Mary DeDecker Botanical Grant Progress Report 2024

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I am a second-year PhD student at California Botanic Garden uncovering the evolutionary relationships within the Latifolia clade, testing the current classification (species and varieties), and improving the classification within the clade as needed. Species first hypothesized to be included within the Latifolia clade are *E. eastwoodianum*, *E. grande*, *E. latifolium*, *E. nudum*, and *E. parvifolium* (Kempton 2012). In a separate study (Grady 2012), *E. apricum* resolved in the clade with *E. nudum*, *E. grande* and *E. parvifolium*. A later study (Pearman et al. 2021) found high support for the Latifolia clade but only sampled *E. latifolium*, *E. nudum*, and *E. parvifolium*. The species, *E. argillosum*, E. *temblorense*, and *E. vestitum* are morphologically similar to *E. eastwoodianum*, yet neither have been sampled for phylogenetic study. *Eriogonum truncatum*, presumed extinct until 2005, is also worthy of investigation as a member of this clade as *E. eastwoodianum* was historically treated as a synonym. The species *E. molestum*, while an annual, is mistaken for E. nudum var. pauciflorum morphologically (Reveal 2014). In summary, the hypothesized species belonging to the clade are *Eriogonum apricum*, *E. argillosum*, *E. eastwoodianum*, *E. grande*, *E. latifolium*, *E. molestum*, *E. nudum*, *E. parvifolium*, *E. temblorense*, *E. truncatum*, and *E. vestitum*. *Eriogonum nudum* occupies a multitude of habitats from coastal to alpine to desert and many soil types, including serpentine, limestone, sand dunes, granite, basalt and tar shale (CCH2 2025 and Reveal 2014). My project involves analyzing soils from populations of *E. nudum* to investigate whether the type soil tolerance has an evolutionary signal. The third aspect of my project entails analyzing floral color diversity and phylogenetic signal within *E. nudum* and *E. grande*.

For the summer 2024 field season, the objective was to collect as many taxa as possible and ascertain the phylogenetic relationship among the varieties within *E. nudum* and the relationship between *E. nudum* and other species within the Latifolia clade. To accomplish this goal, I traveled across California and Oregon collecting from populations of *E. nudum* and putatively closely related species (*E. eastwoodianum*, *E. grande*, *E. latifolium*, *E. parvifolium*, *E. temblorense*, and *E. vestitum*) from native habitats and botanic gardens. I sampled 43 populations (ca. 4000 miles of travel), accounting for 127 individuals and 43 flower collections (for color analysis). Samples from 26 populations of *E. nudum* have been generously provided to me by other botanists, mainly by Travis Columbus. In all, I have acquired 207 samples from 69 distinct populations (Figure 1). These collections represent 14 out of 15 varieties of *E. nudum* (except var. *murinum*), three out of four varieties of *E. grande* (from botanic gardens), and six of the nine remaining putative species in the Latifolia clade. So far, collections have been made from 12 of the 44 type localities (including taxonomic synonyms) in the Latifolia clade.

Support from the CNPS Bristlecone chapter has allowed me to collect samples from various localities in Inyo and Mono counties. With respect to Inyo and Mono counties, three populations of *E. nudum* var. *westonii* (two from Inyo County and one from Mono County) were sampled, DNA-extracted, and sequenced. One of populations of *E. nudum* var. *westonii* collected was the type locality of *Eriogonum saxicola*, a taxonomic synonym of *E. nudum* var. *westonii*. The type locality is in Inyo county, just south of Bishop. One population of var. *gramineum* from The Panamint Ranges was obtained from Travis Columbus, one population of var. *scapigerum* was obtained from Matthew Yamamoto from McGee Creek watershed, and one population of var. *scapigerum* was obtained from Joy England from Rock Creek. The first two were extracted and sequenced and the latter has yet to be sequenced. Unfortunately, *E. nudum* var. *gramineum*, var. *scapigerum*, and var. *westonii* did not sequence well so their phylogenetic placement is

currently uncertain. However, adjustments to DNA extraction and library protocols for these varieties will ensure future successful sequencing.

