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TOMUS NOMINUM ERIASTRI: THE NOMENCLATURE AND TAXONOMY OF *ERIASTRUM* (POLEMONIACEAE: LOESELIEAE)

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ABSTRACT

A revised taxonomy for the genus *Eriastrum* is presented, including type information, synonymy, descriptions, and keys for identification. The nomenclature of *Hugelia lanata*, *Gilia floccosa*, and *Gilia virgata* var. *yageri* is clarified. Additionally, issues pertaining to August Brand's, Thomas Nuttall's, and Asa Gray's names in *Eriastrum* are reviewed. An illustrated glossary of important descriptive terms is provided, along with photographs and illustrations of taxa and features. Lectotypes are proposed for 14 taxa. There is further discussion about the nomenclature and type localities for each taxon, comparison of circumscriptions from previous authors, and some field observations. Discussion of identifying characteristics, geographic range, habitat, demographics, threats, conservation, and etymology is included for each taxon. A listing of unpublished herbarium names is also supplied, with the corresponding currently accepted names. One new combination, *Eriastrum densifolium* subsp. ***patens***, is presented. Five new subspecies, *Eriastrum diffusum* subsp. ***coachellae***, *Eriastrum diffusum* subsp. ***utahense***, *Eriastrum eremicum* subsp. ***markianum***, *Eriastrum pluriflorum* subsp. ***albifaux***, and *Eriastrum sapphirinum* subsp. ***brevibracteatum***, and one new species, *Eriastrum* ***calocyanum***, are described and illustrated. As treated here, *Eriastrum* includes 18 species and 14 subspecies, for a total of 32 taxa.

Key words: August Brand, conservation, *Hugelia*, identification, lectotype, Thomas Nuttall, *Welwitschia*.

INTRODUCTION

> "*Eriastrum* is fraught with many vexatious problems that are reflected unhappily in its tangled nomenclature" (Mason 1945: 66).

For many botanists, *Eriastrum* Wooton and Standley (1913) is a challenging group for species and subspecies identification. This is not a new problem. Even the distinguished botanist Asa Gray lamented, "This [*E. filifolium*] and the preceding [*Gilia floccosa*] probably run together, and all these annual species are hard to distinguish" (Gray 1876*b*: 495), and "Forms of this [*E. diffusum*] approach the preceding [*G. floccosa*] too nearly" (Gray 1870: 272). J. Francis Macbride wrote of "…a number of variable and perplexing forms" from the vicinity of San Diego (Macbride 1917: 51).

A number of taxonomists attempted to make some sense of the group, with varying degrees of success (Gray 1870; Milliken 1904; Brand 1907; Macbride 1917; Craig 1934*b*; Jepson 1943; Mason 1945; Harrison 1972; Table 1). Because each taxonomist classified the species and subspecies in slightly different ways, many taxa now have many synonyms, and have at some point in time been classified within many different species, or even within other genera. Some taxa also have changed rank a number of times, being treated as species, subspecies, or varieties by different authors.

Beyond the tangled nomenclature, there are a few more factors that make identifications difficult. *Eriastrum* appears to have undergone a very recent and rapid radiation. The genus diverged from *Langloisia* and *Loeseliastrum* probably 27–35 million years ago, while most species of *Eriastrum* arose in the last 14 million years (estimated from Porter et al. 2010). Some groups appear to be much younger, displaying great morphological variation but little molecular variation (S. De Groot, unpubl. data). Presumably some amount of this morphological variation is due to local adaptations, and therefore morphologies may be convergent if habitats are similar, even though the taxa may not be closely related. A few putative hybrids have been documented, but it is not clear how often hybridization has occurred. There are also a few taxa that do not fit into any described species or subspecies, and need to be described.

Species of *Eriastrum* are annual or perennial, and occupy open, dry, and usually sandy habitats throughout western North America (Fig. 1). Although the group is still imperfectly known, it is important to have a useful taxonomic framework for further investigation. In order to create such a framework, it is necessary to (1) clarify the nomenclature and ensure that every taxon is properly typified; (2) clarify the circumscription of each taxon, ensuring that each has a full description; (3) publish new names for several taxa that heretofore have been treated within other species or subspecies, but are actually quite distinct; and (4) provide updated keys to the species and subspecies that properly reflect the circumscriptions presented here.

A Brief History of the Taxonomy of Eriastrum

The first four species of *Eriastrum* were described in 1833 by George Bentham within a new genus, *Hugelia*, based on collections that David Douglas had made in California in 1831 or 1832. Within a few years, all the species of *Hugelia* (*Eriastrum*) were transferred into a broadly circumscribed and morphologically variable genus *Gilia* (Bentham 1845). Except for Nuttall's *Hugelia filifolia* (1848*a*, *b*), species of *Eriastrum*

Table 1. Comparison of synonyms and circumscriptions across various revisions (– not treated).

This revision	Harrison 1972	Mason 1945	Jepson 1943
E. abramsii	*E. abramsii*	*E. abramsii*	*H. abramsii*
E. calocyanum	*E. wilcoxii*	*E. wilcoxii*	*H. filifolia* var. *floccosa*
E. densifolium subsp. *densifolium*	*E. densifolium* subsp. *densifolium*	*E. densifolium* [subsp. *densifolium*]	*H. densifolia*
E. densifolium subsp. *austromontanum*	*E. densifolium* subsp. *austromontanum*	*E. densifolium* subsp. *austromontanum*	*H. densifolia* var. *austromontana*
E. densifolium subsp. *elongatum*	*E. densifolium* subsp. *elongatum*	*E. densifolium* subsp. *elongatum*	*H. densifolia*
E. densifolium subsp. *mohavense*	*E. densifolium* subsp. *mohavensis*	*E. densifolium* subsp. *mohavense*	*H. densifolia* var. *mohavense*
E. densifolium subsp. **patens**	–	–	–
E. densifolium subsp. *sanctorum*	*E. densifolium* subsp. *sanctorum*	*E. densifolium* subsp. *sanctorum*	*H. densifolia* var. *sanctarum*
E. diffusum subsp. *diffusum*	*E. diffusum*	*E. diffusum* [subsp. *diffusum*]	*H. diffusa*
E. diffusum subsp. *diffusum*	*E. diffusum*	*E. diffusum* subsp. *jonesii*	– (out of state)
E. diffusum subsp. **coachellae**	*E. diffusum*	*E. diffusum*	*H. diffusa*
E. diffusum subsp. **utahense**	*E. diffusum*	*E. diffusum*	– (out of state)
E. eremicum subsp. *eremicum*	*E. eremicum* subsp. *eremicum*	*E. eremicum* subsp. *eremicum*	*H. eremica*
E. eremicum subsp. **markianum**	*E. eremicum* subsp. *eremicum*	–	– (out of state)
E. eremicum subsp. *yageri*	*E. eremicum* subsp. *yageri*	*E. eremicum* subsp. *yageri*	– (out of state)
E. eremicum subsp. *yageri*	*E. eremicum* subsp. *yageri*	*E. eremicum* subsp. *yageri*	– (out of state)
E. eremicum subsp. *zionis*	*E. eremicum* subsp. *eremicum*	*E. eremicum* subsp. *eremicum*	– (out of state)
E. ertterae	–	–	–
E. filifolium	*E. filifolium*	*E. filifolium*	*H. filifolia*
E. harwoodii	*E. sparsiflorum* subsp. *harwoodii*	*E. diffusum* subsp. *harwoodii*	*H. diffusa* var. *hardwoodii*
E. hooveri	*E. hooveri*	*E. hooveri*	*H. hooveri*
E. luteum	*E. luteum*	*E. luteum*	*H. lutea*
E. pluriflorum subsp. *pluriflorum*	*E. pluriflorum* subsp. *pluriflorum*	*E. pluriflorum* [subsp. *pluriflorum*]	*H. pluriflora*
E. pluriflorum subsp. *sherman-hoytae*	*E. pluriflorum* subsp. *sherman-hoytae*	*E. pluriflorum* subsp. *sherman-hoytae*	*H. pluriflora*
E. pluriflorum subsp. **albifaux**	*E. pluriflorum* subsp. *sherman-hoytae*	*E. pluriflorum* subsp. *sherman-hoytae*	*H. pluriflora*
E. rosamondense	–	–	–
E. sapphirinum subsp. *sapphirinum*	*E. sapphirinum* subsp. *sapphirinum*	*E. sapphirinum* subsp. *sapphirinum*	*H. virgata* var. *sapphirina*
E. sapphirinum subsp. **brevibracteatum**	*E. sapphirinum* subsp. *sapphirinum*	*E. sapphirinum* subsp. *ambiguum*	*H. virgata* var. *ambigua*
E. sapphirinum subsp. *dasyanthum*	*E. sapphirinum* subsp. *dasyanthum*	*E. sapphirinum* subsp. *dasyanthum*	*H. virgata* var. *dasyantha*
E. sapphirinum subsp. *sapphirinum*	*E. sapphirinum* subsp. *sapphirinum*	*E. sapphirinum* subsp. *gymnocephalum*	*H. virgata* var. *dasyantha*
E. signatum	*E. sparsiflorum* subsp. *sparsiflorum*	*E. sparsiflorum* subsp. *sparsiflorum*	*H. filifolia*
E. sparsiflorum	*E. sparsiflorum* subsp. *sparsiflorum*	*E. sparsiflorum*	*H. filifolia*
E. tracyi	*E. tracyi*	*E. tracyi*	–
E. tracyi	*E. brandegeae*	*E. brandegeae*	–
E. virgatum	*E. virgatum*	*E. virgatum*	*H. virgata*
E. wilcoxii	*E. wilcoxii*	*E. wilcoxii*	*H. filifolia* var. *floccosa*

Table 1. Extended.

Craig 1934*b*	Macbride 1917	Brand 1907	Milliken 1904	Gray 1870	Bentham 1833
–	–	*N. abramsii*	–	–	–
–	–	–	–	–	–
G. densifolia var. *typica*	*G. densifolia*	*N. densifolia*	*G. densifolia*	*G. densifolia*	*H. densifolia*
G. densifolia var. *austromontana*	–	–	–	–	–
G. densifolia var. *elongata*	*G. densifolia* var. *elongata*	*N. densifolia* subsp. *elongata*	*G. densifolia*	*G. densifolia*	*H. elongata*
G. densifolia var. *mohavensis*	–	–	(*G. densifolia*)	–	–
–	–	–	–	–	
G. densifolia var. *sanctorum*	*G. densifolia* var. *elongata*	*N. densifolia*	*G. densifolia* var. *sanctora*	–	–
G. filifolia var. *diffusa*	*G. filifolia* var. *diffusa*	*N. filifolia* subsp. *eu-filifolia* var. *diffusa*	*G. virgata* var. *filifolia*	*G. filifolia* var. *diffusa*	–
Type: *G. eremica* var. *yageri*	–	–	–	–	–
G. filifolia var. *diffusa*	*G. filifolia* var. *diffusa*	*N. filifolia* subsp. *eu-filifolia* var. *diffusa*	*G. virgata* var. *filifolia*	*G. filifolia* var. *diffusa*	
G. filifolia var. *diffusa*	*G. filifolia* var. *diffusa*	*N. filifolia* subsp. *eu-filifolia* var. *diffusa*	*G. virgata* var. *filifolia*	*G. filifolia* var. *diffusa*	
G. eremica var. *typica*	–	–	–	Probably *G. floccosa*	–
G. virgata var. *sapphirina*	–	–	–	–	–
G. eremica var. *arizonica*	–	–	–	Probably *G. floccosa*	–
Text: *G. eremica* var. *yageri*	*G. virgata* var. *floccosa*	–	–	–	–
G. eremica var. *zionis*	–	–	–	–	–
–	–	–	–	–	–
G. filifolia [var. *typica*]	*G. filifolia*	*N. filifolia* subsp. *eu-filifolia*	*G. virgata* var. *filifolia*	*G. filifolia*	–
G. filifolia var. *harwoodii*	–	–	–	–	–
–	–	–	–	–	–
G. lutescens	*G. lutescens*	*N. lutea*	*G. lutescens*	*G. floccosa*	*H. lutea*
G. pluriflora	*G. pluriflora*	*N. virgata* subsp. *floccosa* var. *floribunda*	*G. virgata* var. *floribunda*	*G. virgata* var. *floribunda*	–
G. sherman-hoytae	–	–	–	–	–
G. sherman-hoytae	–	–	–	–	–
–	–	–	–	–	–
G. virgata var. *sapphirina*	*G. virgata* var. *sapphirina*	*N. virgata* subsp. *gymnocephala* var. *sapphirina*	*G. virgata*	Probably *G. floccosa*	–
G. virgata var. *ambigua*	*G. virgata* var. *floccosa*	–	–	–	–
G. virgata var. *dasyantha*	*G. virgata* var. *floccosa*	*N. virgata* subsp. *gymnocephala* var. *dasyantha*	*G. virgata*	–	–
G. virgata var. *sapphirina*	Not recognized (unclear name)	*N. virgata* subsp. *gymnocephala* [var. *oligantha*]	–	–	–
G. filifolia var. *sparsiflorum*	–	–	–	–	–
G. filifolia var. *sparsiflorum*	*G. filifolia* var. *sparsiflora*	*N. filifolia* subsp. *sparsiflora*	*G. sparsiflora*	–	–
–	–	–	–	–	–
–	–	–	–	–	–
G. virgata var. *typica*	*G. virgata*	*N. densifolia* var. *lanata*	*G. virgata*	*G. virgata*	*H. virgata*
G. wilcoxii	*G. filifolia*	*N. wilcoxii*	*G. virgata* var. *floccosa*	*G. floccosa*	–

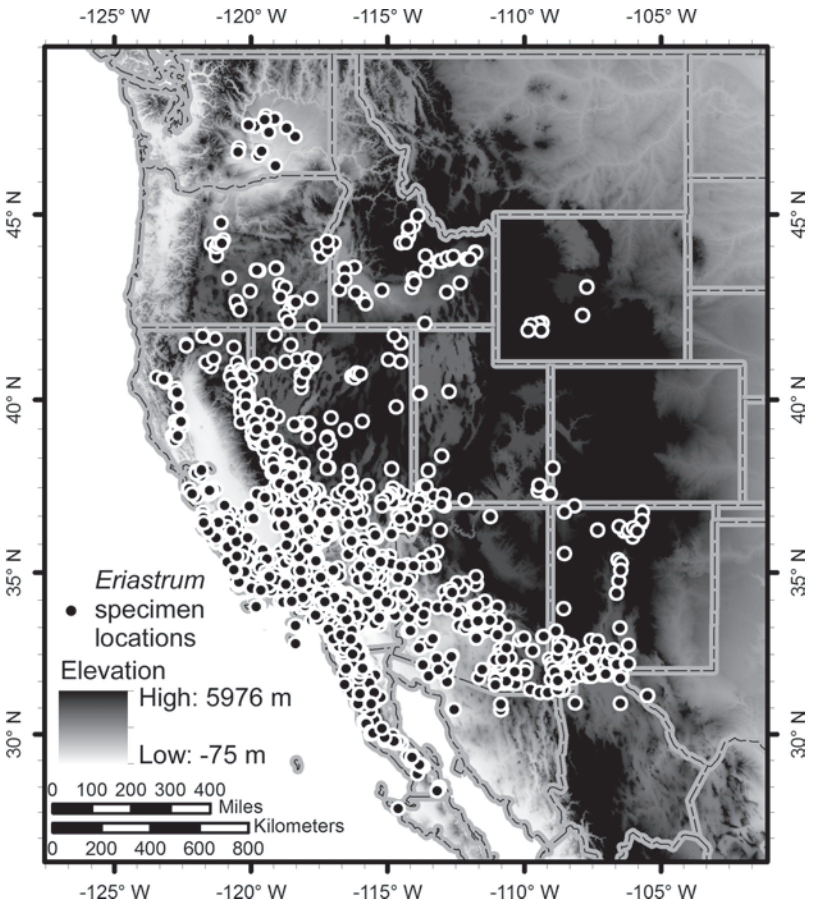


Fig. 1. Map showing specimen locations for all species of *Eriastrum*, approximating the range of the genus. Dashed black and gray lines mark state boundaries. Elevation in meters is indicated.

continued to be recognized within *Gilia* (e.g., Gray 1870; Milliken 1904) until Brand moved all of the then-recognized taxa to *Navarretia* (Brand 1907). This move was not universally accepted (e.g., Macbride 1917), although a few taxa first described by Brand are still recognized (e.g., *E. sapphirinum* subsp. *dasyanthum* (Brand) H. Mason).

By the early 1900s, more taxonomists were concerned with the proper application of names, and in 1905 the first international rules concerning the naming of plants were adopted (Vienna Rules; McNeill et al. 2006). The earliest rules concerning names included the principle of priority, or, that the earliest valid name for a taxon is the name that should be used (see Briquet 1912: 34). Because *Hugelia* Bentham (1833) has an earlier homonym (*Hugelia* Reichenbach 1830), it is illegitimate and therefore not correct to use at the rank of genus. The earliest legitimate name for the genus was *Welwitschia* Reichenbach (1837), but this was unavailable because *Welwitschia* Hooker f. (1862) was conserved for the African Gnetalean taxon (Briquet 1912: 78; Sprague 1921). With no legitimate genus name under which to treat the group, separate from *Gilia*, Wooton and Standley erected the new genus *Eriastrum* in 1913.

In 1934, Thomas T. Craig, an artist and student of Philip Munz at Pomona College, wrote a taxonomic revision of the group for a senior thesis, treating it as *Gilia* subgenus *Hugelia* (Craig 1934*a*). His revision was based on a large number of herbarium specimens, including many of his own collections, and he described several new taxa in addition to clarifying the application of existing names (Craig 1934*b*). Mason wrote that "…we owe the first real characterization and organization of the problems of the genus to him" (Mason 1945: 70).

While Craig's (1934*a*, *b*) species-level taxonomy was of good quality, botanists increasingly believed that the group should be recognized separate from the genus *Gilia*. In his *Flora of California*, Jepson (1943) treated the group separate from *Gilia*, under the illegitimate name, *Hugelia*, which he expected to be conserved (Jepson 1943: 160–161). However, it never was.

Mason (1945) was the first to treat the entire group in Wooton and Standley's new genus, *Eriastrum*, the only legitimate generic name for the group. While Mason's classification was based on Craig's, he elevated a few of Craig's varieties to full species, changed the positions of some subspecies (moved from one species to another), and described several new species. Harrison's (1972) revision was almost identical to Mason's (1945), except that a few of Mason's subspecies were not recognized.

The present work builds primarily on Craig (1934*b*), Mason (1945), and Harrison (1972), but incorporates some more recent taxonomic changes (Hoover 1970; Gowen 2008; Gowen 2013), knowledge of the phylogeny and relationships within Polemoniaceae (Porter and Johnson 2000;

Johnson et al. 2008; Porter et al. 2010; S. De Groot, unpubl. data), and new morphological and geographic data about each taxon.

Nomenclatural Notes

With his description of *Hugelia*, Bentham (1833) included the species *H. densifolia*, *H. elongata*, *H. lutea*, and *H. virgata*. Since each of the four species described under *Hugelia* Bentham has a description, and the genus *Hugelia* Bentham has a description, they are all valid names (McNeill et al. 2012, Art. 32, 35). However, *Hugelia* Bentham is a later homonym, the name having been used before (*Hugelia* Reichenbach 1830, Araliaceae), and it is therefore illegitimate (McNeill et al. 2012, Art. 11, 33, 53). But species published under an illegitimate generic name may still be legitimate (McNeill et al. 2012, Art. 55). Because these four species are valid, have no earlier homonyms at the species rank, and are described under a valid genus, they are legitimate, although they cannot be recognized in the illegitimate genus *Hugelia* Bentham and instead should be recognized in the legitimate genus *Eriastrum* Wooton and Standley (1913).

Another homonym, *Hugelia* R. Brown (Rutaceae), was first named by Endlicher (1840: 1156), based on the previously published description of R. Brown (Brown 1814: 546; see also McNeill et al. 2012, Art. 46 Note 2). Because the name as published by Endlicher (1840) includes both a name and a description, and a reference to a previously published description, it is valid (McNeill et al. 2012, Art. 32). However, the date of *Hugelia* R. Brown would be the date of its valid publication, 1840 (McNeill et al. 2012, Art. 33), making it a later homonym of *Hugelia* Reichenbach (1830) and *Hugelia* Bentham (1833), and therefore illegitimate.

Species of *Eriastrum* have been treated under five different genera: *Hugelia* Bentham (Bentham 1833; Jepson 1943); *Gilia* Ruiz & Pavon (Ruiz and Pavon 1794; Bentham 1845; Gray 1870; Craig 1934*b*); *Navarretia* Ruiz & Pavon (Ruiz and Pavon 1794; Elmer 1906; Brand 1907); *Eriastrum* Wooton & Standley (Wooton and Standley 1913; Mason 1945); and *Welwitschia* Reichenbach (Reichenbach 1837; Rydberg 1917). Many combinations have been made to transfer species between each of these genera, but not *all* combinations have been made (e.g., *Gilia floccosa* has never been treated in *Eriastrum*, so the combination *Eriastrum floccosum* has never been published). In most cases, the circumscription of a taxon more or less follows the specific or infraspecific epithet, regardless of the genus or species in which it was treated. I have endeavored to make synonym lists as complete as possible, but some obscure references may have been missed.

Old names do not necessarily have designated type specimens. In some cases, no specimens were cited; in many cases, no institution was designated. Where a specimen was cited but no institution was specified, I have followed McNeill (2014) and designated a lectotype, usually the specimen at the author's institution or herbarium which could be the holotype. New lectotypes were also verified with the original descriptions and compared with isotype specimens. When no specimens or multiple specimens were cited, I have designated lectotypes where necessary.

Isotype lists are not necessarily complete. While I have attempted to discover all or most of the existing isotypes, it is possible that additional duplicates exist in herbaria that are not mentioned herein. For example, there is a report of Douglas collections in Leningrad/St. Petersburg, and although no specimens of *Eriastrum* were included in the subsequent enumeration (Howell 1937–1939; Harvey 1947) it is possible that additional duplicates exist there or elsewhere.

In many cases, handwriting on specimens is very important. The owner of the handwriting was determined by reference to handwriting samples that include the name or initials of the owner (mostly on herbarium labels or sheets), the handwriting samples at BM, and by reference to the samples in Smith (1954–1956) and Burdet (1975, 1977).

Some Persistent Nomenclatural Issues

1. Hugelia lanata.—The name *Hugelia lanata* Lindley (1848) has been a mystery almost since the time it was published. In 1870, only 22 years after it was published, Asa Gray wrote that it was "said to come from Mexico, of which I know only the character, is probably a form of *G.* [Gilia] *virgata* or of *G. filifolia*" (Gray 1870: 273). Brand (1907) placed it in synonymy under *Navarretia virgata* (Benth.) Brand subsp. *floccosa* (A. Gray) Brand var. *floribunda* (A. Gray) Brand, but with a question mark (incidentally, Brand's *N. densifolia* subsp. *elongata* (Benth.) Brand var. *lanata* is nomenclaturally unrelated to *H. lanata*, being described as a new variety by Brand and not based on any previously published taxon [Brand 1907: 165]). Macbride (1917) cited *H. lanata* as a synonym of *Gilia virgata* (Benth.) Steud. var. *floccosa* (A. Gray) Milliken, but again with a question mark. Thomas Craig left *H. lanata* by itself under "Species incertae et inquirendae," remarking "Because the type is not available, because the description might refer to any of several forms, and because the type locality "America meridionali (Mexico)" is so indefinite; I am unable to definitely refer this name to any form" (Craig 1934*b*: 428). Herbert Mason observed "This is a doubtful species. It is not clear from the literature why no one has been able to ascertain its identity, but since the time of Bentham, *H. lanata* has been questioned by all who have mentioned it" (1945: 76). He went on to speculate that it might refer to either *Eriastrum eremicum* or *E. pluriflorum*, as some characters in the description seem to point to *E. eremicum* while other characters point to *E. pluriflorum*.

Most of the confusion surrounding the name *Hugelia lanata* seems to stem from the fact that no one has ever cited any specimens in conjunction with the name. No type specimen has ever been found, and there is no indication that a type specimen even exists. Neither was a collector cited. Moreover, the description given in the original publication is fairly general, so that it could apply to several different taxa (Mason 1945). The location "America meridionali (Mexico)," given in a later publication by a different author (Walpers 1849), is not specific and can hardly be applied to a specimen. Could it be possible to ascertain the identity of this taxon, so long after it was published?

Original protologue.—

> 3. Hugelia lanata.* An annual about nine inches high, quite white with the short wool that covers every part, except the

> corolla and organs within it. The leaves are linear, with a somewhat spiny point, and one to three short segments on each side; they are about two inches long, and have none of the greenness of H. elongata. The flowers are a clear light blue, and are placed in close heads, arranged in a corymbose manner. Beyond their throat project five long linear arrow-headed white anthers.
>
> It is not a striking plant, but may be found useful as a novelty among hardy annuals.
>
> *Aug.* 30, 1847
>
> **H. lanata*; undique densè albolanata, foliis parcè pinnatifidis linearibus subpungentibus laciniis brevibus nunc ferè obsoletis, capitulis breviter pedunculatis subcorymbosis, bracteis paucis brevibus linearibus recurvis subpungentibus, calyce lanuginoso cylindraceo laciniis brevibus erectis integerrimus inaequalibus tubo corollae multo brevioribus, staminibus exsertis antheris altè sagittatis, ovulis 6–8.—J. L. [*H. lanata*; everywhere densely white-woolly; with linear, somewhat sharp-pointed leaves, moderately pinnately cleft with segments so short almost scarcely apparent; with short pedunculate subcorymbose heads; with few short linear recurved somewhat sharp-pointed bracts; calyx woolly cylindric with short erect entire unequal segments, much shorter than the tube of the corolla; stamens exserted with anthers deeply sagittate; with 6–8 ovules.] (Lindley 1848: 74; English translation of Latin by author).

Background.—John Lindley, who described *H. lanata*, became Assistant Secretary of the Horticultural Society of London in 1826 (now the Royal Horticultural Society; Gardener 1965: 457; Stearn 1999). Through the 1820s and 1840s, the Horticultural Society was very active. Eminent botanist George Bentham served as secretary to the Horticultural Society from 1830 to 1841 (Anonymous 1885: 92–93), and other famous names associated with the Society include Joseph Sabine and Thomas Andrew Knight (see Fletcher 1969). William Jackson Hooker, who became director of Kew Gardens in 1840, was a good friend of Lindley (Gardener 1965: 457). Collectors hired by the Society traveled abroad to places such as China, India, Brazil, Mexico, and western North America. These collectors returned plants in the form of dried specimens, seeds, rootstocks, bulbs, or occasionally whole plants. While the dried specimens were described in works such as Hooker's *Flora Boreali-Americana* (1838) or Bentham's *Plantae Hartwegianae* (1839–1857), the seeds and other propagative material were planted in the garden of the Horticultural Society at Chiswick, and a number of new plants were described from the results—see, for example, the series of articles "New Plants, etc., from the Society's Garden" in the *Journal of the Horticultural Society of London*, vol. 1–4, 1846–1849.

Hugelia lanata was described along with several other plants in one of these "New Plants, etc., from the Society's Garden" articles (Lindley 1848: 74). Many of these articles contain information about who collected the original material, where, and when it was received at the Society's garden, but not every one (such as *H. lanata*). Most of the new names were published within about three years of the material being received, and many were published about two years after the material was received. This strongly suggests that *H. lanata* was based on material that was grown in the garden, and also that the original material was collected two or three years earlier by someone in regular communication with the Horticultural Society—a hired collector, or another botanist who knew about the Society and sent propagative material. According to Hereman (1868), *Hugelia lanata* was introduced into Britain in 1846. Loudon (1880) listed *H. lanata* as introduced in 1847.

Therefore, the likely collector probably would have been a British botanist, connected to the Horticultural Society of London, and collecting in California or western North America around 1845–1847.

Possible collectors.—There were many collectors in Western North America prior to 1850 (see McKelvey 1956; Brewer 1880). Many made collections long before *Hugelia* Benth. was described and therefore seem unlikely collectors of *H. lanata*. Additionally, material from many of the earlier collectors was sent to other experts in Europe or the United States, and there are no (or very few) specimens in British herbaria (e.g., Collignon, Haenke, Née, Moçiño, Langsdorff, Chamisso, Eschscholtz, Wrangel, Deppe, Botta, Wosnessensky, Duflot de Mofras, Brackenridge and Pickering, Gambel, Frémont, Bestor, Fitch). It seems quite unlikely that Lindley would have obtained propagative material from any of these sources, and many of these collectors only made dried specimens.

Of the collectors whose material returned to Britain, a number collected well before 1846, or did not collect any *Eriastrum*: these include Archibald Menzies (1792–1794, Brewer 1880; McKelvey 1956), Alexander Collie and George Tradescant Lay (HMS *Blossom*, 1827; McKelvey 1956; Hooker and Arnott 1841), and botanists on the HMS *Sulphur* (Hinds and Bentham 1844).

Thomas Nuttall collected in California in 1836, although it seems that he did not collect propagative material. His specimens went generally to PH, which was his base of operations in the U.S. There are also a few specimens at GH, and Nuttall's personal herbarium went to BM after Nuttall's death in 1859 (Pennell 1936). Therefore, it is unlikely that Lindley would have seen Nuttall's herbarium prior to 1859.

Thomas Coulter collected in California from November 1831 to 1833 or 1834, mostly around Monterey, but he also made a trip down the coast to San Luis Rey and from there crossed over to the area of Yuma, Arizona, returning by the same route (Coville 1895; McKelvey 1956). Although no comprehensive list of his collections appears to exist, his herbarium was retained by Trinity College, Dublin (TCD), with duplicates sent to Kew (K), Asa Gray (GH), and John Torrey (NY; Coville 1895). A search through specimens at K and GH showed that Coulter collected *E. densifolium* subsp. *elongatum* (453 and s.n., K! (2), GH!, TCD!), *E. sapphirinum* (452, labeled *Hugelia virgata*, K! [cf. subsp. *dasyanthum*], GH! [cf. subsp. *sapphirinum*]), and *E. eremicum* subsp. *eremicum* (452, labeled *Hugelia virgata*, same sheet as *E. s.* cf. subsp. *dasyanthum*, K!). Likely these were all collected on Coulter's trip from Monterey to Yuma, although 453 could have been collected later near Monterey. It seems that Coulter collected mainly dried specimens and wood samples, not living plant material or seeds. The notable exception was his collection of live cacti, sent to De Candolle at Geneva and to James Mackay, the gardener at Trinity College (Coville 1895: 522). Because Coulter returned to Dublin with specimens and not propagative material, and because Coulter's herbarium went to Trinity College, and later duplicates were sent to Kew, it seems unlikely that material from his collections would have been cultivated at the Horticultural Society gardens in London for about fourteen years before Lindley described *Hugelia lanata* from them.

David Douglas.—Originally from Scotland, David Douglas was recommended to the Horticultural Society by William Jackson Hooker, who at that time was Regius Professor of Botany at the University of Glasgow. Douglas was sent first to New England, where he stayed for about a year, and made collections of a number of desirable plants. In 1824, he traveled with the Hudson's Bay Company to the Columbia River, in the northwest United States. He returned to England in 1827, after sending a large number of specimens, seeds, and other propagative material back to England (Douglas 1914).

The Horticultural Society sent Douglas back to North America in 1829. He landed first at San Francisco, then traveled to Monterey, which became his base of operations (Wilks in Douglas 1914: 296). He arrived at Monterey 22 Dec 1830, and stayed in California until Aug 1832 (Jepson 1933; Howell 1937; McKelvey 1956). During the spring of 1831, he made a trip from Monterey to Santa Barbara, traveling by way of the Salinas River valley, San Miguel, San Luis Obispo, La Purisima, and Santa Ynez (McKelvey 1956). The route probably followed El Camino Real, which was approximately the same as modern-day Highway 101 (Harvey 1947). Soon after returning to Monterey, he went to San Francisco, also visiting sites in Marin and Sonoma counties. Sometime later he returned to Monterey, where he spent most of his time, other than a trip to the Santa Lucia Mountains in the spring of 1832. In August of that year, he left for Hawaii, and except for a brief stay in San Francisco in late 1833 (during which he made no collections), that was the last he saw of California (Harvey 1947; McKelvey 1956). Douglas died in Hawaii on 14 July 1834 (Douglas 1914).

Douglas collected four taxa of *Eriastrum* while he was in California, based on specimens at K, BM, CGE, and other herbaria: *E. densifolium* subsp. *densifolium*, *E. densifolium* subsp. *elongatum*, *E. luteum*, and *E. virgatum*. All four were described as new species in a new genus, *Hugelia*, by Bentham in 1833, based on Douglas' specimens. Although Douglas certainly collected seeds of various taxa which were subsequently grown by the Horticultural Society (e.g., *Gilia sinuata* K (Herb. Benth.)!, "Sem ex Amer. bor. occ. (Douglas) Hort. Soc. Hort. Lond. 6-6-28"), I have not found any specimens that indicate any of his collections of *Eriastrum* were ever grown in cultivation, or, if they were, no specimens were preserved from the cultivated material. All four species are listed in both Hereman (1868) and Loudon (1880), are noted to be annual, native to California, and introduced in 1833. Still, 1833 is quite early for a collection of material upon which *H. lanata* Lindley was based.

The Douglas label mix-up.—Two of Douglas' specimens, *Gilia elongata* and *Gilia virgata*, were mislabled in several herbaria, such that the names were switched. It was probably an innocent mistake, and without knowledge of Bentham's determinations of the duplicate sheets at Kew, but it may have propagated error. The labels are correct at K (Herb. Benth., Herb. Hook.), GH (originally switched, but corrected), UC, and CGE; but switched at BM, P, and G-DC. If any specimen with the wrong label was used in identification of a cultivated plant grown from seed, a mis-identification could result.

"H. lanatis."—Although it seems unlikely Douglas' *Eriastrum* material was grown in cultivation in 1846–1848 and was the basis of *Hugelia lanata* Lindley, there are two specimens which complicate the issue. Both originally were labeled "*H. lanatis*." The specimen at K (545588!, Herb. Benth.) is labeled "H. lanatis. on the grassy plains of the Multnomah in North California 1825", and annotated "Navarretia intertexta Hook Benth in DC. Prod. 9. 309" (Fig. 2). The specimen at BM (939573!) originally was thought to be a mixed sheet, and labeled "1. H. lanatis. 2. N. foetida. Both species are found on the grassy plains of the Multnomah in North California 1825.6.7" (Fig. 3). On the back of the sheet is written "North America—D. Douglas" and it was annotated "Navarretia pungens, Hook. Fl. Bor. 2, p. 75?" The handwriting of the original determination and locality is the same on both sheets, and rather distinctive. Presumably both specimens were collected by David Douglas in 1825. Because they are labeled "*H. lanatis*," it is of interest to try to determine more about them and if they are related to *H. lanata* Lindley.

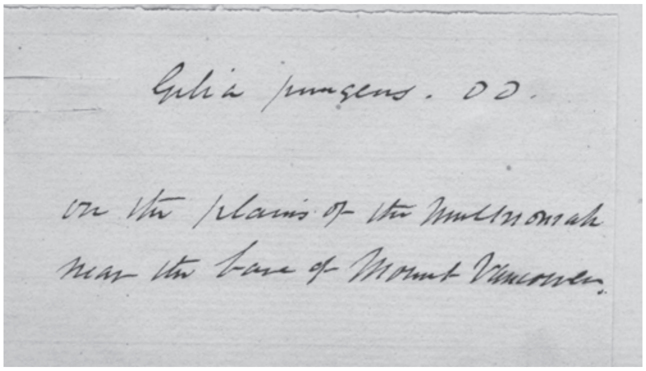
One clue could be the handwriting. Based on the handwriting samples at BM, the handwriting on the *"H. lanatis"* specimens does not appear to be that of George Bentham or John Lindley. That it is not Lindley is corroborated by a specimen of *Gilia* (*Ipomopsis*) *congesta* (K, Herb. Benth.!), which is labeled in the same handwriting as the "*H. lanatis*" specimens: "Gilia congesta Hook. Fl. Bor. Amer. 2. 75. Sandy plains of the Columbia (Lindley says this is a new species)." It is doubtful that Lindley would have written such a note himself. Another likely candidate is William Jackson Hooker, but the handwriting sample in the illustration facing p. 17 in Allen's *The Hookers of Kew* (1967) does not match the writing on the "*H. lanatis*" specimens.

Probably David Douglas himself labeled the specimens "*H. lanatis*." There are few available samples of Douglas' handwriting (a sample is said to be in the frontispiece of Douglas' journal (1914), but this is actually the writing of W. J. Hooker). However, comparison of the handwriting in photographs of a Douglas specimen, letter, and journal pages in Nisbet (2012: xiii, xvi, 69, 87) reveals some striking similarities to the handwriting on the "*H. lanatis*" specimens. Although many words are different, "the" is written the same way in almost every case, usually with the cross of the 't' actually crossing the 'h'. The word "of" is also written the same way both on the specimens and in the photographs.

Another clue can be found on a K specimen of *Navarretia squarrosa*, collected by Douglas (K 545635!, Herb. Hook.; Fig. 4), whose label reads "Gilia pungens. D D. On the plains of the Multnomah near the base of Mount Vancouver." The script is very similar to the handwriting on the "*H. lanatis*" specimens. The "D D" almost certainly refers to David Douglas, and the name may be one that he intended to publish. Douglas apparently drafted manuscripts in which he described these new species (Douglas 1914: 338), although few, if any, were published (see Douglas 1914 Appendix VI, and note that most plants introduced by Douglas were named by other authors). It seems most likely that Douglas recognized the plant labeled "*H. lanatis*" as a new species, first meant to publish it under that name, later drafted a manuscript naming it *Gilia pungens* instead, but did not publish either name. If the handwriting is Douglas', the "*H. lanatis*" cannot refer to *H.*

Fig. 2. "H. lanatis" specimen, K 545588. This specimen shares the sheet with a Geyer specimen from 1845 (*http://specimens.kew.org/herbarium/K000545588*, © copyright of the Board of Trustees of the Royal Botanic Gardens, Kew).

Fig. 3. "H. lanatis" specimen, BM 939573. (Natural History Museum, London. Public domain, Creative Commons CCO 1.0 license. Permanent URL: *http://data.nhm.ac.uk/object/f59edaa5-de98-41a4-846b-50900ba29c1f*).



Gilia pungens. D.D.

on the plains of the Multnomah
near the base of Mount Vancouver

Fig. 4. Label of "*Gilia pungens* D.D." (K 545635), showing handwriting similar to the writing on the "H. lanatis" specimens (*http://specimens.kew.org/herbarium/K000545635*, © copyright of the Board of Trustees of the Royal Botanic Gardens, Kew, photo by author).

lanata Lindley, because Douglas died in 1834 and Lindley's name was not published until 1848.

Gilia pungens was ultimately published by W. J. Hooker (1830), and "*Gilia pungens*. Douglas MSS" is cited as a synonym. The description refers to "…a powerful and disagreeable smell, which induced its discoverer at one time to name the species *foetida*…" (Hooker 1830: t. 2977). One plant on the BM specimen (939573! Fig. 3) of "*H. lanatis*" was indeed labeled "*foetida*," and the sheet was later annotated "*Navarretia pungens*" (a synonym of *G. pungens* Hook.). Additionally, K 545633 (Herb. Hook.!, same sheet as K 545635) is labeled "Gillia foetida. N. W. Am. Cult. Douglas." Douglas is referred to once in the description of *G. pungens* Hook., and as the source of the original material: "Communicated by the Horticultural Society of London, by whom it was raised from seeds brought by Mr. David Douglas. He discovered this curious plant on moist ground in mountain valleys, near the sources of the Multnomack River…" (Hooker 1830: t. 2977). Because of the matches of the location (Multnomah), the collector (Douglas), and the label "foetida", the most plausible hypothesis seems to be that the "*H. lanatis*" specimens from BM and K were both included in the circumscription of *Gilia pungens* Hooker, and the name "*H. lanatis*" on the specimens is only a herbarium name that was never published. Therefore, this name and these specimens are not at all connected to *Hugelia lanata* Lindley.

Theodore Hartweg.—In 1845, the Horticultural Society sent out another collector, Theodore Hartweg, to gather plants in California. After several months of collecting in central Mexico, Hartweg obtained passage to Monterey, California, arrived on 7 June 1846, and stayed until 5 Feb 1848. Although he spent most of his time in the vicinity of Monterey, he also made trips to Santa Cruz, San Francisco Bay, the upper Sacramento River and Sierran foothills, and as far south as Santa Ynez (McKelvey 1956; McVaugh 1970).

In writing about his collections near Monterey, Hartweg listed a "Hugelia, No. 5" (Hartweg 1847*a*: 124). This plant was subsequently described by Bentham in *Plantae Hartwegianae* as *Navarretia atractyloides* (Bentham 1849: 324). Between 7 July and 23 Aug 1846, Hartweg made two excursions, the first to Carmel Bay, and the second to the mission of Carmel and to the Carmel River valley. Of the Carmel River valley, he wrote that he "entered a beautiful wood of alders, willows, and plane-trees… Of herbaceous plants I observed two species of Solidago, Nos. 118 and 119; Mimulus cardinalis; Labiata, No. 122; Asclepias, Nos. 127, **117**; an annual, No. 120…" (Hartweg 1847*b*: 188; emphasis mine). No. 117 was subsequently identified by Bentham as *Gilia* (*Collomioides*) *elongata* (Bentham 1849: 324). It appears that Hartweg identified a *Navarretia* as a *Hugelia* (*Eriastrum*) and an *Eriastrum* as an *Asclepias*. Perhaps since it was late in the season the plants were in a somewhat scrappy state, and therefore characters may have been difficult to see (although herbarium specimens of Hartweg's No. 117 are in flower).

The only collection of *Eriastrum* in *Plantae Hartwegianae* is *Gilia* (*Collomioides*) *elongata* (Hartweg's No. 117; Bentham 1849), and the only Hartweg specimens of *Eriastrum* found at K, BM, and GH have been *E. densifolium* subsp. *elongata* (K 196248 [Herb. Benth.]!, K 545631 [Herb. Hook.]!, BM!, GH!). However, in the Lindley Herbarium at CGE there are two specimens, one of *E. densifolium* subsp. *elongatum* (CGE 12407 [image!]; Fig. 5) and one of *E. virgatum* (CGE 12406 [image!]; Fig. 6). Both are labeled as Hartweg collections: CGE 12407 is labeled "Gilia elongata California Htwg" and CGE 12406 is labeled "California Htwg H.H.J. Aug. 1847 H. elongata".

Lindley's "New Plants, etc."—In the first three volumes of the *Journal of the Horticultural Society* (1846–1848), Lindley and others associated with the Horticultural Society wrote up descriptions of various plants (some new species, some previously described) that recently had been grown in the Society's garden, in a series of short articles entitled, "New Plants, etc., from the Society's Garden." One of these articles included a note, dated 5 Aug 1847, about *Hugelia elongata* (Lindley 1847: 311–312). The plants were "raised from seeds received May 11, 1847, from Mr. Hartweg, who found it in fields near Monterey, in California." Leaves are said to be "cottony at the base, but green, and nearly smooth near the point, which is somewhat spiny, filiform, with two or three long segments of the same form." Lindley further noted, "This quite agrees with the specimens formerly gathered in California by Douglas." The note even includes an illustration (Fig. 7), which looks nothing like the *Gilia elongata* plants collected by Hartweg and preserved at K, BM, GH, or CGE, and the description does not match these plants either (e.g., leaves of *elongata* are generally white-floccose, not green). The illustration more closely resembles *E. virgatum* than *E. densifolium* subsp. *elongatum*.

Chiswick Garden records.—Records of plants received at Chiswick Gardens 1846–1848, from Hartweg's collections, include only three plants identified as *Hugelia* (but not determined to species): Nos. 154, 156, and 179. Number 154 apparently was subsequently determined to be *Navarretia squarrosa* [possibly associated with Hartweg's No. 5?]. Number 156 failed. Number 179 was noted to be an annual, in flower Aug [18]47, and from fields near Monterey. The Chiswick record notes that a specimen was dried (E. Gilbert, Reader Services, Lindley Library of the Royal Horticultural Society, pers. comm. 30 Mar 2010).

Number 179 appears to correspond both to Lindley's note about *Hugelia elongata* and to CGE 12406 (Fig. 6). In the garden record, Lindley's note, and CGE 12406, the plant is annual, flowered in August 1847, was from California (Monterey), and was labeled *Hugelia*, *H. elongata*, or *Hugelia*

Fig. 5. CGE 12407, from the Herbarium of John Lindley. On the left is a Hartweg specimen of *Gilia elongata* (*E. densifolium* subsp. *elongatum*), from California (image courtesy of the Cambridge University Herbarium, reproduced with permission).

Fig. 6. CGE 12406, from the Herbarium of John Lindley. See text for explanation and discussion (image courtesy of the Cambridge University Herbarium, reproduced with permission).

elongata (Lindley 1847: 311–312). The plant on the left in CGE 12406 even resembles the illustration with Lindley's note (Fig. 7).

The likely scenario.—Because there is no type specimen (or any specimens) associated with *Hugelia lanata* Lindley, one can never be entirely certain as to exactly what the name refers. However, there is abundant circumstantial evidence from which we can piece together what probably happened. Recall that the probable collector of the original material would have been a British botanist, associated with the Horticultural Society of London, collecting in California or western North America around 1845–1846.

The collector who best fits this description is Theodor Hartweg, who collected in California from June 1846 to Feb 1848 for the Horticultural Society, and the most likely scenario begins with Hartweg's collections: that Hartweg sent seed of both *H. virgata* and *H. elongata* to the Horticultural Society, and both were grown. Possibly they came as a mixed collection. Since Hartweg was in Carmel late in the season (probably later July or early August), *E. virgatum* would have been mostly past flower. In a dried state, *E. virgatum* could be confused with *E. densifolium* subsp. *elongatum*, particularly by a botanist who earlier may have identified an *Eriastrum* as an *Asclepias*. In cultivation, *Hugelia virgata* flowered first, and perhaps because of the switched labels on Douglas' specimens, Lindley took it to be *H. elongata*. He described it in a note (Lindley 1847) and dried a specimen (Chiswick No. 179; CGE 12406). When the true *H. elongata* plants flowered, Lindley had no name for them, and described them as *H. lanata*.

Answering objections.—A possible objection to the determination that *H. lanata* is *E. densifolium* subsp. *elongatum* would be that *E. densifolium* subsp. *elongatum* is perennial, while *H. lanata* is explicitly described as annual. However, this distinction is not quite as sharp as one might think. In Bentham's revision of Polemoniaceae in De Candolle's *Prodromus*, *Gilia lutescens* (*Eriastrum luteum*) is described as perennial, while it is clearly an annual (S. De Groot, pers. obs. 2005). *Gilia virgata* (*Eriastrum virgatum*), an annual, is described as annual, but with question (Bentham 1845: 311). Also, perhaps the cultivated plants really were perennial, but flowered their first year and died after only one season, making them appear annual. Other perennial *Eriastrum* have been observed to flower during their first season of growth (e.g., *E. densifolium* subsp. *mohavense*, S. De Groot, pers. obs. 2005). Note also that both Loudon (1880) and Hereman (1868) list all species of *Hugelia* as annuals, including *densifolia* and *elongata*.

Fig. 7. Illustration of *Hugelia elongata* sensu Lindley, from the *Journal of the Horticultural Society of London*, vol. 2, p. 312 (Lindley 1847; image credit: RHS, Lindley Library).

Another objection could be that *H. lanata* is described as a "hardy annual" (Lindley 1848: 74). If Chiswick No. 156 corresponds to *H. lanata*, how could it be that a "hardy annual" would "fail"? The apparent contradiction may be addressed by determining the meaning of "hardy." Hartweg had been charged by the Society to collect plants that might grow well outdoors in England (Jepson 1897; see also Loudon 1828, 1880; Lovell 1852; Hereman 1868), i.e., cold-tolerant plants which did not require special protection in the winter. Because *H. lanata* was assumed to be annual, it would not have grown in the winter and therefore would not have needed protection, i.e., it was deemed hardy. Apparently it grew well enough through the summer to flower, because flowers are included in the description (Lindley 1848). Alternatively, No. 156 may not correspond to *H. lanata* at all. If Hartweg's seed collection was a mixture of *E. virgatum* and *E. d. elongatum*, No. 179 might refer to both, but only a specimen of *E. virgatum* was dried (CGE 12406).

Although Lindley may have identified the first of Hartweg's *Hugelia* seed collections as *H. elongata* because of the mislabeled Douglas' specimens, he did not call the second of Hartweg's plants *H. virgata*. The mislabeled Douglas specimen at BM clearly has two years of growth, and is unlikely to be mistaken for an annual, so perhaps Lindley thought that the second garden-grown *Hugelia*, which appeared annual, was very different. Also note that *H. lanata* is said to have leaves "about two inches long" (Lindley 1848: 74), while Hartweg's specimen of *Gilia elongata* (e.g., CGE 12407) has leaves much shorter than two inches. However, leaves on first-year seedlings of *E. densifolium* are often much larger than leaves on second-year or older-growth branches (S. De Groot, pers. obs.). Since *H. lanata* was said to be annual, it must have flowered its first year, and its leaves would still have had seedling or juvenile morphology, unlike the mature specimens of *E. densifolium* subsp. *elongatum* gathered by Hartweg or Douglas.

One might also question why CGE 12407 is labeled "G. elongata" and not "H. virgata," since CGE 12406 is labeled "H. elongata," possibly based on the mislabeled Douglas specimens. Although the handwriting is similar, the identification as a *Gilia* ("G. elongata") as opposed to a *Hugelia* ("H. elongata") suggests that CGE 12407 was labeled at a different time, and probably by someone other than Lindley. Certainly different writing instruments were used, since the lines of the letters on CGE 12406 are finer than the lines on CGE 12407.

It is instructive to compare Lindley's descriptions of *H. elongata* and *H. lanata*. The leaves of *H. elongata* (*sensu* Lindley, actually *virgata*) are described as "cottony at the base, but green, and nearly smooth near the point, which is somewhat spiny, filiform, with two or three long segments [lobes] of the same form" (Lindley 1847: 311–312). Leaves of *H. lanata* "are linear, with a somewhat spiny point, and one to three short segments on each side; they are about two inches long, and have none of the greenness of *H. elongata*" (Lindley 1848: 74). Indeed, from field observations, *E. densifolium* subsp. *elongatum* (*H. lanata*?) does appear to be much more white and woolly than *E. virgata* (*H. elongata* sensu Lindley 1847), and the lobes on its leaves are usually very short, while leaf lobes of *H. virgata* can be fairly long and prominent and green. Lindley described flowers of *H. elongata* (*virgata*) as "deep blue" (1847: 312), and flowers of *H. lanata* as "clear light blue" (1848: 74). Flowers of *E. virgatum* (*H. elongata* sensu Lindley 1847) are generally a royal blue, and flowers of *E. densifolium* subsp. *elongatum* (*H. lanata*?) are a paler blue, at least in the Monterey area. In Lindley's mind, these taxa were clearly different species.

Comparison also can be made between Lindley's description of *Hugelia lanata* (1848) and Bentham's descriptions of *H. elongata* (1833) or *Gilia elongata* (1845), although to some extent they refer to different structures. Bentham's plants had white tomentose leaves, similar to *H. lanata*, "quite white with the short wool that covers every part" (Lindley 1848: 74; Bentham 1833, 1845). Bentham described the leaves as entire or having 1–2 short segments (lobes) on each side, while *H. lanata* had 1–3 lobes on each side. Bentham's *elongata* had intensely blue corollas, while *H. lanata* had "clear light blue" flowers (Lindley 1848: 74; Bentham 1833, 1845). The corolla was exserted from the calyx tube and the stamens were exserted in both. Bentham's plants had elongate anthers while *H. lanata* had deeply sagittate anthers (although anthers of *Eriastrum* could fit either category, depending on the side from which they are viewed). Bentham's *elongata* had few ovules; *H. lanata* had 6–8 (Bentham 1833, 1845; Lindley 1848). While neither description was extensive enough to provide a sure identification, they do seem to resemble each other in a number of points.

One year after Lindley's (1848) publication, Walpers, in his *Annales Botanices Systematicae*, an enumeration of plants that had been recently described, mentioned *H. lanata* (as *Gilia lanata*). He included a description almost word-for-word identical to Lindley's (1848), but also added the remark, "Crescit in America meridionali (Mexico)" (Walpers 1849: 519), i.e., "grows in Mexico." There is no reference to the source of the plant material in Lindley's 1848 publication, but many botanists of that time period corresponded and even visited (see Stafleu 1970), and it is possible that Walpers heard about the plant material through a source other than Lindley's 1848 publication. At minimum, the remark about Mexico serves to associate *H. lanata* with Hartweg's collections, since much of Hartweg's other material came from Mexico.

Conclusion.—Although the identity of *Hugelia lanata* Lindley cannot be determined with complete confidence due to the lack of a type specimen, the most likely conclusion based on herbarium specimens and historical evidence is that *H. lanata* Lindley refers to a plant of *Eriastrum densifolium* subsp. *elongatum*, grown in London from seed collected by Hartweg in late July 1846 in the lower Carmel River valley, that flowered its first year and died, and from which no specimen was ever made.

2. Gilia floccosa.—The name *Gilia floccosa* A. Gray was a name commonly applied in the later 1800s and early 1900s to several species of *Eriastrum* that occur in the Mojave and Great Basin deserts. However, it is actually an illegitimate name (superfluous).

The name traces back to David Douglas' specimen of *E. luteum* (*Hugelia lutea* Benth.), collected in 1831 and received in England in 1833. The name *lutea* refers to its yellow corollas. Asa Gray presumably saw a duplicate of this specimen (Gray 1870: 272; GH 303655! [specimen on right]), and probably several specimens with blue corollas of *Eriastrum* from the southwest deserts, and decided they all represented the same taxon. Corolla color frequently changes when a plant dries, and since Gray had not seen any other specimen with yellowish corollas, he must have assumed that the yellowish corollas on Douglas' specimen of *E. luteum* were the result of drying, not natural color. Since, in his opinion, the plants did not actually have yellow corollas, the specific epithet *lutea* was not appropriate: "Flowers blue or pale purple, becoming white only in age, and though appearing yellowish in original dried specimens of Douglas, probably never yellow. Hence a new specific name is required. Nuttall has an unpublished *Hugelia floccosa* in his herbarium, but with no flowers developed; and, as it is either this or the next [*G. filifolia*], the name may be applied to the present species" (Gray 1870: 272). Therefore the type specimen of *G. floccosa* was the same Douglas specimen upon which *H. lutea* was based.

Gray continued to describe the corolla color of *G. floccosa* as blue or pale purple, stating in the botanical report of the Geological Survey of California, "corolla about 4 lines long, blue or becoming white (probably never 'yellow')… But the flowers were doubtless bluish, faded to dull white" (Gray 1876*b*: 494).

However, in 1876, Edward Palmer collected a plant near San Simeon, which definitely had yellow flowers, and sent a specimen to Gray (GH 303655! [specimen on left]). Hence, in his *Synoptical Flora of North America* (1878), Gray recognized *Gilia lutescens* (= *Hugelia lutea*), noting that it "closely resembles *G. floccosa*" but it had a "bright sulphur-yellow corolla" (Gray 1878: 143). Now that it was obvious that *Hugelia lutea* was different than the blue-flowered plants from the deserts, Gray retained the name *Gilia floccosa* for this latter group, excluding *Hugelia lutea* from the circumscription (Gray 1878: 143). But this also excluded the type specimen of *G. floccosa* from the circumscription of *G. floccosa*.

To remedy this lack of a type specimen, Jepson (1943: 166–167) designated a lectotype (*W. W. Bailey 914*, GH 303672!) for *G. floccosa*, arguing that Gray "wrongly" cited *H. lutea* and that subsequent treatments explicitly exclude *H. lutea* and make it clear that *G. floccosa* refers only to interior and Great Basin plants. However, it seems clear from Gray's early publications that *H. lutea* was intentionally cited as a synonym, and that *G. floccosa* was meant to be a replacement name (Gray 1870: 272; Gray 1876*b*: 494). Because both *Hugelia lutea* and *Gilia floccosa* are based on the same type (*Douglas* [in 1833]), and *H. lutea* is the older name (i.e., has priority), *G. floccosa* is a superfluous name and therefore illegitimate.

Mason (1945: 83) argued that *Hugelia floccosa* Nuttall was not a true synonym of *Gilia floccosa* A. Gray, because Nuttall's name existed on herbarium specimens before it was preempted by Gray. However, I cannot find any valid publication of Nuttall's name. In the two places where it is mentioned in synonymy, it is always referred to as "*Hugelia floccosa* Nutt. in herb." (Gray 1870: 272; Jepson 1943: 165). The combination *Hugelia floccosa* (A. Gray) T. Howell was published much later and without reference to Nuttall's name, with only *Gilia floccosa* Gray cited in synonymy (Howell 1903: 458). Since Nuttall's name was not validly published, it cannot be an earlier legitimate name for Gray's *Gilia floccosa*.

I have found three specimens bearing the designation "Hugelia *floccosa" or "Hugilia +floccosa" in Nuttall's or Gray's handwriting: BM 939593!, GH 303675!, and GH 303674!. None have flowers, but all appear to be young plants of *E. wilcoxii*. The lectotype (*Bailey 914*; Jepson 1943) also is *E. wilcoxii*. Nelson and Macbride (1916: 35) wrote that "*G. Wilcoxii* A. Nels. Bot. Gaz. 34: 27. 1902 is *G. floccosa*." Gray cited Nuttall's "Hugelia *floccosa" as a synonym of his *Gilia floccosa* (Gray 1870: 272). It seems fairly clear that Nuttall's "Hugelia *floccosa" and Gray's *Gilia floccosa* (excluding *H. lutea*) refer to the same taxon, which often is *E. wilcoxii* [the * or + preceding the specific epithet seem to be Nuttall's way of marking those names as new or unpublished].

However, while many plants identified as *G. floccosa* are now identified as *E. wilcoxii*, the circumscription of *G. floccosa* probably also included *E. eremicum*, *E. pluriflorum* subsp. *albifaux*, *E. sapphirinum* subsp. *brevibracteatum*, *E. signatum*, *E. sparsiflorum*, and possibly others. The best practice when encountering a specimen previously identified as *G. floccosa* would be to re-identify it with the most recent taxonomic treatment.

3. Type(s) of E. eremicum *subsp.* yageri.—Although the confusion of types involving *E. eremicum* subsp. *yageri* and *E. diffusum* subsp. *jonesii* was discussed in De Groot (2011*b*: 449), a brief summary is included here. Marcus Jones described *Gilia virgata* var. *yageri* in 1910 (p. 2), and cited 2 specimens as syntypes: *Jones* number *10253* and number *10279*. He also cited *Jones 9935*, from "Yager's," as a paratype (see discussion on the location of "Yager's" under *E. eremicum* subsp. *yageri*). At that time, *Eriastrum* was considered a section (*Hugelia*) of genus *Gilia*.

However, the specimens cited by Jones included multiple entities. In trying to clear up this confusion, Craig decided that the epithet *yageri* should have as its type a specimen from "Yager's," and he re-typified the variety *yageri* with *Jones 9935*, from "Yager's" (Craig 1934*b*: 420–421). But the plants of *Jones 9935* were somewhat different from the plant of *Jones 10253*, so Craig used *Jones 10253* as the type of his variety *arizonica* (Craig 1934*b*: 419–420).

Mason (1945: 78–79) reunited subsp. *yageri* with its original type, *Jones 10253*, and subsumed Craig's variety *arizonica* within subsp. *yageri*. But then Mason took *Jones 9935* and used it as the type of *E. diffusum* subsp. *jonesii* (Mason 1945: 77). Hence, *G. eremica* var. *yageri* T.T. Craig is cited as a synonym under *E. diffusum* subsp. *jonesii* (as to type only, not as to name).

4. August Brand nomenclature.—The nomenclature of Brand names presents some additional challenges. August Brand (1863–1930) was a classical teacher and botanist who collaborated with Engler to produce several treatments, including Polemoniaceae, for *Das Pflanzenreich* (IV. 250; Brand 1907). His herbarium and types were almost exclusively at Berlin (B; Stafleu and Mennega 1995: 7).

One of the biggest difficulties with Brand's taxonomy is that apparently the entire Polemoniaceae collection at Berlin was destroyed during World War II (Hiepko 1987), with the exception of the Willdenow herbarium. Therefore none of Brand's types at Berlin are extant. In many cases, however, duplicates of specimens cited by Brand have been found in other herbaria. In general, duplicates at herbaria that were annotated or likely seen by Brand have been checked with Brand's original description, and the best match has been designated as the lectotype.

Another difficulty is the brevity of Brand's original descriptions. *Navarretia virgata* subsp. *gymnocephala* Brand has no description at all, beyond what is given in the key: "Bracteae vel subnullae vel capitulo haud vel vix longiores, plerumque rigido-erectae [Bracts or somewhat lacking or not at all with head or barely longer (than the head), for the most part (frequently) rigidly erect]" (Brand 1907: 167). The description for *Navarretia virgata* var. *dasyantha* is merely "Capitula 6–8-flora, dense lanata" [heads 6–8-flowered, densely woolly]" (Brand 1907: 168). However, in spite of their terseness, the descriptions can point to unique character combinations, such as for *Navarretia virgata* var. *oligantha*: "Flores singuli vel gemini, bracteae subnullae [flowers single or paired, bracts somewhat lacking]" (Brand 1907: 167).

Brand's use of ! appears irregular and may be confusing. After studying many citations, it seems most likely that Brand used ! after a name (with its author) to signify that he had seen a type specimen for that name. The ! usually follows a basionym, e.g., "*Gilia sapphirina* Eastwood! in Bot. Gaz. XXXVIII. (1904) 71" (Brand 1907: 168). It probably does not mean that Brand saw the author's herbarium. In the above example, Eastwood's herbarium was CAS, and had Brand seen the CAS collection, then the ! following *Gilia sapphirina* Eastwood! but the lack of ! after "*Gilia sparsiflora* Eastwood in Proc. Calif. Acad. Sci. 3. ser. II. (1902*a*) 291" (Brand 1907: 167) would be puzzling. However, it is possible that there was an isotype of *G. sapphirina* at B, while *G. sparsiflora* was a unicate. Alice Eastwood, the collector of the type of *G. sparsiflora*, wrote that on the trip where it was collected, "my botanical oufit had to be very limited and I was not able to collect as much as I would have liked" (Eastwood 1902*b*: 1). In contrast, Blanch Trask, the collector of *G. sapphirina*, usually collected unicates, but apparently collected at least two sheets of *Pinus quadrifolia* from the same area and at the same time that she collected the type of *G. sapphirina* (CCH). So it seems possible that Brand saw a type specimen of *G. sapphirina*, but not of *G. sparsiflora*. Use of ! after a geographic place may mean that Brand saw a specimen from that place (J. L. Reveal, pers. comm.).

It is not likely that Brand's use of ! after an author means that he saw that author's publication. Notice that "*Gilia virgata* var. *floribunda* A. Gray! in Proc. Amer. Acad. VIII. (1870) 272" and "*Gilia floccosa* A. Gray in Proc. Amer. Acad. VIII. (1870) 272" (Brand 1907: 168) were published in the same publication: Gray 1870, and even on the same page, 272. It seems very unlikely that Brand saw a protologue in a paper but did not see another protologue on the *same page* of that *same paper*. But that Brand saw a type specimen of *G. virgata* var. *floribunda* is likely—there are many duplicates of the

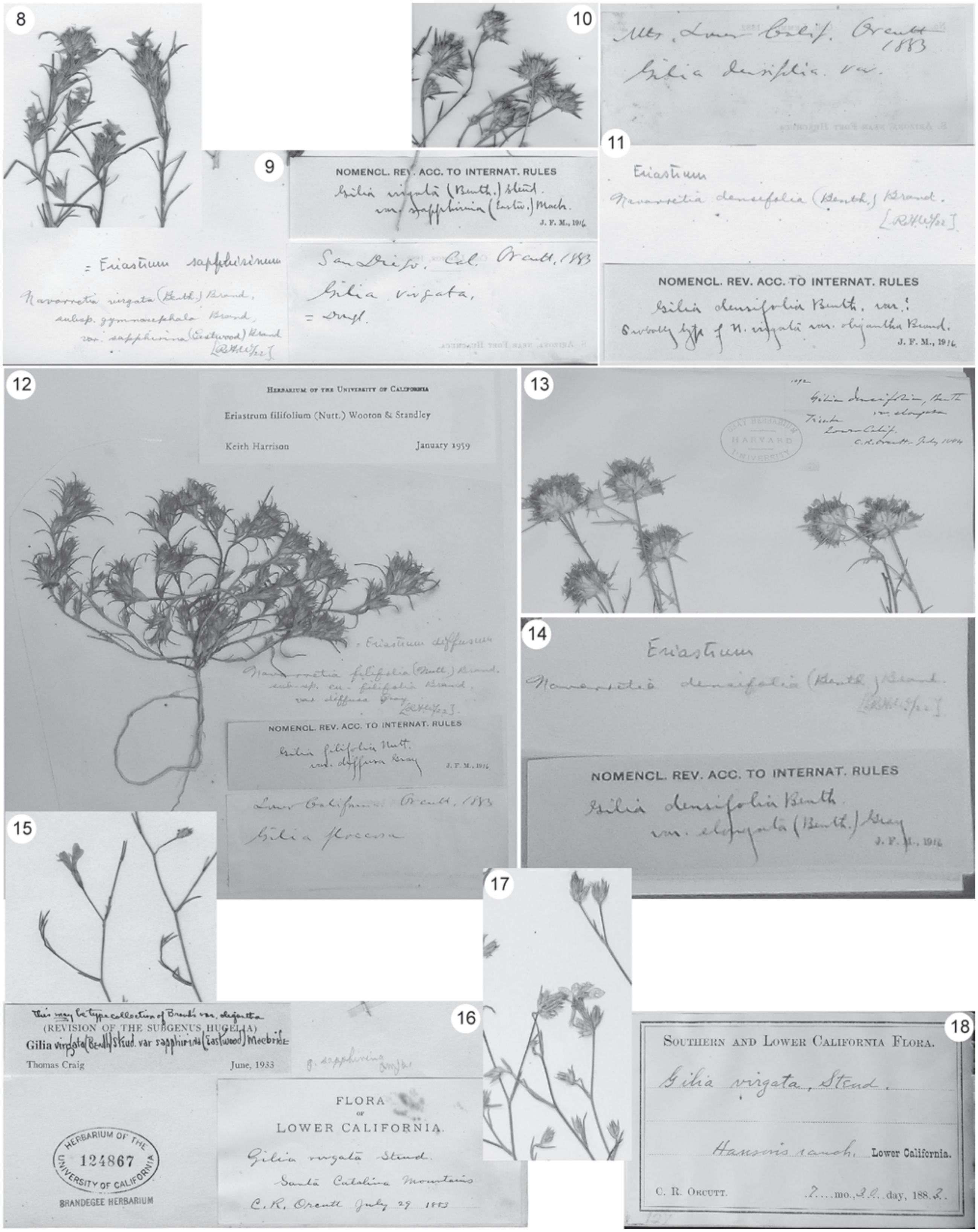


Fig. 8–18. Specimens pertaining to *Navarretia virgata* subsp. *gymnocephala* var. *oligantha*, part 1.— 8–9. Details from GH 303676.—8. Detail of inflorescences.—9. Label (bottom right) and annotations.—10–11. Details of GH 303660.—10. Detail of inflorescences.—11. Label (top) and annotations.—12. *Orcutt* in 1883 (GH).—13–14. Details of *Orcutt 1092* (GH).—13. Detail of inflorescences and original label.—14. Annotations.—15–16. Details of UC 124867.—15. Detail of inflorescences.—16. Label (bottom right) and annotations.—17–18. Details of US 1338026.—17. Detail of inflorescences.—18. Original label (Images of GH 303676 and GH 303660 reproduced with permission from the Gray

Fitch, Wallace, and Brewer collections that Gray cited. Also, it is unlikely that Brand saw a type of *G. floccosa*, because its type originally was the *Hugelia lutea* collection by Douglas, but that was excluded from *G. floccosa* in 1878 (Gray 1878). Jepson did not designate the lectotype until 1943, so in 1907, *G. floccosa* had no type specimen for Brand to see.

Brand sometimes cited specimens under a species, and cited different or the same specimens under subspecies or varieties of that species (see *N. filifolia* and *N. filifolia* var. *diffusa*, *Jones 3642*, Brand 1907: 167). Unless they are cited again, it is not clear to what subspecies or varieties the specimens cited under the species name belong. In the above example, *Elmer 1059* and *Brandegee* are cited under the species *N. filifolia*, but are not included with any of the other specimens cited under each subspecies or variety of *N. filifolia*. If they are to be considered typical, it is odd that they are not cited under *N. filifolia* subsp. *eu-filifolia* (Brand 1907: 167).

For names of taxa that Brand described *de novo* (i.e., not new combinations), he usually appended "n. sp.", "n. subspec.", or "n. var." following his name as the author [e.g., n. sp. (Brand 1907: 139, 140); n. spec. (p. 134); n. form. (p. 116); n. var. (p. 109, 113, 116, 117); n. subvar. (p. 102); n. subsp. (p. 92)].

For names that are autonyms (e.g., *eu-densifolia*) or probably intended to represent the typical form, Brand generally did not add "n. sp.", "n. subspec.", or "n. var." after his name as the author. See, for example, the varieties of *Gilia gilioides* (Brand 1907: 93): there are three varieties described, none are new combinations, but "var. a. *Benthamiana* Brand" is not followed by "n. var." while "var. b. *Greeniana* Brand n. var." and "var. c. *integrifolia* Brand n. var." are. Notice also that *Navarretia virgata* subsp. *gymnocephala* Brand is NOT followed by "n. subspec." This suggests that Brand intended it to be the typical form, even though he did not use an autonym or similar name.

Many of the names in Brand's treatment of *Eriastrum* are new combinations, meaning they were previously described and the holotypes are at herbaria other than Berlin. The new Brand names to be dealt with in *Eriastrum* are:

- *Navarretia densifolia* (Benth.) Brand subsp. *elongata* (Benth.) Brand var. *lanata* Brand (1907: 165).
- *Navarretia densifolia* var. *jacumbana* Brand (1913: 340–341).
- *Navarretia virgata* (Benth.) Brand subsp. *gymnocephala* Brand (1907: 167–168).
- *Navarretia virgata* (Benth.) Brand [subsp. *gymnocephala* Brand] var. *dasyantha* Brand (1907: 168).
- *Navarretia virgata* (Benth.) Brand [subsp. *gymnocephala* Brand] var. *oligantha* Brand (1907: 167–168).

Navarretia densifolia (Benth.) Brand var. *lanata* Brand (1907: 165) is a synonym of *E. virgatum* (Macbride 1917: 57; Craig 1934*b*: 394; Mason 1945: 84). Careful study of Brand's descriptions, circumscriptions, and exsiccatae shows that typical *E. virgatum* is treated only in *N. densifolia* var. *lanata*, and not in *N. virgata* as one might expect (although that is where the basionym *Hugelia virgata* is cited). *Navarretia virgata* (Bentham) Brand contains only *E. pluriflorum*, taxa of the *E. sapphirinum* group, and taxa treated as *Gilia floccosa*, not typical *E. virgatum*. One specimen was cited for *N. densifolia* var. *lanata* Brand, *Heller 6753*, of which several duplicates have been found.

Described in a subsequent publication, *Navarretia densifolia* var. *jacumbana* Brand (1913: 340–341) is currently a synonym of *E. eremicum*. Brand cited a single specimen, *Abrams 3640*, which was widely distributed with many duplicates.

Navarretia virgata (Benth.) Brand subsp. *gymnocephala* Brand (1907: 167–168) presents difficulty because no specimens were cited. It should be considered as the sum of its subordinate varieties: *oligantha*, *sapphirina*, and *dasyantha*, and one variety should be designated as the type of subsp. *gymnocephala* (K. Gandhi, pers. comm. 28 Sep 2006). Of the varieties, var. *sapphirina* is the only one not followed by "n. var.", but this could be because it is a new combination, not a new variety, and does not necessarily indicate that it was intended to represent the typical variety. Designating var. *oligantha* as the type of subsp. *gymnocephala* would preserve current usage (sensu Mason 1945), although some recent revisions considered subsp. *gymnocephala* not distinct from typical *E. sapphirinum* and treated it as a synonym (e.g., Harrison 1972).

Navarretia virgata (Benth.) Brand [subsp. *gymnocephala* Brand] var. *dasyantha* Brand (1907: 168) is the only Brand name that is currently recognized and in use. Brand cited four specimens in the protologue, and duplicates of all four have been found at various herbaria in Europe and the U.S. Therefore in this case it was fairly straightforward to choose a lectotype.

Navarretia virgata (Benth.) Brand [subsp. *gymnocephala* Brand] var. *oligantha* Brand has only one specimen citation: "Orcutt; Herb. Gray" (Brand 1907: 168). The original description is brief, given in the key: "Flores singuli vel gemini, bracteae subnullae [flowers single or paired, bracts somewhat lacking]" (Brand 1907: 167). The text under the varietal name gives no additional description, only range information: "So anscheinend sehr selten. Gesehen nur aus Nieder-Californien [So apparent very rarely. Seen only from Lower California]" (Brand 1907: 168). Therefore, from the protologue we would conclude the type specimen should be an Orcutt collection from Baja California at the Gray Herbarium (GH) that has few bracts and only one or two flowers per head.

There are four specimens of *Eriastrum* collected by C. R. Orcutt at the Gray Herbarium (Fig. 8–14). According to its label, GH 303660 was collected in "Mts., Lower California" by Orcutt in 1883 (Fig. 10–11). The specimen was annotated by J.F.M. in 1916: "Gilia densifolia Benth. var. ! Probably type of N. virgata var. oligantha Brand", and is probably the specimen referred to in Macbride (1917: 56), where J. F. Macbride wrote that it "is apparently a glabrate variety of *G.* [*Gilia*] *densifolia*. But only the upper portion of the plant is present; and if this is the specimen Brand refers to, and it seems that it must be, his description is misleading." Indeed, the inflorescence heads of

←
Herbarium of Harvard University, Cambridge, Massachusetts, USA. UC 124867 reproduced with permission from the University and Jepson Herbaria, University of California, Berkeley. US 1338026 reproduced courtesy of Smithsonian Institution).

this plant have many bracts, and although only one or two flowers are open in any head, each head is large enough to have supported several more flowers during the life of the plant. So although Brand's description is meager, GH 303660 does not fit well.

GH 303676 also was collected by Orcutt in 1883 (Fig. 8–9). The heads are smaller than the heads on GH 303660, but definitely bracted, and probably supporting at least three flowers each. Furthermore, it was from San Diego, not Lower California, in conflict with the location that Brand gave: "Lower California" (Brand 1907: 168).

There are two more specimens at GH that were collected by Orcutt in Lower California. One was collected in 1883 and annotated *Eriastrum filifolium* by Harrison (Fig. 12). Again, it has bracted heads supporting at least three flowers. The other specimen, collected in July 1884, bears Orcutt's collection number 1092 and is a form of *Eriastrum densifolium*, with large, bracted heads (Fig. 13–14). So while there are four Orcutt specimens of *Eriastrum* at GH, none match Brand's description of var. *oligantha*.

Article 9 of the *International Code of Nomenclature for Algae, Fungi, and Plants* (McNeill et al. 2012) describes which specimens comprise the original material, and which are eligible to be used as a lectotype, in order of priority: 1. an isotype; 2. a syntype; 3. a paratype; 4. uncited specimens or illustrations comprising the original material. Although Orcutt specimens at herbaria other than the Gray Herbarium may not have been seen by Brand, they could be isotypes and therefore still eligible to be used as a lectotype. Certainly, a specimen at GH would be preferable since this herbarium was cited in the protologue (sensu Art. 7.8), but none of the Orcutt specimens at GH fit Brand's original description and it would be misleading to use any of them as the type.

I have found four other Orcutt specimens in other herbaria that match the collection dates of the GH specimens (1883–1884) and were collected in Lower California. UC 124867 (Herb. Brandegee, image!; Fig. 15–16) was identified as *Gilia virgata*, and collected from the Santa Catalina Mountains (= Sierra Juarez) by Orcutt on 29 July 1883. The flowers are mostly single, occasionally paired, and with very few bracts. The handwriting on this label compares favorably to the handwriting on the label of a K. Brandegee specimen collected 17 July 1906 (UC 101997), and therefore may be the writing of Katherine Brandegee.

US 1338026 was identified as Gilia virgata Steud., and collected from "Hanson's ranch, Lower California" on 30 July 1883 (Fig. 17–18). It has one or two flowers per head, and few bracts. The handwriting on the label may be C. R. Orcutt's (see discussion below).

There are two specimens at the Field Museum. F 152771 was collected by C. R. Orcutt on 29 July 1884, at "Hansens," Lower California, and originally identified as *Gilia virgata* (Fig. 19–20). Like UC 124867, the flowers are single or paired (more frequently paired), with very few bracts. A stamp indicates that it once was in the Herbarium of Harry N. Patterson. The handwriting on the label is probably C. R. Orcutt's (compare with *Loeselia guttata* specimens, NY 990706 and US 41250 [barcode 110421] [images!, JSTOR Global Plants], both of which have a printed original label identical to F 152771, and very similar handwriting in the same blue ink, but are not associated with Harry Patterson).

The other Field Museum specimen is F 371743, also collected by Orcutt on 29 July 1884, in Lower California (Fig. 21–22). Again, the flowers are single or paired, and the bracts few and short. The specimen contains the stamps of "Indiana University", "J. M. Coulter", and the "University of Chicago" along with the Field Museum. The original label is printed "Ex Herb. Harry N. Patterson" at the bottom, and the determination, locality, collector, and date were handwritten.

Brand cited two additional specimens in another paper in 1913. Because these were seen and cited by Brand after he had published the name *oligantha*, they cannot be considered part of the original material, nor are they available for use as lectotypes (see McNeill et al. 2012, Art. 9). However, they do aid in understanding Brand's concept of var. *oligantha*. The first specimen cited is *Grant 502*, from the Santa Monica Mountains. This was clearly a mixed collection: a duplicate at GH(!) is *E. sapphirinum* subsp. *dasyanthum*, and a duplicate at POM(!) is *E. filifolium*. But the duplicate at G (G 375435, Herb. Delessert, image!; Fig. 23–24), which was annotated "Navarretia virgata oligantha !Br." by Brand, has one or two flowers per head and few bracts, fitting Brand's original description.

The second specimen cited by Brand (1913: 341) is *K. Brandegee* on the road from Julian to Cuyamaca, on 17 July 1906. Both the UC (101997 [image!]; Fig. 25) and POM (3564!) specimens have one or two flowers per head and few bracts, again fitting Brand's original description.

Considering G 375435, UC 101997, and POM 3564 together, we can be assured that Brand really was describing a plant with one or two flowers per head and few bracts. None of the Orcutt specimens at the Gray Herbarium fit this description. This leaves the Orcutt specimens at F (152771, 371743), UC (124867) and US (1338026) as the only specimens available to use as lectotypes.

None of these specimens are ideal lectotypes because currently they are not from GH, nor is there any indication that Brand saw them. However, it is possible that Brand saw duplicates of one or more of them at B, or via loan. Specimens at M include annotations that they were sent to Brand on loan (M 185269 [image!], M 185270 [image!]). Perhaps Brand also requested specimen loans from North American herbaria. There is also a chance that one or more of these specimens was, at some time, at GH. While it is very difficult to track the movements of a particular herbarium specimen in the late 1800s, other than by annotations or stamps, there was a good deal of exchange and sending specimens to experts for identification (see, for example, the Harry Patterson correspondence [Kibbe 1953]). One or more of the specimens, or duplicates of them, may have been sent to Asa Gray, then later passed along to another herbarium.

At this time, however, we cannot be certain about any of these possibilities. Therefore, it seems best to fix the application of Brand's var. *oligantha* by using as a lectotype one of the four specimens of original material fitting his description.

METHODS

The following taxonomy and descriptions are based largely on field observations and my own collections (over 500 collections of *Eriastrum*, plus additional collections of closely

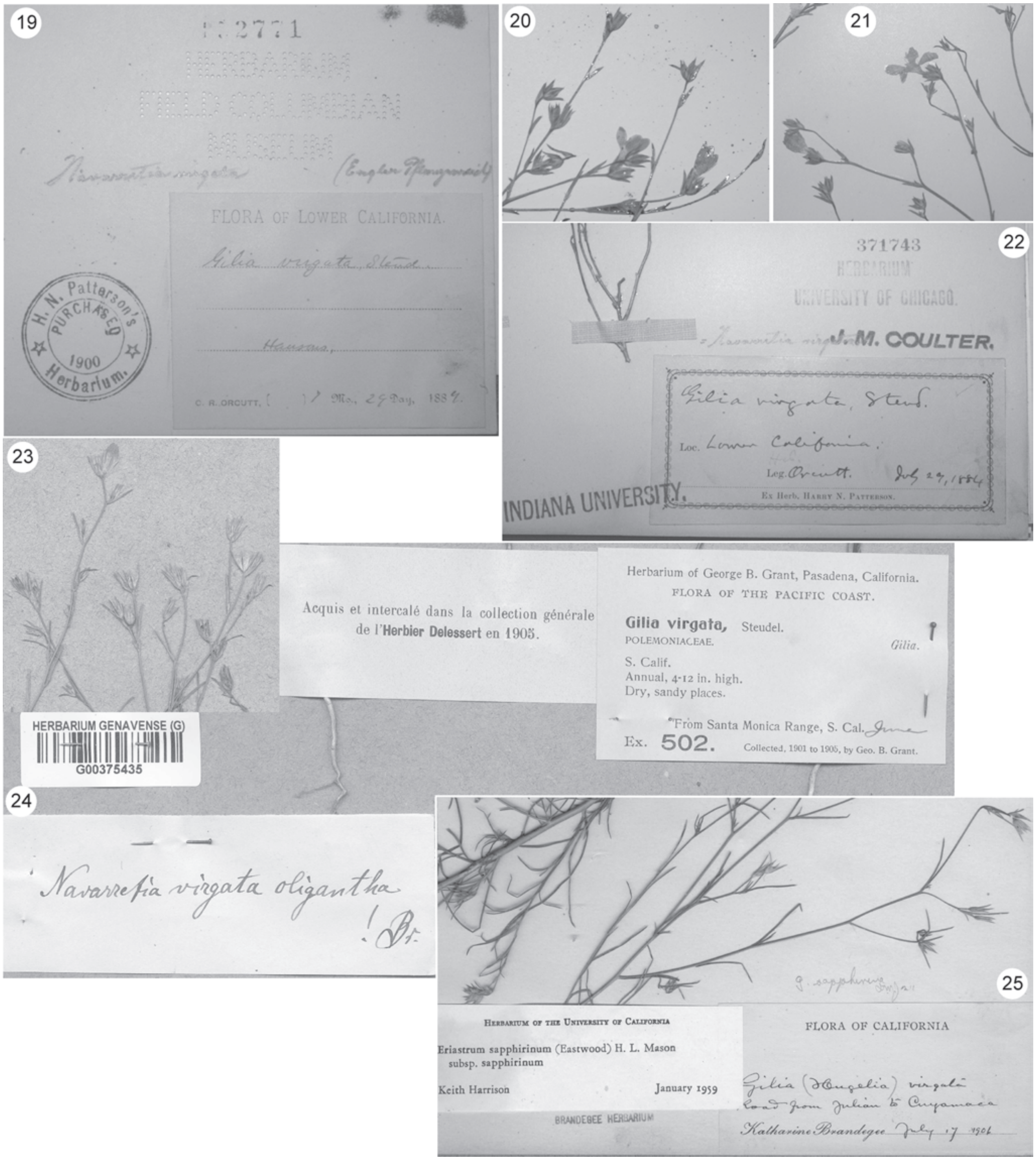


Fig. 19–25. Specimens pertaining to *Navarretia virgata* subsp. *gymnocephala* var. *oligantha*, part 2.—19-20. Details of F 152771.—19. Label and annotations.—20. Detail of inflorescences.—21–22. Details of F 371743.—21. Detail of inflorescences.—22. Label and annotations.—23–24. Details of G 375435.—23. Detail of inflorescences.—24. Label (far right) and annotations. Brand's annotation is in the lower left.—25. Detail of UC 101997 (Photos of F 152771 and F 371743 by the author; specimens property of The Field Museum. Image of G 375435 © Conservatoire et Jardin botaniques de la Ville de Genève, reproduced with permission. UC 101997 reproduced with permission from the University and Jepson Herbaria, University of California, Berkeley).

related genera), made during more than 224 field days and over 36,000 miles traveled across western North America. Detailed population samples were made from just over 300 populations of *Eriastrum*, taken across the range of this genus, with about 40 additional samples gathered from closely related genera. Part of the sampling strategy included taking at least 60 digital photographs per population, for a total of over 24,000 photographs. I also utilized descriptions in the literature, DNA sequence data (S. De Groot, unpubl.), and morphometric data (S. De Groot, unpubl.). In addition, over 4000 herbarium specimens or images of specimens, including most of the types, were consulted. I had the opportunity to look through the collections at BM, CHSC, F, GH, K, RSA-POM, and SD; specimen loans were received from CAS/DS, JEPS, OBI, RM, TCD, and UC; and images of specimens were received from BR, BRY, CAS/DS, CGE, G, JEPS, L, M, MEXU, MIN, MO, NY, OBI, P, PH, S, UC, US, and WIS. Range maps were created in ArcGIS 10 (©ESRI, Redlands, CA), using the GPS locations of collections and additional herbarium specimens whose identity could be verified and location georeferenced (3698 records mapped). The online supplement (*http://www.rsabg.org/scientific-publications*) cites 3353 exsiccatae, although many additional specimens were consulted but are not cited.

Species concept.—Species and subspecies in this revision are recognized mainly by morphology, geography, and ecology, although some additional forms of data such as flowering time, DNA sequences, and pollen morphology have played a role in a few cases. While the use of morphology to delimit species may underestimate diversity by aggregating morphologically identical cryptic taxa, it also can overestimate diversity by splitting apart morphologically variable taxa that have little to no genetic variation (Kerrigan 2012). Defining taxa by morphology is a simple way to create a taxonomic framework which can then be tested by future phylogenetic and population genetic studies. The most parsimonious explanation of morphological similarity is that the taxa in question are closely related; and that morphologically dissimilar taxa may be less closely related and/or have some barrier to gene flow (Kerrigan 2012; McDade 1995). In this revision, geography is employed as an additional criterion, especially for subspecies delimitation, and is based on the assumption that gene flow decreases with distance. Habitat also plays a role, founded on the idea that plants may be adapted to local conditions and have decreased survival outside of those conditions; and also that pollinator assemblages and seed dispersal mechanisms may be specific to a habitat type and may restrict dispersal outside of that habitat (Stuessy 2008).

Deciding the rank at which to recognize a taxon is more challenging. While there may be morphological, geographical, and ecological distinction between two sets of populations, it is difficult to determine whether there is enough *difference* to recognize them as separate species, or enough *similarity* that they should be recognized as subspecies. Few authors have addressed this issue, and few taxonomists spell out explicitly the criteria they use. One paper cited "limited sequence variation" and "broad morphological overlap" as arguments to classify groups as subspecies (Pätsch et al. 2010: 7). Hawlitschek et al. (2012) used three independent lines of evidence, and applied a subspecies rank if taxa differed in only one line of evidence, but a species rank if taxa differed in two or more lines of evidence. However, neither paper spelled out the degree of difference or similarity to rank a taxon as a species or subspecies. Moreover, most taxa of *Eriastrum* are variable, and independent lines of evidence are all likely to show *some* differences. The most rigorous and repeatable criteria were proposed by Tobias et al. (2010). These authors measured the divergence among undisputed sympatric species, and then used this as a calibration standard to assess the rank of other taxa within the group (see also Braby et al. 2012). Such a meticulous quantitative study, although desirable, is beyond the scope of this revision, but a similar qualitative approach was employed here to determine the rank of new taxa: the amount of morphological difference between currently recognized species or subspecies was compared with the difference between new taxa and their closest relatives, and new taxa were ranked based on the amount of divergence relative to other taxa in *Eriastrum*.

The two new species recently segregated from *E. hooveri* were based mostly on the unified species concept of de Queiroz (2005; D. Gowen, pers. comm.). Given that the new taxa are geographically separated and morphologically distinguishable from *E. hooveri*, especially in the length and height of the stamens, it is plausible that they are independently evolving lineages. The new species described here is also presumed to be an independently evolving lineage, given its morphological distinctness from all other *Eriastrum* species.

Note about measurements.—In the treatment below, the measurements given are, for the most part, from live or rehydrated material. Preliminary observations suggest that measurements of dried material can be as much as 25–50% less than the same measurement made on fresh material, but this varies depending on the structure.

Note about figure numbers.—All color photographs of taxa have been numbered continuously with black-and-white figures but have been grouped into eight plates by relationships, morphological similarity, or ease of confusion, enabling side-by-side comparisons to be made. The color plates are located at pp. 143–152 in this monograph. However, the taxa do not necessarily arise in the same order in the text, and figure numbers may appear out of order. It is hoped that any bewilderment resulting from this is outweighed by the usefulness of side-by-side comparisons of easily confused taxa.

RESULTS

The genus *Eriastrum* as treated here consists of 18 species, with 14 subspecies, for a total of 32 taxa.

Note.—The following classification is presented as a hypothesis. The forms are still imperfectly known and barely described; it is anticipated that additional study will result in some circumscriptions or ranks being changed or other forms being named. Descriptions are generally based on the original protologues, type specimens, and a limited sampling of herbarium specimens and morphological data, and include some but not necessarily all of the variation that has been attributed to a particular taxon. However, it seemed preferable to describe well those entities that have already been named and are fairly distinct and recognizable, before delving into the myriad of other forms that bear some resemblance to them but also are notably different. When attempting to identify one of these other forms, it is possible that the plants in question will not fit well into any described taxon, which, while frustrating for the individual attempting to identify it, underscores the need for further, detailed, population-level analyses in this genus.

