

Update on the Conservation Genetic Assessment of Rare *Astragalus* in Southwestern Colorado



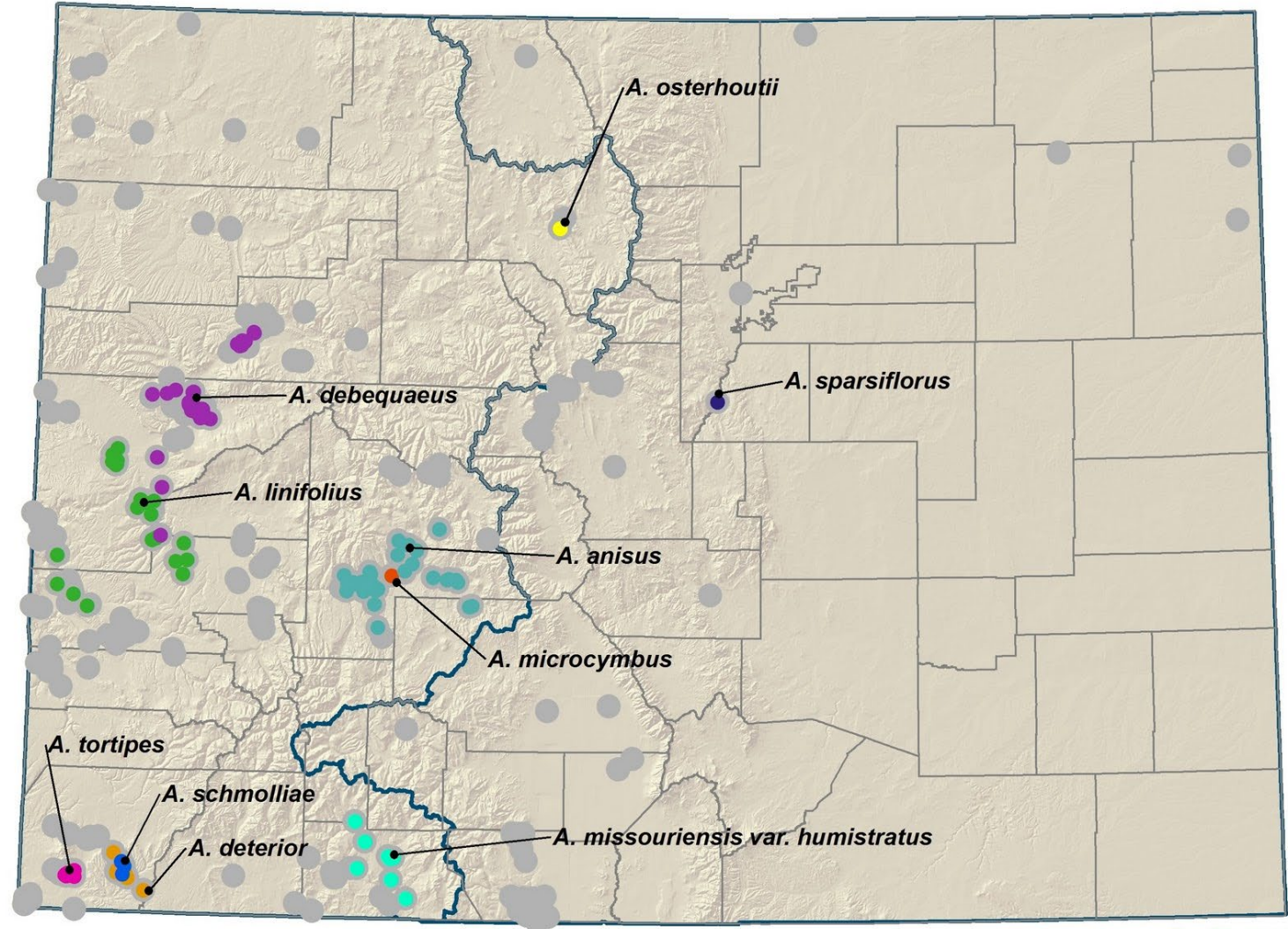
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Durango, CO

Photo: Sleeping Ute Mt. from Hovenweep N.M.

