# The population genomics of desert mistletoe (*Phoradendron californicum)*: syntenty of creosote (*Larrea tridentata)* adapted individuals to established host races

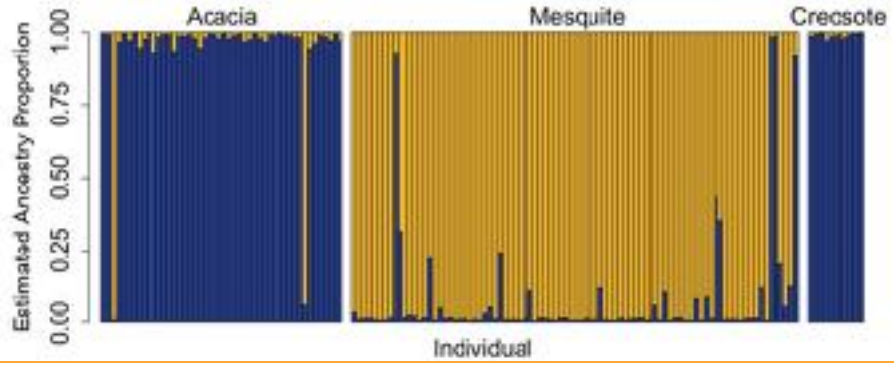
## Research Question:

Are desert mistletoe(*Phoradendron californicum)* that infect creosote *(Larrea tridentata),* genetically differentiated from established mistletoe host races on acacia and mesquite?

## Methodology:

- Collected tissue sample from individual mistletoe growing on 11 distantly separated creosote hosts
- Extracted DNA, amplified & sequenced ten polymorphic loci
- Utilized STRUCTURE to compare proportion ancestry of Individuals found on creosote to mistletoe infecting mesquite and acacia trees

## Data Analysis & Results:




## Interpretation & Conclusions:

- Mistletoe found on creosote share ancestry with those individuals that infect acacia

Mechanisms for genetic isolation and speciation

- Acacia established individuals may have a
- pre-adaptation to parasitize creosote
- Mesquite adapted individuals may be highly specialized
- Observed reproductive isolation may lead to speciation

# How parasitic mistletoe infects its host

1. Dormant seed is deposited on host
2. Seed germinates
3. Hypocotyl grows toward host stem
4. Holdfast develops when host contact is made
5. Penetration peg grows into host epidermis
6. Haustorium grows through cortical tissue through phloem until it reaches the xylem
7. Holdfast develops when host contact is made
8. Penetration peg grows into host epidermis
9. Haustorium grows through cortical tissue through phloem until it reaches the xylem

(Photo credit: S. Blank)

# Host Race Formation Theory

A population within a parasitic species that is partially reproductively isolated from conspecific populations due to adaptation to a specific host (Diehl and Bush, 1984).

