# Spatial Associations between Surface Rocks and Succulents in the Agua Fria National Monument

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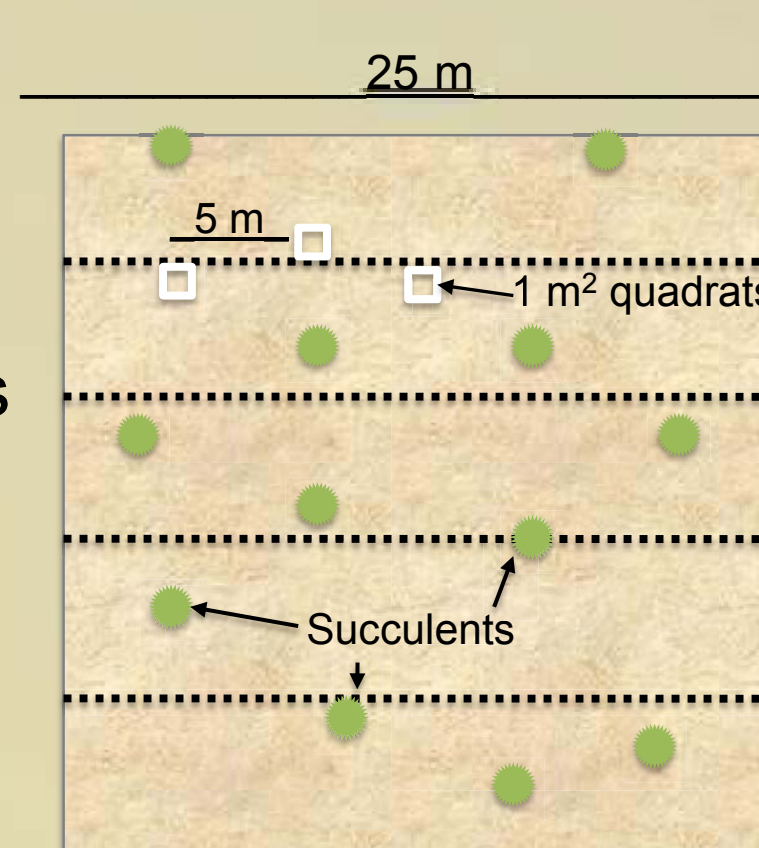*School of Life Sciences, Arizona State University, Tempe, AZ 85287*

## 1. Introduction

• In arid and semi-arid ecosystems, facilitative "nurse" associations ameliorate temperature fluctuations, increase soil water availability and protect against physical disturbance.

• Nurse plant associations have been well-studied (e.g. leguminous trees and saguaro seedlings), but little research has explored the potential abiotic facilitation of plants by rocks.

• Facilitative associations may be abiotic (e.g. surface rocks), which can regulate succulent species composition and distribution.

**In this study, we ask: Is the distribution of surface rocks associated with succulent distribution and composition within prehistorically active landscapes of the Agua Fria National Monument?** We predict that succulent distribution will be more dense within a 2 cm buffer zone of surface rocks than expected by chance, and this association will be strongest within the globose, rosette and cylindrical succulent growth forms compared to shrub-like cacti.

## 2. Methods

**Study Site: Agua Fria National Monument (AFNM)**



• 25 m x 25 m plots on hilltops (high rock cover) and hillslopes (low rock cover)
• 4 parallel N-S transect lines
• Transect points every 0.5 m
• 1 m x 1 m subplots every 5 m

