

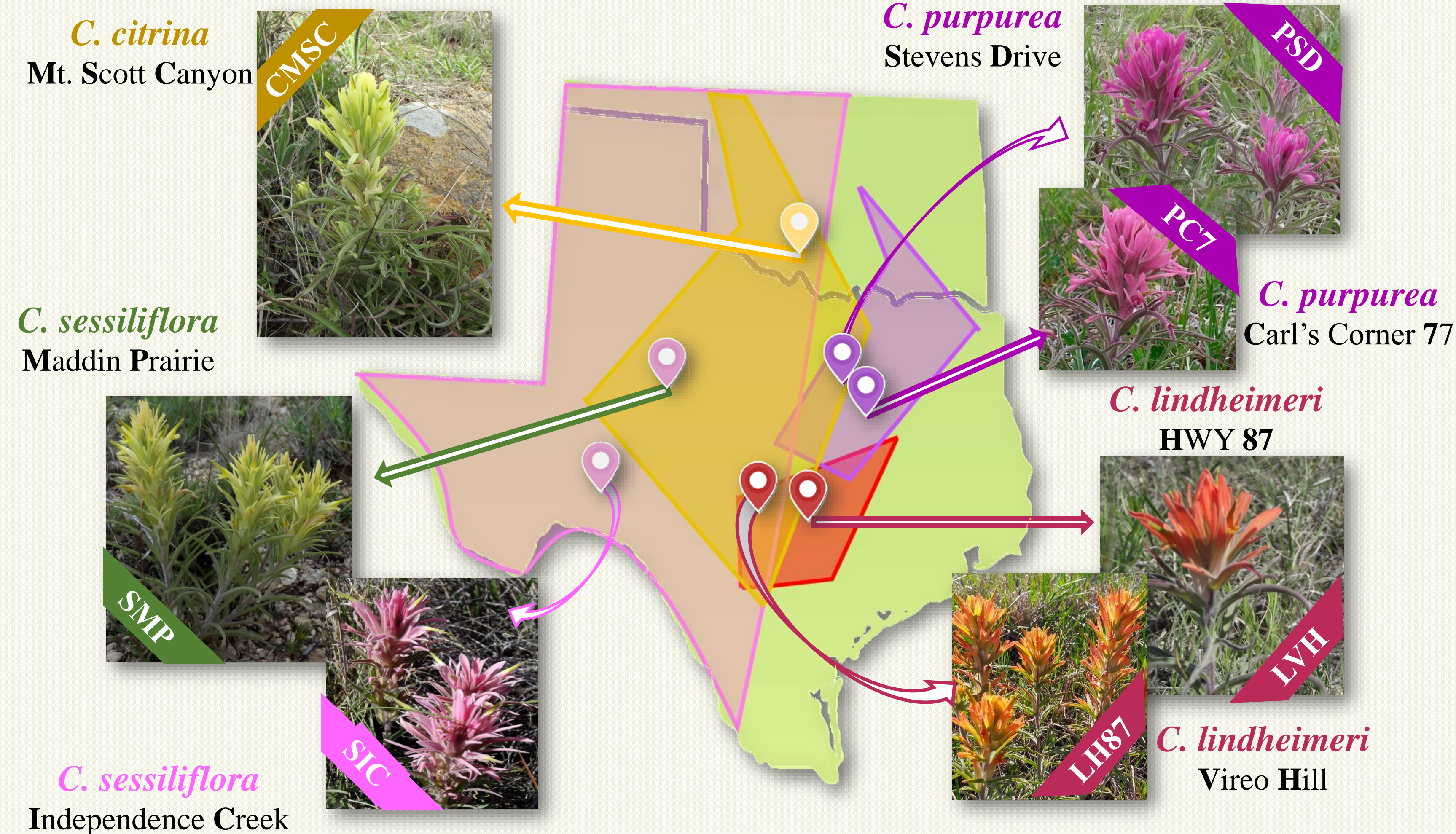
Combining Morphology and Genetic Distance to Determine Species Delimitation in *Castilleja*