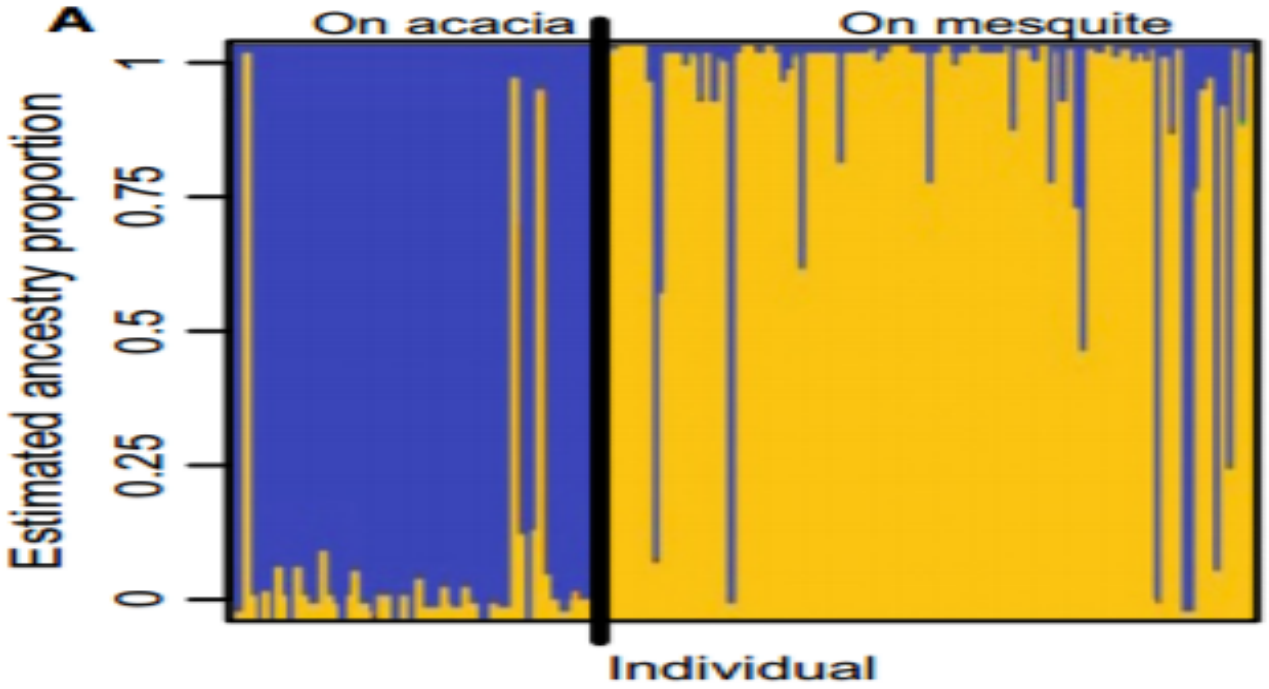
**Velvet Mesquite**
*Prosopis velutina*

**Desert Mistletoe**
*Phoradendron californicum*

**Catclaw Acacia**
*Acacia greggii*

(Photo credit: S. Blank)

Previous research shows genetic differences between populations mistletoe on acacia and populations that infect mesquite (K.M. Yule et. al., 2016).

