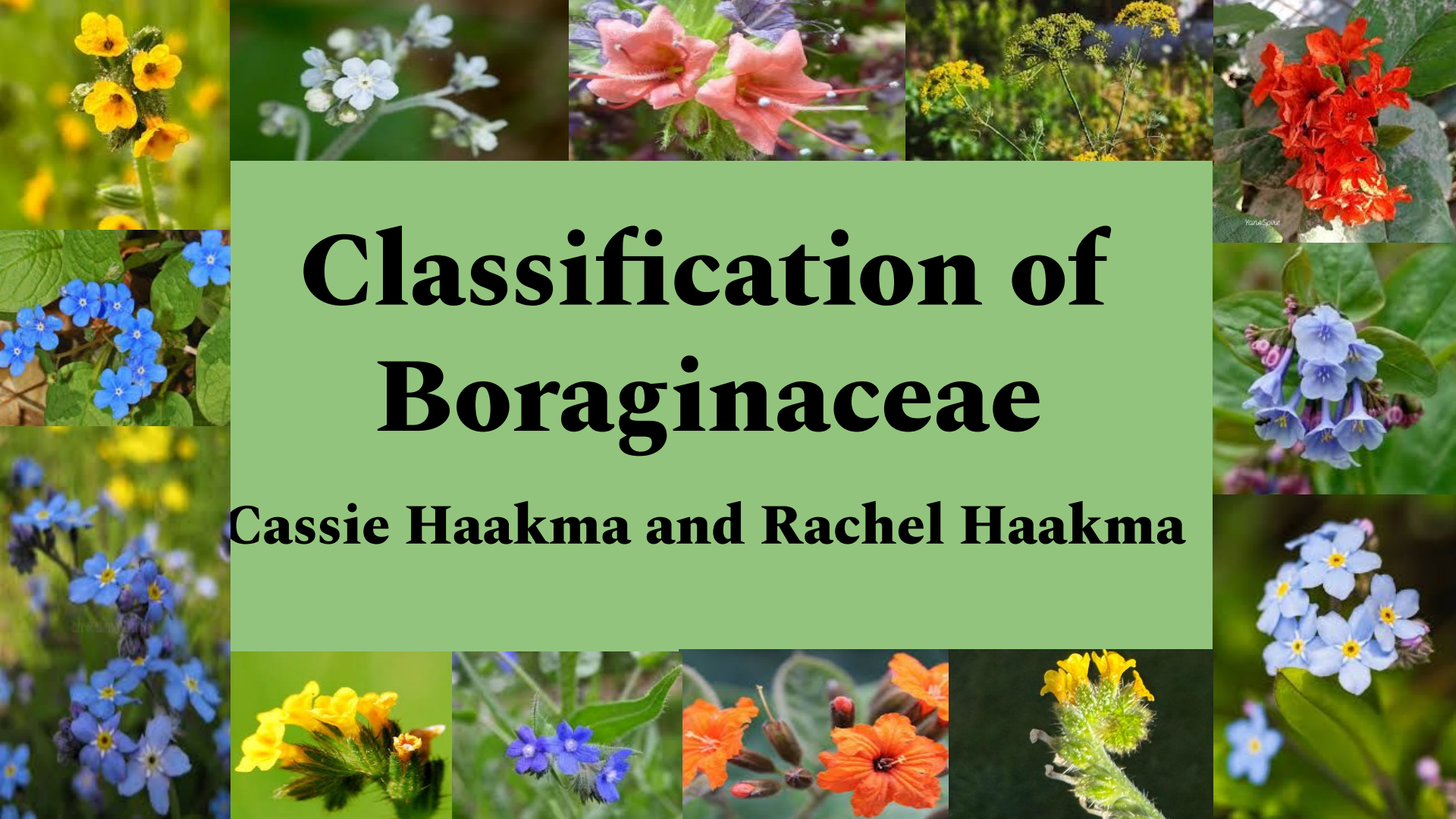


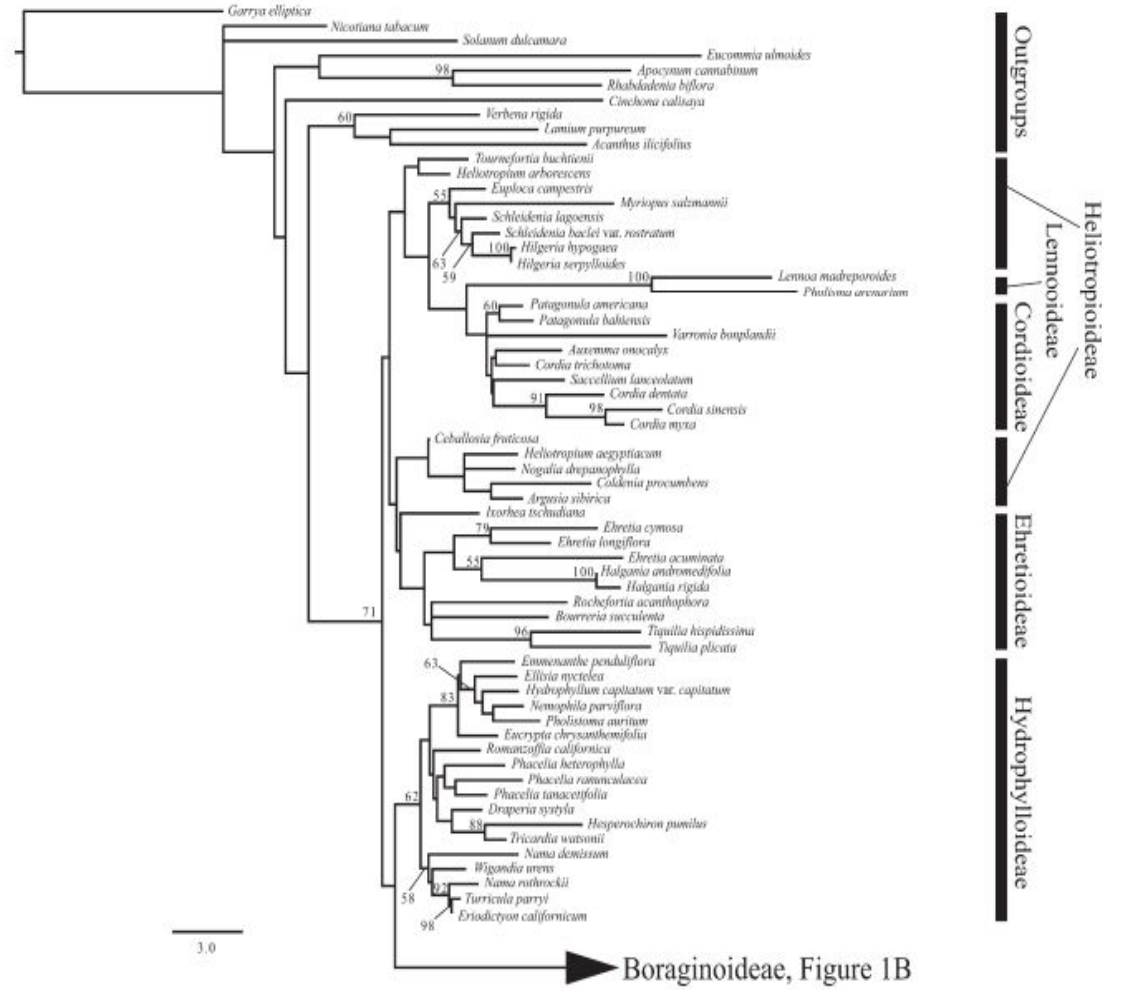
Classification of Boraginaceae

Cassie Haakma and Rachel Haakma

Taxonomic History

- The Boraginaceae group has a complicated taxonomic history, as there has been a lack of consensus on the borders of the family. This has caused the classification of the Boraginaceae family to change drastically overtime. The family originally included separate families, such as hydrophyllaceae and lennoaceae, because of their close genetic similarities. However, the parasitic nature of the lennoaceae and the capsular fruit of the hydrophyllaceae sets them apart from the Boraginaceae family. Therefore, hydrophyllaceae and lennoaceae are now classified as subfamilies of Boraginaceae.
- Originally, Boraginaceae was classified in the order Lamiales by the Cronquist system. More recently, APG (Angiosperm Phylogeny Group) has categorized it within the Solanales order.
- Boraginaceae is currently classified into five subfamilies and eleven tribes.