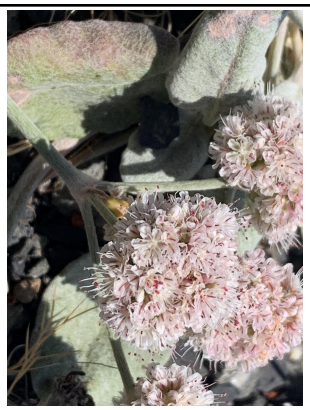
During the late summer and fall, I extracted DNA, prepared a ddRADseq library, and obtained sequences for phylogenetic analyses. From these data, I generated a preliminary phylogenetic tree. All 69 populations were sequenced, yet some samples were removed from phylogenetic analysis due to poor sequencing. I estimated two phylogenies, one with only high-quality sequencing data from 38 populations (Figure 2) and one including middling quality sequencing data totaling 49 populations (Figure 3). Analyses below are based on the Figure 1 phylogeny because it has better overall bootstrap support.

The phylogenetic tree supports the split of *E. nudum* into three distinct species with *E. nudum* var. *pauciflorum* and var. *indictum* forming a grade basal to well established species such as *E. grande* and *E. parvifolium*. The rest of the *E. nudum* varieties that appear form a well-supported clade. Most clades are shown to be well-supported due to having a high bootstrap value, around 80 to 100, along the branch that defines the clade. A high bootstrap value indicates high confidence of a particular branch in the phylogenetic tree. Within this larger clade are several well supported clades that have an uncertain relationship to each other, due to low bootstrap support, thus low confidence in the relationship of taxa grouped together by that branch.

The phylogeny supports the three varieties of *E. grande* sampled as phylogenetically distinct and infers a sister relationship between *E. grande* and *E. parvifolium*. This sister relationship is in contrast to previous phylogenetic studies in *Eriogonum* which show *E. latifolium* and *E. parvifolium* as sister species (Kempton 2012, Pearman 2021). *Eriogonum latifolium* is appears not to be nonmonophyletic being as it is in two separate places in the phylogeny. The type locality (sample 55) is sister to the *E. nudum* clade while the *E. latifolium* population from Oregon (sample 41) is deeply embedded into the *E. nudum* clade. *Eriogonum nudum* var. *decurrens* is sister to the type clade of *E. latifolium* which suggests that *E. nudum* var. *decurrens* may be better treated as a variety of *E. latifolium* instead of *E. nudum*. One species unexpectedly embedded into the *E. nudum* clade is *E. apricum*, a federally endangered species from near Sacramento.

For the 2025 field season, I am planning fieldwork in the California (including California Channel Islands), Oregon, and Washington to obtain a greater sampling of populations from *E. nudum* and to collect taxa not yet obtained from the Latifolia clade. The remaining type locality not yet collected within Inyo and Mono counties is the type locality of *E. nudum* var. *gramineum* from the Argus Range. I intend on collecting from that location during the upcoming field season. I also intend on collecting and sequencing at least two populations of each variety of *E. nudum* found in Inyo County (*E. nudum* vars. *deductum*, *pauciflorum*, *pubiflorum*, *scapigerum*, and *westonii*) and at least two populations of each variety of *E. nudum* found in Mono County (*E. nudum* vars. *deductum*, *pubiflorum*, *scapigerum*, and *westonii*). With more populations collected, extracted, and sequenced I hope to clarify relationships within the phylogeny. I also endeavor to collect and analyze soil samples and perform tests regarding flower color to assess the evolutionary significance of these two variables.

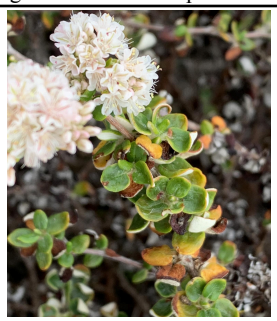
Eriogonum apricum var. apricum



Eriogonum nudum var. paralinum 40

Eriogonum latifolium 41

Eriogonum nudum var. nudum 44



Eriogonum parvifolium 51

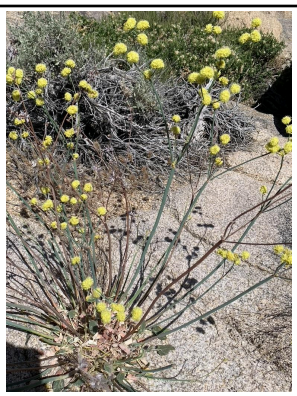
Eriogonum nudum var. decurrens 53

Eriogonum nudum var. auriculatum 54

Eriogonum grande var. rubescens

Eriogonum nudum var. indictum 29

Eriogonum vestitum 23



Eriogonum nudum var. westonii 26

E. nudum var. pubiflorum 49

Figure 1: Select images from the Latifolia clade collected during the 2024 field season representing the diversity of the clade. All but *E. nudum* var. *paralinum* and var. *westonii* are represented in the phylogeny. The numbers correspond to collection numbers which are displayed in the phylogenetic trees below.