**Microhabitat**

• Three zones in relation to surface rock: buffer zone (0-2 cm), extended buffer zone (>2-5 cm) and not associated (>5 cm)
• Data collected from around succulents were compared to expected values calculated from transect points and subplots
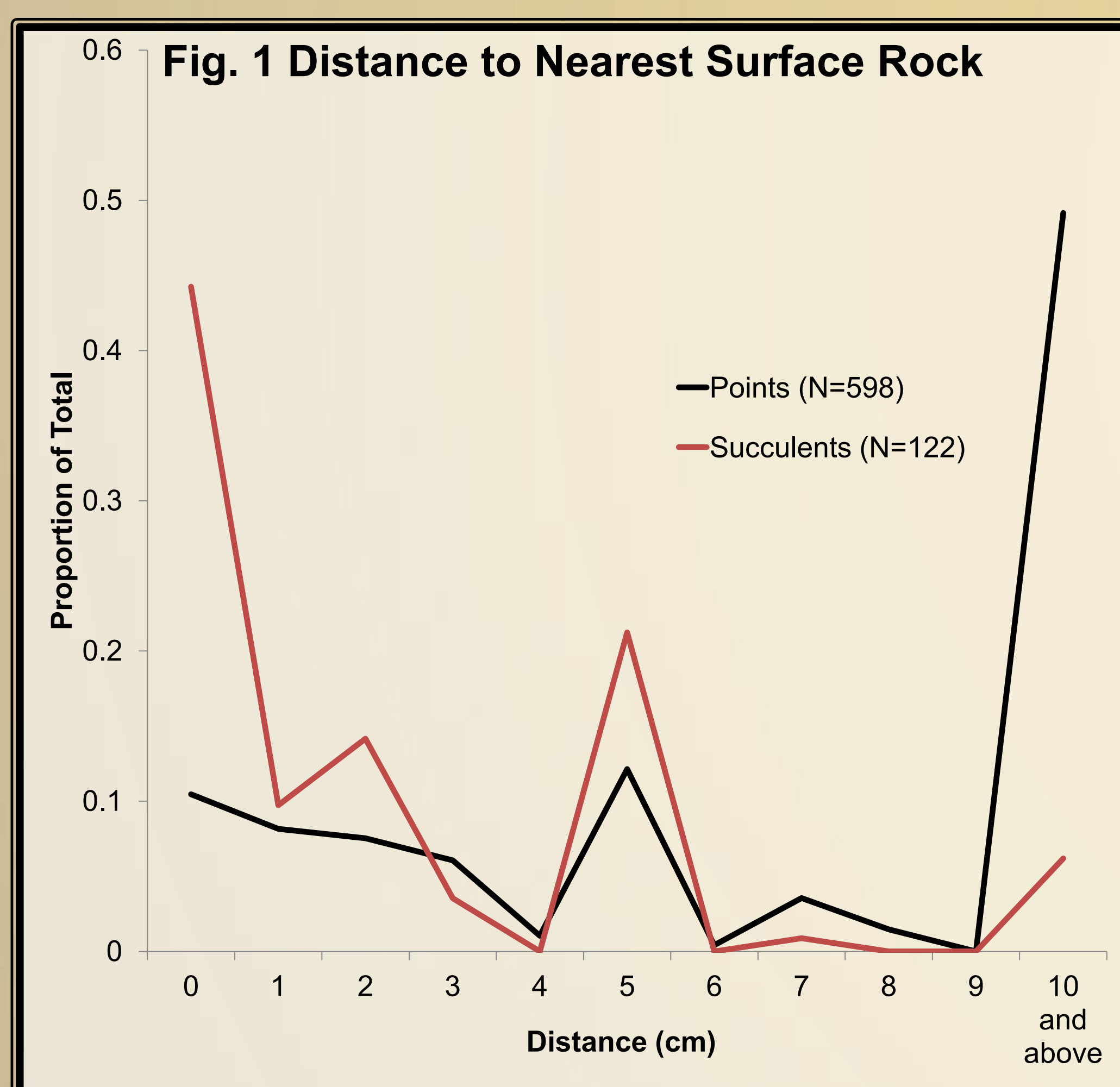
**Data Collection**

| | Succulents | Transect Points | 1 m² Subplots |
|---|---|---|---|
| | Nurse rock size and distance | Nurse rock size and distance | |
| | % Cover: boulder, stone, cobble, gravel, grass | | % Cover: boulder, stone, cobble, gravel, grass |
| | Nurse plant species and distance | Nurse plant species and distance | |

## 3. Results

**Succulents are associated with surface rocks (Fig. 1)**
We found a greater association between succulents and rocks than expected by chance. Nearly 70% of the succulents we encountered (N=122) are associated with rocks within a 2 cm buffer zone. (~23%) are located within 5 cm of a rock and (8%) are not associated with a nurse rock (8%). Approximately equal proportions of our surveyed grid points were located within 2 cm and 5 cm of rocks (~22% each) while most were >5 cm away from rocks (~54%).