Rare *Astragalus* in SW Colorado

Three G1 taxa

- Began project in 2018 with Mesa Verde N.P. to perform genetic survey on *A. schmolliae*
- Expanded to include *A. deterior* at MVNP
- Later expanded to Ute Mountain Ute Tribe to further sample *A. schmolliae* and perform assessment of *A. tortipes*



Astragalus schmolliae

Occurring on Chapin Mesa in MVNP and adjacent Ute Mountain Ute Tribe

Monitoring has occurred since 1980 – intensive monitoring by MVNP and CNHP since 2001

2002 Long Mesa Fire burned 38% of habitat

Fall 2020 recommended by FWS for listing as threatened under ESA with designation of 3635 acres of critical habitat in MVNP and UMUT

February 2022 FWS withdrawals recommendation for listing



View NE from Mesa Verde toward La Plata Mts.



Old Growth Pinyon-Juniper



Burned area

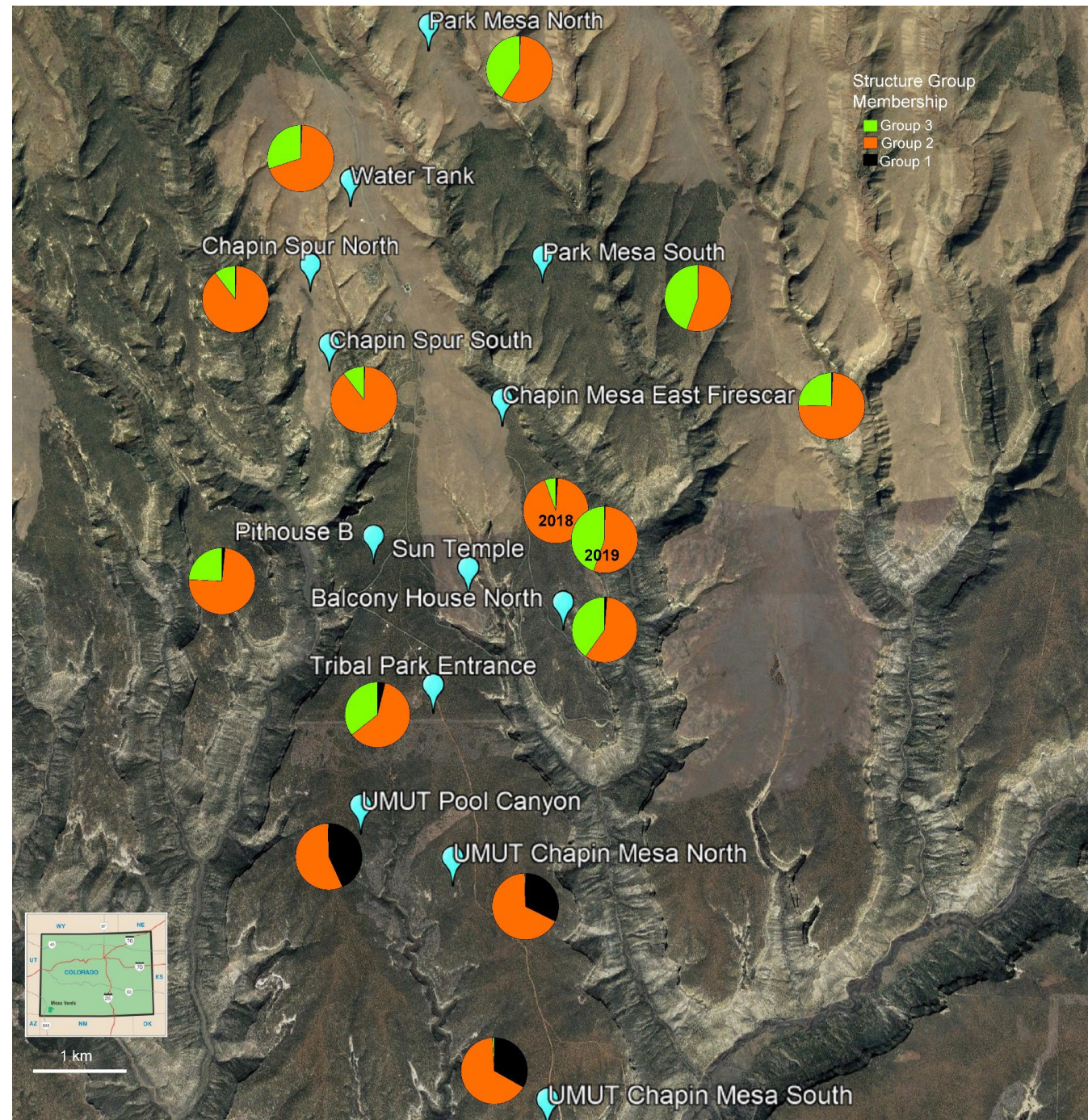
***A. schmolliae* - Population Genetic Survey**