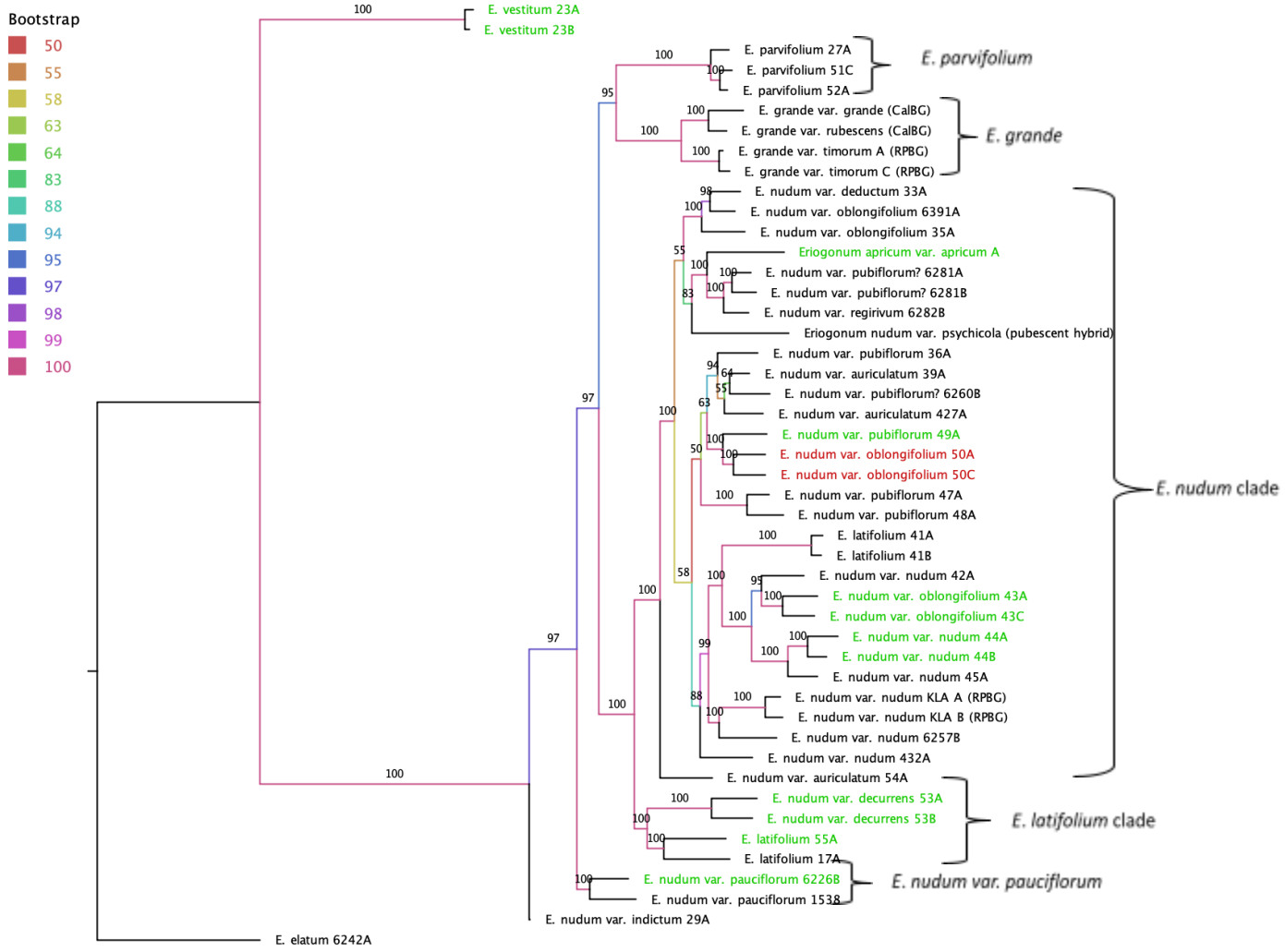


Figure 2: A maximum likelihood phylogeny made in IQ-Tree of the Latifolia clade. *Eriogonum elatum* represents the outgroup. The branch labels show bootstrap support and the color of the branches indicates the level of support. Groupings are shown by brackets. Populations from the type localities are in green. Type localities of synonyms are in red. Populations obtained from botanic gardens are indicated in parentheses. CalBG indicates a collection form the California Botanic Garden. RPBG indicates a collection from the Regional Parks Botanic Garden.

