Species boundaries in two northern California monkeyflowers

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Introduction:

Recently diverged taxa are thought to maintain species boundaries via reproductive barriers (Mayr 1942). Pre-zygotic barriers (Christie & Strauss 2019, Schemske & Bradshaw 1999) work additively with post-zygotic barriers (Wright et al 2013, Twyford et al 2015) to reproductively isolate species.

Close relatives *Mimulus guttatus* and *Mimulus glaucescens* broadly overlap in range, have similar flower morphology and share flowering phenology (Baldwin et al 2012). The species freely interbreed in the greenhouse but are not known to hybridize in nature (Vickery 1964). Previous research examined 14 potential barriers to reproduction but did not find complete isolation (Habecker 2012, Bergmann 2013). Thus, either unmeasured barriers exist or undetected hybridization occurs in nature.

Our research aims to elucidate the species boundaries between *Mimulus guttatus* and *Mimulus glaucescens* through greenhouse, field, and genetic analyses.

Study taxa:

- *Mimulus guttatus* is a widely distributed monkeyflower, occurring throughout western North America (Baldwin et al. 2012).
- *Mimulus glaucescens* is endemic to northern California (Vickery 1964).
- *M. guttatus* and *M.* glaucescens are distinguished through their vegetative morphology, namely bract shape, presence of trichomes, and glaucousness.
- Previous research in the Ivey lab has demonstrated 62 – 67% reproductive isolation between the species (Habecker 2012, Bergmann 2013).

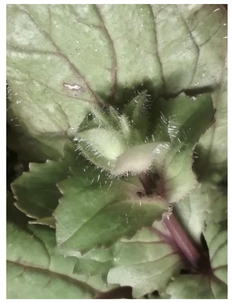

Fig 1. *M. guttatus* exhibits two semi-fused bracts subtending each inflorescence; bract trichomes; and a non-glaucous surface.

Fig 2. *M. glaucescens* exhibits a single, circular bract subtending each inflorescence; glabrous bracts; and glaucousness.

Hypotheses:

Hypothesis 1: *Mimulus guttatus* and *Mimulus glaucescens* are fully reproductively isolated; no introgression is occurring.

Hypothesis 2: *Mimulus guttatus* and *Mimulus glaucescens* are not fully reproductively isolated; introgression is ongoing between the species.

Methods:

Reciprocal transplant experiment in regions of *M. guttatus/M. glaucescens* sympatry.

- Higher survival and flowering rate of native species vs immigrant species supports microhabitat distinctions as a reproductive isolating mechanism.
- Higher or equal survival of immigrant species vs native species supports incomplete reproductive isolation.

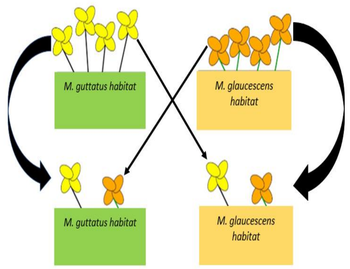

Fig 3. Reciprocal transplant experiments will occur in regions of broad-scale sympatry to assess microhabitat isolation rather than broader geographic isolation.

Genetic analysis of *M. guttatus* and *M. glaucescens* from sympatric and allopatric populations.

- Indetectable levels of introgression supports complete reproductive isolation.
- Genetic evidence of introgression supports incomplete reproductive isolation.

Quantify vegetative morphological traits in *M. guttatus*, *M. glaucescens*, and hybrids.

- Hybrids distinct from both parent species supports complete reproductive isolation.
- Morphological similarity between hybrids and parent species may suggest hybrids are overlooked in the field.

Preliminary results and significance:

- Morphological data suggest that *M. guttatus* and *M. glaucescens* have quantifiably different bract shapes and trichome densities.
- Intermediate hybrid morphology (if present) should be readily detectable.

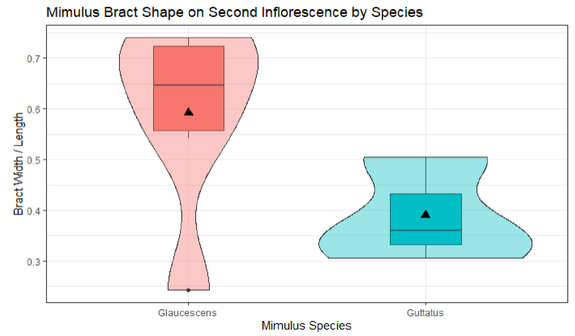

Fig. 4. Mean shape of *Mimulus guttatus* and *Mimulus glaucescens* bracts, measured on the bract subtending the second inflorescence on the day of flowering. *M. glaucescens* bracts are much more circular than *M. guttatus* bracts. The mean shape of *M. glaucescens* at 0.63 (n = 28) compared to 0.33 (n = 24) for *M. guttatus*. A perfectly circular bract would have a shape of 1.0.

- Morphological results, as well as future genetic and reciprocal transplant results, will elucidate the evolutionary relationship between *M. guttatus* and *M. glaucescens.*
- Genus *Mimulus* is a crucial study system for evolutionary genetics; advancing our understanding of *Mimulus* evolution advances our understanding of speciation as a whole.

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