- Sampled 13 “populations” across entire range
- Developed genetic assay using 10 microsatellite loci originally developed in other taxa
- Genotyped ca. 360 individuals
- Assessed patterns of underlying genetic diversity and differentiation across the occurrence of the species



A. schmolliae - Results - Genetic Structure and Gene Flow

- Network analyses (not shown) suggested high level of interconnectedness with no population clustering
- STRUCTURE analysis shows three genetic groups. One common across range with other two segregated between tribal and park lands.



***A. schmolliae* – Conservation Implications**

- 1) While demographic trends suggest reduction in population size, genetic diversity remains high.
 - a) Long age – up to 50 years – allows for mixed-age structure in populations.
 - b) Pattern likely buffers stochastic demographic changes within the natural 300-year fire cycle.
- 2) Large interconnectedness of meta-population allows managers to treat occurrence as a single large population.
- 3) Differentiation however seen between park and tribal lands. Perhaps due to historical land use and management differences.
- 4) Full representation of all diversity requires inclusion of both park and tribal portions of range.



Astragalus deterior



Only known to occur on the southern escarpment of Mesa Verde in MVNP

Almost complete specialization to rim rock

Sporadic monitoring suggests reduction in population sizes

Southern escarpment of Mesa Verde, west of Cliff Palace



Most occurrences are very small with few plants

Sampled four discrete sites varying from mesa top to edge and the single canyon bottom population.

