

## Phylogeny and Taxonomy of the *Eriogonum deflexum* Complex

2023 Mary DeDecker Botanical Grant Progress Report

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Through support from organizations such as the CNPS Bristlecone chapter, I have been able to make progress in my phylogenetics research this year! I am studying a group of species whose flowers are oriented upside-down, referred to as the *Eriogonum deflexum* complex (subgenus *Ganysma*). Species with this trait include the annuals *E. brachypodum*, *E. cernuum*, *E. concinnum*, *E. deflexum* (with 3 varieties), *E. eremicola*, *E. hookeri*, *E. nutans* (with 2 varieties), *E. rixfordii*, and *E. watsonii*, and at least one described perennial, *E. austrinum* (in Baja California). An additional, yet-to-be-described perennial species is known from the Bristol Mountains area in California, and there is question to whether it is the same as *E. austrinum*. These taxa are distributed in arid environments across the western United States, with some species such as *E. eremicola* being a narrow endemic in Death Valley, to others like *E. cernuum* having a wide range across several states. Additionally, there is a lot of morphological diversity within this group, from peduncle length, involucre and tepal shape, to the presence of glands (Figure 1).

My main goal in this study is to shed some light on the relationships among these taxa. The questions I hope to answer are: (1) How many times did deflexed involucres and flowers evolve in this complex? (2) How are the annuals related to the undescribed perennial species?