**Spatial association differs by succulent species (Fig. 2)**
(94%) of *Agave parryi* (rosette) and (83%) *Echinocerus fasciculatus* (cylindrical) individuals grew within 2 cm of rocks (of 32 and 12 individuals of these species surveyed). A lower proportion of shrub-like cacti were found within 2 cm of surface rocks (*Opuntia phaeacantha*, 55%; *Opuntia chlorotica*, 71%; *Cylindropuntia acanthocarpa*, 63%; *Cylindropuntia leptocaulis*, 0%). *A. parryi* and *O. chlorotica* were always located within 5 cm of a rock.
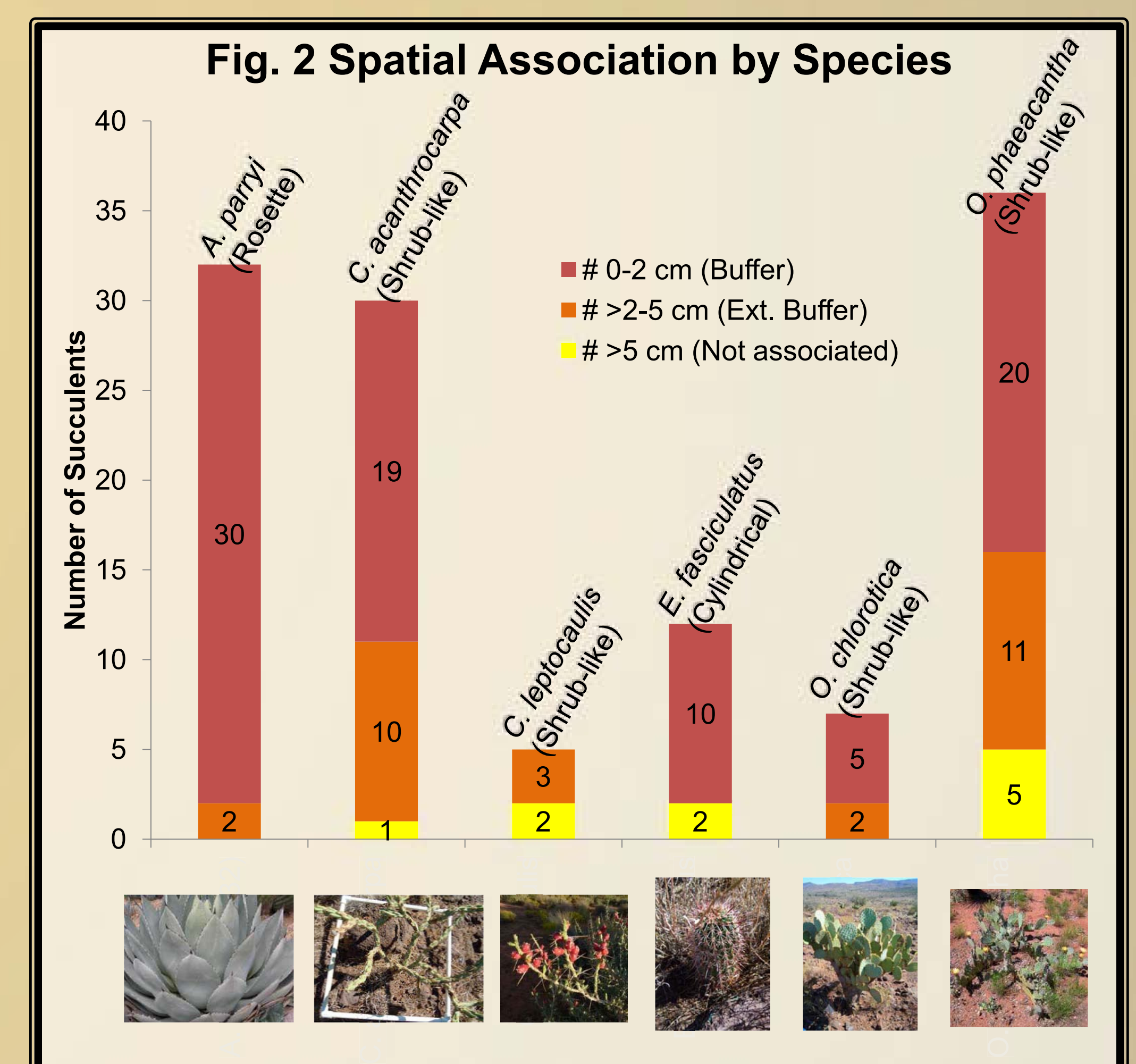


**Figure 1.** Proportion of succulents (red) or transect points (black) encountered relative to distance to a surface rock.



**Figure 2.** Strength of the spatial association between succulent species and surface rocks.

## 4. Discussion

**Succulents are associated with surface rocks**
The majority of succulents are growing within a 2 cm buffer zone of a surface rock, fewer are located between 2-5 cm, and very few are located >5 cm away from surface rock. This pattern is different than the distribution of points as expected by chance.

**Spatial association differs by succulent growth form**
It appears that some succulent growth forms prefer nurse rock compared to others. *A. parryi (rosette)* and *E. fasciculatus (cylindrical)*, appear to be associated with rocks more often than the shrub-like growth forms: *C. acanthocarpa, C. leptocaulis, O. phaeacantha and O. chlorotica.*

## 5. Future Research

**Association between succulents and surface rocks**
We plan to collect data from at least 15 hilltop-hillslope plot pairs before May, 2012. These data will be used to further support the potential role of surface rocks as nurses to facilitate succulent persistence in semi-arid grasslands.

**Spatial association and succulent growth form**
We hope to strengthen the preliminary patterns we see between surface rocks and succulent growth forms. We have not recorded all possible species or growth forms in our preliminary data.

