	12–24	20–36
Inflorescence length	2–10 cm	2–5 cm	4–20+ cm
Bract characteristics	9–15 mm, proximally widest, pinnately lobed and sharply toothed, distally dentate or serrate	12–27 mm, proximally narrowed to a sometimes petiole-like base, distally sharply serrate	(10) 20–50 mm, proximally narrowed to petiole or ± entire, petiole-like base, distally ± expanded, sharply toothed or lobed; proximal-most flowers sometimes in axils of unmodified distal foliage leaves
Calyx length	6–9 mm	10–11 mm	8–15 mm
Corolla color	white to pink, sometimes aging rose-purple	pink	red or maroon (yellow or purple)
Corolla length	13–23 mm	17–18 mm	23–36 mm
Galea	8–13 mm, straight	10–11 mm, distally down-curved	8–17 mm, straight
Lower corolla lip	2–3.5 mm	6 mm	8–12 mm
Capsule length	6–7 mm	± 12 mm	8–13 mm
Seed length	2–3 mm	not available	2.5–4.5 mm

Pedicularis rigginsiae is easily distinguishable from *P. dudleyi* and *P. densiflora* by the characteristics delineated in Table 1. Monfils and Prather (2007) made a detailed comparison of *P. aurantiaca* and *P. densiflora* and illustrated characteristics of the two taxa. The four species may be separated using the following key.

1. Corolla 13–23 mm, white to pink (sometimes aging rose-purple).

   2. Leaves 1.5–4 cm wide; galea straight; lower corolla lip 2–3 mm, lobes unequal, the lateral rounded ..... **Pedicularis rigginsiae**
   2. Leaves 4–6 cm wide; galea distally down-curved; lower corolla lip ± 6 mm, lobes ± equal, all acute ..... **Pedicularis dudleyi**

1. Corolla 23–43 mm, usually red or maroon (yellow, orange, or purple).

   3. Calyx 12–24 mm; lower corolla lip < 8 mm; galea opening > 4/5 its length; corolla tube included within calyx lobes at time of flowering ..... **Pedicularis aurantiaca**
   3. Calyx 10–18 mm; lower corolla lip ≥ 8 mm; galea opening < 4/5 its length; corolla tube exserted beyond calyx lobes at time of flowering ..... **Pedicularis densiflora**

Rarity Status. I recommend to the California Native Plant Society that *Pedicularis rigginsiae* be included in the *Inventory of Rare and Endangered Plants of California* with a California Rare Plant Rank of 1B.1—Rare and Endangered in California and Elsewhere. Although the area of the Hearst Ranch where *P. rigginsiae* occurs is under a conservation easement and the ranch has been conservatively managed, the facts that the site is part of an active cattle ranch and that the species has just one known occurrence justify a Threat Rank of 0.1—Seriously threatened in California (over 80% of occurrences threatened/high degree and immediacy of threat). When evaluated using IUCN (2000) Red List criteria, *P. rigginsiae* qualifies as Endangered (EN) – High risk of extinction in the wild, based on extent of occurrence estimated to be less than ~100 km². The recognition of the Arroyo de la Cruz lousewort as a distinct species decreases the known range of *P. dudleyi*. *Pedicularis dudleyi* has a California Rare Plant Rank of 1B.2 (CNPS Rare Plant Program 2015), and I recommend that it retain that status.

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