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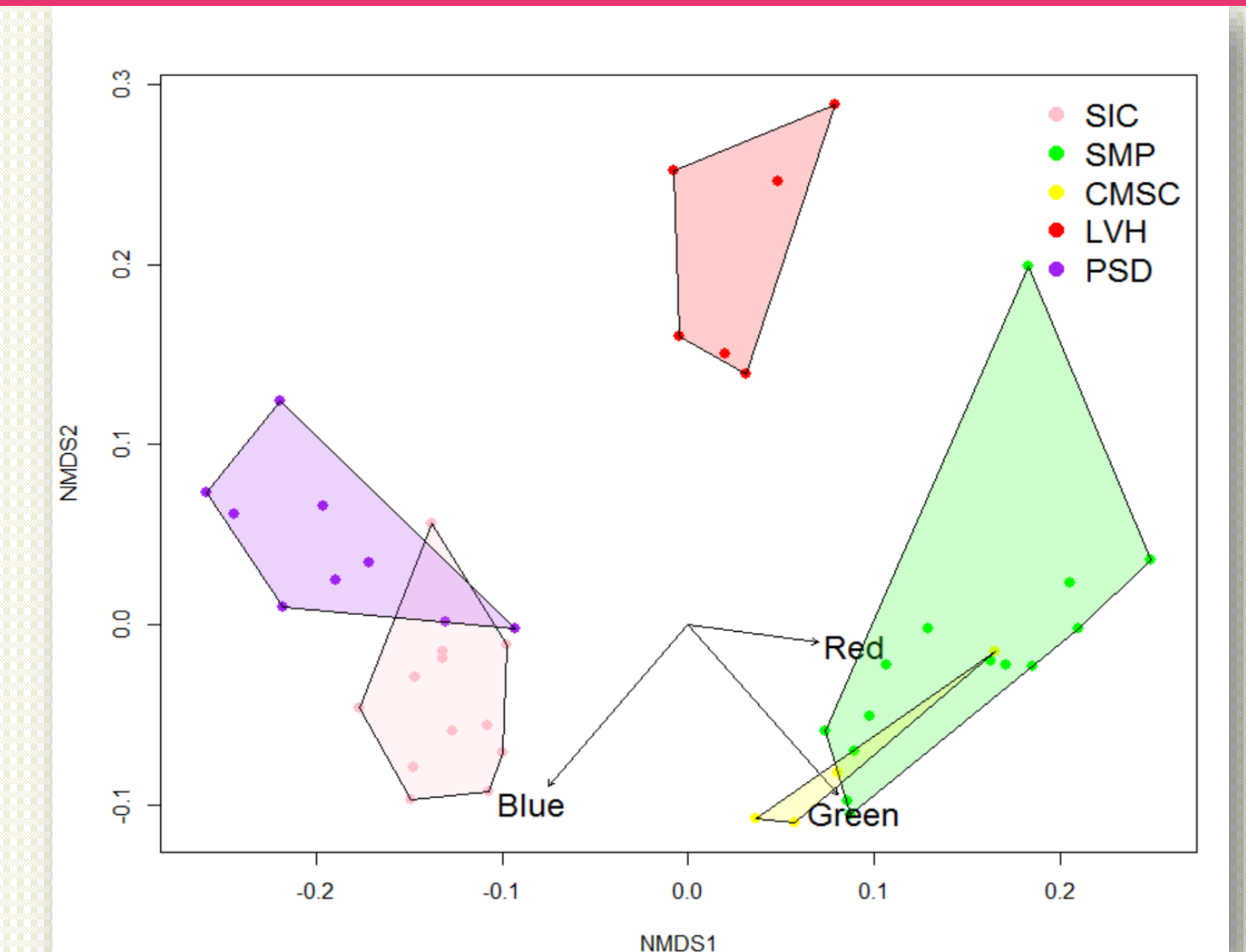
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Introduction

- Disagreement exists about the best criteria used to define species
 - Morphology can be used, but it can be variable
 - Genetic distance can be used to clarify relationship between groups
- In the group *Castilleja* (the Indian paintbrushes; Orobanchaceae), 3 varieties within *C. purpurea* were recently elevated to species based on morphological traits¹
 - Species complex** comprised of *C. purpurea*, *C. citrina*, and *C. lindheimeri*
- This project examines both the genetic makeup and floral morphology of *C. purpurea*, *C. citrina*, and *C. lindheimeri* to test if the genetic makeup of these populations agree with their morphological traits
- We also compare the *C. purpurea* complex species to *C. sessiliflora*, which occurs sympatrically and near-sympatrically in the region.