Glossary of Morphological Terms

Definitions and clarification of many terms used in the descriptions and keys of *Eriastrum* are presented below. Most definitions follow Keck (1959) or Harris and Harris (2000), or are as traditionally used by Craig (1934*b*), Mason (1945), Grant (1959), or Harrison (1972). Modifications or clarifications are discussed below.

Habit.

Perennial: a plant that remains alive, growing, and reproducing for at least two growing seasons in at least two years, often becoming woody near the base. In *Eriastrum*, both perennial and annual species are frequently taprooted.

Annual: a plant that germinates, flowers, fruits, and dies within a single growing season (with a duration of less than one year); generally taprooted, usually not woody, although occasionally reviving for a fall growing season after summer rains.

Stems.

Stem: a general term for any shoot part of the plant, including the main stem or primary axis and any branch of any order, but not including leaves or inflorescences.

Current-year branch: in a perennial plant, the current year's growth. Usually herbaceous (Fig. 26).

Older-growth branch: in a perennial plant, stem growth from previous years. Usually woody (Fig. 26).

Axillary branch: a shoot from a leaf axil near the distal end of a current-year branch (in a perennial) or on an upper stem; usually short and terminating in an inflorescence head; a branch in a compound inflorescence (Fig. 26).

Herbage: herbaceous stems and leaves.

Upper stem: any stem at the distal end of a plant, or the distal ends of branches, usually referring to the upper part of an erect annual plant.

Lower stem: any stem at the proximal or basal end of a plant, nearest the ground.

Middle stem: any stem positioned between the upper and lower stems, in the central part of a plant, neither lower (proximal) nor upper (distal).

Internode: the region of a stem between leaves or nodes. The internode length is measured from one leaf node to the next adjacent leaf node (Fig. 26).

Axillary spur shoots: short shoots that develop in the axils of leaves, usually appearing to be just a small cluster of leaves, but sometimes developing into inflorescence heads.

Leaves.

Mature leaf: a leaf positioned below bracts subtending inflorescence branches, but above the base of the plant. Leaves near the base often have fewer lobes than mature leaves or inflorescence bracts, and sometimes are senescing or missing at flowering time.

Leaf length: leaves of *Eriastrum* are epetiolate (sessile or subsessile), so the total leaf length is measured from the point of attachment with the stem along the primary vein to the distal tip, and not including any lateral lobes.

Leaf primary axis: refers to the main part of the blade, containing the primary vein, and not including any lateral lobes. Leaf primary axis width is the width of the main axis of the leaf blade, i.e., including the primary vein and blade tissue surrounding it, but not including any lateral lobes. Since the leaves are linear to filiform in all species of *Eriastrum*, there is not a great deal of variation in the axis width, but it is taxonomically informative in a handful of taxa. It is usually measured at its widest part on the main axis, or just distal to proximally clustered lateral lobes (Fig. 27–29). Foster and Gifford (1974: 548–551) imply that the leaf rachis is only the portion of the main axis between the petiole and the terminal leaflet (i.e., the part of the main axis to which leaflets are attached). In *Eriastrum*, this division seems artificial in that there is no joint between the petiole (if present) and rachis or between the rachis and terminal lobe, and thus the positions of the ends of the rachis would not necessarily be homologous and could be in different positions in different leaves, even on the same plant. In some species, leaves are entire, leading to debate about whether a rachis is present or not. For clarity, in the following treatment the term rachis has been dropped and "primary axis" is used to refer to the main axis of the leaf, from the point of attachment on the stem to the distal tip, including the terminal lobe but not including any lateral lobes.

Pinnately lobed: in *Eriastrum*, the leaves are entire to pinnately lobed (pinnatifid), but the lateral lobes are generally clustered near the proximal end of the leaf and in a few cases may be so tightly clustered there that the leaf is effectively palmately lobed. In other taxa the lateral lobes are distributed along more of the leaf primary axis (Fig. 27–28).

Terminal leaf lobe: portion of the leaf primary axis distal to the distal-most lateral lobes.

Number of leaf lobes: a count of the total number of lateral lobes plus the terminal leaf lobe; if lobes are in pairs this will be an odd number. If the leaf is entire it could be said to have 1 lobe. If "lateral lobes" is specified, the terminal lobe is not included in the count (Fig. 27).

Upper leaves: leaves subtending branches terminating in inflorescence heads (generally found on the upper stems).

Lower leaves: leaves not subtending branches in the thyrse; found along the more proximal stems below the thyrse (generally along the middle and lower stems).

Inflorescence.

The inflorescence in *Eriastrum* is (in general) a dense dichasium, which is a form of cymose inflorescence where each axis terminates in a flower, but also produces two opposite or subopposite lateral axes (see also Schönenberger 2009: 1147). The pedicels tend to be very short, making the inflorescence a dense, head-like cluster that is referred to as a head, inflorescence head, or capitate inflorescence.

Arrangement of inflorescence heads: usually a determinate thyrse with alternate branching. The development and maturation of the inflorescence heads is centrifugal, with the terminal or central head maturing first, followed by the lateral heads.

Thyrse: a compound inflorescence with cymose partial inflorescences (Weberling 1989: 211, 216, etc.). This is the collective term for all inflorescence heads on a plant.

Head length and width: measurements do not include the tips of the bracts. This is how previous authors have measured head size. By excluding the tips of the bracts, the length becomes more representative of the calyx and pedicel lengths, and the width is representative of the number of flowers and tightness of flower packing in the head. Including the tips of the bracts would reflect bract length and curvature, which can be quite variable and appears to be less informative.

Number of flowers per head: an approximate count; very difficult to determine accurately because within a single head flowers mature at different times, and usually only a few flowers are open at any given

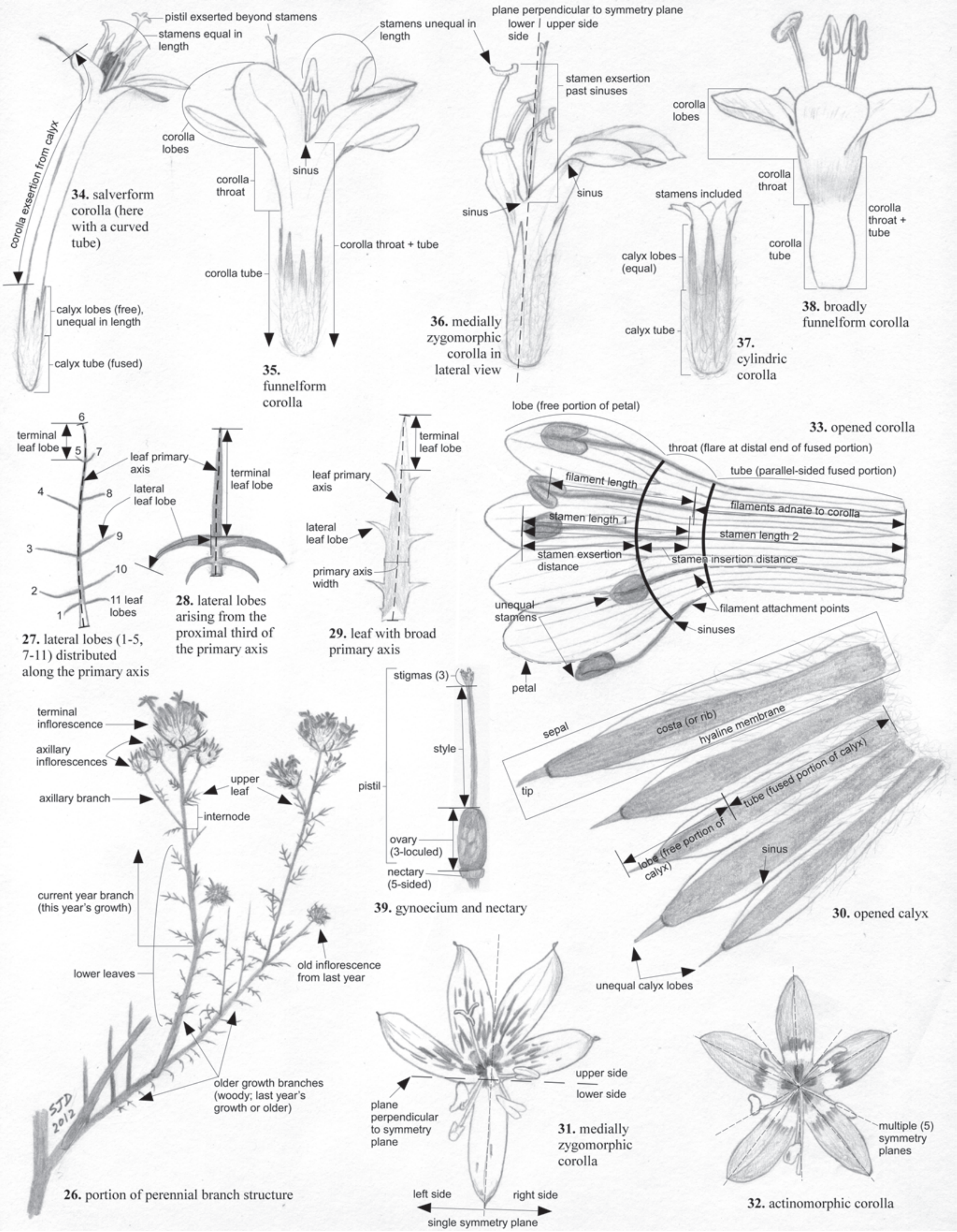


Fig. 26–39. Glossary illustrations.—26. Portion of the multi-year branching structure of a perennial, *Eriastrum densifolium* subsp. *austromontanum* (*De Groot 5048*).—27. Leaf showing lateral lobes distributed along the primary axis (*E. pluriflorum* subsp. **albifaux**, *De Groot 5050*).—28. Leaf showing lateral lobes clustered near the proximal end of the primary axis (*E. wilcoxii*, *De Groot 5463*).—29. Leaf with a broad

time. Best determined by counting capsules after a plant has finished flowering.

Bracts.

Outer bracts: bracts found near the outside of the inflorescence head (at proximal nodes), subtending clusters of flowers or subtending the head, also known as inflorescence bracts.

Inner bracts: bracts subtending the flowers, also known as floral bracts.

Pinnately lobed: see the note about pinnate lobing under leaves, since it also applies to bracts. The outer bracts of a number of *Eriastrum* taxa are often sub-palmately lobed or nearly so.

Number of lobes: See note about the number of lobes under leaves. There are usually fewer lateral lobes on inner bracts compared to outer bracts.

Calyx.

Sepal: unit of the calyx whorl, usually 1/5 of the calyx; fused with adjacent sepals at the base (tube), but free at the distal tip (lobe). Usually green in the center (costa or rib) and hyaline on the margin at anthesis (Fig. 30; see also Fig. 257 [Color Plate 7]).

Costa: central, green portion of a sepal.

Calyx lobe: distal, free portion of a sepal.

Calyx tube: fused portion of the sepals; in *Eriastrum* the sepals are usually connected only by their hyaline margins.

Lobes equal or unequal: having calyx lobes of different lengths. The calyx sinuses are usually more or less equal, suggesting that only the lobes are unequal and not the tube. However, sepals with longer lobes usually also have a broader costa.

Corolla.

Symmetry terms are used as defined by Neal et al. (1998), Endress (1999, 2012), and Schönenberger (2009) and refer to corolla frontal symmetry.

Zygomorphic: bilaterally symmetric or having two mirror images on either side of a vertical central plane, at least when viewing the distal portion of the flower face-on. Also known as irregular, bilabiate, or medial zygomorphy, a form of monosymmetry (Neal et al. 1998; Endress 2012). Following Endress (2012), the mirror-image sides of a medially zygomorphic corolla are referred to as the left and right sides. The two unequal sides divided by a plane at right angles to the single plane of symmetry are referred to as the lower (i.e., nearest the ground) and upper (i.e., facing the sky) sides (Fig. 31, 36). See also terminology notes under "inside of the corolla tube."

Actinomorphic: radially symmetric or having multiple planes of symmetry by which the flower can be divided. Also known as regular or polysymmetric (Neal et al. 1998; Endress 1999; Fig. 32). Very often the upper and lower sides of the flower are also equal and symmetric (Fig. 35, 37, 38).

Exsertion from calyx: the portion of the corolla that is distal to the calyx at anthesis, measured from the tip of the most distal calyx lobe (Fig. 34).

Petal: basic unit of the corolla, fused to adjacent petals at the proximal end (tube, throat) and free at the distal end (lobe) (Fig. 33).

Tube: the cylindrical, parallel-sided, proximal part of the fused portion of the corolla, very often (but not always) it corresponds to the distance from stamen attachment point to base of corolla (sensu Mason 1945: 72; Fig. 33, 35, 38).

Inside of the corolla tube: the adaxial or ventral side, because it faces the main axis (which presumably runs through the center of the corolla tube), according to Keck (1959) and Harris and Harris (2000). The outside of the corolla tube would then be the abaxial or dorsal side. However, some authors (e.g., Coen 1996) use "ventral" to refer to the lower parts of a flower (i.e., nearest the ground) and "dorsal" to refer to the upper parts of a flower (i.e., parts facing the sky). Other authors (e.g., Endress 1999) use "abaxial" to refer to the lower parts of a flower (i.e., nearest the ground) and "adaxial" to refer to the upper parts of a flower (i.e., parts facing the sky). Given this confusion with terms, it would seem clearest to refer to the inside of the corolla tube as simply the inside or interior of the corolla tube.

Tube puberulent inside or not: sometimes the epidermal cells on the inside of the corolla tube have projections. These vary in density and length. They are usually part of the epidermal cell, but in a few taxa are multi-cellular (see Fig. 269 [Color Plate 7]).

Throat: here defined as the wider (sometimes slightly) distal portion of the fused part of the corolla, very often (but not always) it corresponds to the distance from the corolla sinuses to the point of stamen attachment (sensu Mason 1945: 72; Fig. 33, 35, 38).

Throat symmetry: related to corolla frontal symmetry; usually symmetric in actinomorphic corollas, but asymmetric in zygomorphic corollas, where the upper side tends to be longer than the lower (Fig. 36).

Tube plus throat length: the length of the entire fused portion of the corolla. Useful when the throat is poorly differentiated (Fig. 35, 38).

Lobes: the distal, free portions of petals (Fig. 33, 35, 38).

Lobe length: measured along the midvein from the height of the sinus to the distal tip. In the case of unequal sinuses, lengths are measured from the heights of both sinuses and averaged.

Androecium.

Stamen attachment point or insertion: the proximal portions of the filaments are adnate to the corolla tube, and in the following descriptions "insertion point" (or attachment point, see below) refers to the point at which the filament becomes free from the corolla (Fig. 33).

Insertion distance: the distance from the sinuses to the stamen attachment point or insertion (Fig. 33). This is usually given as a range when sinuses are unequal.

Stamen length: in most cases, two lengths are given: that of the free portion of the stamen, or the distance from the point where the filament becomes free from the corolla to the distal tip of the anther (often ≅ filament length + 1/2 anther length); and that of the entire stamen from the distal tip of the anther to the base of the corolla where the staminal vein enters from the receptacle (Fig. 33).

←

primary axis (*E. densifolium* subsp. *mohavense*, *De Groot 5907*).—30. Calyx, opened (*E. filifolium*, *De Groot 5590*).—31. Medially zygomorphic corolla viewed from the front, with a single, vertical plane of symmetry marked as a dashed line (*E. eremicum* subsp. *zionis*, *De Groot 5271*).—32. Actinomorphic corolla viewed from the front, with multiple (5) planes of symmetry marked as dashed lines (*E. virgatum*, *De Groot 5302*).—33. Corolla, opened by removal of one petal. A single petal is outlined by the dashed line. Stamen length 1 is the length of the free portion; stamen length 2 is the total length of the stamen (*E. diffusum* subsp. *diffusum*, *De Groot 4996*).—34. Flower viewed from the side, displaying a curved, salverform corolla long-exserted from the calyx (*E. pluriflorum* subsp. *pluriflorum*, *De Groot 5650*).—35. Flower viewed from the side, displaying a funnelform corolla. The proximal end of the corolla tube is hidden by the calyx (*E. densifolium* subsp. *densifolium*, *De Groot 5700*).—36. Flower with a medially zygomorphic corolla viewed from the side, displaying an asymmetric corolla throat, unequal sinuses, and curved, unequal stamens (*E. eremicum* subsp. *eremicum*, *De Groot 5810*).—37. Flower viewed from the side, with a cylindric corolla barely exserted from the calyx, and stamens included (*E. hooveri*, *De Groot 6385*).—38. Broadly funnelform corolla with stamens (calyx removed), viewed from the side (*E. luteum*, *De Groot 5024*).—39. Gynoecium and nectary disk (*E. ertterae*, *De Groot 5310*). Drawings are not all to the same scale.

Exsertion distance: calculated by subtracting the insertion distance from the length of the free portion of the stamen, to obtain the length of the portion of the stamens that project beyond the sinuses (Fig. 33). If the insertion distance is longer than the length of the free portion of the stamen, the stamens do not project beyond the corolla sinuses and are included (Fig. 37).

Equal or unequal, and length difference: all 5 stamens within a flower may be approximately the same length, or they may vary in length, with some short stamens and some long stamens in the same flower. The length difference is calculated by subtracting the length of the shortest stamen measured from the length of the longest stamen measured (Fig. 33, 35, 36).

Filament length: distance from the point where the filament becomes free from the corolla to the point where the filament attaches to the anther (Fig. 33)

Filament length difference is calculated the same way as stamen length difference.

Anther length: total length of the thecae, from the distal tip to the sagittate base.

Gynoecium.

Gynoecium: the entire female whorl or whorls in a flower, all of the carpels or pistils collectively (Fig. 39).

Pistil: a single female reproductive structure within a flower. In Polemoniaceae, three carpels are fused to form a single pistil, consisting of an ovary (with three locules), a style, and a stigma with three lobes. Because the three carpels of the gynoecium are fused, the terms pistil and gynoecium are essentially synonymous in Polemoniaceae, but in other families they are not. In this paper, pistil is used to refer to the female floral structure, and gynoecium is reserved for the entire female reproductive whorl in general (Fig. 39).

Pistil length: measured (as much as possible) on a mature pistil. Because in some taxa the pistil continues to elongate after anthesis, a mature (or receptive) pistil is here defined as one in which the stigma lobes have spread.

Exsertion or inclusion of the pistil relative to stamens (herkogamy): mostly important for reproductive biology; flowers with pistils at the same degree of exsertion as the stamens are thought to be more likely self-pollinating. Calculated by comparing the total pistil length to the total stamen length measured to the base of the corolla (Fig. 34, 35).

Pistil trichomes: mostly glandular, occasionally not, the stalk one cell wide but several cells long, the gland unicellular; varying in density and distribution on the style and ovary (see Fig. 104, 285–288 [Color Plate 8]).

Stigma length: measured from the point of divergence of the three lobes to the distal tips of the lobes (or to the tip of the longest lobe) (Fig. 39; see also Fig. 144–146).

Style length: measured from the distal tip of the ovary to the point of divergence of the three stigma lobes (Fig. 39).

Nectary: a 5-lobed disk situated at the proximal end of the pistil, just proximal to the ovary. Its homology is not clear; it may have been derived from an extra whorl of stamens, or from ovarian tissue (Schönenberger and Grenhagen 2005). In this paper, it is treated as a structure separate from either the stamens or the carpels (Fig. 39; see also Fig. 147, 234–236 [Color Plate 6]).

Fruit.

Number of seeds per locule: may be fewer than the number of ovules per locule, since in some taxa some ovules are known to abort.

Abbreviations

≡ means that the synonym shares the same type as the accepted name (homotypic synonym).

= means that the synonym has a different type than the accepted name, but is treated as the same taxon (heterotypic synonym).

≠ means that the name is not a synonym.

! following a specimen citation indicates that the specimen was seen by the author.

Image! following a specimen citation indicates that an image (photograph or scan) of the specimen was seen by the author.

Herb. Benth. = Herbarium Benthamianum, or, George Bentham's herbarium, now part of the collection at Kew (K).

Herb. Hook. = Herbarium Hookerianum, or, William Jackson Hooker's Herbarium, now part of the collection at Kew (K).

Herbaria are generally referred to by their abbreviations as given in *Index Herbariorum* (Holmgren et al. 1990; Thiers, continuously updated). Author names follow the abbreviations given in Brummitt and Powell (1992), with the exception that last names are often spelled out in full unless quoting the citation of another author.

CCH: Consortium of California Herbaria, an online searchable database of specimen records from herbaria throughout California.

Categories

Information in the taxonomic treatment is categorized under several headings, which are described below. Some categories are not present for all taxa. For accepted taxa, the original descriptions have been incorporated into the descriptions given here. In some cases, descriptions of heterotypic synonyms may also have been included.

Identification.—These sections provide some means by which to tell apart co-occurring or easily confused species of *Eriastrum.*

Phenology.—The approximate time of flowering and fruiting. Note that in any given year, the flowering or fruiting probably will not have a duration as long as the time period indicated here—these also reflect year-to-year variation—but flowering and fruiting is likely to occur for a shorter duration sometime during the interval indicated.

Distribution.—Given in two parts: (1) the political geography, and (2) the floristic or climatic provinces in which the taxon occurs (sensu McLaughlin 2007; Baldwin et al. 2012; Jepson Flora Project 2015).

Habitat.—Provides the elevation, topography, slope, aspect, substrate, and vegetation where a taxon may be found. These were compiled primarily from field observations.

Population dynamics.—Summarizes information about population sizes, plant abundance, seed germination, seedling recruitment, competition, and mortality, as much as is known. These were compiled from field observations and published literature.

Threats.—Lists and discusses known and possible threats to the survival, persistence, or success of a taxon.

Conservation.—Summarizes current conservation status, including global rank (G), U.S. federal or state legal status under the U.S. Federal Endangered Species Act or the California Endangered Species Act, national rank (N), subnational or state rank (S), California Native Plant Society (CNPS) Rare Plant Rank, and any other status such as a Sensitive listing by the U.S. Forest Service (USFS) or Bureau of Land Management (BLM). The global rank refers to the status of the taxon throughout its entire range, national rank refers to the status of the taxon in its range within a nation (in this case, the United States or Mexico), and subnational rank refers to the status of the taxon in its range within a state. "T" refers to the status of a taxon below the rank of species (in this case, subspecies) throughout its entire range. The numbers 1–5 following a rank indicate rarity, amount of threat, or population trends, with 1 being the most rare or threatened and 5 being the most widespread or secure. California Rare Plant Rank 1B is for plants that are rare, threatened, or endangered in California and elsewhere; 3 is for plants about which more information is needed—a review list; 4 is for plants of limited distribution—a watch list (CNPS

2016). The decimal numbers following CNPS ranks similarly indicate the degree of threat, with 0.1 being the most threatened, and 0.3 being the least threatened (CNPS 2013). Most information was compiled from CNPS (2013) and NatureServe (2013), but additional sources were used for some taxa and are cited there. All conservation information is compiled in Table 2. For a few taxa, current mitigation or conservation measures are mentioned, and occasionally some possibilities for future conservation are suggested.

Etymology.—Gives the derivation and meaning of the taxon's epithet.

Common name.—Lists common names that have been used or proposed for a taxon.

Other specimens, or paratypes.—Mentions other specimens of particular interest; usually these are paratypes or ones cited in a previous revision. Citations of most specimens examined are in the Appendix.

Discussion.—These sections provide a fuller explanation of various topics pertinent to the taxon, such as why a particular lectotype was chosen; the location of the type locality; issues relating to position, rank, or circumscription; notes about the morphology, biogeography, or reproductive biology; etc.

TAXONOMIC TREATMENT

ERIASTRUM Wooton and Standley 1913, *Contr. U.S. Natl. Herb*. Vol. 16 part 4 p. 160.

Type: *Hugelia densifolia* Bentham 1833, Edwards's Botanical Register t. 1622 (designated by Grant 1959: 122).

=*Hugelia* Bentham 1833, *Edwards's Botanical Register* t. 1622 (nom. illeg., non *Hügelia* Reichenbach 1828 or 1829). Jepson 1925, A Manual of the Flowering Plants of California, p. 792. Jepson 1943, A Flora of California Vol. 3 Part II pp. 160–161.

Type: *Hugelia densifolia* Bentham (Grant 1959: 122).

=*Welwitschia* Reichenbach 1837, Handbuch des natürlichen Pflanzensystems, 194 (name unavailable by conservation of *Welwitschia* Hooker f. 1862; Briquet 1912; Sprague 1921; McNeill et al. 2012, Art. 14.10). P.A. Rydberg 1917, Flora of the Rocky Mountains and Adjacent Plains, p. 688.

Type: interpreted as *Hugelia densifolia* Bentham (Grant 1959: 122).

=*Gilia* Ruiz and Pavon [unranked] *Collomioides* Endlicher 1839, Genera Plantarum secundum ordines naturales disposita. 657. Bentham 1845, *in* De Candolle, Prodromus Systematis Naturalis Regni Vegetabilis 9: 310–311.

Type: *Hugelia densifolia* Bentham (designated by Grant 1959: 122).

=(in part) *Gilia* Ruiz and Pavon 1794, Flora Peruvianae et Chilensis Prodromus. 25. t. 4. Steudel, 1840, Nomenclator Botanicus, seu Synonymia Plantarum Universalis, enumerans Ordine Alphabetico Nomina Atque Synonyma, tum generica tum specifica, et a Linnaeo et a recentioribus de re botanica scriptoribus plantis phanerogamis imposita. p. 683.

Type: *Gilia laciniata* Ruiz & Pavon.

(in part)= *Gilia* section *Pseudocollomia* Bentham 1845, *in* De Candolle, Prodromus Systematis Naturalis Regni Vegetabilis 9: 311.

Type: *Gilia lutescens* Steudel (automatic type; see also McNeill et al. 2012 Art. 10; Grant 1959: 123).

=*Gilia* [unranked] *Hugelia* A. Gray 1870, *Proc. Amer. Acad. Arts Sciences* 8: 271.

Type: *Hugelia densifolia* Bentham (designated by Grant 1959: 122).

=*Gilia* section *Hugelia* Bentham and Hooker 1876, Genera Plantarum 823 (as "*Huegelia*").

Type: *Hugelia densifolia* Bentham (designated by Grant 1959: 122).

=(in part) *Navarretia* Ruiz & Pavon 1794, Flora Peruvianae et Chilensis Prodromus, p. 20. Kuntze 1891, Revisio Generum Plantarum, Pars II p. 432–434.

Type: *Navarretia involucrata* Ruiz & Pavon (automatic type; see also McNeill et al. 2012 Art. 10; Grant 1959: 123).

=*Gilia* subgenus *Hugelia* Milliken 1904, A Review of California Polemoniaceae. *Univ. Calif. Publ. Bot.* Vol. 2: 24. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 385–386.

Type: *Hugelia densifolia* Bentham (Grant 1959: 122).

=(in part) *Navarretia* subgenus *Hugelia* (Bentham) Brand 1907, *in* Engler's Das Pflanzenreich, p. 164.

Type: *Hugelia densifolia* Bentham (Grant 1959: 122).

=*Navarretia* subgenus *Hugelia* (Bentham) Brand Section *Euhugelia* Brand 1907, *in* Engler, Das Pflanzenreich IV. 250: 164.

Type: *Hugelia densifolia* Bentham (Grant 1959: 122).

≠*Hügelia* Reichenbach 1828 or 1829, Conspectus Regni Vegetabilis… pars prima, p. 144 (Araliaceae). See also Reichenbach 1830. Iconographia Botanica Exotica, sive Hortus Botanicus [3: 1] 201.

Type: *Hügelia coerulea* Reichenbach 1830, Ic. exot. 201.

≠*Hügelia* R. Brown, in Endlicher, 1840, Gen. Pl. p. 1156. See also Endlicher 1839, Gen. Pl. p. 657; Brown 1814, Bot. Flinder's Voyage II: 546 (nom. illeg.; Rutaceae).

≠*Welwitschia* Hook.f. 1862, *Gard. Chron*. p. 71 (nom. cons.; Welwitschiaceae). See Briquet 1912; Sprague 1921.

Type: *Welwitschia mirabilis* Hook.f.

Perennial or annual, woody or herbaceous, shrub, subshrub, suffrutescent perennial, or forb, 1–90 cm tall, about 1–50 cm wide or more, stems branching from the base or above, erect to spreading, sometimes decumbent, sometimes caespitose; virgate, racemose, corymbose, paniculate, or unbranched, sometimes zig-zag, occasionally tortuous; axillary branches, buds, or spur shoots well-developed or not; lateral branches sometimes overtopping the primary axis. **Stems** slender to stout, flexible to rigid, sometimes wiry, straight or curved, sometimes brittle; upper (young) stems light green, yellow-green, gray-green, or green, sometimes canescent, lower (older) stems often brown, reddish, purplish, gray-brown, or tan, sometimes spotted or streaked, sometimes obscured by wool; glabrous to densely floccose, more woolly near the heads and axillary buds than in the proximal parts, sometimes glandular-hairy; stems sparsely to densely leafy, internodes 0.25–6.5 cm long, the longer lengths found just below the heads in some species, but the shorter lengths near the heads in other species. **Leaves** alternate (occasionally opposite at the base of the plant), sessile or subsessile, entire to pinnatifid; mostly ascending to spreading, sometimes appressed, sometimes curved, curling, or recurved; 3–50 (–60) mm long; yellow-green or light green to gray-green or green, sometimes canescent, occasionally yellowish, aging brown, reddish, purplish, or tan, sometimes with a darker green or reddish tip; glabrous to densely floccose, usually with some woolly trichomes at least at the base, becoming more glabrous in age; glandular-hairy or not; flexible to rigid, sometimes becoming brittle in age; with 1–13 (–15) lobes, often in pairs, usually spreading, sometimes recurved; arising from the base, proximal third, half, 2/3, or 3/4 of the leaf, or equally spaced along the primary axis, often with several lobes clustered near the base of the leaf, the lower leaves often with fewer lateral lobes than the upper leaves; leaves linear, lanceolate, or ovate in outline, the lobes and primary axis filiform to linear, sometimes terete, the primary axis sometimes broader and nearly lanceolate; apex subulate, acute to aristulate, usually tipped with a white bristle; lateral lobes 1–15 mm long, sometimes reduced to teeth, or the most proximal lateral lobes sometimes reduced; rarely some leaves may be bi-pinnate. **Inflorescences** capitate, bracteate, lightly to densely floccose-woolly, sometimes glandular, green to white-canescent, usually terminating the branches, sometimes with additional axillary heads, heads solitary or arranged in a racemose or corymbose thyrse, open to dense; 1–250 or more heads per plant; heads spherical, turbinate, elongate, or obovoid; 3–25 mm long, 2–30 (–40) mm wide excluding the flowers and the tips of the bracts, with flowers to 60 mm across, sometimes wider in fruit, axillary heads may be smaller; usually with 1–40 flowers or more, but usually with no more than 12 open at one time. **Bracts** entire to pinnatifid, sometimes palmatifid, ascending to spreading, sometimes curved, few to many

Table 2. Conservation status (CNPS 2013; CNDDB 2013; NatureServe 2015). NR = not ranked.

	Global Rank[1]	U.S. Federal Status	U.S. State Legal Status	National Rank	Subnational/State Rank[2]	California Rare Plant Rank[3]	Other status
abramsii	G3	not listed	not listed	USA (NR)	California (NR)	NR	
calocyanum	NR	not listed	not listed	USA (NR)	California (NR)	NR	
densifolium sp.	G4	Implied: partial status[4]	not listed	USA (NR), Mexico (NR)	California (NR), Baja California (NR)	NR	
densifolium densifolium[5]	G4TNR	not listed	not listed	USA (NR)	California (NR)	considered but rejected	
densifolium austromontanum	G4TNR	not listed	not listed	USA (NR), Mexico (NR)	California (NR), Baja California (NR)	NR	
densifolium elongatum	G4TNR	not listed	not listed	USA (NR), Mexico (NR)	California (NR), Baja California (NR)	NR	
densifolium mohavense	G4T3?	not listed	not listed	USA (N3 – vulnerable)	California (NR)	NR	
densifolium patens[5]	G4TNR	not listed	not listed	USA (NR)	California (NR)	NR (considered but rejected)	
densifolium sanctorum	G4T1	Endangered (1987)	California: Endangered (1987)	USA (N1)	California (S1)	1B.1	USFS – S – Sensitive
diffusum sp.	G5	not listed	not listed	USA (NR), Mexico (NR)	Arizona (NR), California (NR), Colorado (NR), Nevada (NR), New Mexico (NR), Texas (NR), Utah (NR)	NR	
diffusum diffusum	G5TNR	not listed	not listed	USA (NR), Mexico (NR)	Arizona (NR), California (NR), Colorado (NR), Nevada (NR), New Mexico (NR), Texas (NR); Baja California (NR), Chihuahua (NR), Sonora (NR)	NR	
diffusum coachellae	G5TNR	not listed	not listed	USA (NR)	California (NR)	NR	
diffusum utahense	G5TNR	not listed	not listed	USA (NR)	Arizona (NR), Nevada (NR), Utah (NR)	NR	
eremicum sp.	G5	not listed	not listed	USA (NR), Mexico (NR)	Arizona (NR), California (NR), Nevada (NR), Utah (S3); Baja California (NR)	NR	
eremicum eremicum	G5T5?	not listed	not listed	USA (NR), Mexico (NR)	Arizona (NR), California (NR), Nevada (NR); Baja California (NR)	NR	
eremicum markianum	G5TNR	not listed	not listed	Mexico (NR)	Baja California (NR)	NR	
eremicum yageri	G5T2T4	not listed	not listed	USA (NR)	Arizona (NR)	NR	
eremicum zionis	G5TNR	not listed	not listed	USA (NR)	Arizona (NR), Nevada (NR), Utah (NR)	NR	
ertterae	G1	not listed	not listed	USA (N1)	California (S1)	1B.1	
filifolium	G4G5	not listed	not listed	USA (NR), Mexico (NR)	California (NR), Baja California (NR)	considered but rejected	
harwoodii	G3	not listed	not listed	USA (NR)	California (S3)	1B.2	BLM – S – Sensitive
hooveri[6]	G3	listed 1990, de-listed 2003	not listed	USA (N3)	California (S3)	4.2	USFS – S – Sensitive
luteum	G2	not listed	not listed	USA (N2)	California (S2.2)	1B.2	BLM – S – Sensitive; USFS – S – Sensitive

Table 2. Continued.

	Global Rank[1]	U.S. Federal Status	U.S. State Legal Status	National Rank	Subnational/State Rank[2]	California Rare Plant Rank[3]	Other status
pluriflorum sp.	G3?	not listed	not listed	USA (NR)	California (NR)	NR	
pluriflorum pluriflorum	G3?TNR	not listed	not listed	USA (NR)	California (NR)	NR	
pluriflorum albifaux	G3?TNR	not listed	not listed	USA (NR)	California (NR)	NR	
pluriflorum sherman-hoytae	G3?T3?	not listed	not listed	USA (NR)	California (NR)	considered, but rejected	
rosamondense	G1	not listed	not listed	USA (N1)	California (S1)	1B.1	
sapphirinum sp.	G3G4	not listed	not listed	USA (NR), Mexico (NR)	California (NR), Baja California (NR)	NR	
sapphirinum sapphirinum	G3G4TNR	not listed	not listed	USA (NR), Mexico (NR)	California (NR), Baja California (NR)	NR	
sapphirinum brevibracteatum	G3G4TNR	not listed	not listed	USA (NR)	California (NR)	NR	
sapphirinum dasyanthum	G3G4TNR	not listed	not listed	USA (NR), Mexico (NR)	California (NR), Baja California (NR)	NR	
signatum	G4G5	not listed	not listed	USA (NR)	California (NR), Idaho (NR), Nevada (NR), Oregon (NR), Utah (NR).	NR	
sparsiflorum	G3G4[7]	not listed	not listed	USA (NR)	California (S3?)	4.3	
tracyi[8]	G3Q	not listed	California: Rare (1982)	USA (N3)	California (S3)	3.2	BLM – S – Sensitive; USFS – S – Sensitive
virgatum	G3	not listed	not listed	USA (N3)	California (S3.3)	4.3	
wilcoxii	G5	not listed	not listed	USA (NR)	California (NR), Idaho (NR), Nevada (NR), Oregon (NR), Utah (NR), Washington (NR), Wyoming (S1S2)	NR	

[1] Global rank = status of the taxon throughout its entire range; National rank = status of the taxon in its range within a nation (in this case, the United States or Mexico); Subnational (state) rank = status of the taxon in its range within a state. "T" refers to the status of a taxon below the rank of species (in this case, subspecies) throughout its entire range. The numbers 1–5 following a rank indicate rarity, amount of threat, or population trends, with 1 being the most rare or threatened and 5 being the most widespread or secure: 1: critically imperiled, 2: imperiled, 3: vulnerable, 4: apparently secure, 5: secure. "Q" means there are taxonomic questions about this species.

[2] State status outside California verified at Arizona Game and Fish Department [*http://www.azgfd.gov/w_c/edits/hdms_species_lists.shtml*]; Colorado Natural Heritage Program [*http://www.cnhp.colostate.edu/download/list/vascular.asp*]; Idaho Fish and Wildlife Information System [*https://fishandgame.idaho.gov/ifwis/portal/sites/ifwis/files/user/idfg-jstrickland/INHP_Tracked_Plant_Species--2013-05.pdf*]; Nevada Natural Heritage Program [*http://heritage.nv.gov/species/process_list.php?list=NNHPtrack&page=7&sort=MINOR_GROUP_ID&order=ASC*]; Natural Heritage New Mexico [*http://nhnm.unm.edu/query_bcd/bcd_basic_query.php5*]; Oregon Biodiversity Information Center [*http://orbic.pdx.edu/rte-species.html*]; Texas Parks and Wildlife [*http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/texas_rare_species/listed_species/*]; Utah Natural Resources, Division of Wildlife Resources [*http://dwrcdc.nr.utah.gov/rsgis2/Search/SearchSelection.asp?Group=PLANT&Species=PLANT*]; Washington State Department of Natural Resources [*http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html*]; Wyoming Natural Diversity Database [*http://www.uwyo.edu/wyndd/species-of-concern/plants/vascular-plants.html*] and 2012 Wyoming Plant Species of Concern List [*http://www.uwyo.edu/wyndd/_files/docs/soc-plants/2012_plant_soc.pdf*].

[3] California Rare Plant Rank 1B = plants rare, threatened, or endangered in California and elsewhere; 3 = plants about which more information is needed—a review list; 4 = plants of limited distribution—a watch list. The decimal numbers following the ranks similarly indicate the degree of threat, with 0.1 being the most threatened, and 0.3 being the least threatened (CNPS 2013, 2016; NatureServe 2013).

[4] "Partial status" indicates that part of this species (subsp. *sanctorum*) has U.S. federal status (endangered) under the Endangered Species Act (NatureServe 2013).

[5] Ranks probably include both *E. densifolium* subspp. *densifolium* and *patens* together.

[6] *E. hooveri* rankings probably include *E. rosamondense* from Antelope Valley, but not *E. ertterae*.

[7] NatureServe (2015) gives *E. sparsiflorum* a global rank of G4G5, but this includes *E. signatum*.

[8] *Eriastrum tracyi* was fairly recently downgraded to 3.2 from 1B.2, although it remains state-listed as Rare (CNPS 2015). *Eriastrum brandegeae*, synonymized here, is ranked G1Q, S1, rare plant rank 1B.1, and BLM Sensitive (CNDDB 2013).

per head; 3–27 mm long, equalling or exceeding the calyces; light green, yellowish-green, gray-green, green, or tan, sometimes reddish, often becoming tan or reddish in age, tips light green, yellowish, reddish, tan, or brown, often becoming more so in age; subglabrous to canescent or densely floccose, at least at the base, the bases and sometimes the tips visible or completely obscured by dense, white wool, sometimes glandular; with 1–11 lobes, most lobes arising from the wide base, the proximal third, half, 2/3, or 3/4 of the bract, or along the length of the primary axis, but usually lobes are more dense near the base of the bract, inner bracts usually with fewer lobes than the outer; bracts linear, lanceolate or ovate in outline, sometimes keeled at base, lobes filiform to linear, mostly spreading, sometimes recurved, sometimes with a short membrane in the sinuses between the lobes; lateral lobes 1–10.5 (–12) mm long, apex subulate, acuminate, aristulate, or aristate. **Calyx** tubular to campanulate, 4–12 mm long, composed of 5 sepals with central costae bordered by a hyaline margin, straight and erect, linear to lanceolate, lightly lanate to densely floccose, sometimes partly or completely hidden by woolly trichomes, sometimes glandular-puberulent and viscid; costae light green, yellowish-green, or green, color sometimes lighter proximally, tips often darker green, reddish, yellow, or brown; subulate, acuminate, aristulate, or aristate; margins hyaline and usually somewhat translucent, fused to form a tube for the proximal 1/3 to 2/3 of the calyx length; lobes nearly equal or subequal to unequal, differing in length within a flower by 0.25–4 mm, often with 2 long lobes and 3 short, or 3 long and 2 short. **Corolla** composed of 5 (rarely 4, 6, 7, 8) petals fused at the base, broadly funnelform to salverform, actinomorphic to strongly medially zygomorphic (sometimes shape is more or less actinomorphic but color distribution is zygomorphic), upper and lower sides sometimes asymmetric, or corolla lobes asymmetric from interactions with the calyx lobes or bracts; 4.2–33.0 mm long; corolla well-exserted with the tube projecting beyond the calyx, or mostly included with only the distal portions of the lobes projecting beyond the calyx. Tube slender to relatively broad, straight or curved, 2.0–19.5 mm long; white, cream, pale blue, lavender, pink, purple, reddish, or yellow, base sometimes yellowish or reddish, sometimes with a ring of a contrasting color just proximal to the throat, the whole tube sometimes drying yellowish or translucent; glabrous or puberulent inside with 1–3-celled epidermal papillae, occasionally glandular. Throat funnelform, campanulate, or noticeably flared and wider than the tube, sometimes asymmetric due to unequal sinuses; 0.2–5.7 mm long; white, cream, pale blue, lavender, purple or with purple dots, yellow or yellow-spotted, or pink, sometimes drying yellowish. Tube plus throat 2.6–23.0 mm long. Lobes mostly spreading widely but sometimes ascending; lanceolate, oblanceolate, elliptic, obovate, oval, strap-shaped, spatulate, or oblong, sometimes asymmetric; apices acute, cuspidate, obtuse, rounded, truncate, notched, retuse, or oblique, sometimes irregularly crenate; tips sometimes curled, inrolled, or twisted; usually glabrous; 1.3–11 mm long, 22–67% of the total corolla length, equal to subequal, varying in length in a single flower by 0.0–0.9 mm; 0.6–5.0 mm wide; various shades of blue, violet, purple, lavender, white, cream, yellow, or light pink, sometimes translucent or transparent; veins often darker blue or purple, occasionally with purple, blue, red, lavender, or brown dots, lines, or streaks, usually near the proximal end of the lobe. Buds white, cream, yellow, or pale blue. **Stamens** 5 (rarely more or fewer), antisepalous, in a single whorl, adnate to the corolla at the base, included 0.6 mm below the sinuses of the corolla to exserted 7.0 mm beyond the sinuses, often equalling or shorter than the lobes, but sometimes projecting beyond them by up to 1.0 mm, attached 0.0–4.4 mm below the sinus, the insertion distance varying within a flower by 0.0–2.6 mm; free portion of stamen 0.75–11 mm long, to the base of the corolla 2.5–28.1 mm long, equal to unequal, differing in length within a flower by 0.0–4.4 mm. Filaments threadlike to stout, straight or curved, 0.4–9.5 mm long; white, cream, yellow, blue, lavender, or purple. Anthers bi-thecous, versatile; ovate to elliptic, oblong, or linear; apex obtuse, base sagittate or cordate; 0.4–4 mm long, 0.4–1.75 (–2?) mm wide, white, cream, yellow, pale blue, lavender, violet, or purple, sometimes drying yellowish. Pollen blue, lavender, gray, pale yellow, cream, or white, with an average grain diameter of 22–39 μm; zonate, anomotreme, or pantotreme aperture arrangements. The **gynoecium** is composed of a single pistil of 3 fused carpels; pistil about 2.6–30 mm long, about 2 mm shorter than the stamens to 4.6 mm longer; glabrous or with sparse to dense 2–6-celled glandular trichomes at the distal tip of the ovary and/or the proximal 2/3 of the style, occasionally with a few non-glandular trichomes as well; stigma 3-lobed, lobes 0.1–1.5 mm long, often white or cream-colored; style about 0.7–27 mm long, white, cream, yellow, blue, lavender, or purple; ovary oblong to ovate, 3-loculed, with axile placentation; 1–11 ovules per locule. At the base of ovary is a 5-sided nectary disk. **Fruit** is a 3-celled capsule, oblong or elliptic, rounded to triangular in cross-section, apex pointed, loculicidally dehiscent; (1.3–) 1.75–6.0 (–10?) mm long, (0.8–) 1–2.7 mm wide; tan to purplish, sometimes reddish-tipped when immature, smooth and shining; usually with about 1–11 seeds in each locule (occasionally 0), may be fewer than the number of ovules, abortive ovules sometimes present. **Seeds** 0.8–3.5 mm long, 0.5–1.4 mm wide, tan to brown or gray-brown; elliptic, ovate, oblong, rhombic, or angular; subterete to slightly dorsiventrally flattened, sometimes with translucent, unfilled margins; mostly developing mucilage when wetted, but a few species may not.

Identification.—Traditionally, *Eriastrum* has been recognized on the basis of characters such as entire or once-pinnatifid leaves, lanate pubescence, unequal calyx lobes, and sagittate or cordate anthers (Bentham 1833; Mason 1945). But further study has shown that other genera in Polemoniaceae share some of these traits. Many other species throughout the family have entire or once-pinnatifid leaves (e.g., Fig. 12 in Grant 1959). Unequal calyx lobes are also present in several species of *Navarretia* (Patterson 2012; Johnson 2012). Some of the small-flowered species of *Eriastrum* (e.g., *E. abramsii*) have small, roundish anthers similar to anthers in *Navarretia* (Mason 1945). Since the anthers of all genera in Polemoniaceae are bi-thecous and filaments are usually attached near the middle of the anthers (Schöenenberger 2009), a slight spreading of the proximal ends of the thecae would render the anther sagittate; therefore using this character to distinguish the genus *Eriastrum* seems dubious.

The woolly trichomes present on the calyces, bracts, and sometimes upper stems and leaves of *Eriastrum* plants are perhaps the best distinguishing character for the genus. While other genera in Polemoniaceae, such as *Microgilia*, *Langloisia*, *Loeseliastrum*, *Ipomopsis*, *Gilia*, or *Navarretia*, frequently have hairs, none have the woolly trichomes in the inflorescence like *Eriastrum*. The woolly trichomes may be reduced or sparse, as in *E. sapphirinum* subsp. *sapphirinum*, but usually there are at least a few present, appearing like small wisps of cotton. Other genera that might be confused with *Eriastrum* all lack woolly trichomes in or near the inflorescences.

Phenology.—Flowering occurs from about mid-March through August and probably into September at some sites. A few species will flower again following summer precipitation. The actual duration of flowering in any given year is much shorter than the range given above. Fruiting occurs from late April through October. Flowering and fruiting times may vary from year to year depending on weather conditions.

Distribution.—Western United States and northwest Mexico: Arizona, California, Colorado, Idaho, Nevada, New Mexico, Oregon, Texas, Utah, Washington, Wyoming; Baja California, Baja California Sur, Sonora, and Chihuahua. Plants are found mostly west of the Rocky Mountains, in the California Floristic Province, the Great Basin, the western Rocky Mountains, the Colorado Plateau, the Mojave Desert, the Sonoran Desert, the Madrean Floristic Province, and the Chihuahuan Desert (as defined by McLaughlin 2007; Baldwin et al. 2012; Fig. 1).

Habitat.—*Eriastrum* species have been collected from sea level (0 m) up to about 2700 m (0–8860 ft) in elevation. One report suggests some species could be found as high as 3200 m (10,500 ft; Craig 1934*b*). They occupy sand dunes, benches or floodplains above washes or creeks, shallow washes or drainages, playas, flats, alluvial plains, meadows, open slopes, ridge tops, firebreaks, old dirt roads, or roadsides. Plants are generally found in open areas, in full sun at least part of the day. Several populations were found in areas that had burned the previous year or a few years in the past. They have been found in areas that were disturbed (graded, mowed, or cleared of other vegetation) in the past. The slope varies from flat (0°) to fairly steep (36°), although plants tend to grow in flatter areas. All aspects have been reported. The substrate is often sand, but also may contain silt, clay, gravel, rock, loam, adobe, or leaf litter; it is usually dry, and may be hard-packed or loose; and can be derived from granite, mixed alluvium, sandstone, shale, rhyolite, schist, basalt, tuff, various other volcanic rocks, serpentine, metamorphic rocks such as gneiss, or limestone. At some sites, the soil may be somewhat alkaline. Cryptobiotic crust is sometimes present. Surrounding vegetation may be grassland; meadow; various scrub communities including coastal dune, coastal sagebrush, alkaline, creosote bush, rabbit brush, blackbrush, and sagebrush scrub; chaparral or various shrublands; oak, juniper, or mesquite savannah; Joshua tree, juniper, pinyon, oak, conifer, or riparian woodland; or pine or mixed forest. Often plants are found in mixtures of two or more of these types, or at the borders between types. At least one population appeared to be associated with areas of moss.

Population dynamics.—Population sizes of 4 to over 1,000,000 adult plants have been recorded. Sometimes seedlings and juveniles can be numerous. Population sizes may vary dramatically from year to year, probably dependent to some extent on the amount of winter precipitation received. At a site, plants may be rare, infrequent, occasional, scattered, frequent, common, or abundant. Plants often are found localized in patches, but in some cases populations may extend for considerable distances. Patch size may be small to large and of varying shapes, mostly depending on the size of open space between shrubs or trees.

Threats.—The main threat to any species of *Eriastrum* is habitat loss, due to factors such as competition from invasive or non-native plants, grazing, agricultural development, wind or solar development, urban development, energy exploration, vehicle use, road maintenance or construction, illegal dumping, trampling, trail maintenance, sand and gravel mining, hydrological alterations, and erosion or flash flooding. Some species have small global ranges or patch sizes and might be extirpated fairly easily if their habitat was destroyed. At several sites, many plants appeared dead. The reason for this is unknown. Several species have few recent collections, and therefore it is difficult to determine how rare or common they might be at present.

Some sites are in protected areas, such as parks, national forests, or open space preserves. Wildfire, brush clearance, fuel reduction, fire break maintenance and logging may not pose threats, since many species appear to do well following fire or moderate vegetation removal.

Etymology.—From Greek *erio*, woolly, and *astro*, star (Latin *astrum*, neuter, second declension); referring to the floccose trichomes and five-petaled, star-like flowers.

Common name.—Woolly-Star.

Discussion.—When Wooton and Standley (1913) described the genus *Eriastrum*, as a replacement name for the illegitimate *Hugelia* Bentham (1833) or the unavailable *Welwitschia* Reichenbach (1837), the only species cited in the protologue was *E. filifolium* (Nuttall) Wooton and Standley. However, this was not designated as a type by Wooton and Standley; it was merely included to publish the new combination *Eriastrum filifolium* (Nuttall) Wooton & Standley. Since the genus *Eriastrum* Wooton & Standley is a replacement name (nom. nov.) based on *Hugelia* Bentham, the type of *Hugelia* Bentham is also the type of *Eriastrum* (Wooton and Standley 1913; McNeill et al. 2012, Art. 7.4). Grant (1959: 122) designated *Hugelia densifolia* Bentham as the type of *Hugelia* Bentham, therefore *Hugelia densifolia* Bentham is also the type of *Eriastrum* Wooton & Standley. Other publications, citing *E. filifolium* as the type of the genus, are erroneous (see Mason 1945: 69; Grant 1959: 122–123; Harrison 1959: 59, 1972: 2; Porter and Johnson 2000: 74).

It is interesting that when Wooton and Standley described the genus *Eriastrum*, *E. filifolium* included *E. diffusum*, and since Wooton and Standley published the name prior to publishing the Flora of New Mexico (Wooton and Standley 1915), undoubtedly they had *E. diffusum* in mind when they cited *E. filifolium*. As circumscribed here, *E. diffusum* is common in New Mexico, but *E. filifolium* does not occur there.

Notes About the Key

1. Some couplets have overlapping ranges of particular measurements. If a plant falls into this zone of overlap, consider measuring a different plant, or several plants, and try to determine the general trend. Most plants should key to the correct species.
2. Geography, floristic region, and habitat are quite important in this key. Strive to note such information when making collections. However, species have been recorded far outside of what was thought to be their range, or in atypical habitat (although usually not both).
3. Floral zygomorphy or lack thereof is a key character for a few desert taxa that co-occur. It is wise to note such information prior to pressing.
4. Measurements of the stamens, anthers, and degree of exsertion past the sinuses need to be quite precise—best made by opening a fresh corolla under a microscope, or rehydrating a dried one. Measurements are mostly based on rehydrated or fresh material.

Key to the Species of Eriastrum

1. Longest stamens exserted 2 mm or more beyond the corolla sinuses and anthers 1 mm long or longer

2. Perennial, woody, secondary growth in at least some plants in a population. . . . . .3. *densifolium*

2' Annual, sometimes stout or resprouting after summer rainfall, but no true woodiness or secondary growth

3. Corollas, filaments, and style bright golden yellow. . . . . .10. *luteum*

3' Corollas, filaments, and style white to blue or purple, sometimes pale yellowish (in some subsp. of *sapphirinum*, particularly on the abaxial side of corolla lobes); not bright golden yellow

4. Anthers mostly longer than 1 mm; corolla lobe length 3.2 mm or longer

5. Corollas noticeably zygomorphic, sinuses generally unequal; stamens usually exserted 3.5 mm or more beyond the sinuses, unequal, often clustered toward the lower side of the corolla and frequently curving upward beyond the sinuses; upper stems and leaves not to slightly glandular; plants of the Mojave Desert, Sonoran Desert, and Colorado Plateau. . . . . .5. *eremicum* (4)

5' Corollas actinomorphic or slightly zygomorphic (mostly in coloration pattern), sinuses mostly equal to slightly unequal; stamens exserted 0.7–10 mm beyond the sinuses, equal or unequal, sometimes clustered toward the lower side of the corolla and curving upward beyond the sinuses, but mostly not; upper stems and leaves not to densely glandular; plants of the California Floristic Province, Sonoran Desert, Vizcaíno Desert, western Mojave Desert, Great Basin

6. Filaments longer than 4.5 mm

7. Tube + throat longer than 9 mm; plants of the California Central Coast Ranges; corollas mostly 15 mm or longer. . . . . .17. *virgatum*

7' Tube + throat shorter than 9 mm, if longer, then plants from the Sonoran Desert (*E. eremicum* subsp. *yageri*); corollas 7–20 mm long

8. Plants of the southern California Floristic Province and western Mojave Desert; upper stems and leaves often with dense glandular hairs, sparsely to densely woolly. . . . . .13. *sapphirinum* (2)

8' Plants of the Sonoran Desert of Arizona; upper stems and leaves sometimes slightly glandular but not with dense glandular hairs. . . . . .5. *eremicum* (4)

6' Filaments shorter than 4.5 mm

9. Plants of the Great Basin and east slope of the Sierra Nevada; stamens usually exserted about 0.7–2.3 mm beyond the sinuses; throat tapered or funnelform. . . . . .18. *wilcoxii* (2)

9' Plants of the California Floristic Province, Mojave, Sonoran, or Vizcaíno deserts; stamens usually exserted more than 2 mm; throat cylindric, tapered, funnelform, or campanulate

10. Plants of the Sonoran or Vizcaíno Deserts. . . . . .5. *eremicum* (4)

10' Plants of the California Floristic Province or Mojave Desert

11. Mature leaves generally with 5 or more lobes; upper stems and leaves not densely glandular. . . . . .11. *pluriflorum*

11' Mature leaves generally with 3 or fewer lobes (occasionally 5); upper stems and leaves often with dense glandular pubescence or densely woolly. . . . . .13. *sapphirinum* (2)

4' Anthers 1 mm long or shorter; corolla lobe length usually shorter than 4.4 mm

12. More than 1 ovule per locule; plants of the Sonoran, Chihuahuan, and southern Mojave deserts. . . . .4. *diffusum* (2)

12' Single ovule per locule; plants of the California Coast Ranges. . . . . .2. **calocyanum** (2)

1' Longest stamens exserted less than 2 mm beyond the sinuses (sometimes to 2.3 mm, but then anthers 1 mm or less in length), anthers mostly 1 mm long or shorter (*E. filifolium* to 1.1 mm)

13. Ovary with 1 ovule per locule (occasionally with 1 locule with 2 ovules, other locules with 1)

14. Leaves with mostly 3 or more filiform lobes; inflorescence large (in proportion to plant height), densely white-woolly; many flowers (usually >6) open at a single time. . . . . .1. *abramsii*

14' Leaves with mostly 3 (occasionally 4) or fewer linear lobes; inflorescence lanate; few flowers (usually <5) open at a single time

15. Plants of the central and Southern Coast Ranges of California (San Benito, Monterey, San Luis Obispo, Santa Barbara counties); stamens exserted 0–2.2 mm beyond the sinuses. . . . . .2. **calocyanum** (2)

15' Plants of the Mount Hamilton Range, east slope of the Northern Coast Ranges of California, southern Cascade Range, and western Sierra Nevada foothills; stamens included, 0.6 mm below the sinuses, to exserted 1.3 mm beyond the sinuses. . . . . .16. *tracyi*

13' Ovary with more than 1 ovule in each locule (occasionally 1 locule with only 1 ovule, other locules with more)

16. Corollas 7 mm long or shorter, and stamens included to exserted 1 mm or less beyond the sinuses; upper stems, leaves, and bracts not markedly glandular; plants growing in alkaline areas or dry washes, but not on sand dunes; San Joaquin Valley and surrounding foothills, southern Sierra Nevada, San Francisco Bay area, and southwest Mojave Desert (Antelope Valley)

17. Stamens exserted 0.4–1.0 mm beyond the sinus; leaf primary axis about 1 mm wide; southwest Mojave Desert (Antelope Valley). . . . . .12. *rosamondense*

17’ Stamens exserted 0.5 mm or less beyond the sinus, sometimes included; leaf primary axis about 0.5–0.75 mm wide; San Joaquin Valley and surrounding foothills, southern Sierra Nevada, San Francisco Bay area

18. Corolla tube + throat 3.7 mm long or longer; filaments 1.3 mm long or longer; plants of the Mount Diablo region, Contra Costa County. . . . . .6. *ertterae*

18’ Corolla tube + throat 3.6 mm or shorter; filaments 1.3 mm or shorter; plants of the San Joaquin Valley, eastern Central Coast Ranges, northern Western Transverse Ranges, or southern Sierra Nevada. . . . . .9. *hooveri*

16’ Corollas mostly 7 mm or longer, if shorter, then stamens exserted 1 mm or more beyond the sinuses, or upper stems, leaves, and bracts markedly glandular, or plants growing on semi-stabilized sand dunes, or plants from the Sonoran Desert; stamens exserted 0.5 mm or more beyond the sinuses

19. Anthers mostly 1 mm long and longer

20. Stamens usually equal in length (up to 0.3 mm length difference); corolla lobes 1.5 mm wide or less . . . . .7. *filifolium*

20’ Stamens usually unequal in length (0.2 mm length difference or more, usually more than 0.5 mm difference); corolla lobes 1.3 mm wide or wider

21. Plants of the Great Basin desert and east slope of the Sierra Nevada; corollas mostly actinomorphic. . . . . .18. *wilcoxii* (2)

21’ Plants of the Mojave, Sonoran, or Vizcaíno deserts or Colorado Plateau; corollas zygomorphic or actinomorphic, if actinomorphic, then from the Sonoran or Vizcaíno deserts. . . .5. *eremicum* (4)

19’ Anthers mostly 1 mm long and shorter

22. Heads usually with 3 or fewer flowers (total); upper stems, leaves, and bracts densely covered with short glandular hairs, sparsely woolly. . . . . .15. *sparsiflorum*

22’ Heads usually with 3 or more flowers per head (although only 1 flower may be open at a given time, additional buds or fruits are present in the head); upper stems, leaves, and bracts may be slightly glandular but not with dense, short, glandular hairs

23. Ovaries usually with 2 ovules per locule (sometimes 1 or 3); usually found in pinyon-juniper woodland or chaparral. . . . . .14. *signatum*

23’ Ovaries usually with 2–7 ovules per locule; usually found in Mojave, Sonoran, Chihuahuan, Vizcaíno, or Colorado Plateau desert scrub

24. Plants growing almost exclusively on semi-stabilized sand dunes; filaments usually 0.75–1 mm long; upper stems markedly woolly. . . . . .8. *harwoodii*

24’ Plants often in washes, flats, or gentle slopes, not usually on semi-stabilized sand dunes; filaments usually 1–3 mm long; upper stems sparsely woolly. . . . . .4. *diffusum* (2)

1. ERIASTRUM ABRAMSII (Elmer) H. Mason 1945, *Madroño* 8(3): 90.

Basionym: *Navarretia abramsii* Elmer 1906, *Bot. Gaz.* 41(5): 314–315.

Type: USA, California, Santa Clara County: Black Mountain, July 1903, *A. D. E. Elmer 4586*.

Lectotype, designated here (possibly holotype): DS 0060856 (image!). Isolectotypes: US 665480 (image!), NY 336953 (image!). There probably also was a specimen at B (Brand 1907 Das Pflanzenreich IV. 250: 160), now destroyed (Hiepko 1987).

≡*Navarretia abramsii* Elmer 1906, *Bot. Gaz.* 41(5): 314–315.

≡*Hugelia abramsii* (Elmer) Jepson & V.L. Bailey, *in* Jepson 1943, A Flora of California Vol. 3 Part II p. 167–168.

≠*Gilia Abramsii* (Brand) H. Mason and V.E. Grant 1948, *Madroño* 9(6): 216. ≡*Gilia arenaria* var. *Abramsii* Brand 1913, *Annuaire Conserv. Jard. Bot. Genève* 15–16: 330.

Densely lanose annual herbs, usually about 6–15 cm tall and wide. **Stems** solitary or several from the base, rigidly erect, branched racemosely or corymbosely from the middle, or diffusely from the base; branches rather stout and straight, ascending, terminated by solitary comparatively large heads, green to tan or brown, but usually obscured by wool. Herbage floccose, often densely so below the inflorescences, internodes 0.5 to 2.5 cm long. **Leaves** alternate, pinnatifid, ascending to spreading, frequently curved, medium green, contrasting with the white wool, 8–30 (–45) mm long, 3- to 7- (usually 5-) lobed, mostly from the proximal 2/3 of the leaf, the lobes and primary axis filiform, not rigid, floccose at least at the base, and often densely so, becoming glabrous and brittle in age, terminated by a fine sharp point; lateral lobes (2–) 5–11 mm long. **Inflorescence** heads one to several, terminal, turbinate, about 5–12 mm wide (excluding tips of bracts), about 5–10 mm long, densely surrounded by a matrix of lanate hairs, 6- to 10-flowered (at a given time, over the life of the plant many more flowers may develop from the same head). **Subtending** bracts similar to the leaves but smaller, pinnatifid, filiform, about 7–18 (–25) mm long, ascending to spreading, frequently curved, exceeding the heads by 1.0–1.5 cm, light green, the bases often completely obscured by dense, white wool, 3–7-lobed, mostly from the proximal 2/3 of the bract, lateral lobes about 1–8 mm long. **Calyx** 5.0–6.0 mm long, embedded in white wool, the sepals straight and erect, linear, green, acuminately pointed, with hyaline margins fused together about 2/3 of the length of the calyx, lobes unequal by 0.3–0.7 mm. **Corolla** actinomorphic, of 5 fused petals, narrowly funnelform or salverform, 5.0–8.0 mm long, only about 1/2 the lobes exserted from the calyx; tube 2.8–3.5 mm long, pale blue to white, sometimes drying translucent, glabrous inside; throat 0.7–1.25 mm long, bluish to white; tube plus throat 3.7–4.4 mm long; lobes elliptic, sometimes notched at tip, 1.5–2.5 mm long, differing in length within a flower by 0.0–0.1 mm, 28–32% of total corolla length, 0.6–0.8 mm wide, bluish or lavender to nearly white, midvein often darker, glabrous. Buds pale blue. **Stamens** 5, adnate to corolla tube, barely exceeding the throat of the corolla (exserted 0.4–0.6 mm past sinus), more or less equally inserted 0.4–0.7 (–2.0) mm below the sinus; free portion 1.5 mm long, to base of corolla 4.1–4.8 mm long, equal or subequal in length (length difference 0.0–0.3 mm); filaments threadlike, 0.8–1.3 mm long, white; anthers versatile, ovate or elliptic, white, 0.50–0.75 mm long, 0.5 mm wide, apex obtuse, base sagittate. Pollen white, average grain diameter 29 μm, pantotreme aperture arrangement. **Pistil** 3.5–4.25 mm, with sparse 2- to 3-celled glandular trichomes at the base of the style and tip of the ovary, occasionally with a few non-glandular trichomes as well (ca. 5-celled); stigma lobes about 0.5 mm long, often situated at the same height as the bases of the anthers; style 2.0 mm long, white, persistent; ovary at anthesis about 1.00–1.25 mm long, with 3 locules. **Capsule** triangular, when mature easily falling out from the persistent calyx, straw-colored, smooth and shining, 4 mm long, 1.5 mm in diameter, apex pointed, 3-celled, loculicidally dehiscent. **Seeds** one per locule, subterete to slightly dorsiventrally flattened, 3 mm long, about 0.75 mm wide, brown and very hard, with a gelatinous cover which readily dissolves in water (Fig. 40–44 [Color Plate 1]; Elmer 1906: 314; Harrison 1972: 25; S. De Groot, unpubl. data).

Identification.—There are few species that are likely to be confused with *E. abramsii*. Plants are usually fairly short and with disproportionally large inflorescence heads that are very white-woolly. Flowers are tiny and usually many are open at once. *Eriastrum tracyi* also can be found in the same geographic area and in similar habitats, but its inflorescence heads are not so large and have only 1 to a few flowers open at a time. Plants of *E. tracyi* are usually more open-paniculately branched, while plants of *E. abramsii* are usually fairly dense and compact. *Eriastrum abramsii* might be more easily confused with species of *Navarretia* than with other species of *Eriastrum*, but can be differentiated by the woolly hairs in the inflorescence. Species of *Navarretia* are often hairy, but not woolly.

Eriastrum signatum and *E. calocyanum* approach the range of *E. abramsii*, but the leaves of *E. abramsii* tend to have more lobes (3–7) than leaves of either *E. signatum* or *E. calocyanum* (1–3 or rarely 4 lobes). *Eriastrum signatum* and *E. calocyanum* have larger corollas, on average (>7 mm long) than *E. abramsii*, which has a corolla about 5–8 mm long. The corolla tube + throat of *E. abramsii* is up to 4.5 mm long, while the corolla tube + throat of *E. signatum* or *E. calocyanum* is 4.5 mm or longer. While both *E. abramsii* and *E. calocyanum* have only one ovule per locule, *E. signatum* usually has two (occasionally one or three).

Phenology.—Although Elmer (1906: 315) called this species a "very late summer-flowering annual," and Brand (1907) wrote that it flowers in July, herbarium specimens document it in flower May–June, possibly late April or early July, although the duration is probably no more than about three weeks. It fruits June–July and possibly into August.

Distribution.—California endemic; North Coast Ranges (Clear Lake area), San Francisco Bay area (Santa Cruz Mountains, Mount Diablo, Mount Hamilton), South Coast Ranges (1 specimen from 1942; Fig. 69).

Habitat.—*Eriastrum abramsii* has been collected between about 650 and 900 m (2130–2950 ft) in elevation. It is frequently found in open areas at the edges of chamise (*Adenostoma fasciculatum* Hook. & Arn.) thickets (Elmer 1906), on rolling hills, in ditches, on roadsides, or in other open spaces between shrubs. The slope varies from about 4° to 20°, and aspects of west-, northwest-, and east-facing have been documented. The substrate is often dry adobe, but also may contain various gravels, shale, and leaf duff. Surrounding vegetation is chaparral, usually chamise chaparral (Elmer 1906). The range map (Fig. 69) attempts to show the association between *E. abramsii* locations and shrublands.

Population dynamics.—Population sizes of about 30 to more than 2000 plants have been recorded. Plants have been noted to be infrequent, occasional, patchy, or locally frequent.

Threats.—While there are a number of collections of this species, most are historic. There have been no collections of *E. abramsii* from Lake County since 1945. Many sites occur on private land, near urban areas, and development may be a threat. A few sites are in protected areas, such as the Monte Bello Open Space Preserve and Morgan Territory Regional Park. Competition from non-natives may be a threat if they cover the open soil on which this species prefers to grow. Although the response of this species to fire is unknown, occasional fires may serve to open up spaces in chamise chaparral, providing habitat for *E. abramsii*.

Conservation.—Global Rank: G3 – vulnerable. Otherwise, not listed or ranked (CNPS 2013; CNDDB 2013; Table 2).

Etymology.—The specific epithet is "for Mr. L. R. Abrams, a former student of botany and classmate at Stanford University" (Elmer 1906: 315). Le Roy Abrams (1874–1956) was a botany professor at Stanford University and author of, among other works, the multi-volume *Illustrated Flora of the Pacific States* (1923–1960).

Common name.—Abrams' woolly-star.

Other specimens.—Topotype: *Pendleton 137* (K!, BM!, GH!, POM!).

Discussion.—The holotype has the collection date of July 1903, while the protologue gives the collection date as July 1905. Based on a search of Elmer's collections on CCH, it appears that Elmer did not collect at all in 1905, and therefore the collection date should be 1903, as it is on the holotype specimen (DS 60856).

This species was first described as a *Navarretia*, and Jepson (1943: 167–168) was the first to place the species into *Hugelia*. The affinity of the species to *Hugelia* (*Eriastrum*) rather than *Navarretia* was first mentioned by Brand: "Nota. Species ex habitu subgeneri *Hugelia* magis affinis; structura embryonis et ab hoc et ab omnibus aliis speciebus ordinis valde diversa" (1907: 160). This was also discussed in detail by Sharsmith (1944) and mentioned by Craig (1934*b*: 423).

Jepson (1925: 788; 1943: 167–168) first suggested this species might also occur in Lake County, California. This has been verified by specimens (see Appendix).

2. **Eriastrum calocyanum** De Groot, sp. nov.

Type: USA, California, San Benito County: along Coalinga Road at mile marker 9.82 from Highway 25, 36.36176° N, 120.87075° W, 682 m/2237 ft elevation, 1 June 2008, *De Groot 5880*.

Holotype: RSA! Isotypes: CAS!, GH!.

Previously included in *Eriastrum wilcoxii* (Mason 1945: 85–86; Harrison 1959: 227, 249–254).

Excluded from *Eriastrum signatum* (Gowen 2008: 84).

Erect slender annual herbs 4–25 (–37) cm high. **Stems** virgate, paniculate, or racemose, often zig-zag, occasionally branched from the base; lightly to densely floccose throughout, stems green, tan, brown, or reddish, internodes to 5 cm long. **Leaves** alternate, entire to pinnatifid, mostly ascending, sometimes spreading in age, green to gray-green, sometimes reddish or tan in age, slightly floccose to floccose, 7–35 mm long, subulate; leaves entire to 4-lobed, lobes arising from the proximal third or half of the leaf, lobes linear filiform, 2–387 mm long, subulate,

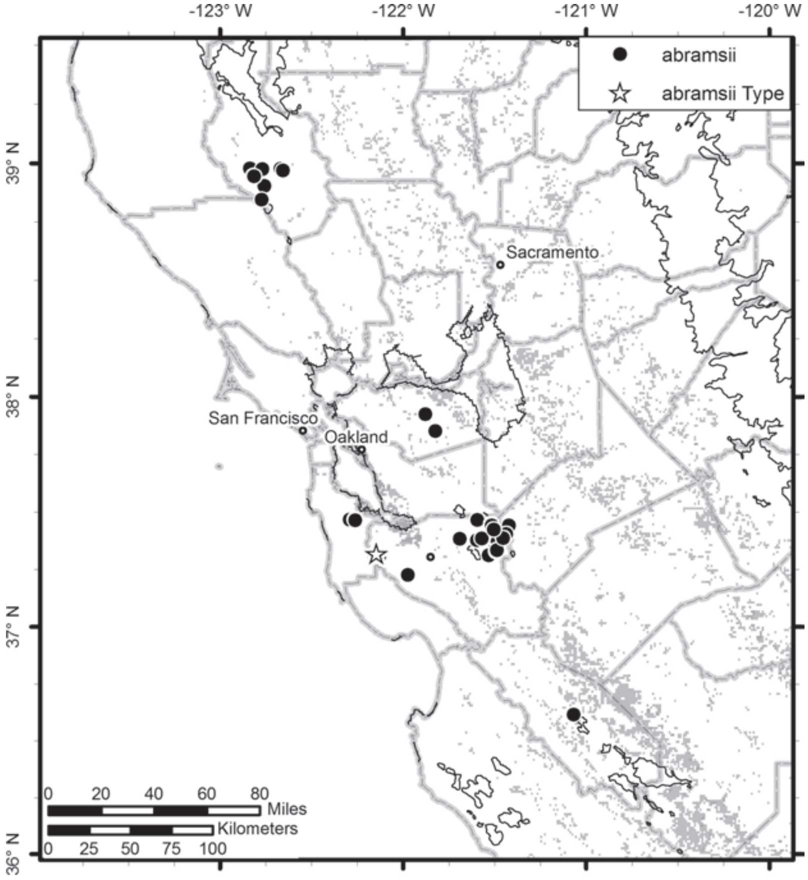


Fig. 69. Range map for *E. abramsii*, showing specimen locations and the type locality. Major cities and county boundaries are marked. Thin black lines are topographic contours (1000 m interval). The gray shading shows areas of shrubland as mapped in the UMD Global Land Cover Classification (1 km resolution; Hansen et al. 1998, 2000).

aristulate. **Inflorescence** heads about 3 to 130 or more per plant, often 30 or fewer, obovoid, about 5–8 mm long and 3–10 mm broad excluding the tips of bracts, one to several heads at the tip of a branch, densely floccose, with about 3–8 flowers per head; axillary heads sometimes single-flowered; terminal heads in exceptionally large plants with up to 17 flowers. **Bracts** pinnatifid, mostly ascending, 6–16 mm long, green, occasionally reddish- or tan-tipped (mostly in age), exceeding the heads, sometimes curving outward, densely floccose proximally, loosely floccose distally, aristulate; inner bracts 2–3-lobed from the proximal half of the bract, or occasionally entire, outer bracts 3–5-lobed from the proximal third, occasionally entire, sometimes with a short membrane in the sinuses between the lobes, lateral lobes 1–6 mm long. **Calyx** lobes unequal to subequal, commonly 2 long and 3 short or 3 long and 2 short, about 0.6–1 mm difference in length between short lobes and long lobes, the longest sepals 5.3–8 mm long, densely floccose, hyaline membrane fused about halfway or more to the tips of the lobes, tips subulate to aristulate, not obscured by woolly trichomes. **Corolla** actinomorphic (occasionally asymmetric from interaction with calyx lobes), 7.0–10.1 mm long, more or less salverform, with throat often noticeably flared, wider than the tube; tube 3.8–5.3 mm long, generally white, cream, or yellow, glabrous or minutely puberulent inside with scattered short epidermal papillae; throat 1.0–2.0 mm long, white to yellow; tube plus throat 5.0–7.0 mm long, generally slightly shorter than the calyx, 61–68% of the total corolla length; lobes strap-shaped to narrowly elliptic, light blue or lavender to deep royal blue, often with a dark reddish or purplish spot at the base, 2.3–4.2 mm long and 0.9–1.3 mm wide, differing in length within a flower by 0.0–0.2 mm, 32–39% of total corolla length. **Stamens** exserted 0.0–2.3 mm beyond the sinus, attached at the base of the throat, 0.9–1.5 mm below the sinus (usually about 1 mm); free portion about 1.5–3.5 mm long, to base of corolla 5.3–8.0 (–8.8?) mm long, equal to unequal (length difference 0.1–1.5 mm); filaments 1.0–2.75 mm long, white to cream or pale yellow; anthers 0.75–1.0 mm long, 0.4–0.75 mm wide, oval, sagittate, versatile, white to pale blue. Pollen white or cream to blue, average grain diameter 27 μm. **Pistil** 5.0–8.3 mm long, exceeding the anthers or not; stigma lobes 0.2–0.75 mm long; style about 3.75–4.5 mm long, white to cream, glabrous or with a few glandular trichomes at the base; ovary at anthesis about 1.0–1.5 mm long, with glandular 3–5-celled trichomes at tip. **Capsule** about 3–4 mm long and 1.5–2 mm wide, oblong ellipsoid, 3-loculed. **Seeds** 1 per locule, 2.0–2.5 mm long and about 1 mm wide, tan (Fig. 82–88 [Color Plate 2], 98–105).

Identification.—Specimens of *Eriastrum calocyanum* were excluded from *E. signatum* in part by "slightly longer filaments, attached lower in the corolla tube" and by "longer, unevenly exserted stamens" (Gowen 2008: 84). While in general the stamens of *E. calocyanum* are indeed slightly longer, attached slightly lower in the tube, and exserted slightly farther, there is a good deal of overlap with *E. signatum*. A more reliable distinguishing character is the number of ovules per locule: *E. calocyanum* has only one ovule in each locule, whereas *E. signatum* has two (or more) ovules in at least one of the locules (see Gowen 2008).

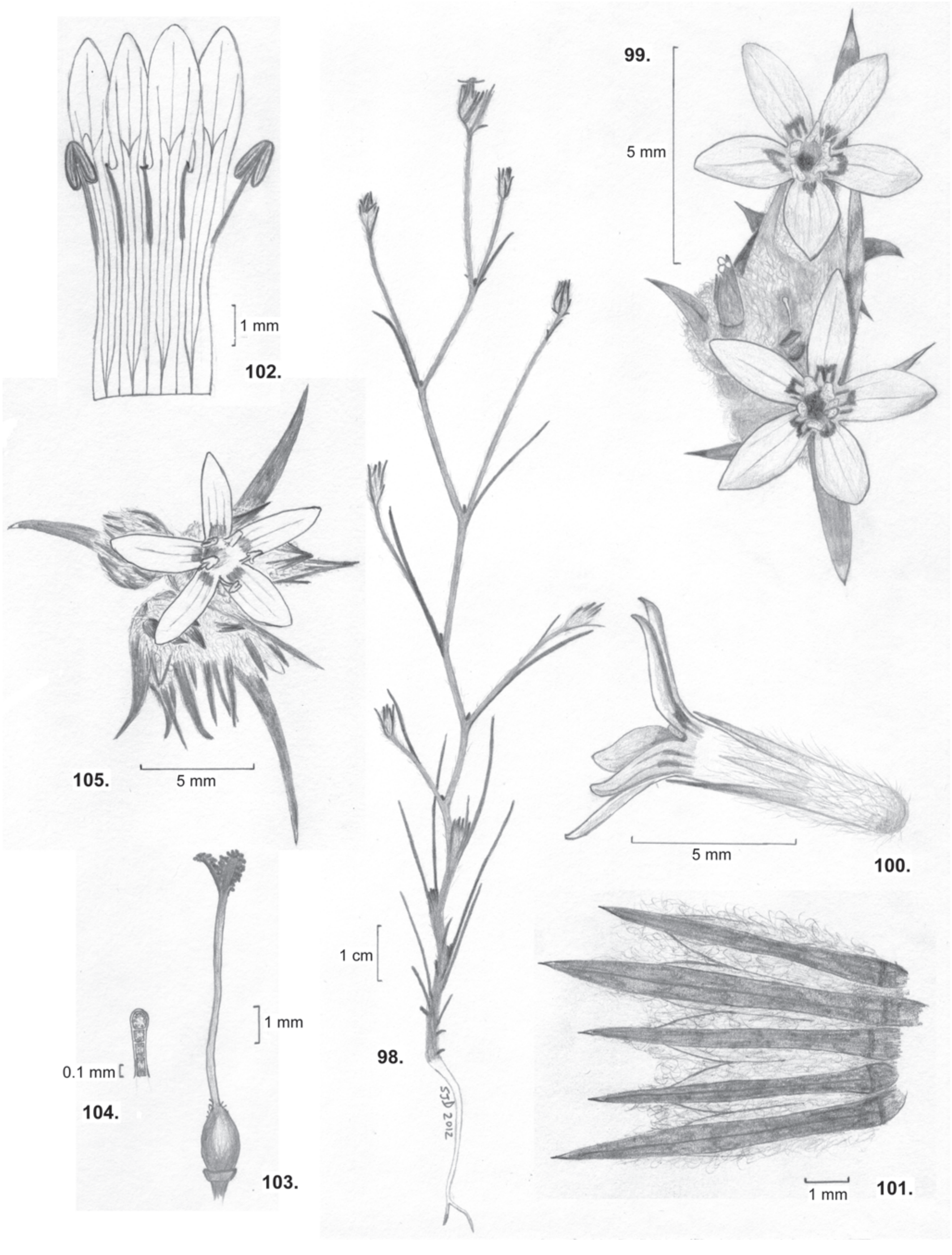


Fig. 98–105. **Eriastrum calocyanum**.—98. Habit (*De Groot 5880*).—99. Inflorescence with flower in face view (*De Groot 5880*).—100. Flower in side view (*De Groot 5880*).—101. Opened calyx, showing lobes of unequal length (*De Groot 5880*).—102. Opened corolla (1 petal and 3 anthers

The most obvious difference between *E. calocyanum* and *E. tracyi* is the dark purplish spot at the base of the corolla lobe in *E. calocyanum* and the lack of a spot in *E. tracyi*. The stamens of *E. tracyi* are generally equal, while the stamens of *E. calocyanum* are usually somewhat unequal.

Eriastrum wilcoxii has two or more ovules per locule, as opposed to the single ovule in each locule in *E. calocyanum*. The anthers of *E. calocyanum* are 1 mm long or shorter, while the anthers of *E. wilcoxii* are 1–2 mm long. The corollas of *E. wilcoxii* are generally larger, 9–14 mm long, while *E. calocyanum* corollas are 7.8–10 mm long, and the corolla lobes of *E. wilcoxii* are 1.3 mm or wider, while the corolla lobes of *E. calocyanum* are 1.3 mm wide or less.

Eriastrum virgatum is easily distinguished from *E. calocyanum* by its larger corollas (15 mm or longer), exserted stamens (4 mm or more), and 2 or more ovules per locule. In contrast, *E. calocyanum* corollas are 10 mm or less in length, stamens are exserted up to 2.3 mm beyond the sinuses, and there is only a single ovule in each locule.

Eriastrum calocyanum approaches the range of *E. abramsii*, but the leaves of *E. abramsii* tend to have more lobes (3–7) than leaves of *E. calocyanum* (1–3 or rarely 4 lobes). *Eriastrum calocyanum* has larger corollas, on average (>7.7 mm long) than *E. abramsii*, which has a corolla about 5–8 mm long. The corolla tube plus throat of *E. abramsii* is up to 4.5 mm long, while the corolla tube plus throat of *E. calocyanum* is 5.2 mm or longer.

Although the ranges of *E. filifolium* and *E. calocyanum* are peripatric, several morphological characters separate these species. *Eriastrum filifolium* has 3–6 ovules per locule, while *E. calocyanum* has only 1. The anthers of *E. filifolium* are mostly equal, while those of *E. calocyanum* are usually unequal to subequal. The corolla tube plus throat of *E. filifolium* is shorter (4.3–5.4 mm) in general than the corolla tube plus throat of *E. calocyanum* (5.2–6.6 mm).

In the western and northern parts of its range, *E. hooveri* approaches the range of *E. calocyanum*. These species are easily distinguished by corolla color—*E. hooveri* is mostly white, while *E. calocyanum* has bright blue lobes, usually with darker spots at the bases. Furthermore, the corollas of *E. hooveri* are usually less than 7 mm long, while the corollas of *E. calocyanum* are 7.8 mm long or longer.

Eriastrum ertterae also approaches the range of *E. calocyanum*. Corollas of *E. ertterae* are mostly white to pale blue, and are usually less than 7 mm long, while *E. calocyanum* has bright blue lobes, usually with darker spots at the bases, and the corollas are 7.8 mm long or longer.

Eriastrum pluriflorum subspp. *pluriflorum* and *sherman-hoytae* both have corollas 12 mm long or longer, which differentiates them from *E. calocyanum*, which has corollas 10 mm long or shorter. Most of this length difference is attributable to the length of the tube plus throat: *E. calocyanum* has a tube plus throat 7.0 mm long or shorter, while subspp. *pluriflorum* and *sherman-hoytae* have a tube plus throat 7.7 mm or longer.

Stamens of *E. calocyanum* are exserted up to 2.3 mm, while stamens of *E. sapphirinum* are exserted 2.3 mm or more beyond the sinuses. Furthermore, *E. calocyanum* has a single ovule per locule, while *E. sapphirinum* has 2–7.

Phenology.—Flowering mid-late May through mid-June. Some flowers stay open past 6 p.m. Fruiting in June.

Distribution.—California endemic (San Benito, Monterey, San Luis Obispo, and Santa Barbara Counties); South Coast Ranges (Fig. 106).

Habitat.—*Eriastrum calocyanum* is found at elevations between 400 and 1300 m (1310–4270 ft), in open, sunny areas on benches above creeks or along road shoulders. It has been found in areas that were disturbed (graded) in the past. The slope varies from 0–8° and both east- and west-facing aspects have been documented. The substrate is usually coarse sand or gravel, derived from granite or mixed alluvium. Plants might not prefer to grow on chalky soil. Surrounding vegetation may be chaparral, chaparral with scattered pines, savannah, riparian vegetation, or mixed woodland.

Population dynamics.—Population sizes from about 150 to over 2000 plants have been recorded. At sites, plants are usually locally frequent to locally abundant, although they tend to occur in patches within open areas or on preferred substrates.

Threats.—Patches are often fairly small, increasing the possibility of extirpation through disturbance. Habitat loss due to development or disturbance is a potential threat. The distribution and frequency are not well understood, and it is difficult to say whether this species is globally rare or simply undercollected and mis-identified. Note that many locations for *E. calocyanum* occur on private land (Fig. 106).

Conservation.—Not yet ranked or listed (CNPS 2013; Nature Serve 2013); global rank possibly could be G3, based on NatureServe (2016) criteria. Currently, there are about 25 known locations of this species, with about half of those occurring on federal lands. The majority of land (by area) within the species' range is privately owned, and more plants might occur in those areas. The known global range is about 918,000 hectares (2.3 million acres, 3,544 square miles).

Etymology.—The specific epithet is from Greek *kalos*, beautiful or pretty, and *cyanos*, blue; literally, "pretty blue woolly-star." I informally refer to many species of *Eriastrum* as "pretty blue flowers" so it seems appropriate to make that an official name for one of them. While this may not be the largest or showiest, it is nonetheless attractive.

Common name.—Pretty blue woolly-star.

Other specimens.—"Plants found in San Benito, Monterey, and western Kern counties (*Gowen 117*, *Yadon s.n.*, *Twissel-*

←
removed), showing equal lengths of petals and filaments (*De Groot 5880*).—103. Gynoecium with three-lobed stigma, style, ovary, and nectary disk (*De Groot 5880*).—104. Multi-cellular trichome from the pistil (*De Groot 5880*).—105. Inflorescence and flower from the southern form (*De Groot 5877*).

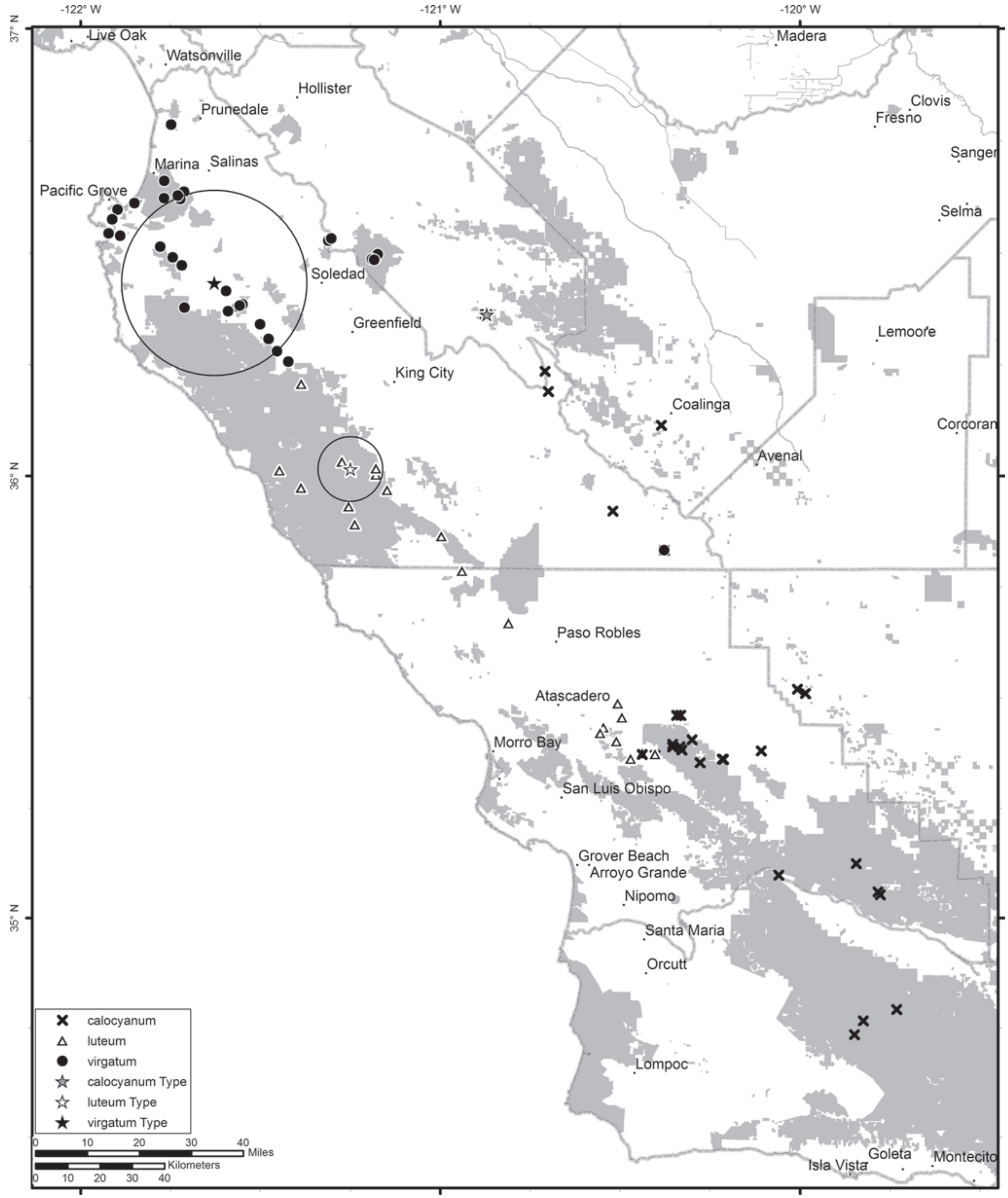


Fig. 106. Range map for **E. calocyanum**, *E. luteum*, and *E. virgatum*, showing specimen locations. Circles around the stars indicate uncertainty about the exact location of the type collection. Shaded gray areas indicate federal, state, or local government lands; no shading is privately owned. Major cities are marked. Note the large amount of private land in these species' ranges.

mann 1243, *4466*, *17808*)…" and "Plants from San Luis Obispo Co. that Mason (1945) referred to *E. wilcoxii* (e.g., *Hoover 6162*, *Bacigalupi 5143*, *Gifford 830*)…" (Gowen 2008: 84).