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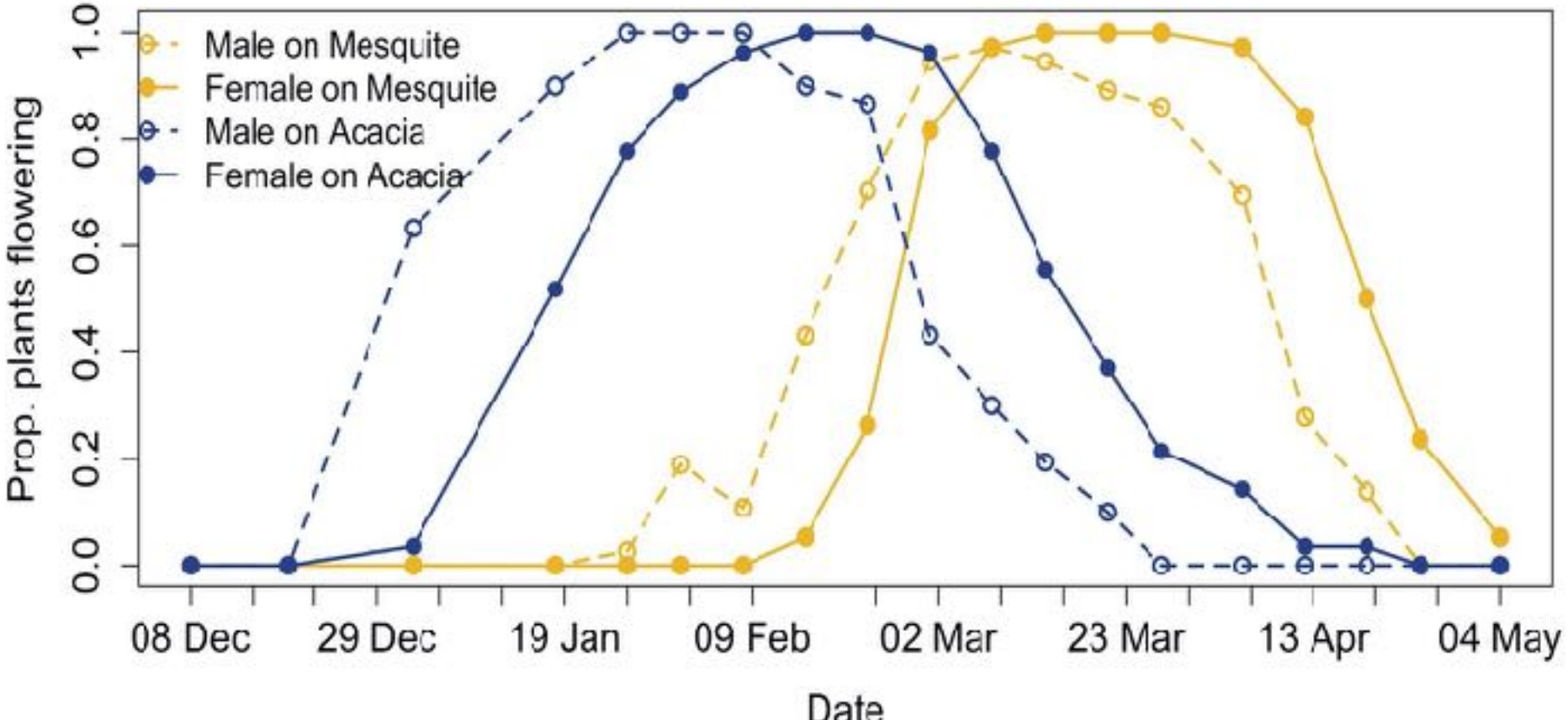
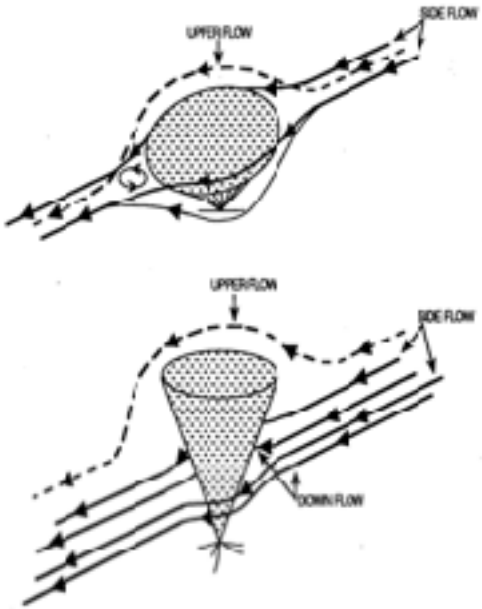
Previous research reveals a separation of reproduction phenology (life history) such as the timing of flowering in mistletoe that infect mesquite as compared to mistletoe that infect acacia (K.M. Yule et. al., 2016)



# A peculiar host...

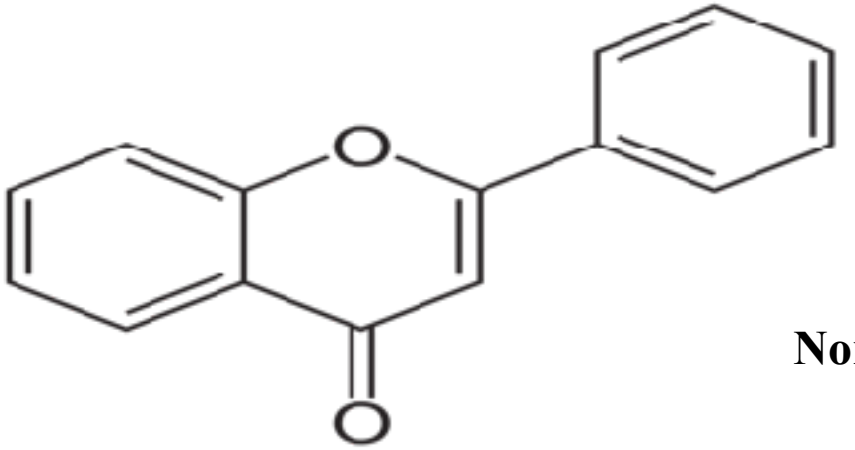



(Whitford et. al., 1995)