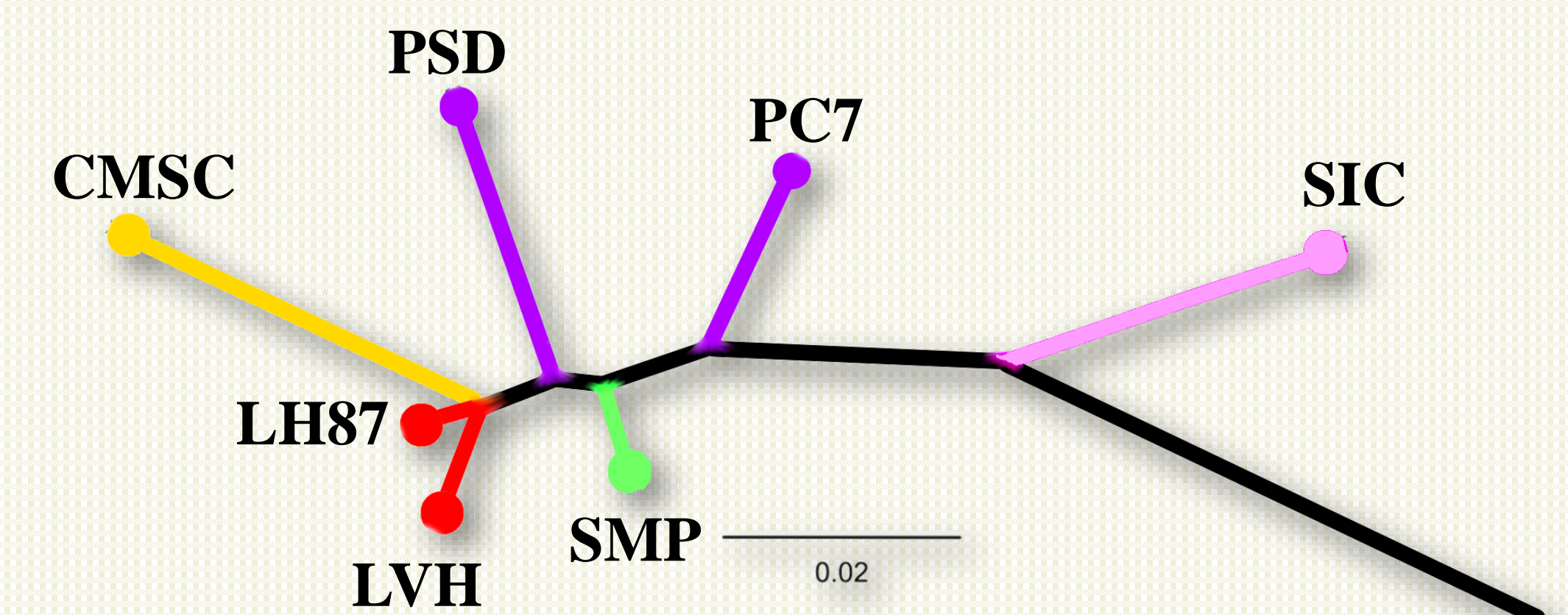


Floral Color Ordination



Floral color ordination shows distinct groupings for each population in *C. purpurea* complex and within *C. sessiliflora*

Genetic Distance



Distance tree calculated using pairwise F_{st} values. Populations within each species group together, except in *C. sessiliflora*. SMP and SIC are separated.

Discussion

- Some evidence of morphological difference** between the species in *C. purpurea* complex
 - Main difference is in floral color
- In *C. sessiliflora*, one population (SMP) shows a **shorter genetic distance** to *C. purpurea* complex than expected
- C. purpurea* shows greater genetic distance from *C. citrina* and *C. lindheimeri* than expected based on morphology
- No striking correlation** between morphology and genetic distance
- Future work: Increase sample size for the populations in *C. purpurea* complex for floral measurements; Increase number of markers for genetic analysis

Hypothesis

We expect genetic distance to reflect the pattern of morphological difference within the groups. We also expect *C. sessiliflora* to be more genetically distant from the *C. purpurea* complex.