**Lasting effects of prehistoric agriculture in AFNM**
If our preliminary hypotheses are supported, we plan to assess the effects of surface rock manipulation by prehistoric agriculturalists on succulent distribution and richness.
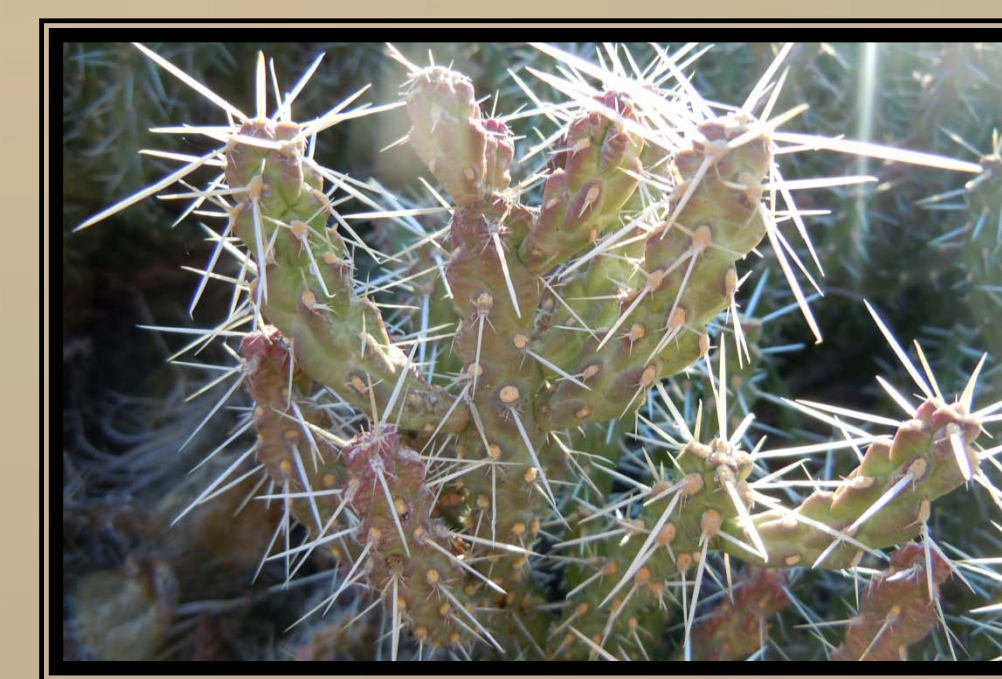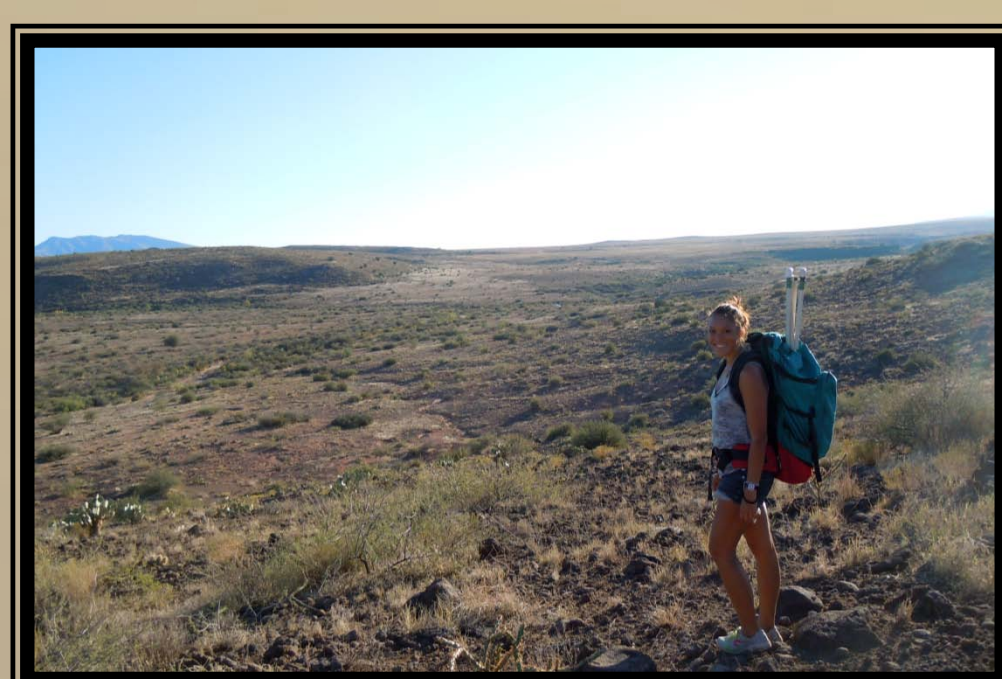
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