Phylogenetic Relationshipsand Patterns of Homoplasy in *Mentzelia* section *Bicuspidaria* (Loasaceae)

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Fig 1. *M. hirsutissima*

Fig 2. *M. involucrata*

Fig 3. *M. reflexa*

Introduction

Mentzelia section *Bicuspidaria* is a small monophyletic group of annual wildflowers native to the southern Mojave Desert and the western Sonoran Desert in the southwestern United States and western Mexico. Due in part to its remote distribution, phylogenetic relationships within section *Bicuspidaria* have not been thoroughly investigated and remain poorly understood. Most species in section *Bicuspidaria* have 5 broad petals and are easily distinguished from one unusual species, *M. reflexa*, that usually has 8 small narrow petals. However, preliminary work using chloroplast DNA sequences has suggested that *M. reflexa* is actually closely related to the broad-petalled *M. tricuspis* and *M. tridentata* within section *Bicuspidaria*.

Fig 4. *M. tricuspis*

Fig 5. *M. tridentata*

Methods

In order to test this hypothesis, we gathered multiple herbarium specimens of each species in *Bicuspidaria*. We sampled the following: *M. hisutissima*, *M. involucrata*, *M. reflexa*, *M. tricuspis*, and *M. tridentata*. Extraction and amplification for the cpDNA spacer *ndhF-rpL32R* and the nuclear internal transcribed spacer (ITS) were conducted using standard protocols (Marlowe and Hufford, 2007). We combined sequences with those of the chloroplast intergenic spacers *rpL32-trnL, trns-trnfM, trns-trnG*, and *trnH-psbA.* Amplified DNA was cycle sequenced and sequenced by the DNA Analysis Facility at Yale University; sequences were edited using Sequencher version 4.10 (Gene Codes Corp., Ann Arbor, Michigan, USA) and aligned manually using SE-AL (v2.0a11; Rambaut 1996-2002). We conducted ML searches including all *Mentzelia* sequences using the program GARLI v. 0.95 (Zwickl, 2006) in order to infer the chloroplast and ITS phylogenies of *Bicuspidaria*.

Results

The phylogeny of *Bicusipidaria* suggests two major clades with weak and moderate support respectively (Clade 1 and Clade 2; Fig. 6). Clade 1 contains 3 strongly supported (> 95% bootstrap) lineages, including two groups of *M. hirsutissima* (Group 1 and 2) and one of *M. involucrata*. However, *M. hirsutissima* Group 1 is strongly supported as monophyletic with *M. involucrata* rather than *M. hirsutissima* Group 2, rendering *M. hirsutissima* paraphyletic. Clade 2 is composed of monophyletic groups of specimens from *M. reflexa*, *M. tridentata*, and *M. tricuspis*. Within Clade 2, *M. reflexa* and *M. tridentata* form a weakly supported clade. The ITS phylogeny (Fig. 7) differs in that Clade 1 and Clade 2 are separated by species from outside section *Bicuspidaria*, rendering *Bicuspidaria* paraphyletic.

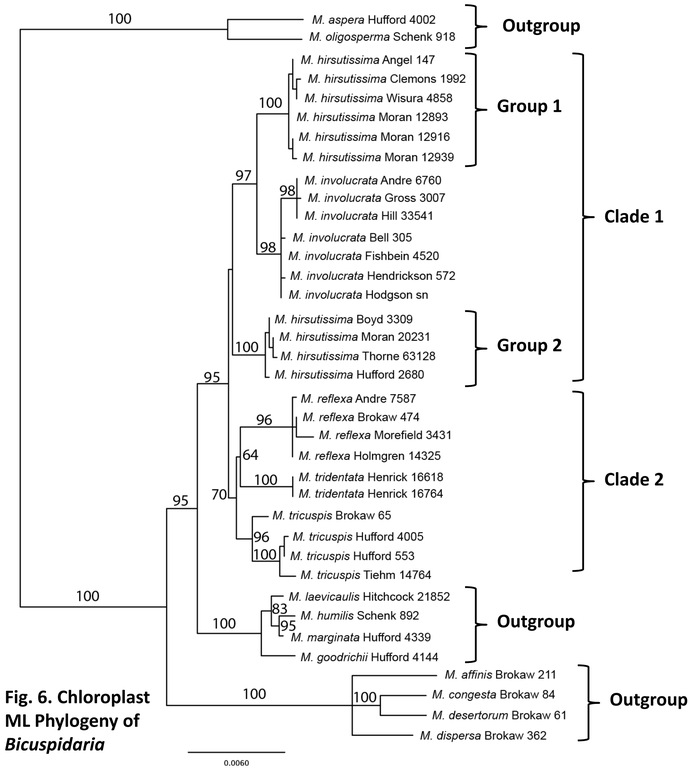
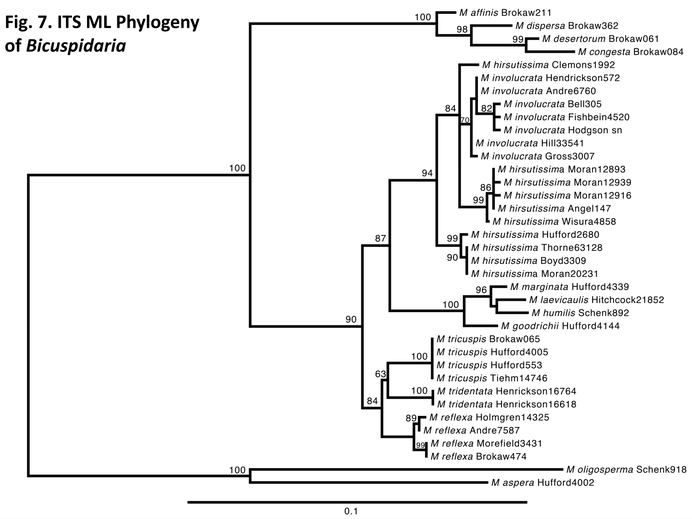


Fig. 6. Chloroplast ML Phylogeny of *Bicuspidaria*

Fig. 7. ITS ML Phylogeny of *Bicuspidaria*



Discussion

According to both phylogenies, we find support for the idea that *M. reflexa* is more closely related to *M. tridentata* and *M. tricuspis* than all of the other species in *Bicuspidaria*. We also believe that there is sufficient evidence to suggest that either group 1 or group 2 of *M. hirsutissima* is a newly discovered species based on both phylogenies. This is due to the support of the monophyly of Group 1 *M. hirsutissima* and *M. involucrata* to the exclusion of Group 2 *M. hirsutissima*. However, some doubt exists whether the chloroplast and ITS phylogenies represent congruent evolutionary histories due to the paraphyly of *Bicuspidaria* the ITS phylogeny. Either the genes have different histories or the histories are obscured by sequence homoplasy. Similarities in bract morphology of *M. involucrata* and *M. congesta* are very likely to be an example of homoplasy in these distantly related species.

Fig 8. *M. congesta*

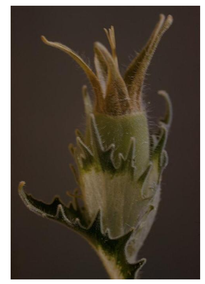


Fig 9. *M. involucrata*

Conclusions

- Despite its unusual characteristics, *M. reflexa* is not distantly related to other species in *Bicuspidaria*..
- However, *M. hirsutissima* is paraphyletic with respect to *M. involucrata* and may actually represent two previously undiscriminated species.
- ITS reconstructions suggest that *Bicuspidaria* is paraphyletic.
- *M. involucrata* is not closely related to *M. congesta* despite similarities.

Works Cited

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