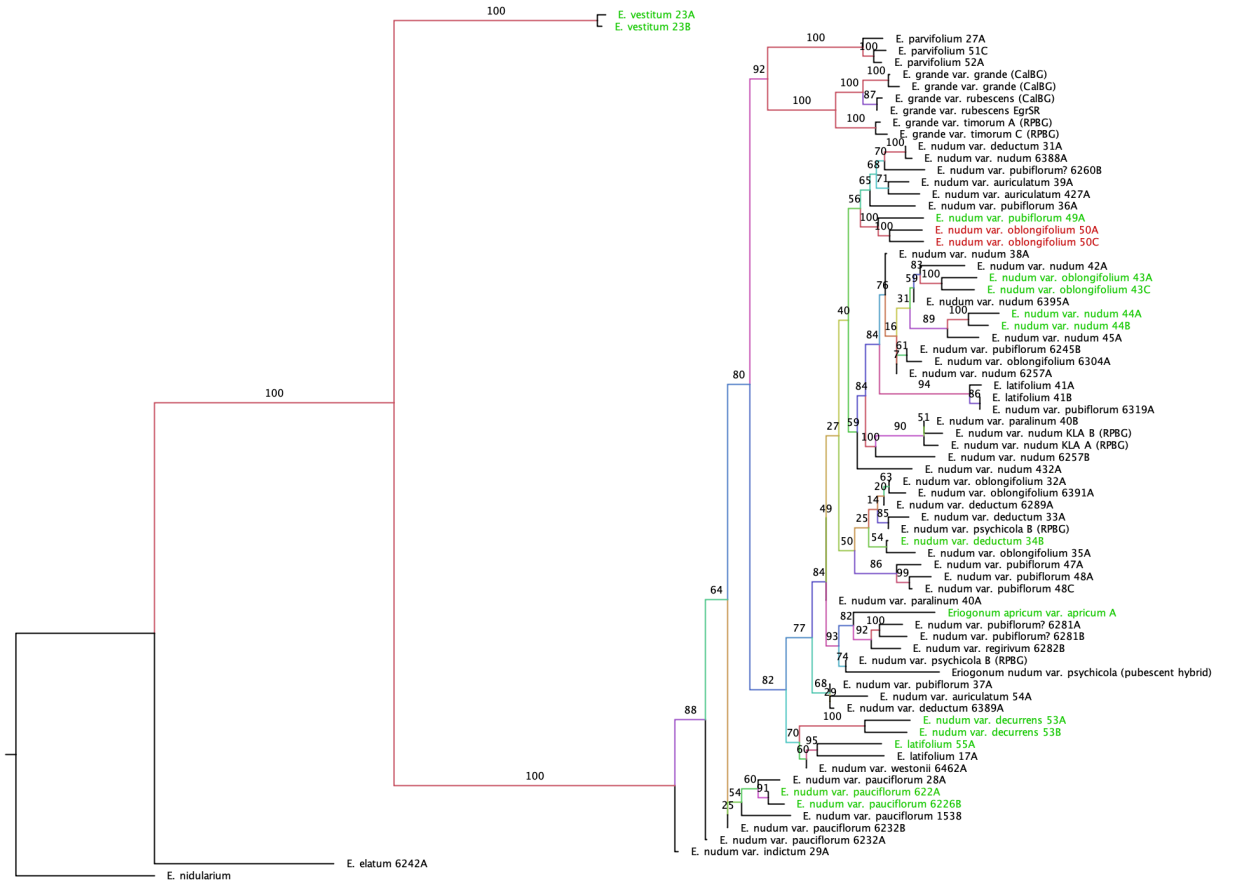


Figure 3: A maximum likelihood phylogeny made in IQ-Tree of the Latifolia clade. *Eriogonum elatum* and *E. nidularium* represent the outgroup. The branch labels show bootstrap support and the color of the branches depend on the bootstrap value. Populations from the type localities are typed in green letters. Type localities of synonyms are typed in red letters. Populations obtained from botanic gardens are indicated in parentheses. CalBG indicates a collection form the California botanic garden. RPBG indicates a collection from the Regional Parks Botanic Garden.

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