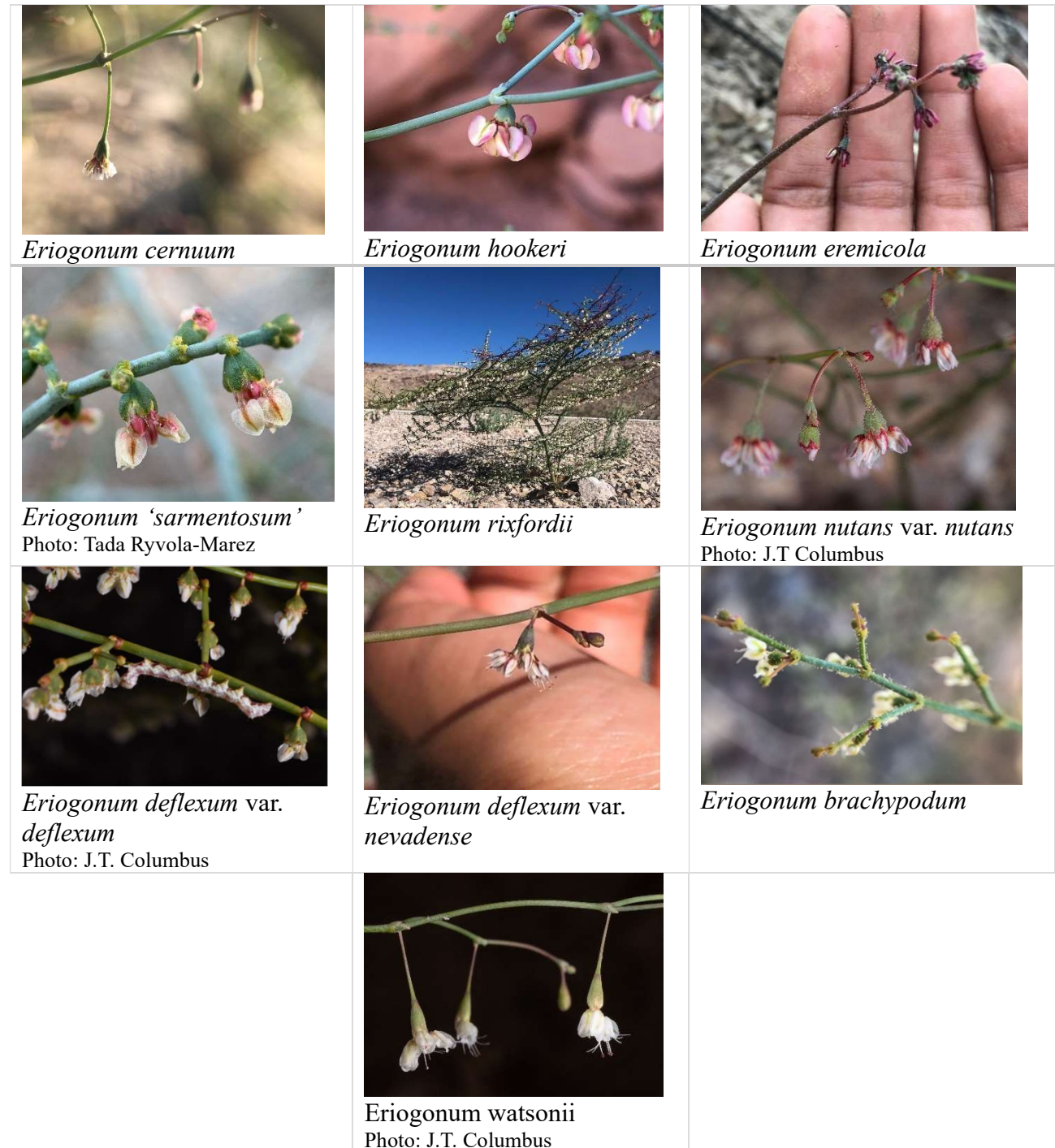
This field season, my advisor, field assistants, and I traveled across the western United States to collect from populations of the *E. deflexum* complex and other members of the subgenus *Ganysma*. During the fall, I extracted DNA, prepared and sequenced a library, and generated a preliminary phylogenetic tree along with an ancestral state reconstruction for deflexed versus not deflexed involucres. The efficacy of the ddRAD approach used was adequate to infer phylogenetic relationships with a preliminary dataset. A total of 68 samples with 22 provisionally-identified taxa were included. Several samples from this sequencing run had to be removed due to poor sequencing reads, and a few previously-sequenced samples (collected by J. Travis Columbus and Peter Pearman) were added. Although there are areas of bootstrap low support, overall, the clades of the phylogenetic tree show decent support (Figure 2). The data suggests that this complex is not monophyletic; there are taxa without deflexed involucres integrated between and within clades of taxa with deflexed involucres. For example, clade III is made up of the two varieties of *E. hoffmannii* which do not have deflexed involucres, and it is sister to clades I and II as well as clade IV, which have taxa with deflexed involucres. Furthermore, within clade IV, there are taxa without deflexed involucres (*E. salicornioides* and *E. rotundifolium*). The ancestral state reconstruction suggests that deflexed involucres are a derived trait that evolved at least once with multiple reversal events (Figure 3). The star indicates the first shift to deflexed involucres, and the arrows point to the hypothesized reversal events. Overall, there is great taxonomic diversity within this complex, and leads to further questions regarding the adaptive benefits of deflexed involucres.

The 2023 DeDecker grant made it possible for me to travel to populations of crucial members of the *E. deflexum* complex in the Inyo County region including *E. rixfordii* and *E. eremicola*. I have yet to present my research, however, I plan to during the upcoming year of 2024!