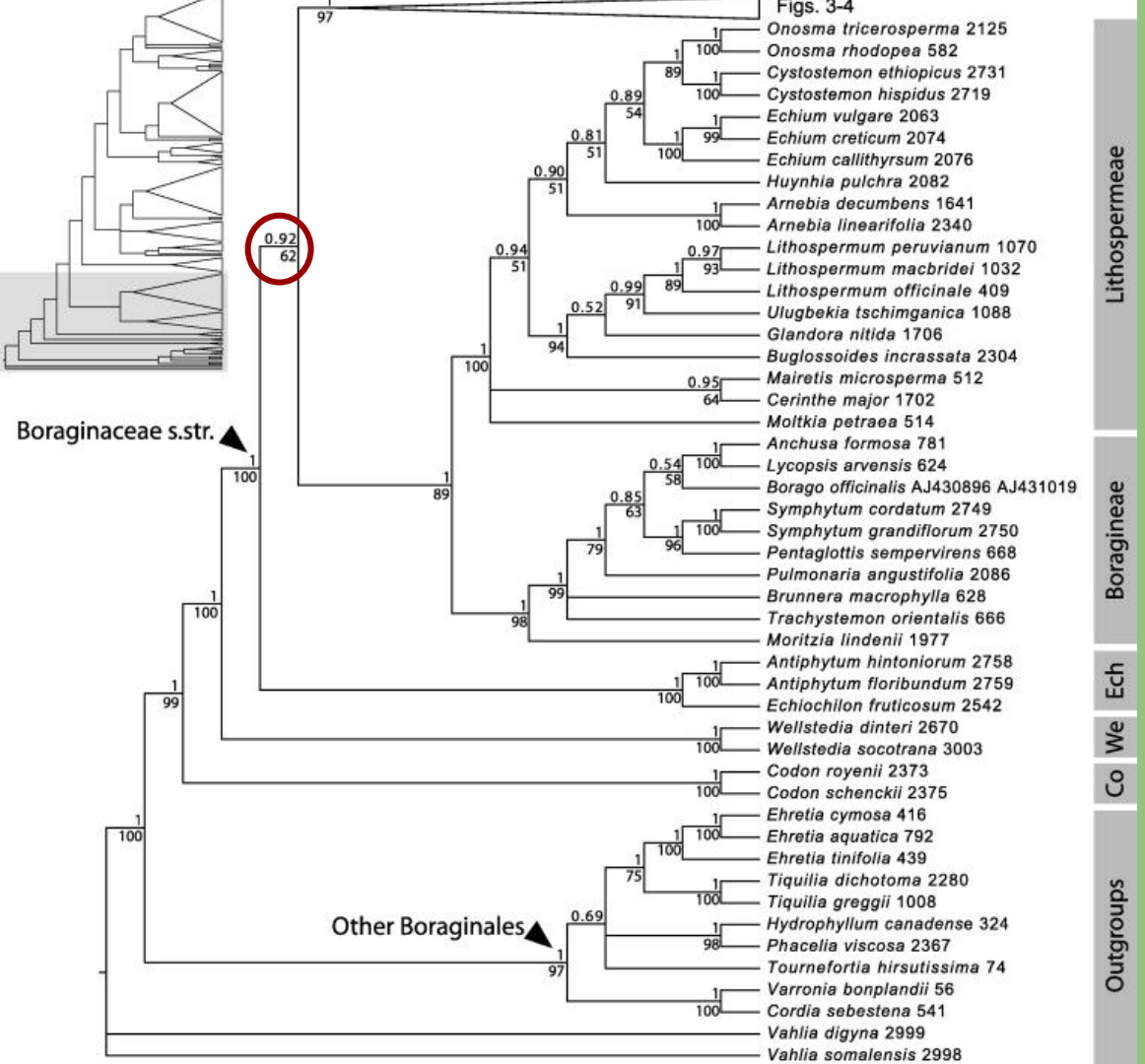
Kingdom: Plantae
Phylum: Streptophyta
Class: Equisetopsida
Subclass: Magnoliidae
Order: Boraginales
Family: Boraginaceae



Phylogeny of Boraginales Families

- Cladogram of various boraginales families
- Major clades:
  - Codonaceae
  - Wellstediaceae
  - Echiochileae
- Bootstrap values

https://plants.sdsu.edu/amsinckiinae/pdfs/Nazaire_Hufford2012-Mertensia-Boraginac.pdf



Bootstrap values:

the numbers located underneath the branches. They are the numbers used to estimate the confidence of the phylogenetic tree. Bootstrap values closer to 100 indicate that the values are strongly supported.