Genotyped using the 10 microsatellite assay

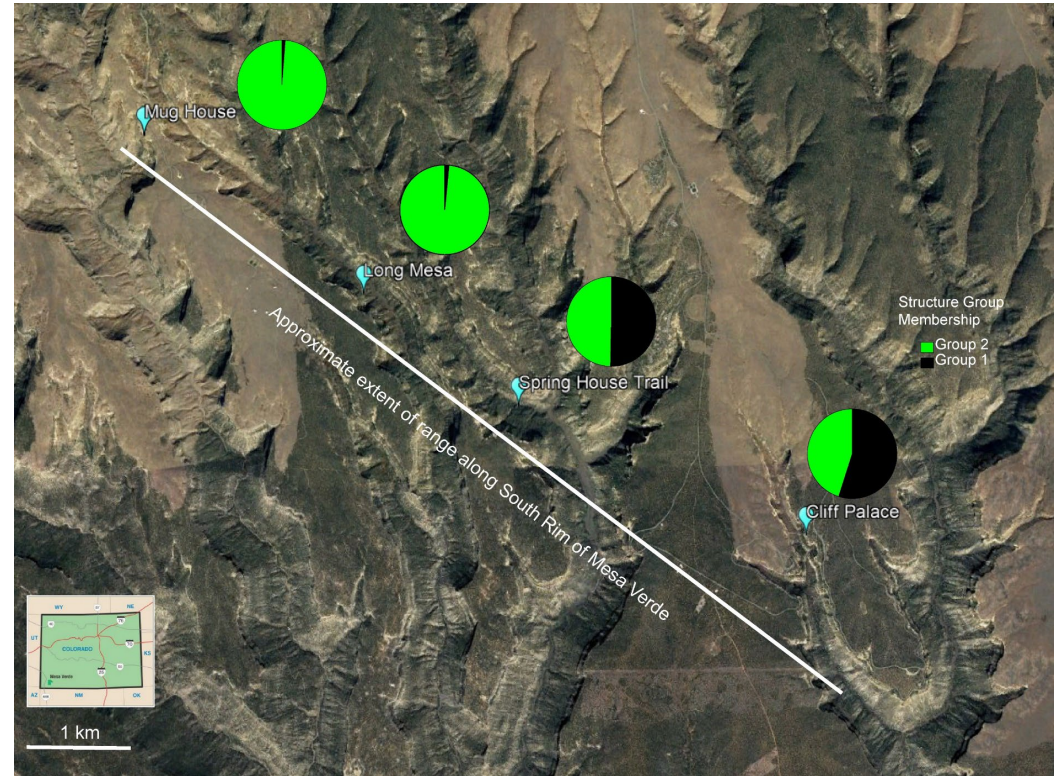
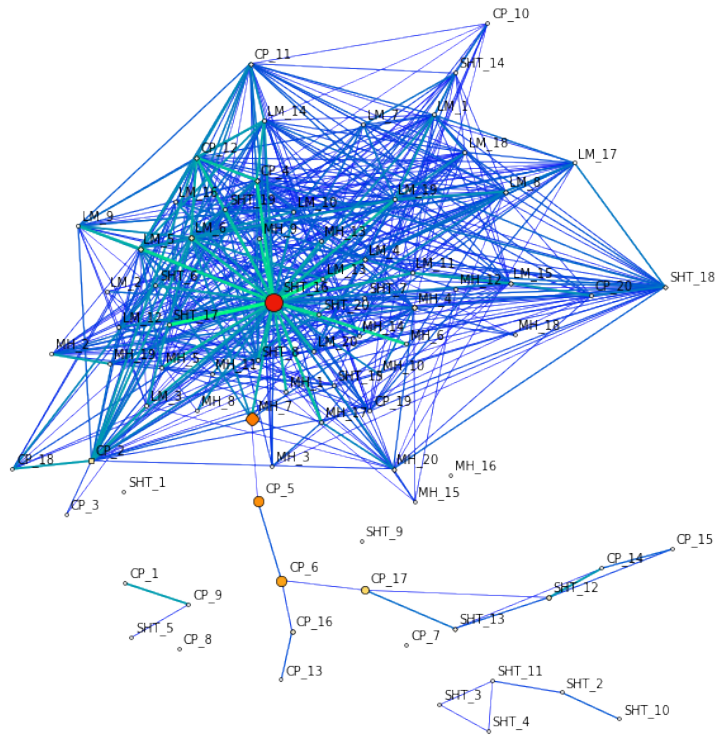
A. deterior - Results - Diversity



Population	n	Na	N _e	Ap	P	H _o	H _E	F _{IS}	
Cliff Palace	20	7.9 (1.08)	4.503 (0.768)	14	100%	0.465 (0.071)	0.691 (0.064)	0.282 (0.115)	
Long Mesa	20	6.1 (0.96)	3.452 (0.607)	9	100%	0.537 (0.065)	0.620 (0.064)	0.087 (0.101)	
Mug House	20	6.3 (1.274)	4.188 (0.721)	9	100%	0.523 (0.076)	0.681 (0.058)	0.208 (0.113)	
Spring House Trail	20	7.500 (1.014)	4.940 (0.730)	6	100%	0.517 (0.086)	0.725 (0.060)	0.239 (0.128)	
Mean		19.250 (0.147)	6.950 (0.537)	4.271 (0.352)	9.5	100%	0.510 (0.036)	0.680 (0.030)	0.204 (0.056)