Methods

GENETICS:

- Collected leaf tissue samples on 4 species, 2 populations each (except 1 pop. for *C. citrina*), 30 samples per population
- DNA extraction and amplification
 - CTAB extraction protocol and PCR (6 microsatellite loci)
- Individuals were genotyped with the Beckman CEQ 8000
- Genetic differentiation (F_{st}) between populations was calculated

MORPHOLOGY:

- Collected floral data on 4 species, 1 population each (except 2 populations for *C. sessiliflora*), 10 samples per population (except 30 samples for *C. sessiliflora*)
- Measured floral morphology (ex: calyx lobe width, bract lobe width, stigma exsertion, corolla length and width, among others)
- Measured inflorescence color using RHS color charts, converted to RGB values

Floral Morphology

Fig. 2: Floral Morphology Ordination

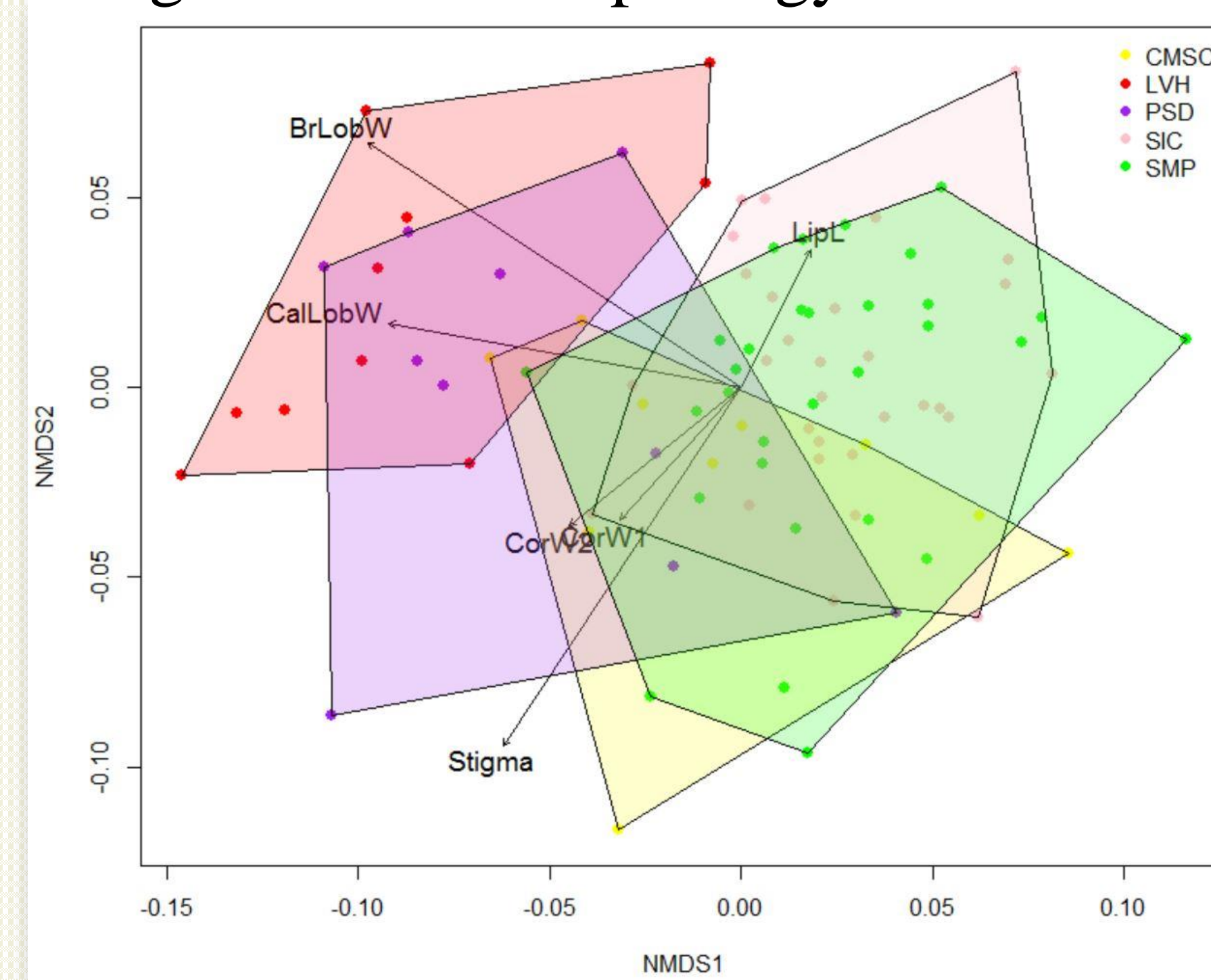


Fig. 2: NMDS ordination of 8 floral traits shows large overlap between populations