Creoste: *Larrea tridentata*

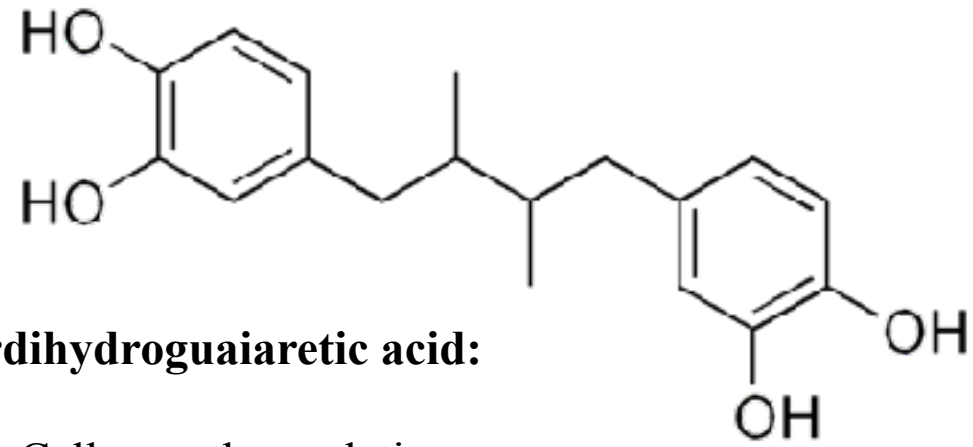
- Can last years without water
- Survives without sufficient nutrients
- Phenolic defense
- Dispersal dependent on rainfall
- A member of the Zygophyllacae family

Phot credit: http://www.redcliffsdesertreserve.com/wp-content/uploads/2011/12/Creosote-bush-in-flower-2.jpg



**Flavonoid:**

- Three benzene rings with a hydroxyl (OH) group
- Decrease palatability and nutrients
- Toxins




**Nordihydroguaiaretic acid:**

- Cell growth regulation
- Slows excessive growth on skin cells on surface
- Fights inflammation
- Controls bacterial growth

Also has phenolic acids, alkaloids, and waxes that constitute part of the 83-91% of phenols that make up creosote resin (U.S. Department of Health)

**Are desert mistletoe that infect creosote bush genetically differentiated from the established mistletoe host races?**

# Hypotheses:

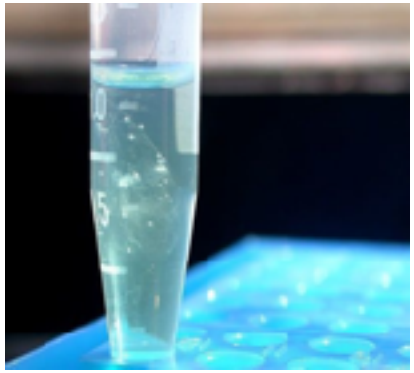
$H_1$ :Individuals parasitizing creosote bush will demonstrate genetic similarity to either the mesquite or acacia host race populations

$H_2$ :Individuals parasitizing creosote will belong to a unique genetic population

$H_{null}$ : Individuals parasitizing creosote will show equal genetic similarity to both established host races