-*Hydrophyllum canadense* = outgroup

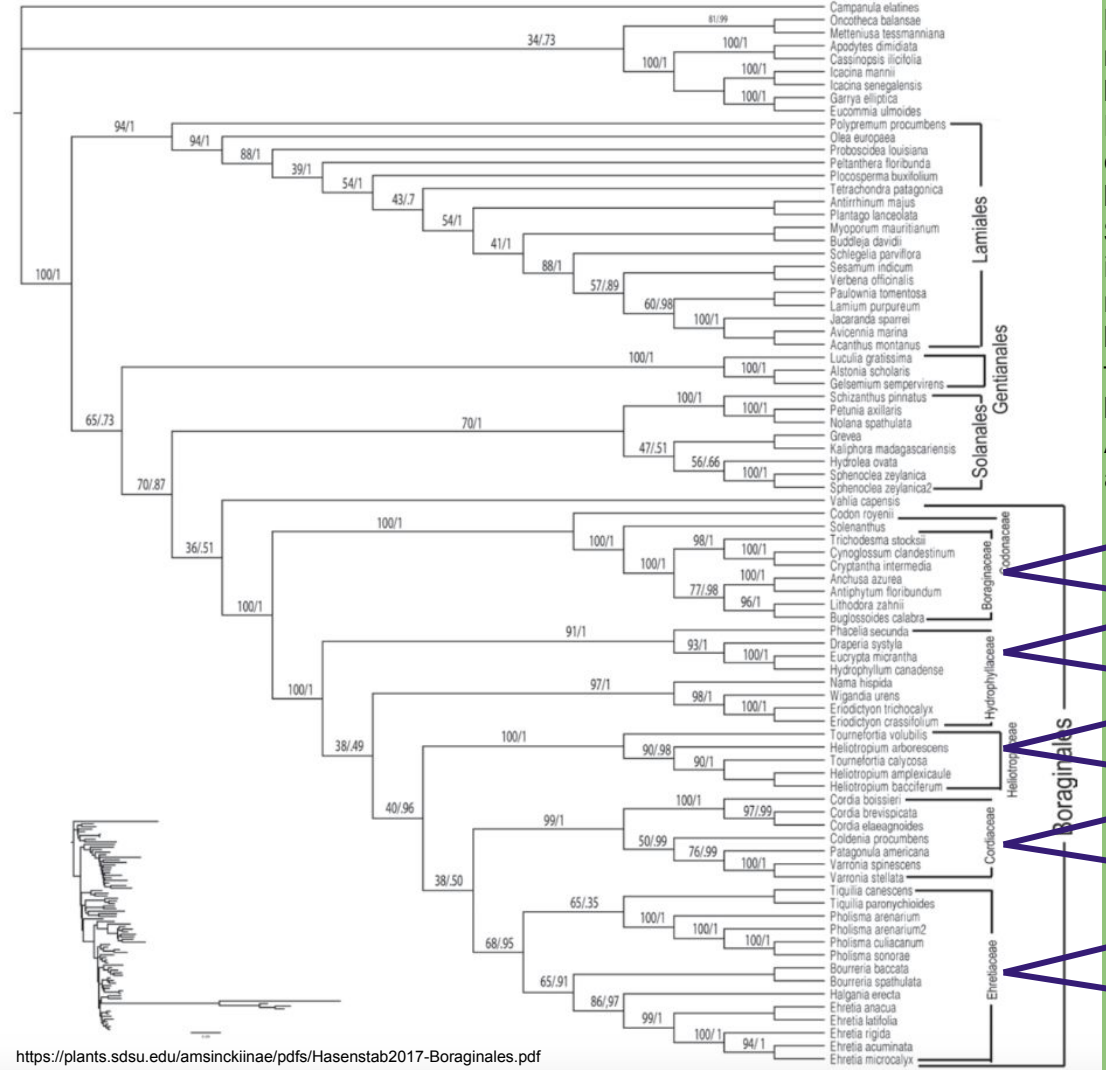
The circled clade has a 62 bootstrap value, indicating that researchers are still uncertain about the relationships within Boraginaceae sensu stricto.