Discussion.—Previously, this species was treated as *E. wilcoxii*: "There is uncertainty about the identity of our plants, but H. L. Mason classified a collection from the La Panza Range as *E. Wilcoxii*. This interpretation is here followed" (Hoover 1970: 231). *Eriastrum wilcoxii* is a common annual throughout the Great Basin Desert; to find this species in the Central Coast Ranges of California would be a range extension and a very different habitat. While *E. calocyanum* is similar to *E. wilcoxii* in flower size, anther exsertion, and plant habit, there are notable differences in anther size, corolla size, and ovule number (see Identification).

When he published *E. signatum*, Gowen (2008) recognized that the plants from the Central Coast Ranges previously identified as *E. wilcoxii* were an undescribed species, different from *E. signatum*, and explicitly excluded specimens of those plants from the circumscription of *E. signatum*. Although he recognized that they belonged to an undescribed species, he did not at that time publish a name and description for them. However, he did want to make it clear that the Central Coast plants did not belong in *E. signatum* (Gowen 2008; and D. Gowen, pers. comm.).

Gowen (2008) wrote that there are two races within *E. calocyanum*, a northern form from San Benito, Monterey, and western Kern counties that has slightly longer filaments attached lower in the corolla tube, and a southern form from San Luis Obispo County that has longer, unevenly exserted stamens and longer corolla lobes. It is possible that southern plants represent a lineage distinct from the northern plants, but I have not yet had the opportunity to see more than one population in the field, or gather quantitative data. Study of available herbarium specimens (RSA-POM, OBI, CAS/DS) suggests that these northern and southern forms actually represent extremes of a continuum. Furthermore, some plants from Santa Barbara County more closely resemble the northern form than the southern form. Plants of the southern form tend have larger flowers with longer lobes, longer stamens exserted farther beyond the sinuses, and blue pollen as opposed to white or cream in the more northern plants. However, there is much overlap in quantitative ranges, both have 1 seed per locule, and are very similar vegetatively.

3. ERIASTRUM DENSIFOLIUM (Bentham) H. Mason 1945, *Madroño* 8(3): 73.

Type: *E. densifolium* subsp. *densifolium*.

≡*Hugelia densifolia* Bentham 1833, *Edwards's Botanical Register* t. 1622.

≡*Gilia Hugelia* Steudel 1840, Nomenclator botanicus I, 683.

≡*Gilia densifolia* Bentham 1845, *in* De Candolle, Prodromus Systematis Naturalis Regni Vegetabilis, 9: 311. A. Gray 1870, *Proc. Amer. Acad. Arts Sciences* 8: 272. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 388.

≡*Navarretia densifolia* (Bentham) Kuntze 1891, Revisio Generum Plantarum, Pars II, p. 433.

≡*Navarretia densifolia* (Bentham) Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 165.

≡*Welwitschia densifolia* (Bentham) Tidestrom 1925, *Contr. U.S. Natl. Herb*. 25: 429.

≠*Gilia densiflora* Bentham 1845, *in* De Candolle, Prodromus Systematis Naturalis Regni Vegetabilis 9: 316. =*Leptosiphon densiflorus* Bentham 1835, *Edwards's Botanical Register* vol. 20 t. 1725.

Perennial, woody at base or above, sometimes shrubby, 8–90 cm tall; with 1–several older-growth branches generally arising from base, sometimes above, sometimes densely branched, erect to divaricately spreading, sometimes decumbent, rarely procumbent, sometimes elongate; current-year branches erect or ascending, sometimes arising from stems below persistent inflorescence heads from previous years, most ending in a terminal inflorescence but sometimes vegetative, somewhat virgate, stout to flexible, sometimes brittle; axillary branches sometimes present; herbage green to canescent, glabrate to floccose, especially lanate near the heads, lower stems sometimes becoming glabrate. **Stems** green, tan, or dark purplish gray-brown, outer layers sometimes flaking off; sparsely to densely leafy, internodes usually 0.5–4.5 cm long or less, the longer lengths found just below the heads; axils with or without canescent buds, short spur shoots appearing like fascicles of leaves sometimes present in axils, 0.5–2.0 cm long or longer, sometimes developed into short branches, green or canescent, sometimes woolly. **Leaves** alternate, linear to lanceolate in outline, entire to pinnatifid, ascending to spreading, sometimes curved, light green to gray-green, 10–50 mm long, primary axis to 3.5 mm wide, rigid or not, glabrate to floccose, with 1–13 (–15) lobes, older senescing leaves often with fewer lobes than younger leaves; lobes usually subulate and spine-tipped, usually 1–10 mm long, sometimes recurved, generally arising from the proximal half or 3/4 of the leaf, or equally spaced along the axis, terminal lobe nearly equal to 3 times longer than lateral lobes. **Inflorescence** heads few to many (up to about 200 or more), generally terminal, sometimes with additional heads on short lateral branches, heads solitary, or in a racemose or corymbose thyrse, open to dense, old heads from previous years sometimes persisting; heads 0.75–2.5 cm long and 0.5–3.0 (–4.0) cm wide, excluding the flowers and tips of bracts, with flowers to 6 cm across, usually 1–40-flowered or more; lightly to densely woolly, green to white-canescent. **Bracts** entire to pinnatifid, linear to lanceolate in outline, ascending to spreading, often numerous, 5–26 mm long, equalling or exceeding the calyces, green to gray-green or tan, tips sometimes reddish or tan, subglabrous to canescent or densely floccose, sometimes glandular, bracts entire to 7-lobed (occasionally 9-lobed), most lobes arising from the wide base or proximal 3/4 of the bract, lateral lobes mostly 1–10 mm in length, sometimes recurved, terminal lobe usually longer than lateral lobes, lobes subulate and spine-tipped; inner bracts and sometimes outer bracts often partly hidden by woolly trichomes. **Calyx** 5–11 mm long, sepals lanate to densely floccose, sometimes partly or completely hidden by woolly trichomes; costae light green, yellowish-green, or green, bases sometimes lighter, often with red, yellow, or brown tips, subulate, spine-tipped, tips sometimes glandular; each sepal bordered by a hyaline membrane that is fused about half to 2/3 of the length, forming a tube; lobes equal or subequal to unequal, differing in length by (0.25–) 0.5–1.5 (–2) mm. **Corolla** broadly funnelform to salverform, actinomorphic, 10.5–33.0 mm long, lobes exserted from calyx, tube and throat included or partly exserted; tube white to pale blue, lavender, pink, or purple, base sometimes yellowish, or whole tube drying yellowish, 4.5–19.5 mm long, puberulent inside with 1–3-celled epidermal papillae, occasionally glandular; throat white to pale blue to lavender, occasionally purple, pale yellow, or pink, sometimes drying yellowish, about 0.9–5.7 mm long; tube plus throat 6.4–23.0 mm long; lobes deep blue, blue-violet, bright blue, pale blue, sky blue, or lavender, sometimes white, veins often darker blue or purple, occasionally with purplish spots, elliptic to obovate, tips rounded to acute, 3.5–11 mm long, equal to subequal, 22–42% of the total corolla length, 1.8–5.0 mm wide. Buds white, cream, yellowish, or pale blue. **Stamens** exserted about 2.1–7.0 mm beyond the sinuses of the corolla, equalling or shorter than the lobes, attached 0.0–3.0 mm below the sinus, the insertion distance varying within a flower by 0.0–0.5 (–1.5) mm, free portion of stamen 4–10 mm long, to the base of the corolla 8.1–28.1 mm long, equal to subequal (length difference 0.2–1.4 mm); filaments 2–8 mm long, white to pale blue or lavender; anthers white to pale blue or violet, sometimes drying yellowish, 2–4 mm long, 0.5–1.75 (–2?) mm wide, versatile, sagittate.

Pollen blue, pale blue, sky blue, lavender, gray, or white; with an average grain diameter of 29–32 µm, and possibly an anomotreme or pantotreme aperture arrangement. **Pistil** about 11.5–30 mm long, shorter if not completely elongated (in younger flowers), usually glabrous or occasionally with a few 3–4-celled trichomes at the distal tip of the ovary; stigma lobes 0.5–1.5 mm long, often white; style about 10–27 mm long, white to pale blue, lavender, or purplish; ovary 3-loculed, with 2–9 (–11) ovules per locule. **Fruit** is a capsule, about (1.3–) 2.5–6.0 mm long and (0.8–) 1.3–2.7 mm wide, tan, with 3 locules, usually with about 1–11 seeds in each locule. **Seeds** (1.3–) 1.8–3.5 mm long, (0.5–) 0.8–1.2 mm wide, tan to brown or gray-brown, elliptic to oblong, sometimes angular (Fig. 107–144 [Color Plate 3], 147; Bentham 1833, t. 1622; Craig 1934*a*, *b*: 389–392; Jepson 1943: 161–162; Mason 1945: 73–75; Harrison 1972: 5–7; Milliken 1904: 39; Hoover 1970: 230; S. De Groot, unpubl. data).

Identification.—*Eriastrum pluriflorum* can be distinguished from *E. densifolium* by its annual habit. *Eriastrum densifolium* is perennial, and usually woody at least at the base, in mature (or at least second-year) plants. *Eriastrum pluriflorum* can grow fairly large, and sometimes can live long enough to appear woody at the base, but does not have secondary growth or branches that have over-wintered, as *E. densifolium* does. Additionally, most anthers of *E. pluriflorum* are 2.5 mm long or shorter, while anthers of *E. densifolium* are 2 mm or longer, and in areas where the two species might be confused, *E. densifolium* anthers are usually 2.5 mm or longer.

Eriastrum virgatum has an annual lifespan and herbaceous stems, in contrast to *E. densifolium*, which is perennial and woody at least near the base. The woolly trichomes on *E. virgatum* are sparse enough that the stems, leaves, and bracts appear green, while sympatric *E. densifolium* subsp. *elongatum* is usually canescent. While *E. virgatum* is often virgate, racemose, or occasionally has one or two branches from the base, *E. densifolium* usually has more than two branches from a woody base.

Eriastrum densifolium is often found in the same areas as *E. sapphirinum*, but is easily differentiated by its perennial habit, stems that are woody near the base, larger inflorescence heads, and longer corollas. Most of the corolla length difference is in the fused portion, with the tube plus throat of *E. densifolium* usually 8 mm long or longer, and the tube plus throat of *E. sapphirinum* 7.7 mm or shorter. Plants of *E. sapphirinum* are usually herbaceous and annual.

The perennial life form and woody stems (at least at the base) distinguish *E. densifolium* from all other species of *Eriastrum*, which are annual and, for the most part, herbaceous. A few annual species might persist into the autumn and develop thick stem bases if conditions are favorable, but they do not survive to resprout during a second spring growing season.

Phenology.—Flowering mid-May through July, fruiting late June through October.

Distribution.—California and Baja California (and western Nevada?); California Central Coast, Southern Sierra Nevada and foothills, east of Sierra Nevada, Mojave Desert, Tehachapi Mountains, South Coast Ranges, Transverse Ranges, Peninsular Ranges, South Coastal Plain (Fig. 148–151).

Habitat.—*Eriastrum densifolium* is found from sea level up to about 2300 m (0–7550 ft) in elevation. It grows on stabilized or semi-stabilized coastal sand dunes, benches or floodplains above washes or creeks, 'islands' within wash channels, ditches, shallow washes, flats, open slopes, rolling hills, ridge tops, firebreaks, road banks or road shoulders; generally in full sun. Several sites had recently been cleared of other shrubs, and at least one site had burned the previous fall. Usually it is found in openings between shrubs. The slope varies from flat to 33°, and most aspects have been reported although southeast-, south-, and southwest-facing seem to be the most common. The substrate is usually fine to coarse sand, gravel, pebbles, loam, adobe, leaf duff, or a mixture of these types, and may be derived from silicates, granite, mixed volcanics, various metamorphics, shale, or mixed alluvium. Surrounding vegetation may be coastal dune scrub, chaparral, grassland, alluvial sage scrub, Mojave desert scrub, Great Basin scrub, Joshua tree woodland, juniper woodland, pinyon woodland, riparian woodland, oak woodland, conifer woodland, mixed forest, or (often) mixtures of two or more of these types. Plants can be found along the edge of vegetation bordering a road. At some sites, plants might be associated with cryptobiotic crust.

Population dynamics.—Population sizes of 4 to over 5000 adult plants have been recorded. Sometimes, seedlings and juveniles can be twice as numerous as adult plants. Plants may be widely scattered, patchy, frequent, common, or abundant. Often, populations are found in patches between other shrubs or trees, but in some cases may extend for considerable distances (about 1 mile in one case).

Threats.—Competition from invasive non-native plants, development, urbanization, vehicle use, road maintenance or construction, illegal trash dumping, sand and gravel mining, hydrological alterations, erosion, trampling, and a small range size may be threats to populations. At several sites, many plants appeared dead. The reason for this is unknown. Wildfire, brush clearance, fuel reduction, fire break maintenance and logging may not pose threats.

Conservation.—Global Rank: G4 – apparently secure; U.S. Federal Status: Implied: partial status; otherwise not ranked or listed (CNPS 2013; NatureServe 2013; Table 2). "Partial status" indicates that part of this species (subsp. *sanctorum*) has U.S. federal status (endangered) under the Endangered Species Act (NatureServe 2013).

Etymology.—From Latin *densus*, dense, and *–folius*, -leaved; presumably for the numerous, closely-packed leaves and short internodes.

Common names.—Dense-leaved woolly-star, many-leaved woolly-star, perennial woolly-star (Mason 1951), giant woolstar (Nature Serve 2013).

Discussion.—*Eriastrum densifolium* is a highly variable species, with much more variation than can be characterized well by six subspecies. There is a short, dense form, often found on rocky slopes, that might be placed into either subsp. *austromontanum* or subsp. *elongatum*, depending on the amount of leaf pubescence. Although leaves of subspp. *austromontanum* and *elongatum* usually have several lobes, some forms of both subspecies have entire, linear leaves. Some plants in subspp. *austromontanum*, *elongatum*, or *densifolium* may appear more virgate than is typical. Plants of both subspp. *austromontanum* and *elongatum* may have very small, sometimes solitary, heads.

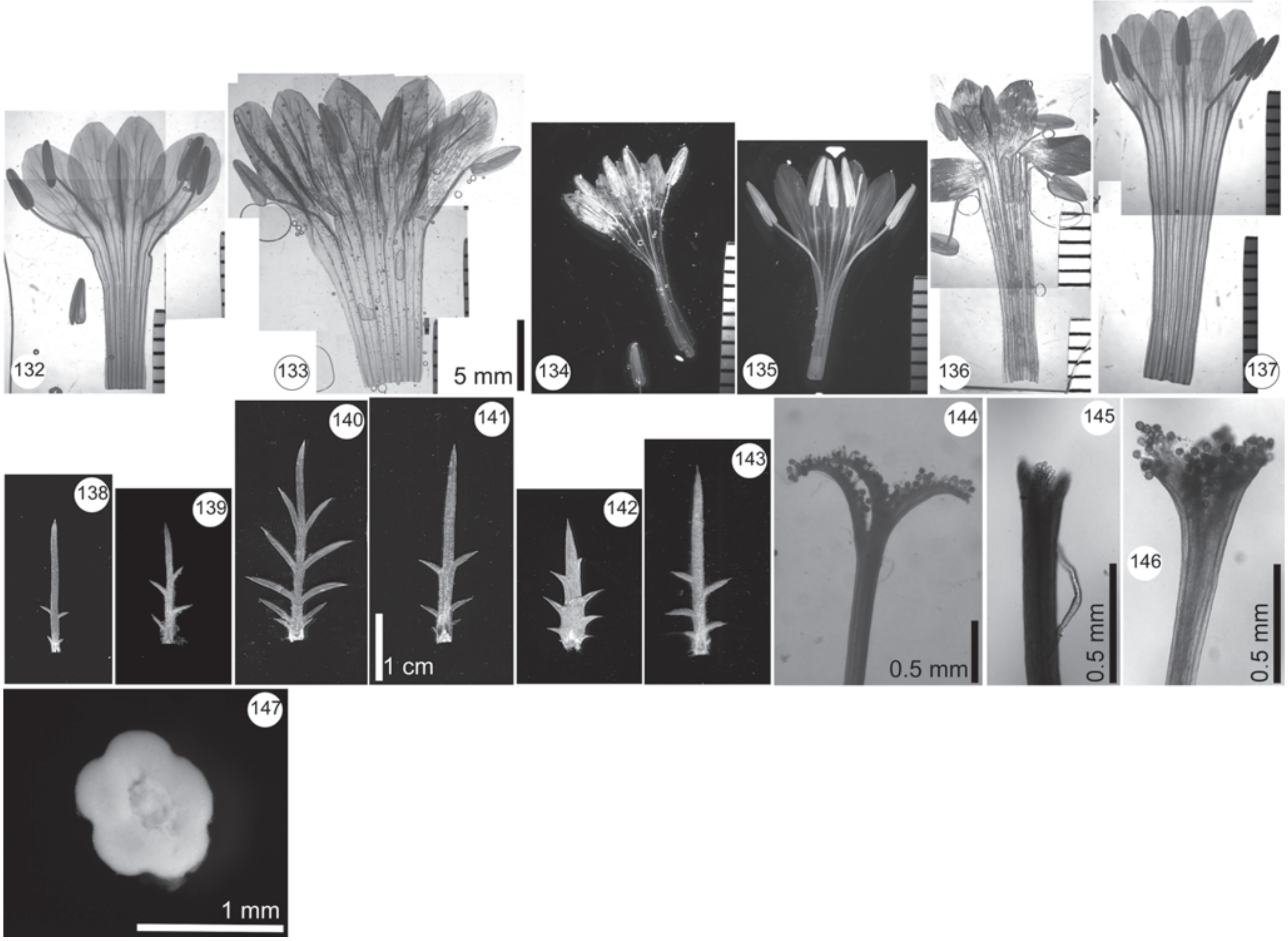
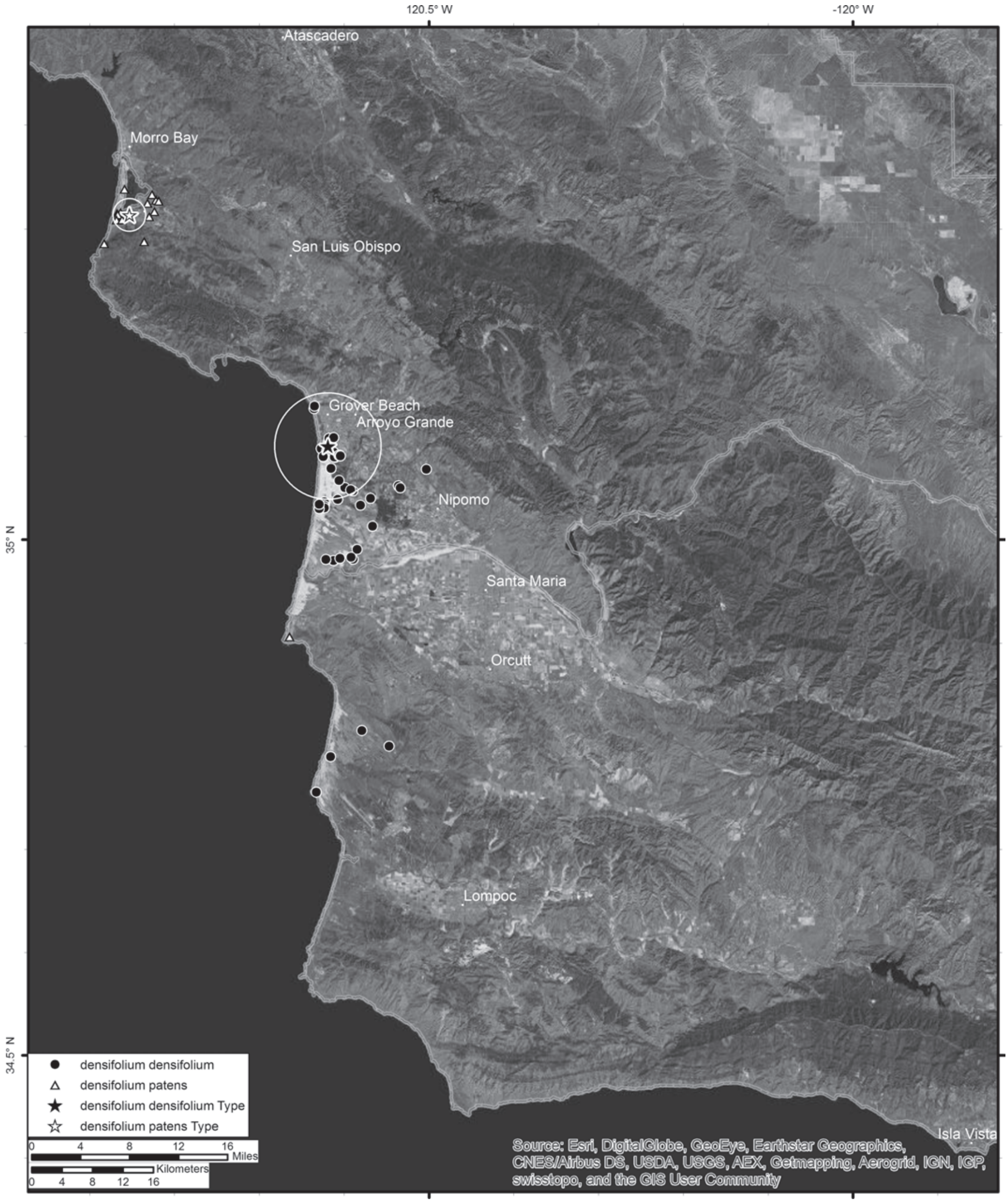


Fig. 132–147. Corollas, leaves, and nectary of *E. densifolium*; stigmas of *Eriastrum*.—132–137. Corollas of *E. densifolium*. Scale bars are in mm, and approximately the same for all six photographs. In all cases except 133, one petal was removed to open the corolla.—132. Corolla of subsp. *densifolium* (*De Groot 5700*).—133. Corolla of subsp. **patens** (*De Groot 5641*).—134. Corolla of subsp. *austromontanum* (*De Groot 5048*).—135. Corolla of subsp. *elongatum* (*De Groot 5646*).—136. Corolla of subsp. *mohavense* (*De Groot 5054*).—137. Corolla of subsp. *sanctorum* (*De Groot 5703*).—138–143. Mature leaves of *E. densifolium*, all to approximately the same scale.—138. Leaf of subsp. *densifolium* (*De Groot 5700*).—139. Leaf of subsp. **patens** (*De Groot 5641*).—140. Leaf of subsp. *austromontanum* (*De Groot 5910*).—141. Leaf of subsp. *elongatum* (*De Groot 5646*).—142. Leaf of subsp. *mohavense* (*De Groot 5907*).—143. Leaf of subsp. *sanctorum* (*De Groot 5703*).—144–146. Stigmas of *Eriastrum*. Round objects are pollen grains.—144. Stigma of *E. densifolium* subsp. *sanctorum*, with long lobes (*De Groot 5703*).—145. Stigma of *E. luteum*, with short lobes (*De Groot 5300*).—146. Stigma of *E. rosamondense*, with lobes of average length (*De Groot 4976*).—147. Five-lobed nectary of *E. densifolium* subsp. *sanctorum* (*De Groot 5703*).

Plants of subsp. *elongatum* from desert areas look slightly different from plants of subsp. *elongatum* occurring in cismontane areas. On Vandenberg Air Force Base, there is a form of subsp. *densifolium* that has longer internodes and smaller heads than the typical form. Some plants appear morphologically intermediate between two or more subspecies, such as a plant with the form of subsp. *elongatum* but lacking white tomentum on the leaves; or a plant with the many-lobed, green leaves of subsp. *austromontanum* but with the smaller inflorescences of subsp. *elongatum*. Specimens from Point Sal in Santa Barbara County appear to be a very woolly form of subsp. *patens* that is found considerably farther south of its usual range; although the plants also somewhat resemble subsp. *mohavense*.

Population genetic data suggests that there is high genetic diversity within this species, both within the species and within populations (Brunell and Whitkus 1997). Genetic distance seems to be primarily correlated with geographic distance (but not elevation), and populations do not form distinct clusters based on similar genetic markers, although the number of population samples included was small (Brunell and Whikus 1997; Slenzka et al. 2013). A small sample of *Eriastrum densifolium* populations found no well-defined morphological groups, and morphology was not correlated with either geography or genetics (Brunell and Whitkus 1999*b*). These data suggest that *E. densifolium* may be in the process of ecological adaptation and perhaps differentiation. Additional population genetic study, using many samples and coupled with morphological, geographic, and ecological analysis, may elucidate this.

For now, this means that the currently recognized subspecies may intergrade morphologically, and there may be forms in nature that do not fit well into any of the subspecies. While frustrating when attempting to identify a plant, this is just the nature of the species.



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Fig. 148. Range map for *E. densifolium* subspp. *densifolium* and **patens** showing specimen and type locations. Circles around the stars indicate uncertainty about the exact location of the type collection. Cities are marked. The background is a satellite image. Note that plants tend to be found on stretches of coastline that are angled the same way, where coastal sand dunes accumulate. The farthest south specimen of subsp. **patens**, from Pt. Sal, is an odd, densely floccose variant.

Key to the Subspecies of E. densifolium

1. Plants of coastal sand dunes; corolla broadly funnelform; lobes slightly (~1.5–3.0 mm) shorter than the tube plus the throat, 7 mm long or longer, usually wider than 3.0 mm (*patens* sometimes 2.5 mm)
    2. Stems and leaves glabrous to subglabrous; inflorescence floccose. . . . . .3A. subsp. *densifolium*
    2’ Stems and leaves lanate; inflorescence floccose. . . . . .3E. subsp. **patens**

1’ Plants of chaparral, alluvial scrub, montane forest, or desert scrub habitats; corolla narrowly funnelform to salverform; lobes shorter (by 2 mm or more) than the tube plus the throat, 7 mm long or shorter (*sanctorum* to 7.7 mm), usually narrower than 3.5 mm (subsp. *sanctorum* to 4.5 mm)
    3. Stems and leaves glabrous to subglabrous, usually appearing green; inflorescence lanate to floccose. . . . . .3B. subsp. *austromontanum*
    3’ Stems and leaves lanate, usually appearing white-canescent (sometimes gray-green); inflorescence floccose
        4. Leaf blade primary axis >2 mm wide just above the distal-most lobe; lobes generally less than 2 times longer than the width of the primary axis. . . . . .3D. subsp. *mohavense*
        4’ Leaf blade primary axis <2 mm wide just above the distal-most lobe; if wider, then lobes generally more than 2 times longer than the width of the primary axis
            5. Corolla <22 mm long; widespread. . . . . .3C. subsp. *elongatum*
            5’ Corolla >22 mm long; plants found only in the floodplains of the lower Santa Ana River. . . . . .3F. subsp. *sanctorum*

3A. ERIASTRUM DENSIFOLIUM (Bentham) H. Mason subsp. DENSIFOLIUM. Mason 1945, *Madroño* 8(3): 73.

Basionym: *Hugelia densifolia* Bentham 1833, *Edwards's Botanical Register* sub t. 1622.

Type: USA, California, *Douglas* in 1831 (label: 1833).

Lectotype, designated here (possibly holotype): K 196251! (Herb. Benth.). Isolectotypes: K 196250! (Herb. Hook.), P 643637 (image!), G-DC 135007 (image!), GH 303654!, UC 163785 (image!), CGE 12402 (image!), BR 5280124 (image!); probable isolectotype NY 277879 (image!). Photograph of K 196251: POM 188266!.

≡*Hugelia densifolia* Bentham 1833, *Edwards's Botanical Register* t. 1622. Jepson 1925, *Manual of the Flowering Plants of California*, p. 792, probably including *elongata*. Jepson 1943, *Flora of California* Vol. 3 Part II p. 161–163, including *elongata*.

≡*Gilia Hugelia* Steudel 1840, Nomenclator Botanicus, p. 683. = “*Hugelia densiflora* Benth.” In this publication, *Gilia elongata* was recognized separately.

≡*Gilia densifolia* Bentham 1845, *in* De Candolle, Prodromus Systematis Naturalis Regni Vegetabilis, 9: 311. Gray 1870, *Proc. Amer. Acad. Arts Sciences* 8: 272. Gray 1876*b*, *in* Brewer and Watson, Geological Survey of California, Botany I: 494, here including both *densifolia* (“a short stout form”) and *elongata*. Greene 1894, Manual of the botany of the region of San Francisco Bay, p. 249, probably including *elongata* (plants said to be floccose-woolly). Davidson and Moxley 1923, Flora of Southern California, p. 289, probably including material of subspp. *austromontana* and *mohavense*, but not *elongata* or *sanctora*.

≡*Navarretia densifolia* (Benth.) Brand subsp. *eu-densifolia* Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 165, perhaps including *Gilia densifolia* var. *sanctora* Milliken, but this name cited as synonym of the species only, not this subspecies.

≡*Navarretia densifolia* (Benth.) Brand 1913, *Annuaire Conserv. Jard. Bot. Genève*, vol. XV et XVI, p. 340, including *Gilia pluriflora* Heller.

≡*Gilia densifolia* Benth. var. *typica* T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 388, 390–391; not including *elongata* (nom. inval.).

Eriastrum densifolium (Benth.) H.L. Mason subsp. *densifolium*. Harrison 1959, Morphological and taxonomic studies in the genus *Eriastrum*, p. 66–74, 304–307. Harrison 1972, *Brigham Young University Science Bulletin* 16(4): 5. Porter and Johnson 2000, *Aliso* 19(1): 74.

=*Gilia densifolia* var. *Peirsonii* T.T. Craig 1934*a*, A revision of the subgenus *Hugelia* of the genus *Gilia*. Senior Thesis, Pomona College. p. 13 (nom. inval.—not effectively published [McNeill et al. 2006 Art. 30.5; McNeill et al. 2012 Art. 30.8]).

Type: USA, California, San Luis Obispo County, 2 [1–3] mi. south of Pismo on sand dunes, 3 July 1933, *T. Craig 1875*. Holotype: POM 185027!. Isotypes: RSA 7132!; A 00303652!; GH 00303648!; CHSC 40089!; POM 201912!; JEPS 15015 (image!); UC 536820 (image!), UC 574950 (image!).

=*Gilia densifolia* Bentham var. *pismoensis* T.T. Craig in herb. (ined.) SD 87647! (ex POM 185021), 1 mile south of Pismo on sand dunes, 29 July 1920, *F. W. Peirson 2224*.

Plant low, (10–) 20–30 (–50) cm high, distinctly shrubby, woody, perennial; with older-growth branches diverging from the base, erect or spreading then ascending (sometimes decumbent); current-year branches erect, arising from stems below the persistent inflorescence heads from previous years, somewhat virgate, stout to flexible. **Stem** glabrate to subglabrous, dark green to brown, sometimes hidden by closely packed leaves; internodes very short, often 1 cm or less, but usually longer just below the inflorescence heads; with conspicuous axillary short shoots, appearing as fascicles of short leaves, 1–2 cm long or longer, green. **Leaves** alternate, entire to pinnatifid, bright green, not rigid, 12–37 mm long, ascending, glabrate; entire or with 3–7 lobes, lateral lobes mostly arising from the proximal half of the leaf, terminal lobe long, lateral lobes usually 5 mm long or less, subulate, awn-tipped. **Inflorescence** heads terminal, often composed of several heads in a compact cluster, large, often 25- or more flowered, 1–3 (–4) cm in diameter and 1.0–2.5 cm long, excluding flowers and bract tips, heads to 6 cm across with flowers, lightly floccose, appearing mostly green. **Bracts** entire to pinnatifid, ascending, 5–24 mm long, exceeding the calyces, lightly lanate to subglabrous, glandular, light green in contrast to the white wool surrounding the calyces, tips sometimes reddish, aristate, entire to 5-lobed (rarely 7-lobed), lobes arising from the proximal half of the bract, lateral lobes 1–7 mm long, terminal lobe long, subulate, awn-tipped. **Calyx** 6.5–9.0 mm long, densely floccose with persistent, tangled, white trichomes, glandular; lobes unequal to subequal, differing in length within a flower by 0.75–1.5 (–2) mm, light green to green, tips sometimes dark reddish-brown, aristate; hyaline margins fused about 2/3 of the length of the sepals to form a tube. **Corolla** broadly funnelform, actinomorphic, 17.3–21.7 (–25) mm long; tube 8.4–11.2 mm long, exserted from calyx, puberulent inside with projections from epidermal cells, some occasionally glandular, some 2-celled; throat 1.6–3.8 mm long; throat and tube usually white, sometimes pale yellow, purple, or pink; tube plus throat 10.0–13.2 mm long; the lobes about 6.5–8.7 mm long, differing in length within a flower by 0.0–0.3 mm, 36–42% of the total corolla length, 3–5 mm wide, elliptic to elliptic-spatulate, bright blue, veins often darker, tips rounded; buds often white to yellowish. **Stamens** exserted 4.4–6.0 mm beyond the sinuses, nearly to the tips of the corolla lobes (1.2–2.8 mm shorter than lobes), attached 0.1–0.6 (–1.0) mm below the sinus; free portion of stamen 6.5–10 mm long, to base of corolla 14.8–18.4 mm long, subequal, 0.5–1.4 mm difference in length within a flower; filaments 4.3–6.4 mm long, white; anthers white to pale blue, versatile, sagittate, 3–4 mm long, 1.0–1.5 mm wide. Pollen lavender, average grain diameter 31 μm, possibly pantotreme aperture arrangement. **Pistil** about 18–21 mm long, shorter if style is not completely elongated (in younger flowers), glabrous or occasionally with a few 4-celled trichomes at the distal tip of the ovary; stigma lobes 0.75–1.25 mm long; style 15.5–18 mm long, white to pale blue; ovary with 6–9 ovules per locule. **Fruit** a capsule. **Seeds** about 1.3–1.8(+) mm long, 0.5–0.7(+) mm wide, tan (Fig. 107–110 [Color Plate 3], 132, 138; Bentham 1833, t. 1622; Craig 1934*a*: 13; Craig 1934*b*: 390; Jepson 1943: 161–162; Mason 1945: 73; Harrison 1972: 5; S. De Groot, unpubl. data).

Identification.—Subsp. *densifolium* is most easily confused with subsp. *patens*, since both subspecies are found on coastal sand dunes. The stems of subsp. *densifolium* are glabrate or nearly so, which distinguishes it from subsp. *patens*, which has woolly stems and leaves. Both subspecies have floccose inflorescences, so it is important to look not at the bracts and pedicels but at the leaves and stems farther below the inflorescence. Subspp. *elongatum*, *mohavense*, and *sanctorum* also have woolly stems and leaves, but are found farther inland, not on coastal dunes. The corolla lobes of both subsp. *densifolium* and subsp. *patens* are usually longer than the corolla lobes of subsp. *austromontanum*, which also is found farther inland. Both subspp. *densifolium* and *patens* are perennial, and usually woody, although sometimes only at the base (and sometimes the base is deeply buried by drifting sand).

Phenology.—Flowering (May) June through July (occasionally later; mostly mid-June through early July), fruiting (July) August–October.

Distribution.—California endemic; southwest San Luis Obispo and western Santa Barbara Counties (southern part of the California Central Coast; Fig. 148).

Habitat.—*Eriastrum densifolium* subsp. *densifolium* is found from sea level up to about 60 m (200 ft) in elevation. It grows on stabilized or semi-stabilized coastal sand dunes, and may be found on slopes, ridges, or depressions (often running east-west) in dunes. Field observations suggest that it may prefer ecotone areas between dunes and coastal chaparral. Usually it is found in openings between shrubs or in patches on open sand. Slopes from 6 to 26° and most aspects have been reported. The substrate is always a fine silica sand. Surrounding vegetation may be coastal dune scrub, coastal chaparral, or (often) the interface between these two types. Note that these plants are found on sections of the coast that are angled the same way, where coastal sand dunes accumulate from the action of the prevailing winds, but not in areas of the coast in between these sections (Fig. 148).

Population dynamics.—Population sizes of 4 to over 1000 plants have been recorded. Plants may be widely scattered, frequent, or abundant.

Threats.—*Ehrharta calycina* Sm. (Poaceae) in particular poses a major threat by invading large areas of coastal dunes and crowding out native plants. A site heavily invaded by *Eh. calycina* supported only 4 plants of *E. densifolium*, while sites without *Ehrharta* usually have over 100 plants of *Eriastrum*. Coastal development or urbanization may be threats. In some areas, off-highway vehicle use may impact populations.

Conservation.—Global rank: G4TNR. Considered for California rare plant ranking, but rejected (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—From Latin *densus*, dense, and *-folius*, -leaved; presumably for the numerous, closely packed leaves and short internodes. The epithet *peirsonii* is for Frank Warrington Peirson (1865–1951), a botanical collector. He was a resident of Altadena from about 1902 and collected all over southern California. His personal herbarium of ca. 14,000 sheets is now at RSA (Cantelow and Cantelow 1957). The epithet *pismoensis* presumably refers to the collection location of that specimen, near Pismo Beach.

Common names.—Dense-leaved woolly-star, many-leaved woolly-star, perennial woolly-star (Mason 1951).

Other specimens.—Under *G. densifolia* var. *Peirsonii*, Craig (1934*a*) cited *Ingalls* in 1912 from Haynes Ranch (CAS), a paratype of Hoover's *E. densifolium* var. *patens*; and *Peirson 2224* (Peirson Herbarium, RSA 76259), one sheet of which he had previously annotated as *G. densifolia* var. *pismoensis* T.T. Craig ined. (SD 87647! [ex POM 185021]).

Discussion.—Regarding the holotype, Harrison (1972) specified only "Type: Kew." There are two specimens at Kew, one from Bentham's herbarium and one from Hooker's. Because Bentham wrote the original description, the K specimen selected here as the lectotype is a Douglas specimen from Herbarium Benthamianum. The K isolectotype is from Hooker's herbarium.

It seems that Craig confused subspp. *densifolium* and *elongatum* in his thesis (1934*a*). Subsp. *elongatum* was treated there as var. *typica* (with both *Hugelia elongata* Benth. and *Hugelia densifolia* Benth. cited as synonyms), and subsp. *densifolium* was treated as var. *peirsonii*. No synonyms were cited for var. *peirsonii*, but the type specimen (*Craig 1875*) compares favorably to the type specimen of typical *densifolium*. Craig, however, corrected the application of these names in his *Bull. Torr. Bot. Club* (1934*b*) publication. Subspecies *densifolium* and *elongatum* were recognized separately as vars. *typica* and *elongata*, respectively, and var. *peirsonii* was not mentioned. The type specimen of var. *peirsonii* was not cited, but three paratypes of var. *peirsonii*—*Peirson 2224*, *Eastwood 14944*, and *Eastwood 867*—were cited under var. *typica*.

Using the current range of subsp. *densifolium* and David Douglas' route of travel in the early 1830s, we can guess the likely locality where the type specimen was collected. Douglas made a trip from Monterey to Santa Barbara in the spring of 1831, probably following El Camino Real, which lay roughly along the route of modern-day Highway 101 (Harvey 1947; McKelvey 1956). This path was mostly inland from the coast, except at the Pismo Beach area. Since Highway 101 intersects the current range of subsp. *densifolium* from about Nipomo through Arroyo Grande to Pismo Beach, we can guess that the type specimen was collected somewhere in this area, probably in the spring of 1831. Although the specimen labels give the collection date as 1833, this probably was the date when the specimens were received in England, not the actual collection date, since Douglas left California in August of 1832 (Jepson 1933; Howell 1937; McKelvey 1956).

Plants from Vandenberg Air Force Base appear to have broader, green, glabrous leaves, that are entire or 2–3-lobed; longer internodes (leaves less densely packed than typical); possibly larger flowers, fewer flowers per head; and a nearly herbaceous habit. More samples and study are needed to determine if this should be recognized separately from subsp. *densifolium*.

3B. ERIASTRUM DENSIFOLIUM (Bentham) H. Mason subsp. AUSTROMONTANUM (T.T. Craig) H. Mason 1945, *Madroño* 8(3): 74.

Basionym: *Gilia densifolia* Bentham var. *austromontana* T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 391–392.

Type: USA, California, San Diego County: from dry slope near Nellie, Palomar Mts., at 5000 ft alt., 24 June 1924, *P.A. Munz 8341*.

Holotype: POM 48414!. Isotype: GH 00303653!.

≡*Gilia densifolia* (Bentham) Bentham var. *austromontana* T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 391–392.

Probably included in *Navarretia densifolia* subsp. *eu-densifolia* Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 165.

≡*Hugelia densifolia* Bentham subsp. *austramontana* (T.T. Craig) Ewan 1937, *Bull. Torrey Bot. Club* 64: 520.

≡*Hugelia densifolia* Bentham var. *austromontana* (T.T. Craig) Jepson 1943, A Flora of California Vol. 3 Part II p. 162–163.

≡*Eriastrum densifolium* (Bentham) H. Mason var. *austromontanum* (T.T. Craig) Hoover 1970, Vascular Plants of San Luis Obispo County, 231.

Suffrutescent perennial 10–30 (–45) cm high, usually several older stems from base, erect or spreading, sometimes decumbent; current-year branches erect; axillary branches sometimes present; herbage glabrate to slightly floccose, especially around the heads. **Stems** leafy, internodes usually less than 1.5 cm long, sometimes longer just below heads, rarely to 2.5 cm, lower stems sometimes brownish, upper generally green; axils without canescent buds, short spur shoots sometimes present in axils. **Leaves** alternate, pinnatifid, ascending to spreading, 15–35 mm long, light green, subglabrous, apex subulate to aristulate; usually with 7–13 (–15) lobes, sometimes 5-lobed, rarely entire; lobes subulate, twice to many times longer than the width of the primary axis, arising along the length of the primary axis, the terminal lobe short, lateral lobes 10 mm long or less. **Inflorescence** heads almost entirely terminal; heads small to medium-sized, 1.0–1.5 cm long and 1.0–2.0 cm wide (occasionally to 3.0 cm) excluding flowers and tips of bracts, frequently with as many as 20 flowers, moderately woolly. **Bracts** pinnatifid, numerous, ascending to spreading, well-developed, 10–25 mm long, exceeding the calyces by up to 2 cm in length, green, lightly floccose, subulate to aristulate; with 3–7 lobes (rarely 8 or 9), often crowded toward a broad primary axis base, lateral lobes short, mostly less than 1 cm long. **Calyx** 5–8 mm long; sepals narrow, aristulate, densely floccose; costa green; hyaline margins fused 1/2 to 2/3 of the length of the calyx to form a tube; lobes unequal to subequal, differing in length about 0.5–1.2 mm. **Corolla** narrowly funnelform, actinomorphic, 10.8–18 (–23) mm long; tube 4.5–10 (–11) white to pale blue or lavender, sometimes purplish, base sometimes yellowish, tube sometimes drying yellowish, puberulent inside; throat white to pale blue or lavender, 1–2 mm long; tube plus throat 6.4–15 mm long; lobes deep blue to pale blue, veins often darker, 3.6–7 mm long, differing in length within a flower by 0.0–0.4 mm, 25–41% of total corolla length, 1.8–3.5 mm wide, elliptic to obovoid to elliptic-spatulate. Buds white to pale yellow or pale blue. **Stamens** exserted 2.1–3.2 mm past the sinus, about 1 mm shorter than the lobes, attached 0–0.5 mm below the sinus; free portion 4–6 mm long, to base of corolla 8.1–14.3 mm, mostly equal, 0.2–0.5 (–0.8) mm difference in length within a single flower; filaments 3–4 (2.4–4.3) mm long, 0.1–0.6 (–0.9) mm difference in length, white to pale blue; anthers 2.5–3.5 mm long, versatile, sagittate, white to pale blue. Pollen blue to lavender, average grain diameter 29 µm, possibly anomotreme aperture arrangement. **Pistil** about 16–19 mm, glabrous; stigma lobes 1 mm long, white; style about 13–17 mm long, white; 3–6 ovules per locule, 10–16 ovules total. **Capsule** about 4–4.5 mm long, 2–2.5 mm wide, tan, few-seeded, about 1–5 seeds per locule. **Seeds** 2.0–2.9 mm long, 0.8–1.1 mm wide, light gray-brown, elliptic to oblong, sometimes angular (Fig. 128–131 [Color Plate 3], 134, 140; Craig 1934*a*, *b*: 391; Mason 1945: 74; Harrison 1972: 5–6; S. De Groot, unpubl. data). Chromosome number: $2n = 14$ (Grant 1959).

Identification.—Subsp. *austromontanum* is most frequently confused with subsp. *elongatum*. The relationship between these two subspecies is complex, and there may be one or more undescribed, cryptic subspecies that complicates the morphological distinctions between the two. However, for the purposes of this treatment, subsp. *austromontanum* is best differentiated from subsp. *elongatum* by the paucity of trichomes on its leaves. Leaves of subsp. *austromontanum* generally appear green, while leaves of subsp. *elongatum* generally appear white-canescent to gray-green (although there may be a continuum in this character). Typical subsp. *austromontanum* often has larger terminal heads and few axillary inflorescence heads, while subsp. *elongatum* has smaller, canescent terminal heads and usually several axillary heads. Subsp. *austromontanum* tends to occur in moist, montane forest or montane chaparral, and subsp. *elongatum* is often found in drier areas at lower elevations; however, subsp. *austromontanum* sometimes is also found in drier areas at lower elevations as well. The flowers of subsp. *austromontanum* are similar to those of subspp. *densifolium* and *patens*, but these are found on coastal sand dunes while subsp. *austromontanum* is found farther inland. *Eriastrum densifolium* subsp. *austromontanum* can be distinguished from other *Eriastrum* occurring in the same area by its perennial habit, with stems near the base becoming at least somewhat woody.

Phenology.—Flowering very late May through August. Fruiting July through September.

Distribution.—California and Baja California; Southern Sierra Nevada and foothills, east of Sierra Nevada, Tehachapi Mountains, South Coast Ranges, Transverse Ranges, Peninsular Ranges, South Coast (Fig. 149).

Habitat.—*Eriastrum densifolium* subsp. *austromontanum* occurs between about 950 and 2300 m (3100–7550 ft) in elevation. Subsp. *elongatum* overlaps this elevational range, being found from about 130–2000 m (425–6560 ft; Fig. 149). Subsp. *austromontanum* is found on benches or floodplains above washes or creeks, hillsides, knolls, openings in forest, ditches, or road banks or shoulders. Several sites had recently been cleared of other shrubs, and at least one site had burned the previous fall. The slope varies from flat to 33°, and although most aspects have been documented, southeast-, south-, or southwest-facing seem to be the most common. The substrate is usually fine to coarse sand, gravel, loam, adobe, leaf duff, or a mixture of these types, and may be derived from granite, various metamorphics, or mixed alluvium. Surrounding vegetation may be mixed forest, conifer woodland, oak woodland, riparian woodland, pinyon woodland, chaparral, Great Basin scrub, grassland, or (often) mixtures of two or

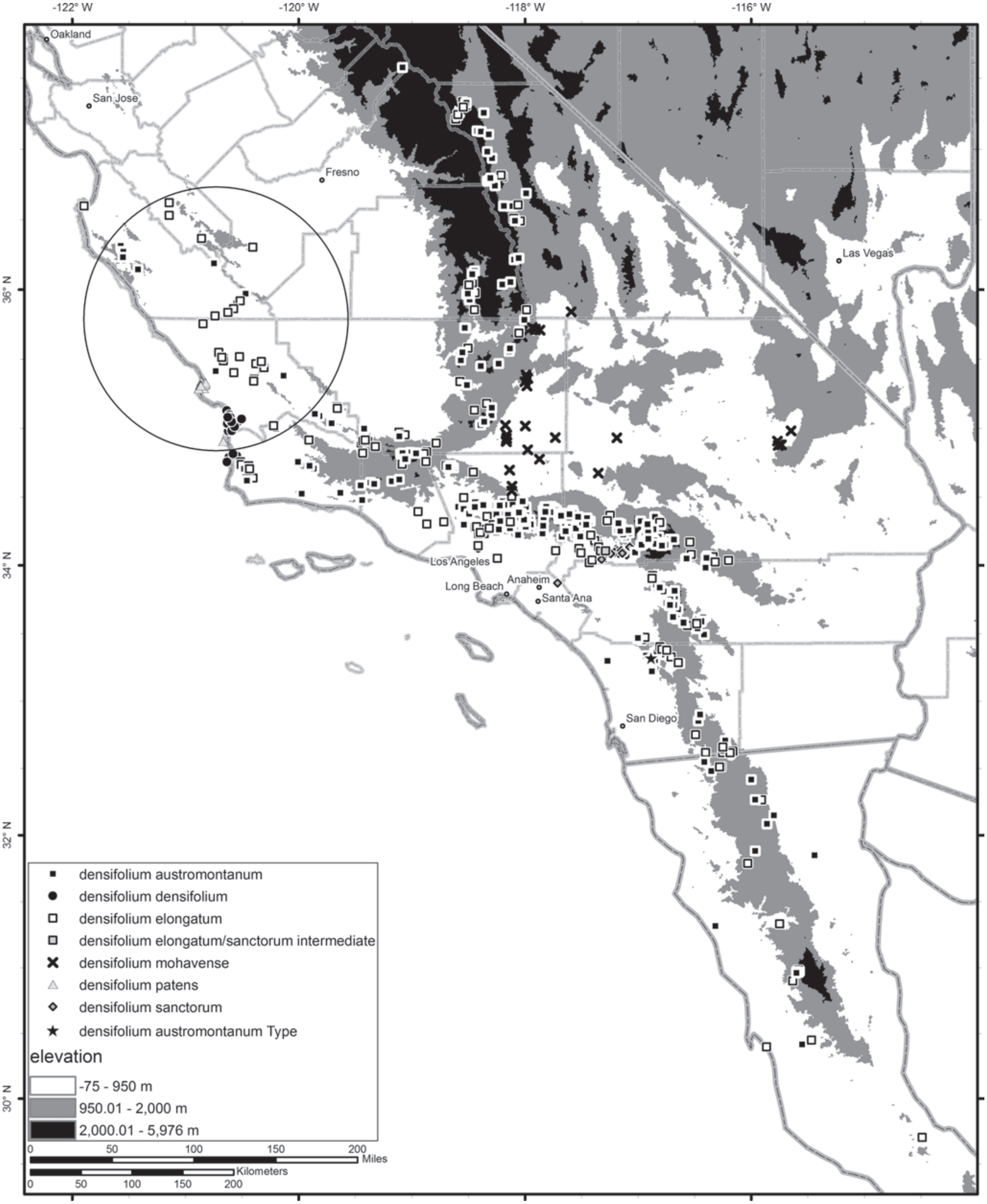


Fig. 149. Range map for *E. densifolium* showing specimen locations primarily of subspp. *austromontanum* and *elongatum*, although all subspecies locations are mapped for reference. The type of subsp. *elongatum* is marked as a large circle, showing the uncertainty of its exact collection location. Elevation (in m) is indicated; below 950 m mostly just subsp. *elongatum* is found, between 950 and 2000 m both subspp. *austromontanum* and *elongatum* can be found, and above 2000 m mostly just subsp. *austromontanum* is found.

more of these types. Sometimes plants might be found along the edge of vegetation bordering a road.

Population dynamics.—Population sizes from about 20 to over 2000 adult plants have been recorded. At one site, 50 seedling or juvenile plants were documented, but this number probably varies depending on the time of year of the survey and the amount of winter precipitation received. Plants have been reported to be scattered, patchy, frequent, common, or abundant, usually in open, sunny areas between shrubs or trees.

Threats.—Plants appear to respond well following fire, and several other populations appeared to be doing well following clearance of other growth. Therefore, wildfire, brush clearance, fuel reduction, and fire break maintenance may not pose serious threats and in some cases may be beneficial, as long as fires are not too hot and there is minimal ground disturbance. Similarly, logging may open up areas and allow populations to expand, provided that source populations remain intact. Larger threats may be road maintenance (such as grading of shoulders) or construction, or development. A few populations had many dead plants. The cause of death is unknown.

Conservation.—Global rank: G4TNR; otherwise not ranked or listed (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—From Latin *austro*-, south, and *montanus*, montane or growing on mountains. Literally "southern-montane," presumably referring to the geographic range and general habitat of the subspecies.

Common names.—Mountain woolly-star, southern mountain woolly-star.

Other specimens.—*Palmer 414* (K 196246!, GH 303691!) probably the specimen referred to under *Gilia virgata* var. *floribunda* [*Eriastrum pluriflorum*] in Gray (1878: 143), is better placed in *E. densifolium* subsp. *austromontanum*.

Discussion.—Subspecies *austromontanum* and *elongatum* are both highly variable morphologically, and often overlap in morphology such that they can be frustrating and difficult to identify. Mason wrote, "Morphological intergradation with subsp. *elongatum* is almost complete and I retain it as separate only with hesitancy" (1945: 74). This subspecies has been noted to "intergrade freely" with subsp. *elongatum* (Munz 1935: 401). The types, however, are distinct. While this morphological overlap is frustrating to the taxonomist, it underscores the need for detailed population-level study of this species. The two subspecies may differ in habitat or ecology (S. De Groot, pers. obs.), but this has not been studied.

Field observations note that flowers have been visited by swallowtail and California Dogface butterflies, and aphids may be found in the inflorescences.

3C. ERIASTRUM DENSIFOLIUM (Bentham) H. Mason subsp. ELONGATUM (Bentham) H. Mason 1945, *Madroño* 8: 73–74.

Basionym: *Hugelia elongata* Bentham 1833, *Edwards's Botanical Register* sub t. 1622.

Type: USA, California, *Douglas* in 1831 or 1832 (label: 1833).

Lectotype, designated here (possibly holotype): K 196249! (Herb. Benth., labeled *Hugelia elongata*). Isolectotypes: K 545587! (Herb. Hook., labeled *Hugelia elongata*); BM 939578! (labeled *Hugelia virgata*); P 643641(image!, labeled *Hugelia virgata*); G-DC 135038 (image!, labeled *Hugelia virgata*); GH 303711! (originally labeled *Hugelia virgata*, but *virgata* was crossed out and corrected to *elongata*, perhaps in Asa Gray's handwriting); UC 163790 (image!, labeled *Hugelia elongata*); CGE 12403 (image!, labeled *Hugelia elongata*, shares sheet with Douglas collection of *Hugelia virgata*); CGE 12448 (image!, labeled *Gilia elongata*, shares sheet with Douglas collection of *Gilia densifolia*), NY 277880 (Torrey Herbarium, image!, not originally identified). Photograph of K 196249: POM 188267!.

≡*Hugelia elongata* Bentham 1833, *Edwards's Botanical Register* sub t. 1622.

≡*Gilia elongata* Steudel 1840, Nomenclator botanicus. I. 683. Bentham 1845, *in* De Candolle, Prodromus Systematis Naturalis Regni Vegetabilis. 9: 311. Bentham 1849, Plantae Hartwegianae p. 324.

Included in *Gilia densifolia* Bentham by A. Gray 1870, *Proc. Amer. Acad. Arts Sciences* 8: 272.

≡*Gilia densifolia elongata* A. Gray (nom. inval. [ined.]). A.A. Heller 1900, Catalogue of North American Plants, North of Mexico. 2nd ed.

≡*Navarretia densifolia* (Bentham) Brand subsp. *elongata* (Bentham) Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 165.

≡*Gilia densifolia* Bentham var. *elongata* (Bentham) A. Gray ex Brand (nom. inval. [ined.]). Macbride 1917, *Contr. Gray Herb.* NS Vol. 49 No. 3. p. 55–56. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 389–390.

Included in *Hugelia densifolia* Bentham by Jepson 1943, A Flora of California Vol. 3 Part II p. 161–163.

≡*Eriastrum densifolium* (Bentham) H. Mason var. *elongatum* (Bentham) Hoover 1970, Vascular Plants of San Luis Obispo County, 231.

≡*Gilia densifolia* Bentham var. *elongata* A. Gray in herb. (Brand 1907: 165).

Probably =*Hugelia lanata* Lindley 1848, *J. Hort. Soc. London* III: 74. Type: none cited. No range listed. Apparently no specimen was ever made, so no lectotype will be designated. To interpret to what this name refers, one could refer to *Hartweg no. 1845*, although first-year plants grown from seed in cultivation probably retained juvenile morphology and looked different than this mature specimen.

≡*Gilia lanata* (Lindley) Walpers 1849, Annales Botanices Systematicae I: 519. Range given: "Crescit in America meridionali (Mexico)."

≡*Gilia lanata* Lindley. A. Gray 1870, *Proc. Amer. Acad. Arts Sciences* 8: 273, "…said to come from Mexico, of which I know only the character, is probably a form of *G. virgata* or of *G. filifolia*."

≡? *Navarretia virgata* (Benth.) Brand [subsp. *floccosa* (A. Gray) Brand] var. *floribunda* (A. Gray) Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 168. *Hugelia lanata* Lindley and *Gilia lanata* Walpers listed as synonyms but with question.

Perennial plants 20–50 (–90) cm tall, less woody than subsp. *densifolium*, with elongate, divaricate or rarely procumbent branches arising from a woody base, current-year branches mostly erect; herbage canescent-lanate when young, remaining so at least in the upper half of the plant through maturity; internodes 1–4 cm long; axils with weak development of short canescent buds, short axillary branches with small heads often present in the distal portions of current-year branches. **Leaves** alternate, pinnatifid, ascending to spreading (from base), gray-green, 15–36 mm long, somewhat rigid, linear, subulate; entire or with up to 9 lateral lobes, the primary axis generally less than 2 mm wide, the length of the lateral lobes usually more than twice the width of the primary axis, but often less than 5 mm long, occasionally to 10 mm long, lateral lobes arranged near the proximal part of the leaf, or, if many, nearly equally spaced, making the terminal lobe short; all white-tomentose, or glabrate in age. **Inflorescence** branching racemose or corymbose; heads terminal and lateral, comparatively small, 0.75–1.5 cm long, 1–2 cm wide excluding the tips of bracts, white-canescent, usually with fewer than 15 flowers.

Bracts entire or pinnatifid, ascending to spreading, 6–15 mm long, occasionally to 20 mm long, equaling to exceeding the calyces, green, tips often reddish, sometimes partly hidden by dense white woolly trichomes, subulate to aristulate; inner bracts mostly entire, outer bracts with 3–5 lobes arising from the proximal half of the bract, lateral lobes mostly 2 mm long or shorter. **Calyx** completely hidden by dense woolly trichomes, 5–7.5 mm long; sepal costae green to yellowish-green, bases often lighter, sepal tips often reddish, subulate to aristulate, bordered by a hyaline membrane, which is fused for the proximal 1/2 to 2/3 of the length to form a tube; lobes subequal, differing in length by about 0.5–0.8 mm. **Corolla** 13–18.2 mm long, very rarely to 20 mm long, narrowly funnelform, actinomorphic; tube exserted from calyx, white to pale blue or lavender, sometimes purplish, sometimes appearing yellowish when dried, 7.0–9.5 mm long, puberulent inside with 1–3-celled trichomes, occasionally glandular; throat white to pale blue or lavender, 1.6–3.9 mm long; throat plus tube 8.0–12.5 mm long; lobes bright blue, lavender-blue, blue-violet, or pale blue, veins often darker, 4–7 mm long, differing in length within a flower by 0.0–0.4 mm, half the length of the tube, 29–39% of total corolla length, 1.9–3.3 mm wide, elliptic to elliptic-spatulate. Buds yellowish to white. **Stamens** exserted 2.8–4.5 mm beyond sinuses, but 0.9–2.7 mm shorter than lobes, attached 0.5–1.7 mm below the sinus; free portion 4.5–5 mm long, to base of corolla 11.0–15.4 mm, subequal, 0.2–1.1 mm difference in length within a flower; filaments 2.8–5.6 mm long, pale blue or lavender; anthers white to pale blue or violet, versatile, sagittate, 3.0–3.5 mm long, 0.75–1.00 mm wide. Pollen lavender to blue, average grain diameter 30 µm. **Pistil** 11.5–17.5 mm long, glabrous; stigma lobes 0.5–1.0 mm long; style 10–15 mm long, pale blue or lavender; ovary 3-loculed, with 3–6 ovules per locule. **Fruit** is a capsule, 3.8–5.0 mm long, 1.5–1.7 mm wide, tan. **Seeds** about 1.8–2.3 mm long, 0.8–1.0 mm wide, tan, oblong to angular (Fig. 124–127 [Color Plate 3], 135, 141; Bentham 1833 t. 1622; Craig 1934*b*: 389; Mason 1945: 74; Harrison 1972: 6; S. De Groot, unpubl. data).

Identification.—Subsp. *elongatum* is most frequently confused with subsp. *austromontanum*. The relationship between these two subspecies is complex, and there may be one or more undescribed, cryptic subspecies which complicate the morphological distinctions between the two. However, for the purposes of this treatment, subsp. *elongatum* is best differentiated from subsp. *austromontanum* by the woolliness of its leaves. Leaves of subsp. *elongatum* generally appear white-canescent to gray-green, while leaves of subsp. *austromontanum* generally appear green (although there may be a continuum in this character). Typical subsp. *elongatum* has smaller, canescent terminal heads and usually several axillary heads, while subsp. *austromontanum* often has larger terminal heads and few axillary inflorescence heads.

The width of the leaf primary axis is a key character by which to differentiate subsp. *elongatum* from subsp. *mohavense*. In subsp. *elongatum*, the leaf primary axis is usually less than 2 mm wide, and the lateral lobes are more than twice as long as the primary axis width. In subsp. *mohavense*, the leaf primary axis is usually 2 mm wide or more, and the lobes are generally shorter than twice the width of the primary axis. Furthermore, the leaves of subsp. *elongatum* are generally straight, while the leaves of subsp. *mohavense* are frequently curved downward. Subsp. *mohavense* is found exclusively in the California deserts. Subsp. *elongatum* may be found at the western edge of the deserts, but also occurs in cismontane areas.

Subsp. *elongatum* is also sometimes mistaken for subsp. *sanctorum*, but subsp. *sanctorum* has much larger flowers (frequently longer than 25 mm) than subsp. *elongatum*, whose corollas usually do not exceed 22 mm in length. Subsp. *sanctorum* is restricted to the Santa Ana River drainage in southern California, while subsp. *elongatum* is widespread from central California to northern Baja California.

Eriastrum densifolium subsp. *elongatum* can be distinguished from other annual *Eriastrum* occurring in the same area by its perennial habit, with stems near the base becoming at least somewhat woody.

Phenology.—Flowering from about mid-May through July. Fruiting July, August, and possibly September.

Distribution.—California and Baja California (and western Nevada?); Southern Sierra Nevada and foothills, east of Sierra Nevada, South Coast Ranges, Transverse Ranges, South Coast, Peninsular Ranges (Fig. 149).

Habitat.—*Eriastrum densifolium* subsp. *elongatum* is found between elevations of 130 m and 2000 m (425–6560 ft), on benches above creeks or washes, floodplains, hillsides, open slopes, flats, rolling hills, ridge tops, firebreaks, or roadsides, generally in full sun. The slope varies from flat to 25°, and all aspects have been reported. The substrate is often some sand with adobe, loam, pebbles, or duff. Soils may be derived from granite, shale, mixed alluvium, or mixed volcanics. Surrounding vegetation may be grassland, Great Basin sagebrush scrub, coastal chaparral, montane chaparral, oak woodland, Joshua tree woodland, juniper woodland, mixtures of several of these types, or transitions between two of these types. At some sites, plants might be associated with cryptobiotic crust. Subsp. *elongatum* overlaps this elevation and habitat to some extent, being found from about 950–2300 m (3100–7550 ft; Fig. 149).

Population dynamics.—Population sizes from about 40 to over 3000 plants have been recorded. Plants have been reported to be scattered, locally frequent, locally common, or locally abundant. Often, populations are found in patches between other shrubs or trees, but in some cases may extend for considerable distances (about 1 mile in one case).

Threats.—Plants have been found in firebreaks and along roads, suggesting that slight disturbance is not detrimental. More severe disturbance, such as frequent vehicle use, road construction or grading, or development may be threats.

Conservation.—Global rank: G4TNR; otherwise not ranked or listed (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—From Latin *elongatus*, elongated; probably referring to the long branches and racemose or corymbose inflorescence shape. The epithet *lanata* is from Latin *lanatus*, woolly; probably referring to the wool covering every part (Lindley 1848: 74).

Common name.—Elongate woolly-star.

Other specimens.—*Coulter 453* (GH 303692! [ex-TCD], K!, TCD!). *Coulter s.n.* (BM 939588!, K!, CGE 12407 [image!], CGE 12452 [image!]). *Hartweg 1845* (GH 303711! [barcode 303651], K 196248!, K 545631!, BM!, CGE 12407 [image!]).

Discussion.—See discussion in the Introduction about *Hugelia lanata* and its relationship to *E. densifolium* subsp. *elongatum*.

See notes under *E. densifolium* subsp. *densifolium* about Craig's confusion of subspp. *densifolium* and *elongatum*.

Some Douglas specimens of *E. densifolium* subsp. *elongatum* and *E. virgatum* have their labels switched. I have found labels switched at BM, P, and G-DC; but specimens are correctly labeled at K, GH, UC, and CGE. These switched labels may have caused confusion in the identification of other specimens (see discussion about *Hugelia lanata* in the Introduction). A specimen at NY (277880 [image!]) was never originally determined, being received from Bentham labeled only with the collector and place, and subsequently determined by Torrey, Gray, or one of their associates.

The probable type locality cannot be determined with precision. In the spring of 1831, Douglas traveled from Monterey to Santa Barbara and back, probably following El Camino Real (Harvey 1947; McKelvey 1956). *Eriastrum densifolium* subsp. *elongatum* may be found in many places along this route, from the area of La Purisima Mission near present-day Lompoc to the Salinas River valley, and the type collection could have been made anywhere in between (circle in Fig. 149).

About this subspecies, Mason wrote, "It has a very complex genetic and geographic pattern and careful field and genetic study will undoubtedly yield a basis for subdividing it. As at present known, it is not too well differentiated from *E. densifolium* subsp. *austromontanum*" (1945: 74). However, the types are distinct. Careful population analyses should aid our understanding of this subspecies and its relationships to other subspecies of *E. densifolium*.

There is much variation within *E. densifolium* subsp. *elongatum* (see discussion under *E. densifolium* species). Plants on Camp Roberts have mostly entire leaves, while typical subsp. *elongatum* has a few lobes or teeth. Plants in the western Mojave Desert also look slightly different from the typical form.

3D. ERIASTRUM DENSIFOLIUM (Bentham) H. Mason subsp. MOHAVENSE (T.T. Craig) H. Mason 1945, *Madroño* 8(3): 74–75, as "*mohavensis*."

Basionym: *Gilia densifolia* Bentham var. *mohavensis* T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 392–393.

Type: USA, California, Kern County: sand dunes between Rosamond and Mohave, 7 June 1928, *T. Craig 1360*.

Holotype: POM 182123!. Isotypes: UC 494768 (image!), POM 182264.

≡*Gilia densifolia* Bentham var. *mohavensis* T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 392–393.

≡*Hugelia densifolia* Bentham var. *mohavensis* (T.T. Craig) Jepson 1943, A Flora of California Vol. 3 Part II p. 162–163.

Perennial, plants low (8–30 cm), rounded; stems woody, brittle, densely branched, ascending; dead heads persisting from the previous year, new branches arising below old heads; stem in older portions scaly and light cream-tan in color as outer layers flake off; herbage, except the old stem, canescent-lanate. **Stem** somewhat leafy, internodes 0.5–1.0 cm long; lower axils usually with short canescent buds. **Leaves** alternate, pinnatifid, ovate-lanceolate in outline, 10–32 mm long, dull grey-green, canescent-lanate, younger leaves ascending, more mature leaves ascending at base, but curving so that the tips are spreading (or recurved/arcuate in the older leaves), rigid, leaf primary axis 2.0–3.5 mm wide; generally 5–9-lobed (very old leaves near the base of the plant sometimes entire), lobes arising from the proximal 3/4 of the primary axis, the lateral lobes 1–6 mm long, usually less than twice the width of the primary axis, lobes spine-tipped. **Inflorescence** heads few to numerous, from 25 in very small plants up to 200 in large ones, each branch usually producing several, in a short, tight racemose or corymbose arrangement, sometimes so close as to appear as a single head; heads small, about 1 cm long and 1.5 cm wide, excluding flowers and tips of bracts, densely woolly; approximately 3–13 flowers per head. **Bracts** pinnatifid, lanceolate-dentate, mostly ascending, outer bracts sometimes curving so that the tips are spreading, 7–18 mm long, approximately equal to head, gray-green to tan, canescent, tips reddish to tan; 3–7-lobed, lobes arising from the proximal 3/4 of the primary axis, innermost bracts occasionally entire, lobes spine-tipped, lateral lobes short, 1–4 mm long, canescent, often with only the tip visible, the rest buried in woolly trichomes. **Calyces** hidden by a dense mat of long white woolly trichomes; sepals 6–10 mm long, light green, tips often reddish or yellowish, glandular; lobes unequal, differing by 0.5–1.5 mm in length, spine-tipped; sepals with hyaline margins fused to form a tube, about 1/2 to 2/3 of total length. **Corolla** narrowly funnelform to salverform, actinomorphic, 14–24 mm long; tube white to pale blue or purplish, 8–15.5 mm long, about 2/3 of corolla length, puberulent inside; throat white to pale blue, 0.9–2.9 mm long; tube plus throat 13.3–17.9 mm long; lobes elliptic, obovoid, or spatulate, pale blue or pale lavender, sometimes almost white, veins often slightly darker, 4.7–6.5 mm long, differing in length within a flower by 0.0–0.7 mm, 24–30% of the total corolla length, 2.2–3.5 mm wide, the length less than twice the width and about half the length of the tube. Buds cream-colored, white, or pale blue. **Stamens** exserted 2.6 mm or more past the sinuses, but generally 1.5 mm shorter than the lobes, attached 0.1–0.9 mm below the sinuses, the insertion distance varies by 0.0–0.5 (–1.5) mm within a flower; free portion 4–5 mm long, to base of corolla 15.1–21.7 mm, subequal, differing in length within a flower by 0.2–1.0 mm; filaments 2–5 mm long, differing in length within a flower by 0.2–1.1 (–1.6) mm, white to pale blue; anthers versatile, sagittate, 2.50–3.25 mm long, 1.00–1.75 mm wide, white to pale blue. Pollen lavender to sky blue, average grain diameter 32 μm, possibly pantotreme aperture arrangement. **Pistil** 13.0–20.5 mm long, mostly glabrous, occasionally with a few 3–4-celled glandular trichomes at the distal tip of the ovary; stigma lobes 1.0–1.5 mm long; style 10.5–18 mm long, white to pale blue; (8–) 12–15 ovules total, 2–5 per locule. **Capsule** about 2.5–4 (–6) mm long, about 1.3–1.7 mm wide, tan, with 3 locules, 2–5 seeds per locule. **Seeds** about 2.2–2.8 mm long, 0.8–1.0 mm wide, tan, elliptic (Fig. 119–123 [Color Plate 3], 136, 142; Craig 1934*a*, *b*: 392; Mason 1945: 75; Harrison 1972: 6–7; S. De Groot, unpubl. data).

Identification.—The width of the leaf primary axis is a key character by which to differentiate subsp. *mohavense* from subsp. *elongatum*. In subsp. *mohavense*, the primary axis of an upper leaf is usually 2 mm wide or more, and the lobes are generally shorter than twice the width of the primary axis. It is important to look at leaves within about 7 cm of the terminal inflorescence, since lower leaves may have a narrower primary axis. In subsp. *elongatum*, the leaf primary axis of both upper and lower leaves is usually less than 2 mm wide, and the lateral lobes are more than twice as long as the primary axis width. Furthermore, the leaves of subsp. *mohavense* are frequently curved downward or ascending at the base and curving so that the tips are spreading, while the leaves of subsp. *elongatum* are generally straight. Subsp. *mohavense* is found exclusively in the California deserts. Subsp. *elongatum* may be found at the western edge of the deserts, but also occurs in cismontane areas.

Other species of *Eriastrum* that may co-occur with *E. densifolium* subsp. *mohavense* are all annual, in contrast to *E. d.* subsp. *mohavense* which is perennial and usually woody at the base, at least in large or medium-sized plants. Some plants of subsp. *mohavense* have been observed to flower during their first growing season, so it is important to examine habit and leaf and inflorescence morphology of multiple plants

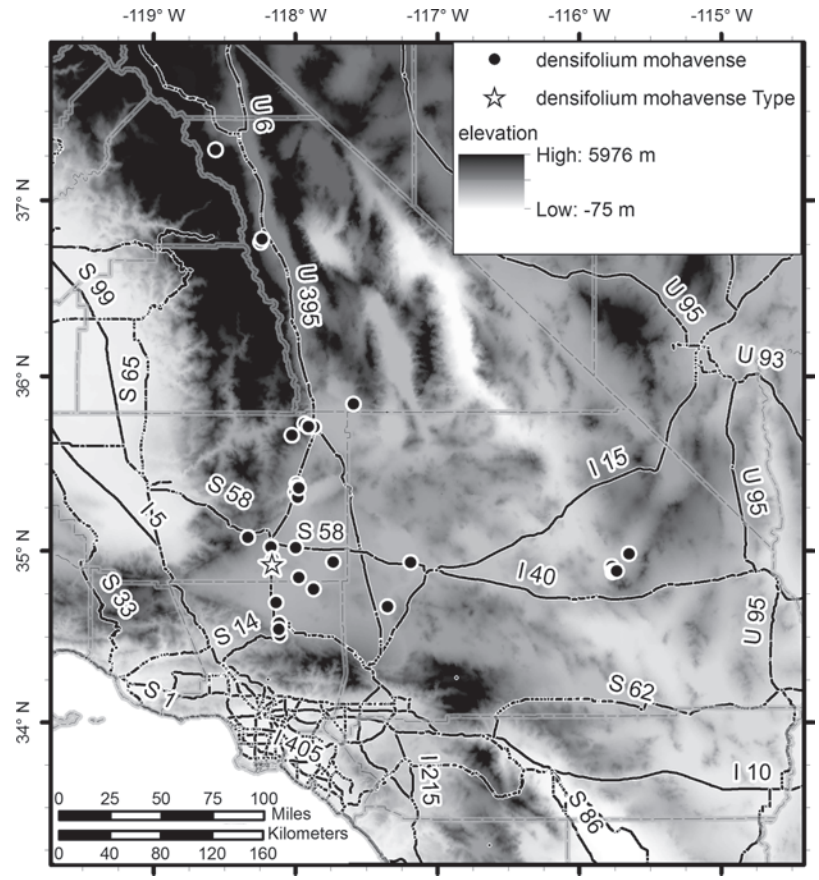


Fig. 150. Range map for *E. densifolium* subsp. *mohavense*, showing specimen locations and the type locality. Major roads are marked with black lines, where I = Interstate, U = U.S. highway, and S = California state highway. Dashed black and gray lines are county boundaries. The background is elevation in meters, where higher elevations appear darker. Note that subsp. *mohavense* is found only in transmontane California.

in an area when determining if a particular plant is annual or perennial.

Phenology.—Flowering in June. Fruiting July–August.

Distribution.—California endemic; east of Sierra Nevada, Mojave Desert (Fig. 150).

Habitat.—*Eriastrum densifolium* subsp. *mohavense* occurs at elevations between about 700 and 1100 m (2300–3600 ft), on floodplains, benches above washes, shallow washes, or open slopes. The slope of a site can be flat to 20°, and east- and south-facing aspects have been documented. The substrate is usually sand, sometimes with loam or pebbles, and derived from granite or mixed alluvium. Surrounding vegetation is Mojave desert scrub (including creosote bush scrub).

Population dynamics.—Population sizes from about 100 to over 1000 live plants have been recorded (sometimes additional dead plants are present). Plants have been observed to be scattered, frequent, or abundant.

Threats.—At several sites, many plants appeared dead, or at least had no green leaves when surveyed. The reason for this is unknown. Possibly they were dormant, but other plants were in flower. Other concerns or threats include off-highway vehicle use, illegal trash dumping, erosion, and trampling.

At least two populations occur in protected areas (Red Rock Canyon State Park, and Mojave National Preserve).

Conservation.—Global rank: G4T3? – vulnerable; National rank: USA (N3 – vulnerable; CNPS 2013; NatureServe 2013; Table 2).

Etymology.—From *Mojave*, referring to the Mojave Desert, and *–ensis*, indicating a place of growth. *Mohave* is an older (mis-?) spelling of Mojave, and is the spelling used originally by Craig (1934*b*). The ending *-ense* is the correct one, which agrees with *Eriastrum* in gender and case.

Common name.—Mojave woolly-star.

Other specimens.—Topotype: *Newsom* 1 July 1933 (POM 185026!).

Discussion.—Known locations of this subspecies are widely scattered, and appear slightly different morphologically. The amount of gene flow between populations is unknown, and morphological differences may represent local adaptations. Alternatively, the subspecies may occur at sites in between known populations and has not yet been found by collectors, and morphological differences reflect a variable subspecies.

A species of sphinx moth was observed visiting flowers of *E. densifolium* subsp. *mohavense* almost exclusively.

So far I have not located POM 182264.

3E. ERIASTRUM DENSIFOLIUM (Bentham) H. Mason subsp. **patens** (Hoover) De Groot, comb. nov.

Basionym: *Eriastrum densifolium* var. *patens* Hoover 1970, The Vascular Plants of San Luis Obispo County, p. 230.

Type: USA, California, San Luis Obispo County: south side of Morro Bay, Los Osos, in sandy field, 6 June 1964, *R.F. Hoover 8973*.

Holotype: here interpreted as OBI 06305 (image!). No known isotypes.

Included in *Gilia densifolia* var. *typica*, T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 390–391.

Probably included in *Eriastrum densifolium* subsp. *densifolium* by Mason (1945) and Harrison (1959, 1972) or overlooked.

Perennial, about 10–25 cm tall; with several older-growth stems spreading from a woody root, the current-year branches ascending, at times arising from stems below the persistent inflorescence heads from previous years, most ending in a terminal inflorescence but occasionally some shorter branches with vegetative tips; internodes short, mostly less than 1 cm and often less than 0.5 cm, usually longer just below the inflorescence heads; stems and leaves densely and persistently woolly, subglabrate in age, green to tan; fascicles or short shoots sometimes present in leaf axils, about 5–15 mm long, light green, woolly. **Leaves** alternate, pinnatifid, light green, 13–26 mm long, ascending (upper) to spreading (lower), sometimes curved, woolly; generally with 5–7 lobes (rarely to 10 lobes), older senescing leaves sometimes with fewer than 5 lobes, lobes subulate and awn-tipped, lateral lobes generally arising from the proximal 2/3 of the leaf, terminal lobe longer than lateral lobes, lateral lobes up to about 5 mm long, sometimes recurved. **Inflorescences** terminal, solitary or with 1 to several smaller heads just below main terminal cluster, few to many (ca. 25 or more) flowers at one time, about 10–15 mm long and 13–20 mm wide excluding flowers and tips of bracts, with flowers to 40 mm across, floccose. **Bracts** entire to pinnatifid, mostly ascending, 5–18 mm long, slightly exceeding calyces, woolly, light green, sometimes reddish-tipped, entire or with 2–7 subulate awn-tipped lobes, terminal lobe longer, lateral lobes to 5 mm long, generally arising from the proximal 2/3 of the bract, sometimes recurved. **Calyx** about 7–11 mm long, sepals lanate, often with reddish tips, subulate, joined by hyaline margins which are fused at least half of the calyx length, lobes equal to subequal, differing in length about 0.5–1 mm. **Corolla** broadly funnelform, actinomorphic, 16–23 (–23.5) mm long, lobes exserted from calyx but tube and sometimes throat mostly included; tube about 6–9 mm long; throat about 1.0–2.5 mm long; throat plus tube 8–12 (–14) mm long; throat and tube white to pale blue, when dried sometimes yellowish, occasionally with a purple ring at the base of the throat; lobes equal to or slightly shorter than the tube plus the throat, slightly less than half the length of the corolla, 7–11 mm long and 2.5–5.0 mm wide, oblancelate to obovate to elliptic, sky-blue, sometimes white, often with darker blue veins. Buds pale blue. **Stamens** exserted about 5–8 mm from the throat, attached about 0.5–3.0 mm below the sinus; free portion 6.5–10.0 mm long, to base of corolla about 14.5–22.0 mm, subequal, differing in length by about 0.5–1 mm; filaments 5–8 mm long, white to pale blue; anthers about 2–3 mm long, 0.5–1.0 mm wide (–2 mm dehisced), white to pale blue, drying yellowish, versatile, sagittate. Pollen gray to white, average grain diameter 32 µm. **Pistil** about 16–24 mm long, shorter if style is not completely elongated (in younger flowers); stigma lobes 0.5–1.0 mm long; style about 17–22 mm long at maturity, white or sometimes purplish; ovary at anthesis ~1.5–2.0 mm long and ~1 mm wide, with 3 locules, about 4 ovules per locule. **Fruit** is a capsule, about 4.2–5.0 mm long and 1.8–2.5 mm wide. **Seeds** are about 1.5–2.0 mm long and 0.5–1 mm wide (Fig. 111–114 [Color Plate 3], 133, 139; Hoover 1970: 230; S. De Groot, unpubl. data).

Identification.—To quote from the protologue: "Var. *patens* is a well-marked local race, differing from all previously named subspecies in its spreading habit. From var. *densifolium* it differs additionally in the persistently woolly herbage, the lighter color (on the average) of the flowers, and the very large corolla-lobes. From var. *elongatum* it differs in its notably larger, lighter-colored corollas with lobes much longer in proportion to the tube, and the tendency for the bracts to have more lobes" (Hoover 1970: 230–231). The spreading habit character is a bit dubious, because other plants of various *E. densifolium* subspecies can be spreading depending on habitat, but the persistently woolly herbage sets this form apart from the typical subsp. *densifolium*. Both subspecies have floccose inflorescences, and both may have woolly axillary buds or short shoots, so it is important to look not at the bracts or pedicels or buds but at the leaves and stems farther below the inflorescence. Other subspecies of *E. densifolium* with woolly stems and leaves are found farther inland and not on coastal sand dunes. Other species of *Eriastrum* that might be in the same coastal areas are annual, while both subspp. *densifolium* and *patens* are perennial, and usually woody, although sometimes only at the base (and sometimes the base is deeply buried by drifting sand).

Phenology.—Flowering in June. Fruiting late June through August.

Distribution.—Western San Luis Obispo County (Morro Bay), on the California Central Coast. There is at least one collection from Pt. Sal, Santa Barbara County, that would key to *patens* but looks somewhat different and is disjunct from other localities by 55 km (34 mi; Fig. 148).

Habitat.—*Eriastrum densifolium* subsp. *patens* has been found between 2 and 30 m (6–100 ft) in elevation above sea level. It occurs on coastal sand dunes (Hoover 1970), often near the base of the leeward side, in open spaces between other shrubs. Slopes of 5° and 14° have been recorded, and documented aspects were south- and southeast-facing. The substrate is fine sand, usually silica-based. Surrounding vegetation is a sand dune plant community, coastal chaparral, or the transition between these types. Note that populations are found on stretches of coastline oriented the same way, where their angle is just right to accumulate aeolian sand from prevailing winds (Fig. 148).

Population dynamics.—Population sizes from about 50 to over 100 have been observed. Plants are usually locally frequent in patches.

Threats.—This subspecies has a very small range size of about 20 square miles. While it appears to be fairly frequent there, it is found nowhere else. Most plants are found on Montana de Oro State Park or El Moro Elfin Forest (owned by California State Parks and San Luis Obispo County Parks, respectively), but some older collections were made outside the park and these sites may now be underneath the towns of Los Osos or Baywood Park. Development of these coastal areas is probably the largest threat. Destruction of even part of this subspecies' habitat could mean destruction of a large percentage of the number of known individuals. Invasive plants also could threaten this subspecies; of particular concern is *Ehrharta calycina*, a non-native grass that has invaded large areas of coastal dunes in Santa Barbara County and crowded out native plants.

Conservation.—*Eriastrum densifolium* subsp. *densifolium*, probably including subsp. *patens*, was considered but rejected for CNPS listing (CNPS 2013). It has a global rank of

G4TNR, but otherwise is not ranked (CNPS 2013; NatureServe 2013; Table 2).

Currently, there are about 15 known occurrences of subsp. *patens*, seven on Montana de Oro State Park, and eight on private or county land. One additional occurrence on BLM land at Pt. Sal may belong to this subspecies. Excluding the Pt. Sal location, the known range size is about 5830 hectares (23 square miles).

Etymology.—Latin *patens*, spreading, outspread, diverging from the axis at almost 90°; presumably referring to the low, spreading primary branches of these plants.

Common name.—Spreading woolly-star.

Paratypes.—Haynes Ranch, *Ingalls in 1912* (CAS 36253! [barcode 26281]); coast south of Hazard Canyon, *Hoover 7186* (OBI 11580!, UC 1034566 [image!]).

Discussion.—While the difference of hairy vs. glabrous leaves may seem slight, there appears to be some geographic distinction between subsp. *patens* and subsp. *densifolium* (Fig. 148). Further morphometric and genetic study is needed involving multiple populations of both subspecies, to determine exactly the characters and states which distinguish them.

The specimen from Pt. Sal, Santa Barbara County (OBI 04888!), is a very woolly plant and was found in sand, which fits subsp. *patens*. However, all of the other occurrences of subsp. *patens* are found around Morro Bay, and most locations of subsp. *densifolium* are from the Guadalupe and Pismo Beach area, which lies between Pt. Sal and Morro Bay (Fig. 148). While one might expect the subspecies to segregate, one to the north and one to the south, it is possible that instead each is adapting to local environmental conditions. More research is needed to determine the affinity of the Pt. Sal plants.

3F. ERIASTRUM DENSIFOLIUM (Bentham) H. Mason subsp. SANCTORUM (Milliken) H. Mason 1945, *Madroño* 8(3): 75.

Basionym: *Gilia densifolia* Bentham var. *sanctora* J. Milliken 1904, *Univ. Calif. Publ. Bot.* Vol. 2: 39.

Type: USA, California, Riverside County: Santa Ana River near Riverside, 3 July 1897, *H.M. Hall 683*.

Holotype: here interpreted as UC 52454 (image!). No known isotypes.

≡*Gilia densifolia* Bentham var. *sanctora* Milliken 1904, *Univ. Calif. Publ. Bot.* Vol. 2: 39. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 390.

Included in *Navarretia densifolia* (Bentham) Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 165.

Included in *Gilia densifolia* Bentham var. *elongata* (Bentham) A. Gray ex Brand. Macbride 1917, *Contr. Gray Herb.* NS Vol. 49 No. 3 p. 55–56.

≡*Hugelia densifolia* Bentham var. *sanctora* Jepson 1925, A Manual of the Flowering Plants of California, p. 792.

≡*Hugelia densifolia* Bentham var. *sanctarum* (Milliken) Jepson 1943, A Flora of California Vol. 3 Part II p. 162–163.

=*Gilia densifolia* var. *longiflora* A. Gray, in herb. (nom. inval. [ined.]). Jepson 1943, A Flora of California Vol. 3 Part II p. 163.