*Fig. 3 shows significant variation in stigma exsertion (ANOVA $p = 0.005$)

Fig. 4: shows no significant variation in corolla length (ANOVA $p = 0.400$)

Fig. 3: Stigma Exsertion*

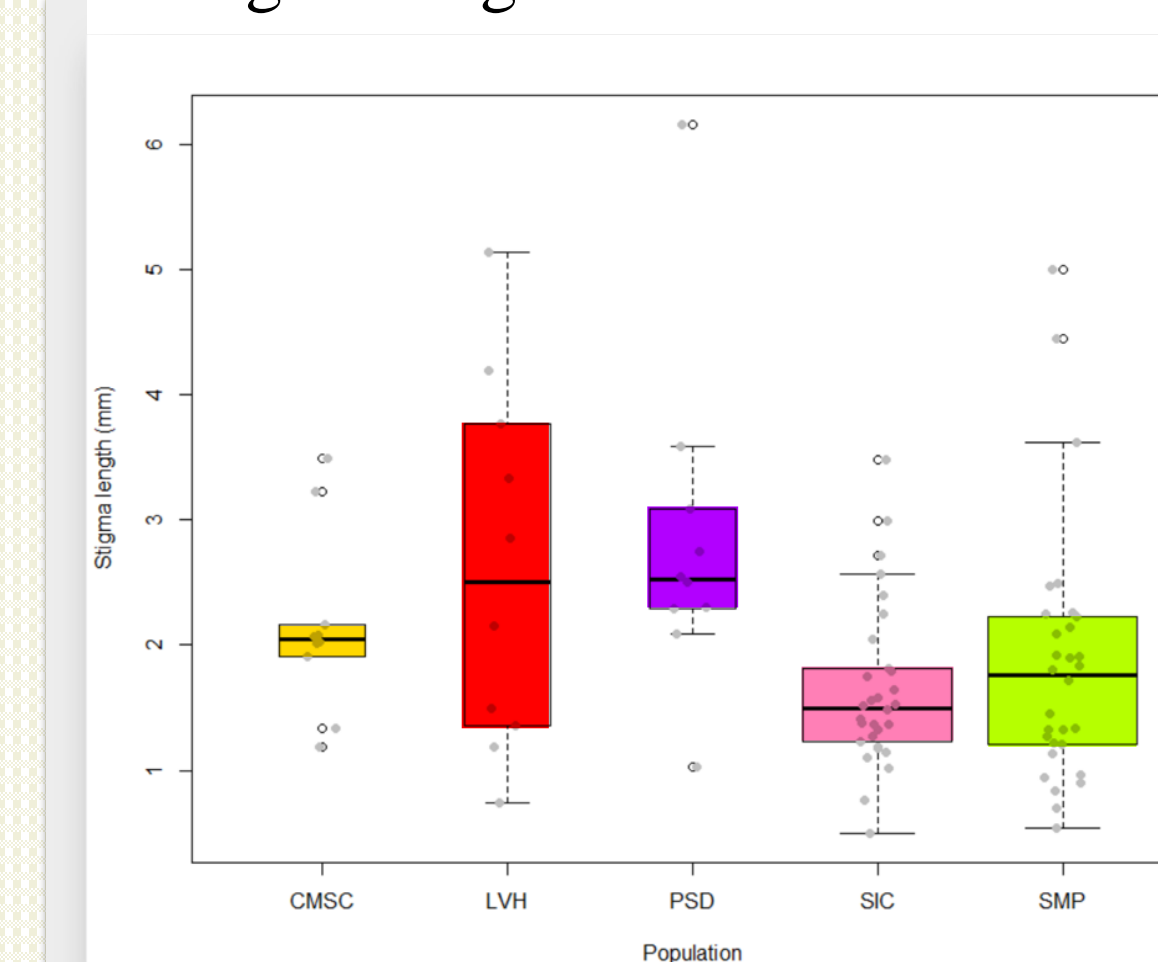


Fig. 4: Corolla Length