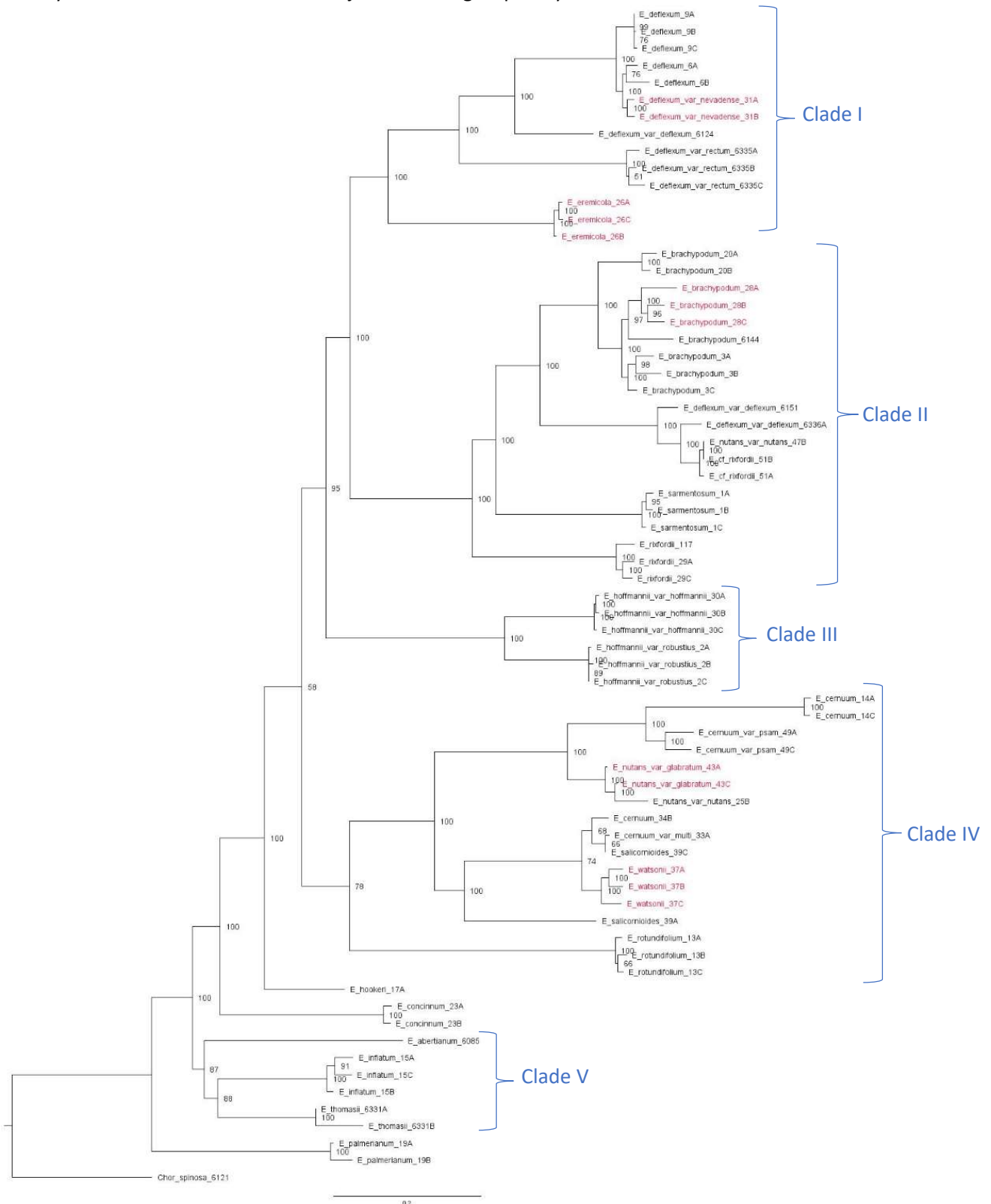
Currently, I am planning fieldwork for next spring and summer. One of the goals I have is to travel to Baja California to visit populations of *E. austrinum* in order to compare it with the undescribed perennial in the Bristol Mountains. Additionally, because there are areas of low resolution and bootstrap

support in this preliminary tree, I plan to sample from more populations, conduct more sequencing, and generate a more well-supported phylogenetic tree of this complex.

**Figure 1:** Images of *E. deflexum* complex taxa included in this phylogeny.



**Figure 2:** Maximum likelihood tree constructed in IQ-Tree. The tree is rooted to *Chorizanthe spinosa* and support for clades are measured with bootstrap. The red letters indicate samples collected from the type locality. The tree is divided into five major clades as grouped by the brackets.



**Figure 3:** Ancestral state reconstruction for the evolution of deflexed versus not deflexed involucres. The likelihood of a state at each node is indicated by the pie charts, where dark green = not deflexed, and light green = deflexed. The star indicates the first shift to deflexed involucres, and the arrows point to the hypothesized reversal events to not deflexed involucres.