Perennial subshrub, 25–75 cm tall, woody at base, stems mostly erect, sometimes decumbent and ascending at tips; stems and leaves densely floccose and often canescent except for the oldest stems and leaves, which are loosely floccose to glabrate. **Stems** leafy, internodes to 4.5 cm, but often 1.5 cm or less; spur shoots in axils well-developed and short lateral branches are common, particularly toward the distal tips of the branches. **Leaves** alternate, pinnatifid, gray-green, floccose, the upper leaves ascending but the lower leaves are often curving so that the tips are spreading, 25–50 mm long; entire or 3–7-lobed, with lateral lobes usually arising in the proximal half of the leaf, about 1–8 mm long, apex aristulate. **Inflorescences** in terminal heads, sometimes several heads per current-year branch on short corymbose axillary branches near the tip; heads woolly, about 8–15 mm long and 5–15 mm wide excluding the tips of the bracts, about 4–30 (–40) flowers per head. **Bracts** entire to pinnatifid, ascending to spreading, 11–26 mm long, equaling or exceeding the calyces, green to gray-green, often canescent, densely floccose, subulate to aristulate, inner bracts 1–3-lobed, outer bracts 3–5-lobed (occasionally entire), lateral lobes arising from the proximal half of the bract, lateral lobes 1–4 mm long. **Calyx** 6–8 (–10?) mm long, sepals densely floccose, green, tips sometimes reddish, subulate, margins hyaline, proximal 1/2 to 2/3 of total length fused to form tube, with unequal to subequal lobes, differing in length by 0.5–1.5 mm. **Corolla** 23–33 mm long, narrowly funnelform to salverform, actinomorphic; tube purple to lavender to white, 12.5–19.5 mm long, 2–3 times the length of the calyx, slightly puberulent inside with 1–2-celled papillae; throat white, 2.2–5.7 mm long; throat plus tube 16–23 mm long; lobes blue to pale blue, rarely white, veins often darker, 5.2–7.4 (–9?) mm long, approximately one third as long as the tube, 22–30% of total corolla length, lobes differing in length within a flower by 0.0–0.5 mm, 2.1–4.4 (–5?) mm wide, elliptic to spatulate to obovoid. Buds yellowish. **Stamens** exserted 2.8–5.2 mm past the sinuses, attached 0.2–1.8 mm below the sinus; free portion about 4.5–8.0 mm long, to base of corolla 19.0–28.1 mm long, subequal, differing in length by 0.2–0.9 mm within a flower; filaments 2.6–5.9 mm long, white to bluish; anthers versatile, sagittate, white to pale blue, 3–4 mm long and 1–1.5 (–2?) mm wide. Pollen pale blue to blue or lavender, average grain diameter 29 μm, possibly anomotreme or pantotreme aperture arrangement. **Pistil** about 20–30 mm long, usually glabrous; stigma lobes to 1.0–1.5 mm long, white; style about 17–27 mm long, white to pale blue; ovary with 5–9 (–11) ovules per locule. **Capsule** about 5.5–5.8 mm long, 2.1–2.7 mm wide, tan, with 3 locules, usually with 2–11 seeds in each (Stone 1995). **Seeds** 2.5–3.5 mm long, 1.0–1.2 mm wide, brown, elliptic to angular (Fig. 115–118 [Color Plate 3], 137, 143, 144, 147; Milliken 1904: 39; Craig 1934*b*: 390; Mason 1945: 75; Harrison 1972: 7; S. De Groot, unpubl. data).

Identification.—Subsp. *sanctorum* is vegetatively very similar to subsp. *elongatum*. Both have white-canescent to gray-green floccose stems and leaves. However, the corollas of subsp. *sanctorum* are usually 23 mm long or longer (frequently longer than 25 mm), while corollas of subsp. *elongatum* are usually shorter than 22 mm. Subsp. *sanctorum* is restricted to floodplains along the Santa Ana River in southern California, while subsp. *elongatum* is widespread from central California to northern Baja California.

The long corollas and perennial habit of this subspecies distinguish it from all other species of *Eriastrum* with which it could co-occur.

Phenology.—Flowering from about mid-June through early July. Fruiting in July and August.

Distribution.—California endemic; found only in the Santa Ana River watershed in southern coastal California, from the southwest edge of the San Bernardino Mountains to the Santa Ana River gorge through the Santa Ana Mountains (but probably extirpated there; Fig. 151). Formerly this subspecies occurred in San Bernardino, Riverside, and Orange counties, but now is presumed extirpated in Orange County since there is no suitable habitat (CNPS 2013; Zembal and Kramer 1984). The historic range of this species spanned about 60 miles along the Santa Ana River, from about 150–460 m

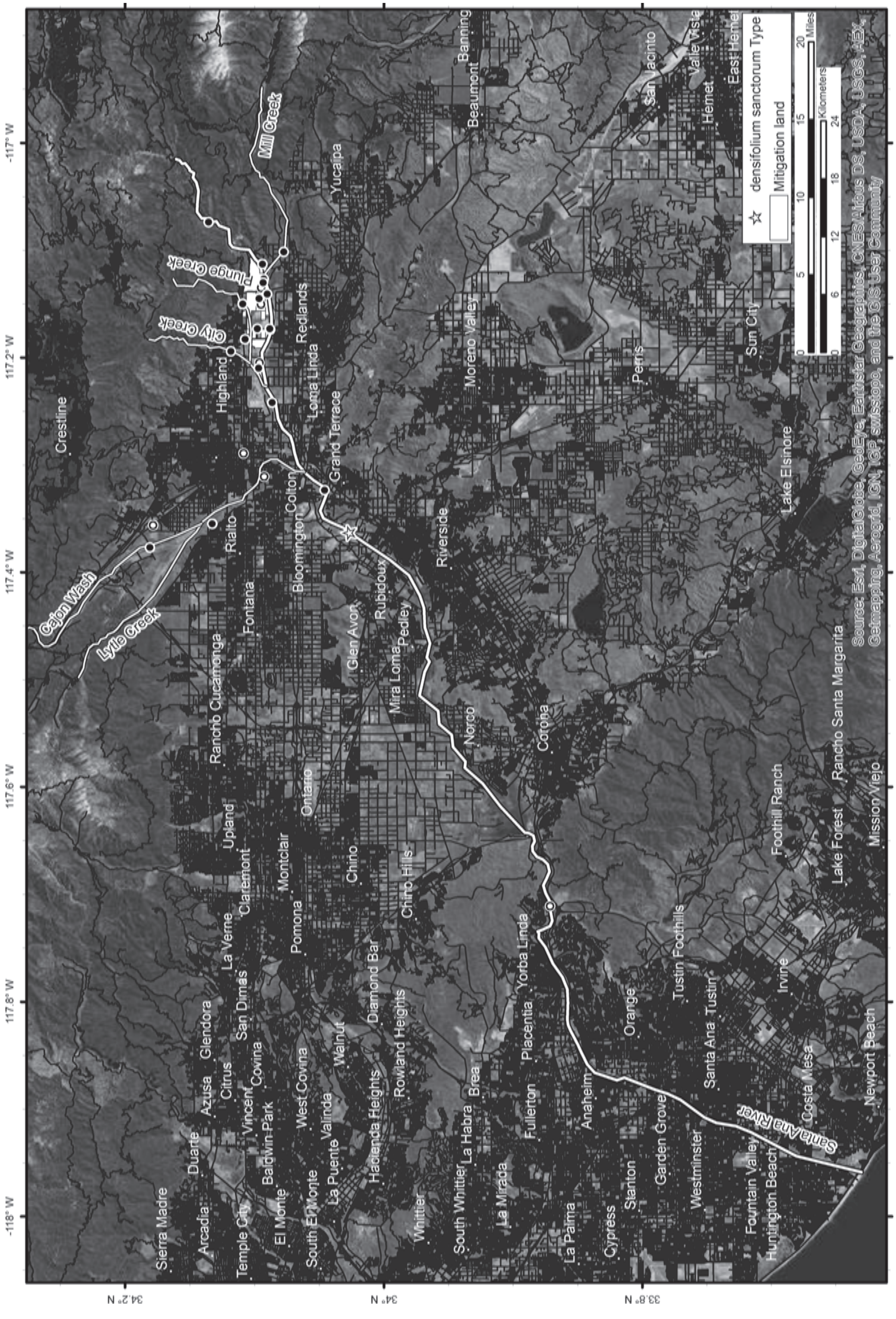


Fig. 151. Range map for *E. densifolium* subsp. *sanctorum* showing specimen locations and the Santa Ana River Woolly-Star mitigation land. White dots mark older specimens collected before 1953, black dots mark more recent specimens collected after 1983, and the white star marks the type locality. White lines indicate the Santa Ana River watershed, including the Santa Ana River, Lytle Creek, Cajon Wash, Plunge Creek, City Creek, and Mill Creek. The solid dark lines in the background are streets, which approximate the degree of urbanization in this subspecies' range. Some cities in the area are labeled.
]

(500–1500 ft) in elevation (Zembal and Kramer 1984). Today, populations are restricted within about 20 miles along the river.

Habitat.—*Eriastrum densifolium* subsp. *sanctorum* is found currently between elevations of about 270 to 800 m (885–2625 ft), on benches and floodplains along the Santa Ana River and its tributary washes. There is some indication that subsp. *sanctorum* plants prefer 25-year floodplains or other early-successional habitats (Burk et al. 1989; Wheeler 1988; Wheeler 1991). The slope is usually flat to about 8°, but at one site some plants were growing on a sandy berm whose sides had a 20° slope. South-, southwest-, and west-facing aspects are most common, although northwest- and north-facing aspects have also been observed. The substrate is granitic sand, mixed alluvium, or a combination. Cover of other plants is usually lower in areas with *E. densifolium* subsp. *sanctorum*, and the amount of bare ground appears to be an important characteristic (Wheeler 1988). Surrounding vegetation is usually alluvial sage scrub, sometimes with some chaparral or riparian elements. For a more detailed analysis of the vegetation and habitat where *E. densifolium* subsp. *sanctorum* occurs, see Smith (1980), Zembal and Kramer (1984), Wheeler (1988), and Burk et al. (1989).

Historically, the habitat for this subspecies in Santa Ana Canyon (Orange County) was described as "islands" of the Santa Ana River bottom: "At a few points alluvial fans extend into the cañon from the north or south and here and there in the broad river-bottom are bar-like ridges or 'islands' five or ten feet above the river level. These fans and 'islands' due to their height above the river level and their sandy rocky character are much drier than any other part of the river-bottom and are related floristically to the arid hills covered by plants of the sagebrush formation. On the fans and 'islands' of the river-bottom grow some of the most interesting plants of the cañon, plants that are native of the interior valleys and that are brought into the cañon at times of flood" (Howell 1929: 251).

Population dynamics.—Population sizes from 47 to over 5000 plants have been recorded. At some sites, seedlings and juveniles can be twice as numerous as adult plants. Plants are usually found in open areas between other shrubs, and may be scattered, patchy, frequent, common, or abundant.

Plants live an average of 5 years, at most 10 years (Wheeler 1988). They are unable to self-pollinate (Burk et al. 1989) and are self-incompatible (Brunell and Whitkus 1999*a*; Atallah and Jones 2003). Seeds do not disperse far from the parent plant (up to about 152 cm [60 in.], Burk et al. 1989), creating fairly high-density patches (Wheeler 1991). Seeds do not require any pretreatment, beyond wetting, to germinate, although germination can be increased by simulating about 1 inch of rainfall (Burk et al. 1989). Most seeds sprout with the first substantial rain in the autumn, and few if any remain in the soil seed bank (Wheeler 1988). Seedlings may not compete well with other plants or seedlings (Wheeler 1991), and seedling survivorship is lowest in older successional areas that have higher plant cover and increased cover of annuals (Wheeler 1988).

Threats.—Threats to *E. densifolium* subsp. *sanctorum* include urbanization, hydrological alterations (such as flood control projects), sand and gravel mining, vehicles, illegal dumping, road construction, and non-native plants (Zembal and Kramer 1984; Wheeler 1988; CNPS 2013). Urbanization, aggregate mining, and flood control are the biggest threats, because urbanization and aggregate mining can eliminate habitat completely, and flood control projects can reduce or eliminate the periodic floods that scour areas and open up the newer habitats that *E. densifolium* subsp. *sanctorum* prefers to colonize (CDFW 2004).

Zembal and Kramer (1984) estimated that at least 70% and possibly as much as 90% of this subspecies' former habitat has been lost, mostly due to urbanization: "The nearby site of Howell's 1927 collection is now under the Prado Dam and reservoir" (Zembal and Kramer 1984: 7). Note the extent of urban areas in this subspecies' range (Fig. 151).

Burk et al. (1989) noted that cover of non-native annuals is low in areas with *E. densifolium* subsp. *sanctorum*, suggesting that competition or invasion by non-native weeds could be a threat. Similarly, Wheeler (1988) found that the amount of bare ground is an important characteristic of the habitat, and that seedling survival is lower in areas with higher cover of annuals.

Conservation.—Global Rank: G4T1 – critically imperiled; U.S. Federal Status: Endangered (28 Sep 1987; Kramer 1987); U.S. State Legal Status: California: Endangered (January 1987; CDFW 2013); National Rank: USA (N1 – critically imperiled); Subnational/State Rank: California (S1 – critically imperiled); California Rare Plant Rank: 1B.1 (rare, seriously threatened); Other status: USFS – S – Sensitive (CNPS 2013; CNDDB 2013; NatureServe 2013; Table 2).

A 764-acre area of mitigation land in the Santa Ana River flood plain was established in 1988 by the U.S. Army Corps of Engineers (CDFW 2004). Currently this area is managed by the San Bernardino County Flood Control District, and requires special permission for access.

Eriastrum densifolium subsp. *sanctorum* was included in the Western Riverside County Multiple Species Habitat Conservation Plan (CDFW 2004).

Transplanting has had limited success. During construction on State Route 30 (now Insterstate 210) in 1988, 733 individuals of *E. densifolium* subsp. *sanctorum* were transplanted to similar habitat away from the area affected by construction (Fiedler 1991). One year after transplanting, the plants had suffered an average of 48% mortality (= 52% survival rate). After two years, the survival rate was 44.2%. Possible reasons given for the loss of plants were drought, transplant shock, natural mortality, and competition. Many surviving plants were reproductive, and seedling production was fairly high, but there was no information about seedling survival (Fiedler 1991).

Given that adult plants produce "abundant" seed, that seed germinates readily (>95%) without any pretreatment other that leaching, and that plants live on average five years (Wheeler 1988), propagation by seed may be the most effective means to increase the numbers of individuals *ex situ*.

Etymology.—Perhaps from Latin *sanctus*, sacred, with the genitive plural (neuter) ending *–orum*, indicating possession; literally "of the sacred." Probably pertaining to the name of the river, *Santa Ana* (Spanish, Saint Ana or Saint Anne), along which this subspecies grows.

Common name.—Santa Ana River woolly-star.

Discussion.—Harrison (1959, 1972) lists both *Hall 683* (UC 52454) and *173* (UC 23521) as types. Craig (1934*b*: 390) and Mason (1945: 75) also list both specimens. Since Milliken cited only *Hall 683*, it should be the type, not *Hall 173*.

Hall (no date) lists only trips to "San Jacinto Mt." for 1897. 1897 was the year before he entered the University of California (Berkeley), so presumably he was simply roving around the area near his home near Riverside when he made this collection (Babcock 1934).

According to G. B. Newcomb's October 1960 annotation on UC 52454, Hall's notebook specifies "Across river from Spanish Town" as the collection locality. "Spanish Town" or "Spanishtown" was an early 20th century nickname for the community of La Placita, which was on the southeast bank of the Santa Ana River across from Agua Mansa. Both La Placita and Agua Mansa were devastated by the flooding of 1862, and while both were rebuilt, today there is only a cemetery at Agua Mansa and a few old adobes at La Placita (e.g. Trujillo Adobe; Hoover et al. 1966: 294; Durham 1998 [Colton entry]). Across the river from Spanish Town would be the vicinity of the site of Agua Mansa.

Brunell and Whitkus (1997) concluded that there was "no major discontinuity" between subsp. *sanctorum* and adjacent populations or the other subspecies of *E. densifolium*, based on an analysis of RAPD markers. However, only one population of subsp. *sanctorum* was sampled, and in some analyses it was an outlier, while in other analyses it was grouped with other populations. Morphological analysis had a similar pattern, with subsp. *sanctorum* distinct in most analyses, and grouped with the other subspecies in other analyses (Brunell and Whitkus 1999*b*). Hence those authors concluded that two subspecies should be recognized within *E. densifolium*: subsp. *sanctorum* and subsp. *densifolium* (Brunell and Whitkus 1999*b*).

Populations at Lytle Creek and the La Cadena Avenue crossing of the Santa Ana River have been suspected to be hybrids involving subsp. *sanctorum*, or at least are different from the subsp. *sanctorum* type morphology (Wheeler 1988; Burk et al. 1989; De Groot 2009). Morphometric analysis has shown that plants from these sites are intermediate between subsp. *sanctorum* and subspp. *austromontanum* and *elongatum* (De Groot 2009). Similarly, a population in Cajon Wash also had corollas of intermediate length (La Pré and Pendleton 1988). If these plants are of hybrid origin, subsp. *sanctorum* is likely one of the parents, but it is impossible to be sure without additional data and population samples. They could represent independently evolving, stable entities (De Groot 2009).

A microlepidopteran coccoon was found on a leaf.

4. ERIASTRUM DIFFUSUM (A. Gray) H. Mason 1945, *Madroño* 8(3): 76–77.

Type: *E. diffusum* subsp. *diffusum*.

≡*Gilia filifolia* Nuttall var. *diffusa* A. Gray 1870, *Proc. Amer. Acad. Arts Sciences* 8: 272. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 423–424.

Probably included in *Gilia virgata* Steudel var. *floccosa* (A. Gray) Milliken 1904, *Univ. Calif. Publ. Bot.* Vol. 2: 39–40.

≡*Navarretia filifolia* (Nuttall) Brand [subsp. *eu-filifolia* Brand] var. *diffusa* A. Gray. Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 167.

≡*Welwitschia diffusa* (A. Gray) Rydberg 1917, Flora of the Rocky Mountains and Adjacent Plains, p. 688.

≡*Welwitschia filifolia diffusa* (A. Gray) Tidestrom 1935, *Proc. Biol. Soc. Wash.* 48: 42.

≡*Hugelia diffusa* (A. Gray) Jepson 1943, A Flora of California Vol. 3 Part II p. 167.

≠*Gilia diffusa* Philippi 1859, *Linnaea* 30: 197. ≡*Navarretia diffusa* (Phil.) Kuntze 1891, Revis. Gen. Pl. 2: 433. ≡*Polemoniella antarctica* f. *diffusa* (Phil.) Wherry 1944, *Amer. Midl. Nat.* 31: 213. See also Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 46.

≠*Gilia diffusa* Congdon 1900, *Erythea* Vol. VII, No. 12, Part 2.

≠*Microsteris diffusa* A. Heller 1899, *Bull. Torrey Bot. Club* 26: 313. =?*Phlox gracilis* (Hook.) Greene.

Annual herb, stems (1–) 1.5–25.0 cm long, erect to spreading, sometimes decumbent, often diffusely branched from base or above, paniculate or racemose. **Stems** slender, wiry, young (upper) stems green, lower (older) stems often brown, reddish brown, or tan; internodes 0.5–3 cm long, but usually shorter along the main stem and near the heads; herbage densely floccose to subglabrous, often subglabrous to glabrate with age. **Leaves** alternate, entire to pinnatifid, slender, ascending to spreading, light green, aging brown, reddish, or tan, lanate to floccose, becoming subglabrous in age, 4–26 mm long, entire or with 2–5 lobes, lateral lobes generally arising from the proximal half of the leaf, 1–7.5 mm long, aristulate. **Inflorescence** heads few to many (usually depending on the size of the plant), terminal, 3–10 mm long and wide excluding tips of bracts, 3–20-flowered, lightly to densely floccose. **Bracts** pinnatifid, ascending to spreading, 5–15 mm long, exceeding the heads, green to yellowish-green, tips sometimes yellowish or reddish, lightly floccose to densely floccose at least at the base, apex subulate to aristulate; with 3–5 lobes arising from the proximal half, lateral lobes 1–7 mm long, sometimes curling. **Calyx** 4.0–7.5 mm long, sepals floccose, sometimes glandular, bright green, green, or yellowish green, tips often darker green or reddish, apex aristulate; sepal margins joined by a hyaline membrane which is fused for the proximal half to 2/3 of the calyx length to form a tube; lobes subequal to unequal, differing in length within a flower by 0.25–2.0 mm, apices subulate to aristulate. **Corolla** funnelform, 5.5–11 (–12) mm long, actinomorphic or occasionally slightly zygomorphic, sometimes asymmetric from interactions with the calyx lobes; tube (2.0–) 3.0–5.6 mm long, white, straight or curved, sometimes puberulent inside with short projections from the epidermal cells; throat about 0.5–2.0 mm long, yellow or yellow-spotted; throat plus tube 3.4–7.0 mm long; lobes narrowly elliptic to obovate, oval, or oblong, 1.5–4.0 mm long, about 1/3 to nearly 1/2 of the total corolla length, 0.6–2.0 mm wide, light blue, blue, cream, or white, sometimes with reddish dots or stripes at the base, tip acute to rounded. Buds mostly cream-colored. **Stamens** exserted 0.5–2.3 mm beyond sinuses, but still shorter than the lobes, attached about 0.3–1.5 mm below the sinus; free portion 1.0–3.5 mm long, to base of corolla 4.0–8.0 mm long, subequal to unequal, differing in length within a flower by 0.1–1.4 mm; filaments 0.9–3.0 mm long, white, cream, or pale yellow; anthers about 0.4–1.0 mm long, sagittate, oval to ovate, versatile, white or cream to very pale blue. Pollen gray to cream or white, average grain diameter 25–36 μm, possibly pantotreme, anomotreme, or zonate aperture arrangement. **Pistil** 3.9–8.4 mm long, glandular trichomes sometimes present on the distal end of the ovary and occasionally on the base of the style, sparse to dense; stigma lobes 0.25–1.3 mm long; style (2.3–) 4–6.0 mm long, white to cream or pale yellow; ovary at anthesis about 1 mm long and 0.7 mm wide, 3-loculed, about 2–7 ovules per locule. **Fruit** is a capsule, about 2.7–4 mm long, 1.3–1.6 mm wide, tan. **Seeds** about 1.0–1.7 mm long, 0.5–0.8 mm wide, tan to light brown, mostly angular (Fig. 152–172 [Color Plate 4]; Gray 1870: 273; Jepson 1925: 793; Craig 1934*b*: 423; Mason 1945: 77; Harrison 1972: 23; S. De Groot, unpubl. data).

Identification.—All subspecies of *E. eremicum* tend to have larger anthers (generally >1 mm) than *E. diffusum* (generally <1 mm). Flowers of *E. eremicum* subsp. *yageri* tend to be larger than flowers of *E. diffusum*. *Eriastrum eremicum* subspp. *eremicum* and *zionis* have medially zygomorphic corollas, in noticeable contrast to *E. diffusum*'s actinomorphic corollas. Other key features of *E. diffusum* are the corolla lobes that are generally blue or pale blue, occasionally white, and generally elliptic. Corolla lobes of *E. eremicum* subsp. *yageri* tend to be oval to obovate.

Eriastrum diffusum might be confused with *E. harwoodii*, since both species are found in the desert and can have small, cream-colored flowers with short stamens and small anthers. However, *E. harwoodii* is found exclusively on sand, usually on semi-stabilized small dunes. *Eriastrum diffusum* is not usually found on sand dunes although it often occurs in washes. When it is found on open, sandy soils, it tends to have a more spreading habit, often branched from the base, while *E. harwoodii* is erect and usually branched above the base. Also, *E. harwoodii* usually has more wool on the upper stems, leaves, and inflorescences than *E. diffusum*. Bracts of *E. diffusum* tend to be shorter than those of *E. harwoodii*.

Toward the northern edge of its range, *E. diffusum* might be confused with *E. signatum*. Usually, *E. diffusum* is more widely branched, while *E. signatum* has a more erect habit. A more discriminating character, though, is the number of ovules or seeds per locule: *E. signatum* usually has two, while *E. diffusum* usually has more than two in at least one of the locules.

Eriastrum diffusum has smaller anthers (1 mm or less in length) than *E. wilcoxii* (1 mm long or longer). Corollas of *E. wilcoxii* are also longer than corollas of *E. diffusum*, and the corolla lobes in particular, but there is slight overlap in the size ranges.

Toward the northwestern part of its range, *E. diffusum* comes near the range of *E. sparsiflorum*. The most obvious characters by which to differentiate these species are the dense glandular hairs on the upper stems of *E. sparsiflorum*, and the lack or sparse distribution of glandular hairs on the upper stems of *E. diffusum*. Additionally, *E. sparsiflorum* usually has only 1–3 flowers per inflorescence head, while *E. diffusum* usually has more (although not necessarily open all at one time).

In Antelope Valley, *E. rosamondense* possibly could be confused with *E. diffusum*, although *E. diffusum* has not been collected in that area. The stamens of *E. rosamondense* are usually exserted 1 mm or less, while the stamens of *E. diffusum* are exserted 1 mm or more past the sinuses. The corollas of *E. rosamondense* are generally smaller than the corollas of *E. diffusum*, and the style of *E. rosamondense* is usually 3 mm long or shorter, while the style of *E. diffusum* is usually 4 mm long or longer.

Stamens of *E. diffusum* are usually unequal, while stamens of *E. filifolium* are equal (length difference ≤0.3 mm). Anthers of *E. diffusum* are usually 1 mm long or less, while anthers of *E. filifolium* are usually 1 mm long or more. The style of *E. diffusum* is usually 4 mm long or more, while the style of *E. filifolium* is usually 4 mm long or less. The calyx of *E. filifolium* tends to be longer than the calyx of *E. diffusum*, while the corollas are about the same size. Additionally, *E. diffusum* is primarily transmontane, while *E. filifolium* tends to grow in cismontane areas.

Phenology.—Flowering from late March through May, perhaps into June. Fruiting late April though July.

Distribution.—Southwest United States (Arizona, California, Nevada, New Mexico, Texas, Utah) and Northern Mexico (Baja California, Sonora, Chihuahua); east of Sierra Nevada, White and Inyo mountains, Mojave Desert, Sonoran Desert, eastern base of the Peninsular Ranges, Apachean Subprovince, Chihuahuan Desert, Vizcaíno Desert, Colorado Plateau, southern Great Basin; probably southern Rocky Mountains (specimens not verified; Fig. 173).

Habitat.—*Eriastrum diffusum* has been collected at elevations from sea level to 1800 m (330–5900 ft) in elevation. Plants are usually found in open sunny areas between or occasionally under shrubs, on bars or benches in or along washes, in ditches, on floodplains, flats, alluvial plains, slopes, ridges, rolling hills, alluvial fans, old dirt roads, and roadsides. The slope varies from flat to 24°, and all aspects have been reported. The substrate is often sand, but with silt, clay, gravel, pebbles, rock, or loam. It may be packed hard, dry and cracking, or somewhat loose, in various colors. Soils are derived from granite, rhyolite, basalt, other volcanics, metamorphics, limestone, igneous alluvium, or mixed alluvium. Cryptobiotic crust is sometimes present. Surrounding vegetation may be Vizcaíno, Sonoran, Mojave, or Chihuahuan desert scrub or woodland; this includes creosote bush scrub, creosote-mesquite grassland, grassland, mesquite savannah, mesquite-acacia scrub, alluvial scrub, riparian scrub, desert wash plant community, rabbit brush scrub, sagebrush scrub, blackbrush scrub, chaparral, juniper savannah, pinyon-juniper woodland, Joshua tree-pinyon-juniper woodland, or combinations of these. Plants are mostly found on open soil, but occasionally may be mixed with forbs or small grasses.

Population dynamics.—Population sizes from about 50 to over 1,000,000 plants have been documented. Population sizes may vary quite dramatically from year to year. Plants have been observed to be rare, infrequent, scattered, patchy, frequent, common, or abundant.

Threats.—Vehicle use, illegal dumping, competition from invasive plants, or flash flooding could threaten or damage plants at some sites. Road maintenance might affect populations growing on or near roads. Grazing might cause problems by encouraging growth of non-native plants.

Conservation.—Global rank: G5 – secure; otherwise not ranked (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—Latin *diffusus*, diffuse, loosely, irregularly or widely spreading; presumably referring to the branching pattern.

Common names.—Diffuse woolly-star, spreading woolly-star.

Discussion.—The subspecies of *E. diffusum* loosely correspond with floristic regions of western North America, with subsp. *coachellae* found mostly in the Californian Floristic Province, and subsp. *utahense* occurring in the vicinity of the Colorado Plateau, Great Basin, and northern Mojavean provinces (Fig. 173). Subsp. *diffusum* is found in all southwestern provinces, and the restriction of the atypical subspecies to certain areas may reflect local adaptation. Separation of the subspecies may not be complete, and they may grade together morphologically in some areas. Subsp. *diffusum* is rather variable across its range; plants in Arizona and New Mexico (center of its range) tend to have larger, bluer flowers, and plants on the edges of the range tend to have smaller, whiter flowers.

Key to the Subspecies of E. diffusum

1. Plants of the western Coachella Valley, California; corollas white or cream with a bright yellow throat, usually lacking spots or stripes. . . . .4B. subsp. **coachellae**

1' Plants of the deserts outside the Coachella Valley; corollas white to sky blue, sometimes with spots or stripes, throat yellow or yellow-spotted
  2. Plants of the Colorado Plateau and southern Great Basin; corolla lobes white to pale blue (often, but not always, with reddish streaks), oval to oblong. . . . . .4C. subsp. **utahense**
  2' Plants of the Chihuahuan, Mojave, Vizcaíno, and Sonoran Deserts (except Coachella Valley); corolla lobes white to sky blue, lacking reddish streaks, elliptic to obovate. . . . . . .4A. subsp. *diffusum*

4A. ERIASTRUM DIFFUSUM (A. Gray) H. Mason subsp. DIFFUSUM. Mason 1945, *Madroño* 8(3): 76–77.

Basionym: *Gilia filifolia* Nuttall var. *diffusa* A. Gray 1870, *Proc. Amer. Acad. Arts Sciences* 8: 272.

Type: none cited in protologue.

Lectotype: USA, New Mexico, Grant County: Pachetiju [Apache Teju], south of Copper Mines [Santa Rita], June 1857, *George Thurber 326*.

Lectotype (designated by Harrison 1972: 23): GH 78866!; probable isolectotype GH 78867!.

≡*Gilia filifolia* Nuttall var. *diffusa* A. Gray 1870, *Proc. Amer. Acad. Arts Sciences* 8: 272. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 423–424.

Included in *Gilia virgata* Steudel var. *filifolia* (Nuttall) Milliken 1904, *Univ. Calif. Publ. Bot.* Vol. 2: 39–40.

≡*Navarretia filifolia* (Nuttall) Brand [subsp. *eu-filifolia* Brand] var. *diffusa* A. Gray. Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 167.

≡*Welwitschia diffusa* (A. Gray) Rydberg 1917, Flora of the Rocky Mountains and Adjacent Plains, p. 688.

≡*Welwitschia filifolia diffusa* (A. Gray) Tidestrom 1935, *Proc. Biol. Soc. Wash.* 48: 42.

≡*Hugelia diffusa* (A. Gray) Jepson 1943, A Flora of California Vol. 3 Part II p. 167.

=*Hugelia virgata* Bentham var. *pygmaea* Jepson 1925, A Manual of the Flowering Plants of California, p. 793.
Type: USA, California, San Bernardino County: New York Mtns, ~4000 ft alt., 10 May 1913, *Jepson 5463*. Holotype: JEPS 2637 (image!). No known isotypes.

=*Eriastrum diffusum* (A. Gray) H. Mason subsp. *jonesii* H. Mason 1945, *Madroño* 8(3): 77.
Type: USA, Arizona, Pima County: Yager's, north of Tucson, 22 May 1890, *Jones 9935*. Holotype: here interpreted as POM 74576! No known isotypes.
Based on *Gilia eremica* var. *Yageri* (M.E. Jones) T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 420–421 as to lectotype only, not based on *Gilia virgata* var. *Yageri* M.E. Jones 1910, *Contr. W. Bot.* 13: 2.

=*Gilia floccosa* var. *linearifolia* No author. (Herb. name) F 288380! USA, Arizona, Tucson, Spring 1907, *Prof. F. E. Loyd* (s.n.).

=*Gilia* (*Hugelia*) *filifolia* var. *depressa* (A. Gray) H. Mason in herb. K! USA, California, San Bernardino County: south slope of the New York Mountains, 3450 ft alt., 3 May 1940, *A. Alexander and L. Kellogg 1301*.

=*Gilia* or *Hugelia parviflora* Nuttall. GH 78866! [A. Gray] annotation on *Wright 1642*.

Annual herb. **Stems** (1–) 2–25 cm long, erect to spreading, sometimes decumbent, generally diffusely branched from base, paniculate, sometimes racemose; stems slender, wiry, young stems green, lower (older) stems often brown or reddish brown; internodes 0.5–3 cm long, but usually shorter along the main stem and near the heads; herbage floccose to subglabrous, often glabrate with age. **Leaves** alternate (lowest occasionally subopposite), entire to pinnatifid, slender, ascending to spreading, light green, older leaves often becoming reddish, young leaves floccose, becoming subglabrous in age, 9–26 mm long; entire or with 3–5 lobes, lobes arising from proximal half of primary axis, lateral lobes 1–7 mm long, subulate, aristulate. **Inflorescence** heads few to many (usually depending on the size of the plant), terminal, 5–10 mm long and wide excluding tips of bracts, 3–20-flowered, densely to lightly floccose. **Bracts** pinnatifid, inner bracts ascending, outer ascending to spreading, 6–15 mm long, exceeding the heads, green, sometimes with yellowish or reddish tips, floccose at least at the base, apex subulate to aristulate; with 3–5 lobes, lateral lobes arising from proximal half of primary axis, sometimes curling, 1–6 mm long. **Calyx** 5–7.5 mm long, sepals floccose, bright green, tips often reddish, apex aristulate, joined by a hyaline membrane, fused for the proximal 2/3 of the calyx length to form a tube, lobes unequal to subequal, differing in length within a flower by 0.25–1.25 mm. **Corolla** funnelform, 6–11 (–12) mm long, actinomorphic or occasionally slightly zygomorphic; tube (2.0–) 3.2–5.6 mm long, white, puberulent inside with short projections from the epidermal cells; throat about 0.7–2.0 mm long, yellow or yellow-spotted; throat plus tube 3.4–7.0 mm long; lobes 2.1–4.0 mm long, varying in length within a single flower by 0.0–0.6 mm, 30–44% of total corolla length, 0.9–2.0 mm wide, elliptic to obovate, light blue, blue, cream, or white. **Stamens** exserted (0.7–) 1.0–2.3 mm beyond sinuses, but still at least 1.2 mm shorter than the lobes, attached about 0.3–1.5 mm below sinus; free portion 1.6–3.5 mm long, to base of corolla 4.0–8.0 mm long, subequal or unequal, differing in length by 0.1–1.4 mm; filaments 1.0–3.0 mm long, differing in length by 0.0–1.0 mm, white to cream; anthers about 0.6–1.0 mm long, sagittate, cordate, oval, versatile, white to very pale blue. Pollen gray to cream or white, average grain diameter 25 µm, possibly pantotreme, anomotreme, or zonate aperture arrangement. **Pistil** 3.9–8.4 mm long, equal or slightly longer than the stamens; approximately 4-celled glandular trichomes present on the distal end of the ovary, sparse to dense, occasionally on the base of the style; stigma lobes 0.5–1.3 mm long; style (2.3–) 4.9–6.0 mm long, white to cream; ovary 3-loculed, 2–7 ovules per locule. **Fruit** is a capsule, about 2.7–3.0 mm long, 1.5–1.6 mm wide, tan. **Seeds** about 1.3–1.7 mm long, 0.6–0.8 mm wide, tan to light brown, mostly angular (Fig. 152–163 [Color Plate 4]; Gray 1870: 273; Jepson 1925: 793; Craig 1934*b*: 423; Mason 1945: 77; Harrison 1972: 23; S. De Groot, unpubl. data).

Identification.—See notes under the *E. diffusum* species description for characters distinguishing *E. diffusum* from other *Eriastrum* species.

One of the better discriminators of the subspecies of *E. diffusum* is corolla color, with subsp. *diffusum* tending to have pale blue corollas and subspp. *utahense* and *coachellae* having mostly white corollas, but sometimes subsp. *diffusum* also has white corollas. The corolla lobes of subsp. *diffusum* tend to be elliptic to obovate, while the lobes of subsp. *utahense* tend to be oval to oblong. Lobes of subsp. *coachellae* are generally elliptic, but usually shorter than 2 mm long, while lobes of subsp. *diffusum* are generally longer than 2 mm. Filaments of subsp. *coachellae* are usually around 1 mm long, while filaments of subsp. *diffusum* are 1–3 mm long and filaments of subsp. *utahense* are about 1.5–2.75 mm long.

Phenology.—Flowering in April and May, possibly in late March. Fruiting in May and June.

Distribution.—Southwest United States (Arizona, California, Nevada, New Mexico, Texas) and Northern Mexico (Baja California, Sonora, Chihuahua); East of Sierra Nevada, White and Inyo Mountains, Mojave Desert, Sonoran Desert, Apachean Subprovince, Chihuahuan Desert, Vizcaíno Desert, Colorado Plateau; probably Southern Rocky Mountains (specimens not verified; Fig. 173).

Habitat.—*Eriastrum diffusum* subsp. *diffusum* has been collected between 100 and 1800 m (330–5900 ft) in elevation. Plants are usually found in open sunny areas between or at the edges of shrubs, in washes, on bars or benches above washes, on the floodplains of rivers, in small drainages through flat plains, in ditches, on slopes, on rolling hills, on alluvial fans, on old dirt roads, and on roadsides. The slope varies from flat to 18°, and all aspects have been reported. The substrate is often sand, but with clay, gravel, pebbles, rock, loam, clay loam, or silty loam. It may be packed hard, dry and cracking, or somewhat loose. The color varies from off-white to tan to reddish or pinkish. Soils are derived from granite, volcanics, metamorphics, igneous alluvium, or mixed alluvium. Cryptobiotic crust is sometimes present. Surrounding vegetation may be Vizcaíno, Sonoran, Mojave, or Chihuahuan desert scrub, arid woodland, or grassland; including creosote bush scrub, creosote-mesquite grassland, mesquite savannah, mesquite-acacia scrub, alluvial scrub, riparian scrub, desert wash plant community, rabbit brush scrub, sagebrush scrub, blackbrush scrub, pinyon-juniper woodland, Joshua tree-pinyon-juniper woodland, or combinations of these. Plants are mostly found on open soil, but occasionally may be mixed with forbs or small grasses.

Population dynamics.—Population sizes from about 50 to over 10,000 plants have been documented. Most populations support several hundred to a few thousand plants. Plants have been observed to be rare, widely scattered, scattered, patchy, locally frequent, frequent, or common.

Threats.—At some sites, vehicle disturbance might be a threat. Competition from invasive plants may affect some sites. Trash dumping could be a problem in a few areas. Road maintenance might affect populations growing on or near roads.

Conservation.—Global rank: G5TNR; otherwise not ranked (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—From Latin *diffusus*, diffuse, loosely, irregularly or widely spreading; presumably referring to the branching pattern. The epithet *pygmaea* presumably was from Latin *pygmaeus*, pygmy or dwarf; referring to the small size of the plant. The epithet *jonesii* honors the collector of the type specimen of subsp. *jonesii*, Marcus Eugene Jones (1852–1934), a geologist, mining engineer, and botanist. From about 1882 until 1934, he traveled around the entire western United States and Mexico, collecting plants, and described many new species. Some new names were published in his own journal, *Contributions to Western Botany*. His herbarium was purchased by Pomona College (POM) in 1923 (Cantelow and Cantelow 1957; Lenz 1986).

Common names.—Diffuse woolly-star, spreading woolly-star.

Other specimens.—On the right side of GH 78867 is *Thurber s.n.*, between Pachetiju and Ojo de Vaca. This suggests that "Pachetiju" was in the vicinity of Ojo de Vaca (see discussion below). There is a duplicate of *Wright 1642* at G (image!) annotated "Navarretia filifolia Brand" by "!Br." In his revision, Brand (1907: 167) treated *E. diffusum* as a variety of *Navarretia filifolia*.

Discussion.—Plants in New Mexico and Arizona tend to have slightly larger corollas, and have been recognized as *E. diffusum* subsp. *jonesii* H. Mason. However, *E. eremicum* subsp. *yageri*, which has nearly actinomorphic corollas, also occurs in this area and may have been confused with *E. diffusum*. Based on my collections and observations, plants of *E. diffusum* in Arizona do have slightly larger corollas than typical material from New Mexico; however, there is overlap and I have not yet found any other character that distinguishes these forms. Plants in Texas, Chihuahua, the California Mojave Desert, and Baja California tend to have smaller corollas than the New Mexico and Arizona forms. Stamens, however, are roughly the same size, and coloration is generally the same (may be paler in Chihuahuan and some California plants). Future population-level study of the morphology and ecology of *E. diffusum* across its range may reveal whether or not subsp. *jonesii* should be recognized as a separate taxon.

Because Asa Gray (1870: 272) did not cite a specimen when he described *Gilia filifolia* var. *diffusa*, but gave only the geographic range ("Fort Mohave and Nevada to New Mexico and the borders of Texas"), Harrison (1972) designated *Thurber 326* (GH 78866) as the lectotype. There are actually 2 separately mounted collections of *Thurber 326* at GH, but Harrison annotated two plants in the upper left of GH 78866 as the lectotype. The *Thurber 326* collection on GH 78867 is annotated as "a portion of the lectotype collection" and should be considered an isolectotype.

When designating the lectotype, Harrison wrote that "it seems proper to select the George Thurber collection (326) as a lectotype" (1972: 23). This specimen was among the collections studied by Gray, and includes two mature plants with flowers. The plants correspond to Gray's (1870) original description, although that description is meagre. Neither specimen of *Thurber 326* at GH was identified or annotated by Gray.

Although Gray did not cite a specimen in the protologue of *Gilia filifolia* var. *diffusa*, he did cite a specimen of *G. filifolia* var. *diffusa* one page later in the same publication. In a description of *Gilia gunnisoni* (which had been described earlier), Gray wrote, "The plants referred to in Bot. Mex. Boundary are different: Wright's 1642 is *G. filifolia* var. *diffusa*" (Gray 1870: 273). *Wright 1642* was cited as a specimen of *Gilia gunnisoni* in the Botany of the Mexican Boundary Survey (Torrey 1859: 146), and since *G. gunnisoni* had been described previous to this publication, *Wright 1642* was simply misidentified. The specimen of *Wright 1642* at GH is mounted on the same sheet as the lectotype collection of *Thurber 326* (GH 78866). There are two names on the label, both in Asa Gray's handwriting: "Gilia Gunnisoni" (in pencil), and "Gilia filifolia var. diffusa" (in blue ink). The use of different writing instruments suggests that the identifications were made at different times. The notation "Gilia Gunnisoni" could correspond to the citation in the Botany of the Mexican Boundary Survey (Torrey 1859), and the "Gilia filifolia var. diffusa" could correspond to Gray's 1870 publication.

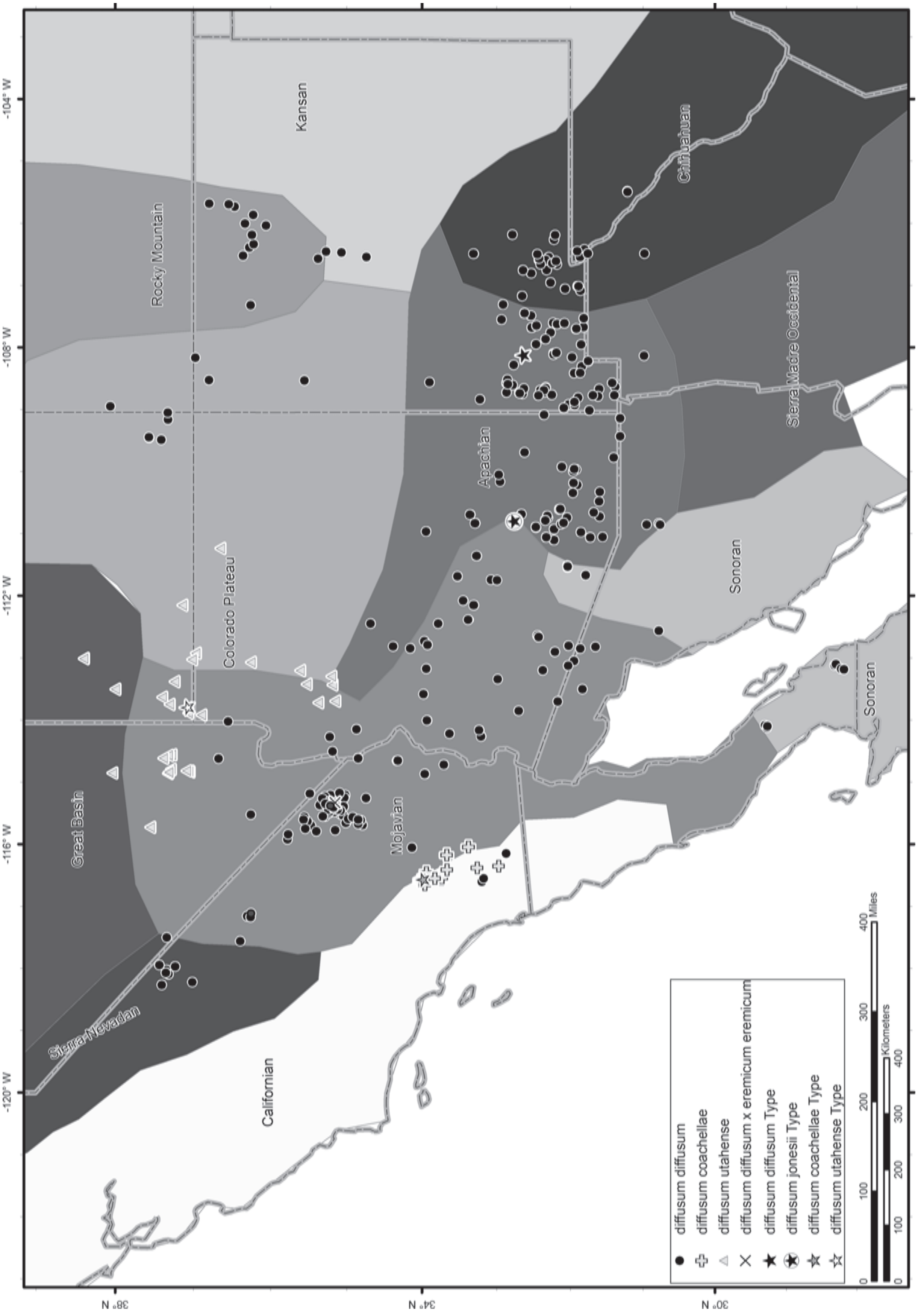


Fig. 173. Range map for *E. diffusum*, showing floristic regions and specimen locations. State boundaries are shown, and McLaughlin's (2007) floristic regions are labeled.

Duplicates of *Wright 1642* in other herbaria are either undetermined (BM!), labeled "Gilia gunnisoni" (K 196239!, Herb. Hook.), or labeled "Gilia filifolia var. diffusa" (K 196240!, Herb. Benth.).

Presumably Harrison overlooked Gray's (1870) citation of *Wright 1642* when chosing the lectotype. However, although *Wright 1642* seems to be a more natural choice, being both cited and annotated by Gray, Harrison's lectotype must stand. Because *Thurber 326* matches the original description, the only grounds for superseding it, according to the *International Code of Botanical Nomenclature*, are if the holotype or any of the original material is discovered (Art. 9.17a, McNeill et al. 2006). Since Gray did not use the term "type" when he cited *Wright 1642*, it cannot be construed as a holotype designation. Therefore, it was appropriate to select a lectotype from among the original material that Gray used, of which *Thurber 326* was part (K. Gandhi, GH, pers. comm. 7 Dec 2011).

The information on the label of *Thurber 326* (lectotype) is "dry hills—Pachetiju June 1851 G.T." The isolectotype label provides slightly different information, "dry hills. Pachiteju (22 miles south of Copper Mines) May 1851— G.T." George Thurber was part of the U.S. Boundary Commission under Colonel Emory, and traveled through the southwest states in 1850 through 1852. His collections were eventually sent to Asa Gray for identification, and Gray published "Plantae Novae Thurberianae" in 1854, a paper in which he described a number of new taxa based on Thurber's specimens. Thurber's travelogue at the beginning of Plantae Novae Thurberianae states that in April of 1851, the party moved from Magoffinsville to the Copper Mines (Gray 1854). The Copper Mines is an older name for present-day Santa Rita, New Mexico (Standley 1910). "In the latter part of May [1851], a trip was made into the State of Sonora as far as Arispe, its former capital. The wagon route of Colonel Cooke was followed as far as Agua Prieta" (Thurber, in Gray 1854: 300). Cooke's route headed southwest from the Copper Mines, then south-southeast to Ojo de Vaca (see *www.mormonbattalion.com/history/mapoftrail/others/cooke.gif*). This latter location is presently called Cow Spring (Wooton 1906). Although neither "Pachetiju" or "Pachiteju" was mentioned by Thurber or Gray (Gray 1854) or marked on Cooke's map, Wooton (1906) mentioned a place called "Apache de hoo" near Ojo de Vaca, which apparently had also been called "Apache Teju" and "Apache Tejo", and is the name of a railroad siding. The name "Apache Tejo" appears on a 7.5' USGS topographic map of the area southeast of Silver City, New Mexico, at 32° 38' 47" N, 108° 07' 43" W (Grant County). It seems likely that "Pachetiju" or "Pachiteju" are just variant names of "Apache Tejo". Since Thurber's trip was made in late May 1851, the specimen could have been collected in either May or June.

Gray did not mention *Gilia filifolia* var. *diffusa* in Plantae Novae Thurberianae, being mostly concerned with publishing a number of new taxa, and presumably not having time enough to determine all of Thurber's collections (Gray 1854: 326).

Charles Wright was also attached to the Boundary Commission (see Gray 1854: 302), and collected in the southwest states in 1849, 1851, and 1852. Wright's plants from 1851 "were mostly collected in New Mexico (about Santa Rita), though all the time from September 2 to October 4 was spent on a trip through southeastern Arizona and northeastern Sonora" (Wooton 1906: 562). Although no date is given on *Wright 1642*, it is likely that it was collected in the same general area as *Thurber 326*. When *Wright 1642* was cited in the report of the boundary survey, its range was given as "Dry places along the upper Rio Grande and west to Sonora" (Torrey 1859: 146), which would refer to southern New Mexico.

See the discussion under *E. eremicum* subsp. *yageri* concerning the location "Yager's," the type locality of *E. diffusum* subsp. *jonesii*.

Field observations suggest that flowers may close early, for example, by 3:30 p.m.

In some plants, the lowest leaves were subopposite. Usually, leaves are alternately arranged.

Branching patterns and architecture is variable, and may be related to the amount of space available or competition from other plants: plants growing in washes with few plants around them tend to be widely branched and/or spreading, while plants growing mixed with other forbs and grasses tend to be more erect and less branched (S. De Groot, unpubl. data).

4B. ERIASTRUM DIFFUSUM (A. Gray) H. Mason subsp. **coachellae** De Groot, subsp. nov.

Type: USA, California, Riverside County: along Worsley Road, just south of Indian Avenue, just east of Highway 62, low sand and gravel bar at south side of broad wash, in mixed alluvium (primarily granitic), slope 6°; desert wash and creosote bush scrub; 33.99662° N 116.57310° W (WGS 84), 481 m/1579 ft elevation, 1 Apr 2008, *S. J. De Groot 5712.*

Holotype: RSA! Isotypes: CAS!, SD!.

Previously included in *E. diffusum* subsp. *diffusum* (Craig 1934*b*: 424; Harrison 1959: 256).

Annual herb. **Stems** 4.5–16.0 cm long, erect to spreading, sometimes decumbent, often diffusely branched from base, paniculate, sometimes racemose; stems slender, wiry, young (upper) stems green, older (lower) stems often brown or reddish brown; internodes up to about 2.5 cm long, shorter along the main stem or near the heads; herbage floccose to subglabrous, often glabrate with age. **Leaves** alternate, entire to pinnatifid, ascending to spreading, light green aging brown or tan, young leaves floccose, becoming subglabrous in age, 7–20 mm long; entire or with 2–3 (occasionally 5) lobes, lobes generally above the base of the leaf (but from proximal half), lateral lobes 2–7.5 mm long, awn-tipped. **Inflorescence** heads few to many (usually depending on the size of the plant), terminal, 5–6 mm long and 5–10 mm wide excluding tips of bracts, 3–20-flowered, densely to moderately floccose. **Bracts** pinnatifid, inner bracts ascending, outer bracts ascending or spreading, 6–15 mm long, exceeding the heads, green to yellowish-green, tips sometimes reddish, floccose at least at the base, sometimes densely so, apex aristulate, with 3–5 lobes arising from the proximal third; lateral lobes sometimes curling, 1–6 mm long. **Calyx** 4–5 mm long, green to yellowish green, sepals joined by a hyaline membrane, fused half to 2/3 of the total calyx length to form a tube, lobes unequal to subequal, differing in length within a flower by about 0.5 mm, apices subulate to aristulate. **Corolla** funnelform, 5.5–8 mm long, actinomorphic or rarely slightly zygomorphic (mostly in color pattern), sometimes asymmetric from interactions with the calyx lobes; tube 3–5 mm long, straight or curving upward, white; throat about 0.50–0.75 mm long, yellow or yellow-spotted; throat plus tube 4.25–5.00 mm long; lobes narrowly elliptic, 1.5–2.0 (–3.0) mm long, about a third of the total corolla length, 0.60–1.25 mm wide, usually white to cream or very pale blue (sometimes drying blue), occasionally with tiny reddish spots or streaks at the base, tip acute. **Stamens** exserted past sinuses 0.5–1.3 mm, attached 0.6–1.2 mm below sinuses, free portion about 1.0–2.2 mm long, to base of corolla about 4–7 mm long, unequal to subequal, differing in length within a flower by 0.2–0.5 mm; filaments 0.9–2.0 mm long, white to cream; anthers about 0.4–0.6 mm long,

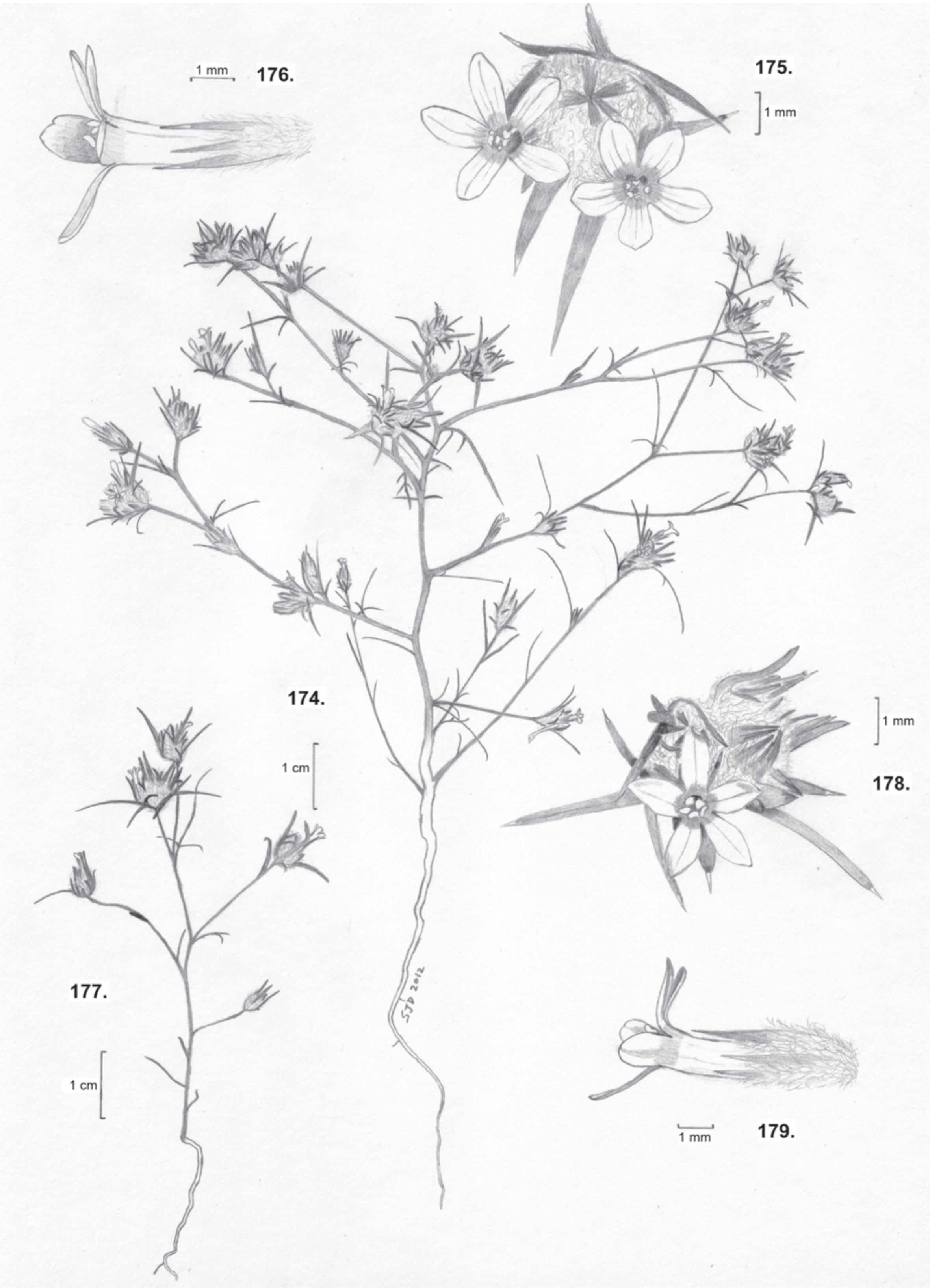


Fig. 174–179. *Eriastrum diffusum* subsp. **coachellae**.—174. Habit of a larger plant (*De Groot 4911*).—175. Inflorescence with two flowers in face view (*De Groot 4911*).—176. Flower in side view (*De Groot 4911*).—177. Habit of smaller plant (*De Groot 5712*).—178. Inflorescence with flower in face view (*De Groot 5712*).—179. Flower in side view (*De Groot 5712*).

sagittate, oval, versatile, white to cream. Pollen white to cream, grain equatorial diameter about 36 µm, zonate aperture arrangement. **Pistil** 5–6 mm long; stigma lobes about 0.25–0.6 mm long; style 4–5 mm long, white to cream; ovary at anthesis about 1 mm long and 0.7 mm wide, 3-loculed, 2–5 ovules per locule, or about 8–9 total. **Fruit** is a capsule, about 3–4 mm long and 1.5 mm wide. **Seeds** about 1.0–1.25 mm long, 0.6–0.8 mm wide, tan, angular (Fig. 168–172 [Color Plate 4], 174–179).

Identification.—See notes under the *E. diffusum* species description for characters distinguishing *E. diffusum* from other *Eriastrum* species.

Some useful discriminating features of subsp. *coachellae* are the generally white corolla lobes, yellow throat, and overall small flower size. The typical subsp. *diffusum* in California also has smaller flowers than plants from Arizona, but usually blue lobes.

One of the better discriminators of the subspecies of *E. diffusum* is corolla color, with subsp. *diffusum* tending to have pale blue corollas and subspp. *utahense* and *coachellae* having mostly white corollas, but sometimes subsp. *diffusum* also has white corollas. The corolla lobes of subsp. *diffusum* tend to be elliptic to obovate, while the lobes of subsp. *utahense* tend to be oval to oblong. Lobes of subsp. *coachellae* are generally elliptic, but usually shorter than 2 mm long (but some to 3.0 mm), while lobes of subsp. *diffusum* are generally longer than 2 mm. Filaments of subsp. *coachellae* are usually around 1 mm long, while filaments of subsp. *diffusum* are 1–3 mm long and filaments of subsp. *utahense* are about 1.5–2.75 mm long.

Phenology.—Flowering from late March through early May. Fruiting late April though June.

Distribution.—California endemic (Riverside, San Diego, Imperial Counties); Coachella Valley, Borrego Valley, and eastern base of the Peninsular Ranges (Fig. 173). Its distribution appears to correspond somewhat to the Californian Floristic Province or its border between with the Mojavean Province, as defined by McLaughlin (2007), while subsp. *diffusum* is mostly found outside of the Californian Floristic Province.

Habitat.—*Eriastrum diffusum* subsp. *coachellae* has been found at elevations from sea level to about 500 m (0–1640 ft). It grows in shallow washes in alluvial plains, often on sandbars in washes or on benches along washes. Sites are flat or gently sloped, to about 6°, and aspects facing north or northeast have been observed. The substrate is usually a sandy or gravelly mixed alluvium, often with a fair amount of granite. Surrounding vegetation is usually creosote bush scrub, with some desert wash plants.

Population dynamics.—Population sizes from about 50 to over 1000 plants have been recorded. Plants may be scattered, or locally abundant in patches.

Threats.—Vehicle use, invasive plants, or illegal dumping could threaten or damage plants at some sites. Since most sites are found in or near washes, a very large flash flood could be detrimental, although if there is a seed source, plants may rapidly re-colonize freshly scoured surfaces.

Conservation.—Global rank: G5TNR; otherwise not yet ranked (CNPS 2013; NatureServe 2013; Table 2). One population is protected on Anza-Borrego Desert State Park. The range of this subspecies is restricted to less than 2000 square miles in the Coachella Valley, and therefore it might be considered for rare plant ranking.

Etymology.—The epithet was formed by declining "coachella" into the genitive singular case, i.e., *coachellae*, literally "of the Coachella [Valley]," referring to the geographic range of this subspecies.

Common name.—Coachella woolly-star.

Paratypes.—USA, California, Riverside County: Below junction of washes from Palm and Murray Canyons, Colorado Desert, Agua Caliente Indian Reservation, *C.M. Wilder 709* (POM 10418!); Palm Canyon, Palm Springs, *H.L. Mason 14214* (RSA 114065!, SD 46109 [image!], UC 1051493); beginning of Hemet Road, San Jacinto Mt. range, alluvial fan, *L. Benson 4172* (POM 279110!); Whitewater Canyon about midway from Bonnie Bell to Trout Farm, *S.D. White 9102* (RSA 700023!); canyon in pass between Whitewater and Morongo Valley, 0.4 miles south of San Bernardino County line, *V. Grant and A. Grant 8836* (RSA59572!); Dry Morongo Wash, *P.A. Munz and I.M. Johnston 5169* (POM13411!, JEPS 24948); sandy wash of Dry Morongo Valley, *P.A. Munz 11921* (POM 172021!); Coachella Valley, ca. 1 mile east of Desert Hot Springs, Long Canyon, *J.M. Porter 12346* (RSA 657392!); Along 86S just south of Desert Shores, north of Salton Sea Beach, between Salton Sea and Santa Rosa Mountains, 22 Apr 2005, *S.J. De Groot 4911* (RSA!). San Diego County: Borrego Valley, 1 mile east of entrance to Palm Canyon Park, *P.A. Munz 12835* (RSA048344!, UC 809685).

4c. Eriastrum diffusum (A. Gray) H. Mason subsp. **utahense** De Groot, subsp. nov.

Type: USA, Utah, Washington County: Beaver Dam Mountains, crest along dirt road past microwave station, from turn off at pass along Highway UT 91, 37.07897° N, 113.80242° W (WGS84), 1780 m/5840 ft elevation, 23 May 2006, *S. J. De Groot 5274, with J. M. Porter and E. A. Kempton.*

Holotype: RSA! Isotypes: CAS!, BRY!, GH!.

Previously included in *E. diffusum* subsp. *diffusum* (Mason: 1945: 76–77; Harrison 1959: 257–258; 1972: 23).

Annual herb. **Stems** 1.5–14 cm long, erect to spreading, sometimes decumbent, generally diffusely branched from base, paniculate or sometimes racemose; stems slender, wiry, young (upper) stems green, older (lower) stems often brown, reddish brown, or tan; internodes 0.5–1.5 cm long, usually shorter along the main stem and near the heads; herbage densely to lightly floccose, often subglabrous to glabrate with age. **Leaves** alternate, entire to pinnatifid, ascending to spreading, light green, lanate, aging brown or reddish, 4–20 mm long; entire or with 2–3 (occasionally 5) lobes, lateral lobes generally arising from the proximal third of the leaf, 1–7.5 mm long, often aristulate. **Inflorescence** heads few to many (usually depending on the size of the plant), terminal, 3–10 mm long and wide excluding tips of bracts, 3–20-flowered, rather densely floccose. **Bracts** pinnatifid, mostly ascending, outer sometimes spreading, or ascending at base and spreading at tips, 5–15 mm long, exceeding the heads, green, sometimes with reddish tips, lightly floccose at least at the base, apex subulate to aristulate, with 3–5 lobes usually near the base (at least from proximal half), lateral lobe length 1–7 mm. **Calyx** 4.0–6.5 mm long, floccose, glandular, bright green, sepal tips darker green, apex aristulate, sepals joined by a hyaline membrane, fused at least half the calyx length to form a tube, lobes unequal to subequal, differing in length within a flower by about 0.25–2.0 mm. **Corolla** funnelform, 6.5–9.0 mm long,

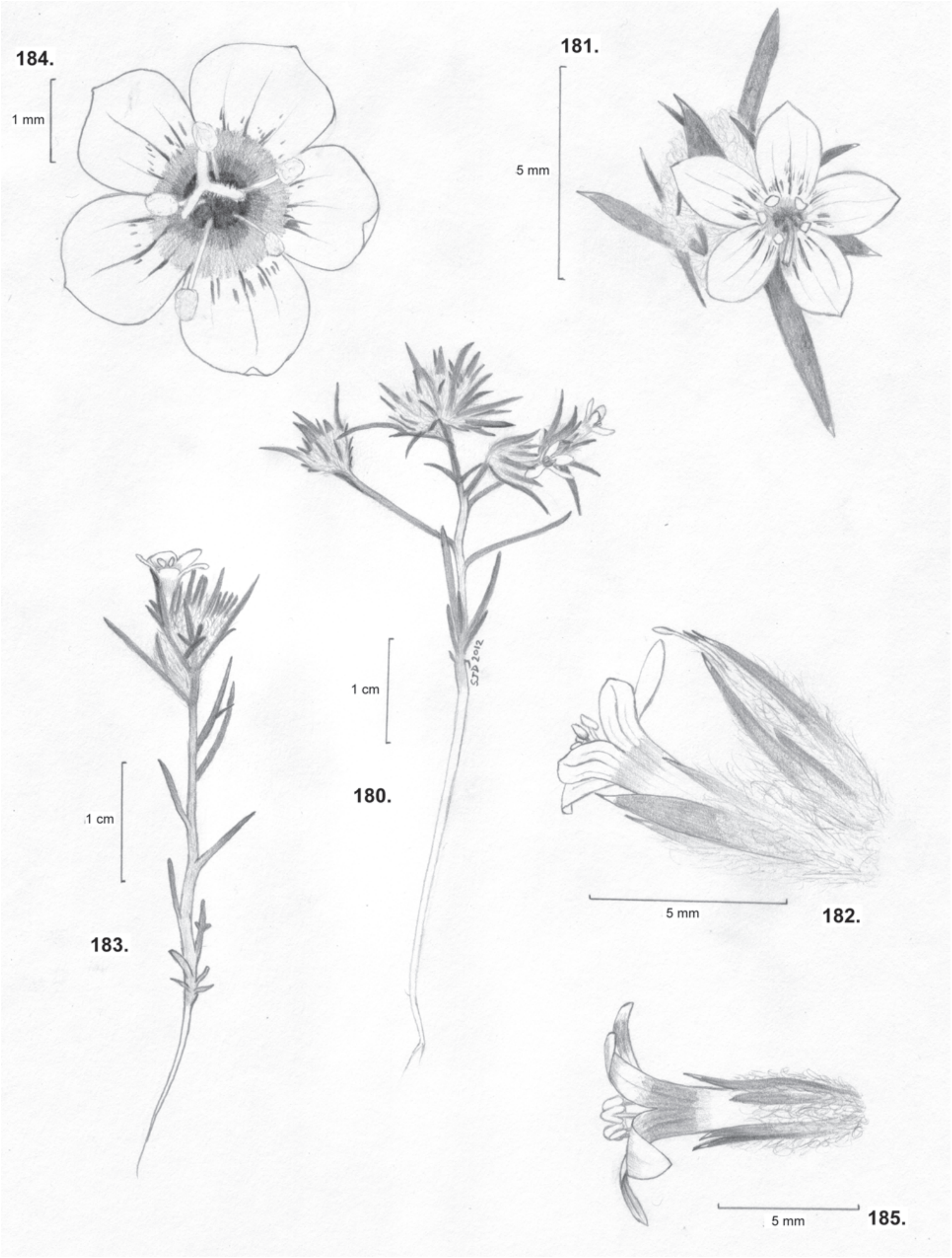


Fig. 180–185. *Eriastrum diffusum* subsp. **utahense**.—180. Habit (*De Groot 5274*).—181. Inflorescence with flower in face view (*De Groot 5274*).—182. Flower and young fruit in side view (*De Groot 5274*).—183. Habit (*De Groot 5598*).—184. Flower in face view, showing typical markings and open stigma lobes (*De Groot 5268*).—185. Flower in side view (*De Groot 5269*).

actinomorphic or rarely slightly zygomorphic; tube 3.0–5.5 mm long, white; throat about 1.0–1.5 mm long, yellow or yellow-spotted; throat plus tube 4.0–6.5 mm long; lobes oval to oblong, 1.75–3.00 mm long, about 1/3 or slightly more of the total corolla length, 1.00–1.75 mm wide; white, cream, or pale blue, usually with some reddish stripes at the base. Buds cream-colored. **Stamens** exserted about 1–1.5 (–2?) mm beyond sinuses, attached 0.75–1.0 mm below sinuses, free portion about 2–3 mm long, to base of corolla about 5–6 mm, unequal, differing in length within a flower by about 0.75 mm; filaments 1.25–2 mm long, white to pale yellow; anthers about 0.5–0.75 mm long, sagittate, oval to ovate, versatile, white to cream. Pollen cream, average grain diameter 25 µm. **Pistil** 5.5–7.0 mm long; stigma lobes 0.25–0.5 mm long; style 4–5 mm long just post-anthesis, white to pale yellow; ovary 3-loculed, about 2–3 ovules per locule. **Fruit** is a capsule, about 2.8–2.9 mm long, 1.3–1.6(+) mm wide, tan. **Seeds** about 1.2–1.5 mm long, 0.5–0.8 mm wide, tan to light gray-brown, angular (Fig. 164–167 [Color Plate 4], 180–185).

Identification.—See notes under the *E. diffusum* species description for characters distinguishing *E. diffusum* from other *Eriastrum* species.

Some good discriminating features of this subspecies are the generally white corolla lobes with reddish stripes that are generally short and broad with a rounded tip.

One of the better discriminators of the subspecies of *E. diffusum* is corolla color, with subsp. *diffusum* tending to have pale blue corollas and subspp. *utahense* and *coachellae* having mostly white corollas, but sometimes subsp. *diffusum* also has white corollas. The corolla lobes of subsp. *diffusum* tend to be elliptic to obovate, while the lobes of subsp. *utahense* tend to be oval to oblong. Lobes of subsp. *coachellae* are generally elliptic, but usually shorter than 2 mm long, while lobes of subsp. *diffusum* are generally longer than 2 mm. Filaments of subsp. *coachellae* are usually around 1 mm long, while filaments of subsp. *diffusum* are 1–3 mm long and filaments of subsp. *utahense* are about 1.5–2.75 mm long.

Phenology.—Flowering in May, perhaps into June. Fruiting June–July.

Distribution.—Northern Arizona, southern Utah, eastern Nevada; northern Mojave Desert, Colorado Plateau, southern Great Basin (Fig. 173). There may be loose correspondence between this subspecies' range and the Colorado Plateau and Great Basin floristic provinces (McLaughlin 2007).

Habitat.—*Eriastrum diffusum* subsp. *utahense* has been found between 890 and 1780 m (2920–5840 ft) in elevation, in open sunny areas between or occasionally under shrubs, in washes, on slopes, ridges, flats, roadsides, or old dirt roads. One population was found mixed with other plants around the edge of a small spring-fed pond. Sites are flat to sloped 24°, and all aspects except south- and northeast-facing have been reported. The substrate may be silt, clay, sand, gravel, pebbles, or mixtures of these, in various colors. It is usually derived from granite, rhyolite, basalt, other volcanics, limestone, or mixed alluvium. One site had a fairly high percentage of cow manure. Surrounding vegetation may be creosote bush scrub, rabbitbrush scrub, sagebrush scrub, chaparral, juniper savannah, juniper and Joshua tree woodland, pinyon-juniper woodland, or a combination of these.

Population dynamics.—Population sizes from about 100 to over 1,000,000 plants have been recorded. Population sizes may vary quite dramatically from year to year. Plants have been observed to be infrequent, scattered, fairly frequent, in fairly dense patches, or abundant.

Threats.—At some sites, vehicle disturbance, competition from invasive plants, or illegal trash dumping might be threats. Road maintenance might affect populations growing on or near dirt roads. Grazing might cause problems by encouraging growth of non-native plants, which might crowd out *Eriastrum* plants.

Conservation.—Global rank: G5TNR; otherwise not ranked (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—The subspecific epithet *utahense* refers to the geographic range, since most populations of this subspecies are found in or near southern Utah.

Common name.—Utah woolly-star.

Discussion.—Some plants may be very tiny (~1 cm/0.5 in. tall). Like many species of *Eriastrum*, these plants prefer to grow in open areas, such as dirt roads (once I accidentally parked on a population).

5. ERIASTRUM EREMICUM (Jepson) H. Mason 1945, *Madroño* 8(3): 78.

Type: *E. eremicum* subsp. *eremicum*.

Probably was previously included in *G. floccosa*, *G. filifolia*, or *G. virgata* by various authors.

Included in *Gilia virgata* (Bentham) Steudel var. *floccosa* (A. Gray) Milliken. Macbride 1917, *Contr. Gray Herb.* NS Vol. 49 No. 3. p. 57–58.

= *Gilia floccosa* in part, not as to type (Craig 1934*b*).

≡ *Hugelia eremica* Jepson 1925, A Manual of the Flowering Plants of California, p. 793. Jepson 1943 (5 May), A Flora of California Vol. 3 Part II p. 163–164.

≡ *Gilia eremica* (Jepson) T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 416–418.

Annual herb, sometimes slender, erect to spreading, usually much-branched; racemose, corymbose, paniculate, or branched from base, branches in turn often branched, smaller plants sometimes virgate; about 2–30 cm high and 1–40 cm across. **Stems** wiry or sometimes thick, upper (young) stems green but lower (older) stems becoming dark reddish brown or tan in age, glabrous to floccose, sometimes glandular, lower stems sometimes becoming woody in long-lived plants. Internodes 3–50 mm long, the shorter lengths near the heads and the longer lengths usually in the proximal parts of branches. **Leaves** alternate, entire to pinnatifid, ascending to spreading, 6–35 (–45) mm long, bright green, gray-green, or green, lightly floccose to subglabrous but becoming glabrate and sometimes reddish-brown or tan in age, middle-age leaves sometimes yellowish; pinnately divided with 1 to 9 short linear lobes, lateral lobes 1–14 mm long, arising from the proximal half or distributed along the length of the primary axis, apex subulate to aristulate, the most proximal lateral lobes sometimes reduced. **Inflorescences** capitate, terminal, 1–250 or more per plant; heads small, lightly to densely floccose, few-flowered (2–26), 5–11 mm long, 2–25 mm wide (excluding flowers and tips of bracts). **Bracts** pinnatifid, ascending to spreading, 4–23 mm long, with some bract tips exceeding the heads, bright green, light green, or green, tips sometimes reddish, lightly to densely floccose, sometimes markedly glandular, apex subulate to aristulate; with 3–7 lobes, mostly arising from the proximal half of the primary axis, lateral lobes 1–10 mm long, apex subulate to aristulate. **Calyx** 4.0–9.9 mm long; sepal costae light green to green, tips sometimes reddish, floccose to densely floccose, sometimes glandular, apex subulate to aristulate; margins hyaline, the lower 1/2 to 2/3 fused into a tube; lobes subequal to unequal, differing in length within a single flower by 0.5–2.6 mm. **Corolla** narrowly funnelform to sub-salverform, actinomorphic to strongly medially zygomorphic (sometimes shape more or less actinomorphic but color zygomorphic), 10–23 mm long, throat included to well-exserted beyond the calyx and bracts; tube 3.0–9.1 mm long, about 1/3 to 2/3 the total corolla length, white, lavender, or pale blue, sometimes with a reddish edge, inner surface puberulent with 1- or rarely 2-celled projections from epidermal cells; throat 0.2–4.7 mm long, somewhat asymmetric due to unequal sinuses, pale blue, lavender, or white, or sometimes yellow or with yellow dots or patches; tube plus throat 4.7–12.4 mm long; lobes narrowly elliptic to obovate, sometimes strap-shaped to oblong, sometimes asymmetric, apex rounded to acute, sometimes slightly retuse, notched, or oblique, tips sometimes curled, inrolled, or twisted; 3.2–7.8 mm long, varying in length in a single flower by 0.0–0.9 mm due to unequal sinuses, 28–52% of total corolla length, 1.6–3.7 mm wide; violet, lavender, blue, or almost white, often with darker purple, blue, or reddish streaks or spots on or near veins, usually near the proximal end of the lobe, sometimes yellow at the base or on the abaxial side. **Stamens** exserted 1.2–6.5 mm past the sinuses, but usually still proximal to the tips of the lobes, attached 0.7–4.4 mm below the sinuses, the sinus to stamen insertion distance differing in a single flower by 0.1–2.6 mm; free portion of the stamen 2–9 mm long, to the base of the corolla 6.1–16.3 mm long, unequal in length, differing in a single flower by 0.6–4.4 mm; filaments 1.5–8.3 mm long, often turning upward at the distal ends, white to light blue or lavender; anthers 1.0–2.5 mm long, elliptic to ovate, sagittate, versatile, white to pale blue or lavender. Pollen white to blue, lavender, or gray, average grain diameter 26–39 μm, possibly zonate, anomotreme, or pantotreme aperture arrangement. **Pistil** 5.8–15.0 mm long, equal to the stamens or exserted up to 4.6 mm beyond stamens, glabrous or with a few 2–5-celled glandular trichomes at the apex of the ovary and the base of the style; stigma lobes 0.4–1.4 mm long, often white; style 3.5–13 mm long, white to light blue; ovary at anthesis oblong to pear-shaped, about 1–2 mm long and 0.75–1.7 mm wide, 3-loculed, 6–15 ovules total (2–5 per locule). **Fruit** is a capsule, about 2.5–5 mm long, 1.1–2.2 mm wide, tan to purplish, usually with about 2–4 seeds per locule. **Seeds** about 1.0–2.0 mm long, 0.6–0.8 mm wide, tan to light brown, elliptic to angular (Fig. 186–212 [Color Plate 5]).

Identification.—All subspecies of *E. eremicum* tend to have larger anthers (generally >1 mm) than *E. diffusum* (generally <1 mm). Flowers of *E. eremicum* subsp. *yageri* tend to be larger than flowers of *E. diffusum*. *Eriastrum eremicum* subspp. *eremicum* and *zionis* have medially zygomorphic corollas, in noticeable contrast to *E. diffusum's* actinomorphic corollas. Other key features of *E. diffusum* are the corolla lobes which are generally elliptic and flat. Corolla lobes of *E. eremicum* subsp. *yageri* tend to be oval to obovate, and the tips of subspp. *eremicum* and *zionis* are often twisted.

Although *E. densifolium* occurs in the western part of the range of *E. eremicum*, it is easily distinguished by its perennial growth form and stems that are woody at the base. *Eriastrum eremicum* has been observed occasionally to resprout following summer rainfall and continue growing into the autumn, but plants do not persist to the next spring growing season. In addition, the corollas of *E. eremicum* are medially zygomorphic where its range overlaps with that of *E. densifolium*, whereas the corollas of *E. densifolium* are actinomorphic.

In the northwestern part of its range where *E. eremicum* may come in contact with *E. wilcoxii*, *E. wilcoxii* can be distinguished from *E. eremicum* by having actinomorphic corollas and equal sinuses, while *E. eremicum* has medially zygomorphic corollas and unequal sinuses. Often, the filaments of *E. eremicum* tend to curve in the same direction and are often clustered at the lower side of the corolla (toward the ground). Filaments of *E. wilcoxii* are not all curved the same direction or clustered. Additionally, stamens are exserted farther in *E. eremicum* (>3.5 mm) than in *E. wilcoxii* (<2.5 mm).

Although corollas of *E. sapphirinum* can be slightly medially zygomorphic, similar to flowers of *E. eremicum*, the upper stems of *E. sapphirinum* are usually glandular-hairy, while those of *E. eremicum* are not.

Corollas of *E. pluriflorum* are actinomorphic and have equal sinuses, in contrast to the medially zygomorphic corollas of *E. eremicum* and their unequal sinuses.

Eriastrum harwoodii, *E. hooveri*, *E. rosamondense*, *E. signatum*, and *E. sparsiflorum* all have actinomorphic corollas mostly 11 mm long or shorter. Where *E. eremicum* approaches the ranges of these species, its corollas are medially zygomorphic and 11 mm or longer. Furthermore, the stamens of those four species are usually exserted less than 1.5 mm, while *E. eremicum* in that area usually has stamens exserted more than 3 mm.

Phenology.—Flowering April through May and perhaps as late as mid-June or early July at some sites. Fruiting late April through September. Occasionally flowering again in August or September after receiving some summer precipitation.

Distribution.—Southern California, southern Nevada, Arizona, Southwest Utah, Baja California; southwestern Great Basin, Mojave Desert, Sonoran Desert, Vizcaíno Desert, Apachian Subprovince of Madrean Floristic Region, west edge of Colorado Plateau (Fig. 213).

Habitat.—*Eriastrum eremicum* has been found between about 100 and 1760 m (330–5780 ft) in elevation, in open, sunny areas in or near shallow washes or on benches above washes, in ditches, on flats, slopes, bajadas, rolling hills, ridges, sand dunes, playas, or roadsides. The slope at sites varies from flat to about 30°, although it is usually fairly gentle. All aspects have been recorded. The substrate is often sand of various colors and textures, but also may contain silt, clay, gravel, rock, or loam; it is usually dry, and may be hard-packed or loose; and can be derived from granite, mixed alluvium, sandstone, calcareous alluvium, basalt, metamorphics, cinders, or possibly limestone. At a few sites, the soil was somewhat alkaline. Surrounding vegetation is usually some form of desert scrub or woodland, chaparral, riparian woodland, or combinations of two or more vegetation types. Some plants have been found in areas that burned recently.

Population dynamics.—Population sizes from about 20 to over 1,000,000 have been recorded. Plants often occur in patches, and have been reported to be occasional, scattered, frequent, common, or abundant. The number of plants seen at a site in a given year is probably dependent to some extent on the amount of winter precipitation received.

Threats.—Development, vehicle use, road maintenance, competition from invasive weeds, grazing, illegal dumping, off-trail hiking, or trail maintenance might impact some sites. This species has been found several times on recently burned areas, suggesting that its seedbank can survive low- or perhaps moderate-intensity fires. Some sites occur in protected areas such as national parks or BLM wilderness areas.

Conservation.—Global Rank: G5 – secure; Subnational/State Rank: Utah (S3 – vulnerable); otherwise not ranked (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—From Greek *erem*-, desert, and –*icus*, belonging to; i.e., "belonging to the desert," alluding to the habitat and general area where this species occurs.

Common name.—Desert woolly-star.

Discussion.—There may be some correspondence between the subspecies and floristic regions (McLaughlin 2007). Subsp. *markianum* appears to be the only subspecies found in the Sonoran region. Subsp. *yageri* is the only subspecies in the Apachian region, although it also occurs in the Mojavean region with subspp. *eremicum* and *zionis* (Fig. 213). In areas where the subspecies are peripatric or sympatric, they may intergrade.

Key to the Subspecies of E. eremicum

1. Corollas distinctly medially zygomorphic; longest stamens exserted 3.5 mm or more above the sinuses, filaments often curved; plants from the western Sonoran (California) Desert, Mojave Desert, and the Colorado Plateau (transmontane Southern California, northern Baja California [Norte], Nevada, Utah, and northwestern Arizona)
    2. Leaves with 1–3 (occasionally 5) lobes; corolla tube + throat 7.5 mm long or shorter; stigma about 1 mm long; plants of the Colorado Plateau. . . . . .5D. subsp. *zionis*
    2' Leaves with 3–9 lobes; corolla tube + throat 7.6 mm long or longer; stigma about 0.8 mm long or shorter; plants of the western Sonoran (California) and Mojave Deserts. . . . . . . .5A. subsp. *eremicum*

1' Corollas actinomorphic or very slightly zygomorphic; longest stamens exserted 1.2–4.4 mm beyond sinuses, filaments generally straight; plants of the eastern Sonoran (Arizona) Desert and southern Vizcaíno Desert (Arizona and southern Baja California [Norte])
    3. Plants of Arizona; corolla lobe tips rounded; corolla tube + throat 6.2–11.2 mm; stamens inserted 1.2–4.4 mm below the sinuses; filaments 2.7–8.3 mm long. . . . . .5C. subsp. *yageri*
    3' Plants of Baja California (Norte); corolla lobe tips acute to rounded (sometimes oblique), often inrolled; corolla tube + throat length 5.4–8.0 mm; stamens inserted 0.8–2.3 mm below the sinuses; filaments 2–4 mm long. . . . . 5B. subsp. **markianum**

5A. ERIASTRUM EREMICUM (Jepson) H. Mason subsp. EREMICUM. Mason 1945 *Madroño* 8(3): 78.

Basionym: *Hugelia eremica* Jepson 1925, A Manual of the Flowering Plants of California, p. 793.

Type: USA, California, San Bernardino County: Mohave Desert, Calico Wash, northeast of Barstow, 6 May 1913, *Jepson 5414*.

Lectotype, designated here (possibly holotype): JEPS 2635 (image!). Isolectotype: RSA 270391!.

Probably was previously included in *G. floccosa*, *G. filifolia*, or *G. virgata*. See notes on species synonymy.

≡*Hugelia eremica* Jepson 1925, A Manual of the Flowering Plants of California, p. 793. Jepson 1943, A Flora of California Vol. 3 Part II p. 163–164.

≡*Navarretia virgata* var. *eremica* Jepson in herb. (JEPS 2635 [image!])

≡*Hugelia virgata* var. *eremica* Jepson in herb. (JEPS 2635 [image!])

≡*Gilia eremica* (Jepson) T.T. Craig var. *typica* T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 417–418.

=*Navarretia densifolia* (Bentham) Brand var. *jacumbana* Brand 1913, *Annuaire Conserv. Jard. Bot. Genève*, vol. XV et XVI, p. 340–341.

Type: USA, California, San Diego County: Desert slopes, Jacumba, 29 May 1903, *Abrams 3640*.

Lectotype, designated here (possibly holotype): G 375432 (l'Herbier Delessert; image!). Isolectotypes: NY 743595 (image!), GH 303649!, BM 939594!, K 545582!, CAS 162133 (image!), DS 19689 (image!), UC 407342 (image!), POM 3513!, POM 156644!, F 186797!.

Annual herb, erect to spreading, usually much-branched, about 2–30 cm high and 1–40 cm across. **Stems** many from the base or branched above, the branches freely and often dichotomously branched, corymbose, racemose, or paniculate, wiry or sometimes thick, green and lightly floccose but becoming dark reddish brown or tan and glabrous in age, lower stems sometimes becoming woody in long-lived plants. Internodes 3–50 mm long, the shorter lengths near the heads and the longer lengths usually in the proximal parts of branches. **Leaves** pinnatifid, ascending to spreading, gray-green to green, 6–30 (–45) mm long, lightly floccose but becoming glabrate and sometimes reddish-brown in age, pinnately divided with 5–9 (occasionally 3) short linear lobes, lateral lobes 2–10 mm long, arising along the length of the primary axis, subulate-tipped, the basal lateral lobes sometimes reduced. **Inflorescence** heads small, terminating the main stem or branches, densely woolly, numerous (2–250), few-flowered (2–15), 5–10 mm long, 4–17 mm wide (excluding flowers and tips of bracts). **Bracts** pinnatifid, to about 10 mm long, lanate, light green to green, sometimes markedly glandular, tips often reddish, often spreading, outer bracts often exceeding heads, with 3–5 (–7) lobes, mostly arising from the proximal half of the primary axis, lobe length 1–6 mm, subulate-tipped. **Calyx** 4–7 mm long; sepals light green, floccose, apex aristulate, tips often reddish, margins hyaline, the lower 1/2 to 2/3 of the sepals fused into a tube, lobes subequal, differing by 0.7–1.6 mm. **Corolla** 11–19 mm long, well-exserted from calyx and bracts, narrowly funnelform to sub-salverform, usually medially zygomorphic to occasionally nearly actinomorphic, its lobes usually arranged either with 3 lobes up and 2 down, or with 4 lobes up and 1 down; tube 4.0–8.8 mm long, usually half the length of the corolla or less, white to lavender or pale blue, inner surface puberulent; throat 1.0–4.7 mm long, pale blue, lavender, or white, or sometimes yellow or with yellow dots, often asymmetric due to unequal sinuses; throat plus tube 7.6–12.4 mm long; lobes narrowly elliptic to obovate, sometimes asymmetric, 4.1–7.8 mm long, varying in length in a single flower by 0.0–0.9 mm due to unequal sinuses, 28–42% of total corolla length, 1.7–3.0 mm wide, violet, lavender, blue, or almost white, often with darker purplish or reddish streaks on or near veins, tips acute to obtuse, often twisted. **Stamens** generally exserted 3.5–5.6 mm past the sinuses, but not quite to the tips of the lobes, attached 0.7–4.0 mm below the sinuses, the sinus to stamen insertion distance differing in one flower by 0.5–2.6 mm, usually by 1 mm or more; free portion 2–9 mm long, to base of corolla 8.1–16.3 mm long, distinctly unequal in length, differing in a single flower by 1.0–4.2 mm; the filaments 1.5–8.0 mm long, often curving downward (toward the ground) in the tube and throat, but turning upward beyond the throat, white to light blue; anthers 1.0–2.5 mm long, sagittate, versatile, white to pale blue. Pollen white to blue or lavender, average grain diameter 27 µm, possibly anomotreme or pantotreme aperture arrangement. **Pistil** 9.9–14.8 mm long, equal to the stamens to about 4 mm longer, glabrous or occasionally with a few 2–4-celled glandular trichomes at the apex of the ovary; stigma lobes 0.4–0.8 mm long; style 8–13 mm long, white to light blue; ovary 3-loculed, 6–12 ovules total (2–4 per locule). **Fruit** is a capsule, about 2.5–3.1 mm long, 1.1–1.5 mm wide, tan. **Seeds** about 1.0–1.9 mm long, 0.7–0.8 mm wide, mostly angular, sand-colored (Fig. 186–193 [Color Plate 5]; Brand 1913: 19–20; Jepson 1925: 793; Craig 1934*b*: 416; Harrison 1972: 15–16; S. De Groot, unpubl. data).

Identification.—Distinguishing features of subsp. *eremicum* include medially zygomorphic corollas with exserted stamens, and usually more than 3 lobes on the leaves.