# Methods

Collect mistletoe tissue samples from creosote hosts



Isolate DNA from samples

Amplify DNA using PCR

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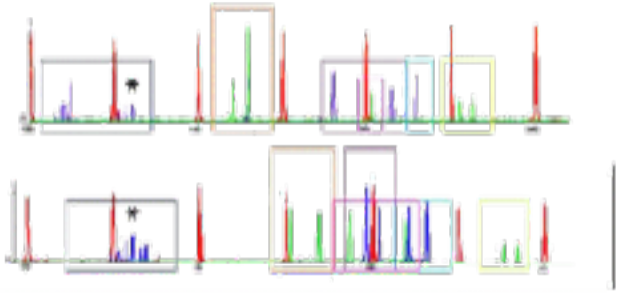
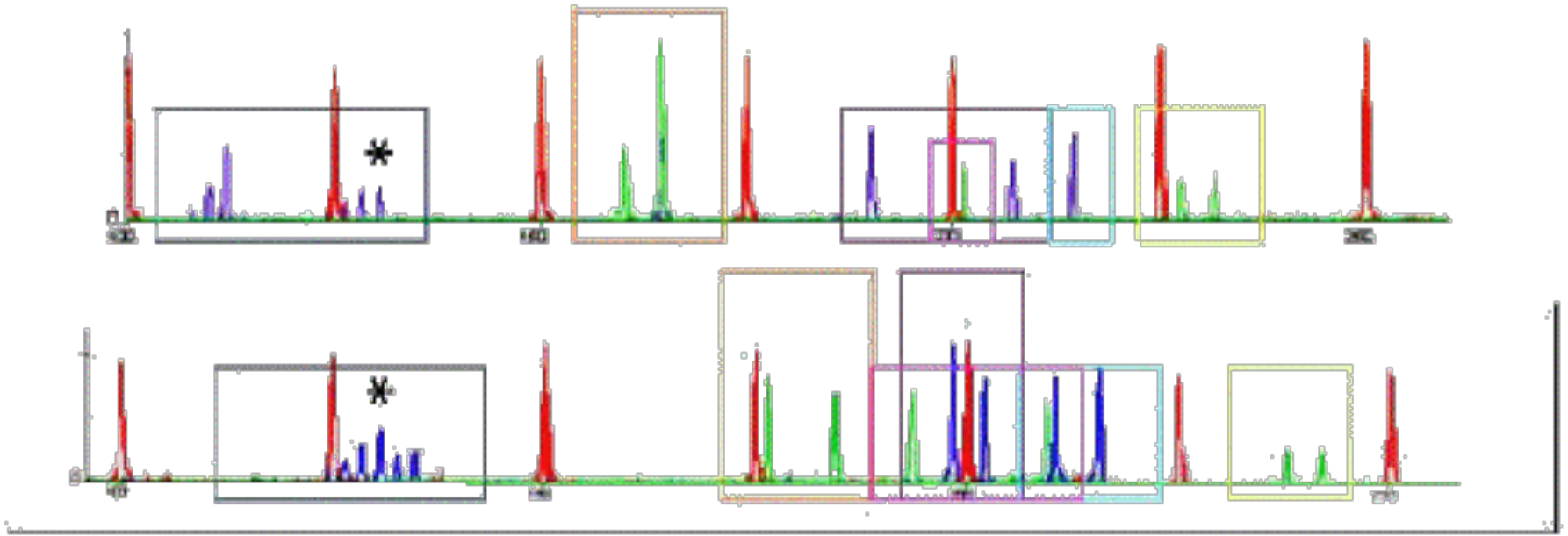
Sequence DNA