https://www.sciencedirect.com/science/article/pii/S1055790313001590

Phylogenetics of Boraginaceae

- Approximately 2,000 species worldwide
- Genetics demonstrate that the affinities and subdivisions for this family are unsatisfactory
  - There is much speculation around the major clades of the family and the monophyly of some of the larger genera
- Recent studies have used to plastid markers to segregate the orders of this family into different clades
- Consists of five subfamilies:
  - Boraginoideae
  - Cordiodeae
  - Heliotropioideae
  - Hydrophylloideae
  - Ehretioideae

https://plants.sdsu.edu/amsinckiinae/pdfs/Nazaire_Hufford2012-Mertensia-Boraginac.pdf



https://plants.sdsu.edu/amsinckiinae/pdfs/Hasenstab2017-Boraginales.pdf

Family 1: largest subfamily, divided into 20 tribes; found in northern North America and Asia

Family 2: Waterleaf family; found in diverse habitats like Great Basin scrub, chaparral, coastal areas, and rocky slopes in conifer forests

Family 3: found in North and South America, Asia, and Australia; found in tropical, subtropical, and temperate regions

Family 4: found located in areas closer to the equator, not usually found in CA

Family 5: found in Asia, Africa, North America, and Australia in both arid desert and tropical woodlands.

Family 1: Boraginoideae

Family 2: Hydrophylloideae

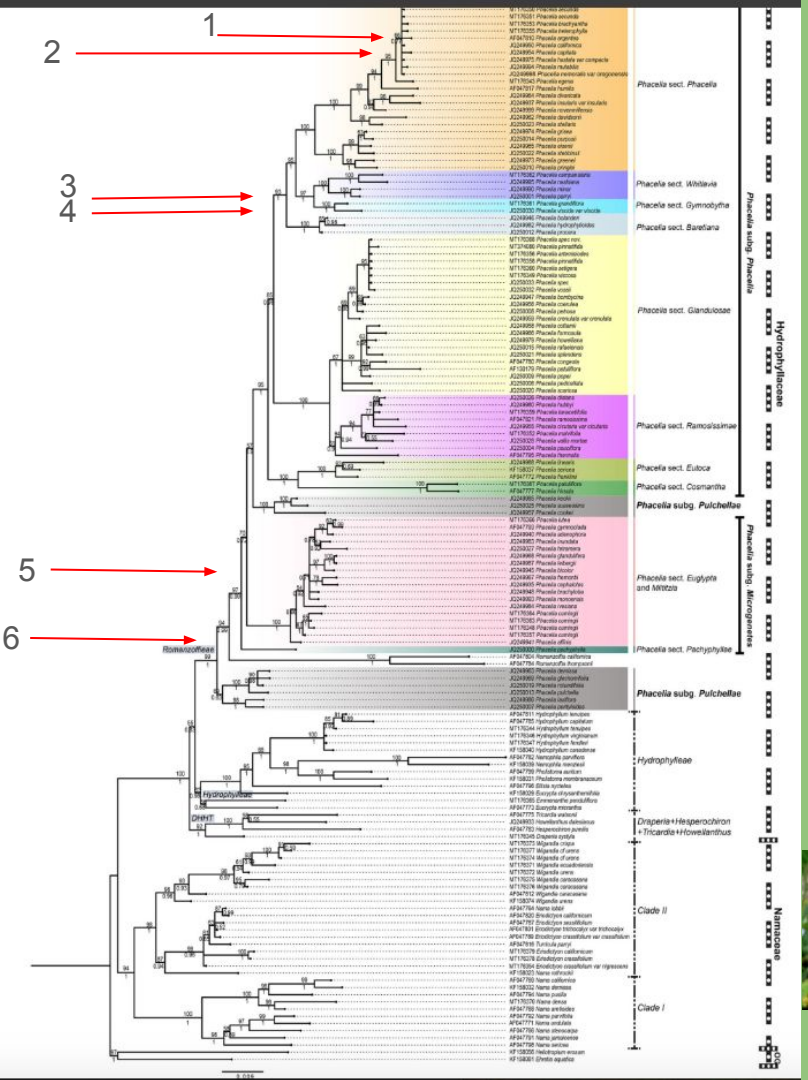
Family 3: Heliotropioideae

Family 4: Cordiodeae

Family 5: Ehretioideae

Phylogeny of Phacelia

https://repositorio.uchile.cl/bitstream/handle/2250/176470/Phylogeny-and-historical-biogeography.pdf