- Patterns of genetic diversity – typical to other short-lived outcrossing perennials.
- Lowered level of diversity across all populations as evidenced by the consistent pattern of $H_o < H_E$.
- The positive F_{IS} values in all populations suggests a pattern of reproduction among few individuals.

A. deterior - Results - Genetic Structure



- Network analysis shows *A. deterior* is principally structured as a single large meta-population across its small range.
- STRUCTURE shows some two genetic clusters with the western-most populations being homogeneous and the eastern more varied.



***A. deterior* – Conservation Implications**

- 1) Species shows lowered genetic diversity and potential inbreeding
- 2) Recommend expanded monitoring to better track population size.
- 3) Work on reproductive biology needed to understand potential cause of population decline.



Photo: Hannah Ertl

Astragalus tortipes

Described in 1994

Endemic to Mancos-shale badlands along the southern lower slopes of Sleeping Ute Mt on lands of the Ute Mountain Ute Tribe

Little scientific work or monitoring but surveys by the tribe show scattered occurrences over ca. 5 mi² area with local areas of high plant density.

View E toward Mesa Verde from southern end of Sleeping Ute Mt.



100 plants were sampled from five segregated “populations” across the known range.

Genetic assessment made using the 10 microsatellite assay.

View SE from southern end of Sleeping Ute Mt.

A. tortipes - Results - Diversity



Population	n	Na	N _e	Ap	P	Ho	H _E	F _{IS}
1	20	5.714 (1.128)	3.342 (1.065)	2	100%	0.488 (0.096)	0.560 (0.094)	0.152 (0.090)
2	20	4.714 (1.063)	2.566 (0.505)	2	100%	0.463 (0.086)	0.506 (0.098)	0.042 (0.064)
3	20	5.857 (0.857)	2.934 (0.673)	6	100%	0.424 (0.111)	0.562 (0.081)	0.384 (0.137)
4	20	5.286 (1.375)	3.265 (1.007)	2	100%	0.507 (0.081)	0.559 (0.094)	0.031 (0.102)
5	15	4.571 (0.841)	2.697 (0.658)	0	100%	0.435 (0.085)	0.524 (0.084)	0.188 (0.123)

- Consistent patterns across sampled sites.
- Slightly lowered levels of diversity than would be expected for a long-lived perennial
- Inbreeding high in one population (3) – smaller geographic size of site

***A. tortipes* - Results - Genetic Structure and Conservation Implications**



- No patterns of clustering seen across sites in network or STRUCTURE analysis
- Current numbers suggest a stable population with few on the ground disturbances
- Effects of drought are noticeable – long-term effect on *A. tortipes*?

Progress on other projects

Origin of Rare *Astragalus* species

- 60 species of *Astragalus* in the Four Corners area
- 15 of these are endemic
- What is the origin of these?
- Phylogenetic project to evaluate the relationships of these taxa
- Currently including all regional taxa and sequencing using nuclear (ITS+ETS) and chloroplast (*ycf1*) genes