Subsp. *eremicum* can be distinguished from *E. pluriflorum* subsp. *albifaux*, *E. signatum*, and *E. wilcoxii* by its medially zygomorphic corollas, since those three taxa all have actinomorphic corollas. In dried material, the flowers of subsp. *eremicum* will have unequal sinuses, while flowers of the other taxa will have mostly equal sinuses. Additionally, filaments of subsp. *eremicum* tend to curve in the same direction and are often clustered at the lower side of the corolla (toward the ground). Filaments of *E. p.* subsp. *albifaux*, *E. signatum*, and *E. wilcoxii* are not all curved the same direction or clustered. In dried material, corolla lobes of *E. signatum* and *E. wilcoxii* are usually straight, while lobes of *E. eremicum* subsp. *eremicum* are often reflexed. Stamens are exserted farther beyond the sinuses in subsp. *eremicum* (>3.5 mm) than in *E. signatum* (<1.5 mm) or *E. wilcoxii* (<2.5 mm).

Although stamens are exserted about the same distance in both *E. e.* subsp. *eremicum* and *E. sapphirinum* subsp. *brevibracteatum*, subsp. *eremicum* still has unequal sinuses while those of subsp. *brevibracteatum* are mostly equal. Additionally, the upper stems of subsp. *brevibracteatum* are usually glandular, while those of subsp. *eremicum* are not.

Stamens of subsp. *eremicum* are exserted farther (≥3.5 mm) than stamens of *E. filifolium* (<1.4 mm), and also are unequal, while stamens of *E. filifolium* are mostly equal.

Subsp. *eremicum* can be differentiated from subsp. *zionis* by its longer tube plus throat (>7.5 mm) and more numerous leaf lobes (generally 3 or more). Stamens of subsp. *zionis* may be exserted farther beyond the sinuses than stamens of subsp. *eremicum*. Subspp. *markianum* and *yageri* have mostly actinomorphic corollas, while subsp. *eremicum* has medially zygomorphic corollas.

Phenology.—Flowering April through May and perhaps as late as mid-June or early July at some sites. Fruiting May through September. Occasionally this species will re-sprout and flower again in August or September after receiving some summer precipitation. Sites at lower latitudes may start and finish flowering earlier than sites at higher latitudes.

Distribution.—Southern California, southern Nevada, extreme western Arizona, Baja California; Sonoran and Mojave Deserts, southern tip of Owens Valley (Fig. 213).

Habitat.—*Eriastrum eremicum* subsp. *eremicum* has been found between about 100 and 1760 m (330–5780 ft) in elevation, in open, sunny areas in or near shallow washes, on flats, slopes, bajadas, rolling hills, sand dunes, playas, or roadsides. The slope at sites varies from flat to about 30°, although it is usually fairly gentle. All aspects except northwest-facing have been recorded. The substrate is often a light colored granitic sand, but also may be silt, gravel, rock, or loam, sometimes hard-packed, and can be derived from mixed alluvium, calcareous alluvium, basaltics, metamorphics, or cinders. At a few sites, the soil was somewhat alkaline. Surrounding vegetation is often some form of Mojave, Sonoran, or Vizcaíno desert scrub, such as creosote bush scrub, desert wash community, sand dune community, saltbush scrub, alkaline or halophytic scrub, sagebrush scrub, rabbitbrush scrub, creosote bush-Joshua tree scrub, blackbrush scrub, Joshua tree woodland, juniper-Joshua tree woodland, pinyon-juniper woodland, or combinations of these. Some plants have been found in areas burned the previous fall.

Population dynamics.—Population sizes from about 20 to over 1,000,000 have been recorded. Plants often occur in patches, and have been reported to be occasional, scattered, frequent, common, or abundant. In good years, they may form large patches that extend for several miles. The number of plants seen at a site in a given year is probably dependent to some extent on the amount of winter precipitation received.

Threats.—Vehicle use, road maintenance, invasive weeds, or illegal dumping might impact some sites. This subspecies has been found several times on recently burned areas, suggesting that its seedbank can survive low- or perhaps moderate-intensity fires.

Conservation.—Global rank: G5T5? – secure; otherwise not ranked (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—From Greek *erem-*, desert, and *–icus*, belonging to; i.e., "belonging to the desert," alluding to the habitat and general area where this species occurs. The epithet *jacumbana* presumably was derived from the location of the type collection, Jacumba, with the Latin *–anus*, indicating position, connection, or possession—"of Jacumba."

Common name.—Desert woolly-star.

Discussion.—A brief explanation is in order regarding the lectotype of *N. densifolia* var. *jacumbana*. In the introduction to his 1913 paper, where this taxon was described, Brand stated, "The following contributions are based for the most part on the material of Herbarium Delessert, which was accessible to me until after my editing of the Polemoniaceae for the "Pflanzenreich" through the gracious intervention of Mr. Director Briquet; but in addition, a number of insertions of the Berlin Museum also have been used" (mostly literal translation from German; Brand 1913: 323). The Delessert herbarium is now at G (Index Herbariorum, *http://sweetgum.nybg.org/ih/herbarium.php?irn=124334*). Thus, although no herbarium is specified in the protologue for *N. densifolia* var. *jacumbana*, it seems clear that the name was based on a specimen (or specimens) at either G, B, or both. The specimen G 375432 has an annotation "Acquis et intercalé dans la collection générale de l'**Herbier Delessert** en 1906" (emphasis original). The specimen also contains a handwritten annotation, "Navarretia densifolia var. jacumbana nov. var. ! Brand". This handwriting compares favorably to handwritten letters, signed by Brand, that are attached to two specimens of *Gilia* at K (*G. arenaria* or *G. sinuata*, !). The collection information on G 375432 matches the collection information given in the protologue (*Abrams 3640*; Brand 1913: 340–341). The plant specimens themselves match well with Brand's original description. There may have been a duplicate of *Abrams 3640* at B; however, all of the Polemoniaceae specimens at B were destroyed in 1943 (Hiepko

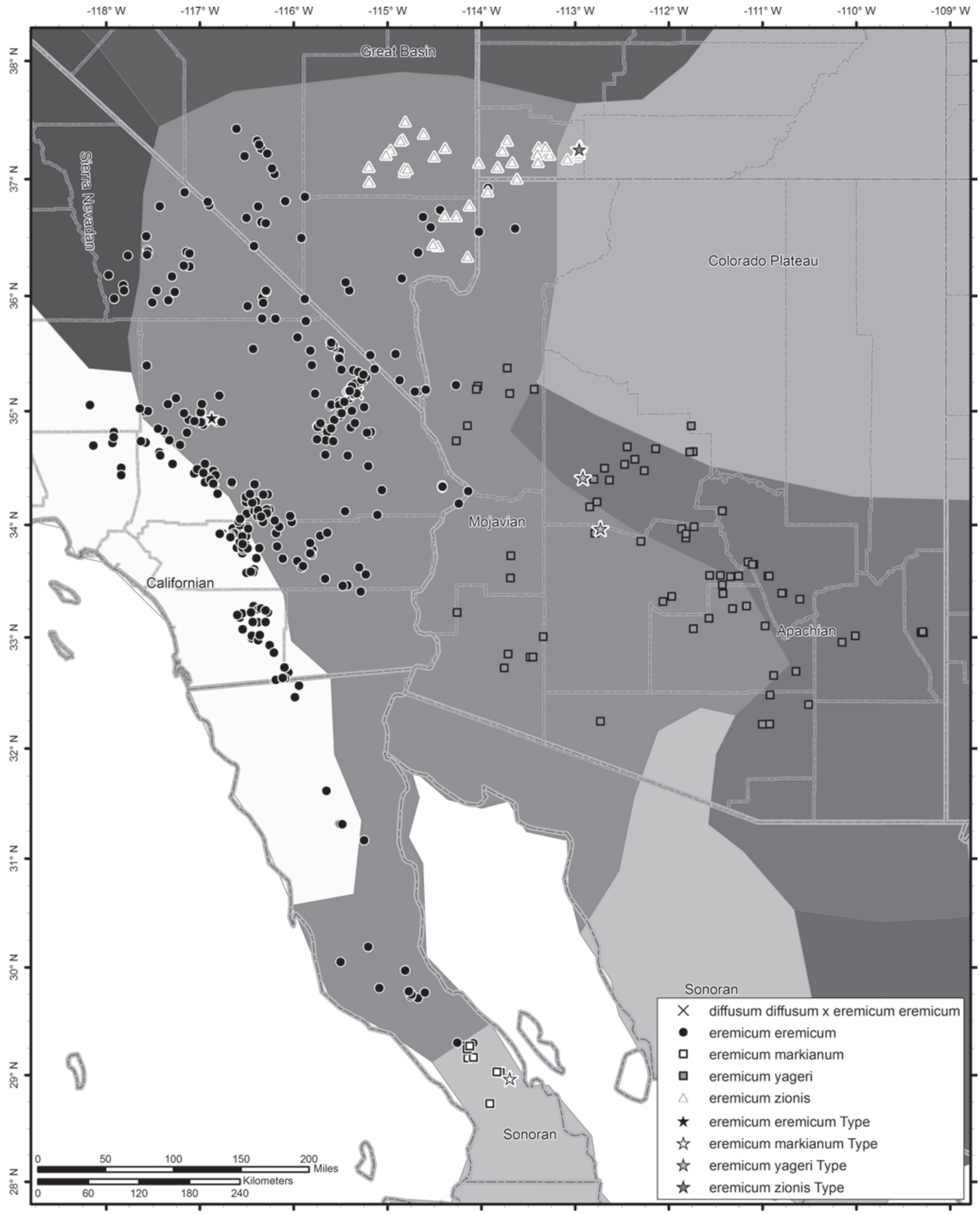


Fig. 213. Range map for *E. eremicum*, showing floristic regions and specimen and type locations. Both syntype locations are marked for subsp. *yageri*, although the lectotype is from the southern locality. The floristic regions are based on McLaughlin (2007). State and county boundaries are indicated.

1987) and it appears impossible to determine today if there was a specimen of *Abrams 3640* at B prior to 1943. Since Brand wrote that the taxa published in his 1913 paper were mostly based on material from the Delessert Herbarium, it seems simplest to designate G 375432, of l'Herbier Delessert, and annotated by Brand, as the lectotype.

No herbarium was cited for the holotype of *Hugelia eremica* (Jepson 1925), but JEPS 2635 was later annotated as the type of *H. eremica*, matches the protologue, and was in Jepson's herbarium. Therefore it is here selected as the lectotype.

Branching patterns and plant architecture can be highly variable in this subspecies. Plants growing in open areas with little competition are often spreading, while plants growing among other forbs or grasses are usually erect and racemosely- or corymbosely-branched (S. De Groot, unpubl. data).

5B. ERIASTRUM EREMICUM (Jepson) H. Mason subsp. **markianum** De Groot, subsp. nov.

Type: Mexico, Baja California (Norte): ca. 0.25 mile [actually ca.10 miles] west of Bahía de los Angeles, inland, along the road to Mex. Highway 1, alluvium of large wash, 28.96805° N, 113.69694° W, 327 m/1074 ft elevation, 1 Apr 2005, *J. M. Porter 14310, with L. Machen, S. De Groot, and J. Anderson*.

Holotype: RSA 767652! Isotypes: probably 2, locations uncertain.

Included in *Gilia virgata* (Bentham) Steudel var. *sapphirina* (Eastwood) J.F. Macbride by Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 412. Craig noted that the specimens were "…closely related to var. *sapphirina* and var. *ambigua*, and at the same time greatly resembling *eremica* in habit" (Craig 1934*b*: 412).

Included in *E. eremicum* (Jepson) H. Mason subsp. *eremicum* (Harrison 1959: 167–180).

Annual herb, erect to spreading, corymbose or paniculate, smaller plants sometimes virgate or racemose, about 5.5–22.5 cm high and 1.5–12 cm (or more) wide. **Stems** mostly branched above, sometimes branched from the base, the branches freely and often dichotomously branched, wiry, green, glandular, and lightly floccose but becoming dark reddish brown or tan and subglabrous in age, generally not woody except perhaps in large plants late in the growing season. **Leaves** alternate, pinnatifid, mostly ascending, 12–31 mm long, bright green, lightly floccose but becoming reddish brown and glabrate in age, 3–7-lobed (often 5), lowest leaves sometimes entire, lateral lobes linear, 1–14 mm long, the most proximal lateral lobes sometimes shorter than the other lateral lobes, subulate to aristulate, distributed along the primary axis or arising from the proximal half. **Inflorescence** heads terminal, small, densely woolly, few-flowered (2–15), 6–8 mm long, 2–11 mm wide; about 1–13 or more heads per plant. **Bracts** pinnatifid, 4–23 mm long, exceeding the heads, lanate, glandular, bright green, ascending to spreading, 3–5-lobed, lateral lobes 1–10 mm long, awn-tipped, lobes mostly arising from the proximal third of the primary axis. **Calyx** 6.5–8 mm long; sepals floccose, glandular, green, aristate, margins hyaline, fused into a tube for the proximal 1/2 to 2/3 of the length; lobes unequal, differing in length within a single flower by 0.75–1.1 mm. **Corolla** 10.0–12.5 mm long, narrowly funnelform, throat sometimes exserted from calyx and bracts, sometimes included; slightly zygomorphic to actinomorphic; tube 4.5–6.7 mm long, usually 40–60% of the length of the corolla, white, inner surface puberulent with projections from epidermal cells; throat 0.2–2.0 mm long, sometimes asymmetric due to unequal sinuses, mostly white, often with yellow dots inside; tube plus throat 5.4–8.0 mm long; lobes elliptic, pale blue to white, with darker blue-purple or red streaks near the bases of the lobes, 3.6–5.1 mm long, varying in length in a single flower by 0–0.6 mm due to unequal sinuses, 35–46% of the total corolla length, 1.8–2.4 mm wide, apex acute to rounded (sometimes oblique), often inrolled. **Stamens** exserted past the sinuses by 1.3–2.9 mm, but shorter than the corolla lobes by 1.6–3.1 mm, attached 0.8–2.3 mm below the sinuses, the sinus to stamen insertion distance differing in one flower by 0.1–1.3 mm, usually by 0.5 mm or more; free portion 2.5–4.5 mm long, to base of corolla 6.1–9.9 mm long, unequal in length, differing in a single flower by 0.6–1.7 mm, the longer stamens often toward the lower side of the flower and the shorter ones frequently upper; the filaments 2–4 mm long, white, sometimes turning upward at the distal ends; anthers 1.0–1.5 mm long, white, ovate, sagittate, versatile. Pollen white to gray, average grain diameter 39 μm, pantotreme to sub-zonate arrangement of apertures. **Pistil** 5.8–10.1 mm long, equal to or exserted beyond the stamens up to about 2.5 mm; tip of ovary and base of style with a few 4–5-celled trichomes; stigma lobes 0.7–1.0 mm long, white; style 3.5–7.3 mm long, white; ovary at anthesis oblong to pear-shaped, 1.5–2 mm long, 3-loculed, 12–15 ovules total (4–5 per locule). **Fruit** is a capsule, about 4–5 mm long and 2.0–2.2 mm wide, tan, with about 4 seeds per locule. **Seeds** about 1.2–2.0 mm long, tan to light brown (Fig. 206–212 [Color Plate 5], 214–221).

Identification.—Corollas of subsp. *markianum* are usually actinomorphic (sometimes color pattern is zygomorphic), while corollas of subspp. *eremicum* and *zionis* are usually medially zygomorphic. Corollas of subsp. *yageri* are also actinomorphic, but generally larger, with larger anthers (>1.25 mm) and longer stamens, exserted farther. Corolla lobe tips of subsp. *markianum* are usually acute and sometimes inrolled, while corolla lobe tips of subsp. *yageri* are often rounded.

All subspecies of *E. eremicum* tend to have larger anthers (generally >1 mm) than *E. diffusum* (generally <1 mm). Stamens of subsp. *markianum* are unequal (length difference >0.5 mm) while stamens of *E. filifolium* are equal (length difference ≤0.3 mm).

Phenology.—Flowering in April. Fruiting late April through May.

Distribution.—Baja California endemic; Vizcaíno Desert. Mostly localized at the foot of the Sierra La Asamblea (Fig. 213). It appears to be the only subspecies of *E. eremicum* found in the Sonoran Floristic Region, sensu McLaughlin (2007).

Habitat.—*Eriastrum eremicum* subsp. *markianum* has been collected at elevations between about 220 and 680 m (720–2230 ft), usually in open, sunny areas in washes or on benches above washes. The slope is usually flat to about 6°, and although east-facing is the only documented aspect, sites probably could face any direction. The substrate is a coarse sand, sometimes with rock, and derived from decomposed granite or mixed alluvium. Surrounding vegetation is the Vizcaíno phase of Sonoran desert scrub.

Population dynamics.—Population sizes of about 100 or more plants have been recorded. Plants may be found scattered or in small patches.

Threats.—Off-road vehicle use, illegal dumping, overgrazing, or development could impact sites. The total range area is about 400 square miles or less.

Conservation.—Global rank: G5TNR; otherwise not ranked (CNPS 2013; NatureServe 2013; Table 2). Given the small range size, this species perhaps should be considered for rare plant ranking. It might be useful to search potential habitat in the vicinity for additional populations.

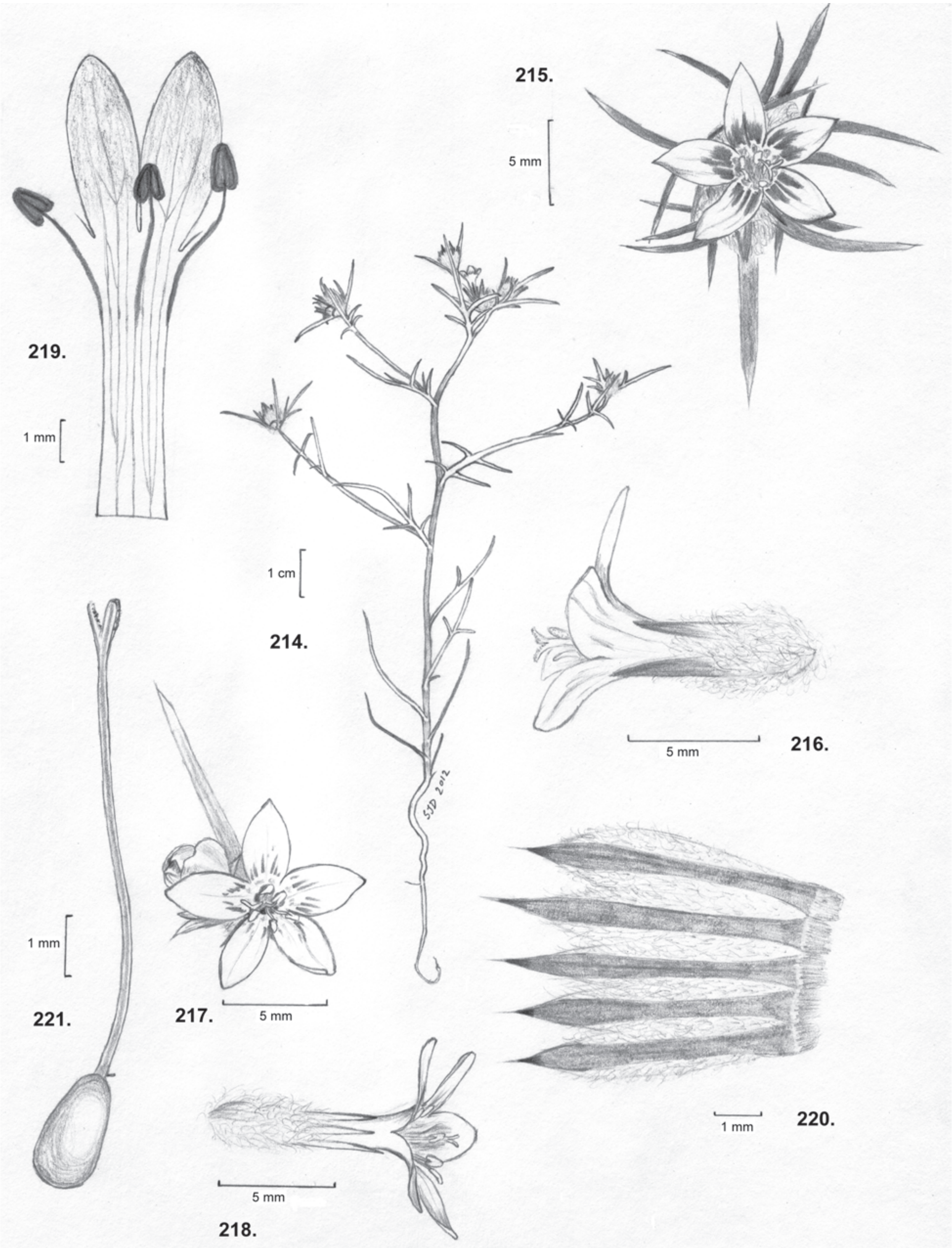


Fig. 214–221. *Eriastrum eremicum* subsp. **markianum**.—214. Habit (*De Groot 4896*).—215. Inflorescence and flower in face view (*De Groot 4896*).—216. Flower in side view (*De Groot 4896*).—217. Inflorescence head with flower and bud in face view (*De Groot 4850*).—218. Flower from the side (*De Groot 4850*).—219. Two petals of opened corolla, with three stamens (*De Groot 4850*).—220. Opened calyx (*De Groot 4850*).—221. Pistil, composed of a three-lobed stigma, style (with a single trichome), and ovary (*De Groot 4850*).

Etymology.—The subspecific name is in complement (*-anum*) to Dr. J. Mark Porter, student of Polemoniaceae, who assisted with making my first two collections of this taxon (and, incidentally, informed me that they were *E. eremicum*, which I rather doubted at the time, previously having seen typical *eremicum* in the northern Sonoran Desert of California).

Common name.—J. Mark's woolly-star.

Paratypes.—Mexico, Baja California: northeast of El Crucero, Sierra la Asamblea, *Rebman 11021* (RSA 701053!); northeast of El Crucero, *Porter 11639* (RSA 672132!); road near El Crucero, Sierra La Asamblea, *S. J. De Groot 4896* (RSA!); Mina Desengaña, ca. 16 miles north of Punta Prieta, *Gentry 8901* (RSA 568879!); along highway to Bahía de los Angeles, *Heil 6500* (RSA 571982!); along road west of Bahía de los Angeles, between town and road to San Borja Mission, *S. J. De Groot 4850* (RSA!).

Discussion.—Craig (1934*b*: 412) cited two specimens from Baja California, which he said had the flower of *E. sapphirinum* but the habit of *E. eremicum*. The flowers of subsp. *markianum* are more actinomorphic than typical *E. eremicum*, and similar to *E. sapphirinum*. The leaves and habit of subsp. *markianum* are very similar to typical *E. eremicum*. Without seeing the specimens that Craig cited, it is not possible to be sure, but the plants in his description resemble subsp. *markianum* and Craig may have been the first to recognize this variation.

Although the flowers are similar to *E. sapphirinum*, plants of subsp. *markianum* are more like typical subsp. *eremicum* in leaf and habit, bloom at about the same time as other *E. eremicum* (*E. sapphirinum* usually blooms a bit later), and occupy desert habitats. The typical subspecies and subsp. *markianum* are peripatric near El Crucero. So although subsp. *markianum* may resemble *E. sapphirinum* in flower, it appears to have more affinity to *E. eremicum*, and is treated in that species, at least until new data might suggest otherwise.

5c. Eriastrum eremicum (Jepson) H. Mason subsp. yageri (M.E. Jones) H. Mason 1945, *Madroño* 8(3): 78–79.

Basionym: *Gilia virgata* var. *Yageri* M.E. Jones 1910, *Contr. W. Bot.* No. 13. p. 2.

Syntypes: USA, Arizona, Yavapai County: Hillside, 1 May 1903, *Jones 10279* (POM 74570!); USA, Arizona, Maricopa County: Wickenberg, 5 May 1903, *Jones 10253* (POM 74569!), UC (Brandegee Herbarium, Mason 1945: 79)?.

Lectotype, designated here: POM 74569. Possibly an isolectotype at UC (Brandegee Herbarium).

≡*Gilia virgata* var. *Yageri* M.E. Jones 1910, *Contr. W. Bot.* No. 13. p. 2.

Included in *Gilia virgata* (Bentham) Steudel var. *floccosa* (A. Gray) Milliken. Macbride 1917, *Contr. Gray Herb.* NS Vol. 49 No. 3 p. 57–58.

≡*Gilia eremica* (Jepson) T.T. Craig var. *arizonica* T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 419–420.

As to name, not type: =*Gilia eremica* (Jepson) T.T. Craig var. *Yageri* (M.E. Jones) T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 420–421. Retypified by *Jones 9935*, from Yagers, north of Tucson, POM 74576!.

≡*Gilia virgata* var. *ambigua* M.E. Jones in herb. (*Jones 10279*, POM 74570!). This combination apparently was never published. This specimen is a syntype of *Gilia virgata* var. *yageri* M.E. Jones.

Annual herb, slender, widely and much branched, 3.5–28 cm tall and to 34 cm wide. **Stems** erect, paniculate to corymbose, smaller plants virgate to racemose; branched above, sometimes branched from the base if the tip of the main stem has been removed or if the plants have grown quite large; wiry; lower (older) stems dark reddish-brown, upper (young) stems green; floccose or lightly floccose, becoming subglabrous with age, also slightly glandular. **Leaves** alternate, entire to pinnatifid, ascending to spreading, 8–35 mm long; older leaves dark reddish brown or tan, young leaves green, middle-age leaves sometimes yellowish; subglabrous, younger leaves lightly lanate, becoming glabrate in age, apex subulate to aristate; lower leaves entire to 3-lobed, upper leaves 3–5-lobed, occasionally entire; lateral lobes arising from proximal third of leaf, 1–12 mm long, apex subulate to aristate. **Inflorescence** capitate, terminal, usually 1 per branch, 1–41 or more per plant; heads small, 6–25 mm wide, 7–11 mm long, lightly to densely floccose, 5–26 or more flowers per head (sometimes fewer on depauperate plants). **Bracts** pinnatifid, mostly ascending, sometimes spreading at tips, 7–22 mm long, some tips exceeding head, green, tips sometimes reddish, lightly floccose (bases and inner bracts more densely so), apex subulate to aristulate; inner bracts 3–5-lobed, outer 3–5-lobed, occasionally 7-lobed, lateral lobes arising from proximal half of bract, 1–10 mm long, apex subulate to aristulate. **Calyx** 5.0–9.9 mm long, sepals floccose, green, tips sometimes reddish, subulate, margins hyaline, lower 1/2 to 2/3 fused into a tube, lobes glandular, unequal by 0.8–2.6 mm. **Corolla** 10–23 mm long, exserted beyond calyx by about 2.1–6.3 mm, noticeably zygomorphic to nearly actinomorphic (sometimes shape more or less actinomorphic but color zygomorphic); tube 4.3–9.1 mm long, about 1/3 to 1/2 of the total corolla length, white to pale blue (sometimes distal part white, proximal or center pale blue, proximal white, most proximal edge reddish); pubescent inside with projections from epidermal cells, projections longer around veins, rarely 2-celled; throat 0.8–3.5 mm long, somewhat asymmetric due to unequal sinuses (upper side appears longer than lower), yellow, white or pale blue, with yellow patches; tube plus throat 6.2–11.2 mm long; lobes elliptic to obovate, sometimes nearly oblong, apex rounded to nearly obtuse, sometimes slightly retuse or notched, tips sometimes curled, 3.2–7.0 mm long, varying in length by 0.0–0.4 mm, about 1/3 or a little more (but less than half) of corolla length, 1.7–3.7 mm wide, blue to pale blue to white, often with some darker purple or blue streaks or spots near the base, frequently darker toward the tip and fading toward the base, veins sometimes darker blue, sometimes yellow at the base or on the abaxial side. **Stamens** exserted 1.2–4.4 mm beyond the sinuses (but still at least 0.25 mm shorter than the petals), inserted 1.2–4.4 mm below the sinuses, the insertion distance varying within a flower by 0.2–1.4 mm; free portion 3.0–8.0 mm long, to base of corolla 7.4–15.5 mm long, unequal, differing in length within a single flower by 0.6–4.0 mm; filaments white, 2.7–8.3 mm long, differing in length by 0.2–3.8 mm but usually by 1 mm or more, lower filaments sometimes longer and curving upward; anthers 1.25–1.75 mm long, 1 mm wide, pale blue or white, elliptic to ovate, versatile, sagittate. Pollen white to sky blue or lavender, average grain diameter 26 μm, possibly pantotreme aperture arrangement. **Pistil** 7.2–15.0 mm long, equal to stamens or exserted up to 4.6 mm beyond stamens, ovary and style mostly glabrous, rarely with a few 4-celled trichomes; stigma lobes 0.5–1.4 mm long, white; style 6.2–11.6 mm long, white; ovary at anthesis about 1.25–1.75 mm long and 0.75–1.7 mm wide, 3-loculed, with 2–5 ovules per locule (8–14 ovules total). **Capsule** about 4 mm long and 2 mm wide. **Seeds** about 1.5–1.7 mm long, 0.6–0.8 mm wide, tan to light brown, mostly angular (Fig. 194–199 [Color Plate 5]; Jones 1910: 2; S. De Groot, unpubl. data).

Identification.—All subspecies of *E. eremicum* tend to have larger anthers (generally >1 mm) than *E. diffusum* (generally <1 mm). Flowers of *E. eremicum* subsp. *yageri* tend to be larger than flowers of *E. diffusum*. Other key features of *E. eremicum* subsp. *yageri* are the corolla lobes which are oval to obovate. Corolla lobes of *E. diffusum* generally tend to be elliptic.

Subsp. *yageri* is differentiated from subspp. *eremicum* and *zionis* by its nearly actinomorphic corollas. Corollas of subspp. *eremicum* and *zionis* are fairly strongly medially zygomorphic. Corolla lobes of subsp. *yageri* are often rounded, while lobes of other *E. eremicum* subspecies are generally pointed and often twisted. Leaves of subsp. *yageri* have fewer lobes than subsp. *eremicum* (see Mason 1945: 78).

Phenology.—Flowering from about mid-April through mid-May. Fruiting in May and June.

Distribution.—Arizona endemic; eastern Mojave Desert and Apachian Subprovince of Madrean Floristic Region (Fig. 213).

Habitat.—*Eriastrum eremicum* subsp. *yageri* has been collected between 530 and 1460 m (1740–4790 ft) in elevation, in open areas in or along washes, on rolling hills, slopes, flats, or roadsides. The slope of sites varies from flat to about 24°, and most aspects except south- and southwest-facing have been observed. The substrate is dry, packed or loose sand, gravel, rock, or loam, and may be derived from alluvium, granite, or possibly limestone. Surrounding vegetation may be Sonoran desert scrub (including Arizona Upland), alluvial scrub, riparian scrub, or pinyon-juniper woodland.

Population dynamics.—Population sizes of about 100 or more plants have been recorded. Plants tend to be scattered, often in small patches, and may be more frequent near drainages.

Threats.—At least one site had some impact from cattle grazing. Vehicles, illegal dumping, and competition from invasive plants may be threats.

Conservation.—Global rank: G5T2T4 – vulnerable; otherwise not ranked (NatureServe 2013; Table 2).

Etymology.—Presumably named for Yager's, north of Tucson, Arizona, a location in the range of the subspecies and the locality of one of the paratypes (*Jones 9935*; see discussion below). I have not yet determined exactly who Yager was, although I suspect he may have been a rancher or at least a land owner. Craig's var. *arizonica* presumably refers to the geographic range of that taxon, which is found in Arizona.

Common name.—Yager's woolly-star.

Discussion.—The lectotype designation deserves a comment. *Jones 10279* is annotated "Gilia virgata var. ambigua Jones type" in Jones' handwriting. However, this combination was never published: *ambigua* was published by Jones as *Gilia floccosa* var. *ambigua* M.E. Jones with different type specimens. But in the protologue for *Gilia virgata* var. *yageri* M.E. Jones, Jones wrote, "I regard as the types Nos. 10279 and 10253" (1910: 2). Perhaps Jones never annotated No. 10279 to reflect this type designation. *Jones 10279* is a single, small plant with only one flower, and has generally been regarded as providing insufficient reference as to what the variety *yageri* refers ("…so imperfect a specimen as to be impossible of exact reference…" Craig 1934*b*: 421). In contrast, *Jones 10253* is a large plant with many flowers. Mason (1945) cited *Jones 10253* alone as the type of *Eriastrum eremicum* subsp. *yageri* (M.E. Jones) H. Mason, and this was followed by Harrison (1972). Both *Jones 10279* and *Jones 10253* fit the protologue (which is rather general), except that the anthers (mentioned in the protologue) cannot be seen on *Jones 10279*. To preserve the current usage of the name *yageri*, with a good specimen for reference, *Jones 10253* is better designated as the lectotype.

See also the notes in the Introduction, Mason (1945: 77–79), Harrison (1972: 16–17), and De Groot (2011*b*: 449) about the type of *E. eremicum* susbp. *yageri* and its relationship with *E. diffusum* subsp. *jonesii* and *Gilia eremica* var. *arizonica*.

The locality "Yager's" (*Jones 9935*) is difficult to determine exactly. In May 1890, Jones was travelling north from Tucson. He wrote, "Left Tucson on the 21st and botanized at the pump house north of there. On the 22nd botanized at Willow Spring and Yager's on the road to Riverside. On the 23rd collected at Putnam's Ranch and Riverside" (Jones 1965: 204).

The pump house was probably Steam Pump Ranch, along modern-day Highway 77 near its intersection with Cañada del Oro (Granger 1983; USGS Oro Valley 7.5' quadrangle map). Willow Spring was the site of a ranch (Willow Spring Ranch), and also a post office and stage station named Manleyville (or Manlyville; Granger 1983). Putnam Wash flows into Camp Grant Wash near Putnam Spring, just west of the San Pedro River and old Camp Grant (Granger 1983). Putting these together, Jones' route from Tucson probably went through Cañada del Oro to Willow Spring, along Camp Grant Wash to Putnam Spring and the San Pedro River, then north along the river to Dudleyville (near Winkelman) and Riverside (near Kelvin; Granger 1983; see also [map of the] Territories of New Mexico and Arizona/prepared in the Office of the Chief of Engineers USA, 1879. Library of Congress call number G4320 1879.U5. Digital ID g4320 ct003308, *http://hdl.loc.gov/loc.gmd/g4320.ct003308*). Assuming his written account was chronological, Yager's was probably a ranch or homestead in the vicinity of Camp Grant Wash, between Willow Spring and Putnam Spring.

5D. ERIASTRUM EREMICUM (Jepson) H. Mason subsp. ZIONIS (T.T. Craig) De Groot 2011*b*, *Syst. Bot.* 36(2): 461.

Basionym: *Gilia eremica* (Jepson) T.T. Craig var. *zionis* T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 418–419.

Type: USA, Utah, Washington County: Zion National Park, 18 June 1928, *T. Craig 1400*.

Holotype: POM 184135!; isotype POM 182268!.

≡*Gilia eremica* (Jepson) T.T. Craig var. *zionis* T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 418–419.

Included in *Eriastrum eremicum* (Jepson) H. Mason 1945, *Madroño* 8(3): 78.

Annual herb, 6–25 cm high; generally erect, racemose, corymbose, or branched from base, branches in turn often branched. **Stems** wiry, green, floccose, becoming reddish-brown, glabrate, internodes 5–30 mm long. **Leaves** alternate, entire to pinnatifid, ascending to spreading, 8–30 mm long, green, lightly floccose to subglabrous, becoming reddish-brown and glabrate in age, subulate to aristulate, entire or 3-lobed, rarely 5-lobed, lobes linear; the lateral lobes arising from the basal third of primary axis, 2–12 mm long. **Inflorescences** in heads, terminating the branches, 1–34 or more, 6–7 mm long and 5–11 mm wide, floccose, several-flowered. **Bracts** pinnatifid, ascending (inner) to spreading (outer), 4–16 mm long, a few outer bracts exceeding the heads, green, densely floccose, aristulate, 3–5-lobed from base, lobes 1–7 mm long. **Calyx** 4.0–6.0 mm long, sepals green, tips sometimes red, densely floccose, aristulate, bordered by hyaline membrane, membranes fused a little more than halfway to form the tube, lobes unequal to subequal, differing in length within a single flower by 0.5–1.5 mm. **Corolla** slightly to strongly zygomorphic, narrowly funnelform to subsalverform, 10–14 mm long; tube often exserted at least slightly from the calyx, pale blue to white, about 3–6 mm long, about 34–48% of the corolla length, pubescent inside with projections from epidermal cells; throat white or pale blue, often with yellow blotches, about (0.8–) 1–3 mm long, somewhat asymmetric due to unequal sinuses; tube plus throat 4.7–7.5 mm; lobes strap-shaped to narrowly elliptic or nearly oblanceolate, blue, pale blue, or lavender, veins sometimes darker, often with reddish lines or spots near the base, narrowly elliptic to oblong, 4.2–6.5 mm long, differing within a flower by 0.0–0.3 mm, 36–52% of the total corolla length, 1.6–2.4 mm wide, the width less than half of the length, tips acute to rounded, occasionally notched, sometimes curled or twisted. **Stamens** exserted 4.2–6.5 mm beyond the sinuses, attached in tube about 1.0–3.5 mm below sinuses, insertion distance varying by 0.6–2.2 mm; free portion about 2.0–8.5 mm long, to base of corolla 7.3–12.7 mm long, unequal, differing in length within a flower by 0.7–4.4 mm, a common arrangement being one short, two of medium length, and two long (or 2 short, 2 medium, 1 long); filaments 3.9–7.6 mm long, white to lavender; anthers 1–2 mm long, white to lavender, shape oval, sagittate, versatile. Pollen blue, average grain diameter 27 μm, possibly zonate aperture arrangement. **Pistil** 7–10 mm long; stigma lobes about 1 mm long; style 5.5–8.0 mm long, white; ovary at anthesis about 1 mm long and 0.75 mm wide, glabrous or with a few 4-celled trichomes, with 2–4 ovules per locule. **Capsule** 3-loculed, about 2.8 mm long and 1.5 mm wide, tan to purplish, usually with 2–3 (–4) seeds per locule. **Seeds** about 1.3–1.9 mm long, 0.6–0.8 mm wide, tan, elliptic to angular (Fig. 200–205 [Color Plate 5]; Craig 1934*a*, *b*: 418; S. De Groot, unpubl. data).

Identification.—Subsp. *zionis* can be differentiated from subsp. *eremicum* by its shorter tube + throat (<7.5 mm) and fewer leaf lobes (generally 3 or fewer). Stamens of subsp. *zionis* may be exserted farther beyond the sinuses than stamens of subsp. *eremicum*. Other subspecies of *E. eremicum* have mostly actinomorphic corollas, in contrast to subsp. *zionis*, which has medially zygomorphic corollas.

All subspecies of *E. eremicum* tend to have larger anthers (generally >1 mm) than *E. diffusum* (generally <1 mm). *Eriastrum eremicum* subsp. *zionis* has medially zygomorphic corollas, in noticeable contrast to *E. diffusum's* actinomorphic corollas.

Subsp. *zionis* can be distinguished from *E. wilcoxii* and *E. signatum* by its medially zygomorphic corollas, since both of those taxa have actinomorphic corollas. In dried material, the flowers of subsp. *zionis* will have unequal sinuses, while flowers of the other taxa will have mostly equal sinuses. Stamens are exserted farther in subsp. *zionis* (>4 mm) than *E. wilcoxii* (<2.5 mm) or *E. signatum* (<1.5 mm).

Phenology.—Flowering in May. Fruiting late May and June.

Distribution.—Southwest Utah, northwest Arizona, southeast Nevada; northeast Mojave Desert, west edge of Colorado Plateau (Fig. 213).

Habitat.—*Eriastrum eremicum* subsp. *zionis* has been found between 300 and 1460 m (980–4790 ft), but mostly above 800 m (2625 ft). It occurs in open areas in or along washes, in ditches, on ridges, benches, slopes, flats, or roadsides. Sites are flat or gently sloped to about 8°, and most aspects except north- and northwest-facing have been documented. The substrate is often fine sand, but may also contain clay, gravel, pebbles, or loam. It is often reddish, pinkish, or tan, and may be derived from sandstone, granite, basalt, various volcanics, or mixed alluvium. In some areas it can be traced to a particular formation, such as the Kayenta or Navajo formations. Surrounding vegetation may be creosote bush scrub, a sagebrush-rabbitbrush community, *Artemisia filifolia-Psorothamnus* association, sand dune scrub, Joshua tree woodland, chaparral, juniper woodland, riparian woodland, pinyon-juniper-oak woodland, or combinations of these types. At least one site had burned recently. Occasionally this subspecies may be associated with cryptobiotic crust.

Population dynamics.—Population sizes of about 200 to at least 1400 plants have been recorded. Plants are often found in patches of various sizes, and may be scattered, frequent, or fairly abundant, but usually are quite localized. Population sizes probably vary from year to year.

Threats.—Vehicle use, road maintenance, illegal dumping, off-trail hiking, or trail maintenance could impact some sites. At least one site had burned recently, so fire may not be completely devastating. Many sites occur in Zion National Park where they are protected.

Conservation.—Global rank: G5TNR; otherwise not ranked (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—The subspecific epithet is a genitive singular derivation of the name of the type locality, Zion National Park; *zionis* means literally, "of Zion."

Common name.—Zion woolly-star.

Discussion.—Subspp. *zionis* and *eremicum* appear to grade into each other in eastern California and southern Nevada, and may be difficult to distinguish there.

6. ERIASTRUM ERTTERAE D. Gowen 2013, *J. Bot. Res. Inst. Texas* 7(1): 21–23.

Type: USA, California, Contra Costa County: Lime Ridge Open Space, south of summit near power line area, 1 July 2005, *D. Gowen 471*.

Holotype: JEPS. Isotype: BRY.

Previously identified as *Eriastrum brandegeae* (JEPS 103961, UC 1784081). Sometimes has been treated in *E. hooveri*.

Annual herb, 1.5–20 (–25) cm tall. **Stems** not often branched, but if branched, generally branched above the base; some larger plants with 1 side branch from base; stems erect, racemose to corymbose, wiry, green, floccose, becoming reddish-brown and subglabrous in age; internodes to about 1.3 cm long. **Leaves** alternate, entire to pinnatifid, mostly ascending, older (lower) sometimes spreading, filiform, 9–29 mm long, green, but often with a darker reddish tip, becoming reddish-brown in age, younger leaves floccose, older leaves subglabrous, primary axis width about 0.5–0.75 mm, apex aristate; lower leaves entire, upper entire to 3-lobed, lateral lobes arising from proximal third of leaf, 2–7 mm long. **Inflorescence** capitate, with 1–21 or more heads; heads terminating branches, sometimes also present in axils below the terminal head, 5–7 mm long and 2–7 mm wide excluding the tips of the bracts, floccose, and somewhat densely so near the base, with about 3–9 flowers (axillary heads sometimes with only 1 flower). **Bracts** entire to pinnatifid, ascending, 5–19 mm long, the tips exceeding the calyces, green, tips sometimes reddish, floccose, more densely so near the base, glandular, apex aristate; entire to 3-lobed, the lateral lobes arising from proximal half of bract, 1.5–7.0 mm long. **Calyx** (4–) 5.5–6.25 (–7) mm long, sepals with a green tip, light green toward base, floccose, margins hyaline, apex aristate, the proximal two-thirds fused into a tube, lobes unequal to subequal, length difference within a flower 0.7 mm. **Corolla** narrowly funnelform, actinomorphic, sometimes appearing asymmetric due to interactions of the corolla lobes with the calyx lobes or bracts, (5–) 5.8–6.9 (–7) mm long, only the corolla lobes exserted from calyx, corolla sinuses sometimes proximal to calyx lobe tips; tube 2.9–3.4 mm long, about half of the total corolla length, white, glabrous inside; throat 0.8–1.3 mm long, nearly symmetric, white to cream; tube plus throat (3–) 3.7–4.7 (–5) mm long; lobes elliptic, tip acute to slightly cuspidate, not always spreading widely when open, 2.0–2.4 mm long, varying in length within a flower by 0.0–0.1 mm, about one third of the total corolla length, 0.9–1.2 mm wide, white to very pale blue, often with a few lavender streaks on or near veins. **Stamens** included 0.2 mm below sinus to exserted 0.5 mm above the sinus, 1.7 mm or more shorter than the lobes, attached 1.1–1.6 (–2) mm below the sinuses, the insertion distance varying within a flower by 0.0–0.2 mm; free portion (1.5–) 1.75–2.0 (–2.5) mm long, to base of corolla 4.0–4.9 mm long, equal to subequal, the length varying within a flower by 0.0–0.3 mm; filaments (1.25–) 1.3–1.9 (–2) mm long, the length varying within a flower by 0.1–0.3 (–0.6) mm, filaments straight, white to cream; anthers (0.3?–) 0.8 mm long, 0.5 mm wide, cream, broadly elliptic to slightly ovate, versatile, sagittate. Pollen cream-colored, average grain diameter 34 μm. **Pistil** 4–5 mm long, exserted or included about the same amount as the stamens, glabrous; stigma lobes (0.25–) 0.4–0.5 mm long; style (2.5–) 2.75–3 mm long; ovary 3-loculed, at anthesis about 1.5 mm long and 0.75 mm wide, with 9–14 ovules total, or 3–5 per locule. **Capsule** about 3–4 mm long, 1.25–2 mm wide, tan, with 2–4 seeds per locule. **Seeds** about 1.0–1.5 mm long, 0.7–1.0 mm wide, tan to light brown, angular (Fig. 57–62 [Color Plate 1]; Gowen 2013; S. De Groot, unpubl. data).

Identification.—The leaf primary axis of *E. ertterae* is about 0.5–0.75 mm wide, in contrast to the leaf primary axis of *E. rosamondense*, which is about 1 mm wide. The stamens of *E. rosamondense* are exserted 0.4–1.0 mm beyond the sinuses, while the stamens of *E. ertterae* are included or exserted up to 0.5 mm beyond the sinuses.

The corolla tube plus throat of *E. ertterae* is 3.7 mm long or longer, while in *E. hooveri* it is 3.6 mm long or shorter. The filaments of *E. ertterae* are 1.3 mm long or longer, but the filaments of *E. hooveri* are 1.3 mm long or shorter.

Most plants of *E. ertterae* have more than one ovule per locule—if one locule has only one ovule, other locules in that ovary will usually have two or more ovules. In contrast, locules of *E. tracyi* have only one ovule each—if one locule has more than one ovule, other locules in that ovary will have only one ovule each. Further, bracts of *E. ertterae* are usually 1–3-lobed, while bracts of *E. tracyi* are often 3–5-lobed.

Eriastrum sparsiflorum is noticeably glandular along the upper stems, while *E. ertterae* is not. Corollas of *E. ertterae* are usually smaller (<7 mm long) than corollas of *E. signatum* (7 mm or longer). Stamens are generally more exserted in *E. signatum* (0.8 mm or more) than in *E. ertterae* (0.5 mm or less), and the style of *E. signatum* is longer (>3 mm) than the style of *E. ertterae* (3 mm or less).

Eriastrum ertterae approaches the range of *E. calocyanum*. These species are easily distinguished by corolla color—*E. ertterae* is mostly white to pale blue, while *E. calocyanum* has bright blue lobes, usually with darker spots at the bases. Furthermore, the corollas of *E. ertterae* are usually less than 7 mm long, while the corollas of *E. calocyanum* are 7.8 mm long or longer.

Phenology.—Flowering around mid-June. Fruiting June-July.

Distribution.—California endemic (Contra Costa County); San Francisco Bay area (northwest Mount Diablo; Fig. 222).

Habitat.—*Eriastrum ertterae* is found from about 190 to 280 m (625–920 ft) in elevation, often on old dirt roads or firebreaks or in other open, mostly bare areas. The slope is nearly flat, to about 6°, and most aspects have been observed. The substrate is usually sand or sandstone, but may contain some carbonates. Surrounding vegetation may be chaparral or oak woodland, and at least one site was found in the transition area between these two types.

Population dynamics.—Population sizes from about 50 to over 200 plants have been documented. Plants occur in small patches, which are usually restricted to open areas. Sometimes a few other annuals are mixed in but usually are not very dense.

Threats.—The total known area containing populations of this species is about 350 hectares (1.3 square miles). Although plants are protected on an open space preserve, the preserve is owned by two cities (Concord and Walnut Creek) and mostly surrounded by urban development, leaving little opportunity for range expansion. If this area is ever developed, this species easily could be extirpated. Currently, it is known from two sites (Fig. 222).

Conservation.—Global Rank: G1; National Rank: USA (N1); Subnational/State Rank: California (S1); California Rare Plant Rank: 1B.1 (CNPS 2013; NatureServe 2013; Table 2).

Given the small range size and proximity to urban development, this species perhaps should be considered for listing under the Endangered Species Act. It would be useful to search potential habitat in the vicinity for additional populations.

Etymology.—Named for Barbara Ertter, prolific collector and botanist in the San Francisco Bay area and around the western United States (Gowen 2013).

Common name.—Ertter's woolly-star.

Discussion.—Neither Mason (1945) nor Harrison (1959) cited any specimens from Contra Costa County under *E. hooveri* or *E. brandegeae*. Apparently this taxon was first collected in the late 1990s.

7. ERIASTRUM FILIFOLIUM (Nuttall) Wooton and Standley 1913, *Contr. U.S. Natl. Herb.* Vol. 16 part 4 p. 160.

Basionym: *Gilia* (sect. *Collomioides*) *filifolia* Nuttall 1848*a*, *Proc. Acad. Natl. Sci. Philadelphia* 4: 11. Nuttall 1848*b*, *Journal Acad. Natl. Sci. Philadelphia* ser. 2 vol. 1 part 2: 156.

Type: "Hab. Near Santa Barbara, Upper California." No specimen cited.

Lectotype: USA, California, Santa Barbara County: Santa Barbara, *Nuttall*, ca. April 1836.

Lectotype, designated here: BM 939575!. Isolectotypes: K 196237! (Herb. Hook.), GH 303681!, NY 336835 (image!). Photo of K 196237: POM 188265! Possible isolectotype: GH 303682!

≡*Gilia* (sect. *Collomioides*) *filifolia* Nuttall 1848*a* (Mar/Apr), *Proc. Acad. Natl. Sci. Philadelphia* 4: 11. Nuttall 1848*b* (Aug), *Journal Acad. Natl. Sci. Philadelphia* ser. 2 vol. 1 part 2: 156 (See also Reveal and Spevak 1967, *Taxon* 16: 407–414). A. Gray 1870, *Proc. Amer. Acad. Arts Sciences* 8: 272.

≡*Navarretia filifolia* (Nuttall) Kuntze 1891, Revisio Generum Plantarum. Pars II. p. 433.

≡*Gilia virgata* Steudel var. *filifolia* (Nuttall) Milliken 1904, *Univ. Calif. Publ. Bot.* Vol. 2: 39.

≡*Navarretia filifolia* (Nuttall) Brand subsp. *eu-filifolia* Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 167.

≡*Eriastrum filifolium* (Nuttall) Wooton & Standley 1913, *Contr. U.S. Natl. Herb.* Vol. 16 part 4 p. 160. Mason 1945, *Madroño* 8(3): 84.

≡*Gilia floccosa* A. Gray var. *filifolia* (Nuttall) A. Nelson and J.F. Macbride 1916, *Bot. Gaz.* 61: 35.

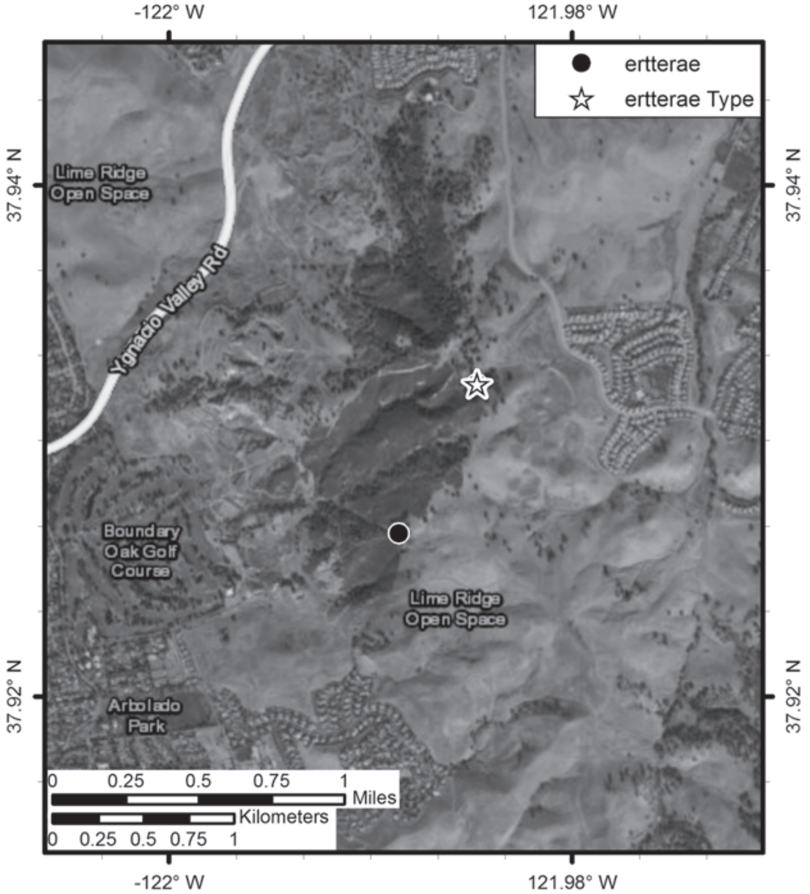


Fig. 222. Range map for *E. ertterae*, showing specimen locations and the type locality. Currently, *E. ertterae* is known from only two sites. The background image is an aerial photograph, with some streets and points of interest indicated. Note the scale of the map and the proximity of urban development.

≡*Welwitschia filifolia* (Nuttall) Rydberg 1917, Flora of the Rocky Mountains and Adjacent Plains, p. 688.

≡*Hugelia filifolia* (Nuttall) Jepson 1925, A Manual of the Flowering Plants of California, p. 792.

≡*Gilia filifolia* Nuttall var. *typica*. T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 421–423.

=*Hugelia curvifolia* Nuttall in herb. K 196238!, BM 939575!

=*Gilia curvifolia* Nuttall in herb. GH 303679!

≠*Gilia filiformis* Parry ex A. Gray 1875, *Proc. Amer. Acad. Arts Sciences* 10: 75. ≡*Navarretia filiformis* (Parry) Kuntze 1891, Revisio Generum Plantarum. Pars II. p. 433. ≡*Linanthus filiformis* (Parry ex A. Gray) J.M. Porter and L.A. Johnson 2000, *Aliso* 19(1): 82.

Annual herb, 3–40 (–45) cm tall, branched from the base or above, virgate, racemose, diffusely branched, sometimes nearly simple (Channel Islands plants tend to be more virgate). **Stems** erect to ascending, slender, and rigid, lightly floccose, becoming subglabrous below, green or tan, often becoming reddish-brown; internodes to 3 (rarely 4) cm long; small axillary buds sometimes present, can be confused with lateral leaf lobes. **Leaves** alternate, ascending to appressed, lower sometimes spreading or curling, entire to pinnatifid, filiform, (3–) 10–35 (–60) mm long, light green, becoming red-brown in age, lightly floccose to subglabrous, subulate or awn-tipped, tips sometimes becoming reddish; 1–5-lobed, lateral lobes arising from the proximal half of the leaf, lateral lobes about 1.5–12.5 mm long, filiform, needle-like and rigid. **Inflorescence** heads both axillary and terminal, few to several, frequently with fan-shaped agglomerations of several heads at the tips of branches, narrow and elongate, 5–9 mm long and 4–8 mm wide excluding the tips of bracts, corymbose and white-woolly at base, 3–15-flowered. **Bracts** pinnatifid, 7–20 mm long, lanate, green, ascending or with tips curling or spreading, tips protruding above wool and exceeding the flowers, sometimes reddish, acuminate to aristulate; usually with 3–5 lobes, occasionally entire (1-lobed), lateral lobes arising near the proximal end of the bract, lateral lobes 1–9 mm long. **Calyx** slender-cylindric, 6–10 mm long; sepals floccose, green, bordered by a hyaline membrane, which is fused about half of the total calyx length; lobes unequal, difference in length 1–4 mm, often with 2 long lobes and 3 shorter, tips green or reddish, acuminate to aristulate. **Corolla** actinomorphic (occasionally irregular due to interference of the calyx lobes or bracts), salverform to narrowly funnelform, 7–9 mm long, glabrous inside; tube 3.2–4.0 mm long, approximately equal to the length of the calyx, pale yellow to white; throat about 0.8–1.6 mm long, light yellow to white; tube plus throat 4.3–5.4 mm; lobes 2.5–3.6 mm long and 1.0–1.5 mm wide, differing in length within a flower by 0.0–0.2 mm, 34–42% of total corolla length, lanceolate to narrowly elliptic or strap-shaped (Channel Islands plants more broadly elliptic), tip rounded or truncate to subacute, light blue to royal blue or occasionally lavender, veins sometimes darker, sometimes white at the base, some populations with dark purple between blue lobes and white throat. **Stamens** exserted from the corolla throat, about 1.1–1.6 mm past the sinuses, attached about 0.8–1.3 mm below the sinuses; free portion about 2–3.5 mm long, to base of corolla 5.6–6.5 mm, equal (up to 0.3 mm difference in length); filaments 2–3 mm long, whitish to purplish; anthers 1.0–1.1 mm long, about 0.6–0.75 mm wide, white, sagittate, and versatile. Pollen white to gray,

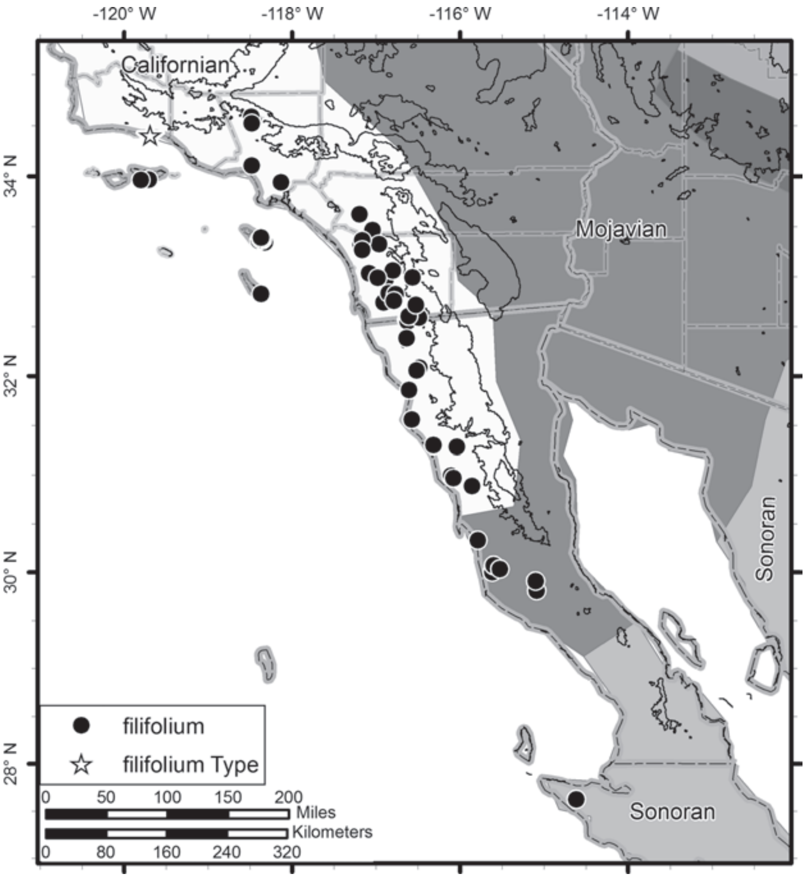


Fig. 249. Range map for *E. filifolium*, showing specimen locations and the type locality. Black lines are topographic contours (1000 m interval). McLaughlin's (2007) floristic regions are marked. Plants from the southern-most location, in Baja California Sur, look different than the others and may represent an undescribed taxon.

average grain diameter 30 µm, zonate aperture arrangement. **Pistil** at maturity exserted just beyond anthers, at least 4–7 mm long; stigma lobes 0.75 mm long; style 3–4 mm long, with 2–3- (rarely 4-) celled trichomes along the proximal 2/3; ovary long, cylindric, glabrous, and 3-loculed, with 3–6 ovules per locule. **Capsule** about 4–5 mm long and 1–1.5 mm wide; each locule with 3–5 (–6) seeds. **Seeds** about 1.4–1.7 mm long, 0.8–0.9 mm wide, tan to light brown, angular, sometimes with translucent, unfilled margins (Fig. 223–228 [Color Plate 6]; Nuttall 1848*a*: 11, 1848*b*: 156; Craig 1934*b*: 422; Harrison 1972: 17; S. De Groot, unpubl. data).

Identification.—Two unique features of *E. filifolium* are its thread-like leaves and bracts and its long-cylindric ovary.

Eriastrum filifolium is sometimes confused with *E. sapphirinum* subsp. *dasyanthum*, but can be distinguished by its smaller anthers (~1.1 mm or shorter), smaller corollas (9 mm long or less), and shorter stamen exsertion (1.6 mm or less). Anthers of subsp. *dasyanthum* are usually longer than 2 mm, it has corollas usually longer than 9 mm, and its stamens are exserted 2.3 mm or more. In addition, the pedicels of subsp. *dasyanthum* may be noticeably glandular, while those of *E. filifolium* are not.

Eriastrum signatum differs from *E. filifolium* in habitat, being found most often in pinyon-juniper woodland, while *E. filifolium* is found mostly in chaparral. Additionally, *E. filifolium* has 3–6 ovules per locule, while *E. signatum* has 3 or fewer (often 2); anthers of *E. filifolium* are usually 1 mm long or slightly longer, while anthers of *E. signatum* are usually 1 mm or shorter; and filaments of *E. filifolium* are usually 2–3 mm long while filaments of *E. signatum* are usually 1.0–2.2 mm long.

Stamens of *E. eremicum* are unequal (length difference >0.5 mm) while stamens of *E. filifolium* are equal (length difference ≤0.3 mm). Stamens of *E. diffusum* also are usually unequal. Anthers of *E. filifolium* are usually 1 mm long or more, while anthers of *E. diffusum* are usually 1 mm long or less. The style of *E. filifolium* is usually 4 mm long or less, while the style of *E. diffusum* is usually 4 mm long or more. The calyx of *E. filifolium* tends to be longer than the calyx of *E. diffusum*, while the corollas are about the same size. Additionally, *E. filifolium* tends to grow in cismontane areas, while *E. diffusum* is primarily transmontane.

Although the ranges of *E. filifolium* and *E. calocyanum* are peripatric, several morphological characters separate these species. *Eriastrum filifolium* has 3–6 ovules per locule, while *E. calocyanum* has only 1. The stamens of *E. filifolium* are mostly equal in length, while those of *E. calocyanum* are usually unequal to subequal. The corolla tube plus throat of *E. filifolium* is shorter (4.3–5.4 mm) in general than the corolla tube plus throat of *E. calocyanum* (5.2–6.6 mm).

While *E. filifolium* and *E. virgatum* both have royal blue corolla lobes, the corollas of *E. virgatum* are much larger (15–23 mm long) than the corollas of *E. filifolium* (7–9 mm). Moreover, the stamens are exserted much farther beyond the sinus in *E. virgatum* (4–10 mm) than in *E. filifolium* (1.1–1.6 mm).

Phenology.—Generally, flowering in April and May. Sometimes flowering as early as late March or as late as mid-June. Fruiting occurs approximately May–August.

Distribution.—Southern California and Baja California; South Coast, foothills of Peninsular Ranges, western Transverse Ranges, Channel Islands (Fig. 249). NatureServe (2013) reports this species to occur in California and Colorado, but nowhere in between. The Colorado report is probably an error based on specimens still identified as *Gilia filifolia* var. *diffusa* (= *E. diffusum*).

Habitat.—*Eriastrum filifolium* is found between about 35 and 940 m (115–3080 ft) in elevation, in wash bottoms, on flat benches above washes, in ditches, on slopes, ridge tops and saddles, on old dirt roads, or along maintained roads. At least two sites had burned the previous year, and additional sites were found in older burn areas. The slope may be flat to 32°, and all aspects except due south have been recorded. The substrate is usually fairly fine clay or sand, sometimes with adobe, loam, ash, or rock, and derived from granite, schist, volcanic rock, or alluvium. Surrounding vegetation may be chaparral, coastal chaparral, island chaparral, coastal sagebrush scrub, or grassland. At one site, plants may have been associated with cryptobiotic crust.

Population dynamics.—Population sizes of about 50 to over 1000 have been recorded. Population sizes may flucuate by at least one order of magnitude between years, e.g., one site that historically had several hundred plants had only 30 in a dry year. Plants tend to grow in patches in open areas between shrubs, and patch size can vary tremendously depending on the amount of space available. Patches have been noted to be scattered or frequent, and within patches plants are usually frequent.

Threats.—Small patch size means that habitat disturbance could easily extirpate a population. Also, *E. filifolium* occurs in cismontane areas, where habitat loss due to development is a threat. At some sites, vehicle use may impact populations. This species has been found in several burned areas and appears to do well following fire, perhaps due to reduced competition and increased nutrient resources.

Conservation.—Global rank: G4G5 – apparently secure. Considered but rejected for California rare plant ranking. Otherwise not ranked (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—From Latin *fili-*, thread-, and *–folius*, -leaved; alluding to the thread-like leaves and bracts.

Common name.—Thread-leaved woolly-star.

Discussion.—Based on BM 939575, K 196237, NY 336835, GH 303681 (original material of *filifolia*); K 196238, and GH 303679 (original material of *curvifolia*), the collector appears to be Thomas Nuttall. Nowhere on any of these specimens is Gambel named, but Nuttall is named on most of them, and sometimes named as the collector (e.g., GH 303681). While many plants described in "Plantae Gambelianae" where collected by Gambel, some were collected by Nuttall (McKelvey 1956; Brewer 1880).

Both Nuttall and Gambel collected in and near Santa Barbara, California (McKelvey 1956). Nuttall collected in Santa Barbara and its vicinity from later March to about mid-April 1836 (McKelvey 1956: 617; Pennell 1936: 38; Graustein 1967: 314), when *E. filifolium* would be in early flower. William Gambel had crossed overland to California in autumn 1841 and collected in California in the spring of 1842 (Pennell 1936: 43 says spring 1845, crossed in 1844). He may have been in Santa Barbara ca. April–May 1842 (McKelvey 1956: 737), when *E. filifolium* would have been in mid-late flower, and he did collect some plant specimens around Santa Barbara (e.g., *Apium graveolens* (Nuttall 1848*b*: 183) or *Collomia longiflora* (K!, "Nuttall from Gambell"). All specimens of original material of *G. filifolia* appear to be near the early side of flowering, consistent with a Nuttall collection in early April. The exact type locality was probably in or very near Santa Barbara (Jepson 1943).

After Nuttall's death, his personal herbarium went to the British Museum (BM; Pennell 1936: 44), and BM 939575 has the annotation "Herb. Thomas Nuttall."

Because Nuttall merely cited a location and not any specimens with the description, a lectotype should be designated for *G. filifolia* Nuttall. Of the available original material, BM 939575! is the best choice, because it matches the description and location given in the protologue, was in Nuttall's personal herbarium, and the original label was hand-written by Nuttall (compare handwriting with samples in Smith 1954–1956 and Burdet 1977).

A specimen at PH, 12218 (image!), collected by Nuttall in "R. Mts" was originally determined to be *Gilia diffusa*, and subsequently annotated *Gilia filifolia* Nutt. However, later annotations identify the plant as *Gilia pumila* Nutt., and this specimen probably corresponds to Nuttall's description and publication of *G. pumila*, where a Nuttall specimen from the Rocky Mountains is cited (Nuttall 1848*a*: 11; 1848*b*: 156). Therefore, PH 12218 has nothing to do with *G. filifolia*.

Plants seem to be larger and more abundant in areas that have been burned the previous year (S. De Groot, pers. obs.).

Most populations occur within the California Floristic Province (McLaughlin 2007), although a few southern ones creep into the semi-desert areas in Baja California. A population near La Bocana in Baja California resembles *E. calocyanum*, and more study is needed to determine the relationship between these species and the affinity of this population. Similarly, a specimen collected in Baja California Sur, in the Sonoran Floristic Region, looks different and additional sites should be sought in this area (Fig. 249).

8. ERIASTRUM HARWOODII (T.T. Craig) D. Gowen 2008, *Madroño* 55(1): 86–87.

Basionym: *Gilia filifolia* var. *Harwoodii* T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 424–425.

Type: USA, California, Riverside County: Blythe Junction, sandy desert, alt. 1200 ft., 2 Apr 1920, *P.A. Munz and R.D. Harwood 3589*.

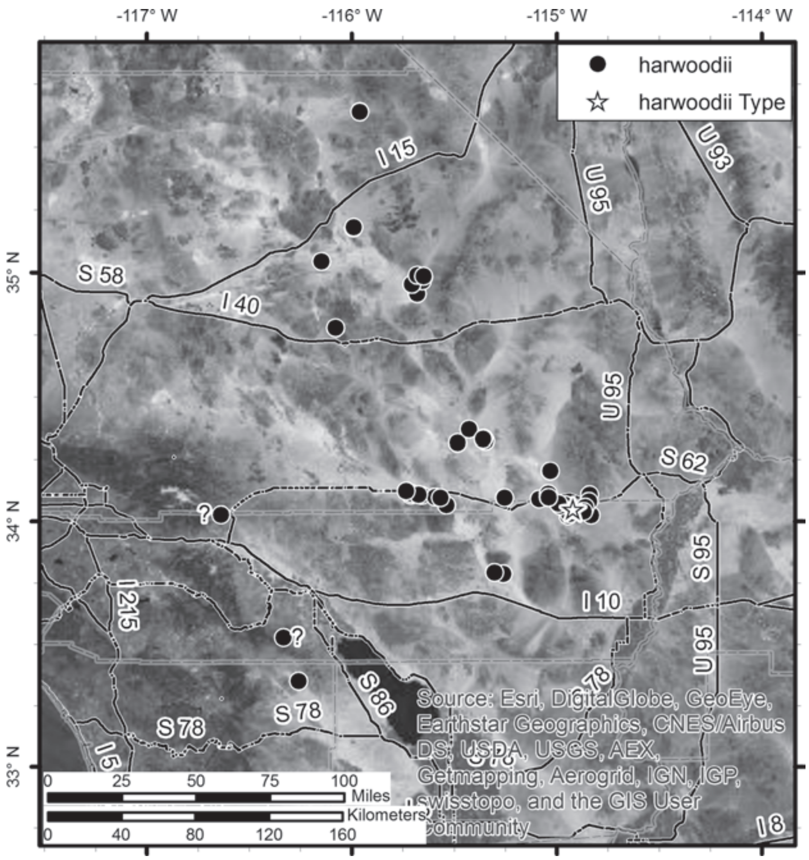
Holotype: POM 7622!. No known isotypes.

≡*Gilia filifolia* var. *Harwoodii* T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 424–425.

≡*Hugelia diffusa* (A. Gray) Jepson var. *harwoodii* (T.T. Craig) Jepson 1943, A Flora of California Vol. 3 Part II p. 167.

≡*Eriastrum diffusum* (A. Gray) H. Mason subsp. *Harwoodii* (T.T. Craig) H. Mason 1945, *Madroño* 8(3): 77–78.

≡*Eriastrum sparsiflorum* (Eastwood) H. Mason subsp. *Harwoodii* (T.T. Craig) H.K. Harrison 1968, *Phytomorphology* 18(3): 401.



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Fig. 250. Range map for *E. harwoodii*, showing specimen locations and the type locality. Question marks indicate questionable locations: the western-most locality (Mission Creek, *E.C. Jaeger s.n.* 2 Apr 1939) has no recent records; it is uncertain if *E. harwoodii* actually occurs there. Likewise, the site from southwest Riverside County (Pinon Alta Flats, Santa Rosa Mtns, *E.C. Jaeger s.n.* 4 May 1939) has no recent records and it is unknown if this species occurs in that area. Major highways are marked: I = Interstate, U = U.S. highway, S = California State highway. Dashed black and gray lines indicate county boundaries. The background is a satellite image.

Annual herb, erect, to 20.0 cm tall, mostly branched above the base, racemose, paniculate, or corymbose. **Stems** wiry, yellow-green to gray-green or tan or reddish, canescent-lanate, glabrate in age, internodes 1–2 cm long. **Leaves** alternate, entire to pinnatifid, ascending to spreading, 5–35 mm long; yellow-green to gray-green, canescent-lanate, aristulate; with 1–3 (occasionally 4–5) lobes, arising from the proximal third of the primary axis, subulate, awn-tipped (aristulate), lateral lobes 1–10 mm long. **Inflorescence** heads few to many, mostly terminal, or axillary, densely floccose, few-flowered (at a single given time), about 4–12 mm long and 3–8 (–11) mm broad excluding tips of bracts, with about 2–10 flowers per head (often about 5); up to 130 or more heads per plant, but often about 10–30. **Bracts** entire to pinnatifid, to 10–15 mm long, exceeding the heads, outer spreading, inner generally ascending, yellow-green to gray-green, densely floccose, tips light green to tan, aristulate; with 1–3 (occasionally 4–5) lobes, outer bracts with lobes arising from the proximal third of the primary axis, inner with lobes from the proximal half, lateral lobes 1–7 mm long. **Calyx** 5–8 (–9.25) mm long, sepals densely woolly, green, joined by a hyaline membrane, fused about half to 2/3 of the length, lobes unequal, length difference 1–2 (–3.25) mm, tips subulate. **Corolla** actinomorphic, narrowly funnelform, 6–8 mm long; tube about 4.0–4.5 mm long, white, glabrous inside; throat 0.75–1.00 mm long, yellow to white, symmetric to slightly asymmetric; tube + throat about 2/3 or a little more of corolla length, about 4.8–5.5 mm long; corolla lobes elliptic, 2.00–2.75 mm long and 1.0–1.5 mm broad, apiculate, pale yellow or cream to white; the lobes about 1/3 or a little less of the total corolla length. Bud color white to cream, base sometimes yellowish. **Stamens** exserted about 0.5–1.25 mm beyond the sinuses, attached about 0.25–0.75 mm below the sinus; free portion 1.0–1.5 mm long, to base of corolla about 5–6 mm long, subequal to equal, differing in length within a single flower by about 0.0–0.3 mm; filaments 0.75–1.00 mm long, white; anthers sagittate, versatile, 0.7–0.9 mm long, about 0.6 mm wide, white. Pollen white to gray, average grain diameter 24 µm, anomotreme to pantotreme aperture arrangement. **Pistil** 5.0–6.5 mm long, usually surpassing anthers by about 1 mm at anthesis; with a few to a fair number of 2–5-celled glandular or non-glandular trichomes at the tip of ovary and occasionally at the base of the style; stigma lobes 0.5–1.0 mm long, style 3.5–4.3 mm long, white, ovary at anthesis about 1.25–1.75 mm long and 0.75–1 mm wide. **Capsule** 3-loculed, about 3.6–4.7 mm long, 1.7–2.0 mm wide, tan, generally with 2–3 seeds per locule. **Seeds** 1.7–2.4 mm long, 0.8–1.0 mm wide, light gray-brown, sometimes angular, sometimes with an unfilled tip (Fig. 45–49 [Color Plate 1]; Craig 1934*a*, *b*: 424; Harrison 1972: 19, 21; S. De Groot, unpubl. data).

Identification.—The habitat type of semi-stabilized sand dunes is one of the easiest distinguishing characteristics of *E. harwoodii*.

Eriastrum diffusum might be confused with *E. harwoodii*, since both species are found in the desert and can have small, cream-colored flowers with short stamens and small anthers. However, *E. harwoodii* is found exclusively on sand, usually on semi-stabilized small dunes. *Eriastrum diffusum* is not usually found on sand dunes, although it often occurs in washes. When it is found on open, sandy soils, it tends to have a more spreading habit, while *E. harwoodii* is erect. Also, *E. harwoodii* usually has more wool on the upper stems, leaves, and inflorescences than *E. diffusum*. Bracts of *E. diffusum* tend to be shorter than those of *E. harwoodii*.

Corollas of *E. harwoodii* are small (8 mm long or less), and cream-colored. In contrast, corollas of *E. eremicum* or *E. pluriflorum* subsp. *albifaux* are at least 9.9 mm long, and usually white to blue, often with darker blue lines. The tube plus throat of *E. harwoodii* is 5.5 mm long or shorter, while the tube plus throat of *E. eremicum* or *E. pluriflorum* subsp. *albifaux* is at least 5.6 mm or longer. Stamens are exserted up to 1.25 mm past the sinus in *E. harwoodii* flowers, but exserted at least 2 mm in flowers of *E. eremicum* or *E. pluriflorum* subsp. *albifaux*.

Although the corollas of *E. harwoodii* are small (6–8 mm long), the corollas of *E. rosamondense* are smaller, with most plants having corollas 6 mm long or shorter. The length of the corolla tube plus throat is more discriminatory: *E. harwoodii* has a tube plus throat 4.8 mm or longer; corollas of *E. rosamondense* have a tube plus throat no greater than 4.5 mm.

Eriastrum sparsiflorum is noticeably glandular-hairy along the upper stems, while *E. harwoodii* is not obviously glandular-hairy. The filaments of *E. harwoodii* are mostly shorter (0.75–1 mm long) than the filaments of *E. signatum* (1.0–2.2 mm) or *E. sparsiflorum* (0.9–2.0 mm).

Phenology.—Flowering from about mid-March to mid-May, probably varying from year to year depending on weather conditions. Fruiting from late April through June.

Distribution.—Apparently a California endemic, but expected in southwestern Nevada; Mojave and Sonoran deserts (Fig. 250).

Habitat.—*Eriastrum harwoodii* occurs between about 130 and 1600 m (430–5250 ft) in elevation, exclusively on semi-stabilized sand dunes, sandy hummocks, or sand ramps. Plants are usually found in open sand between shrubs, and often in small depressions between dunelets. The slope may be flat to 18°, and most aspects have been documented. The substrate always includes fine, loose, aeolian sand, usually light-colored, and sometimes with some mixed alluvium. Surrounding vegetation is usually creosote bush scrub and typical sand dune plants such as *Oenothera deltoides* or *Abronia villosa*. One site also had some *Atriplex canescens*.

Population dynamics.—Population sizes from about 100 to over 3000 plants have been recorded. Plants may be widely scattered, frequent, or abundant, and often occur in patches in open areas.

Threats.—The primary threat to *E. harwoodii* is habitat destruction by vehicles or solar development. Mining for sand might also pose a threat. Since *E. harwoodii* is found exclusively on sand dunes and has very narrow habitat requirements, the loss of habitat could mean extirpation for a population. In some areas, non-native plants may out-compete and crowd out *E. harwoodii* (see CNPS 2013).

Conservation.—Global Rank: G3 – vulnerable; Subnational/State Rank: California (S3 – vulnerable); California Rare Plant Rank: 1B.2 (rare, somewhat threatened); Other status: BLM – S – Sensitive; otherwise not ranked or listed (CNPS 2013; CNDDB 2013; NatureServe 2013; Table 2).

Etymology.—The specific epithet is presumably for Robert Daniel Harwood (1899–1984), associate collector of the type. He served as an assistant in botany at Pomona College 1919–1920, and received an A.B. from Pomona College in 1920. Presumably he had accompanied Philip Munz as a field assistant on the trip when the type was collected. He went on to obtain a Ph.D in entomology from Cornell in 1928, then a professorship at San Diego State University (Harvard University Index of Botanists [*http://kiki.huh.harvard.edu/databases/botanist_index.html*]; “Del Sudoeste” yearbook from San Diego State College [now university] 1954, 1956, 1961, available at *library.sdsu.edu*).

Common name.—Harwood’s woolly-star.

Discussion.—Blythe Junction is an old name for Rice, in Riverside County (Durham 1998).

Flowers are open from about 9 a.m. to 4 or 5 p.m. (S. De Groot, pers. obs.; De Groot 2009). Many plants seem to lean east, perhaps from the prevailing wind (De Groot 2009). At one site, plants had a lot of herbivory from a small grasshopper species, with some plants almost completely defoliated (S. De Groot, pers. obs.).

Two locations of *E. harwoodii* specimens are questionable (Fig. 250), because the habitat at these sites appears to be rocky washes or slopes and quite different from the usual semi-stabilized sand dunes where this species is typically found. In addition, each site is represented by a single E. C. Jaeger collection from 1939, and apparently no recent specimens.

9. ERIASTRUM HOOVERI (Jepson) H. Mason 1945, *Madroño* 8(3): 89.

Basionym: *Hugelia hooveri* Jepson 1943, A Flora of California Vol. 3 Part II p. 167.

Type: USA, California, Kern County: 7 miles south of Shafter, 11 Apr 1937, *Hoover 1846*.

Holotype: JEPS 2636 (image!); isotypes: RSA 76506!, JEPS 9640 (image!), UC 908103 (image!).

Previously this species included plants from the southwestern Mojave Desert now treated in *E. rosamondense*. At times, it included plants from Contra Costa County now treated in *E. ertterae*.

Annual herb, 2–15 cm tall. **Stems** from base or above, erect to ascending, corymbose, racemose, virgate, or paniculate, lateral branches sometimes overtopping the primary axis; slender, wiry, young (upper) stems and leaves often wilting rather promptly, older (lower) stems reddish to brownish or tan, younger (upper) stems green; lightly floccose to subglabrate; internodes 0.5–3.0 cm long. **Leaves** alternate, entire to pinnatifid, ascending, lower (older) leaves or tips sometimes spreading, 3–25 mm long, green, becoming reddish-brown in age, lightly floccose to subglabrate, linear to filiform, sometimes curling or twisting in age, apex acute to aristate; entire or 3-lobed, lateral lobes about 1–6 mm long, usually arising from lower 1/3 of the leaf primary axis. **Inflorescence** capitate, heads 1 to a few, terminal, usually 1 per branch but occasionally some axillary heads also present in large plants, if so, arrangement usually racemose; heads 5–7 mm long and 4–5 mm wide excluding the tips of the bracts, lightly floccose to floccose, 2–8-flowered. **Bracts** entire to pinnatifid, ascending, tips often curling outward, 4–16 mm long, tips exceeding the heads, green, sometimes reddish at tips, lightly floccose to floccose, at least at the base, apex aristate; entire to 3-lobed (rarely 4 or 5), lobes generally arising from the lower third of the primary axis in outer bracts, and from the lower half in inner bracts, lateral lobes about 1–6 mm long. **Calyx** 4.0–7.6 mm long, sepals lightly floccose to floccose, light green, darker green or reddish at tips, apices aristate, joined by a hyaline membrane, the proximal third to two-thirds fused into a tube

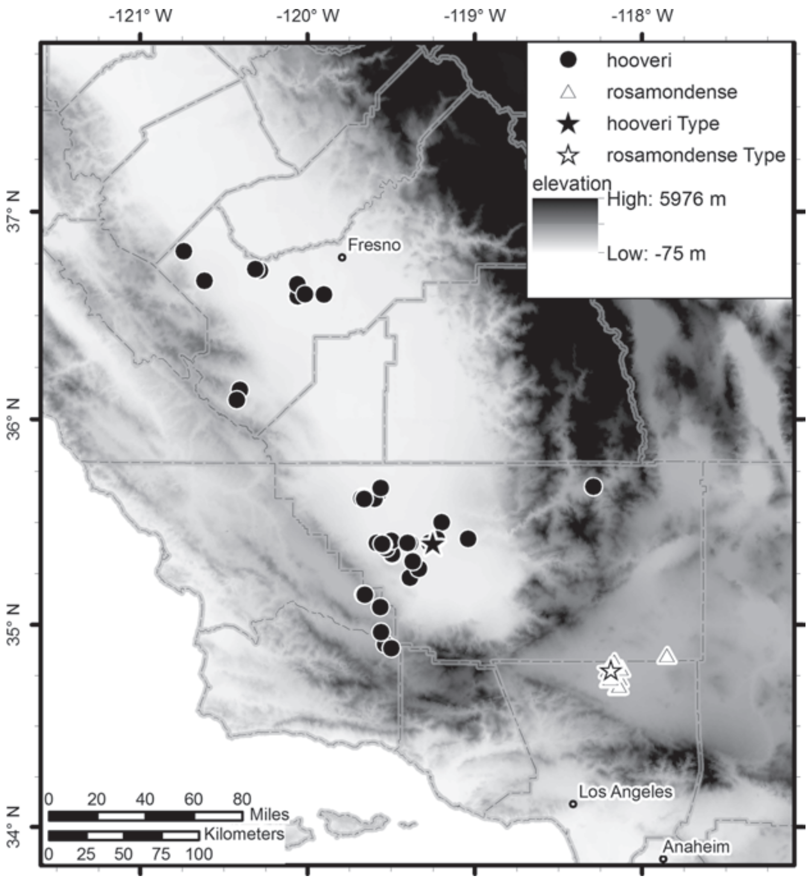


Fig. 251. Range map for *E. hooveri* and *E. rosamondense*, showing specimen locations. Major cities and county lines are indicated. The background shows elevation. Notice these two species are found on opposite sides of the Tehachapi Mountains.

(although the tube is often half of the total calyx length or less), lobes unequal, differing in length within a flower by 0.9–2.2 mm. **Corolla** funnelform to occasionally subsalverform, actinomorphic, 4.2–6.0 mm long, generally longer than the shortest calyx lobes, but shorter than the longest; tube 2.0–2.8 mm long, about half of the total corolla length, white to cream; throat (0.3–) 0.5–0.9 (–1.0) mm long, white to cream, sometimes pale yellowish; tube plus throat 2.6–3.6 mm long; lobes obovate to elliptic, sometimes spatulate, mostly ascending, spreading in older flowers, 1.3–2.5 mm long, lobes varying in length by 0–0.5 mm, about one third of the total corolla length, 0.6–1.0 mm wide, tip rounded, acute to subacute, or sometimes cuspidate, white, translucent, or transparent. **Stamens** included 0.4 below the sinus to exserted 0.1 mm above, attached 0.8–1.7 mm below the sinus, the insertion distance varying by 0.1–0.4 mm; free portion 1.0–1.25 mm long, to base of corolla 2.5–3.4 mm long, equal to subequal, the length varying within a single flower by 0.1–0.3 mm; filaments 0.75–1.3 mm long, differing in length by 0–0.2 mm, white to cream; anthers 0.5–0.7 mm long, about 0.5–0.7 mm wide, white to cream, broadly sagittate-cordate, versatile. Pollen white to cream, average grain diameter 23 µm. **Pistil** 2.6–4.8 mm long, equal in length to the stamens to 2 mm longer, with a few short trichomes at the tip of the ovary and the base of the style, or glabrous; stigma lobes 0.25–0.6 mm long, 3-branched; style 0.7–2.0 mm long, white to cream; ovary 3-loculed, 1.0–2.3 (–3.6) mm long, 0.5–1.5 (–2.2) mm wide, with 3–6 ovules per locule. **Capsule** about 3–4 mm long, 1–2 mm wide, with 1–4 seeds per locule. **Seeds** mucilaginous when wetted, about 0.8–1.2 mm long, 0.5–0.7 mm wide, tan to light brown, often angular (Fig. 50–56 [Color Plate 1]; Harrison 1972: 25; Taylor and Davilla 1986; S. De Groot, unpubl. data).

Identification.—Characters that distinguish *E. hooveri* from *E. rosamondense* include a leaf primary axis 0.75 mm wide or less (*E. rosamondense* leaf primary axis is usually 0.75–1 mm wide), and anthers that are included or exserted to 0.1 mm beyond the sinuses (anthers exserted 0.4–1.0 mm in *E. rosamondense*).

The corolla tube plus throat of *E. ertterae* is 3.7 mm long or longer, while in *E. hooveri* it is 3.6 mm long or shorter. The filaments of *E. ertterae* are 1.3 mm long or longer, but the filaments of *E. hooveri* are 1.3 mm long or shorter.

Eriastrum sparsiflorum is noticeably glandular along the upper stems, while *E. hooveri* is not. Corollas of *E. hooveri* are usually smaller (≤6 mm long) than corollas of *E. signatum* (7 mm or longer) or *E. sparsiflorum* (6.5 mm or longer). Stamens are generally more exserted in *E. signatum* (0.8 mm or more) than in *E. hooveri* (0.1 mm or less), and the style of *E. signatum* is longer (>3 mm) than the style of *E. hooveri* (2 mm or less).

In the western and northern parts of its range, *E. hooveri* approaches the range of *E. calocyanum*. These species are easily distinguished by corolla color—*E. hooveri* is mostly white, while *E. calocyanum* has bright blue lobes, usually with darker spots at the bases. Furthermore, the corollas of *E. hooveri* are usually 6 mm long or less, while the corollas of *E. calocyanum* are 7.8 mm long or longer.

Phenology.—Flowering from late March into May, fruiting from about June to August (Taylor and Davila 1986).

Distribution.—California endemic; San Joaquin Valley, Southern Sierra Nevada foothills (Lake Isabella; Fig. 251).

Habitat.—*Eriastrum hooveri* subsp. *hooveri* occurs at elevations between about 45 and 810 m (150–2660 ft), but most sites are found below 305 m (1000 ft). It prefers open swales or barren mound tops in slightly undulating plains of alkali sink, flat banks above washes, or floodplains. The slope is usually flat to about 5°, and the aspect, if there is any, tends to be west- or southwest-facing. The substrate is a fine alkaline clay, fine granitic sand, or mixed alluvium. Surrounding vegetation may be sparse *Atriplex* scrub (mostly *Atriplex polycarpa*), or other arid or alkaline scrub, usually with some annual cover, and sometimes with some riparian vegetation mixed in (see Taylor and Davilla 1986). Plants may be mixed with other small annuals, such as *Crassula* sp. Plants may be associated with cryptobiotic crust (Taylor and Davilla 1986), although this association is probably more strongly correlated with the fact that areas of cryptobiotic crust usually have less cover of other plants (see Holmstead and Anderson 1998). It appears that *E. hooveri* does not compete well with other plants (Taylor and Davilla 1986) and may favor areas with crust simply because there is a lower density of other plants and therefore less competition (see also Hinshaw et al. 1998; Hinshaw 2003).