Found in CA:

1. Phacelia argentea–far northwestern CA
2. Phacelia californica–coastal CA
3. Phacelia grandiflora–coastal hills and mt. ranges of Southern CA
4. Phacelia bolanderi–coastal regions of northwestern CA
5. Phacelia bicolor–Mojave and Sonoran desert
6. Phacelia cookei–far north CA


1


2


3


4


5


6

https://repositorio.uchile.cl/bitstream/handle/2250/176470/Phylogeny-and-historical-biogeography.pdf

Phylogeny of Hydrophyllaceae and Namaceae

Found in CA:

1. *Hydrophyllum tenuipes*–northern CA
2. *Hydrophyllum virginianum*–northern CA woodlands
3. *Hydrophyllum fendleri*–northern CA in the Klamath Mountain Range region
4. *Nama californica*–western CA

1

2

3

4

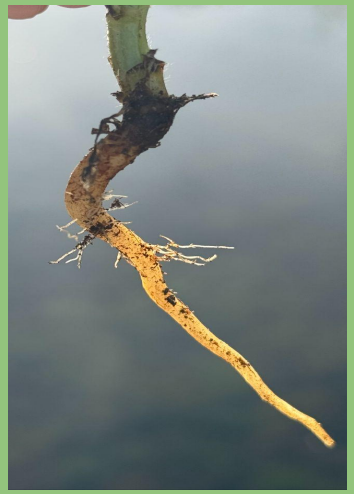
Phylogeny and Historical Biogeography of Hydrophyllaceae

The previous slide is a phylogeny of the outgroups, **Hydrophyllaceae** and **Namaceae**, of the Boraginaceae family. The expanded sampling of Hydrophyllaceae and Namaceae provides the first detailed insights into their historical biogeography. They both appear to have originated in North America. The results are consistent with the general trend that amphitropical disjunctions are mainly the outcome of long distance dispersal during the Miocene to Holocene and that the most common directionality is from North to South America. Independent of the individual timing and the taxa involved, long-distance dispersal is credited for the exchange between North and South America. Although some species demonstrate no obvious dispersal mode, a range of dispersal mechanisms including ant dispersal of the seeds and adhesion to animals are recognized.

https://repositorio.uchile.cl/bitstream/handle/2250/176470/Phylogeny-and-historical-biogeography.pdf

Major Identifying Characteristics

All photos taken at SJNWR and CA-trans pathway



Roots:

- Exhibit a robust taproot system
- Allows them to have greater access to nutrients from deeper soil layers
- Provides stability

Fruits:

- A schizocarp that usually splits into 4 segments that resemble seeds
- A drupe, capsule, or schizocarp of fruits

Flowers:

- 5-lobed
- Tubular
- Usually radially symmetrical
- Have both pollen-bearing and ovule-bearing parts
- Petals often fused at base

Leaves:

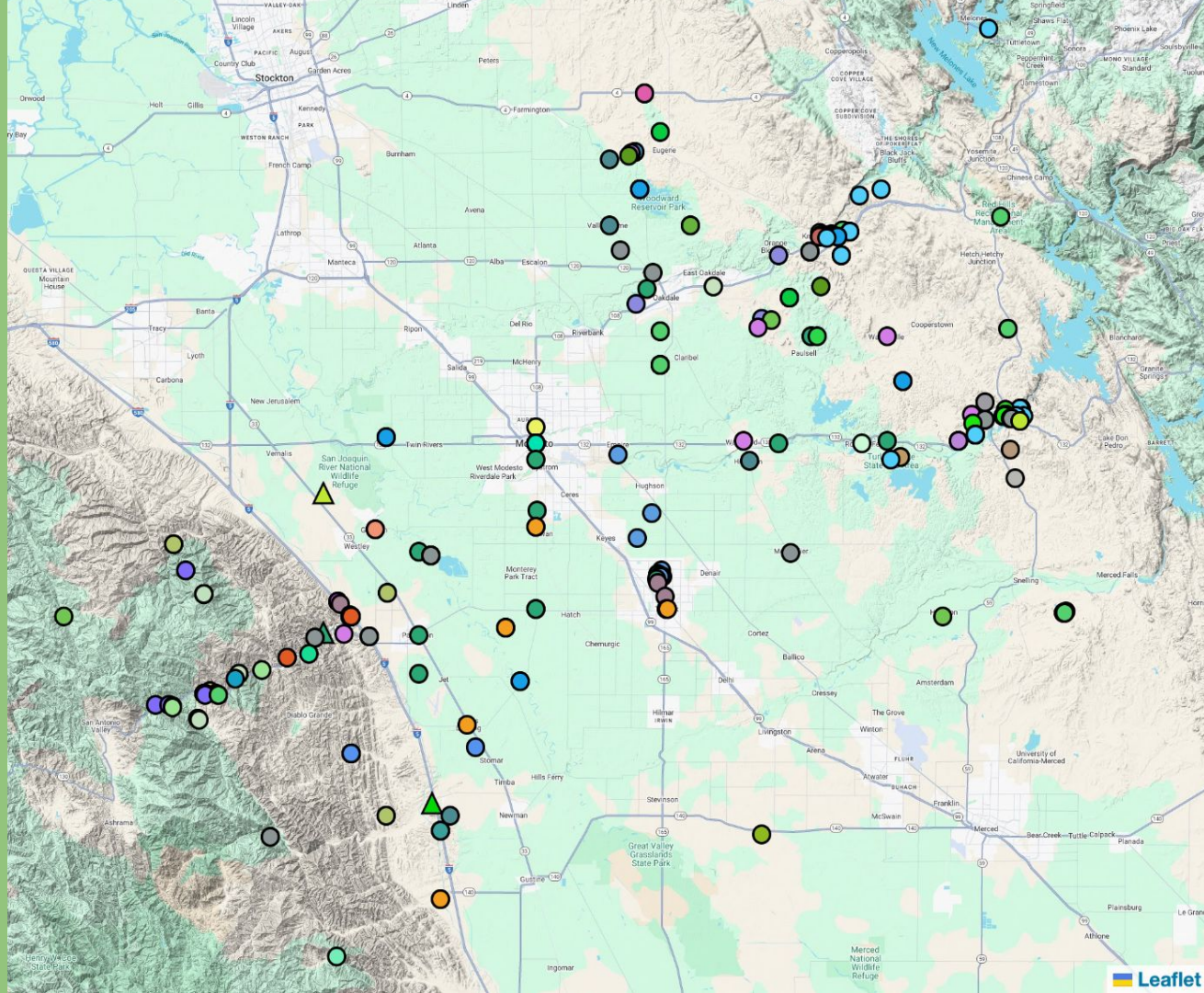
- Narrow and lance-shaped
- Alternate leaves
- Simple leaves
- Leaves have entire margins
- Has hairs that can be irritable to both humans and livestocks

Distribution of Boraginaceae Species in Stanislaus County

CCH2 shows a narrow interpretation of boraginaceae

Different shapes/colors = different species collected and reported on CCH2

https://www.cch2.org/portal/collections/list.php

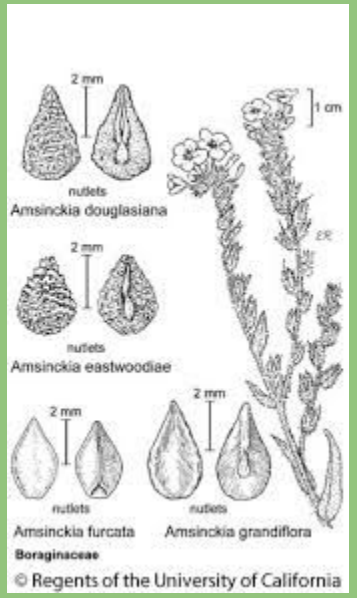


Boraginaceae Species/Genuses Commonly Found in Stanislaus County

- *Amsinckia*
  - *Amsinckia douglasiana*
  - *Amsinckia parviflora*
  - *Amsinckia tessellata*
- *Cryptantha*
  - *Cryptantha barbigera*
  - *Cryptantha mariposae*
- *Plagiobothrys*
  - *Plagiobothrys greenei*
  - *Plagiobothrys stipitatus*