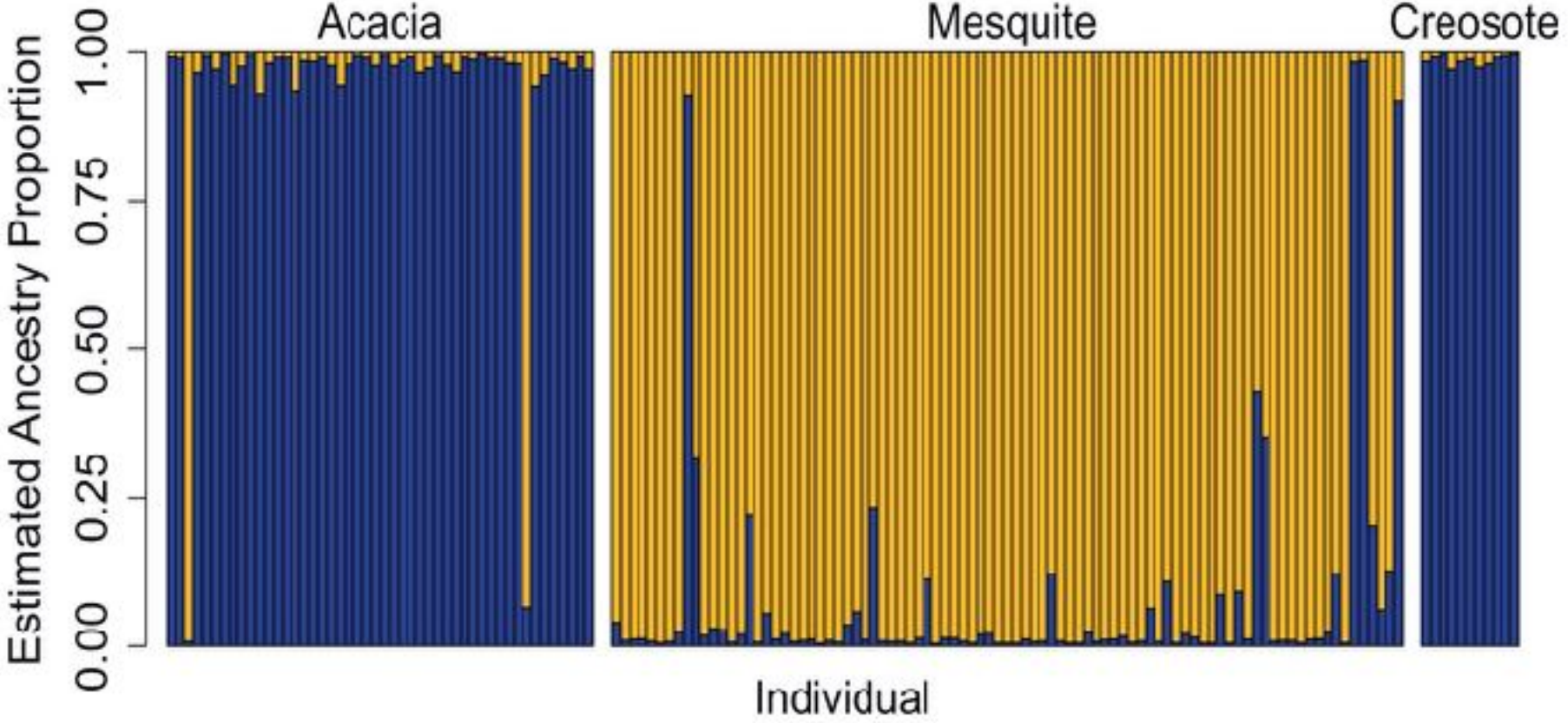


Analyze sequence data for Single Nucleotide Polymorphisms

Single nucleotide polymorphisms: identifying nucleotide changes between mistletoe infecting creosote and mistletoe infecting traditional mesquite and acacia hosts



Results: Genetic data shows that mistletoe that infects creosote closely align with mistletoe that infect acacia and are distinctly different from those that infect mesquite



# What this means and why we care:

- Mechanisms for genetic isolation and speciation
  - Acacia established individuals may have a pre-adaptation to parasitize creosote
  - Mesquite adapted individuals may be highly specialized
  - Reproductive isolation leads to speciation

- Not a lot is known about speciation in parasitic plants- this serves as a model
- Desert mistletoe sustains desert wildlife year-round
  - Mistletoe aides in the biodiversity of the environment
  - Dependent on vector behavior phainopepla, vice versa
- Informs “Pest” management

Artist credit: Michael Plagens

**Next Steps**:

Mistletoe Seed collection. (Photo credit: S. Blank)

Am currently working on:

- Seed deposition study
- Germination study
- Pollination study

Would like to look into:

- Vector behavior influencing mistletoe dispersal
- Possible HGT events allowing the acacia host population to survive on creosote
- Mistletoe host races in other species/regions

# References Cited:


- Diehl SR, Bush GL (1984). An evolutionary and applied perspective of insect biotypes. *Ann Rev Entomol* **29**: 471–504.
- Yule, K. M., Koop, J. A. H., Alexandre, N. M., Johnston, L. R., & Whiteman, N. K. (2016). Population structure of a vector-borne plant parasite. Molecular Ecology, 25, 3332–3343. https://doi.org/10.1111/mec.13693