A. naturitensis



A. humilimus

Photo R. Sivinski



A. chuskanus

Photo D. Roth



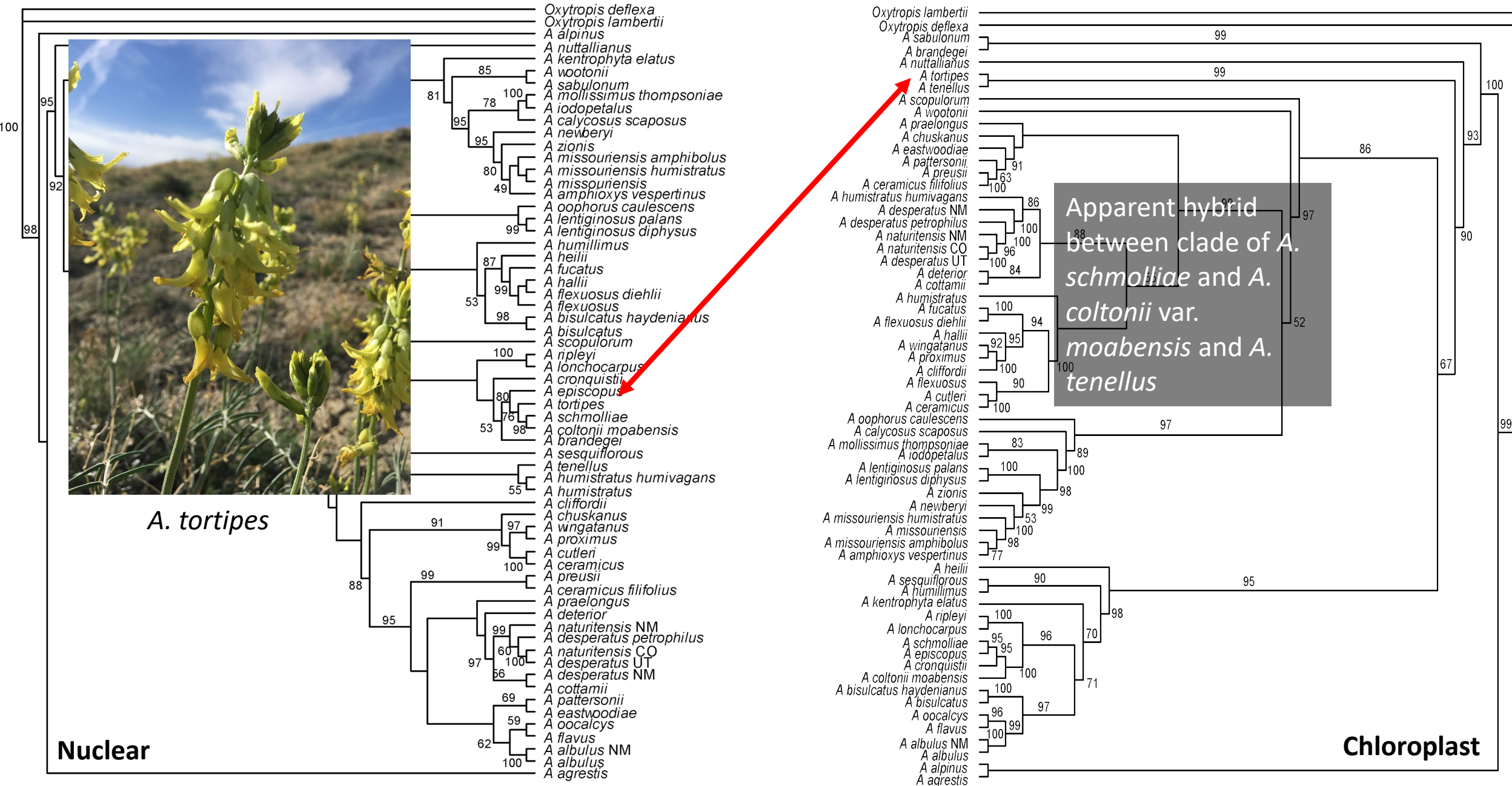
A. oocalycis

Photo R. Sivinski



A. proximus

Photo A. Schneider



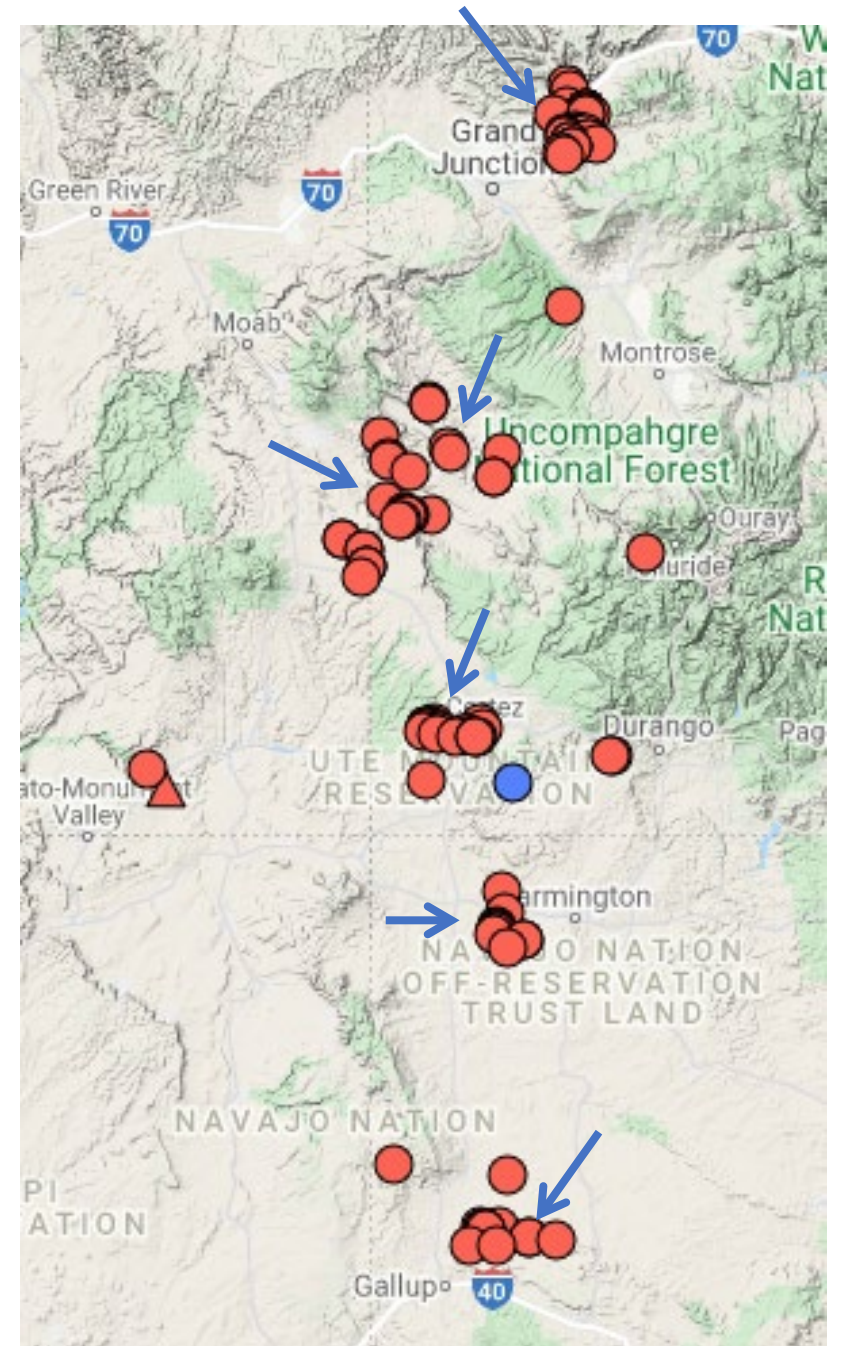
Results of ML analyses

Continuing work

1) Refining regional phylogeny to evaluate the origin of all endemic taxa.



2) Population genetic analysis of *A. naturitensis* and comparison with phenotypic traits to evaluate potential species segregation.



while not in Colorado...

Hogback SE of Shiprock, NM
Rediscovered *A. naturitensis*
Last record for NNHP - 1983



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