Amsinckia douglasiana – Douglas' Fiddleneck

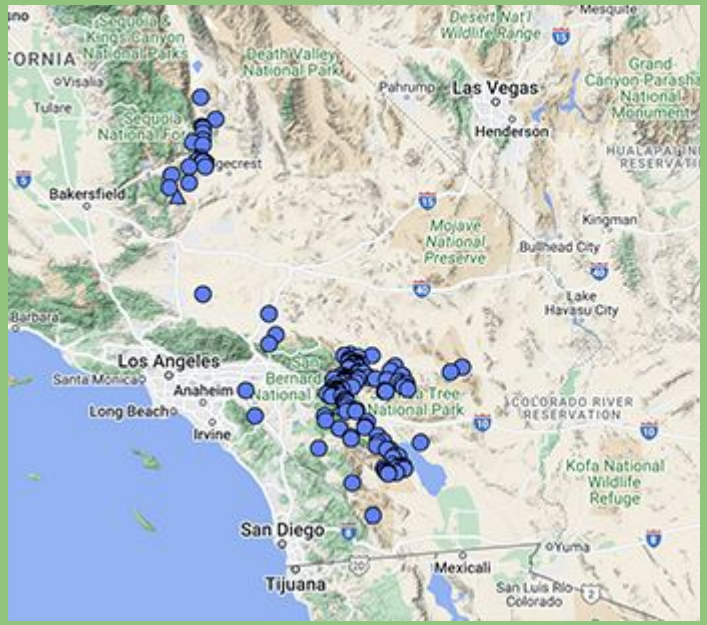
Is native to the coastal Santa Monica Mountains and Santa Ynez Mountains of Southern California



Annual herb
Produces coiled, fiddlehead-shaped inflorescences
Yellow-orange flowers often with <5 lobes
Bloom period is March-May
Low water tolerant
Elevation range: 600-6000 ft
Succulent leaves, each ending with a bristly hair

Cryptantha barbigera *– Bearded Catseye*

- *Cryptantha barbigera* is an annual herb that is native to California. It is also found elsewhere in western North America.
- It typically blooms from February until June.
- Found in varied elevations ranging at about 5,450 meters. It inhabits drier, hotter environments.
- *Cryptantha barbigera* is a dicot flower. It is a sporadically branched plant that has wide leaves and bristly, hairlike structures. These plants have a fuzzy calyx.



Plagiobothrys greenei – Greene's Popcornflower

Blooms March-May

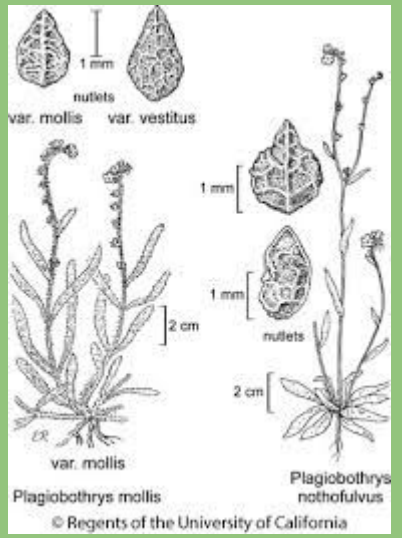
Annual herb

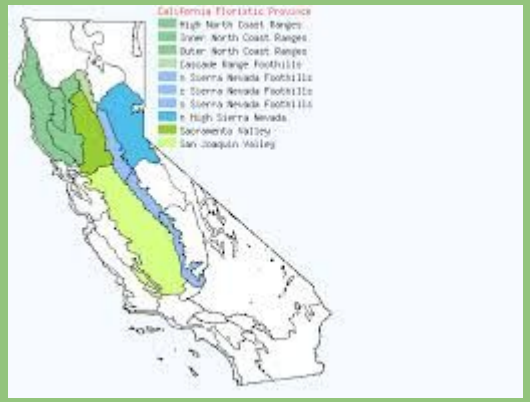
Native habitat includes wet sites, woodlands, grasslands

Bristly/sharp-haired stems

Calyx lobes fused at middle

Inflorescences are a series of tiny white flowers with 5 lobed-corollas





Colors represent different regions of CA where the plant is found
Is native to Western North America