Population dynamics.—Population sizes from about 8 to 11,000 have been recorded (Taylor and Davilla 1986). Plants are usually found in patches in open areas between shrubs. Patches may be widely scattered, but within patches, plants are often frequent.

Threats.—Habitat loss due to agricultural or other development is one of the main threats. Most existing populations of *E. hooveri* are found on small parcels surrounded by agricultural fields or orchards. While some areas may be too small for cost-effective farming, others could be developed, either into agricultural areas, facilities to process agricultural run-off, or urban areas (Taylor and Davilla 1986). Habitat disturbance due to energy exploration and extraction is also a threat. Studies have shown that *E. hooveri* plants were negatively affected by surface disturbance associated with oil field development, although it appears to re-colonize disturbed areas fairly readily if conditions are favorable (Hinshaw et al. 1998; Holmstead and Anderson 1998; see also Bartel 1990). Off-highway vehicle use, trash dumping, or grazing may pose threats to some sites (Taylor and Davilla 1986; CNPS 2013).

Conservation.—These rankings probably include *E. rosamondense* from Antelope Valley, but not *E. ertterae*: Global Rank: G3 – vulnerable; U.S. Federal Status: listed 1990, de-listed 2003; National Rank: USA (N3 – vulnerable); Subnational/State Rank: California (S3 – vulnerable, somewhat threatened); California Rare Plant Rank: 4.2 (uncommon in CA, somewhat threatened); other status: USFS – S – Sensitive (Bartel 1990; Hinshaw 2003; CNPS 2013; CNDDB 2013; NatureServe 2013; Table 2).

This taxon was listed as threatened under the Endangered Species Act by the U.S. Fish and Wildlife Service in 1990 (Bartel 1990), but de-listed in 2003 because additional populations had been discovered, partly due to efforts following the publication of a multi-species recovery plan in 1998 ("Recovery Plan For Upland Species of the San Joaquin Valley, California"), and that the taxon appeared less affected by oil field development than previously thought (Hinshaw 2003). While this taxon does well with small amounts of disturbance, it is unknown if it will persist in areas of moderate to severe disturbance. It may be time for another survey of extant populations to determine the status of the species.

Etymology.—Probably named for Robert F. Hoover, the collector of the type specimen and author of *The Vascular Plants of San Luis Obispo County* (Hoover 1970). He was a professor at California Polytechnic University in San Luis Obispo and the namesake of the Hoover Herbarium (OBI; Hoover 1970).

Common name.—Hoover's woolly-star.

Discussion.—The stems of fruiting plants often break off near the soil surface, perhaps facilitating a "tumbleweed" sort of seed dispersal (Taylor and Davilla 1986).

10. ERIASTRUM LUTEUM (Bentham) H. Mason 1945, *Madroño* 8 (3): 81–84.

Basionym: *Hugelia lutea* Bentham 1833, *Edwards's Botanical Register* sub t. 1622.

Type: USA, California, *Douglas* in 1831 or 1832 (label: 1833).

Lectotype, designated here (possibly holotype): K 196245! (Herb. Benth.). Isolectotypes: K 196243! (Herb. Hook.), BM 939589!, P 643639 (image!), G-DC 135113 (image!), GH 303655!, PH 1071796 (image!), CGE 12401 (image!), UC 163780 (image!), BR 5269372 (image!).

≡*Hugelia lutea* Bentham 1833, *Edwards's Botanical Register* sub t. 1622.

≡*Gilia lutescens* Steudel 1840, Nomenclator botanicus. I. 684. Bentham, 1845, *in* De Candolle, Prodromus Systematis Naturalis Regni Vegetabilis. 9: 311. Gray 1878, Synoptical Flora of North America, Vol. II, Part 1, Gamopetalae after Compositae, p. 143. Macbride 1917, *Contr. Gray Herb.* NS Vol. 49 No. 3 p. 58.

≡*Navarretia lutescens* (Steudel) Kuntze 1891, Revisio Generum Plantarum, Pars II. p. 433.

≡*Navarretia lutea* (Bentham) Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 168.

The following as to type, not as to name:

≡(in part) *Gilia floccosa* A. Gray nom. illeg. (nom. superfl.). Gray 1870, *Proc. Amer. Acad. Arts Sciences* 8: 272. Originally was a replacement name for *Hugelia lutea* Bentham and was based on its type, *Douglas* in 1833.

≠*Gilia floccosa* A. Gray nom. illeg. (nom. superfl.). Gray 1878, Synoptical Flora of North America, Vol. II Part 1, Gamopetalae after Compositae. p. 143. Excluded *Hugelia lutea* Bentham and the original type (*Douglas* in 1833).

Lectotype (designated by Jepson 1943: 166–167): USA, Nevada, probably Washoe County: Truckee Desert, July 1867, *W.W. Bailey 914* (GH 303672!). No isolectotypes known.

=*Hugelia floccosa* Nuttall in herb. Cited in Jepson 1943, A Flora of California Vol. 3 Part II p. 165. See also Gray 1970, *Proc. Amer. Acad. Arts Sciences* 8: 272; Mason 1945, *Madroño* 8(3): 83.

≡*Navarretia floccosa* (A. Gray) Kuntze 1891, Revisio Generum Plantarum. Pars II. p. 433.

≡*Navarretia virgata* (Bentham) Brand subsp. *floccosa* (A. Gray) Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 168.

≡*Hugelia floccosa* (A. Gray) Howell 1903, A Flora of Northwest America. Vol. 1, Phanerogamae: 458.

≡*Gilia virgata* Steudel var. *floccosa* (A. Gray) Milliken 1904, *Univ. Calif. Publ. Bot.* Vol. 2: 40.

≡*Welwitschia floccosa* (A. Gray) Rydberg 1917, Flora of the Rocky Mountains and Adjacent Plains, p. 688.

≡*Hugelia virgata* Bentham var. *floccosa* (A. Gray) Jepson 1925, A Manual of the Flowering Plants of California, p. 793.

=*Hugelia filifolia* (Nuttall) Jepson var. *floccosa* (A. Gray) Jepson 1943, A Flora of California Vol. 3 Part II p. 166–167.

≠*Gilia lutea* Steudel 1840. Nomenclator botanicus, I. 684 (=*Leptosiphon luteus* Bentham).

Annual herb, 5–30 cm tall. **Stems** mostly branched above, erect, virgate, or racemose, or sometimes branched from the base, somewhat stout and stiff to wiry, lower stems and leaves often red brown or tan, upper stems greenish, stems glabrate to lightly floccose, more woolly in distal parts than proximal; internodes about 1.0–2.0 cm long, rarely 3 cm long; axillary buds well-developed or not (usually depending on size of plant). **Leaves** entire to pinnatifid, mostly ascending to spreading, sometimes appressed, 6–36 (–40) mm long, narrowly linear, upper leaves and bracts light green, lower leaves reddish, glabrate to densely floccose, becoming less floccose in age, apex subulate to aristate; entire to 3- (sometimes 5-) lobed, axillary bud sometimes mimicking leaf lobes, lateral lobes arising from the base or the proximal third of the leaf, spreading, (1–) 2–10 mm long. **Inflorescence** capitate, with 1–20 or more heads, mostly terminal on the main stem or on primary branches, axillary heads sometimes present in larger plants, then heads arranged racemosely or corymbosely, sometimes with several heads tightly aggregated at the tip of a stem; heads about 5–7 mm long, 3–10 (–15) mm wide, densely floccose-lanate with white wool, with 2–15 or more flowers (usually not more than 6 open at one time). **Bracts** pinnatifid, generally ascending, 5–15 mm long, outer bracts exceeding calyces, inner bracts approximately equal in length to calyces, bright green, lanate to floccose, generally densely so at the base, subglabrous to somewhat glandular near tips, tips often projecting beyond wool, apices aristate; mostly with 3 to 5 lobes, occasionally entire or 6–7-lobed, lateral lobes arising mostly from the base, although innermost bracts sometimes have lobes nearly halfway along the primary axis, lateral lobes about 1–7 mm long. **Calyx** 4.0–6.0 mm long, sepals bright green, densely floccose, mostly hidden in wool, margins hyaline, apices spine-tipped (aristate, or possibly aristulate), the proximal half to two-thirds fused to form a tube, lobes nearly equal to slightly unequal, differing in length by 0.3–1.5 mm. **Corolla** funnelform, actinomorphic or very slightly zygomorphic, 6.7–9.5 mm long, the tube and throat mostly included within the calyx (throat sometimes partly exserted), the lobes spreading distal to the calyx; tube 2.9–3.8 mm long, about as long as the lobes and slightly less than half of the total corolla length, white, cream, or occasionally pale yellowish, glabrous; throat 0.7–1.5 mm long, golden yellow; tube plus throat 3.9–5.0 mm long; lobes obovate to elliptic, tips rounded to acute, sometimes nearly cuspidate, 2.6–4.0 mm long, varying in length within a flower by 0.0–0.3 mm, about as long as the tube and slightly less than half (about 2/5) of the total corolla length, shorter than the tube plus the throat, 1.6–2.5 mm wide, golden yellow, often with red to brown spots at the base of the lobes or top of the throat (approximately even with sinuses), usually with a single large spot per lobe, but occasionally a few additional smaller spots, spots occasionally absent. Buds golden yellow. **Stamens** exserted 2.4–3.8 mm past the sinuses, 0.5 mm shorter than lobes to 0.5 mm longer, attached 0.9–1.6 mm below sinuses (about 1/4 of the length of the tube plus the throat), insertion distance varying within a flower by 0.0–0.5 mm; free portion 4.5–6.5 mm long, to base of corolla 6.0–8.7 mm long, equal to subequal, differing in length within a flower by 0.1–0.4 mm; filaments 3.3–5.5 mm long, differing in length within a flower by 0.1–0.5 mm, golden yellow, generally spreading fairly straight from throat, but tending to bend toward the center of the tube just before they diverge from the corolla, meeting up with each other and the style and more or less closing off a chamber below (presumably for nectar); anthers 2.0–2.5 mm long, 0.75 mm wide, pale yellow to cream or white (lighter on the edges, darker yellow in center near connective with filament), versatile, sagittate, filament attached about midway between base and tip. Pollen white to pale yellow, average grain diameter 22 μm, anomotreme aperture arrangement. **Pistil** about 8.5–10 mm long, exserted as far or a little farther than the stamens, with 3–6-celled glandular trichomes scattered along much of the length of the style, absent from the most distal end, occasionally a few hairs at the tip of the ovary; stigma lobes very short, often not apparent, 0.2–0.3 (–0.5?) mm long; style about 7.5–9 mm long, golden yellow; ovary at anthesis about 1 mm long, 0.75 mm wide, 3-loculed, with usually 1 or rarely 2 ovules per locule (if 2 ovules in one locule, other locules will have 1 ovule); nectary disk about 0.75 mm in diameter and 0.25 mm tall. **Capsule** 1.75–3.0 mm long, 1.15–2.0 mm wide, with 1 seed per locule (occasionally 0 or 2 seeds). **Seeds** 1.3–1.8 mm long, 0.8–0.9 mm wide, light brown, usually angular (Fig. 145, 229–233 [Color Plate 6]; Bentham 1833 t. 1622; Bentham 1845: 311; Craig 1934*b*: 413; Harrison 1972: 11; S. De Groot, unpubl. data).

Identification.—Bright golden yellow flowers and exserted stamens distinguish *E. luteum* from all other species of *Eriastrum*. Although flowers of *E. harwoodii* or *E. diffusum* or *E. sparsiflorum* sometimes can be cream-colored, the stamens are exserted only up to 2.3 mm, while the stamens of *E. luteum* are exserted 2.4 mm or more.

Some flowers of *E. sapphirinum* (particularly subspp. *dasyanthum* or *brevibracteatum*) can be yellowish, mostly on the outside of the petals. However, even these flowers are not as bright yellow as flowers of *E. luteum*, and corollas of these subspecies of *E. sapphirinum* tend to be larger (7–14 mm long) with longer lobes (>3.5 mm) than *E. luteum* (corolla 6.7–9.5 mm long, lobes 2.6–4.5 mm). The peduncle of *E. luteum* is not obviously glandular, but usually is glandular in subspecies of *E. sapphirinum*. The outer bract axis and lobes of *E. luteum* are linear or filiform and exceeding the head; the outer bract axis and lobes of *E. sapphirinum* subsp. *brevibracteatum* are broader than linear, at least at the base, and mostly not exceeding the head in typical forms.

Phenology.—Flowering from about mid-May through about mid-June. Fruiting June–July.

Distribution.—California endemic (Monterey, San Luis Obispo Counties); outer South Coast Ranges (Santa Lucia Mountains; Fig. 106).

Habitat.—*Eriastrum luteum* is found at elevations between about 240 and 580 m (800–1900 ft), in open, more barren areas on gentle slopes. Recorded slopes vary from 10 to 16°, and aspects have been west- or south-facing. The substrate is usually coarse sand or gravel, derived from granite or sandstone, and may have some amount of shale or loam. Surrounding vegetation is usually grassland or oak savannah or woodland. At some sites, plants were mixed with other annuals. At two sites, plants appeared to be associated with cryptobiotic crust.

Population dynamics.—Population sizes from about 300 to at least 3000 plants have been recorded. Plants are usually found in patches in open areas, where they may be frequent or locally common.

Threats.—Most known sites of *E. luteum* are on private land (Fig. 106), and many sites are historic records that have not been relocated recently: of 24 records in the CNDDB (CNDDB 2013), only 2 have been seen in the last 20 years. One or more populations probably were lost when the

San Antonio Reservoir was constructed and filled. Another threat is habitat loss through agricultural development. However, several populations occur on Fort Hunter Liggett Military Reservation and are afforded some protection there.

Conservation.—Global Rank: G2 – imperiled; National Rank: USA (N2 – imperiled); Subnational/State Rank: California (S2.2 – imperiled, somewhat threatened); California Rare Plant Rank: 1B.2 (rare, threatened, or endangered in CA; somewhat threatened), other status: BLM – S – Sensitive, USFS – S – Sensitive (CNPS 2013; CNDDB 2013; NatureServe 2013; Table 2).

Etymology.—Latin *luteus*, yellow; referring to the color of the corolla (which really is yellow, no matter what dried specimens might suggest or what Asa Gray believed to be true). The epithet *floccosa* is from Latin *floccosus*, floccose, with tufts of soft hairs, or having matted woolly hairs.

Common names.—Yellow woolly-star, golden woolly-star.

Discussion.—Although some past treatments of *Eriastrum* recognized *Gilia floccosa* as a wide-spread blue-flowered taxon, it is here treated as a synonym of *E. luteum*. Because both *Hugelia lutea* and *Gilia floccosa* are based on the same type (*Douglas* in 1833), and *H. lutea* is the older name (i.e., has priority), *G. floccosa* is a superfluous name and therefore illegitimate (see further discussion in the Introduction; Mason 1945: 82–84). Many plants now recognized as distinct species were at one time included in *Gilia floccosa*, and the best practice upon encountering a specimen identified only as "*Gilia floccosa*" is to re-identify it.

During the spring of 1831, David Douglas traveled from Monterey to Santa Barbara, probably via El Camino Real. His route included the Mission San Antonio de Padua, about 6 miles northwest of modern-day Jolon. There are a number of sites of *E. luteum* in this area, and it seems probable that the type specimen was collected near here, probably in late May or early June as Douglas returned to Monterey (McKelvey 1956; Harvey 1947).

11. ERIASTRUM PLURIFLORUM (A. Heller) H. Mason 1945, *Madroño* 8(3): 75.

Type: *Eriastrum pluriflorum* subsp. *pluriflorum*.

≡*Gilia virgata* Steudl. var. *floribunda* A. Gray 1870, *Proc. Amer. Acad. Arts Sciences* 8: 272.

≡*Gilia pluriflora* A.A. Heller 1906, *Muhlenbergia* 2(1): 113. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 414–415.

≡*Navarretia virgata* (Bentham) Brand [subsp. *floccosa* (A. Gray) Brand] var. *floribunda* (A. Gray) Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 168.

=(as to name; possibly in part) *Navarretia virgata* (Bentham) Brand var. *floribunda* (A. Gray) Brand 1913, *Annuaire Conserv. Jard. Bot. Genève*, vol. XV et XVI, p. 340.

=(in part) *Navarretia densifolia* (Bentham) Brand 1913, *Annuaire Conserv. Jard. Bot. Genève*, vol. XV et XVI, p. 340.

≡*Gilia brauntonii* Jepson & H. Mason. Jepson 1924, A Flora of the Economic Plants of California, p. 130.

≡*Hugelia brauntonii* Jepson & H. Mason. Jepson 1925, A Manual of the Flowering Plants of California, p. 793.

≡*Hugelia pluriflora* (A. Heller) Ewan 1937, *Bull. Torrey Bot. Club* 64: 520–521. Jepson 1943, A Flora of California Vol. 3 Part II p. 163. Here includes *Gilia sherman-hoytae* T.T. Craig.

≡*Eriastrum pleuriflorum* (A. Heller) H. Mason. J.M. Porter and L.A. Johnson 2000, *Aliso* 19(1): 74. The spelling of the specific epithet here is treated as an error to be corrected.

≠*Gilia floribunda* A. Gray 1870, *Proc. Amer. Acad. Arts Sciences* 8: 267. =*Navarretia floribunda* (A. Gray) Kuntze 1891, Revisio Generum Plantarum. Pars II. p. 433.

Annual herb, occasionally persisting into autumn, 2–40 (–45) cm tall, up to 50 cm wide, erect, branched from the base or above, sometimes caespitose or spreading; unbranched, virgate, racemose, or corymbose. **Stems** slender to stout, upper stems floccose to subglabrous, light green to green, lower stems often becoming subglabrous, reddish-brown or tan; internodes 0.7–6.5 cm long, commonly 1–2 cm, sometimes shorter near the heads or in caespitose plants. Stems sometimes becoming nearly woody at the base in plants that persist into autumn. **Leaves** alternate, pinnatifid, ascending to spreading, 6–40 (–50?) mm long, light green to green, sometimes tips or older leaves darker purplish, reddish-brown, or tan, floccose to subglabrous, apex subulate to aristulate; with 1–13 pinnate, filiform to linear lobes arising along the length of the primary axis or from proximal half, often with several lobes clustered near the base of the leaf, lobes sometimes broken off in the oldest leaves; lateral lobes 2–15 mm long, sometimes reduced to teeth, spreading, subulate; rarely some leaves may be bipinnate. **Inflorescence** heads 1–20 or more, terminating the branches, rarely axillary, 6–15 mm long, 4–25 mm broad excluding the tips of the bracts, with bracts and flowers to 4 cm wide, lanate to densely floccose, about 2–50-flowered but sometimes only 1 flower is open at a given time. **Bracts** pinnatifid, ascending to spreading, 4–23 mm long, exceeding the heads, green, tips often reddish or tan, floccose at base, subglabrous distally, sometimes markedly glandular, with 1–11 filiform spreading lobes, lobes arising mostly from the proximal half or along the length of the primary axis, but usually more dense near the base of the bract, the lateral lobes of the inner bracts sometimes arising nearer to the distal end, 1–10 (–12) mm long, tips subulate to aristulate. **Calyx** 4.5–10 mm long, sepals floccose to densely floccose, sometimes slightly glandular, costae green to light green, apex reddish and aristulate or acuminate; hyaline margins fused about half the length of the calyx, or about 3–4 mm, the length of the fused portion sometimes variable within a single calyx; lobes unequal, differing in length within a single flower by 0.5–2 mm, often with 2 long lobes and 3 short. **Corolla** well exserted from the calyx, 9.9–20.0 (–23.5) mm long, actinomorphic, salverform to narrowly funnelform; tube slender, 4.2–9.3 mm long and 1.00–1.25 mm wide, white to purple, blue, or reddish, sometimes drying yellowish, puberulent inside with projections from epidermal cells; throat 0.6–2.8 mm long, white, cream, pale or bright yellow, sometimes with pale yellow spots inside, sometimes bell-shaped and conspicuously wider than the tube; tube plus throat 5.6–18.0 mm long; lobes (2.0–) 3.6–6.5 (–7) mm long, differing in length within a flower by 0.0–0.5 mm, 27–47% of total corolla length, 1.1–3.0 (–4) mm wide, narrowly to widely elliptic, oblanceolate, strap-shaped, or obovate, tip acute, obtuse, or rounded, white to blue to lavender or blue-purple, with veins often marked by darker lines, occasionally with a few darker streaks at the base. **Stamens** exserted about 2.1–5 (–6) mm past the sinuses, but equal to or shorter than the lobes, attached 0.05–1.2 mm below the sinuses, insertion distance differing within a flower by up to 0.8 mm; free portion about (2–) 2.5–6.5 mm long, to base of corolla 6.5–14.3 mm long, equal to subequal, differing in length within a single flower by 0.1–3.2 mm; filaments 0.6–4.4 mm long, white to blue or purple; anthers 1.0–2.5 mm long, about 1.0 mm wide, oblong, sagittate, versatile, white, cream, yellow, pale blue, or purple. Pollen white, blue, lavender, or gray, average grain diameter 27–30 μm, possibly a pantotreme aperture arrangement. **Pistil** at maturity generally exserted beyond the stamens, length about 8.5–18 mm, occasionally glabrous or with sparse to dense 2–6-celled trichomes at tip of ovary and sometimes on the base of the style; stigma lobes 0.3–1.0 mm long, often white; style 6.5–16 mm long, white to lavender or pale blue; ovary at anthesis about 1.0–1.5 mm long, 0.5–

1 mm wide, 3-loculed, each with 1–6 ovules. **Capsule** about 2–5 mm long, 1–1.5 mm wide. **Seeds** about 1.2–2.8 mm long, 0.6–1.0 mm wide, tan or gray-brown, angular to elliptic (Fig. 252–272 [Color Plate 7]).

Identification.—Corollas of all subspecies of *E. pluriflorum* are strictly actinomorphic.

Eriastrum pluriflorum can be distinguished from *E. densifolium* by its annual habit. *Eriastrum densifolium* is perennial, and usually woody at least at the base, in mature plants. *Eriastrum pluriflorum* can grow fairly large, and sometimes can live long enough to appear woody at the base, but does not have branches that have over-wintered, as *E. densifolium* does. Additionally, most anthers of *E. pluriflorum* are 2.5 mm long or shorter, while anthers of *E. densifolium* are 2 mm or longer, and in areas where the two species might be confused, *E. densifolium* anthers are usually 2.5 mm or longer.

Eriastrum virgatum has longer filaments (5 mm or longer) than *E. pluriflorum* (up to about 4.5 mm). Although the corollas are about the same length, the tube plus throat is longer in *E. pluriflorum* and its lobes are shorter. Stamens are inserted closer to the sinus in *E. pluriflorum*; stamens in *E. virgatum* are inserted about 0.9 mm or more below the sinus, while in *E. pluriflorum* subspp. *pluriflorum* and *sherman-hoytae* the stamens are inserted 0.75 mm or less below the sinus.

Eriastrum pluriflorum subspp. *pluriflorum* and *sherman-hoytae* both have corollas 12 mm long or longer, which differentiates them from most of the other smaller-flowered species of *Eriastrum* co-occurring in the same geographic areas: *E. tracyi*, *E. hooveri*, *E. signatum*, *E. calocyanum*, and *E. sparsiflorum* all have corollas 11 mm long or shorter. Most of this length difference is attributable to the length of the tube + throat: all of these species have a tube plus throat 7.6 mm long or shorter, while subspp. *pluriflorum* and *sherman-hoytae* have a tube plus throat 7.7 mm or longer.

While *E. signatum* tends to have fewer leaf lobes (1–3) than *E. pluriflorum* (3 or more), a better distinguishing character is stamen exsertion: stamens of *E. signatum* are exserted less than 1.5 mm beyond the corolla sinuses, while stamens of *E. pluriflorum* are exserted at least 2 mm. The anthers of *E. signatum* are mostly 1 mm long or shorter, while the anthers of *E. pluriflorum* are generally 1 mm or longer.

Corollas of *E. pluriflorum* are actinomorphic and have equal sinuses, in contrast to the medially zygomorphic corollas of *E. eremicum* and their unequal sinuses.

While *E. pluriflorum* corolla throats may be pale to golden yellow, the lobes are always blue, lavender, purplish, pale blue, or white, not yellow. In contrast, *Eriastrum luteum* corolla lobes and throats are always bright golden yellow.

The ranges of *E. pluriflorum* and *E. sapphirinum* are mostly non-overlapping, although they may abut each other in places. The main distinction between these two species is that *E. sapphirinum* is markedly glandular-pubescent on the upper stems, but *E. pluriflorum* is not. Leaves of *E. pluriflorum* usually have more lobes (>3) than leaves of *E. sapphirinum* (3 or fewer). The tube plus throat of the corolla is generally longer in *E. pluriflorum* than in *E. sapphirinum*.

Phenology.—Flowering possibly as early as mid-April, but mostly beginning in late April and continuing through July, possibly into August. Fruiting from about June through September.

Distribution.—California endemic; San Joaquin Valley, southern half of Sierra Nevada, South Coast Ranges, western Transverse Ranges, western Mojave Desert (Fig. 273).

Habitat.—*Eriastrum pluriflorum* in found at elevations from about 100 m to about 1830 m (330–6000 ft), in open, sunny areas mostly on slopes, hillsides, flat plains, in washes, on banks above washes, roadcuts, or old roads. At least one site had been recently burned. The slope varies from flat to 36°, and most aspects have been recorded (except perhaps northwest-facing). The substrate is silt, clay, sand, gravel, or loam, sometimes with some rock, and derived from granite, sandstone, serpentine, mixed alluvium, basalt, or various volcanics. At some sites, the soil may be slightly alkaline. Surrounding vegetation may be grassland, arid or alkaline scrub, desert scrub, juniper shrubland or savannah, chaparral, mixed forest, or combinations of two or more of these types. At one site, plants were found in an ecotone between two vegetation types.

Population dynamics.—Population sizes from 12 to over 1,000,000 have been recorded. Plants may be localized or not, and have been observed to be rare, scattered, patchy, frequent, common, or abundant.

Threats.—Competition from non-native plants, road maintenance, development, overgrazing, or off-highway vehicle use.

Conservation.—Global rank: G3? – vulnerable; otherwise not ranked (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—The specific epithet is from Latin *plur-*, several or many, and *florum*, the genitive plural form of *flos*, flower: “of many flowers.” The epithet *floribunda* is from Latin *florere*, to flower, and *–bundus*, which indicates doing, or action accomplished: literally, “flowering” or “full of flowers.” The epithet *brauntonii* honors Ernest Braunton (1867–1945), a landscape architect and horticultural consultant in the Los Angeles area (Anonymous 1945). He authored *The Garden Beautiful in California* (Braunton 1940), a manual for home gardeners.

Common name.—Many-flowered woolly-star.

Discussion.—When A.A. Heller (1906: 113) made the combination *Gilia pluriflora* A. Heller, he cited two specimens: “No. 7734, collected April 20, at Sunset, Kern county, on dry gravelly hills, abundant” and “No. 7742, collected April 22, at Oil City, Kern county, in sand.” While some authors assumed these were syntypes, Heller was simply enumerating the collections from the field season of 1905. Presumably while doing so, he decided that the entity which had been called *Gilia virgata* Steudl. var. *floribunda* A. Gray was better treated as a separate species, rather than a variety of *G. virgata*. Since the epithet *floribunda* was already in use at the species rank in the genus *Gilia*, Heller created a new name, *pluriflora*, but it was based on *Gilia virgata* Steudl. var. *floribunda* A. Gray and on Gray’s type, since that basionym was cited immediately below Heller’s name. Therefore, *Heller 7734* and *7742* are not types. Further discussion of the type specimens of *E. pluriflorum* follows under subsp. *pluriflorum*.

Key to the Subspecies of E. pluriflorum

1. Corolla tube + throat length is less than twice the length of the lobes; throat white; 2–6 ovules in each locule. . . . . .11B. subsp. **albifaux**

1' Corolla tube + throat length is equal to twice the length of the lobes or longer; throat white to yellow; 1–3 ovules in each locule
  2. Throat bright orange-yellow; lobes sky blue, lavender, or nearly white. . . . .11C. subsp. *sherman-hoytae*
  2' Throat white, purplish, or pale yellow; lobes royal blue to violet. . . . . .11A. subsp. *pluriflorum*

11A. ERIASTRUM PLURIFLORUM (A. Heller) H. Mason subsp. PLURIFLORUM. H. Mason 1945, *Madroño* 8(3): 75.

Basionym: *Gilia virgata* Steudl. var. *floribunda* A. Gray 1870, *Proc. Amer. Acad. Arts Sciences* 8: 272.

Type: "California, Fitch, Wallace, Brewer."

Lectotype (designated by Harrison 1972: 8): USA, California, Alameda County: top of very dry hill near Corral Hollow, 3 June 1862, *W. H. Brewer 1212*.

Lectotype (designated by Harrison 1972: 8): GH 78496!. Isolectotypes: K 545583!, K 545584!, UC 23883 (image!), UC 30166 (image!), YU 65401 (image!).

≡*Gilia virgata* Steudl. var. *floribunda* A. Gray 1870, *Proc. Amer. Acad. Arts Sciences* 8: 272.

≡*Gilia pluriflora* A. Heller 1906, *Muhlenbergia* 2(1): 113. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 414–415.

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≡*Hugelia pluriflora* (A. Heller) Ewan 1937, *Bull. Torrey Bot. Club* 64: 520–521. Here includes *Gilia sherman-hoytae* T.T. Craig.

≠*Gilia floribunda* A. Gray 1870, *Proc. Amer. Acad. Arts Sciences* 8: 267. =*Navarretia floribunda* (A. Gray) Kuntze 1891, Revisio Generum Plantarum. Pars II. p. 433.

Annual herb, 2–40 (–45) cm tall, up to 50 cm wide, erect; unbranched, virgate, racemose, or corymbose; usually branched above the base, sometimes with a few branches from the base; internodes 1–5 cm long, commonly 1–2 cm. Upper **stems** floccose to subglabrous, green, lower stems often becoming subglabrous, reddish-brown or tan. **Leaves** alternate, pinnatifid, mostly ascending, sometimes spreading, 9–30 (–50?) mm long, light green, sometimes tips or older leaves darker purplish, floccose to subglabrous, apex subulate to aristulate; with 3–11 (–12) pinnate, filiform lobes arising along the length of the primary axis, lobes frequently broken off in the oldest leaves, or very oldest leaves with 1–3 lobes; lateral lobes to about 12 mm long, spreading, subulate-tipped. **Inflorescence** heads densely floccose, terminating the branches, large, 6–15 mm long, 6–25 mm broad excluding tips of bracts, with bracts and flowers to 4 cm wide, 8–50-flowered but sometimes only 1 flower open at a given time. **Bracts** pinnatifid, ascending (inner) to spreading (outer), 4–23 mm long, exceeding the heads, green, tips reddish, floccose at base, subglabrous distally, with (1–) 3–11 filiform spreading lobes, on outer bracts the lobes arise from the proximal half of the primary axis, or along the length of the primary axis but with more lobes in the proximal half, on inner bracts the lobes arise about midway along the primary axis or sometimes more toward the distal end, 1–10 (–12) mm long, tips subulate to aristulate. **Calyx** 5–10 mm long, sepals densely floccose, green to light green, apex reddish and aristulate; joined by a hyaline membrane, fused portion about half the length of the calyx or a little less, about 3–4 mm long, sometimes varies within a single calyx, lobes unequal, differing in length within a single flower by 0.5–2 mm. **Corolla** well exserted from the calyx, exceeding the heads, (11–) 12.8–20.0 (–23.5) mm long, actinomorphic, salverform to very narrowly funnelform; tube long and slender, 7.3–9.3 mm long and 1.00–1.25 mm wide, white to purple, sometimes drying yellowish, puberulent inside; throat 1.1–2.8 mm long, white to pale or dull yellow; tube plus throat 8.5–18.0 mm long; lobes (2.0–) 3.8–6.5 mm long, differing in length within a flower by 0.0–0.3 mm, 27–35% of total corolla length, 1.1–2.5 mm wide, rarely to 3 mm wide, narrowly elliptic to oblanceolate to strap-shaped, tip acute or appearing so due to curling of petal margins, blue to lavender or blue-purple, with veins often marked by darker lines. **Stamens** attached in the throat, 0.05–0.40 mm below the sinuses, exserted past the sinuses about 2.3–4.5 (–6) mm, the longest stamen equalling the tip of the corolla lobe or nearly so (sometimes to 2.9 mm less); free portion about 3–5 mm long, to base of corolla 10.5–14.3 mm long, equal or subequal, differing in length within a single flower by 0.1–1.4 mm (often by 1 mm or less); filaments 1.2–4.0 mm long, white to blue or purple; anthers 1.25–2.5 mm long, 1.0 mm wide, sagittate, versatile, white, yellow or purple. Pollen lavender, average grain diameter 30 µm. **Pistil** at maturity generally exserted beyond stamens, length 12–18 mm; with 4–6-celled trichomes scattered to dense at tip of ovary and sometimes on the base of the style, sometimes subglabrous; possible abscission zone at the base of the style; stigma lobes 0.75–1.0 mm long; style 11–16 mm long, white to lavender or pale blue; ovary 3-loculed, each with 1–2 ovules. **Capsule** 4–5 mm long, 1–1.5 mm wide. **Seeds** about 1.9–2.8 mm long, 0.8–1.0 mm wide, tan, sometimes angular (Fig. 252–257, 270 [Color Plate 7]; Gray 1870: 272; Craig 1934*b*: 414; Harrison 1972: 8; S. De Groot, unpubl. data).

Identification.—See notes above on how to differentiate *E. pluriflorum* from a number of other co-occurring species.

Subspp. *pluriflorum* and *sherman-hoytae* can be difficult to distinguish because although their means differ for many characters, the ranges overlap. In general, the leaf lobes of subsp. *pluriflorum* tend to be filiform, while the leaf lobes of subsp. *sherman-hoytae* are linear (broader than filiform). Subsp. *pluriflorum* has large inflorescence heads, usually with many flowers open at one time, while the inflorescence heads of subsp. *sherman-hoytae* tend to be smaller with fewer flowers open at once. Heads of subsp. *pluriflorum* tend to have woollier inner bracts and calices than heads of subsp. *sherman-hoytae*. Bracts subtending heads of subsp. *sherman-hoytae* are usually broader than filiform, although bracts subtending heads of large plants of subsp. *pluriflorum* may also be broader than filiform, at least at the base. The corolla tube plus throat is generally shorter for subsp. *sherman-hoytae* than subsp. *pluriflorum*, but the ranges still overlap. The throat of subsp. *sherman-hoytae* is golden yellow, while the throat of subsp. *pluriflorum* is white to pale or dull yellow.

Subsp. *albifaux* is exclusively transmontane, while subsp. *pluriflorum* is cismontane.

Phenology.—Flowering possibly as early as mid-April, but mostly beginning in May and continuing through July. In some areas, plants may flower into August. Fruiting from about June through September. Flowering and fruiting times are likely very site-specific and at least partly correlated with elevation and habitat.

Distribution.—California endemic; San Joaquin Valley, southern half of Sierra Nevada, eastern South Coast Ranges, western Transverse Ranges (Fig. 273). This subspecies occurs in areas generally surrounding the San Joaquin Valley.

Habitat.—*Eriastrum pluriflorum* subsp. *pluriflorum* in found at elevations from about 100 m to about 1830 m (330–6000 ft), mostly on slopes or hillsides, including roadcuts. At least one site had been recently burned. The slope varies from flat to 36°, and aspects from west- to south- to east-facing have been recorded. The substrate is silt, clay, fine sand, sand, or loam, sometimes with some rock, and derived from granite, serpentine, basalt, or various volcanics. Surrounding vegetation may be grassland, alkaline scrub, juniper shrubland, chaparral, mixed forest, or combinations of two or more of these types. At one site, plants were found in an ecotone between two vegetation types.

Population dynamics.—Population sizes from 12 to over 2000 have been recorded. Many sites had a few hundred plants. Plants are sometimes mixed with other annuals, or sometimes not, and have been observed to be locally rare, scattered, locally patchy, locally frequent, or locally abundant. Populations tend to be in patches that vary in size from about 1 m^2 to at least 3000 m^2.

Threats.—Although *E. pluriflorum* subsp. *pluriflorum* has been found growing among other annuals, competition from larger or more vigorous non-native plants (e.g., *Brassica* spp.) might pose a threat by out-performing and excluding *Eriastrum* plants. Weeds tend to move into areas that have been burned several times at close intervals, therefore *Eriastrum* populations in these types of areas may be more threatened. However, this subspecies appears to prefer open areas and may do well following clearance by fire if weeds are not too dense. Populations growing on roadcuts or near roads might be impacted by road maintenance or improvement.

Conservation.—Global rank: G3?TNR – vulnerable, subspecies not ranked; otherwise not ranked (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—The specific epithet is from Latin *plur*-, several or many, and *florum*, the genitive plural form of *flos*, flower: "of many flowers."

Common name.—Many-flowered woolly-star.

Other specimens.—California, *Fitch* (GH 78496!) has a Synoptical Flora of North America annotation in Asa Gray's handwriting "Gilia virgata var. floribunda." Only the top of a plant is present; the roots are missing.

Tejon, June 1854, *Wallace s.n.* (GH 303656!) has only the upper portions of two plants and is missing roots, but otherwise is typical pluriflorum. The corolla color is faded. Asa Gray noted 2–4 ovules per locule and annotated it "Gilia virgata var. floribunda" for the Synoptical Flora of North America.

Kern County, Sunset, 20 Apr 1905, *A.A. Heller 7734* (UC 130369 image!; DS 24796!; DS 136426!; GH!) is not a type. The specimens resemble *E. pluriflorum* subsp. *pluriflorum*, although they trend toward subsp. *sherman-hoytae*.

Kern County, Oil City, 22 Apr 1905, *A.A. Heller 7742* (UC 130368 image!; DS 136581!; GH!) is not a type. The specimens are typical *E. pluriflorum*.

California or Arizona, no location specified, 1876, *E. Palmer 414* (GH 303691!) was annotated "Gilia virgata var. floribunda" by A. Gray, but actually resembles *E. densifolium* subsp. *austromontanum.* A duplicate (K 196246!) also resembles *E. densifolium* subsp. *austromontanum*, and was communicated by A. Gray to Kew on October 1877.

Discussion.—Flowers have been visited by small black beeflies or solitary bees, butterflies (swallowtail), and a large bumblebee or carpenter bee (S. De Groot, pers. obs.).

In the Central Coast Ranges of California, there appears to be a small-flowered form of *E. pluriflorum* subsp. *pluriflorum*. In dried material, the corollas are ca. 11–13 mm long total, with the tube + throat ca. 10–11 mm, and lobes ca. 2–3 mm (OBI 11568!, RSA 185440!). It has been infrequently collected, and it is unknown if the small-flowered plants on herbarium sheets are odd variations within a population of large-flowered plants, or if whole populations are small flowered.

In the protologue of *Gilia virgata* var. *floribunda*, Gray cited three specimens (syntypes), all from California: Fitch, Wallace, and Brewer (Gray 1870: 272). Jepson may have attempted to designate one as a type, although the words "lectotype" and "designated here" are missing: "For Gilia virgata var. floribunda, Gray mentions three collectors, but the collection of Fitch as the first cited, may well be taken for the type" (Jepson 1943: 163). However, this was not in accordance with nomenclatural rules, so Harrison (1972: 8) formally designated *Brewer 1212* (GH78496!) as the lectotype. It is a good specimen with many flowers, a fairly precise location, and there are a number of isolectotypes in other herbaria (UC, JEPS, K, YU). The specimen at GH was annotated by Gray as "*Gilia* (*Hugelia*) *virgata* var. *floribunda*" (Harrison 1972: 8–9).

William Henry Brewer collected the type specimen in June of 1862, while engaged with the Geological Survey of California as "Principal Assistant, in charge of the Botanical Department" (Farquhar, in Brewer 2003: xxxviii). On June 3, the party camped at the mouth of Corral Hollow (Camp 72; see UC 23883). They had surveyed that area in October of 1861, so they remained in that area only a few days in 1862, taking observations. Brewer wrote that on June 4, he "climbed a high hill several miles south" of Corral Hollow (Brewer 2003: 276). Possibly this is the hill referred to on the label of the type, or possibly the type was collected on a different hill that Brewer climbed on June 3 but did not record in his journal. Corral Hollow is on the San Joaquin Valley side of the Mount Diablo Range, east of Livermore and southwest of Tracy. It is marked on the USGS topographic maps.

11B. ERIASTRUM PLURIFLORUM (A. Heller) H. Mason subsp. **albifaux** De Groot, subsp. nov.

Type: USA, California, San Bernardino County: along Highway 395 just south of Atolia and Red Mountain, 35.29333° N, 117.61417° W, 955 m/3134 ft elevation, 20 June 2005, *De Groot 5050*.

Holotype: RSA! Isotypes: CAS!, GH!, BRY!

Previously, specimens may have been identified as either *E. pluriflorum* subsp. *sherman-hoytae*, *E. eremicum*, or perhaps *G. floccosa*.

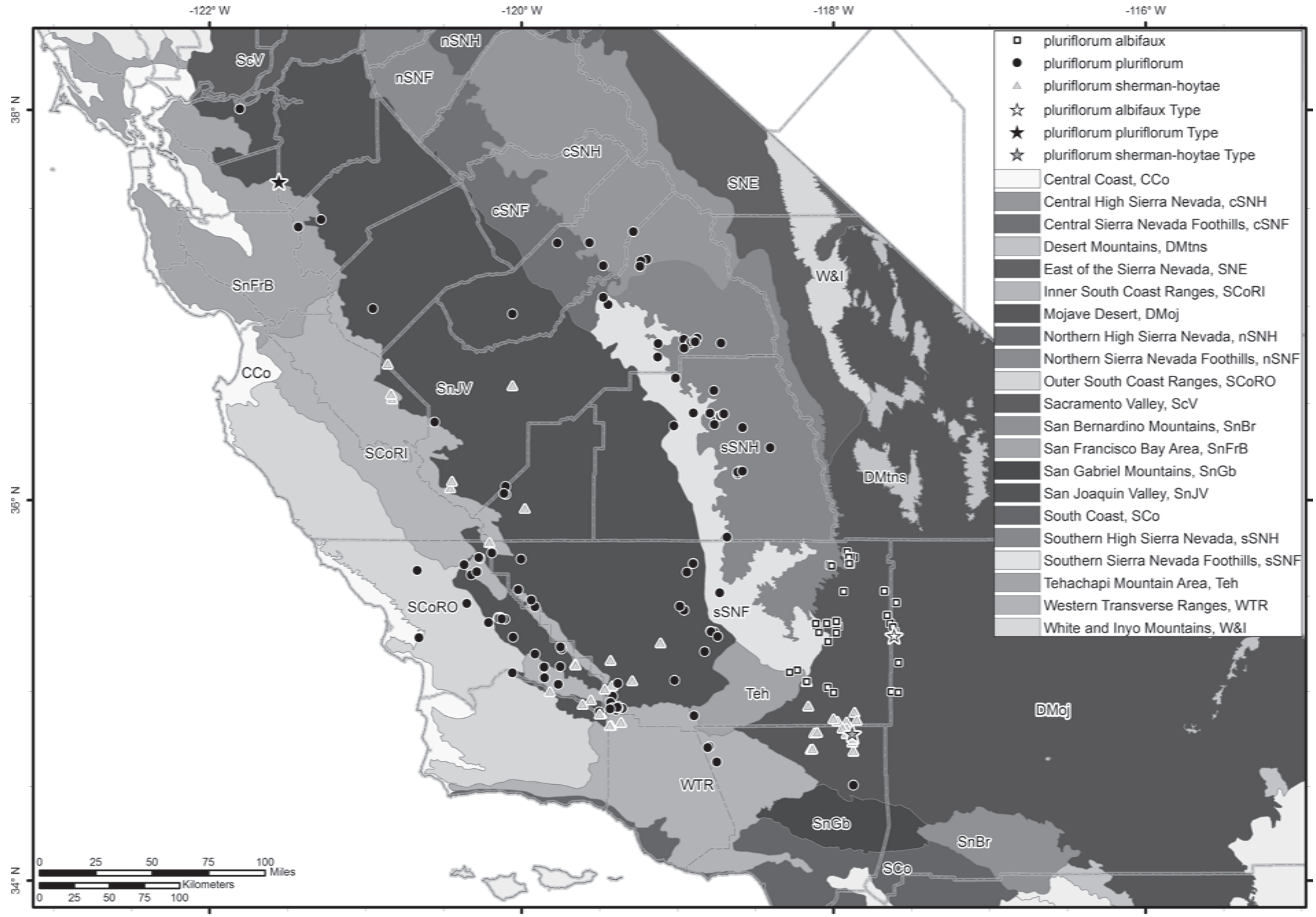

Fig. 273. Range map for *E. pluriflorum*, showing specimen and type locations. County boundaries and the geographic subdivisions of California from the Jepson Flora Project are marked (Geographic Subdivisions of California used with permission from the Jepson Herbarium; Jepson Flora Project 2015).

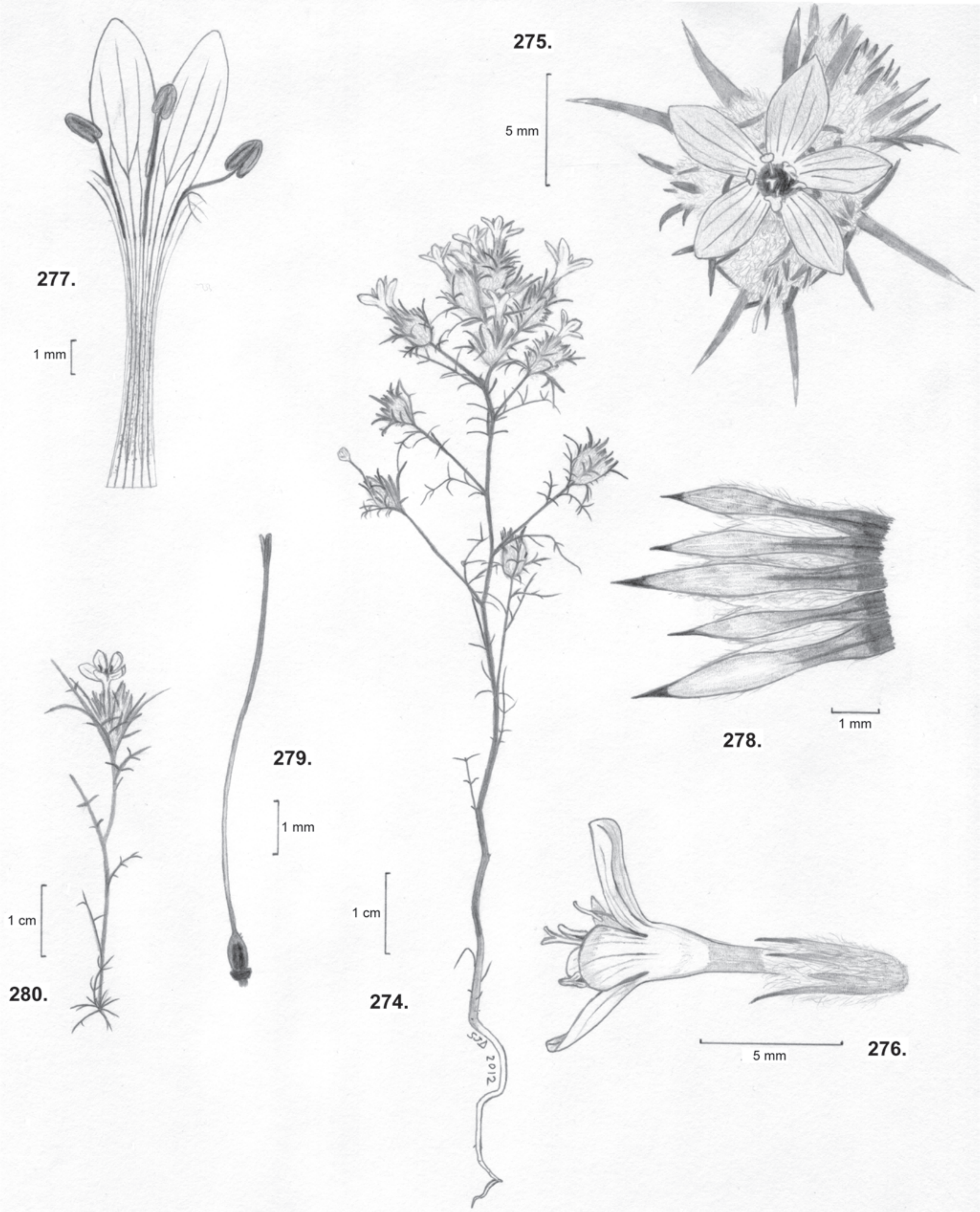

Fig. 274–280. *Eriastrum pluriflorum* subsp. **albifaux**.—274. Habit of larger plant (*De Groot 5050*).—275. Inflorescence with flower in face view (*De Groot 5050*).—276. Flower in side view (*De Groot 5053*).—277. Two petals of opened corolla with three stamens (*De Groot 5053*).—278. Opened calyx, showing unequal lobes (*De Groot 5053*).—279. Gynoecium with stigma, style, ovary, and nectary disk (*De Groot 5053*).—280. Habit of small plant (*De Groot 6029*).

Annual herb, occasionally persisting into autumn, 3.5–24 cm tall, erect, sometimes caespitose or spreading, to 30 cm wide (sometimes more), racemose, paniculate, or corymbose, branched from base or above, branches sometimes virgate. **Stems** light green to tan, upper stems floccose to subglabrous, lower (older) stems becoming subglabrous; internodes about 1–2 cm long, sometimes shorter near the heads or in caespitose plants. Stems sometimes becoming nearly woody at the base in plants that persist into autumn. **Leaves** alternate, pinnatifid, ascending or spreading, lightly floccose to subglabrous, green, older leaves sometimes reddish-brown or tan, 6–30 mm long, apices acuminate; 5–13-lobed, lateral lobes sometimes broken off on older leaves, lobes arising along the length of the primary axis, although often with several lobes clustered near the base of the leaf, lateral lobes 1–10 mm long; rarely some leaves may be bi-pinnate. **Inflorescence** heads several to many, terminating the branches, 6–11 mm long, 4–15 mm wide excluding tips of bracts, floccose, about 3–8 (or more) flowers per head, although up to about 5 are usually open at any single time. **Bracts** pinnatifid, ascending to spreading, 5–18 mm long, exceeding heads, green, often with reddish or tan tips, floccose at the base, subglabrous distally, sometimes markedly glandular, inner bracts entire to 5-lobed (rarely 7-lobed), outer bracts 5–11-lobed, lobes arising along the length of the primary axis, but usually more dense near the base of the bract, lateral lobes about 1–6 mm long. **Calyx** 4.75–7.5 mm, sepals green, often with reddish tips, densely floccose, apices acuminate, fused about 3–3.5 mm or a little more than halfway, length difference between lobes 0.5–1.75 mm, often 2 long and 3 short. **Corolla** exserted from calyx, 9.9–16.0 mm long, actinomorphic, narrowly funnelform; tube 4.2–8.1 mm long, purple or white, pubescent inside with projections from epidermal cells; throat 0.6–1.9 mm long, white to cream, sometimes with pale yellow spots inside, usually bell-shaped and conspicuously wider than the tube; tube plus throat 5.6–11.0 mm long; lobes 3.9–6.0 (–7) mm long, differing in length within a flower by 0.0–0.5 mm, 33–47% of total corolla length, 1.6–3.0 mm wide, widely elliptic to obovate, white to pale blue, veins sometimes darker, occasionally with a few darker streaks at the base, tip acute or sometimes rounded. **Stamens** exserted from corolla throat 3–4 mm (2.1–3.8 mm beyond the sinuses), attached 0.1–1.2 mm below the sinuses (insertion distance differing by 0.2–0.8 mm within a flower); free portion 2.5–6 mm long, to base of corolla 6.5–12.0 mm long, equal to subequal, differing in length within a single flower by 0.7–3.2 mm; filaments 0.6–4.1 mm long (length difference 0.8–2.9 mm within 1 flower), white; anthers about 1.25–1.75 mm long and about 1 mm wide, oblong, sagittate, versatile, white to yellow. Pollen blue to gray, average grain diameter 27 µm. **Pistil** 8.5–12 mm long, tip of ovary with sparse 4–5-celled trichomes; stigma lobes 0.5–0.75 mm long, style 6.5–10 mm long, ovary at anthesis 1.25–1.5 mm long and about 1 mm wide, 6–17 ovules total, 2–6 per locule. **Capsule** 2–3 mm long, 1–1.25 mm wide. **Seeds** about 1.2–2.0 mm long, 0.6–1.0 mm wide, tan, angular to elliptic (Fig. 263–269, 272 [Color Plate 7], 274–280).

Identification.—In the western Mojave Desert, *E. eremicum* and *E. pluriflorum* subsp. *albifaux* both occur, and vegetatively look very similar. Subsp. *albifaux* is distinguished from *E. eremicum* by its strictly actinomorphic corollas. *Eriastrum eremicum* in the western Mojave Desert has noticeably medially zygomorphic corollas. The throat of subsp. *albifaux* is often flared (rather bell-shaped), whereas it is tapered in *E. eremicum*. Although the stamens may be of unequal lengths in both taxa, the filaments in flowers of *E. eremicum* are often curved and clustered toward the lower part of the corolla; while in subsp. *albifaux* the filaments are straight, or, if curved, not clustered. In dried material, the primary useful character for distinguishing these two taxa is the presence of unequal sinuses in *E. eremicum* (indicating a zygomorphic corolla), and equal sinuses in subsp. *albifaux* (indicating an actinomorphic corolla).

In California, subsp. *albifaux* can be differentiated from *E. diffusum* by its longer corollas—usually about 10 mm or longer, whereas corollas of *E. diffusum* are usually shorter than 9 mm. The longest stamens of subsp. *albifaux* are usually exserted at least 2.1 mm beyond the sinus, while the longest stamens of *E. diffusum* or *E. wilcoxii* are usually exserted 2.3 mm or less. Both *E. diffusum* and *E. wilcoxii* usually have fewer flowers open in each inflorescence head at a single time than subsp. *albifaux*.

The white corolla throat of subsp. *albifaux* is one of the most useful features by which to distinguish it from subsp. *sherman-hoytae*, which has a golden yellow corolla throat. Also, the corolla tube plus throat of subspp. *pluriflorum* and *sherman-hoytae* is twice the length of the corolla lobes or longer, while the corolla tube plus throat of subsp. *albifaux* is less than twice the length of the lobes.

See notes above on how to differentiate *E. pluriflorum* from a number of other co-occurring species.

Phenology.—Flowering from late April through June and possibly into July. Fruiting June–July.

Distribution.—California endemic (Kern and San Bernardino counties); western Mojave Desert (Fig. 273).

Habitat.—*Eriastrum pluriflorum* subsp. *albifaux* occurs at elevations from about 800 m to 1440 m (2630–4730 ft), on flat plains, open hillsides, shallow drainages, and roadcuts, usually in open, sunny areas. The slope ranges from flat to 30°, and aspects of south- to east- to north-facing have been recorded. The substrate is usually a coarse sand or gravel, derived from granite or mixed alluvium. Surrounding vegetation is usually some form of Mojave desert scrub or creosote bush scrub.

Population dynamics.—Population sizes of about 50 to over 1,000,000 plants have been reported. Population sizes appear to fluctuate greatly between years, at least in part due to the amount of winter precipitation. Plants may be scattered in a small area, frequent, common, abundant, or abundant in large patches for several miles.

Threats.—Habitat loss due to development (solar development may impact this species), off-highway vehicle use, competition from non-native plants such as *Brassica tournefortii*.

Conservation.—Global rank: G3?TNR – vulnerable, subspecies not ranked; otherwise not ranked (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—The subspecific epithet is from Latin *albi-*, white, and *faux*, throat, referring to the white throat of the corolla, a key character by which to distinguish this subspecies from *E. pluriflorum* subsp. *sherman-hoytae*, which has a yellow throat.

Common name.—White-throated woolly-star.

Discussion.—Subsp. *albifaux* is restricted to the western Mojave Desert and bordering Sierran areas (Fig. 273). Although it approaches the range of subsp. *sherman-hoytae*, they do not overlap, and subsp. *albifaux* does not overlap at all with subsp. *pluriflorum*.

11c. ERIASTRUM PLURIFLORUM (A. Heller) H. Mason subsp. SHERMAN-HOYTAE (T.T. Craig) H. Mason 1945, *Madroño* 8(3): 75–76.

Basionym: *Gilia Sherman-Hoytae* T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 415–416.

Type: USA, California, Los Angeles County: sandy flats 10 miles south of Muroc, 13 May 1933, *P.A. Munz and T.T. Craig 12925*.

Holotype: POM 185022!. Isotypes: BM 901475!, P 643640 (image!), DS 393287 (image!), DS 243645!, JEPS 16259 (image!), JEPS 69102 (image!), PH 1068937 (image!), US 1699056 (image!), UC 574949 (image!), POM 201911!, MICH 1192661 (image!), GH 78810!, POM 186743 (image!).

≡*Gilia Hoytae* T.T. Craig 1934*a*, A revision of the subgenus *Hugelia* of the genus *Gilia*. Senior Thesis, Pomona College. p. 29–31 [nom. inval., not effectively published].

≡*Gilia Sherman-Hoytae* T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 415–416.

Included in *Hugelia pluriflora* Ewan. Jepson 1943, A Flora of California Vol. 3 Part II p. 163.

≡*Eriastrum pluriflorum* (A. Heller) H. Mason var. *Sherman-Hoytiae* (T.T. Craig) Hoover 1970, Vascular Plants of San Luis Obispo County, 231.

≡*Eriastrum pleuriflorum* (A. Heller) H. Mason subsp. *sherman-hoytae* (T.T. Craig) H. Mason. J.M. Porter and L.A. Johnson 2000, *Aliso* 19(1): 74.

Erect annual herb, 3–33 cm high, branched from the base or above, simple to corymbose, virgate, or racemose. **Stems** slender, green to tan or dark red brown, upper stems usually floccose, older stems becoming subglabrous; internodes 0.7–6.5 cm. **Leaves** alternate, pinnatifid, ascending to spreading, 9–40 mm long, green, lightly floccose, older leaves subglabrous and reddish-brown, apex aristulate, with 1–7 (–9) pinnate lobes, lateral lobes 2–15 mm long, sometimes reduced to teeth, filiform to linear, arising from proximal third, occasionally from proximal half of the leaf. **Inflorescence** heads 1–20 or more, terminating the branches, rarely axillary, 6–10 mm long, 5–13 mm wide, lanate, with 2–8 (–10?) flowers per head. **Bracts** pinnatifid, ascending (inner) to spreading (outer), 7– 21 mm long, exceeding the heads, green, sometimes with tan or reddish tips, floccose at base, subglabrous distally, with 1–7 pinnate lobes, lateral lobes to about 9 mm long, arising from proximal half or the bract. **Calyx** 4.5–8 mm long, sepals floccose, slightly glandular, green, tips often reddish, aristulate, fused about halfway or about 3 mm, with unequal lobes, differing in length within a single flower by 0.5–1 mm, often 2 long lobes and 3 short. **Corolla** well exserted, 12.0–17 (–20) mm long, narrowly funnelform, usually actinomorphic; tube long and slender, 5.6–8.9 mm long, purple or reddish to blue or white, often purple distally and white proximally, pubescent inside with projections from epidermal cells; throat 1.7–2.6 mm long, bright orange-yellow; tube plus throat 7.7–12.0 mm long, at least twice as long as the lobes; lobes 3.6–5.7 (–7?) mm long, differing in length within a flower by 0.0–0.2 mm, the lobes about 30–37% of total corolla length, about 1.9–2.8 (–4) mm wide, the length generally less than twice the width, elliptic to obovate, apex obtuse to rounded, pale blue to coerulean or lavender, veins often darker. **Stamens** exserted about 3–5 mm past the sinuses, but shorter than the lobes usually by 1 mm or more, attached 0.1–0.75 mm below the sinuses; free portion (2–) 3–6.5 mm long, to base of corolla 8.6–14.1 mm long, equal to subequal, differing in length within a single flower by 0.2–3.0 mm (often 4 long, 1 short, or 3 long, 2 short); filaments 1.0–4.4 mm long, white; anthers 1.0–2.5 mm long, sagittate, versatile, cream to pale blue. Pollen blue to nearly white, average grain diameter 28 μm, possibly pantotreme aperture arrangement. **Pistil** at maturity generally exserted beyond the stamens, to about 14–15 mm long; base of style and tip of ovary with scattered 2–4-celled glandular trichomes (occasionally glabrous); stigma lobes 0.3–1.0 mm long, white; style to about 13 (–14) mm long, white; ovary at anthesis 1.0–1.4 mm long, 0.5–0.9 mm wide, 1–3 ovules in each locule. **Capsule** about 2–3 mm long, 1 mm wide. **Seeds** about 1.3–1.8 mm long, 0.6–0.8 mm wide, gray-brown (Fig. 258–262, 271 [Color Plate 7]; Craig 1934*a*, *b*: 415; Harrison 1972: 9; S. De Groot, unpubl. data).

Identification.—See notes above on how to differentiate *E. pluriflorum* from a number of other co-occurring species.

Eriastrum pluriflorum subsp. *sherman-hoytae* sometimes might be confused with *E. eremicum*, but can be differentiated by its actinomorphic corollas. In California, *E. eremicum* has noticeably medially zygomorphic corollas. Furthermore, stamens are attached 0.75 mm or less below the sinus in *E. pluriflorum* subsp. *sherman-hoytae*, but attached 0.7 mm or more below the sinus in *E. eremicum*.

Subspp. *pluriflorum* and *sherman-hoytae* can be difficult to distinguish because although their means differ for many characters, the ranges overlap. In general, the leaf lobes of subsp. *pluriflorum* tend to be filiform, while the leaf lobes of subsp. *sherman-hoytae* are linear (broader than filiform). Subsp. *pluriflorum* has large inflorescence heads, usually with many flowers open at one time, while the inflorescence heads of subsp. *sherman-hoytae* tend to be smaller with fewer flowers open at once. Heads of subsp. *pluriflorum* tend to have woollier inner bracts and calices than heads of subsp. *sherman-hoytae*. Bracts subtending heads of subsp. *sherman-hoytae* are usually broader than filiform, although bracts subtending heads of large plants of subsp. *pluriflorum* may also be broader than filiform, at least at the base. The corolla tube plus throat is generally shorter for subsp. *sherman-hoytae* than subsp. *pluriflorum*, but the ranges still overlap. The throat of subsp. *sherman-hoytae* is golden yellow, while the throat of subsp. *pluriflorum* is white to pale or dull yellow.

The golden yellow corolla throat of subsp. *sherman-hoytae* is one of the most useful features by which to distinguish it from subsp. *albifaux*, which has a white corolla throat. Also, the corolla tube plus throat of subsp. *sherman-hoytae* is twice the length of the corolla lobes or longer, while the corolla tube plus throat of subsp. *albifaux* is less than twice the length of the lobes.

Phenology.—Flowering May through June, possibly into July in some areas. Fruiting July–August.

Distribution.—California endemic; San Joaquin Valley, southeast South Coast Ranges (Carrizo Plain area), western Mojave Desert (Fig. 273).

Habitat.—*Eriastrum pluriflorum* subsp. *sherman-hoytae* is found at elevations between about 400 and 1000 m (1310–3280 ft) in washes, on banks above washes, old roads, or hillsides, in open, sunny areas. The slope ranges from about 5 to 16° and recorded aspects have been southwest-, south-, or southeast-facing. The substrate is fine to coarse sand, sometimes with rock, derived from granite, sandstone, mixed volcanics, or mixed alluvium. Soil is usually light-colored and in a few areas may be slightly alkaline. Surrounding vegetation may be grassland, arid or alkaline shrubland, Mojave desert scrub, juniper savannah, or juniper-sagebrush vegetation.

Population dynamics.—Population sizes from about 300 to about 1,000,000 plants have been recorded. At sites, plants have been noted to be locally frequent or locally abundant, usually occurring in patches in open areas between shrubs or along roads.

Threats.—Habitat loss due to development, overgrazing, or vehicle use.

Conservation.—Global rank: G3?T3? – vulnerable; considered for California rare plant ranking, but rejected; otherwise not ranked (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—According to Craig, "This species is named in honor of Mrs. Albert Sherman Hoyt, who has contributed much to the Botany of the Southwest through her work to preserve the flora of the deserts" (Craig 1934*b*: 416). Minerva Hamilton Hoyt married Dr. Albert Sherman Hoyt and moved to South Pasadena in the late 1890s. Although she was involved in a number of local civic and cultural activities, Mrs. Hoyt is best known for her efforts in desert conservation. She was fascinated by the southern California deserts since the first time she saw them, and became alarmed at the increase in collection of full-grown desert plants for urban gardens. In response, she organized the International Deserts Conservation League in 1930, which enjoyed support from a variety of garden clubs and individuals in the scientific and local community, including Philip Munz and E.C. Jaeger. She is best known for her tireless efforts that culminated in the creation of Joshua Tree National Monument (very nearly christened "Minerva Hoyt National Park") in 1936 (Sorensen 1996).

As far as I can determine, the correct ending is *–ae*, not *–iae*, as in Hoover (1970) or De Groot et al. (2012).

Common name.—Mrs. Hoyt's woolly-star.

Discussion.—Muroc is an old name for a site now on Edwards Air Force Base, 3 miles east of Edwards at the edge of Rogers Lake. Other names for the site include "Yucca," "Rodriguez," "Rogers," and "Rod" (Durham 1998). The type locality, "ten miles south of Muroc," would be the sandy flats south of Rogers Lake.

The ranges of subspp. *sherman-hoytae* and *pluriflorum* overlap to a large extent, especially in the southwest San Joaquin Valley (Fig. 273). There are no obvious habitat differences, and these two subspecies may be difficult to distinguish in some areas.

12. ERIASTRUM ROSAMONDENSE D. Gowen 2013, *J. Bot. Res. Inst. Texas* 7(1): 23–24.

Type: USA, California, Los Angeles County: northwest of Lancaster at the southwest quadrant of West Avenue D and 30th Street West, 12 May 2010, *D. Gowen 1110*.

Holotype: JEPS. Isotype: BRY.

Included in *Eriastrum hooveri* (see Hinshaw 2003; RSA! and UCR herbarium specimens).

Annual herb, 2–11 cm tall. **Stems** mostly branched above but sometimes branched from the base, erect, racemose, or virgate in smaller plants, wiry, lower (older) stems reddish-brown, upper (younger) stems green, lightly floccose to subglabrous; internodes up to about 17 mm long. **Leaves** alternate, entire to pinnatifid, ascending to appressed, 4–13 (–15) mm long, green, becoming reddish-brown in age, subglabrous, primary axis about 1 mm wide, apex subulate to aristate; lower leaves entire; upper leaves entire to 3-lobed, lateral lobes arising from the proximal third of the leaf, 2 mm long. **Inflorescence** capitate, terminal, with 1–9 or more heads; heads about (4–) 5–7 mm long and 4–20 mm wide excluding the tips of the bracts, floccose, with about 1–10 flowers per head. **Bracts** entire to pinnatifid, ascending, but tips often curving outward, (4–) 6–11 (–14) mm long, some tips exceeding heads, green, tips sometimes reddish or yellowish, floccose at least at the base, apices aristate; inner bracts 3-lobed, outer bracts entire to 3-lobed, the lateral lobes arising from the proximal half of the bract, 1–5 mm long. **Calyx** 4.5–6 mm long, sepals floccose, green, margins hyaline, tips sometimes yellowish, apices subulate to aristate, the proximal half to two-thirds of the sepals fused into a tube, lobes unequal, differing in length within a flower by 0.5–1 mm, tips not obscured by trichomes. **Corolla** narrowly funnelform, sometimes persistent, actinomorphic, sometimes appearing asymmetric due to interactions between the corolla lobes and the calyx lobes, 4.4–5.9 (–7) mm long, only the corolla lobes exserted beyond the calyx, sometimes barely; tube 2.5–3.3 mm long, a little more than half of the total corolla length, white, glabrous; throat 0.2–0.8 mm long, mostly symmetric, white to cream; tube plus throat 2.9–4.1 mm long; lobes elliptic, tip obtuse, 1.3–2.0 (–2.5) mm long, varying in length within a flower by 0.0–0.2 mm, about one third of the total corolla length, 0.6–1.0 mm wide, white to pale blue, sometimes translucent, midvein sometimes darker. **Stamens** exserted 0.4–1.0 mm beyond sinus, 0.6–1.1 mm shorter than the corolla lobes, attached 0.4–1.0 mm below sinuses, the insertion distance varying within a flower by 0.0–0.2 mm; free portion 1.25–2.1 (–2.5) mm long, to base of corolla 3.5–4.7 mm long, mostly equal to slightly unequal, differing in length within a flower by 0.0–0.5 mm, but often 0.2 mm or less; filaments 0.9–1.8 mm long, differing in length within a flower by 0.0–0.4 mm, commonly 0.1–0.2 mm, filaments straight, cream-colored; anthers (0.25?–) 0.5–0.75 mm long, 0.5–0.6 mm wide, white, broadly oval, versatile. Pollen white, average grain diameter 28 µm, zonate aperture arrangement. **Pistil** 3.8–5.6 mm long, 0.2 mm shorter than the stamens to 1.0 mm longer, 2–3-celled glandular trichomes fairly dense on proximal part of style, only a few on the tip of the ovary; stigma lobes (0.3–) 0.4–0.8 mm long; style 1.4–3.0 mm long; ovary 3-loculed, at anthesis about 1.25–3.0 mm long and 1–2 mm wide, with 1–4 ovules per locule (4–11 ovules total). **Capsule** about 3.0–4.3 mm long, 1.75–2.2 mm wide, reddish-tipped when immature, with 1–4 seeds per locule. **Seeds** about 1.0–1.4 mm long, 0.5–0.8 mm wide, tan, angular (Fig. 63–68 [Color Plate 1], 146; Gowen 2013; S. De Groot, unpubl. data).

Identification.—Characters that distinguish *E. hooveri* from *E. rosamondense* include a leaf primary axis 0.75 mm wide or less (*E. rosamondense* leaf primary axis is usually 0.75–1 mm wide), and anthers that are included or exserted to 0.1 mm beyond the sinuses (anthers exserted 0.4–1.0 mm in *E. rosamondense*).

The leaf primary axis of *E. ertterae* is about 0.5–0.75 mm wide, in contrast to the leaf primary axis of *E. rosamondense*, which is about 1 mm wide. The stamens of *E. rosamondense* are exserted 0.4–1.0 mm beyond the sinuses, while the stamens of *E. ertterae* are included or exserted up to 0.5 mm beyond the sinuses.

In Antelope Valley, *E. rosamondense* possibly could be confused with *E. diffusum*, although *E. diffusum* has not been collected in that area. The stamens of *E. rosamondense* are usually exserted 1 mm or less, while the stamens of *E. diffusum* are exserted 1 mm or more past the sinuses. The corollas of *E. rosamondense* are generally smaller than the corollas of *E. diffusum*, and the style of *E. rosamondense* is usually 3 mm long or shorter, while the style of *E. diffusum* is usually 4 mm long or longer.

Although the corollas of *E. harwoodii* are small (6–8 mm long), the corollas of *E. rosamondense* are smaller, with most plants having corollas 6 mm long or shorter. The length of the corolla tube plus throat is more discriminatory: *E. harwoodii* has a tube plus throat 4.8 mm or longer; corollas of *E. rosamondense* have a tube plus throat no greater than 4.5 mm.

Eriastrum rosamondense has an actinomorphic corolla less than 7 mm long, whereas *E. eremicum* corollas are medially zygomorphic and 10 mm or longer. Furthermore, the stamens of *E. rosamondense* are usually exserted 1 mm or less, while *E. eremicum* in that area usually has stamens exserted more than 3 mm.

Phenology.—Flowering from about late April through the third week of May. Fruiting May–June, and possibly into July.

Distribution.—California endemic (Kern, Los Angeles Counties); western Mojave Desert (Antelope Valley; Fig. 251).

Habitat.—*Eriastrum rosamondense* occurs at elevations between about 700 and 730 m (2300–2400 ft), on flat, alkaline plains. The substrate is usually fine sand or silt, and often hard packed. Surrounding vegetation is *Atriplex* scrub. This species seems to prefer open spaces between shrubs, often in hollows in slightly undulating (± 30 cm) ground.

Population dynamics.—Population sizes appear to be small, about 100 plants or fewer, although plants are often mixed with other annuals and consequently difficult to detect. Plants may be frequent where they occur.

Threats.—The main threat is habitat loss due to development. Of known sites, all are on private land except for one site on Edwards Air Force Base. One historic site (collected in 1892) may have been lost to development in or around Lancaster. Most populations fit into an area of about 91,000 hectares (350 square miles).

Conservation.—Global Rank: G1; National Rank: USA (N1); Subnational/State Rank: California (S1); California Rare Plant Rank: 1B.1 (CNPS 2013; CNDDB 2013; NatureServe 2013; Table 2).

Etymology.—The specific epithet refers to Rosamond Dry Lake, where many populations of this species are found (Gowen 2013); and the suffix *–ense* indicates a place of growth. The ending *–ense* agrees with *Eriastrum* in gender and case.

Common name.—Rosamond woolly-star.

Other specimens.—A number of specimens of *E. rosamondense* may be identified as *E. hooveri* (RSA, UCR), and at least one may be identified as *E. sparsiflorum* (SBBG).

Discussion.—Although previously identified as *E. hooveri*, *E. rosamondense* is distinct and restricted to the Antelope Valley area in the western Mojave Desert. Its distribution is allopatic with that of *E. hooveri*, which is found farther north in the San Joaquin Valley and southern Sierra Nevada (Fig. 251).

13. ERIASTRUM SAPPHIRINUM (Eastwood) H. Mason 1945, *Madroño* 8(3): 79–80.

Type: *E. sapphirinum* subsp. *sapphirinum*.

≡*Gilia sapphirina* Eastwood 1904, *Bot. Gaz.* 38(1): 71–72.

Included in *Navarretia virgata* (Bentham) Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 167–168.

Included in *Gilia virgata* (Bentham) Steudel. Macbride 1917, *Contr. Gray Herb.* NS Vol. 49 No. 3 p. 58. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 411–412.

Included in *Hugelia virgata* Bentham. Jepson 1925, A Manual of the Flowering Plants of California, p. 793. Jepson 1943, A Flora of California Vol. 3 Part II p. 165.

Annual herb, slender to somewhat robust, 3–54 cm high or more, spreading to 23 cm wide or more. **Stems** erect to spreading, loosely and sometimes widely branched from the base or above, racemose, virgate, corymbose, or paniculate, the main stem and some of the principal branches sometimes zig-zag, occasionally tortuous if growing in deep shade; upper stems green to tan, lower stems reddish, reddish-brown, or tan, middle stems often green and spotted or streaked with red-brown, slender to stout, flexible to stiff, sometimes thick near the base, sparsely-leaved, internodes 0.25–3 (–5.7) cm long; axillary shoots present or not; herbage viscid-glandular-hairy on upper stems or throughout, subglabrous to white-floccose, often becoming glabrate in age. **Leaves** alternate, entire to pinnatifid, ascending to spreading, often with the base ascending but the distal part curving to spread, lower sometimes spreading to slightly recurved, 4–44 (–55) mm long, linear, linear but not filiform, subterete, tipped with a white bristle, younger leaves light green to gray-green or green, older leaves reddish, reddish-brown, or tan, glabrous to floccose, glandular or not, stiff or not, apex subulate to aristate; entire to 5-lobed, occasionally 7-lobed, lateral lobes usually arising from the proximal half of the leaf; lateral lobes 1–15 mm long and bristle-tipped. **Inflorescences** capitate, with 1 to several hundred heads per plant, generally only 1 head per branch, mostly terminal but sometimes axillary heads present, then generally arranged racemosely along each branch; 1- to 12-flowered, heads about 4–8 (–10) mm long and 2.5–15 (–17) mm wide, sometimes wider in fruit, some heads on lower branches or in axils may be smaller, subglabrous to densely floccose; peduncles to 10–15 mm long, generally glandular. **Bracts** pinnatifid, appressed to spreading, outer bract tips often spreading, few to many (–14), hiding the calyces or not, 3–16.5 (–20) mm long, equal to or exceeding the calyces, light green, yellow-green, green, or gray-green, tips sometimes reddish or brown, sometimes membranous in sinuses between lobes, glandular and sparsely to densely woolly, apex aristate; mostly 3–5-lobed (sometimes entire or 7-lobed), lateral lobes arising from the proximal half of the bract, lateral lobes 1–7 mm long; apices aristulate. **Calyx** 4–8.5 mm long, campanulate or tubular, sepals yellowish-green to green, tips sometimes reddish, glandular-puberulent and viscid, lightly floccose to densely woolly, tip aristulate, the proximal half to 2/3 of the sepals fused by their hyaline margins to form a tube; lobes subequal to unequal, differing in length by about 0.25–2.0 mm. **Corolla** broadly funnelform, narrowly funnelform, or sub-salverform, actinomorphic to slightly medially zygomorphic (color pattern is sometimes more strongly zygomorphic than corolla shape), sometimes upper and lower sides are asymmetric but that apparent only in side view, 7–15.0 mm long, tube included in calyx, throat included or exserted, lobes exserted from calyx; the tube 2.3–6.1 mm long, about 23–34% or a little more of the total corolla length, white to light purplish, sometimes upper tube fading into the blue or purple of the lower throat, with scattered short papillae inside (projections from epidermal cells); throat 0.5–3.5 mm long, sometimes asymmetric with the upper side longer that the lower, due to differing heights of the sinuses, white to purple, sometimes with yellow patches or dots; tube plus throat 3.0–7.7 mm long; corolla lobes broadly obovate to narrowly elliptic, apex retuse to rounded or acute (sometimes irregularly crenate), 3.5–8.3 (–10) mm long, lobes differing in length within a flower by 0.0–0.5 mm, about 1/3 to almost 2/3 of the total length of the corolla, 1.5–3.8 mm wide, lavender, dark to pale blue, white, cream, or occasionally pale yellow, veins sometimes darker, often with dark blue or purple or reddish spots or streaks, veins sometimes darker, the proximal end of the lobes sometimes yellow or white, abaxial lobe surface sometimes pale yellow, occasionally a few individuals may have pale blue to white lobes in a population that is otherwise royal blue. Buds light yellow to golden yellow to blue. **Stamens** exserted about 2.3–5.9 (–7) mm beyond the sinuses, about 0.8–2.0 mm shorter than the corolla lobes to 1.0 mm longer, attached (0.3–) 0.7–4.0 mm below the sinuses, the insertion distance varying within a flower by 0.1–1.0 (–1.2) mm; free portion 5–10 mm long, to base of corolla 6.5–12.1 mm long, equal to unequal, differing in length within a single flower by 0.1–3.5 mm (usually 2 mm or less); filaments 2.8–8.5 mm long, differing in length within a flower by 0.3–2.4 mm, white to blue to purple, bases sometimes yellow; the anthers 1.5–3.25 mm long and 0.75–1.5 mm wide, white, cream, pale yellow, grayish lavender to bluish, oblong to ovate, sagittate, and versatile. Pollen white, cream, pale yellow, gray, lavender, or blue, average grain diameter 25–33 μm, zonate or anomotreme aperture arrangement. **Pistil** 8–13 mm long, equal to or exserted a little beyond the stamens, style and ovary tip with few to many scattered 2–6-celled trichomes, glandular or not; stigma lobes 0.25–0.8 mm long; style 7.0–11.5 mm long, white to purple; ovary 3-loculed, at anthesis about 1.0–1.75 mm long and 0.5–1.0 mm wide, ovate, (1–) 2–7 ovules per locule. **Capsule** 3–5 mm long and 1.25–2.5 mm wide, broadly elliptic, usually with 1–4 seeds in each locule, the other ovules present but abortive. **Seeds** about 1.2–2.4 mm long, 0.6–1.1 mm wide, tan to gray-brown, elliptic to angular (Fig. 281–308 [Color Plate 8]).

Identification.—Some flowers of *E. sapphirinum* (particularly subspp. *dasyanthum* or *brevibracteatum*) can be yellowish, mostly on the outside of the petals. However, even these flowers are not as bright yellow as flowers of *E. luteum*, and corollas of these subspecies of *E. sapphirinum* tend to be larger (7–14 mm long) with longer lobes (>3.5 mm) than *E. luteum* (corolla 6.7–9.5 mm long, lobes 2.6–4.5 mm). The peduncle of *E. luteum* is not obviously glandular, but usually is glandular in subspecies of *E. sapphirinum*. The outer bract axis and lobes of *E. luteum* are linear or filiform and exceeding the head; the outer bract axis and lobes of *E. sapphirinum* subsp. *brevibracteatum* are broader than linear, at least at the base, and mostly not exceeding the head in typical forms.

Eriastrum sapphirinum has sometimes been treated as a subspecific entity under *E. virgatum*, but there are multiple characters that differentiate these species. The corollas of *E. virgatum* are larger, usually 15 mm long or longer, while the corollas of *E. sapphirinum* are usually 15 mm long or shorter. Most of the length difference is in the fused portion: the tube plus throat of *E. virgatum* is 10 mm or longer, and the tube plus throat of *E. sapphirinum* is usually less than 8 mm long. The upper stems of *E. sapphirinum* are densely glandular-hairy, while the upper stems of *E. virgatum* may be slightly glandular but are not markedly so.

Eriastrum filifolium is sometimes confused with *E. sapphirinum* subsp. *dasyanthum*, but can be distinguished by its smaller anthers (~1.1 mm or shorter), smaller corollas (9 mm long or less), and shorter stamen exsertion (1.6 mm or less). Anthers of subsp. *dasyanthum* are usually longer than 2 mm, it has corollas usually longer than 9 mm, and its stamens are exserted 2.3 mm or more. In addition, the pedicels of subsp. *dasyanthum* may be noticeably glandular, while those of *E. filifolium* are not.

The stamens of *E. sapphirinum* are exserted farther (2.2 mm or more beyond the sinus) than the stamens of *E. signatum* or *E. sparsiflorum* (usually less than 1.5 mm). The filaments of *E. sapphirinum* are also longer (2.8 mm or more) than the filaments of *E. signatum* or *E. sparsiflorum* (2.2 mm or less). The anthers of *E. sapphirinum* are 1.5 mm long or longer, in contrast to the anthers of *E. signatum* or *E. sparsiflorum*, which are 1 mm long or shorter.

Eriastrum densifolium is often found in the same areas as *E. sapphirinum*, but is easily differentiated by its perennial habit, stems that are woody near the base, larger inflorescence heads, and longer corollas. Most of the corolla length difference is in the fused portion, with the tube plus throat of *E. densifolium* usually 8 mm long or longer, and the tube plus throat of *E. sapphirinum* 7.7 mm or shorter. Plants of *E. sapphirinum* are usually herbaceous and annual.

Although corollas of *E. sapphirinum* can be slightly medially zygomorphic, similar to flowers of *E. eremicum*, the upper stems of *E. sapphirinum* are usually glandular-hairy, while those of *E. eremicum* are not.

The ranges of *E. pluriflorum* and *E. sapphirinum* are mostly non-overlapping, although they may abut each other in places. The main distinction between these two species is that *E. sapphirinum* is markedly glandular-hairy on the upper stems, but *E. pluriflorum* is not. Leaves of *E. pluriflorum* usually have more lobes (>3) than leaves of *E. sapphirinum* (3 or fewer). The tube plus throat of the corolla is generally longer in *E. pluriflorum* than in *E. sapphirinum*.

Stamens of *E. calocyanum* are exserted up to 2.3 mm, while stamens of *E. sapphirinum* are exserted 2.3 mm or more beyond the sinuses. Furthermore, *E. calocyanum* has a single ovule per locule, while *E. sapphirinum* has 2–7.

Phenology.—Flowering from about mid-April through August and probably into September at some sites. Fruiting from May through September or October.

Distribution.—Southern California and Baja California; Southern Sierra Nevada, western Mojave Desert, Transverse Ranges, South Coast Ranges, Peninsular Ranges (Fig. 309).

Habitat.—*Eriastrum sapphirinum* is found at elevations of about 90 to 2650 m (1150–8700 ft) above sea level, in clearings or open sunny areas on flats, floodplains, alluvial plains or fans, meadows, gentle slopes, rolling hills, banks, or road shoulders. Some sites had been burned in the past few years. The slope at a site varies from flat to 20°, and all aspects have been documented. The substrate is silt, sand, loam, rock, talus, or mixtures of these types, sometimes mixed with various kinds of organic matter or leaf litter, adobe, or loam. The rock type is mostly granite, limestone, mixed alluvium, or various volcanic rocks. The surrounding vegetation may be meadow, grassland, savannah, chaparral, arid or desert scrub, mixed or desert woodland, mixed forest, conifer forest, or combinations of several of these types.

Population dynamics.—Population sizes from about 50 to more than 100,000 plants have been recorded. Plants are frequently found in patches in open areas. Where they occur, plants have been observed to be scattered, frequent, common, or abundant.

Threats.—Vehicle use, trail use, road or trail maintenance, and habitat loss due to development.

Conservation.—Global rank: G3G4 – vulnerable; otherwise not ranked (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—The specific epithet is from Latin *sapphirus*, sapphire, and *–inus*, which indicates possession or resemblance. Presumably the epithet refers to the blue corollas, which may resemble sapphires.

Common name.—Sapphire woolly-star.

Discussion.—Although the distributions of subspp. *sapphirinum* and *dasyanthum* overlap to a great degree, the distribution of subsp. *brevibracteatum* is mostly distinct, being found mostly in the transmontane western Mojave Desert (Fig. 309), while the others are primarily cismontane. Additionally, subsp. *sapphirinum* is often found at higher elevations

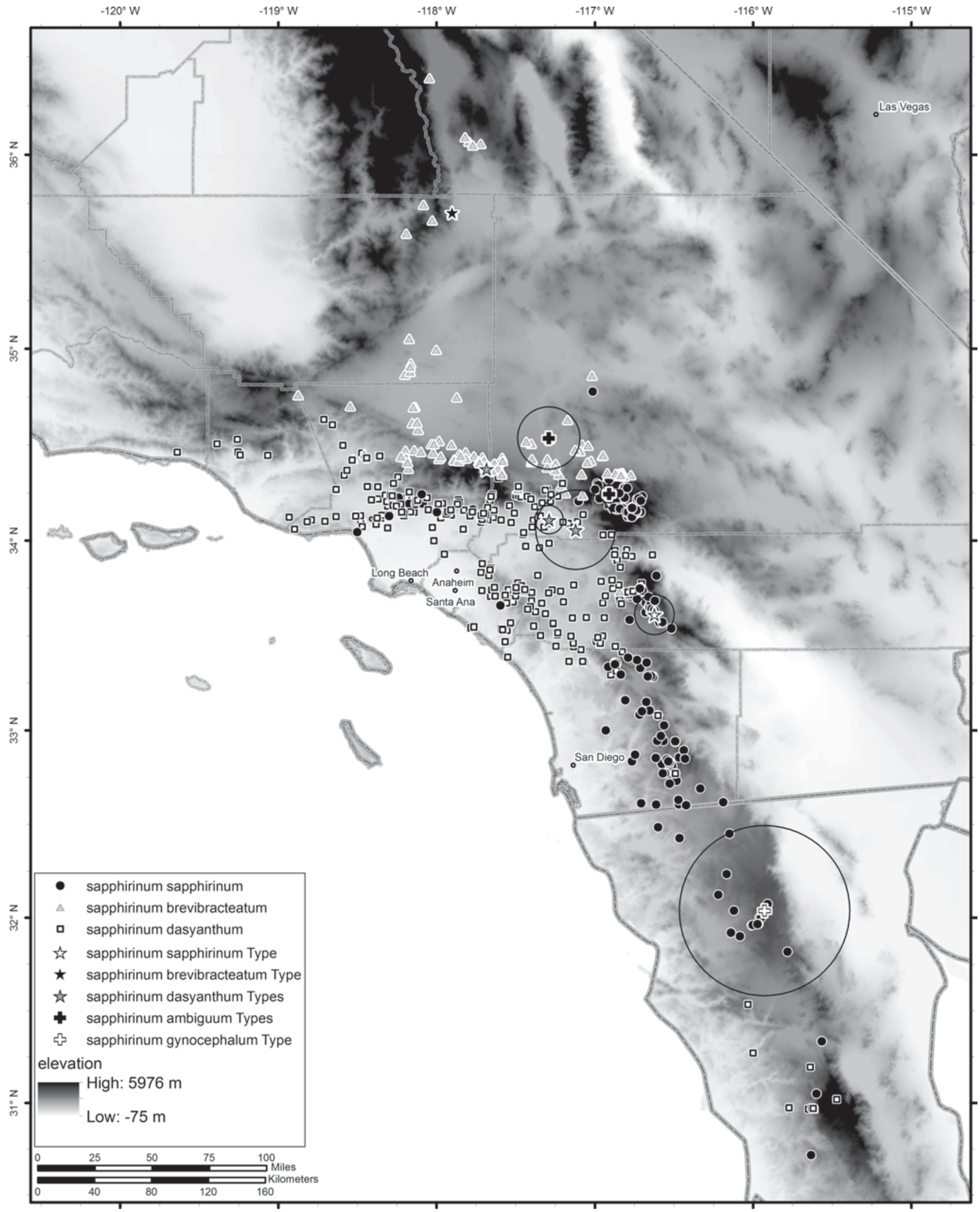

Fig. 309. Range map for *E. sapphirinum*, showing specimen and type locations. + symbols mark locations of types for subspp. *ambiguum* and *gymnocephalum*, names which are not currently recognized. Stars mark type localities of currently recognized names. All four syntypes of subsp. *dasyanthum* are shown, although the lectotype is from the southeastern-most location. Circles around type locations indicate uncertainty. Elevation and major cities are indicated, and dashed gray lines mark county boundaries.

350–2650 m (1150–8700 ft) and in forest, woodland, or montane shrubland habitats. Subsp. *dasyanthum* occurs from about 90 to 2400 m (295–7875 ft) and often in chaparral or coastal sage scrub.

Key to the Subspecies of E. sapphirinum

1. Heads slender, sparsely woolly, with 1–4 flowers and few (1–2) bracts; calyces generally visible and not hidden by bracts or woolly trichomes . . . . .13A. subsp. *sapphirinum*

1' Heads spherical to conical, floccose, with 3–10 flowers and usually more than 2 bracts; calyces generally hidden by bracts and/or woolly trichomes
  2. Anthers less than 2 mm long; each locule with 4 or fewer ovules at anthesis . . . . .13B. subsp. **brevibracteatum**
  2' Anthers more than 2 mm long; each locule with 4 or more ovules at anthesis . . . . .13C. subsp. *dasyanthum*

13A. ERIASTRUM SAPPHIRINUM (Eastwood) H. Mason subsp. SAPPHIRINUM. Mason 1945, *Madroño* 8(3): 79–80.

Basionym: *Gilia sapphirina* Eastwood 1904, *Bot. Gaz.* 38(1): 71–72.

Type: USA, California, Riverside County: San Jacinto Mountain, Nov 1903, *Blanche Trask s.n.*

Holotype: CAS 510 (image!). No known isotypes.

≡*Gilia sapphirina* Eastwood 1904, *Bot. Gaz.* 38(1): 71–72.

≡*Navarretia virgata* (Bentham) Brand [subsp. *gymnocephala* Brand] var. *sapphirina* (Eastwood) Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 168

≡*Navarretia virgata* (Bentham) Brand var. *sapphirina* (Eastwood) Brand 1913, *Annuaire Conserv. Jard. Bot. Genève*, vol. XV et XVI, p. 341.

≡*Gilia virgata* (Bentham) Steudel var. *sapphirina* (Eastwood) J.F. Macbride 1917, *Contr. Gray Herb.* NS Vol. 49 No. 3 p. 58. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 411–412, included *Navarretia virgata* subsp. *gymnocephala* Brand "in large part," and *Navarretia virgata* var. *oligantha* Brand.

≡*Hugelia virgata* Bentham var. *sapphirina* Jepson 1925, A Manual of the Flowering Plants of California, p. 793. Jepson 1943, A Flora of California Vol. 3 Part II p. 165.

=*Navarretia virgata* (Bentham) Brand subsp. *gymnocephala* Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 167–168.

Lectotype (here designated): *Navarretia virgata* (Bentham) Brand subsp. *gymnocephalum* Brand var. *oligantha* Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 167–168.

≡*Eriastrum sapphirinum* (Eastwood) H. Mason subsp. *gymnocephalum* (Brand) H. Mason 1945, *Madroño* 8(3): 80.

=*Navarretia virgata* (Bentham) Brand [subsp. *gymnocephala* Brand] var. *oligantha* Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 167–168. Brand 1913, *Annuaire Conserv. Jard. Bot. Genève*, vol. XV et XVI, p. 341.

Type: Mexico: Baja California, "*Orcutt*, Herb. Gray."

Lectotype (here designated): Mexico, Baja (Lower) California: 29 July 1884, *Orcutt*.

Lectotype: F 371743!. Isolectotype: F 152771!.

Other original material: 29 July 1883, *Orcutt* (UC 124867 [image!]), 30 July 1883, *Orcutt* (US 1338026 [image!]).

Other representative specimens: *Grant 502* (G [image!]; not POM!, not GH!); 17 July 1906, *Brandegee* (UC [image!], POM!).

=*Gilia floccosa* var. *ambigua* M.E. Jones 1910, *Contr. W. Bot.* No. 13 p. 2.

Syntypes: USA, California, San Bernardino County: Victor [Victorville], 17 May 1903, *Jones 10011* (POM 74599!, DS 677923 [image!], NY 336846 [image!], GH!); USA, California, San Bernardino County: Bear Valley, 19 July 1900, *Jones 9917* (POM 74589!).

Lectotype (here designated): *Jones 9917* (POM 74589!). No known isolectotypes.

≡as to name, but not application: *Gilia virgata* (Bentham) Steudel var. *ambigua* (M.E. Jones) T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 412–413.

≡as to name, but not application: *Hugelia virgata* Bentham var. *ambigua* (M.E. Jones) Jepson 1943, A Flora of California Vol. 3 Part II p. 165.

≡as to name, but not application: *Eriastrum sapphirinum* (Eastwood) H. Mason subsp. *ambiguum* (M.E. Jones) H. Mason 1945, *Madroño* 8(3): 80–81.

=*Gilia floccosa* var. *exsuta* [*exserta*?] M.E. Jones in herb (POM 74589!, *Jones 9917*).

"Hugelia linifolia" (DS113244!). A Jepson annotation? unsigned, in pencil.

Annual herb, 3–35 cm high or more, erect, loosely branched from the base or not, racemose, or paniculate, the main stem and some of the principal branches sometimes zig-zag, occasionally tortuous if growing in deep shade. **Stems** green, becoming reddish-brown with age, slender, flexible, sparsely-leaved, internodes to 3 cm; herbage viscid-glandular-hairy throughout, subglabrous or sparsely woolly. **Leaves** alternate, entire to pinnatifid, ascending to spreading, often with the base ascending but the distal part curving to spread, 4–44 (–50) mm long, linear, subterete, tipped with a white bristle, light green to reddish-brown, subglabrous or sparsely woolly; entire or the uppermost sometimes 3-lobed (rarely 5-lobed), lateral lobes usually arising near the proximal end of the leaf; lateral lobes 1–6 mm long and bristle-tipped. **Inflorescences** few to several hundred per plant, capitate, 1- to 4-flowered, heads small, about 5–6 mm long and 2.5–8.0 mm wide, mostly terminal, subglabrous to lightly floccose; peduncles to 10–15 mm long, generally glandular. **Bracts** pinnatifid, mostly ascending, few, 3–13 (–16) mm long, equal to or exceeding the head, light green to green, sometimes membranous in sinuses between lobes, glandular and sparsely woolly, sometimes markedly glandular, mostly 3-lobed (sometimes entire or 5-lobed), lobes arising near the base of the bract; lateral lobes 1–3.5 mm long; apices aristulate. **Calyx** 5.5–8.5 mm long, campanulate or tubular, sepals fused about 2/3 of their length, the central green rib of each sepal 0.75 mm wide, slightly narrower than the membranous fold between, glandular-puberulent and viscid, lightly floccose, tip aristulate, sometimes reddish, lobes subequal to unequal, differing in length by about 0.5–2.0 mm. **Corolla** broadly funnelform to sub-salverform, actinomorphic to slightly zygomorphic (color pattern sometimes more strongly zygomorphic), sometimes upper and lower sides are asymmetric but that apparent only in side view, (8–) 10.5–15.0 mm long; the tube 2.3–4.1 mm long (23–34% of corolla), white, with scattered short papillae inside (projections from epidermal cells); throat 1.0–3.5 mm long, white usually with yellow patches or dots, sometimes asymmetric due to differing heights of the sinuses; tube plus throat (3.4–) 4.8–6.9 mm long, slightly surpassing the calyx lobes; corolla lobes 5.4–8.3 (–10) mm long and 2.6–3.8 mm wide, about half to almost 2/3 of the total length of the corolla (49–62% (–68%) of the corolla), lobes differing in length within a flower by 0.0–0.5 mm, broadly obovate to elliptic, apex retuse to rounded or subacute (sometimes irregularly crenate), sapphire blue, light blue, or bluish-lavender, veins sometimes darker, often with dark purplish spots or streaks near the bases of the lobes, lobes often yellow and white proximal to that. Buds yellow to blue. **Stamens** exserted about 3.6–5.9 (–7) mm past the sinuses, but still about 1 mm shorter than the corolla lobes, attached 1.6–4.0 mm below the sinuses; free portion 5.5–10 mm long, to base of corolla 6.6–11.4 mm long, unequal, differing in length within a single flower by up to 3.5 mm (usually 2 mm or less), shorter stamens often toward the upper side and longer stamens often lower; filaments 4.8–8.5 mm long, differing in length within a flower by 0.3–2.4 mm, white to pale blue; the anthers 2.0–3.25 mm long and about 1 mm wide, white, oblong, sagittate, and versatile. Pollen white to gray or lavender, average grain diameter 33 µm. **Pistil** 9.5–12.5 mm long, style and ovary tip with few to many scattered 3–6-celled trichomes, glandular or not; stigmas lobes short, 0.6–0.8 mm long, narrowly linear; style approximately equal in length to the stamens or projecting beyond them, 7.0–10.25 mm long, white to pale blue; ovary at anthesis about 1.25–1.75 mm long and 0.6–1.0 mm wide, 3–6 (–7) ovules per locule. **Capsule** at maturity barely surpassing the calyx lobes (or equal to calyx), about 3–5 mm long and 1.5–2.5 mm wide, broadly elliptic, usually with 1–2 seeds in each locule, the other ovules present but abortive. **Seeds** about 1.8–2.4 mm long, 1.0–1.1 mm wide, tan, elliptic to angular (Fig. 281–291 [Color Plate 8]; Eastwood 1904: 71–72; Craig 1934*b*: 411; Munz 1959: 495; Harrison 1972: 13; S. De Groot, unpubl. data).

Identification.—See notes above about how to distinguish this species from several other co-occurring species of *Eriastrum*.

The main distinguishing characters of *E. sapphirinum* subsp. *sapphirinum* are the sparse wool and dense glandular pubescence on the upper stems and foliage; the few bracts around the inflorescence heads; three (occasionally four) or fewer flowers per inflorescence; and the broad, membranous margins of the sepals (Eastwood 1904; S. De Groot, pers. obs.). Both subspecies *dasyanthum* and *brevibracteatum* have enough bracts to hide most of the calices, usually have more than three flowers per head, and are fairly densely woolly in the inflorescences and upper stems.

In addition to having glandular hairs on its upper stems, *E. sapphirinum* subsp. *sapphirinum* is distinguished from *E. pluriflorum* subspp. *pluriflorum* and *sherman-hoytae* by its shorter corolla tube plus throat: in subsp. *sapphirinum* it is 7 mm or shorter, while in subspp. *pluriflorum* and *sherman-hoytae* it is 7.7 mm or longer. *Eriastrum pluriflorum* does not have dense glandular pubescence on its stems.

Phenology.—Flowering from about late May through August and probably into September at some sites. Fruiting from late June through September or October.

Distribution.—Southern California and Baja California; Transverse Ranges, South Coast, Peninsular Ranges (Fig. 309).

Habitat.—*Eriastrum sapphirinum* subsp. *sapphirinum* is found at elevations of about 350 to 2650 m (1150–8700 ft) above sea level, in clearings or open areas on flats, gentle slopes, rolling hills, banks, or road shoulders. Some sites had burned in the past few years. The slope varies from flat to 20°, and north-, northwest-, west-, southwest-, and east-facing aspects have been reported. The substrate is usually a sandy soil mixed with various kinds of organic matter or leaf litter, sometimes adobe or loam. The rock type is mostly granite or mixed alluvium, which sometimes contains carbonates or other volcanic rock. The surrounding vegetation may be meadow, grassland/savannah, chaparral, oak-sagebrush scrub, mixed woodland, mixed forest, conifer forest, or combinations of several of these types. At some sites, plants may be mixed with other forbs and annual grasses.

Population dynamics.—Population sizes of a little more than 100 to over 3000 plants have been recorded. Plants usually grow in patches in open areas. Although one patch measured about 9 m × 4.5 m (30 × 15 ft), patches vary greatly in size among sites and among years. Where they occur, plants have been observed to be scattered, locally frequent, common, or abundant. At one site, plants were particularly common around ant nests.

Threats.—Vehicle use, trail use, road or trail maintenance, development.

Conservation.—Global rank: G3G4TNR – vulnerable, subspecies not ranked (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—The specific epithet is from Latin *sapphirus*, sapphire, and *–inus*, which indicates possession or resemblance. Presumably the epithet refers to the blue corollas, which may resemble sapphires. The subspecific epithet *gymnocephalum* is from Greek *gymno-*, naked, and *–cephalus*, -headed; literally, "naked-headed," referring to the few bracts subtending the inflorescence heads. The epithet *oligantha* is from Greek *oligo-*, few-, and *anthos* (Latin *anthus*), flower, again probably referring to the 1–3 flowers per head. The epithet *ambigua* is from the Latin *ambiguus*, meaning doubtful or uncertain. Perhaps Jones, who published this name, was uncertain what it was or where it belonged: although he described it as a variety of *Gilia floccosa*, a syntype of *Gilia virgata* var. *yageri* M.E. Jones (=*E. eremicum* subsp. *yageri*) was labeled "Gilia virgata var. ambigua" (POM 74570!). Or he may have been uncertain that it was actually different from typical *Eriastrum sapphirinum*, which is understandable since the lectotype, *Jones 9917*, falls within the circumscription of *E. sapphirinum* subsp. *sapphirinum*.

Common name.—Sapphire woolly-star.

Other specimens.—Eastwood (1904) cited *H.M. Hall 2630* as a younger specimen of *G. sapphirina*, but this number apparently refers to a collection of *Dicentra chrysantha*, not an *Eriastrum* (CCH 2015). It is uncertain to what specimen Eastwood was referring, unless instead she meant *Hall 2635*, which is *E. sapphirinum* subsp. *sapphirinum* and was collected in the San Jacinto Mountains (POM 3554!, DS 140983!). Alternatively, there is *Hall s.n.* from 1896, also collected in the San Jacinto Mountains, which also is *E. sapphirinum* subsp. *sapphirinum* (DS 24786!).

Discussion.—It is possible that there were two specimens of *Trask* [in 1903], one at CAS and one at B, since Brand suggested that he had seen a type specimen for *G. sapphirina* (Brand 1907: 168; see discussion about Brand nomenclature in the Introduction). Alternatively, Brand may have received the CAS specimen on loan. Whatever the case, since the entire Polemoniaceae collection in the Berlin herbarium was destroyed (Hiepko 1987), currently the only known type specimen for this name is at CAS. Because there is just a single specimen, it may be called the holotype (McNeill 2014).

Following the discussion of Brand nomenclature in the Introduction, the Orcutt specimens at F (152771, 371743), UC (124867) and US (1338026) are the only known specimens available to use as lectotypes for *N. virgata* subsp. *gymnocephala* var. *oligantha*, since none of the Orcutt specimens at GH match the original description. Because it is a good specimen matching Brand's description, F 371743 has been chosen as the lectotype, with F 152771 as an isolectotype. However, this lectotype may be superseded if an Orcutt specimen matching Brand's original description is found at GH, or if a specimen is determined to have been seen by Brand or was at GH ca. 1902–1905.

Since Jones cited two syntypes when he described *Gilia floccosa* var. *ambigua* M.E. Jones (1910: 2), one of those should be designated as the lectotype. The protologue specifies that the corolla is "5–6 lines long" (10.6–12.7 mm; 1 line = 1/12 inch or 2.1167 mm) and that anthers are exserted (Jones 1910: 2). *Jones 10011* has corollas barely 5 lines long, with anthers exserted from the throat, but not past the lobes. *Jones 9917* has corollas within the range of 5–6 lines in length, and anthers exserted slightly beyond the lobes. Therefore, *Jones 9917* has been designated as the lectotype, because it better fits Jones' original description.

However, *Jones 9917* is not markedly different from the typical subsp. *sapphirinum*. Craig already noted this, citing *Jones 9917* as an example of an intergrade between vars. *ambigua* and *sapphirina* (1934*b*: 412, 413). Both Craig (1934*b*) and Mason (1945) recognized *ambigua* as a desert form of E. *sapphirinum*, which they considered to be typified by *Jones 10011*. But while *Jones 10011* is typical of the desert form, it does not fit Jones' original description as well as *Jones 9917*.

While some nomenclatural confusion may result, the best solution appears to be to designate *Jones 9917*, which best fits the protologue, as the lectotype of *Gilia floccosa* var. *ambigua* M.E. Jones. Since this specimen is a form not distinct enough from typical *sapphirinum* to be recognized, var. *ambigua* M.E. Jones will become a synonym of *E. sapphirinum* subsp. *sapphirinum*. The desert form, however, is a distinct entity and recognizable from typical *sapphirinum*, and will receive the new name *brevibracteatum* and a new type. *Jones 10011* falls within the circumscription of subsp. *brevibracteatum* and could have been used as the type, but the flowers are not well preserved.

Blanche Trask (=Luella Blanche Engles) was a resident of Santa Catalina Island 1893–1912 and made most of her collections there (Cantelow and Cantelow 1957). I have not found any information about the occasion of her collection of the type specimen in the San Jacinto Mountains in November 1903. Only one other collector, H. E. Hasse, was in the San Jacinto area in November (22), 1903 (CCH 2013). Possibly Ms. Trask was in the company of Mr. Hasse, although his collection was made in Chino Canyon on the opposite side of the mountains to the likely area of Ms. Trask's collection (see below; CCH 2013).

Ms. Trask collected only one other plant on San Jacinto in November 1903, per CCH: *Pinus quadrifolia*, with the same location: San Jacinto Mts. If the coordinates for other georeferenced CCH specimens are correct, other specimens of *P. quadrifolia* are mapped mostly along the Palms to Pines Hwy (74), south of Idyllwild and Hwy 243; the highest concentration of collections is near the junction with the road to Anza (Hwy 371). Checking CCH records for *E. sapphirinum* subsp. *sapphirinum* in the same area shows an overlap of ranges in the Garner Valley area. While one cannot be sure that Trask collected either species there, it seems possible.

Some plants of *E. sapphirinum* subsp. *sapphirinum* from San Diego County have very few woolly hairs, having heads that are almost glabrous, but usually still glandular. Other plants of *E. sapphirinum* subsp. *sapphirinum* have 5 or 6 flowers per head, although this is rare.

According to Craig (1934*b*: 412), *oligantha* (or subsp. *gymnocephalum*) refers only to extreme specimens of *E. sapphirinum* from the southern end of its range (northern Baja California), plants with smaller flowers and smaller heads, and flowers generally on pedicels. Given the range of the variation within the rest of subsp. *sapphirinum*, this form is simply toward one end of a continuum of morphological variation.

13B. ERIASTRUM SAPPHIRINUM (Eastwood) H. Mason subsp. **brevibracteatum** De Groot, subsp. nov.

Type: USA, California, Kern County: Southern Sierra Nevada, Short Canyon, west of Inyokern and Highways 14 and 395, along road following Los Angeles Aqueduct. 35.70139° N, 117.90083° W (NAD 27), 1027 m/3370 ft elevation. Hillside, coarse granitic sand, Mojave Desert scrub. 20 June 2005, *S. J. De Groot 5052*.

Holotype: RSA! Isotype: CAS!

Gilia floccosa var. *ambigua* M.E. Jones has been misapplied to this taxon, and in prior treatments, subsp. *brevibracteatum* may have been treated under any of the following names:

=(in part) *Gilia floccosa* var. *ambigua* M.E. Jones 1910, *Contr. W. Bot.* No. 13. p. 2.

Included in *Gilia virgata* (Bentham) Steudel var. *floccosa* (A. Gray) Milliken. Macbride 1917, *Contr. Gray Herb.* NS Vol. 49 No. 3 p. 57–58.

=(in part) *Gilia virgata* (Bentham) Steudel var. *ambigua* (M.E. Jones) T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 412–413.

=(in part) *Hugelia virgata* Bentham var. *ambigua* (M.E. Jones) Jepson 1943, A Flora of California Vol. 3 Part II p. 165.

=*Eriastrum sapphirinum* subsp. *ambiguum* (M.E. Jones) H. Mason 1945, *Madroño* 8(3): 80–81.

Included in Eriastrum sapphirinum subsp. sapphirinum. Harrison 1972, Brigham Young University Science Bulletin 16(4): 13–15.

=*Gilia floccosa* A. Gray var. *exserta* M.E. Jones in herb. (NY 336846 [image!], *Jones 10011*).

=*Gilia floccosa* var. *exserta* M.E. Jones in herb. (DS 677923 (image!), *Jones 10011*, ex POM 75010. POM 74599, also *Jones 10011*, has no annotation about var. *exserta*).

Annual herb, 3.5–25 cm tall, spreading to 23 cm wide. **Stems** from base or above, depending on the amount of space available, erect to spreading, generally widely branched, racemose or paniculate, smaller plants virgate, stems sometimes zig-zag, slender, upper stems green, lower stems reddish-brown or tan, stems lightly floccose, becoming subglabrous with age, densely glandular-hairy, at least on the upper stems; internodes about 2.5–25 mm long; axillary shoots mostly not present, axillary buds rarely developed below inflorescence branches. **Leaves** alternate, entire to pinnatifid, ascending to spreading, (6–) 7–44 mm long, older leaves reddish-brown or tan, younger leaves green to gray-green, floccose to subglabrous, not stiff, apex subulate to aristate; lower leaves entire to 3-lobed, upper entire to 5- or occasionally 7-lobed (mostly 3–5-lobed), lateral lobes mostly arising from proximal third of the leaf, 1–7.5 mm long. **Inflorescence** capitate, 1–many heads per plant, generally only 1 head per branch, terminal, occasionally some small axillary heads present in large plants; heads 4–7 mm long, 4–10 mm wide, some heads on lower branches 2 mm wide, in more typical forms the heads are mostly 7 mm wide or less (even in fruit), woolly to densely woolly, with 3–12 or more flowers per head (usually 1–5 open at one time). **Bracts** pinnatifid, outer ascending to spreading, inner appressed, numerous enough to hide the calyces, 3–15 mm long, some outer bracts occasionally exceeding the calyces, but most bracts approximately equal in length to the calyces, yellow-green or gray-green, tips often reddish or brown, inner bracts pinnatifid, generally densely woolly, outer bracts sometimes densely woolly, sometimes lightly floccose, sometimes markedly glandular, apices aristate; outer bracts 3–5- or occasionally 7-lobed, rarely entire (if entire, usually in

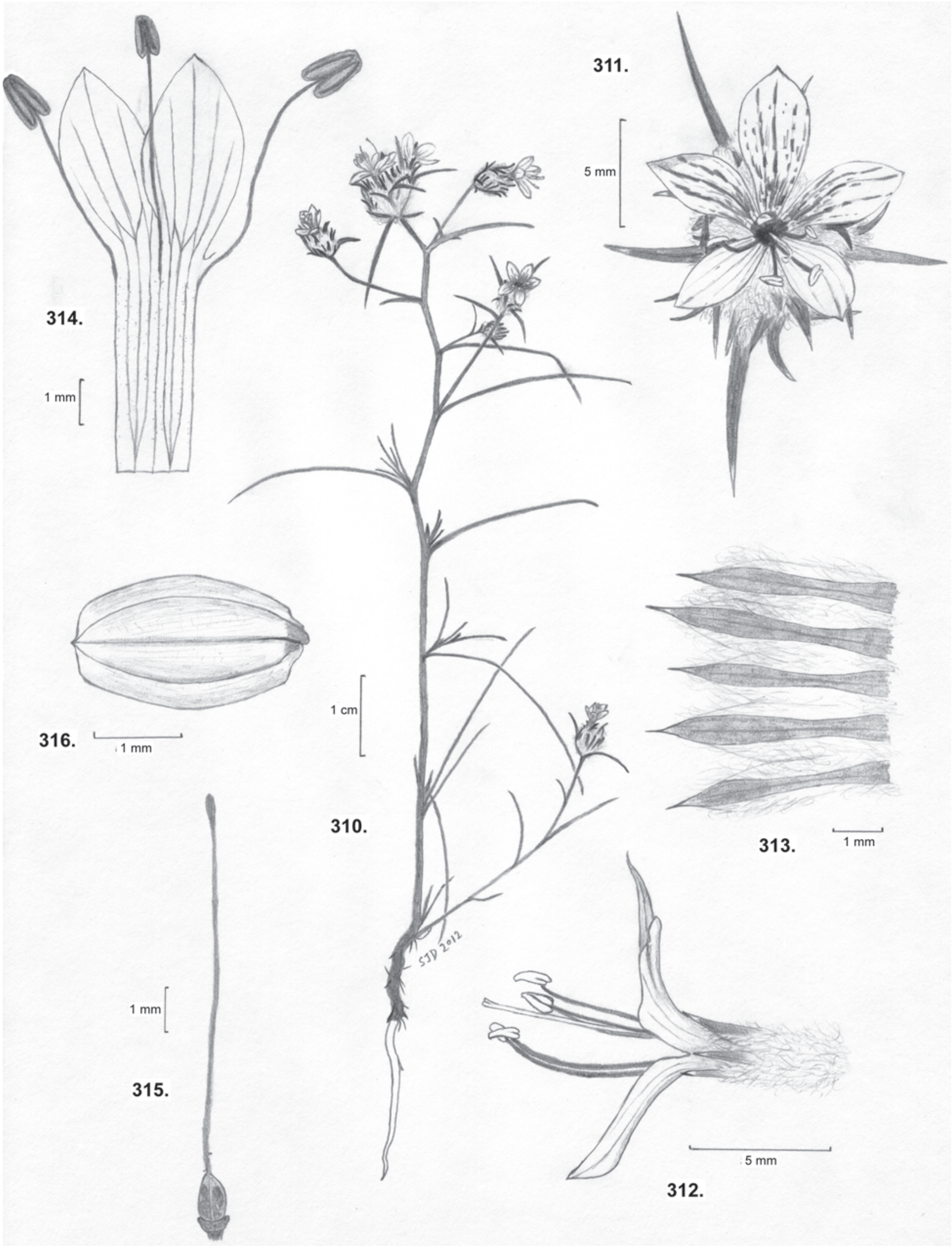

Fig. 310–316. *Eriastrum sapphirinum* subsp. **brevibracteatum**.—310. Habit (*De Groot 5854*).—311. Inflorescence and flower in face view (*De Groot 5854*).—312. Flower in side view (*De Groot 5854*).—313. Opened calyx (*De Groot 5052*).—314. Two petals of opened corolla, with three stamens (*De Groot 5052*).—315. Gynoecium with stigma, style, ovary, and nectary disk (*De Groot 5052*).—316. Capsule (*De Groot 5052*).

depauperate plants), inner bracts generally 3–5-lobed, occasionally entire, lateral lobes arising from the proximal third of the primary axis in outer bracts and the proximal half in inner bracts, 1–6 mm long, the primary axis sometimes not much longer than the lateral lobes. **Calyx** 4–5.5 mm long, sepals yellowish green with hyaline margins, very woolly, hidden by bracts and trichomes, apices aristate, the lower half to two-thirds fused into a tube, lobes subequal, differing in length by 0.25–0.75 mm. **Corolla** subsalverform to narrowly funnelform, slightly medially zygomorphic to nearly actinomorphic, sometimes only the color pattern is zygomorphic and the corolla shape is not, 7–10.4 mm long, tube included in calyx, throat included or exserted, lobes exserted from calyx; tube 2.6–4.0 mm long, about a third of the total corolla length, white, sometimes upper tube fading into the blue or purple of the lower throat, papillate inside with short projections from epidermal cells; throat 0.5–1.9 mm long, often asymmetric, the upper side longer than lower, white with a purple ring in the proximal portion, or all purple, or all white, sometimes with yellow or pale yellow patches; tube plus throat 3.0–5.8 mm long; lobes elliptic to narrowly obovate, 3.5–5.3 mm long, varying in length within a flower by 0.0–0.5 mm, about half or slightly more than half of the total corolla length, 1.5–2.9 mm wide, pale blue, sky blue, royal blue, lavender, white, cream, or occasionally pale yellow, often with darker blue or purple or reddish spots or stripes, veins sometimes darker blue or purple, the base sometimes whitish or pale yellow, abaxial lobe surface sometimes pale yellow; young buds pale to golden yellow, older buds blue, throat yellow in bud. **Stamens** exserted 2.3–5.7 mm beyond the sinuses, 1.9 mm shorter than lobes to 1.0 mm longer, attached (0.3–) 0.8–2.2 mm below the sinuses, the insertion distance varying within a flower by 0.1–0.9 mm; free portion 5–7 mm long, to base of corolla 6.5–10.0 mm long, equal to slightly unequal, differing in length by 0.1–1.2 mm; filaments 2.8–7.3 mm long, differing in length by 0.3–1.3 mm, dark blue or purple to pale blue or nearly white, usually curving up at the distal tips; anthers dehiscing on the upward side, 1.5–1.75 mm long, 0.75–1 mm wide, grayish lavender to bluish, cream, white, or pale yellow, ovate to narrowly elliptic, sagittate, versatile. Pollen blue, cream, or white, average grain diameter 25 μm, anomotreme aperture arrangement. **Pistil** 8–9.5 mm long, exserted about 0.5–1 mm beyond the stamens at anthesis to nearly equal with the stamens, ovary tip with a few 2–4-celled glandular trichomes, style with many trichomes particularly in the proximal half; stigma lobes 0.25–0.5 mm long; style 7–8.5 mm long, pale blue or lavender, to nearly white; ovary 3-loculed, at anthesis about 1 mm long, 0.5–1 mm wide, with (1–) 2–4 ovules per locule. **Capsule** about 3 mm long, 1.5–2 mm wide. **Seeds** liver-brown, about 2 mm long, 1 mm wide (Fig. 300–308 [Color Plate 8], 310–316).

Identification.—See notes above on how to distinguish *E. sapphirinum* from other species of *Eriastrum*.

Eriastrum eremicum subsp. *eremicum* can be distinguished from *E. sapphirinum* subsp. *brevibracteatum* by its longer corollas (11 mm or longer), while those of subsp. *brevibracteatum* are usually less than 10.5 mm long. The majority of the length difference is in the tube plus throat, with subsp. *eremicum* 7.6 mm or longer, and subsp. *brevibracteatum* 5.8 mm or shorter. Subspecies *eremicum* frequently has more lobes (5 or more) on its leaves than subsp. *brevibracteatum* (1–5, sometimes 7). Subspecies *brevibracteatum* has dense glandular hairs on its upper stems, while *E. eremicum* is not noticeably glandular-hairy.

Eriastrum sapphirinum subsp. *brevibracteatum* generally has more woolly trichomes on its upper stems and inflorescences than subsp. *sapphirinum*, and also usually has 3 or more flowers per inflorescence head, and many bracts, while subsp. *sapphirinum* usually has at most 4 flowers, and usually fewer, with at most one or two bracts per flower. The calyces of subsp. *brevibracteatum* are usually 5.5 mm or shorter, while the calyces of subspp. *sapphirinum* and *dasyanthum* are usually 5.5 mm or longer. The corolla of subsp. *brevibracteatum* is generally 10.4 mm or shorter, in contrast to the corolla of subsp. *sapphirinum*, which is generally 10.5 mm or longer. Anthers of subsp. *brevibracteatum* are mostly less than 2 mm, while the anthers of subspp. *sapphirinum* and *dasyanthum* are mostly 2 mm or longer. The bases of the outer bracts of subsp. *brevibracteatum* are often broader and often have at least two more lobes than the bracts of the other subspecies. In general, bracts, corollas, and stamens tend to be shorter in subsp. *brevibracteatum* compared to the other subspecies.

Phenology.—Flowering from late April through about mid-July and possibly later. Fruiting from about June through September or October.

Distribution.—California endemic (Kern, Los Angeles, Riverside, San Bernardino, Ventura Counties); Southern Sierra Nevada, western Mojave Desert, north (desert) slope of Transverse Ranges (Fig. 309).

Habitat.—*Eriastrum sapphirinum* subsp. *brevibracteatum* is found between elevations of 390 and 2200 m (1280–7220 ft). It is found in open sunny areas, often between shrubs, on hillsides, slopes, floodplains, flats near washes, or roadsides. The local slope varies from 2° to about 20° (the larger area may be more steeply sloped) and all aspects have been documented. Plants grow in silt, sand, loam, rock, talus, or mixtures of these types. Soils are derived from granite, limestone, or are mixed alluvium. The surrounding vegetation may be Mojave desert or Great Basin scrub, sagebrush scrub, blackbrush scrub, chaparral, Joshua tree woodland, or open pinyon-juniper woodland, and often there are mixtures of one or more of these types. Some areas appear to have burned in the recent past.

Population dynamics.—Population sizes from about 50 to more than 100,000 have been recorded. Plants tend to be found in patches, sometimes fairly small, scattered patches, but can be scattered, locally common, or abundant where they occur.

Threats.—Vehicle use, road or trail maintenance, or development.

Conservation.—Global rank: G3G4TNR – vulnerable, subspecies not ranked (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—From Latin *brevis*, short, *bractea*, bract, and *–atus*, indicating possession or likeness, referring to the bracts which are mostly the length of the head or shorter. Literally, "having short bract".

Common name.—Ambiguous short-bracted sapphire woollystar.

Paratype.—USA, California, San Bernardino County: Victor [Victorville], 17 May 1903, *Jones 10011* (POM 74599!, DS 677923 [image!], NY 336846 [image!]), GH!).

Discussion.—Jones' name *Gilia floccosa* var. *ambigua* was represented by two type specimens, *Jones 10011* and *Jones 9917*. However, these specimens represented different entities: *Jones 9917* was typical *E. sapphirinum*, or close to it, while *Jones 10011* represented a desert form of *E. sapphirinum* with smaller flowers (Craig 1934*b*; Mason 1945). Because *Jones 9917* was close to typical *E. sapphirinum*, *Jones 10011* came to be seen as the type of the name *ambigua*, which when applied in that way, was a recognizable and distinct subspecies. However, *Jones 9917* fits the original description better. Therefore, to preserve the usage that Jones intended for the name *ambigua*, *Jones 9917* has been designated as the lectotype. Since *Jones 9917* falls within the circumscription of *E. sapphirinum* subsp. *sapphirinum*, the name *ambigua* becomes a synonym of subsp. *sapphirinum*. However, the entity represented by *Jones 10011* still should be recognized. With the name *ambigua* a synonym of subsp. *sapphirinum*, a new name has been created for this desert form. *Jones 10011* falls within the circumscription of subsp. *brevibracteatum* and is considered a paratype. Since the flowers are not well preserved, it is less than ideal for a holotype specimen. See also the notes under subsp. *sapphirinum* about the circumscription and application of *E. sapphirinum* subsp. *ambiguum* (M.E. Jones) H. Mason and the nomenclatural relationship of that taxon to subsp. *brevibracteatum*.

13c. ERIASTRUM SAPPHIRINUM (Eastwood) H. Mason subsp. DASYANTHUM (Brand) H. Mason 1945, *Madroño* 8(3): 80.

Basionym: *Navarretia virgata* (Bentham) Brand [subsp. *gymnocephala* Brand] var. *dasyantha* Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 168.

Syntypes: USA, California, Los Angeles or San Bernardino County: San Antonio Mountains, alt. 6700 ft, 31 July 1896, *Hall 298* (K 545585!); USA, Southern California, no location specified, 1876, *Parry and Lemmon 249* (G 308354 [image!], M 185269 [image!], POM 158811!, CAS 497576!, BM 939598!, NY 1012845 [image!]); USA, California, San Bernardino County: San Bernardino, 1881, *Parish and Parish 1478* (UC 190883 [image!], GH!); USA, California, San Bernardino County: vicinity of San Bernardino, alt. 1000–1500 ft, 20 July 1895, *Parish 3803* (GH!, UC 23881 [image!]). Original types probably at B, destroyed (Hiepko 1987).

Lectotype, designated here: *Parry and Lemmon 249*, G 308354 (image!). Isolectotypes: M 185269 (image!), BM 939598!, POM 158811!, CAS 497576!, NY 1012845 (image!).

≡*Navarretia virgata* (Bentham) Brand [subsp. *gymnocephala* Brand] var. *dasyantha* Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 168.

Included in *Gilia virgata* (Bentham) Steudel var. *floccosa* (A. Gray) Milliken. Macbride 1917, *Contr. Gray Herb.* NS Vol. 49 No. 3 p. 57–58.

≡*Hugelia virgata* Bentham var. *dasyantha* (Brand) Jepson 1925, A Manual of the Flowering Plants of California, p. 793. Jepson 1943, A Flora of California Vol. 3 Part II p. 164–165.

≡*Gilia virgata* (Bentham) Steudel var. *dasyantha* (Brand) T.T. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 395–396.

Annual herb, slender to somewhat robust, 3–54 cm tall. **Stems** usually much branched both from base and above, erect, racemose, virgate, corymbose, or paniculate, generally somewhat stout, upper stems green to tan, lower stems reddish, middle stems often green and spotted or streaked with red-brown, upper stems glandular and floccose, lower stems white floccose, becoming glabrate in age, stems sometimes becoming thick and stout near the base in larger plants; internodes up to about 3 cm long, rarely to 5.7 cm; axillary shoots often present. **Leaves** alternate, entire to pinnatifid, ascending, lower sometimes spreading to slightly recurved, linear but not filiform, 7–40 (–55) mm long, green, becoming reddish in age, glabrous to floccose, usually slightly glandular, somewhat stiff, apex aristate; entire to 5-lobed, the lateral lobes arising from the proximal half of the leaf, 1–15 mm long. **Inflorescence** capitate, with few to very many heads, mostly terminal but sometimes axillary heads present, generally arranged racemosely along each branch; terminal heads 5–8 (–10) mm long, 5–15 (–17) mm wide, (3–) 5–10-flowered (usually 1 to a few flowers open at one time), axillary inflorescences may be narrower and have fewer flowers, all heads may be wider in fruit, densely floccose. **Bracts** pinnatifid, ascending, tips often spreading, outer bracts often prominent, usually with 6–14 bracts per head, 4–16.5 (–20) mm long, at least the tips of some bracts usually exceeding the calyces, bright green to green, tips sometimes reddish, floccose at least at the base, glandular, apex aristate; usually with 3–5 lobes, inner bracts occasionally entire, lateral lobes arising near the proximal end of the bract, 1.5–7 mm long. **Calyx** 5.5–7 mm long, sepals bright green to green, tips sometimes reddish, woolly, glandular, apices aristate, margins hyaline, the proximal two-thirds (or generally more than half) fused to form a tube, lobes subequal to slightly unequal, differing in length by 1.0 mm or less, usually by 0.5 mm or less. **Corolla** commonly narrowly funnelform, sometimes subsalverform, nearly actinomorphic or very slightly zygomorphic, color pattern alone is sometimes zygomorphic, 9.2–15 mm long, tube and throat mostly included within calyx, lobes mostly exserted; tube 4.1–6.1 mm long, slightly more than one third of the total corolla length, white to light purplish, with short papillae (projections from epidermal cells) inside; throat 0.8–2.5 mm long, white to purple, sometimes yellow; tube plus throat 5.6–7.7 mm long; lobes elliptic to narrowly elliptic, tip rounded to acute, 3.5–7.0 mm long, varying in length within a flower by 0.0–0.5 mm, slightly more than one third to one half of the total corolla length, 1.8–2.7 mm wide, or the width one third or less of the length, light blue to royal blue, sometimes with a yellow or white spot, or darker blue or purple pigmentation at the base, veins sometimes darker, occasionally a few individuals may have pale blue to white lobes in a population that is otherwise royal blue. Buds light yellow to blue. **Stamens** exserted 2.3–5.2 mm beyond the sinuses, 0.8–2.0 mm shorter than lobes, attached about 0.7–2.6 mm below sinuses (usually about 1 mm), the insertion distance differing within a flower by 0.2–1.0 (–1.2) mm; free portion 5–8 mm long, to base of corolla 7.6–12.1 mm long, subequal to slightly unequal, differing in length within a flower by 0.1–0.9 mm; filaments 3.6–6.6 mm long, differing in length within a flower by 0.3–1.0 mm, light blue to purple, bases sometimes yellow; anthers 1.5–3 mm long, 1–1.5 mm wide, white to light yellow, oblong, sagittate, versatile. Pollen white to cream, pale yellow, or light gray, average grain diameter 29 μm, zonate aperture arrangement. **Pistil** 9–13 mm long, usually exserted a little beyond stamens, 2-celled glandular trichomes present along most of the length of the style (not on extreme distal end), occasionally on tip of ovary; stigma lobes 0.5–0.7 mm long, white; style 7–11.5 mm long, purple to lavender; ovary 3-loculed, at anthesis about 1.25–1.75 mm long and 0.8 mm wide, ovate, with 4–7 ovules per locule. **Capsule** 3–5 mm long, 1.25–2 mm wide, with 1–4 seeds per locule. **Seeds** mucilaginous when wetted, about 1.2–2.0 mm long, 0.6–0.9 mm wide, tan to light brown, mostly angular, occasionally elliptic (Fig. 292–299 [Color Plate 8]; Brand 1907: 168; Craig 1934*b*: 395; Harrison 1972: 15; S. De Groot, unpubl. data). Chromosome number $2n = 14$ (*Grant 16001*, from Claremont, CA; Grant 1959).

Identification.—See notes above on how to distinguish *E. sapphirinum* from other species of *Eriastrum*.

In addition to having glandular hairs on its upper stems (although sometimes hidden by woolly trichomes), *E. sapphirinum* subsp. *dasyanthum* is distinguished from *E. pluriflorum* subspp. *pluriflorum* and *sherman-hoytae* by its shorter corolla tube plus throat: in *E. sapphirinum* it is 7.7 mm or shorter, while in subspp. *pluriflorum* and *sherman-hoytae* it is 7.7 mm or longer. *Eriastrum pluriflorum* does not have dense glandular pubescence on its stems.

Eriastrum sapphirinum subsp. *dasyanthum* generally has more woolly trichomes on its upper stems and inflorescences than subspp. *sapphirinum* or *brevibracteatum*, and also usually has 3 or more flowers per inflorescence head and many bracts (hiding the calyces), while subsp. *sapphirinum* usually has at most 4 flowers, and usually fewer, and few bracts. The corolla lobes of subsp. *dasyanthum* are commonly 2.7 mm wide or less, in contrast to subsp. *sapphirinum*, whose corolla lobes are typically 2.6 mm wide or more. The calyces of subsp. *brevibracteatum* are usually 5.5 mm or shorter, while the calyces of subspp. *sapphirinum* and *dasyanthum* are usually 5.5 mm or longer. Anthers of subsp. *brevibracteatum* are mostly less than 2 mm long, while the anthers of subspp. *sapphirinum* and *dasyanthum* are mostly 2 mm or longer.

Phenology.—Flowering mid-April through early August; fruiting May through about September. Phenology is very dependent on elevation, latitude, habitat, and the amount of winter precipitation. Flowering may start and finish early at one site, and start and finish late at another. Flowering duration is probably not much more than one month at any site.

Distribution.—Southern California and Baja California; Transverse Ranges, South Coast, Peninsular Ranges (Fig. 309).

Habitat.—*Eriastrum sapphirinum* subsp. *dasyanthum* occurs at elevations between about 90 and 2400 m (to 2700 m, De Groot et al. 2012; 295–7875 ft), although most often it is found below about 1000 m (3280 ft). It grows in open areas on alluvial plains or fans, flats, gentle slopes, benches above drainages, washes, meadows, or on roadsides. It has been found in disturbed areas, sometimes with weeds. One fairly vigorous population was discovered at a site that was burned the previous fall, and other plants have been found in older burn areas. Sites are flat or gently sloped, up to about 12°. Aspects from northwest to west to south to east have been reported. The substrate varies from sandy to rocky, sometimes with adobe, loam, or ash, and is usually derived from granite or mixed alluvium. Surrounding vegetation includes mixed montane or coniferous forest, montane meadow, chamise or ceanothus chaparral, coastal sage scrub, grassland, and mixtures of many of these types.

Population dynamics.—Population sizes of about 200 to well over 10,000 plants have been recorded. Plants have been found to be widely scattered to frequent, common, or abundant. They are frequently found in patches, sometimes small, sometimes large.

Threats.—*Eriastrum sapphirinum* subsp. *dasyanthum* is often found in disturbed areas, sometimes with weeds or other annuals, so it appears that it can tolerate some amount of disturbance or competition. Its main threat is probably habitat loss due to urban development, as shown by several historic collections made between about 1902 and 1943 in the north Los Angeles area, and apparently not collected since then.

Conservation.—Global rank: G3G4TNR – vulnerable, subspecies not ranked (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—From Greek *dasy*-, shaggy or thickly hairy, and *anthos* (Latin *anthus*), flower; alluding to the dense woolly trichomes on the bracts and calyx lobes of the flowers.

Common names.—Shaggy woolly-star, hairy woolly-star, woolly woolly-star.

Other specimens.—*Hall 298* (K 545585!) shows resemblance toward subsp. *sapphirinum*. The anthers are exserted, but the flowers are in larger heads than typical for subsp. *sapphirinum*, more like subsp. *dasyanthum*. Perhaps it was growing in shade.

Parish and Parish 1478 from GH(!) apparently has two collections mounted on the same sheet, #1478 and #1478-A. 1478-A adds the location information "San B. Mts" and date "July 1881". The collections look a bit different, but both could fit into the circumscription of subsp. *dasyanthum*. *Parish and Parish 1478* at UC (193883, image!) specifies "Mesas, San Bernardino" and "June 1883". It is possible that the number 1478 is a herbarium number and these collections were not necessarily made at the same place or time. The UC sheet still is within the circumscription of subsp. *dasyanthum*.

Parish 3803 from GH(!) is a very spreading plant. While plants of subsp. *dasyanthum* do sometimes become spreading (S. De Groot, pers. obs.), Brand's description specifies "stems erect," and therefore this does not seem to fit the original description as well as some of the other syntypes. The UC duplicate (23881, image!) is similarly spreading.

Hall 237 (UC 23877, image!) is said to be "identical" to *Hall 298* (Harrison 1972); however, since it was not cited in the protologue it does not have any type status.

Discussion.—G 308354 was chosen as the lectotype because it was annotated by Brand 4 Feb 1906, prior to the publication of the name in *Das Pflanzenreich*, and it fits Brand's original description. Additionally, there are at least four duplicates of *Parry and Lemmon 249* in other herbaria, and plants are in good condition, with some flowers still showing a bit of color.

The location on the label of *Parry and Lemmon 249* is simply "Southern California," so it is of interest to try to determine more specifically where this collection was made. In the spring of 1876, Charles Christopher Parry and John Gill Lemmon made an extensive collection of plants near San Bernardino, as told by C.C. Parry himself: "In the fall of that year [1875] I continued my collecting trip to Southern California, and in the season of 1876, in connection with Prof. J. G. Lemmon, the enthusiastic California botanist made a very full collection of the plants in the vicinity of San Bernardino, including the high mountain district adjoining, and the desert stretches lying east of the Sierra Nevada" (Parry 1878: 281; see also Preston 1893: 43). Edward Palmer joined them in late May, but left in June for San Luis Obispo. They collected at Crafton, San Gorgonio Pass, near Agua Caliente and Palm Springs, San Bernardino Peak, Cajon Pass, the Mojave River, the San Bernardino Mountains, and probably more locales in the area (Beidleman 2006: 390–391). Because Palmer is not listed as a collector, it seems that No. 249 was collected either in May before Palmer arrived, or in June after he had left; or possibly Palmer's name was left off the label for another reason. Parry and Lemmon probably made the collection around San Bernardino, as far east as Crafton.

Harvey Monroe Hall, in 1896, was probably roving his environs near his home in Riverside, shortly before entering the University of California to study botany in 1898 (Babcock 1934). The manuscript of Hall's botanical journeys (Hall, no date) states that from 30 July through 8 Aug 1896, Hall and his mother, Mrs. Martha Hall, explored Swarthout Canyon in the "Sierra Madre Mts." Sierra Madre was an older name for the San Gabriel Mountains (Durham 1998). Hall's collection number 298 was most likely made near 6700 feet elevation in Swarthout Valley, which today would be between Mountain

High West and Mountain High East ski areas, and about one-half mile southeast of Big Pines.

The Parish collections were presumably made near San Bernardino. Samuel Bonsall Parish's address was 772 D Street in San Bernardino, although it is uncertain if he held additional properties elsewhere in the vicinity (see *C.B. Wolf 4263*, "F.M. Parish Ranch," 1.6 miles below Oak Glen in Potato Canyon; CCH 2015; *Ancestry.com*).

14. ERIASTRUM SIGNATUM D. Gowen 2008, *Madroño* 55(1): 82–85.

Type: USA, California, Kern County: Frazier Mountain Park Road west of Lebec, ca. 5.8 mi west of Interstate 5. Growing in granitic sand between the road and stream. 21 May 2005, *D. Gowen 346*.

Holotype: JEPS 100190 (image!); isotypes: BRY, RSA 756539!.

Included in *Gilia floccosa* A. Gray. Howell 1903, A Flora of Northwest America. Vol. 1, Phanerogamae: 458.

Included in *Gilia filifolia* var. *sparsiflora* (Eastwood) J.F. Macbride. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 425–426.

Probably included in *Eriastrum sparsiflorum* by Mason (1945) and Harrison (1972).

=*Gilia* (*Hugelia*) *parviflora* Nuttall in herb. BM 939591!, K! is *E. signatum* or *E. sparsiflorum*.

=*Hugelia parviflora* Nuttall in herb. K! is either *E. signatum* or *E. wilcoxii*.

Explicitly excluded: "Plants found in San Benito, Monterey, and western Kern counties (*Gowen 117*, *Yadon s.n.*, *Twisselmann 1243*, *4466*, *17808*)…" and "Plants from San Luis Obispo Co. that Mason (1945) referred to *E. wilcoxii* (e.g., *Hoover 6162*, *Bacigalupi 5143*, *Gifford 830*)…" (Gowen 2008: 84). =*E. calocyanum*.

Erect annual herb, 2–45 cm high. **Stem** sometimes simple, but often branching near the base, virgate, racemose, or corymbose; stems somewhat stout, green to tan or brown, herbage floccose, becoming subglabrous in age; internodes 0.5–5 cm. **Leaves** alternate, entire to pinnatifid, ascending to spreading, (4–) 7–34 mm long, light green, becoming reddish-brown in age, floccose, becoming subglabrous in age, subulate-aristulate, entire to 3- or sometimes 5-lobed, lateral lobes arising from the proximal half of the leaf, lobes 2–8 mm long. **Inflorescence** heads 1–150 or more per plant, often about 20–30, generally terminal, floccose, 0.5–1.0 cm long, 2–10 mm wide, terminal heads with about 3–11 flowers, axillary heads sometimes 1-flowered. **Bracts** pinnatifid, mostly ascending, 5–20 mm long, exceeding the heads, green, tips often reddish, aristulate, floccose at least at the base, the tips sometimes subglabrous, 3–5-lobed, sometimes entire, lobes arising from the proximal half of the bract, lateral lobes 1–8 mm long. **Calyx** 4.8–10 mm long, sepals green, densely woolly, tips not obscured by trichomes, sometimes reddish, the lower 36–61% fused into a tube, lobes unequal, differing in length by 0.7–3.0 mm. **Corolla** actinomorphic, sub-salverform, 7–11 (–12.4) mm long; tube 4–6 (–7) mm, white or sometimes slightly purplish distally, minutely puberulent inside with very short projections from epidermal cells; throat 0.6–1.6 mm, yellow to pale yellow; tube plus throat 4.5–7.2 (–8.6) mm long; lobes elliptic, 2.0–4.6 mm long and (0.9–) 1–1.5 (–1.7) mm wide, differing in length within a flower by 0.0–0.3 mm, 29–41% of the total corolla length, blue to lavender or light pink to white, sometimes paler proximally, usually with a dark maroon-colored, irregularly shaped spot near the base. **Stamens** exserted 0.8–1.4 mm past the sinuses, but generally at least 2 mm shorter than the lobes, inserted 0.2–1.1 mm below the sinuses; free portion 1.5–3.0 mm long, to base of corolla 6.3–7.9 mm long, subequal, differing in length within a single flower by 0.1–0.3 (–0.5) mm; filaments 1.0–2.2 mm long, white; anthers versatile, sagittate, white, 0.75–1.5 mm long, 0.5–0.75 mm wide. Pollen white to lavender, average grain diameter 29 μm, anomotreme aperture arrangement. **Pistil** 4.6–10.0 mm long, slightly longer (up to about 2 mm) than the anthers, stigma lobes 0.3–0.75 mm long, style ca. 3.3–5.3 mm long, white, tip of ovary with scattered trichomes, 1–3 ovules per locule, 3–7 ovules total. **Capsule** ca. 6 mm long and 2–2.5 mm wide, 3-loculed; seeds (1) 2 per locule (at least 2 seeds in at least 2 of the locules). **Seeds** light gray-brown, mucilaginous when wet, about 1.6–2.8 mm long, 1.0–1.4 mm wide, elliptic, sometimes angular (Fig. 77–81 [Color Plate 2]; Gowen 2008: 82–83; S. De Groot, unpubl. data).

Identification.—The reddish spot at the base of the corolla lobes has been mentioned as a key character for *E. signatum* (Gowen 2008). However, a few populations lack the spot, and other populations have some plants with spots and some without. Also, *E. sparsiflorum* frequently has small purplish spots at the bases of the corolla lobes, and *E. calocyanum* has large spots at the bases of the corolla lobes.

The glandular stems of *E. sparsiflorum* are the best character for differentiating it from *E. signatum*. While the upper stems of *E. signatum* do have glandular hairs, they are sparsely distributed and appear to be 2–3-celled, in contrast to the dense, 4–5-celled glandular hairs of *E. sparsiflorum*. The outer bracts of *E. signatum* may have more lobes (3–5) than the outer bracts of *E. sparsiflorum* (1–3).

Eriastrum calocyanum was excluded from *E. signatum* in part by "slightly longer filaments, attached lower in the corolla tube" and by "longer, unevenly exserted stamens" (Gowen 2008: 84). While in general the stamens of *E. calocyanum* are indeed slightly longer, attached slightly lower in the tube, and exserted slightly farther, there is a good deal of overlap with *E. signatum*. A more reliable distinguishing character is the number of ovules per locule: *E. calocyanum* has only one ovule in each locule, whereas *E. signatum* has two (or more) ovules in at least one locule (see Gowen 2008).

Likewise, *E. tracyi* has only one ovule per locule (rarely one locule might have two ovules, but then the other locules will have only one). There is a trend toward *E. signatum* having slightly longer corollas with stamens attached slightly lower in the tube and exserted slightly farther than in *E. tracyi*, but with a great deal of overlap.

Smaller corollas of *E. hooveri* (≤6 mm long) and *E. ertterae* (<7 mm long) distinguish these species from *E. signatum*, whose corollas are 7 mm long or longer. Stamens are more exserted in *E. signatum* (0.8 mm or more) than in *E. hooveri* (0.1 mm or less) or *E. ertterae* (0.5 mm or less), and the style of *E. signatum* is longer (>3 mm) than the style of *E. hooveri* (2 mm or less) or *E. ertterae* (3 mm or less).

The leaves of *E. signatum* have fewer lobes (1–3) than leaves of *E. abramsii* (3–7), but the bracts have more lobes (3–5) than bracts of *E. abramsii* (1–3). Corollas of *E. signatum* are generally larger than corollas of *E. abramsii*, with the tube plus throat of *E. signatum* 4.5 mm or longer, and that of *E. abramsii* 4.4 mm or shorter. The corolla lobes of *E. signatum* are usually wider (0.9 mm or more) than the lobes of *E. abramsii* (0.8 mm wide or less). Stamens of *E. signatum* are exserted 0.8 mm or farther past the sinuses, while stamens of *E. abramsii* are exserted 0.6 mm or less. *Eriastrum abramsii* has only one ovule per locule, while *E. signatum* usually has two.

Eriastrum diffusum regularly has more than two ovules per locule. Plants are usually fairly widely branched or sometimes spreading, while plants of *E. signatum* are often erect. The stigma of *E. diffusum* may be longer (0.5–1.3 mm) than the stigma of *E. signatum* (0.3–0.6 mm).

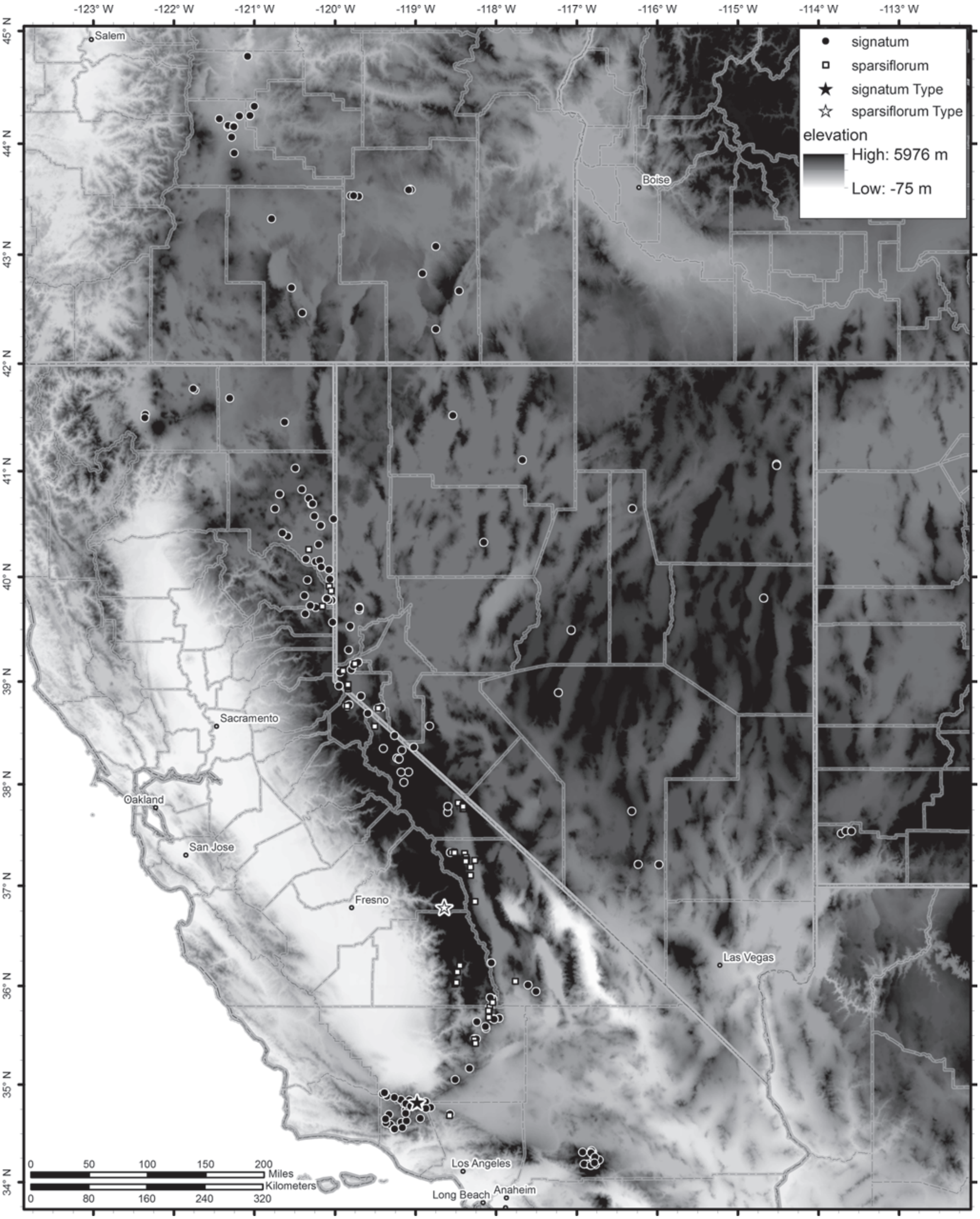

Fig. 317. Range map for *E. signatum* and *E. sparsiflorum*, showing specimen and type locations. County boundaries, major cities, and elevation are shown.

Eriastrum signatum often has fewer leaf lobes (1–3) than *E. wilcoxii* (3–5). In addition, leaves of *E. signatum* are commonly lobed from the base, while leaves of *E. wilcoxii* are often pinnate. The stamens of *E. signatum* are subequal (length difference up to 0.5 mm), while stamens of *E. wilcoxii* vary in length by 0.2–3.0 mm. The anthers of *E. signatum* are usually 1 mm long or less, in contrast to the anthers of *E. wilcoxii*, which are usually 1 mm long or more.

Eriastrum signatum differs from *E. filifolium* in habitat, being found most often in pinyon-juniper woodland, while *E. filifolium* is found mostly in chaparral. Additionally, *E. filifolium* has 3–6 ovules per locule, while *E. signatum* has 3 or fewer (often 2); anthers of *E. filifolium* are usually 1 mm long or slightly longer, while anthers of *E. signatum* are usually 1 mm or shorter; and filaments of *E. filifolium* are usually 2–3 mm long while filaments of *E. signatum* are usually 1.0–2.2 mm long.

While *E. signatum* tends to have fewer leaf lobes (1–3) than *E. pluriflorum* (3 or more), a better distinguishing character is stamen exsertion: stamens of *E. signatum* are exserted less than 1.5 mm beyond the corolla sinuses, while stamens of *E. pluriflorum* are exserted at least 2 mm. The anthers of *E. signatum* are mostly 1 mm long or shorter, while the anthers of *E. pluriflorum* are generally 1 mm or longer.

Eriastrum signatum has an actinomorphic corolla mostly 11 mm long or shorter. Where *E. eremicum* approaches the ranges of this species, its corollas are medially zygomorphic and 11 mm or longer. Furthermore, the stamens of *E. signatum* are usually exserted less than 1.5 mm, while *E. eremicum* in that area usually has stamens exserted more than 3 mm.

The filaments of *E. harwoodii* are mostly shorter (0.75–1 mm long) than the filaments of *E. signatum* (1.0–2.2 mm).

The stamens of *E. sapphirinum* are exserted farther (2.2 mm or more beyond the sinus) than the stamens of *E. signatum* (usually less than 1.5 mm). The filaments of *E. sapphirinum* are also longer (2.8 mm or more) than the filaments of *E. signatum* (2.2 mm or less). The anthers of *E. sapphirinum* are 1.5 mm or longer, in contrast to the anthers of *E. signatum*, which are 1 mm long or shorter.

Phenology.—Flowering from about mid-May through mid-July; fruiting mid-June through early August.

Distribution.—Oregon, Nevada, California [Utah??]; Great Basin, eastern Cascade Ranges, eastern Sierra Nevada, Southern Sierra Nevada, Tehachapi Mountains, Western Transverse Ranges, San Bernardino Mountains, northern Mojave Desert (Fig. 317).

Habitat.—*Eriastrum signatum* is found at elevations between about 915 to 2340 m (perhaps to 2500 m, De Groot et al. 2012; 3000–7680 ft) on hillsides, hill tops, flats, benches above drainages, small washes or dry drainages, ditches, valley bottoms, canyon heads, and roadsides. It has been found often in disturbed areas such as roadsides, road shoulders, in or along dirt roads, or near road gradings. Areas are usually open and sunny, and often in spaces between shrubs, trees, or rock outcrops. The slope is flat to about 20 degrees, and all aspects have been documented. The substrate varies from silt to sand to gravel, sometimes rocky, sometimes with loam, adobe, or boulders, and at times hard-packed. Substrate color is from off-white to brown or reddish, and rock types consist of granite, various volcanics including cinders, other igneous rock, lava, quartzite, and mixed alluvium. Occasionally plants might grow in slightly alkaline substrates. The surrounding vegetation may be mixed forest; open Coulter pine forest; pinyon woodland with oak, juniper, Joshua trees, sagebrush, or grassland; juniper shrubland; Great Basin or Mojave desert scrub, including various sagebrush communities; chaparral or montane chaparral; and mixtures of many of these types. In several cases, plants were found in transition zones between two vegetation types. At one site, plants grew at or near the driplines of junipers.

Population dynamics.—Population sizes from about 20 to over 5000 plants have been recorded, and plants have been observed to be rare, widely scattered, or infrequent to locally frequent, common, or abundant. Often, plants are found in patches of varying sizes.

Threats.—That it has been found often on roadsides, road shoulders, in or along dirt roads, or near road gradings suggests that *E. signatum* may tolerate or prefer some disturbance, although major disturbance that could remove or bury an entire population probably would be detrimental. The species has been found with some weeds, but dense stands of weeds probably would choke it out.

Conservation.—Global rank: G4G5 – apparently secure; otherwise not ranked. This ranking is for *E. sparsiflorum* including *E. signatum*. Since *E. signatum* is the widespread form, this ranking is likely close to appropriate (CNPS 2013; NatureServe 2013; Table 2).

Etymology.—"The specific epithet is derived from the Latin *signum*, meaning mark, or sign" (Gowen 2008: 84) and the suffix *–atus*, indicating possession or likeness.

Common name.—Spotted woolly-star.

Discussion.—According to the RSA isotype and the JEPS holotype, the month of collection given in the protologue (June) is incorrect; it should be May.

Although the spot at the base of the corolla lobe is a key character, some populations lack the spot, and other populations are mixed, some plants having spots, and others lacking it. Populations in the Mt. Pinos area especially seem to lack the spots, but populations from other areas (e.g., Owens Valley) also may lack spots. The holotype (JEPS) includes at least one flower with spots and apparently at least one flower without spots. For the moment, both populations having the spot and lacking the spot are included within *E. signatum*, but additional study should be done to determine if this is simply phenotypic plasticity or if the presence or absence of the spot indicates a fundamental difference such that these should be treated as separate taxa.

At one site, plants growing under pinyon had pinkish corolla lobes, while plants growing in open, sunny areas between pinyon had light blue corolla lobes. This might possibly be related to soil pH (S. De Groot, pers. obs.; and J.M. Porter, pers. comm.).

Craig (1934*b*) mentioned two races within *Gilia filifolia* var. *sparsiflora*, loosely corresponding to *E. sparsiflorum* and *E. signatum*: "Var. *sparsiflora* was originally described by Miss Eastwood from specimens collected in the Sierra Nevada.

These represent a rare race of the variety, for there are two poorly defined races. The first from montane and cismontane California of which Miss Eastwood's collections are typical; as is *Hall* 6580 from Mt. Pinos (P). The other race is from the desert regions of California, Oregon, Washington, Nevada and Idaho, and is more woolly and has larger flower clusters; *Munz 11,101* is typical of this race" (Craig 1934*b*: 426). Craig was partly right—*E. sparsiflorum* has a smaller range than *E. signatum*, and *E. signatum* is more woolly and has larger flower clusters. However, both species occur in both cismontane and desert areas. It is interesting that although Craig published this observation, it took 75 years before these races were recognized as separate species.

Eriastrum sparsiflorum has a much more restricted range than *E. signatum*, although they overlap through much of the range of *E. sparsiflorum* (Fig. 317). *Eriastrum signatum* is much more widespread than *E. sparsiflorum*, being found in several floristic regions (McLaughlin 2007).

15. ERIASTRUM SPARSIFLORUM (Eastwood) H. Mason 1945, *Madroño* 8(3): 86–87.

Basionym: *Gilia sparsiflora* Eastwood 1902*a*, *Proc. Cal. Acad. Sciences* 3rd Series, Botany. Vol. II No. 9: 291–292.

Type: USA, California, Fresno County: Kings River Cañon, and also along Bubbs Creek trail, 1–13 July 1899, *A. Eastwood s.n.*

Holotype: CAS 516 (image!). No known isotypes.

≡*Gilia sparsiflora* Eastwood 1902*a*, *Proc. Cal. Acad. Sciences* 3rd Series, Botany. Vol. II No. 9: 291–292. Milliken 1904, *Univ. Calif. Publ. Bot.* Vol. 2: 40.

≡*Navarretia filifolia* (Nuttall) Brand subsp. *sparsiflora* (Eastwood) Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 167.

≡*Gilia filifolia* Nuttall var. *sparsiflora* (Eastwood) J.F. Macbride 1917, *Contr. Gray Herb.* NS Vol. 49 No. 3 p. 57. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 425–426.

≡*Hugelia filifolia* Jepson var. *sparsiflora* (Eastwood) Jepson 1925, A Manual of the Flowering Plants of California, p. 792.

Included in *Hugelia filifolia* (Nuttall) Jepson 1943 (5 May), A Flora of California Vol. 3 Part II p. 165–166.

≡*Eriastrum sparsiflorum* (Eastwood) H. Mason var. *sparsiflorum*. Cronquist 1984, *in* Cronquist et al., Intermountain Flora, p. 154–155.

=*Gilia* (*Hugelia*) *parviflora* Nuttall in herb. BM 939591!, K! is *E. signatum* or *E. sparsiflorum.*

Annual herb, 10–31(–35) cm tall, generally erect, branching above, racemose, paniculate, or corymbose, with slender, spreading stems, herbage finely glandular-pubescent (hairs generally with 4–5 cells), lightly floccose to subglabrous, becoming glabrous with age. **Stems** generally green, sometimes reddish brown or tan, internodes 1–4 cm long. **Leaves** alternate, entire to pinnatifid, few, linear or terete from the infolding of the margins, mostly ascending, older leaves sometimes spreading, 5–30 mm long, light green to gray-green, reddish or tan in age, lightly floccose to subglabrous, apex aristulate; usually entire or rarely to 3-lobed at the base, lateral lobes less than 7 mm long. **Inflorescence** heads few to numerous, terminating the branches, small, about 4–7 mm long, usually less than 5 mm broad (sometimes to about 8 mm in fruit), floccose, with 2–3 flowers (total), or flowers sometimes solitary in the upper axils. **Bracts** entire to pinnatifid, ascending, outer sometimes curving to spread, keeled at base, 7–27 mm long, surpassing the flowers by 3–15 mm, light green to green, often with tan or reddish tips, densely floccose at the base, loosely lanate to floccose distally; entire or 3-lobed, lateral lobes arising from the proximal third (outer bracts) or half (inner bracts) of the bract, the primary axis much longer and wider than the lateral lobes, lateral lobes usually 4 mm long or less, all subulate-aristulate. **Calyx** 5–6 mm long; sepals clothed with dense, white, cottony wool, costae light green to green, tips sometimes reddish, aristulate-subulate, hyaline margins of the sepals fused 1/2–2/3 to form tube; lobes unequal, differing in length by about 0.5–1 mm. **Corolla** actinomorphic (sometimes asymmetric from interaction with calyx lobes), salverform to narrowly funnel-form, 6.5–8.5 (–10) mm long; tube 3.6–6 mm long, white, glabrous inside; throat funnelform, about 0.4–1.1 mm long, white, often with some purple dots; tube plus throat 4.1–6.1 mm long; lobes narrowly elliptical, 2.4–3.3 mm long, differing in length within a flower by 0.0–0.3 mm, 30–39% of total corolla length, about 1.1–1.7 mm broad, very pale blue or lavender to white or cream. **Stamens** exserted 0.5–1.1 mm past the sinuses, usually attached about 0.6–1.3 mm below the sinus, equally inserted (0.3 mm difference or less); free portion 1.50–2.25 mm long, to base of corolla 4.7–6.9 mm long, equal (length difference within a flower 0.0–0.4 (–0.6) mm); filaments 0.9–2.0 mm long, white to cream; anthers 1.0 mm long, 0.5–0.75 mm wide, white to cream, sagittate, linear to oblong, obtuse at apex. Pollen pale to light blue, average grain diameter 29 µm. **Pistil** (4.6–) 5–6.4 mm long, approximately equal to stamens in length (0.9 mm below to 0.4 mm above), trichomes dense at the distal tip of the ovary and scattered at the base of the style, 3–5-celled, terminal cell long and glandular; stigma lobes 0.3–0.6 mm long, cream-colored; style (2.8–) 3.3–4.6 mm long, white to cream. **Capsule** oblong, approximately equal in length to the calyx, 4.5–6 (–10?) mm long; 3-loculed, 1–3 (generally 2) seeds per locule. **Seeds** about 2.0–2.5 mm long, 1.1–1.3 mm wide, tan to gray-brown, angular, oblique at base, three-sided, somewhat dorsiventrally flattened, generally with rounded angles, developing mucilage and spiracles (Fig. 70–76 [Color Plate 2]; Eastwood 1902*a*: 291–292; Craig 1934*b*: 425; Harrison 1972: 19; S. De Groot, unpubl. data).

Identification.—*Eriastrum sparsiflorum* is noticeably glandular-hairy along the upper stems, while many other taxa such as *E. calocyanum*, *E. diffusum*, *E. eremicum*, *E. ertterae*, *E. harwoodii*, *E. hooveri*, *E. rosamondense*, *E. tracyi*, and *E. wilcoxii* are not obviously glandular-hairy.

Likewise, the glandular stems of *E. sparsiflorum* are the best character for differentiating it from *E. signatum*. While the upper stems of *E. signatum* do have glandular hairs, they are sparsely distributed and appear to be 2–3-celled, in contrast to the dense, 4–5-celled glandular hairs of *E. sparsiflorum*. The outer bracts of *E. signatum* may have more lobes (3–5) than the outer bracts of *E. sparsiflorum* (1–3).

The corollas of *E. sparsiflorum* are about 6.5–8.5 (–10) mm long, smaller than the corollas of *E. wilcoxii* (9–14 mm long). The leaves of *E. sparsiflorum* usually are entire or occasionally 3-lobed, while leaves of *E. wilcoxii* are mostly 3–5-lobed. Stamens of *E. sparsiflorum* are equal to subequal, in contrast to the stamens of *E. wilcoxii*, which may differ in length by up to 3 mm.

Eriastrum pluriflorum has corollas 9.9 mm long or longer, which differentiates it from *E. sparsiflorum*, whose corollas are 8.5 mm or shorter. Most of this length difference is attributable to the length of the tube plus throat: *E. sparsiflorum* has a tube plus throat 4.1–6.1 mm long, while *E. pluriflorum* has a tube plus throat 5.6–18 mm long. Corollas of *E. pluriflorum* are usually blue or lavender, while corollas of *E. sparsiflorum* are usually white.

The stamens of *E. sapphirinum* are exserted farther (2.2 mm or more beyond the sinus) than the stamens of *E. sparsiflorum* (usually less than 1.2 mm). The filaments of *E. sapphirinum* are also longer (2.8 mm or more) than the filaments of *E. sparsiflorum* (2 mm or less). The anthers of *E. sapphirinum* are 1.5 mm or longer, in contrast to the anthers of *E. sparsiflorum*, which are 1 mm long or shorter.

Phenology.—Flowering May–July (mostly June and July), fruiting July–August.

Distribution.—California and Nevada; western Great Basin, Sierra Nevada, western Transverse Ranges (Fig. 317).

Habitat.—*Eriastrum sparsiflorum* occurs at elevations from about 940 m (3080 ft) to 2020 m (6620 ft). It occupies dry, open sunny areas on flats, hillsides, small washes, benches along creeks or rivers, trail sides or roadsides. At least one population was discovered in an area that had been fairly recently burned. Slopes may be flat to 28 degrees, and most aspects have been reported, with south-facing being fairly common. The substrate is almost always a granitic sand, often coarse, at times hard-packed, usually off-white to light brown, and sometimes with a touch of loam, leaf duff, or other organic material. Surrounding vegetation may be *Artemisia* scrub with *Chrysothamnus* or *Purshia*, Blackbrush scrub, Mojave desert scrub, chaparral, mixed forest and chaparral, or open pine forest. Plants are frequently mixed with other annuals.

Population dynamics.—Population sizes from about 100 to over 10,000 plants have been documented. Plants are usually locally scattered to frequent, common, or abundant. Populations tend to be patchy and patches may cover only a small area.

Threats.—The small patch size means a population could be easily extirpated by disturbance; vehicle or trail use or maintenance may impact populations growing near roads or trails. Development may be a threat to transmontane populations.

Conservation.—Global Rank: G3G4 – vulnerable; Subnational/State Rank: California (S3?); California Rare Plant Rank: 4.3 (limited distribution, not very threatened; CNPS 2015; CNDDB 2013). NatureServe (2015) gives *E. sparsiflorum* a global rank of G4G5, but this includes *E. signatum*.

Etymology.—The specific epithet is from Latin *sparsim*, scatteredly or sparsely, and *florum*, the genitive plural of *flos*, flower; literally "of sparse (or scattered) flowers." This probably alludes to the small number of flowers per head, or to the flowering heads that are scattered at the terminal ends of branches in this openly branched annual.

Common name.—Few-flowered woolly-star.

Other specimens.—At Mottsville, Nevada, *E. sparsiflorum* co-occurs with *E. wilcoxii*, and specimens of each species have been collected on the same date; for example, *Mason 12362* (POM 264338!, F 1583817!, K!, GH!) is *E. sparsiflorum*; *Mason 12361* (K!, GH!, POM 264340!) is *E. wilcoxii*.

There was only one other collection in Kings Canyon, in addition to Eastwood's type: *Howell 16142* from Zumwalt Meadows, made 10 Aug 1940 (GH303706!, CAS280915 [image!]).

Palmer 134 is a mixed collection; a specimen at K! is *E. sparsiflorum*; but BM939596! is *E. tracyi*.

Discussion.—See the discussion under *E. signatum* about Craig's (1934*b*) two races.

There are no known isotypes of *E. sparsiflorum*. Perhaps this is because on the trip when the type was collected, Alice Eastwood was restricted in what she could take: "…my botanical outfit had to be very limited and I was not able to collect as much as I would have liked" (Eastwood 1902*b*: 1). This may mean she chose to collect unicates of many different things, rather than collecting duplicate sheets. For more detailed discussion of her route and the current status of *E. sparsiflorum* in Kings Canyon, see De Groot (2011*c*).

Although the range of *E. sparsiflorum* overlaps almost in its entirety with the range of *E. signatum*, *E. sparsiflorum* is the only one of the two species found in Kings Canyon, west of the Sierran divide. *Eriastrum sparsiflorum* is mostly resticted to the Sierra Nevadan Floristic Region (McLaughlin 2007), while *E. signatum* is found in several regions (Fig. 317).

16. ERIASTRUM TRACYI H. Mason 1945, *Madroño* 8(3): 87–88.

Type: USA, California, Trinity County: Hayfork Valley, alt. 2600 ft, 30 June 1923, *J.P. Tracyi 6463*.

Holotype: UC 690662 (image!). Isotypes: CAS 435261 (image!), UC 908551 (image!), JEPS 69082 (image!).

May have been included at times in *Gilia floccosa* or *Gilia sparsiflora*.

=*Eriastrum brandegeae* H. Mason 1945, *Madroño* 8(3): 88–89.

Type: USA, California, Lake County: ridge southeast of Borax Lake, 28 June 1945, *Mason 12604*.

Holotype: UC 693854 (image!). Isotypes: POM 310954!, DS 356932 (image!), F 1583810!, US 2249733 (image!), UC 971719 (image!), PH 01036559 (image!), P 00640950 (image!), GH 00078495!, S-G-2331 (image!), CAS 384736 (image!), K!, HSC 16945, MO 1652987 (image!), BR 526693 (image!), MEXU 83312 (image!), WISv0256063-WIS (image!), L 4051 (image!), MIN 1000943 (image!).

≠*Gilia brandegei* A. Gray 1876*a* [presented 1875], *Proc. Amer. Acad. Arts Sciences* 11: 85. = *Polemonium brandegei* Greene 1887, *Pittonia* 1: 126. =*Navarretia brandegei* (A. Gray) Kuntze 1891, Revisio Generum Plantarum Pars II p. 433.

Erect slender annual herbs 10–25 cm high. **Stems** simple, virgate, paniculate, corymbose, or racemose, branched mostly from above; stems green, tan, or reddish, rather wiry, lightly floccose, internodes 1–4 cm long. **Leaves** alternate, entire to pinnatifid, mostly ascending, older sometimes spreading, gray-green, sometimes reddish-tipped, floccose, 10–25 mm long, subulate, aristulate; leaves entire to 3-lobed above the base, lobes arising from the proximal half of the leaf, lobes to 10 mm long. **Inflorescence** heads 1-several, obovoid, about 4–8 mm long and 5–10 mm broad excluding the tips of bracts, often several heads aggregated at ends of branches, densely floccose, about 1–5 flowers per head. **Bracts** pinnatifid, mostly ascending, the outer sometimes curving to spread, to 15 mm long, green, sometimes reddish-tipped, exceeding the heads, floccose below, becoming glabrate above, tips aristulate; occasionally entire or usually with 3–5 lobes from a broad base, lateral lobes 1–10 mm long, sometimes with a short membrane in the sinuses. **Calyx** 5.0–9.5 mm long; sepals densely floccose, hyaline margins fused about half the length of the calyx to form a tube, sinuses 2.6–4.1 mm from proximal end of calyx (most of this variation between populations); lobe tips subulate-aristulate, not obscured by woolly trichomes, lobes strongly unequal to subequal (often 2 long, 3 short; sometimes 3 long, 2 short), differing in length within a flower by 0.6–2.8 mm. **Corolla** actinomorphic (sometimes appearing asymmetric from interaction with calyx lobes), (4.2–) 5.5–10.5 mm long, subsalverform to narrowly funnelform; tube 2.9–6.2 mm long, reddish-purple to white, often with a darker purplish ring just proximal to the throat, glabrous inside; throat 0.5–2 mm long, white to yellow; tube plus throat generally slightly shorter than the calyx, about 2.8–7.6 mm long; lobes broadly elliptic to strap-shaped, light blue, pinkish, lavender, or white, 1.3–4.0 mm long and 0.6–1.6 mm broad, lobes differing in length within a flower by 0.0–0.5 mm, 23–38% of total corolla length. **Stamens** included 0.6 mm below sinuses to exserted 1.3 mm beyond the sinuses, attached at the base of the throat, (0.2–) 0.5–1.5 (–2.0) mm below the sinuses; free portion about

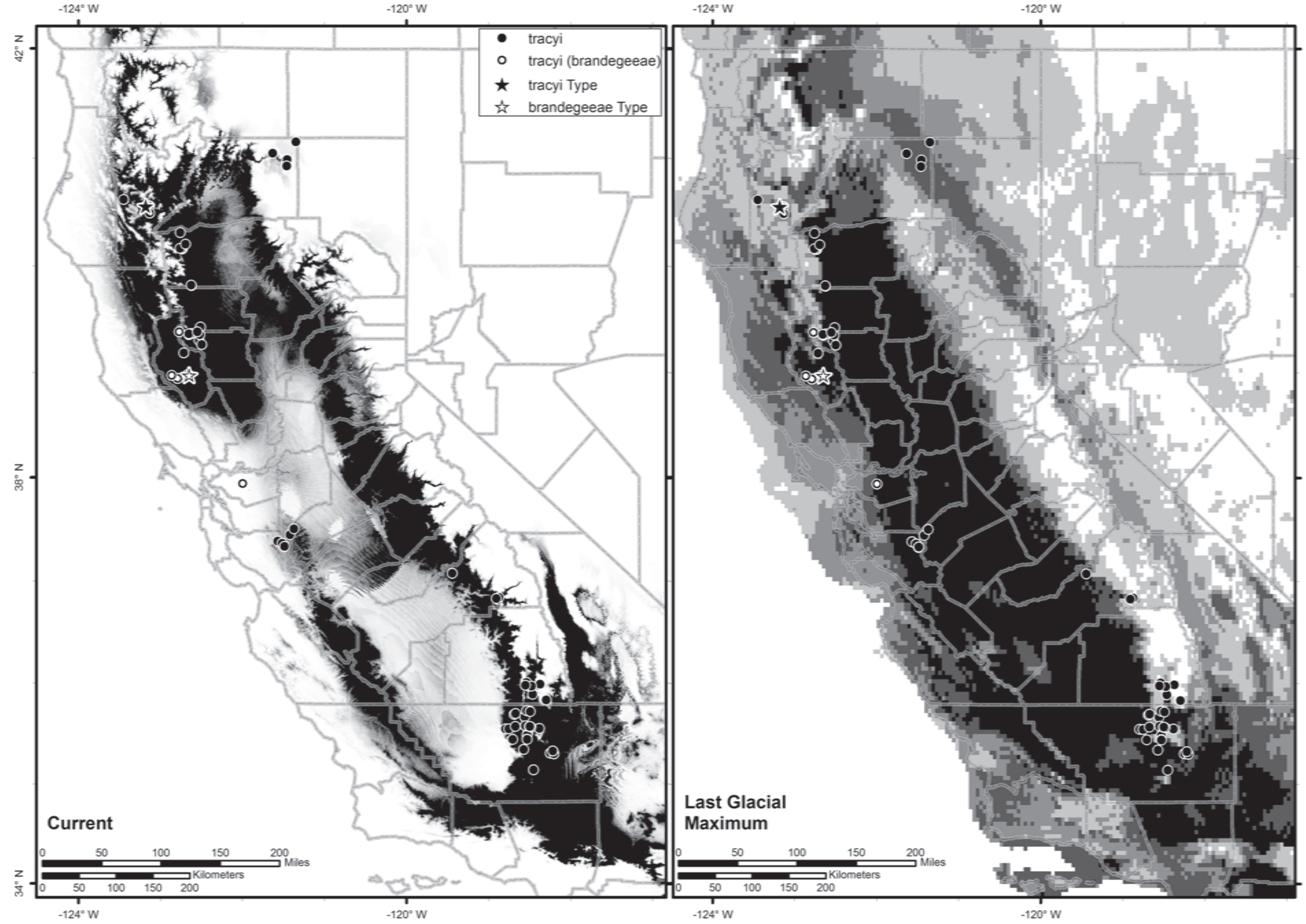

Fig. 318. Range maps for *E. tracyi*, with collections previously identified as *E. brandegeae* differentiated as white dots. The map on the left shows modeled current habitat (darker is more suitable), with specimen locations including types. The map on the right shows modeled habitat from the Last Glacial Maximum (darker is more suitable), with current specimen locations. County boundaries are indicated in both maps.

0.75–1.50 mm long, to base of corolla 2.9–9.1 mm long, equal, 0.0–0.3 (–0.7) mm difference in length within a flower; filaments 0.4–1.7 mm long, cream to pale yellow; anthers 0.75–1.0 mm long, 0.5–0.75 mm wide, oval, sagittate, versatile, cream. Pollen white to cream, average grain diameter 33 µm, anomotreme to sub-zonate aperture arrangement. **Pistil** 4.0–6.5 (–7.1) mm long, generally not exceeding the anthers (below the anthers by about 2 mm or exceeding the anthers by up to 2 mm), glabrous or with 2–4-celled glandular trichomes scattered on the distal tip of the ovary; stigma lobes 0.1–0.7 mm long, style about 1.7–5.2 mm long, white to cream, ovary at anthesis about 0.8–1.9 mm long, 0.6–0.8 mm wide. **Capsule** 4–5 mm long, 2–2.5 mm wide, oblong ellipsoid, 3-sided, 3-loculed. **Seeds** often 1 or occasionally 2 per locule, mucilaginous when wetted, about 1.8–3.2 mm long, 1.0–1.3 mm wide, light gray-brown, elliptic to slightly ovate, occasionally angular (Fig. 89–97 [Color Plate 2]; Mason 1945: 87–89; Harrison 1972: 24; S. De Groot, unpubl. data).

Identification.—*Eriastrum abramsii* can be found in the same geographic area and in similar habitats as *E. tracyi*, but its inflorescence heads are disproportionally large compared with the size of the plant, and the flowers are tiny, usually with many open at once. Inflorescence heads of *E. tracyi* are not as large and have only 1 to a few flowers open at a time. Plants of *E. tracyi* are usually more open-paniculately branched, while plants of *E. abramsii* are usually fairly dense and compact. Leaves of *E. tracyi* usually have 1–3 lobes, while leaves of *E. abramsii* have 3 or more lobes.

Most plants of *E. hooveri* or *E. ertterae* have more than one ovule per locule—if one locule has only one ovule, other locules in that ovary will usually have two or more ovules. In contrast, locules of *E. tracyi* have only one ovule each—if one locule has more than one ovule, other locules in that ovary will have only one ovule each. Further, bracts of *E. hooveri* or *E. ertterae* are usually 1–3-lobed, while bracts of *E. tracyi* are often 3–5-lobed.

Similarly, *E. signatum* usually has two ovules per locule. There is a trend toward *E. signatum* having slightly longer corollas with stamens attached slightly lower in the tube and exserted slightly farther than in *E. tracyi*, but with a great deal of overlap.

The most obvious difference between *E. calocyanum* and *E. tracyi* is the dark purplish spot at the base of the corolla lobe in *E. calocyanum* and the lack of a spot in *E. tracyi*. The stamens of *E. tracyi* are generally equal, while the stamens of *E. calocyanum* are usually somewhat unequal.

Eriastrum pluriflorum subspp. *pluriflorum* and *sherman-hoytae* both have corollas 12 mm long or longer, which differentiates them from *E. tracyi*, which has corollas 10.5 mm long or shorter. Most of this length difference is attributable to the length of the tube plus throat: *E. tracyi* has a tube plus throat 7.6 mm long or shorter, while subspp. *pluriflorum* and *sherman-hoytae* have a tube plus throat 7.7 mm or longer.

The stamens of *E. filifolium* tend to be exserted farther past the sinuses than in *E. tracyi*. The filaments of *E. filifolium* are 2–3 mm long, in contrast to the filaments of *E. tracyi*, which are 0.4–1.7 mm long. Additionally, *E. filifolium* has 3–6 ovules per locule, while *E. tracyi* usually has 1 (rarely 2) ovules per locule.

Phenology.—Flowering mid-May through later June, fruiting mid-June–July. Flowering and fruiting times vary slightly from year to year depending on weather conditions.

Distribution.—California endemic; Klamath Ranges, Inner North Coast Ranges, Cascade Ranges, southern Sierra Nevada, San Francisco Bay area (Mount Hamilton range; Fig. 318).

Habitat.—*Eriastrum tracyi* has been collected at elevations between about 320 and 1610 m (1050–5290 ft). It can be found in habitats such as roadsides, old roads or firebreaks, vacant lots, other disturbed areas, open rolling hills, slopes, ridge tops, open flats, benches above creeks, or small dry washes. The slope of sites varies from flat to steep (0–35°), and all aspects have been documented. Sometimes in fairly flat areas, the aspect is mostly due to the shade of nearby shrubs, rather than the slope of the topography. Soils are usually fairly hard-packed and include silt, sand, clay, adobe, loam, duff, gravel, pebbles, and rock. Rock types may be shale (usually dark brown), granite, volcanic cinders, obsidian, sandstone, and mixed alluvium. In the North Coast Ranges of California, *E. tracyi* has a particular affinity for growing on shale barrens, or areas of dark brown shale fragments where few other plants grow. This may be due to a poor ability to compete. Surrounding vegetation is predominantly some form of chaparral, but also can be grassland, oak savannah, pine-oak woodland, mixed woodland, conifer forest, or mixed forest, and these vegetation types are often mixed. A few populations occur in the ecotone between two vegetation types. At least one population appeared to be associated with areas of moss. Some populations have been found in burned areas, and others are in areas that appear to be mowed or otherwise disturbed.

Population dynamics.—Population sizes of about 60 to over 2000 plants have been recorded. Plants have been described as rare, fairly restricted, widely scattered, locally spotty, scattered, locally frequent, locally common, or abundant, and are often found in patches. Patch size may be small to large and of varying shapes, mostly depending on the size of open, available space between shrubs or trees. Patch sizes of 6 m × 6 m (20 ft × 20 ft) and 6 m × 9 m (20 ft × 30 ft) have been reported.

Threats.—Competition or encroachment from non-native plants, habitat loss due to development or road construction, road maintenance, off-road vehicle use, grazing, recreational activity, development (CNPS 2013; NatureServe 2013).

Conservation.—Global Rank: G3Q – vulnerable, with taxonomic questions; U.S. State Legal Status: California: Rare; National Rank: USA (N3 – vulnerable); Subnational/State Rank: California (S3 – vulnerable); California Rare Plant Rank: 3.2 (taxonomic questions, somewhat threatened; Other status: BLM – S – Sensitive; USFS – S – Sensitive (CNPS 2013; CNDDB 2013; CDFW 2013; NatureServe 2013; Table 2).

Eriastrum tracyi was listed as Rare by the state of California in July 1982 (CDFW 2013). Subsequent to Gowen's 2008 paper, the California rare plant rank was downgraded to 3.2 from 1B.2 (CNPS 2015). *Eriastrum brandegeae*, synonymized here, is ranked G1Q, S1, rare plant rank 1B.1, and BLM Sensitive (CNDDB 2013).

Etymology.—The specific epithet *tracyi* is for Mr. Joseph Prince Tracy (1879–1953), the collector of the type specimen. He lived in Humboldt County most of his life. Although he studied botany at the University of California under H.M. Hall, J. Burtt Davy, W. L. Jepson, and W.A. Setchell, he spent his entire career employed by the Belcher Abstract and Title

Company, as an expert in land titles, deeds, and related documents, a skill he had learned early from his father. In his spare time, he traveled around northwestern California, collecting plants, often alone, but occasionally with others such as Harold Parks. He made extensive collections over about 50 years, with most of his specimens going to the University of California (UC; Bacigalupi 1954; Cantelow and Cantelow 1957). *Tracyina*, a genus of Asteraceae, was named in his honor (Blake 1937).

The specific epithet *brandegeae* is for Dr. Mary Katharine (Layne) (Curran) Brandegee (1844–1920), student of the California flora and long associated with the herbarium at the California Academy of Sciences. She grew up in El Dorado County and married Hugh Curran, who died in 1874. That year, she entered the University of California, studied under H.H. Behr, Albert Kellogg, and E.L. Greene, and graduated in 1878 with a M.D. degree. In 1880 she joined the California Academy of Sciences and volunteered in the herbarium, eventually becoming its curator in 1883. She began collecting plants in 1882, and, with the aid of a general pass on the railroads, traveled extensively by rail, collecting at many railroad stations. She also made many collections of fungi for H.W. Harkness. She founded the California Botanical Club and the journal *Zoe*, and edited a series of Bulletins published by the California Academy of Sciences. In 1889, she married Townshend Stith Brandegee, and in 1894 they moved to San Diego. In 1906, they relocated to Berkeley, donating their extensive library and herbarium collections to the University of California (Setchell 1926; Ewan 1953; Cantelow and Cantelow 1957).

Common name.—Tracy's woolly-star.

Other specimens.—*Palmer 134* is a mixed collection; a specimen at K! is *E. sparsiflorum*; but BM939596! is *E. tracyi*.

Discussion.—Mason (1945) recognized the similarity of *E. tracyi* to *E. brandegeae* and *E. filifolium*, but maintained them as separate species since they appeared to be allopatric: "It is possible that future experimental study may produce evidence to warrant subspecific grouping of these species but at present due to their geographic isolation, no such evidence exists" (p. 88). Harrison (1972) wrote "There are few distinctions between *E. brandegeae* and *E. tracyi*," and he maintained both species with "considerable hesitancy" (p. 24).

Various distinguishing characters have been named by authors who maintained *E. tracyi* and *E. brandegeae* as separate species, but none have worked well. Mason (1945) distinguished them by branching pattern, anther size, and corolla proportions, but Harrison (1972) countered, "Branching is of almost no value in the recognition of species of *Eriastrum*" (p. 24). Gowen (2008) wrote that *E. tracyi* has shorter, mostly included stamens and wider corolla lobes, but Harrison (1972) observed the difference in filament length was "exceedingly slight" (p. 24) and that the anthers had exactly the same range of size.

The length of the free portion of the stamen was used in De Groot et al. (2012) as a distinguishing character between *E. tracyi* and *E. brandegeae*, but measurement of stamens from 26 populations (De Groot 2011*a*) shows that this trait is a continuum. Similarly, the ratios of anther length to filament length and corolla lobe width to length are also continua, with no distinct breaks. Multivariate analysis of morphometric data shows that while some populations can be differentiated from other populations, numerous populations fill the morphological space in between them so that there are no distinct clusters of populations (De Groot 2011*a*).

Genetic data are limited, but preliminary phylogenetic work (S. De Groot, unpubl. data) focused on sequencing the chloroplast *trn*S-G region for 15 individuals from 15 populations. Fourteen of these were from the North Coast Ranges, and the sequences are nearly identical. One was from the Southern Sierra, and differs. It might be instructive to sequence multiple genes or gather population genetic data from populations in each of the four main geographic areas where this species occurs, to determine if there is genetic differentiation. For now, however, in the absence of discrete breaks in morphology, all plants called *E. tracyi* or *E. brandegeae* are considered part of a single, highly variable species (or species complex).

In Patterson (1993, in Hickman 1993), *E. tracyi* was treated as a synonym of *E. brandegeae*, whereas here *E. brandegeae* is treated as a synonym of *E. tracyi*. Both names were first described in the same publication (Mason 1945) and have equal priority. According to the Code, "When two or more homonyms have equal priority, the first of them that is adopted in an effectively published text by an author who simultaneously rejects the other(s) is treated as having priority" (McNeill et al. 2012: Art. 53.6). Although it could be argued that *E. brandegeae* was adopted by Patterson (1993), it is not clear that *E. tracyi* was simultaneously rejected in that publication. Nor was Hickman (1993) intended to publish new taxonomic changes. As we currently understand the distribution and variation within this species complex, *E. tracyi* is the more widespread form (Gowen 2008), and it is more logical to include the narrow endemic, *E. brandegeae*, within the widespread form.

The range map (Fig. 318) includes modeled potential habitat for both the present day and the last glacial maximum. To construct the maps, sampled locations were mapped and values from the nineteen BIOCLIM variables from the WORLDCLIM current dataset (Hijmans et al. 2005) were extracted at each site. These values were used to reclass each raster of climate variables, both for current and last glacial maximum conditions (WORLDCLIM last glacial maximum data; Hijmans et al. 2005), using means, 95% confidence intervals, ±1 standard deviation, minimum and maximum values. Reclassed rasters were combined in an equally weighted overlay using ModelBuilder in ArcMap 9.3 with the Spatial Analyst extension (ESRI, Redlands, CA).

There is no good phylogenetic estimate of when this group might have diverged from its sister taxa, so it is unknown when populations might have differentiated. However, it appears that the species' modeled habitat has oscillated between California's central valley and the foothills surrounding the central valley during glaciations and interglacials. During glacial periods, populations likely would have occupied the central valley, growing in close proximity and relatively connected. During interglacials, the central valley was no longer very suitable habitat, and populations likely moved up into the foothills, forming a ring around the valley. At these times, populations would have been farther apart geographically and gene flow may have diminished, allowing for local adaptations and differentiation due to drift. Since the earth is currently in an interglacial period, these processes are probably in effect at present. Detailed study of the population genetics of this species complex would be needed to test this hypothesis.

17. ERIASTRUM VIRGATUM (Bentham) H. Mason 1945, *Madroño* 8(3): 84.

Basionym: *Hugelia virgata* Bentham 1833, *Edwards's Botanical Register* sub t. 1622.

Type: USA, California. *Douglas* in 1831 or 1832 (label: 1833).

Lectotype, designated here (possibly holotype): K 196247! (Herb. Benth., labeled *virgata*). Isolectotypes K 545586! (Herb. Hook., labeled *virgata*), BM 939603! (labeled *elongata*), P 643638 (image!, labeled *elongata*), G-DC 135114 (image!, labeled *elongata*), GH 303657! (originally labeled *elongata* but corrected to *virgata*), UC 163784 (image!, labeled *virgata*); CGE 12403 (image!, labeled *virgata*, shares sheet with Douglas coll. of *elongata*); CGE 12447 (image!, labeled *virgata*), BR 526938 (image!, labeled *elongata*); photo of K 196247 is POM 188883!.

≡*Hugelia virgata* Bentham 1833, *Edwards's Botanical Register* sub t. 1622. Jepson 1925, A Manual of the Flowering Plants of California, p. 792. Jepson 1943, A Flora of California Vol. 3 Part II p. 164–165.

≡*Gilia virgata* Steudel 1840. Nomenclator botanicus. I. 684. Bentham 1845, *in* De Candolle, Prodromus Systematis Naturalis Regni Vegetabilis 9: 311. Gray 1870, *Proc. Amer. Acad. Arts Sciences* 8: 272. Milliken 1904, *Univ. Calif. Publ. Bot.* Vol. 2: 39. Macbride 1917, *Contr. Gray Herb.* NS Vol. 49 No. 3 p. 57.

≡*Gilia virgata* (Benth.) Steud. var. *typica* Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 393, 394–395.

≡*Navarretia virgata* [Benth.] (Steudel) Kuntze 1891, Revisio Generum Plantarum, Pars II p. 433.

≡(as to name, but not circumscription) *Navarretia virgata* (Bentham) Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 167.

=*Navarretia densifolia* (Bentham) Brand [subsp. *elongata* (Bentham) Brand] var. Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 165.

Type: USA, California, Monterey County: along the railroad near Seaside (beyond Del Monte), 19 May 1903, *A. A. Heller 6753*.

Holotype?: probably B, destroyed (Hiepko 1987). Other type specimens: G 308353 (image!), GH 303650!, DS 24787!, DS 134921!, DS 136402!, UC 58473 (image!), POM 65749!

Lectotype, designated here: G 308353 (image!).

NOTE. This taxon is not related to *Hugelia lanata* Lindley.

Annual herb, 3–40 cm tall (occasionally to 50 cm), erect, very straight, virgate, or racemosely branched above, sometimes branching from the base then ascending virgately, rarely paniculately. **Stems** light green to reddish brown, lightly floccose or sometimes subglabrous, but remaining floccose near the heads and axillary buds; internodes 4–55 mm long. **Leaves** alternate, entire to pinnatifid, linear, ascending to appressed, 15–50 mm long, light green, lightly floccose, apex subulate to aristulate; entire to 3-lobed (rarely 5-) from the base, often with the lower leaves entire and the upper leaves 1–3- (–5-) lobed; lateral lobes slender, to 12 mm long. **Inflorescence** heads 1–23 per plant, often 5 or fewer, often terminal but sometimes axillary, woolly, 3–20-flowered, 5–15 mm long, 5–20 mm broad, sometimes larger in fruit. **Bracts** pinnatifid, inner ascending, outer ascending to spreading, 10–25 mm long, exceeding the heads, light green to green, sometimes with reddish tips, often becoming tan or reddish in age, floccose at least proximally, usually 3–5-lobed near the base, lateral lobes 1–10.5 mm long; tips aristulate. **Calyx** 8–12 mm long, sepals green, often lighter proximally, floccose, aristulate, joined by a hyaline membrane, fused about halfway or a little less to form a tube, tips sometimes reddish, lobes unequal, differing in length within a flower by 1.5–2.5 mm. **Corolla** actinomorphic, funnelform, 15–23 mm long; tube white to pale yellowish, sometimes with a purplish ring on the distal end, about 8.5–12 mm long, approximately equaling the calyx in length, 46–55% of the total corolla length, glabrous inside; throat white distally and yellow proximally, about 1–3 mm long; tube plus throat 10.5–14.9 mm long; lobes obovate to strap-shaped, bright blue, sometimes with a darker blue or purplish spot at the base or darker veins, 5.8–9.5 mm long and 2.3–4.0 mm broad, lobes differing in length within a flower by 0.0–0.3 mm, 35–44% of the total corolla length, tips rounded or sometimes notched. **Stamens** extending nearly to the tips of the corolla lobes (3.3 mm below to 0.3 mm beyond), exserted 4.8–6.5 mm beyond the sinus, attached 0.9–2.7 mm below the sinuses; free portion 6–11 mm long, to base of corolla 15.5–20.0 mm long, unequal or subequal, differing in length within a flower by 0.2–1.2 mm; filaments 5.0–9.5 mm long, differing in length within a flower by 0.1–1.0 mm, white or cream to yellow or sometimes purplish or pale blue; anthers elongated, linear-sagittate, versatile, 2–3 mm long and 0.5–1.0 mm broad, white to cream. Pollen white to cream, average grain diameter 27 μm, possibly pantotreme or anomotreme to zonate aperture arrangement. **Pistil** 12.5–20.5 mm long, trichomes 3–6-celled, sparse to dense at the distal tip of the ovary and the base of the style; stigma lobes 0.75–1.00 mm long, style approximately 10–18 mm long, white to cream or yellow. **Capsule** 4–5.5 mm long, 2.5–3 mm wide, with 3 locules, with 2–4 (occasionally 5) seeds per locule. **Seeds** about 1.5–3.2 mm long, 1.1–1.4 mm wide, gray-brown, mostly elliptic to slightly ovate (Fig. 234–241 [Color Plate 6]; Bentham 1833 sub t. 1622; Bentham in DC. 1845: 311; Gray 1870: 272; Brand 1907: 165; Craig 1934*b*: 394; Harrison 1972: 9, 11; S. De Groot, unpubl. data). Chromosome number: $2n = 14$ (Grant 1959).

Identification.—*Eriastrum sapphirinum* has sometimes been treated as a sub-specific entity under *E. virgatum*, but there are multiple characters that differentiate these species. The corollas of *E. virgatum* are larger, usually 15 mm long or longer, while the corollas of *E. sapphirinum* are usually 15 mm long or shorter. Most of the length difference is in the fused portion: the tube plus throat of *E. virgatum* is 10 mm or longer, and the tube plus throat of *E. sapphirinum* is usually less than 8 mm long. The upper stems of *E. sapphirinum* are densely glandular-hairy, while the upper stems of *E. virgatum* may be slightly glandular but are not markedly so.

Eriastrum virgatum has an annual lifespan and herbaceous stems, in contrast to *E. densifolium*, which is perennial and woody at least near the base. The woolly trichomes on *E. virgatum* are sparse enough that the stems, leaves, and bracts appear green, while sympatric *E. densifolium* subsp. *elongatum* is usually canescent. While *E. virgatum* is often virgate, racemose, or occasionally with one or two branches from the base, *E. densifolium* usually has more than two branches from a woody base.

Eriastrum virgatum has longer filaments (5 mm or longer) than *E. pluriflorum* (up to about 4.5 mm). Although the corollas are about the same length, the tube plus throat is longer in *E. pluriflorum* and its lobes are shorter. Stamens are inserted closer to the sinus in *E. pluriflorum*; stamens in *E. virgatum* are inserted about 0.9 mm or more below the sinus, while in *E. pluriflorum* subspp. *pluriflorum* and *sherman-hoytae* the stamens are inserted 0.75 mm or less below the sinus.

Eriastrum virgatum is easily distinguished from *E. calocyanum* by its larger corollas (15 mm or longer), exserted stamens (4 mm or more), and 2 or more ovules per locule. In contrast, *E. calocyanum* corollas are 10 mm or less in length, stamens are exserted up to 2.3 mm beyond the sinuses, and there is only a single ovule in each locule.

Also occurring in the South Coast Ranges with *E. virgatum* is *E. luteum*, but these two species are easily differentiated by corolla color, royal blue (*E. virgatum*) versus golden yellow (*E.

luteum), and corolla length—15 mm or longer (*E. virgatum*) versus less than 10 mm (*E. luteum*).

While *E. filifolium* and *E. virgatum* both have royal blue corolla lobes, the corollas of *E. virgatum* are much larger (15–23 mm long) than the corollas of *E. filifolium* (7–9 mm). Moreover, the stamens are exserted much farther beyond the sinus in *E. virgatum* (4–10 mm) than in *E. filifolium* (1.1–1.6 mm).

Phenology.—Flowering late May to mid-June. Fruiting in June, perhaps later.

Distribution.—California endemic (Monterey and San Benito Counties); Central Coast, northern South Coast Ranges (Fig. 106).

Habitat.—*Eriastrum virgatum* has been collected between about 9 and 550 m (30–1800 ft) in elevation. It occupies benches above washes, hillside slopes, or old dunes, usually in open sunny areas between shrubs, and sometimes on old roads. Sites are flat to sloped about 25°. The predominant aspect is southwest, but southeast has also been reported. Often plants are found in sandy soils, but also occur on silty loam with gravel, adobe, or mixed alluvium, and rock types include weathered volcanics such as breccia, tuff, and possibly rhyolite. In some sites plants have been associated with cryptobiotic crust. Surrounding vegetation includes oak woodland, California sagebrush and buckwheat scrub bordering on oak-sycamore riparian woodland, low coastal chaparral, low chaparral bordering on riparian vegetation, and chaparral in general.

Population dynamics.—Population sizes of 200 to more than 1000 have been documented. Plants have been reported to occur in widely scattered small patches, or are locally common in fairly dense patches.

Threats.—Habitat loss due to development, road grading, competition from weeds or other plants, possibly grazing. Several populations are protected on the old Fort Ord Military Reservation (now managed by the BLM) and at Pinnacles National Monument (NPS). Other sites occur on private land (Fig. 106).

Conservation.—Global Rank: G3 – vulnerable; National Rank: USA (N3 – vulnerable); Subnational/State Rank: California (S3.3 – vulnerable, but not very threatened); California Rare Plant Rank: 4.3 (limited distribution, not very threatened (CNPS 2013; CNDDB 2013; NatureServe 2013; Table 2).

Etymology.—The specific epithet is from Latin *virgatus*, twiggy, or long and slender, probably referring to the usual branching pattern or habit of the species. The epithet *lanata* is from Latin *lanatus*, woolly.

Common name.—Virgate woolly-star, wand woolly-star.

Other specimens.—CGE12406 (image!; Fig. 6). See also the illustration in the *Journal of the Horticultural Society* (Lindley 1847: 312; Fig. 7).

Discussion.—Since Brand cited a single collection but did not designate a herbarium in the protologue of *N. densifolia* var. *lanata*, a lectotype should be chosen. G 308353 was chosen as the lectotype of *N. densifolia* var. *lanata* Brand because it matches Brand's protologue and appears to be the only surviving type that was annotated by Brand. Probably there was a duplicate of *Heller 6753* at B, but it was destroyed (Hiepko 1987).

Monterey was David Douglas' headquarters while he made collections in California for the Horticultural Society, and since *E. virgatum* is frequent around Monterey, it is likely that he collected the type specimen in that vicinity. The collection could have been made in early summer 1831 or 1832, arriving in England in 1833. Many of Douglas' other collections of *Eriastrum* were probably made in the spring of 1831, and *E. virgatum* may have been collected that year. Since the Douglas specimens have flowers, they were probably collected in early or mid-June, subsequent to his return from a trip to Santa Barbara (McKelvey 1956; Harvey 1947).

Although many occurrences of *E. virgatum* are found near the coast, some populations occur farther inland, such as at Cholame Valley and Pinnacles National Monument. Although there are some habitat differences between coastal and inland sites, it is unknown if populations are becoming adapted to local conditions and isolated from the other form. There is no information on gene flow between coastal and inland sites. Morphologically, inland plants appear to be slightly smaller, but there is a great deal of overlap and this may be due in large part to the local environmental conditions.

18. ERIASTRUM WILCOXII (A. Nelson) H. Mason 1945, *Madroño* 8(3): 85–86.

Basionym: *Gilia wilcoxii* A. Nelson 1902, *Bot. Gaz.* 34: 27–28.

Syntypes cited in protologue: USA, Idaho, Fremont County: dry soil, St. Anthony, 4 July 1901, *Merrill and Wilcox 822* [RM 30222! (shares sheet with *M&W 862*), GH 303658!, US 580923 (image!)]; USA, Idaho, Fremont County: dry soil, St. Anthony, 6 July 1901, *Merrill and Wilcox 862* [RM 30222! (shares sheet with *M&W 822*), GH 303659!]; USA, Idaho, Fremont County: dry soil, 7 miles west of St. Anthony, 8 July 1901, *Merrill and Wilcox 952* [RM 30221!, GH 78811!].

Holotype: here interpreted as *Merrill and Wilcox 952*, RM 30221!. Isotype GH 78811!.

≡*Gilia wilcoxii* A. Nelson 1902, *Bot. Gaz.* 34: 27–28. Craig 1934*b*, *Bull. Torrey Bot. Club* 61: 426–428.

≡*Navarretia wilcoxii* (A. Nelson) Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 165.

≡*Welwitschia Wilcoxii* (A. Nelson) Rydberg 1917, Flora of the Rocky Mountains and Adjacent Plains, p. 688.

≡*Eriastrum sparsiflorum* var. *wilcoxii* (A. Nelson) Cronquist 1959, *in* Hitchcock et al., Vascular Plants of the Pacific Northwest, vol. 4. University of Washington Publications in Biology 17(4): 102. Illustration p. 106.

=(in part) *Gilia floccosa* A. Gray 1870, *Proc. Amer. Acad. Arts Sciences* 8: 272. Gray 1878, Synoptical Flora of North America, Vol. II, Part 1, Gamopetalae after Compositae, p. 143. Nelson and Macbride 1916, *Bot. Gaz.* 61: 35.

Lectotype (designated by Jepson 1943: 166–167): USA, Nevada, probably Washoe County: Truckee Desert, July 1867, *W.W. Bailey 914* (GH 303672!). No isolectotypes known.

≡*Navarretia floccosa* (A. Gray) Kuntze 1891, Revisio Generum Plantarum, Pars II p. 433.

≡*Hugelia floccosa* (A. Gray) Howell 1903, A Flora of Northwest America. Vol. 1, Phanerogamae: 458.

≡*Gilia virgata* Steudel var. *floccosa* (A. Gray) Milliken 1904, *Univ. Calif. Publ. Bot.* Vol. 2: 40.

≡*Navarretia virgata* (Bentham) Brand subsp. *floccosa* (A. Gray) Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 168.

≡*Welwitschia floccosa* (A. Gray) Rydberg 1917, Flora of the Rocky Mountains and Adjacent Plains, p. 688.

≡*Hugelia virgata* Bentham var. *floccosa* (A. Gray) Jepson 1925, A Manual of the Flowering Plants of California, p. 793.

≡*Hugelia filifolia* (Nuttall) Jepson var. *floccosa* (A. Gray) Jepson 1943, A Flora of California Vol. 3 Part II p. 166–167.

=*Gilia* (*Hugelia*) *parviflora* Nuttall in herb. GH 303697!

=*Hugelia parviflora* Nuttall in herb. BM 939592!

=*H. parviflora* Nuttall in herb. K! (Herb. Hook.) Annotations, possibly by A. Gray: "Snake County, Burke" "June. Very sandy soil. Seeds [?] August. Seeds No. 43"

=*Hugelia parviflora* Nuttall in herb. K! is *E. signatum* or *E. wilcoxii.*

=*Hugelia *floccosa* R. Mts. [illegible] Herb. Thomas Nuttall. BM 939593!

=*Hugelia *floccosa* R. Mts. [illegible] GH 303675! Coll. Nuttall. Presented by Elias Durand, 1866. A. Gray annotations: "gossypifera" "Gilia diffusa [Torr. +Gr.]" "not in herb under this name" "Gilia floccosa. too little developed to know if mine"

=*Hugelia +floccosa* Nuttall in herb. GH 303674! "Rky. Mts. Platte. Br. Mus. mine more developed than this!" (A. Gray handwriting).

Annual herb, 1–30 cm high, exceptionally to 40 cm; racemose, corymbose, or branched from the base, the branches in turn sparsely branched, erect or (if several) decumbent at base. **Stems** becoming rigid and brittle, internodes 1–4 cm long; herbage floccose woolly, often densely so, gray-green, becoming glabrate in age. **Leaves** alternate, pinnatifid, mostly ascending, the lower sometimes spreading, gray-green, often canescent, about as woolly as the stems, 15–30 (–50) mm long, 3–7-lobed, the lower leaves sometimes entire; the lateral lobes narrowly linear, mucronate, arising from the proximal two-thirds of the primary axis, widely divaricate, 2–10 mm, usually in pairs. **Inflorescence** of small bracteate terminal heads, up to 180 or more per plant, but often 30 or fewer, about 5–10 mm long and 7–17.5 mm wide, heads several-flowered (about 3–5), but often with several (to about 6) heads in clusters at the branch tips and therefore appearing to have more flowers, densely floccose, especially at the base of the calyx and the subtending green foliar bracts. **Bracts** pinnatifid, mostly ascending, the outer sometimes spreading, 7–30 mm long, green, often with reddish tips, equaling or surpassing the head, densely floccose, apex aristulate, 3–5-lobed from the proximal half of the bract, lateral lobes 1–9.5 mm long. **Calyx** 4.6–10.0 mm long, sepals with green costae bordered by hyaline margin, floccose, pungently mucronate, with the hyaline membrane fused about halfway along the length to form a tube, lobes unequal, differing in length within a flower by 1.1–2.2 mm. **Corolla** actinomorphic to slightly zygomorphic, 9.0–14 mm long, tubular, funnelform; tube white or yellowish, 4.3–7.5 mm long, sparsely and minutely puberulent inside with very short papillae from epidermal cells; throat white, pale blue, or pale yellow, (0.5–) 1.0–2.2 (–2.9) mm long; tube plus throat approximately equal to the calyx, 5.3–8.6 mm long; lobes blue to pale blue or rarely pinkish, sometimes with reddish or purplish lines, dots or stripes at base, oblong, obtuse, or elliptic, about 3.1–4.7 (–6) mm long, differing in length within a flower by 0.0–0.3 mm, 31–40% of the total corolla length, 1.3–2.0 mm wide. **Stamens** exserted about 0.7–2.3 mm beyond the sinuses, attached about 0.5–2.4 mm below sinuses, the attachment point varying by 0.1–0.6 mm; free portion 1.5–4.5 mm long, to base of corolla 5.9–10.5 mm long, unequal to subequal, varying in length within one flower by 0.2–3.0 mm; filaments 1.1–3.7 mm long, white to cream; anthers 1.0–2.0 mm long, 0.5–1.0 mm wide, white to cream or pale blue, versatile, sagittate. Pollen white to blue or lavender, average grain diameter 32 µm, zonate aperture arrangement. **Pistil** 7.3–8.6 mm long, exserted up to about 2 mm beyond the stamens, 3–5-celled glandular trichomes dense at tip of ovary and base of style; stigma lobes about 0.5–1.0 mm long; style 4.8–6.3 mm long, white to cream. **Capsule** about 3–4 mm long, 2–2.5 mm wide, with 3 locules, (1–) 2–4 ovules to each locule, not necessarily all maturing; if one locule contains only 1 seed, then other locules in the same fruit will have more than 1 seed. **Seeds** small, rhombic or narrowly ovoid in outline, obscurely scarious on the angles and the tips, often 1–2 (–3) seeds per cell, apparently not developing mucilage when wetted, about 1.3–2.5 mm long, 0.7–1.2 mm wide, tan (Fig. 242–248 [Color Plate 6]; Nelson 1902: 28–28; Craig 1934*b*: 426; Harrison 1972: 21; S. De Groot, unpubl. data).

Identification.—One distinguishing character is that there is at least one locule with at least two seeds.

Eriastrum signatum often has fewer leaf lobes (1–3) than *E. wilcoxii* (3–5). In addition, leaves of *E. signatum* are commonly lobed from the base, while leaves of *E. wilcoxii* are often pinnate. The stamens of *E. signatum* are subequal (length difference up to 0.5 mm), while stamens of *E. wilcoxii* vary in length by 0.2–3.0 mm. The anthers of *E. signatum* are usually 1 mm long or less, in contrast to the anthers of *E. wilcoxii*, which are usually 1 mm long or more. Throughout most of the range of *E. wilcoxii*, the corolla lobes of *E. signatum* have a dark reddish spot at the base. Some plants of *E. wilcoxii* also have spots, but not as pronounced as the spots in *E. signatum*.

Eriastrum wilcoxii usually has two or more ovules per locule, as opposed to the single ovule in each locule in *E. calocyanum*. The anthers of *E. calocyanum* are 1 mm long or shorter, while the anthers of *E. wilcoxii* are 1–2 mm long. The corollas of *E. wilcoxii* are generally larger, 9–14 mm long, while *E. calocyanum* corollas 7.8–10 mm long, and the corolla lobes of *E. wilcoxii* are 1.3 mm or wider, while the corolla lobes of *E. calocyanum* are 1.3 mm wide or less.

The corollas of *E. sparsiflorum* are about 6.5–8.5 (10) mm long, smaller than the corollas of *E. wilcoxii* (9–14 mm long). The leaves of *E. sparsiflorum* usually are entire or occasionally 3-lobed, while leaves of *E. wilcoxii* are mostly 3–5-lobed. Stamens of *E. sparsiflorum* are equal to subequal, in contrast to the stamens of *E. wilcoxii*, which may differ in length by up to 3 mm.

Within the geographic range of *E. wilcoxii*, the species can be distinguished from *E. eremicum* by having actinomorphic corollas and equal sinuses, while *E. eremicum* has medially zygomorphic corollas and unequal sinuses. Often, the filaments of *E. eremicum* tend to curve in the same direction and are often clustered at the lower side of the corolla (toward the ground). Filaments of *E. wilcoxii* are not all curved the same direction or clustered. Additionally, stamens are exserted farther in *E. eremicum* (>3.5 mm) than in *E. wilcoxii* (<2.5 mm).

Similarly, the longest stamens of *E. pluriflorum* subsp. *albifaux* are usually exserted at least 2.1 mm beyond the sinus, while the longest stamens of *E. wilcoxii* are usually exserted 2.3 mm or less. *Eriastrum wilcoxii* usually has fewer flowers open in each inflorescence head at a single time than subsp. *albifaux*. The throat of *E. pluriflorum* subsp. *albifaux* is often flared or campanulate, but the throat of *E. wilcoxii* is usually tapered or funnelform.

Eriastrum wilcoxii has larger corollas (9–14 mm long) than *E. diffusum* (5.5–11 mm). Anthers of *E. wilcoxii* are usually 1–2 mm long, while anthers of *E. diffusum* are usually 1 mm long or shorter.

A shorter corolla tube plus throat (3–5.8 mm) characterizes *E. sapphirinum* subsp. *brevibracteatum*, in contrast to the corolla tube plus throat of *E. wilcoxii*, 5.3–8.6 mm long. Also,

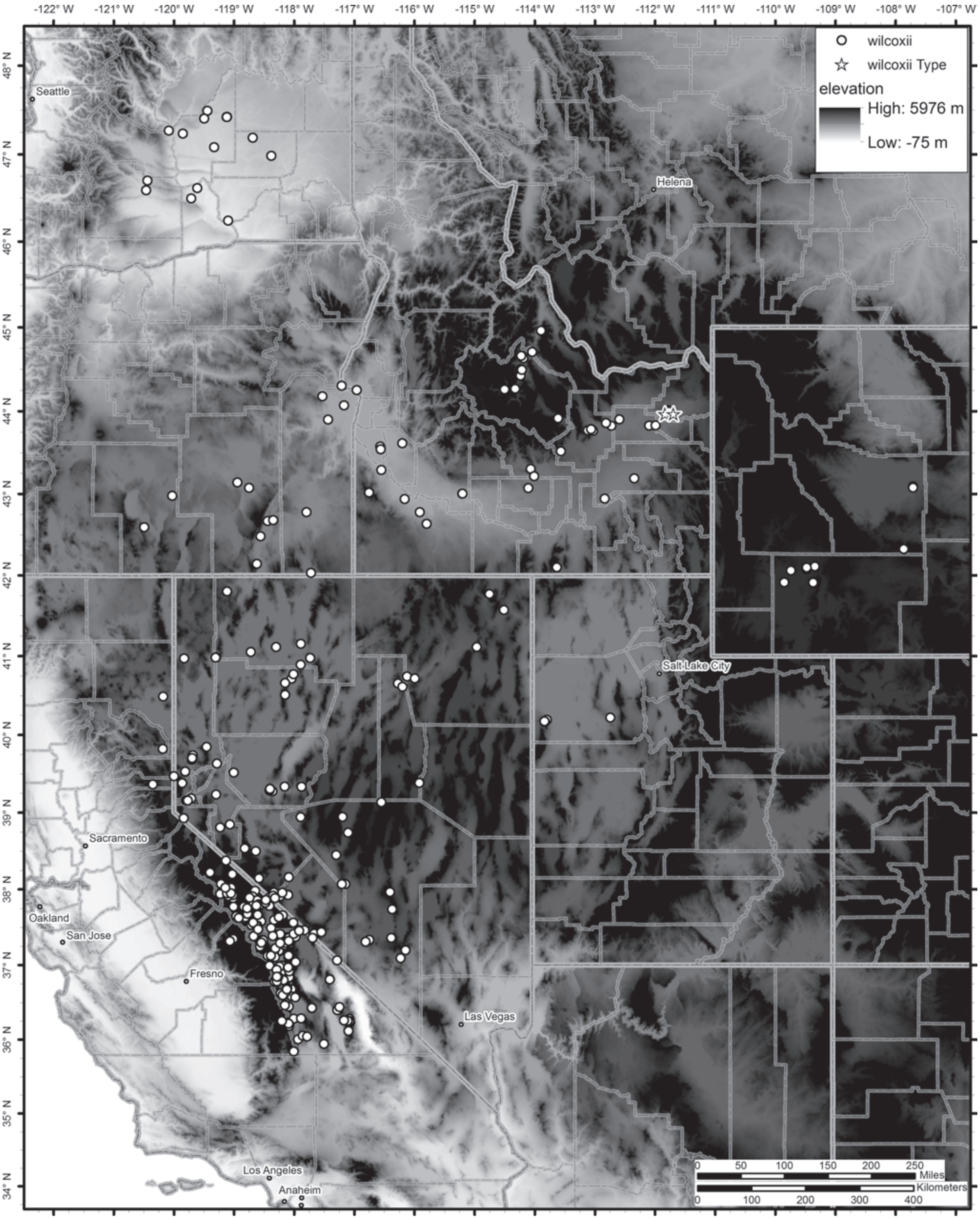

Fig. 319. Range map for *E. wilcoxii*, showing specimen locations and the type localities. County boundaries. major cities, and elevation are shown.

the stamens of subsp. *brevibracteatum* tend to be more exserted (2.3–5.6 mm beyond the sinus) than stamens of *E. wilcoxii* (0.7–2.3 mm). Stems of *E. sapphirinum* subsp. *brevibracteatum* are noticeably densely glandular-pubescent, while stems of *E. wilcoxii* are not.

The single ovule (occasionally 2) per locule distinguishes *E. tracyi* from *E. wilcoxii*, which has 2–4 (rarely 1) ovules per locule. Stamens of *E. wilcoxii* are usually unequal, while stamens of *E. tracyi* are equal to subequal. In general, corollas of *E. wilcoxii* tend to be larger (9–14 mm long) than corollas of *E. tracyi* (5.5–10.5 mm long). *Eriastrum wilcoxii* is found in transmontane areas, while *E. tracyi* occurs in cismontane areas.

Phenology.—Flowering May to early July, fruiting early July to late August, sometimes into September. Plants at lower latitudes tend to flower and fruit earlier than plants at higher latitudes.

Distribution.—Washington, Idaho, Wyoming, Utah, Nevada, Oregon, and California; Great Basin, eastern Cascade Ranges, Rocky Mountains, western edge of Great Plains, Sierra Nevada, northern Mojave Desert (Fig. 319). While most occurrences are in the Great Basin Floristic Region (McLaughlin 2007), some specimens have been found near the edges in neighboring regions.

Habitat.—*Eriastrum wilcoxii* has been collected between 850 and 2675 m (2800–8775 ft) in elevation. It occupies a wide variety of habitats, such as open flats, gentle slopes, dry washes, ditches, depressions, alkaline or semi-alkaline areas. Often it is found in disturbed areas along road shoulders, along or on dirt roads, or sometimes in mowed or burned areas. In general, it grows in open sunny areas between other vegetation. Sites tend to be flat or gently sloped (0–16°) and all aspects are represented. There may be a slight trend toward more south-facing aspects than north-facing aspects. *Eriastrum wilcoxii* can be found on many substrate types—granite, basalt, rhyolite, other volcanics, possibly metamorphics, mixed alluvium, or alkaline soils. Particle size can be rock, gravel, sand (coarse to fine), silt, or occasionally clay; and loose to packed. Surrounding vegetation may be Great Basin sagebrush scrub, an *Artemisia-Lycium* community, *Agropyron* grassland with occasional *Artemisia tridentata*, montane scrub, open pinyon woodland, pinyon-juniper woodland, Mojave desert scrub, blackbrush scrub, *Atriplex* scrub, alkali sink plant community, or halophytes and sand dune vegetation. Although *E. wilcoxii* has been found in *Agropyron* grassland, it is usually found growing in (or restricted to) open areas and not among *Agropyron* plants, suggesting that it may not compete well and may be losing habitat to this grass.

Population dynamics.—Plants have been reported as rare, widely scattered, scattered, frequent, common, or locally abundant. Populations are often (but not always) found in patches, of varying areas. The population size can vary from about 50 plants to more than 10,000. Likely it depends at least in part on the amount of precipitation received during the preceeding winter, and may fluctuate from year to year.

Threats.—*Eriastrum wilcoxii* may be threatened by OHV use, habitat loss due to development or agriculture, and competition from *Agropyron*, *Gypsophylla*, and other invasive plants.

Conservation.—Global rank: G5 – secure; Subnational/State Rank: Wyoming (S1S2 – imperiled; CNPS 2013; NatureServe 2013; Table 2).

Etymology.—The epithet *wilcoxii* is "Named for Mr. Wilcox, mentioned above, who with Mr. Merrill secured three collections of it, all near St. Anthony, Idaho, in July 1901; nos. 822, 862, and 952" (Nelson 1902: 28). Ernest Norton Wilcox (1869–1961) was born in Thawville, Illinois, and died in San Luis Obispo, California. He graduated from South Dakota State College (Brookings) and worked for the Agrostology Division of the U.S. Department of Agriculture, collecting plants in and around Montana. He also farmed in Illinois and in San Luis Obispo county (Harvard University Index of Botanists, *http://kiki.huh.harvard.edu/databases/botanist_search.php?mode=details&id=27685*; *www.calflora.net/botanicalnames/pageW.html*, quoting obituary from the San Luis Obispo Telegram-Tribune, 4 Sep 1961). He is sometimes confused with Early Vernon Wilcox, who also worked for the USDA and collected in the Rocky Mountain area around the turn of the century, roughly the same time as E.N. Wilcox (Vegter 1976; Ewan and Ewan 1981; US herbarium specimens).

The epithet *floccosa* is from Latin *floccosus*, floccose, with tufts of soft hairs, or having matted woolly hairs.

Common name.—Wilcox's woolly-star.

Discussion.—See notes in the Introduction and under *E. luteum* about *Gilia floccosa* and its relationship to *E. wilcoxii*. Specimens collected by Thomas Nuttall and identified as "Hugelia *floccosa" are, for the most part, *E. wilcoxii*. Even in the protologue, Nelson noted the relationship between *E. wilcoxii* and *G. floccosa*: "This is a close ally of G. floccosa Gray" (Nelson 1902: 27–28).

Normally when multiple collections are cited in a protologue, a single collection is later designated as the lectotype. However, in this case *Merrill and Wilcox 952* has been interpreted as the holotype. Some time after the name *G. wilcoxii* was published, Aven Nelson chose single type specimens for names where he had originally listed several syntypes (R. Hartman, RM, pers. comm.). *Merrill and Wilcox 952* is marked "A.N. Type"; *Merrill and Wilcox 822* is marked "A.N. Co-type"; and *Merrill and Wilcox 862* is marked as a paratype. From these annotations, it seems fairly clear that Aven Nelson chose *Merrill and Wilcox 952* as the holotype. Although no herbarium was specified in the protologue, a later designation of a single specimen as a type by the author should be considered the holotype (McNeill 2014). Therefore RM 30221, designated "A.N. Type" is here interpreted as the holotype.

Merrill and Wilcox 952 matches the protologue, and is an adequate specimen to illustrate the application of the name *wilcoxii*. It is interesting, however, to view all three syntypes together, because *Merrill and Wilcox 822* appears to be in early flower, *Merrill and Wilcox 862* is in mid-flower, and *Merrill and Wilcox 952* is in later flower.

There appears to be a fair amount of morphological variation across the range of *E. wilcoxii*. Plants in the northern Great Basin areas (eastern Oregon, Idaho, western Wyoming) have smaller, white or very pale blue corollas, frequently with dark reddish spots at the bases of the lobes, similar to *E. signatum*, but having a white rather than yellow throat. Plants from the southwestern Great Basin and eastern Sierra Nevada have larger, bluer flowers, sometimes with spots or lines near the bases of the lobes, but sometimes lacking these markings. The number of leaf lobes also appears to vary, with plants from higher elevations in the eastern Sierra area having more lobes than plants from lower elevations or from other parts of the Great Basin.

At several sites, *E. wilcoxii* has been found with other *Eriastrum* species, including *E. signatum* and *E. sparsiflorum*. So far, no obvious introgression or hybridization has been noted.

Excluded Names

The following names were at various times treated in the same section or subgenus as *Eriastrum* species, but currently are recognized in other genera and are not included within *Eriastrum*.

Gilia gossypifera Gill. mss. in Bentham 1845, *in* De Candolle, Prodromus Systematis Naturalis Regni Vegetabilis 9: 310. There treated in the same section as *Eriastrum*. Gray (1870) places it in section *Elaphocera*. =*Ipomopsis gossypifera* (Gillies ex Benth.) V.E. Grant 1956, *Aliso* 3: 361 (Porter and Johnson 2000).

Navarretia wrightii (A. Gray) Brand 1907, *in* Engler's Das Pflanzenreich IV. 250: 168 (nom. illeg., later homonym). In Brand's treatment, all species of *Eriastrum* were treated in *Navarretia* subgenus *Hugelia*. Within subgenus *Hugelia* were two sections, section *Euhugelia*, containing all species of *Eriastrum*, and section *Langloisiastrum*, which contained just *Navarretia wrightii*. Although it was placed in the same subgenus as *Eriastrum*, this name was based on *Gilia wrightii* A. Gray 1870, *Proc. Amer. Acad. Arts* VIII: 273. Currently, this species is recognized as *Ipomopsis wrightii* (A. Gray) Shinners 1963, *Sida* 1: 178 (see also Porter and Johnson 2000: 76).

Cross-reference of Herbarium Names

The following names appear only on herbarium specimens and apparently never were validly published.

Gilia densifolia var. longiflora A. Gray, in herb. (nom. inval. [ined.]). Jepson 1943, A Flora of California Vol. 3 Part II p. 163. [no specimens seen]

Gilia densifolia Benth. var. pismoensis Craig n. var. SD 87647! (ex POM 185021), 1 mile south of Pismo on sand dunes, 29 July 1920, *F. W. Peirson 2224*. =*E. densifolium* subsp. *densifolium*.

Gilia (Hugelia) filifolia var. depressa (Gray) Mason. K! (*Alexander and Kellogg 1301*) =*E. diffusum*.

Gilia floccosa var. exserta Jones. *Jones 10011*, NY 336846 (image!) =*E. sapphirinum* subsp. *brevibracteatum*.

Gilia floccosa var. exserta Jones in herb (DS 677923 [image!], *Jones 10011*, ex POM 75010). =*E. sapphirinum* subsp. *brevibracteatum*.

Gilia floccosa var. exsuta [exserta?] Jones in herb. (POM 74589!, *Jones 9917*) =*E. sapphirinum* subsp. *sapphirinum*.

Gilia floccosa var. linearifolia. F 228380! =*E. diffusum*.

Gilia (Hugelia) parviflora Nutt. GH 303697! =*E. wilcoxii*.

Gilia (Hugelia) parviflora Nutt. BM 939591!, K! (*C.L. Anderson 193*) =*E. signatum* or *E. sparsiflorum*.

Gilia virgata var. ambigua Jones. POM 74570!. Syntype of *Gilia virgata* var. *yageri* Jones.

Hugelia curvifolia Nutt. K 196238!, BM 939575! =*E. filifolium*.

"Hugelia *floccosa R. Mts. [Platte?]" Herb. Thomas Nuttall. BM 939593! =*E. wilcoxii.*

"Hugelia *floccosa R. Mts. [Platte?]" "Coll. Nuttall. Presented by Elias Durand, 1866." A. Gray annotations: "gossypifera" "Gilia diffusa [Torr. +Gr.]" "not in herb under this name" "Gilia floccosa. too little developed to know if mine" GH 303675! =*E. wilcoxii*.

"Hugelia +floccosa Nutt. herb. Rky. Mts. Platte. Br. Mus. mine more developed than this!" (A. Gray handwriting) GH 303674! =*E. wilcoxii.*

"Hugelia linifolia" (DS113244!). A Jepson annotation? unsigned, in pencil. =*E. sapphirinum* subsp. *sapphirinum.*

H. parviflora Nutt. see K (Herb. Hook.) "Snake County, Burke" (June. Very sandy soil. Seeds [?] August. Seeds No. 43" Annotated H. parviflora Nutt. possibly by A. Gray. =*E. wilcoxii*.

Hugelia parviflora Nutt. BM 939592! =*E. wilcoxii*.

Hugelia parviflora Nutt. K! (Nuttall coll.) =*E. signatum* or *E. wilcoxii*.

Hugelia virgata var. eremica Jepson in herb. (JEPS 2635 [image!], type of *Hugelia eremica*) =*E. eremicum* subsp. *eremicum*.

Navarretia virgata var. eremica Jepson in herb. (JEPS 2635 [image!], type of *Hugelia eremica*) =*E. eremicum* subsp. *eremicum*.

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Plate 1: Fig. 40–68. *Eriastrum abramsii*, *E. harwoodii*, *E. hooveri*, *E. ertterae*, and *E. rosamondense*.—40–44. *E. abramsii*.—40. Habit (*De Groot 5885*).—41. Inflorescence (*De Groot 5885*).—42. Flower from the side (*De Groot 5885*).—43. Opened corolla, with pistil (*De Groot 5885*).—44. Flower from the front (*De Groot 5885*).—45–49. *E. harwoodii*.—45. Inflorescence (*De Groot 5755*).—46. Flower from the side (*De Groot 5716*).—47. Opened corolla, with some anthers removed (*De Groot 5716*).—48. Flower from the front (*De Groot 5731*).—49. Habit (*De Groot 5716*).—50–56. *E. hooveri*.—50. Habit (*De Groot 6385*).—51. Opened corolla (*De Groot 5240*).—52. Inflorescence, showing a flower from the side (*De Groot 6013*).—53. Flower from the front, displaying a translucent corolla (*De Groot 6385*).—54. Flower from the front, displaying an opaque corolla (*De Groot 6385*).—55. Fruit, from the side (*De Groot 5242*).—56. Mature leaf (*De Groot 5240*).—57–62. *E. ertterae*.—57. Habit of a mostly unbranched plant (*De Groot 5310*).—58. Habit of a branched plant (*De Groot 5309*).—59. Corolla, androecium, and pistil (*De Groot 5310*).—60. Flower from the side (*De Groot 5310*).—61. Flower from the front (*De Groot 5310*).—62. Mature leaf (*De Groot 5310*).—63–68. *E. rosamondense*.—63. Opened corolla (*De Groot 4976*).—64. Mature leaf (*De Groot 4976*).—65. Inflorescence, showing flowers from the front (*De Groot 4976*).—66. Flower from the side (*De Groot 4976*).—67. Habit (*De Groot 4976*).—68. Habit, *in situ* (*De Groot 4976*).

Plate 2: Fig. 70–97. *Eriastrum sparsiflorum*, *E. signatum*, **E. calocyanum**, and *E. tracyi*.—70–76. *E. sparsiflorum*.—70. Habit (*De Groot 5970*).—71. Inflorescence (*De Groot 5439*).—72. Opened corolla (*De Groot 5439*).— 73. Flower from the front (*De Groot 6438*).—74. Flower and fruit from the side (*De Groot 5448*).—75. Inflorescence, showing glandular peduncle (*De Groot 6439*).—76. Flower (*De Groot 6438*).—77–81. *E. signatum*.—77. Flower from the front, showing the usual spots at the bases of the corolla lobes (*De Groot 5098*).—78. Habit of plant in late flower and early fruit (*De Groot 5430*).—79. Opened corolla, with pistil (*De Groot 5899*).—80. Inflorescences from the front, showing two corolla colors (*De Groot 6037*).—81. Inflorescences from the side, showing two corolla colors (*De Groot 6037*).—82–88. **E. calocyanum**.—82. Habit of northern form (*De Groot 5880*).—83. Habit of southern form (*De Groot 5877*).—84. Flower from the front (northern form; *De Groot 5880*).—85. Opened corolla, with pistil (northern form; *De Groot 5880*).—86. Flower from the side (southern form; *De Groot 5877*).—87. Flower from the front (southern form; *De Groot 5877*).—88. Flower from the side (northern form; *De Groot 5880*).—89–97. *E. tracyi*.—89. Flower and inflorescence, from the San Francisco Bay area (*De Groot 5887*).—90. Habit (North Coast Ranges; *De Groot 5690*).—91. Flower from the side (North Coast Ranges; *De Groot 5690*).—92. Flower from the front (North Coast Ranges; *De Groot 5690*).—93. Flower and inflorescence (Shasta County; *De Groot 6164*).—94. Corollas showing the frequent white, purple, and yellow tube and throat coloration (Shasta County; *De Groot 6164*).—95. Flower from the side (North Coast Ranges, small-flowered form; *De Groot 5677*).—96. Inflorescence (southern Sierra Nevada; *De Groot 5948*).—97. Opened corolla (North Coast Ranges; *De Groot 6422*).

Plate 3: Fig. 107–131. *Eriastrum densifolium*.—107–110. Subsp. *densifolium*.—107. Flower from the front (*De Groot 5700*).—108. Flower from the side (*De Groot 5700*).—109. Habit (*De Groot 5697*).—110. Inflorescence (*De Groot 5697*).—111–114. Subsp. **patens**.—111. Habit (*De Groot 5641*).—112. Flower from the side (*De Groot 5642*).—113. Inflorescence (*De Groot 5641*).—114. Flower from the front (*De Groot 5642*).—115–118. Subsp. *sanctorum*.—115. Inflorescence (*De Groot 5702*).—116. Habit (*De Groot 5703*).—117. Flower from the front (*De Groot 5901*).—118. Flower from the side (*De Groot 5702*).—119–123. Subsp. *mohavense*.—119. Inflorescence (*De Groot 5908*).—120. Flower from the side (*De Groot 5908*).—121. Flower from the front (*De Groot 5908*).—122. Mature leaf; note broad primary axis (De Groot 5907).—123. Habit (*De Groot 5907*).—124–127. Subsp. *elongatum*.—124. Inflorescence (*De Groot 5878*).—125. Flower from the front (*De Groot 5646*).—126. Flower from the side (*De Groot 5646*).—127. Habit (*De Groot 5918*).—128–131. Subsp. *austromontanum*.—128. Inflorescence (*De Groot 6074*).—129. Flower from the front (*De Groot 5910*).—130. Flower from the side (*De Groot 5910*).—131. Habit (*De Groot 5910*).

Plate 4: Fig. 152–172. *Eriastum diffusum*.—152–155. Typical *E. diffusum* subsp. *diffusum* from New Mexico.—152. Habit (*De Groot 5533*).—153. Inflorescence showing flowers from the front (*De Groot 5533*).—154. Flower from the side (*De Groot 5533*).—155. Partial opened corolla, with pistil (*De Groot 5532*).—156. Subsp. *diffusum* from California: opened corolla, with pistil (*De Groot 4996*).—157–160. Subsp. *diffusum* from the Chihuahuan Desert.—157. Habit (*De Groot 5525*).—158. Habit (*De Groot 5498*).—159. Flower from the side (*De Groot 5498*).—160. Flower from the front (*De Groot 5498*).—161–163. Larger-flowered *E. diffusum* from Arizona, which is sometimes recognized as subsp. *jonesii*, but here treated within subsp. *diffusum*.—161. Habit (*De Groot 4925*).—162. Flower from the side (*De Groot 4925*).—163. Flower from the front (*De Groot 4925*).—164–167. Subsp. **utahense**.—164. Habit (*De Groot 5598*).—165. Flower from the side (*De Groot 5598*).—166. Flower from the front; note reddish lines (*De Groot 5274*).—167. Opened corolla (*De Groot 5274*).—168–172. Subsp. **coachellae**.—168. Habit (*De Groot 5712*).—169. Flower from the side (*De Groot 5712*).—170. Inflorescence, with flowers viewed from the front (*De Groot 4911*).—171. Flower from the front (*De Groot 5712*).—172. Opened corolla (*De Groot 5712*).

Plate 5: Fig. 186–212. *Eriastrum eremicum*.—186–193. Subsp. *eremicum*.—186. Habit of erect plant (*De Groot 5764*).—187. Habit of spreading plant (*De Groot 5757*).—188. Inflorescence, with light blue flowers (*De Groot 5750*).—189. Inflorescence, with nearly white flowers (*De Groot 5764*).—190. Opened partial corolla (*De Groot 4967*).—191. Flower from the side, showing unequal stamens (*De Groot 5810*).—192. Flower from the side, showing unequal sinuses (*De Groot 5740*).—193. Mature leaf (*De Groot 4967*).—194–199. Subsp. *yageri*.—194. Mature leaf (*De Groot 4931*).—195. Habit (*De Groot 5547*).—196. Pale flower, viewed from the front (*De Groot 5547*).—197. Opened corolla, notice unequal sinuses and stamens (*De Groot 4931*).—198. Blue flower, viewed from the side (*De Groot 5547*).—199. Blue flower, viewed from the front (*De Groot 4931*).—200–205. Subsp. *zionis*.—200. Habit (*De Groot 5802*).—201. Mature leaf (*De Groot 5283*).—202. Flower from the front (Zion National Park; *De Groot 5282*).—203. Opened corolla (*De Groot 5282*).—204. Flower from the side (*De Groot 5275*).—205. Flower from the front (southwest Utah; *De Groot 5275*).—206–212. Subsp. **markianum**.—206. Habit (*De Groot 4850*).—207. Mature leaf (*De Groot 4896*).—208. Flower from the front (*De Groot 4850*).—209. Flower from the side (*De Groot 4850*).—210. Opened corolla (*De Groot 4850*).—211. Flower from the front (*De Groot 4896*).—212. Flower from the side (*De Groot 4896*).

Plate 6: Fig. 223–248. *Eriastum filifolium*, *E. luteum*, *E. virgatum*, and *E. wilcoxii*.—223–228. *E. filifolium*.—223. Habit (*De Groot 5871*).—224. Inflorescence (*De Groot 5760*).—225. Flower from the side (*De Groot 5760*).—226. Flower from the front (*De Groot 5760*).—227. Flower from the front (Baja California population; *De Groot 4841*).—228. Opened corolla, showing the pistil with a long cylindric ovary (*De Groot 5590*).—229–233. *E. luteum*.—229. Woolly, multi-cellular trichomes (*De Groot 5300*).—230. Habit (*De Groot 5024*).—231. Inflorescence, with a flower viewed from the front (*De Groot 5024*).—232. Flower from the side (*De Groot 5024*).—233. Opened corolla (*De Groot 5300*).—234–241. *E. virgatum*.—234. Ovary; arrows point to nectary disk. Note also the glandular trichomes at the ovary apex (*De Groot 5307*).—235. Nectary disk, adaxial side, viewed obliquely, showing the usual conical form. The ovary was attached in the center (*De Groot 5307*).—236. Nectary disk, adaxial side, viewed from the top (*De Groot 5307*).—237. Inflorescence (*De Groot 5306*).—238. Flower from the front (*De Groot 5307*).—239. Flower from the side (*De Groot 5307*).—240. Partially opened corolla (*De Groot 5307*).—241. Habit (*De Groot 5305*).—242–248. *E. wilcoxii*.—242. Habit (*De Groot 5416*).—243. Flower from the side (Idaho plant; *De Groot 5416*).—244. Flower from the front (Idaho; *De Groot 5416*).—245. Flower from the front (southeast California; *De Groot 5827*).—246. Opened corolla with pistil (*De Groot 5395*).—247. Flower from the side (large-flowered form from the eastern Sierra Nevada, California; *De Groot 5445*).—248. Flower from the front (large-flowered form from the eastern Sierra Nevada, California; *De Groot 5445*).

Plate 7: Fig. 252–272. *Eriastrum pluriflorum*.—252–257, 270. Subsp. *pluriflorum*.—252. Habit (*De Groot 5952*).—253. Flower from the front (*De Groot 5040*).—254. Flower from the side (*De Groot 5650*).—255. Inflorescence (*De Groot 6035*).—256. Opened partial corolla (*De Groot 5040*).—257. Opened calyx, showing unequal lobes (*De Groot 5040*).—258–262, 271. Subsp. *sherman-hoytae*.—258. Flower from the side, notice the yellow throat (*De Groot 6041*).—259. Flower from the front (*De Groot 5032*).—260. Inflorescence (*De Groot 6042*).—261. Habit (*De Groot 6042*).—262. Opened partial corolla (*De Groot 5032*).—263–269, 272. Subsp. **albifaux**.—263. Inflorescence (*De Groot 6029*).—264. Habit (*De Groot 5050*).—265. Flower from the side, notice the white throat (*De Groot 5050*).—266. Opened partial corolla (*De Groot 5053*).—267. Flower from the side, showing equal sinuses (*De Groot 6029*).—268. Flower from the front, showing actinomorphy (*De Groot 5050*).—269. Inside of the corolla tube, showing epidermal projections (*De Groot 5053*).—270-272. Mature leaves. Scale is the same for all three.—270. Leaf of subsp. *pluriflorum* (*De Groot 5952*).—271. Leaf of subsp. *sherman-hoytae* (*De Groot 6042*).—272. Leaf of subsp. **albifaux** (*De Groot 5050*).

Plate 8: Fig. 281–308. *Eriastrum sapphirinum*.—281–291. Subsp. *sapphirinum*.—281. Habit (*De Groot 5980*).—282. Inflorescence (*De Groot 5977*).—283. Flower from the front (*De Groot 5977*).—284. Flower from the side (*De Groot 5977*).—285. Trichomes along the style (*De Groot 5102*).—286–288. Style trichomes. Scale is the same for all three panels.—286. 2-celled style trichome (*De Groot 5102*).—287. 3-celled style trichome (*De Groot 5102*).—288. 5-celled style trichome (*De Groot 5102*).—289. Upper stems, showing glandular hairs (*De Groot 5102*).—290. Opened corolla (*De Groot 5102*).—291. Inflorescence bract (subtended a head; *De Groot 5977*).—292–299. Subsp. *dasyanthum*.—292. Inflorescence bract (*De Groot 5973*).—293. Inflorescence (*De Groot 5746*).—294. Flower from the front, with the usual royal blue corolla (*De Groot 5746*).—295. Habit (*De Groot 5973*).—296. Flower from the side, with the usual royal blue corolla (*De Groot 5746*).—297. Flower from the side, with a nearly white corolla (*De Groot 5113*).—298. Opened corolla (*De Groot 5049*).—299. Flower from the front, with a nearly white corolla (*De Groot 5113*).—300–308. Subsp. **brevibracteatum**.—300. Sample of corolla color variation within a single population, from light blue to white, and with various degrees of spotting (*De Groot 6758*).—301. Habit (*De Groot 5854*).—302. Inflorescence (*De Groot 5940*).—303. Flower from the front (*De Groot 5052*).—304. Opened corolla (*De Groot 5052*).—305. Flower from the side, showing yellow coloration on the abaxial side of the petals (*De Groot 6758*).—306. Flower from the side, with the usual blue corolla (*De Groot 5854*).—307. Inflorescence bract (*De Groot 5854*).—308. Upper stems, showing glandular hairs (*De Groot 5052*).

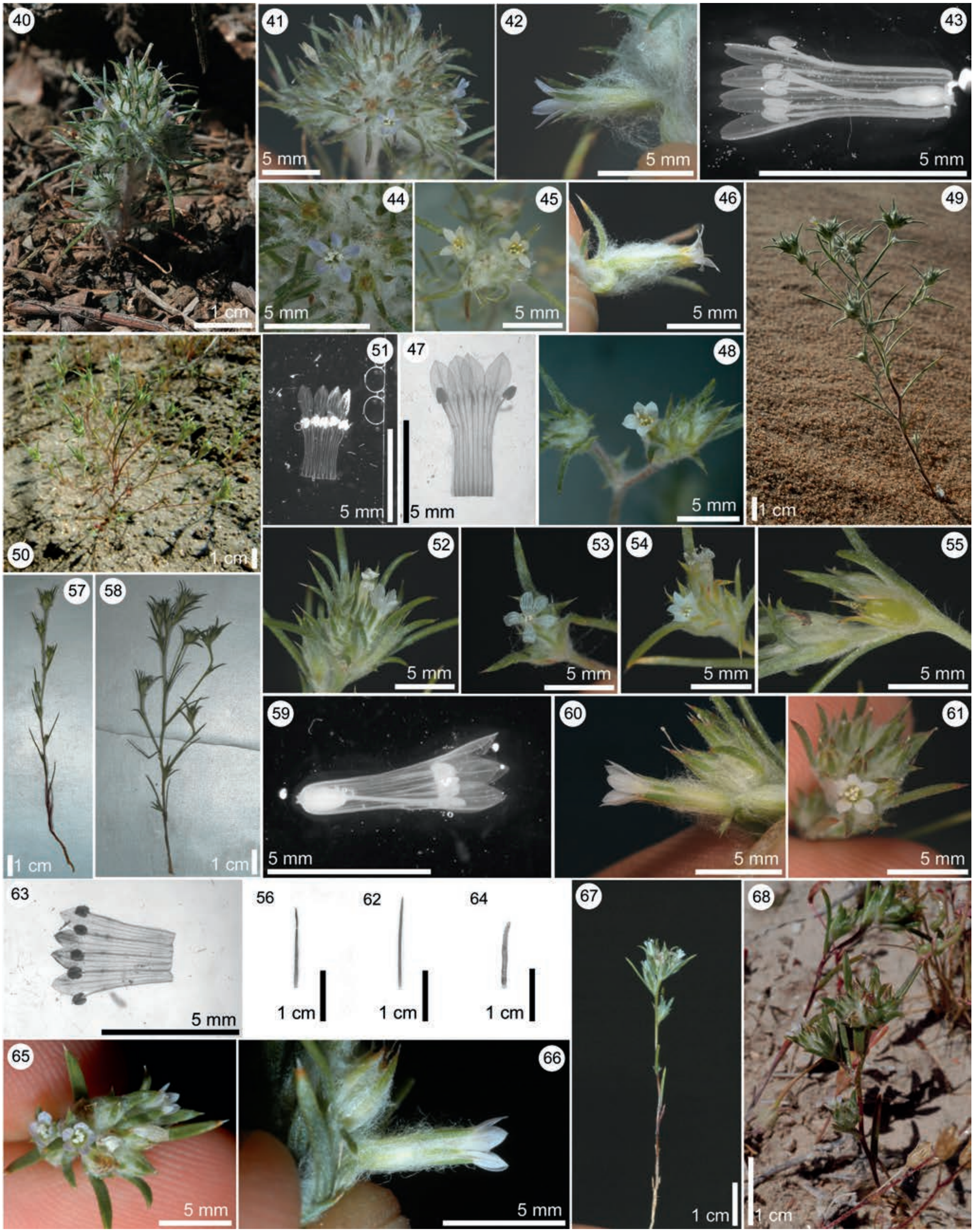

Plate 1: Fig. 40–68.

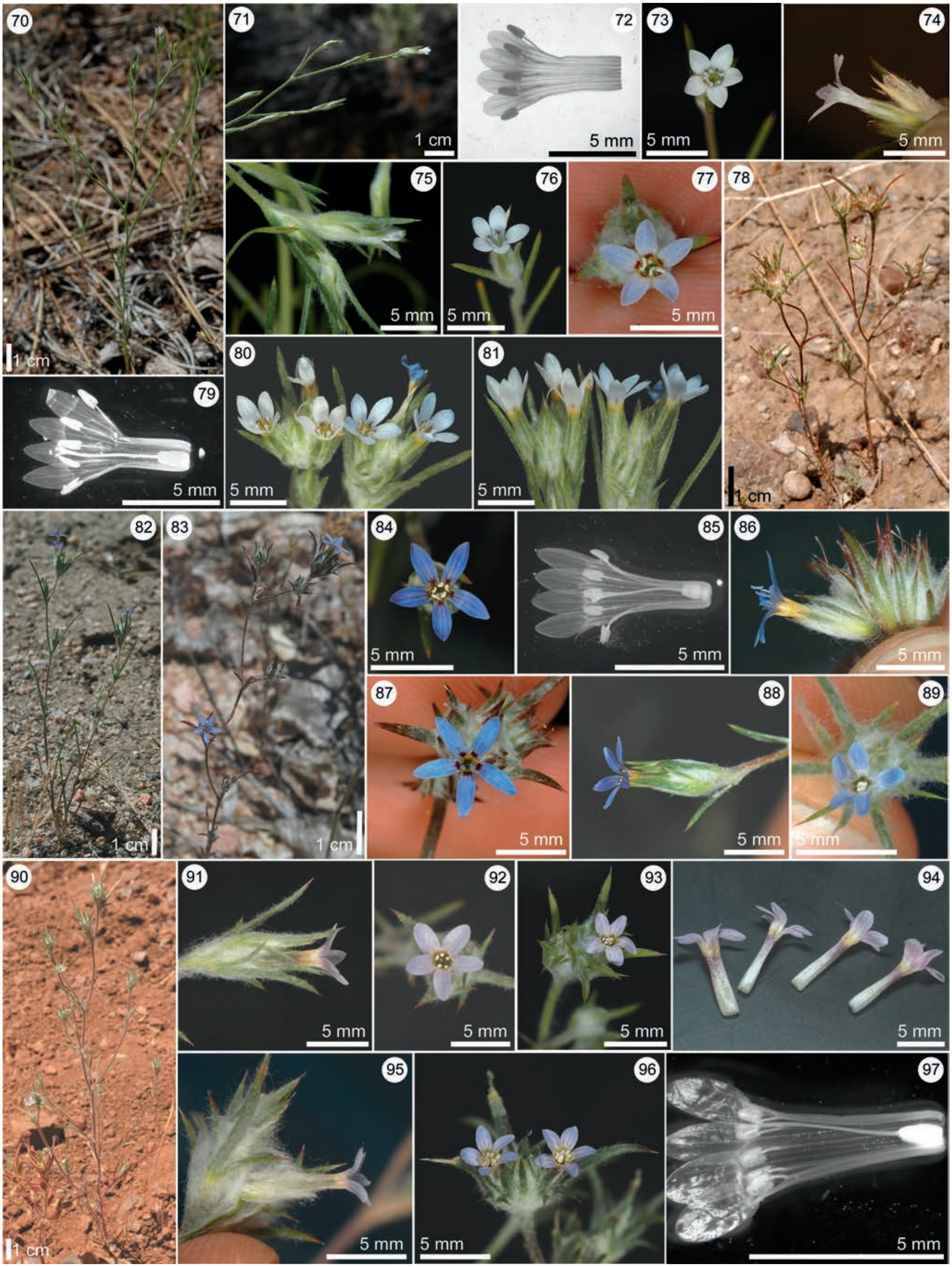

Plate 2: Fig. 70–97.

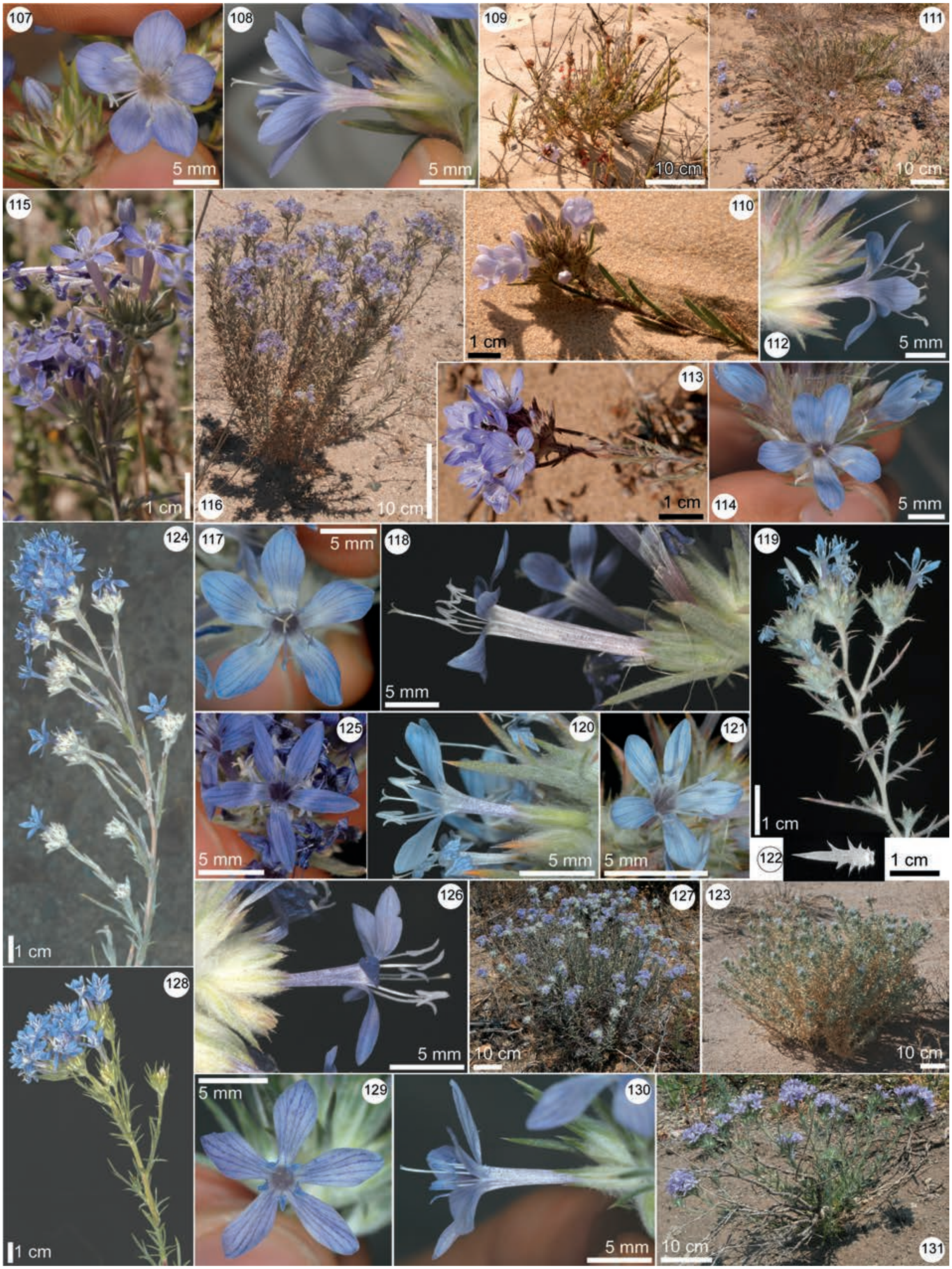

Plate 3: Fig. 107–131.

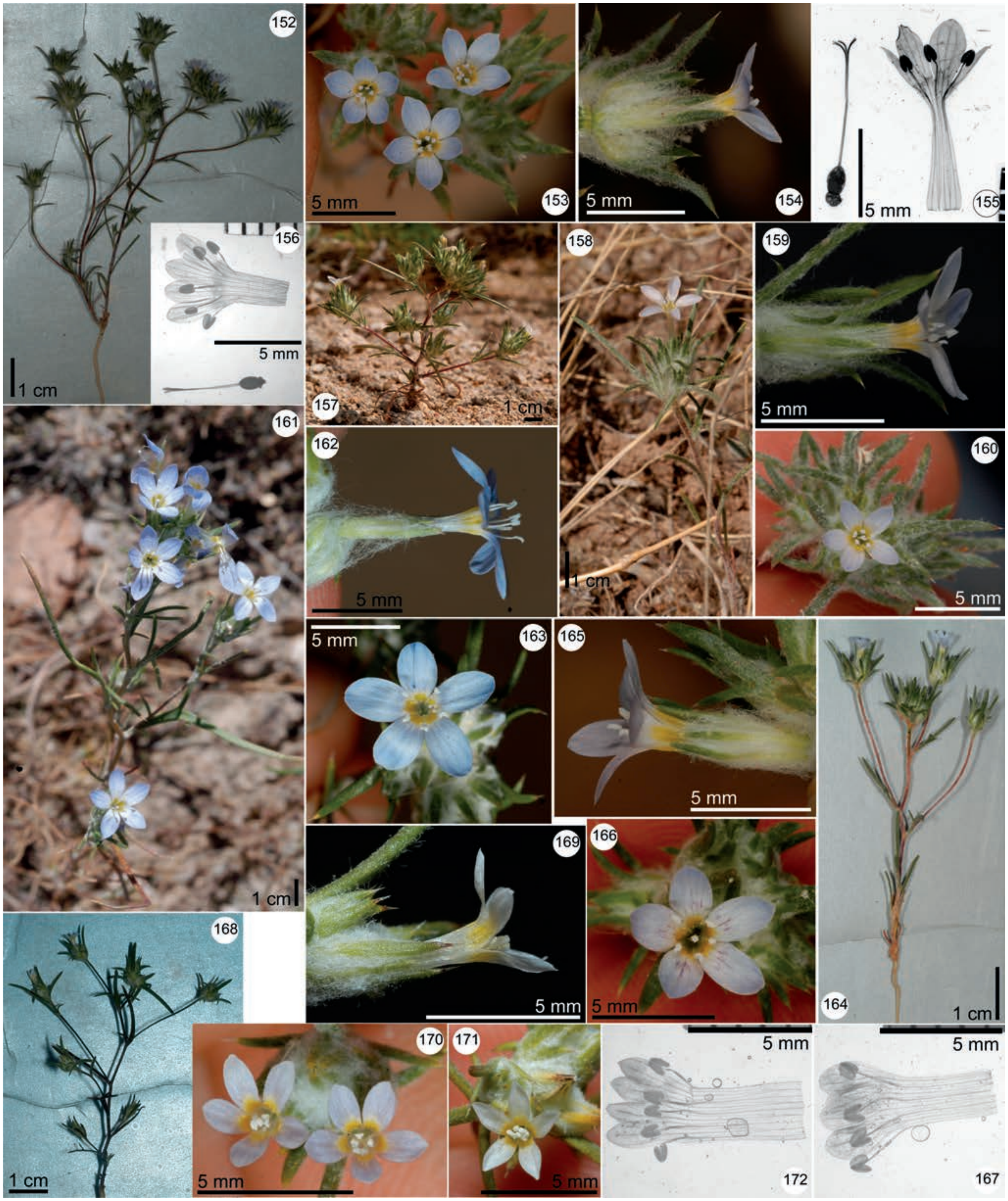

Plate 4: Fig. 152–172.

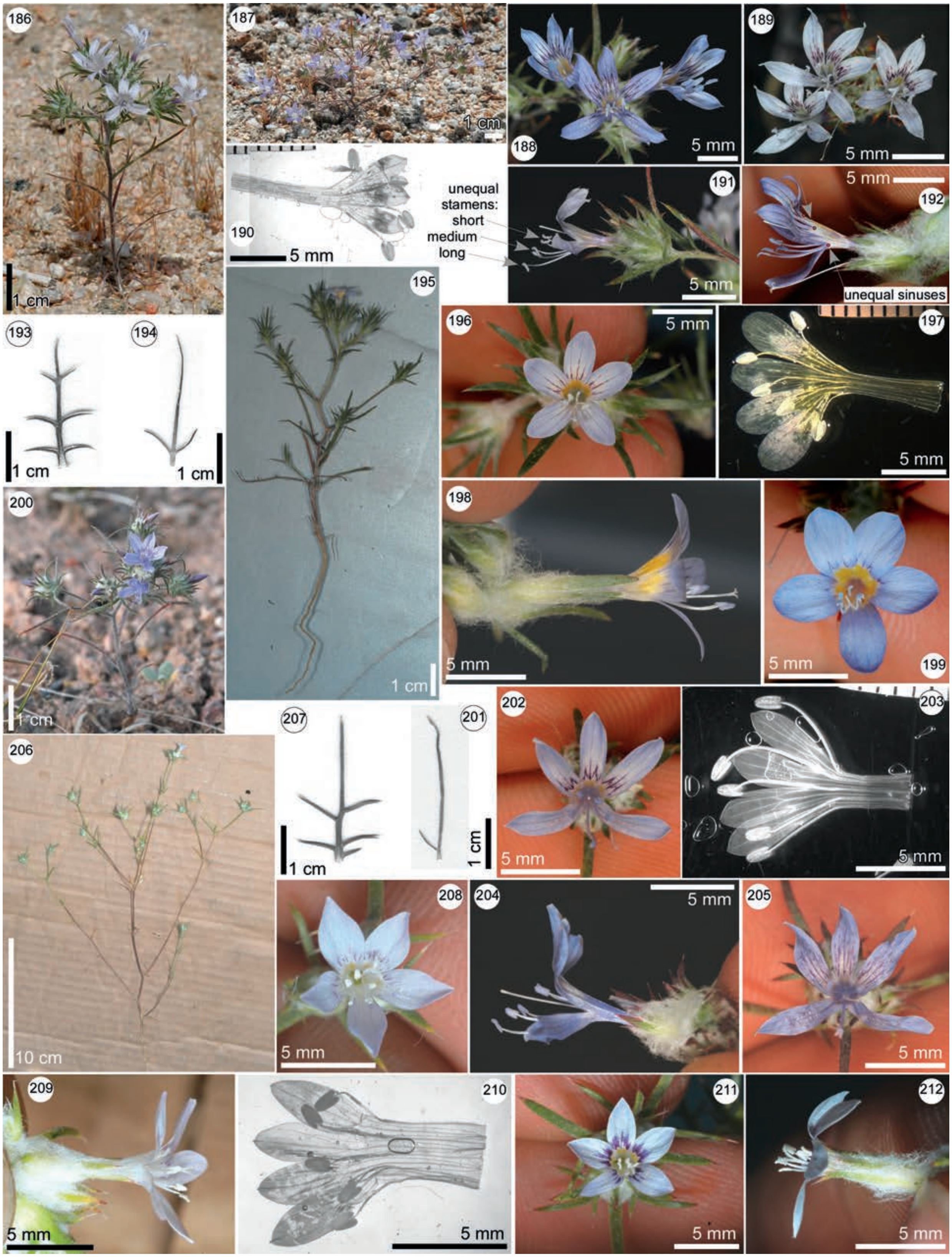

Plate 5: Fig. 186–212.

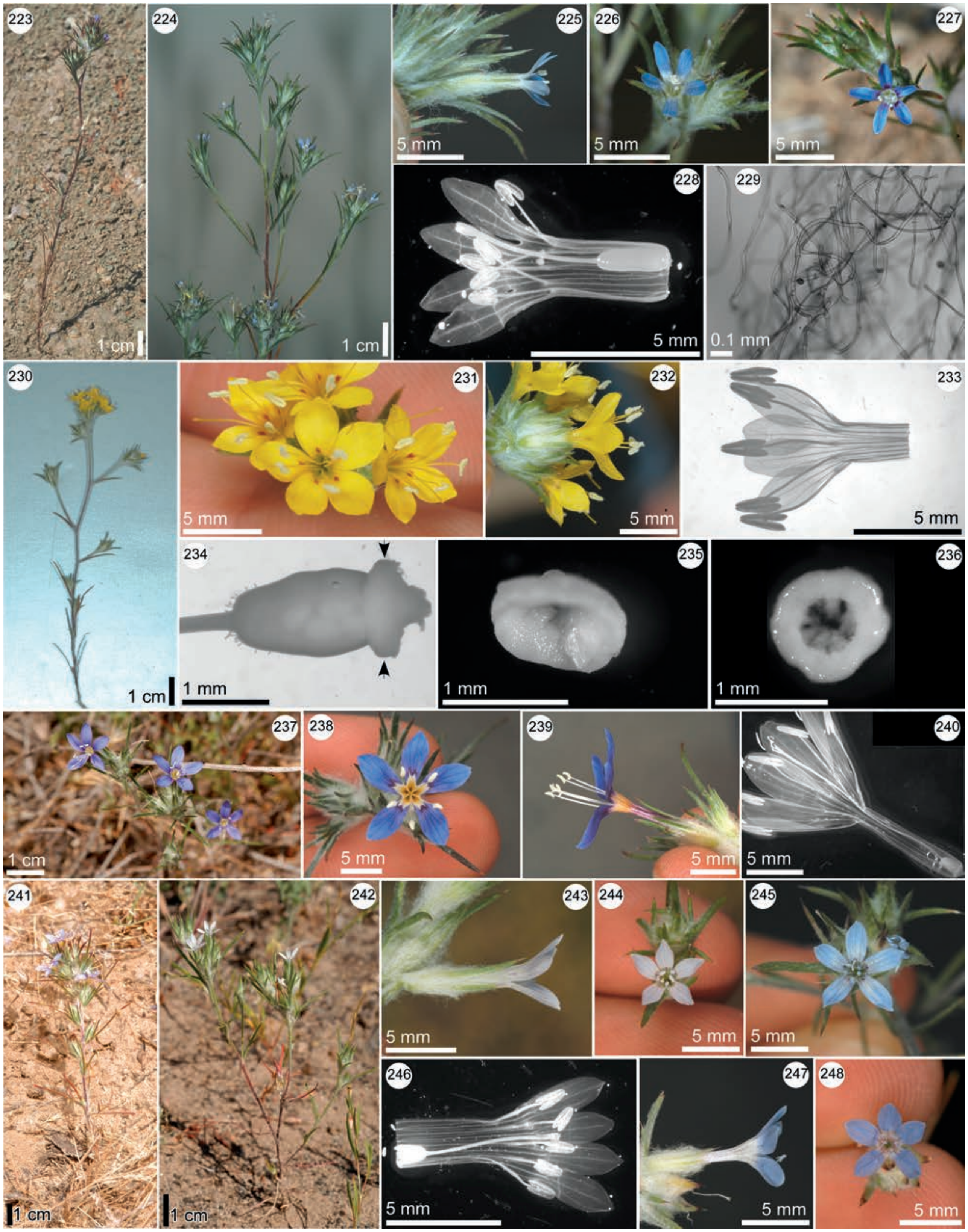

Plate 6: Fig. 223–248.

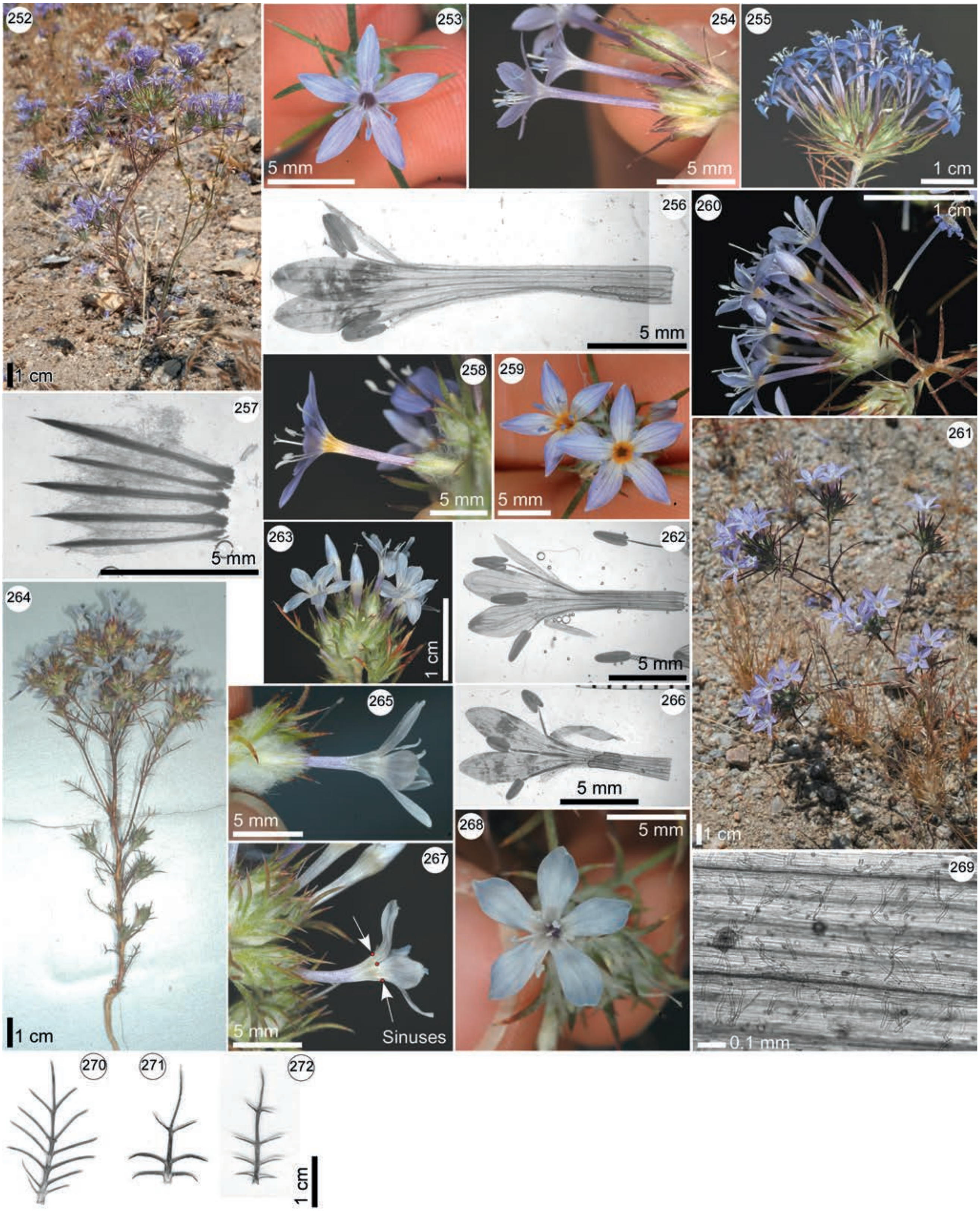

Plate 7: Fig. 252–272.

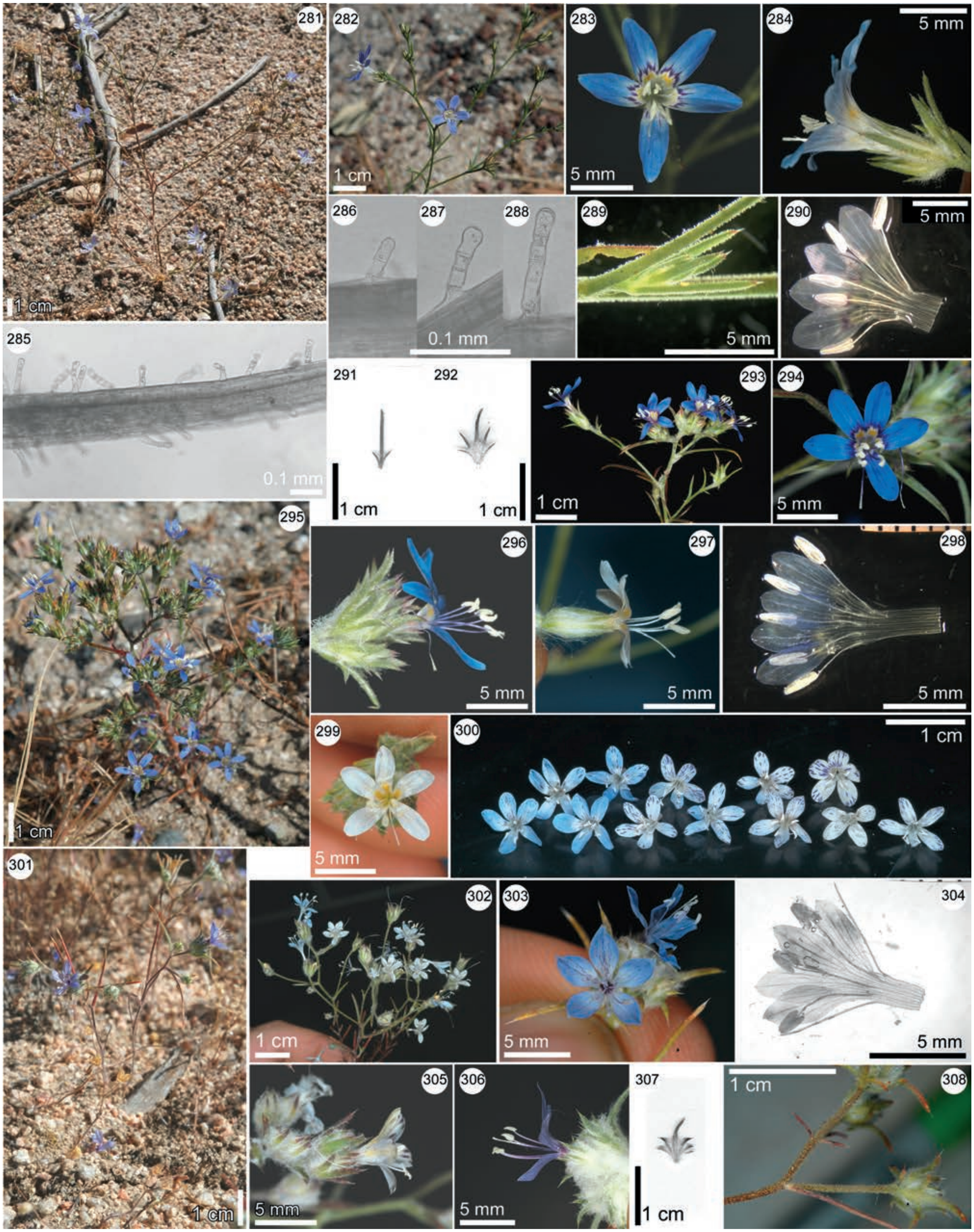

Plate 8: Fig. 281–308.