

SPATIAL ASSOCIATIONS BETWEEN SURFACE ROCKS AND SUCCULENTS IN THE AGUA FRIA NATIONAL MONUMENT

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1. Introduction

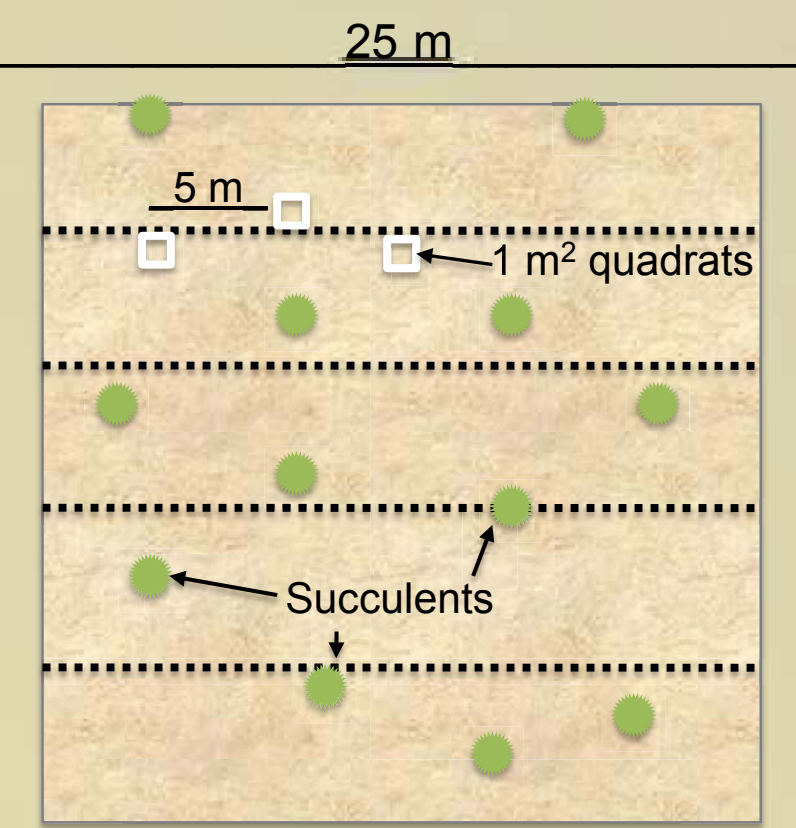
- In arid and semi-arid ecosystems, facilitative “nurse” associations ameliorate temperature fluctuations, increase soil water availability and protect against physical disturbance.
- Nurse plant associations have been well-studied (e.g. leguminous trees and saguaro seedlings), but little research has 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 m ² 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%) *Echinocereus 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.

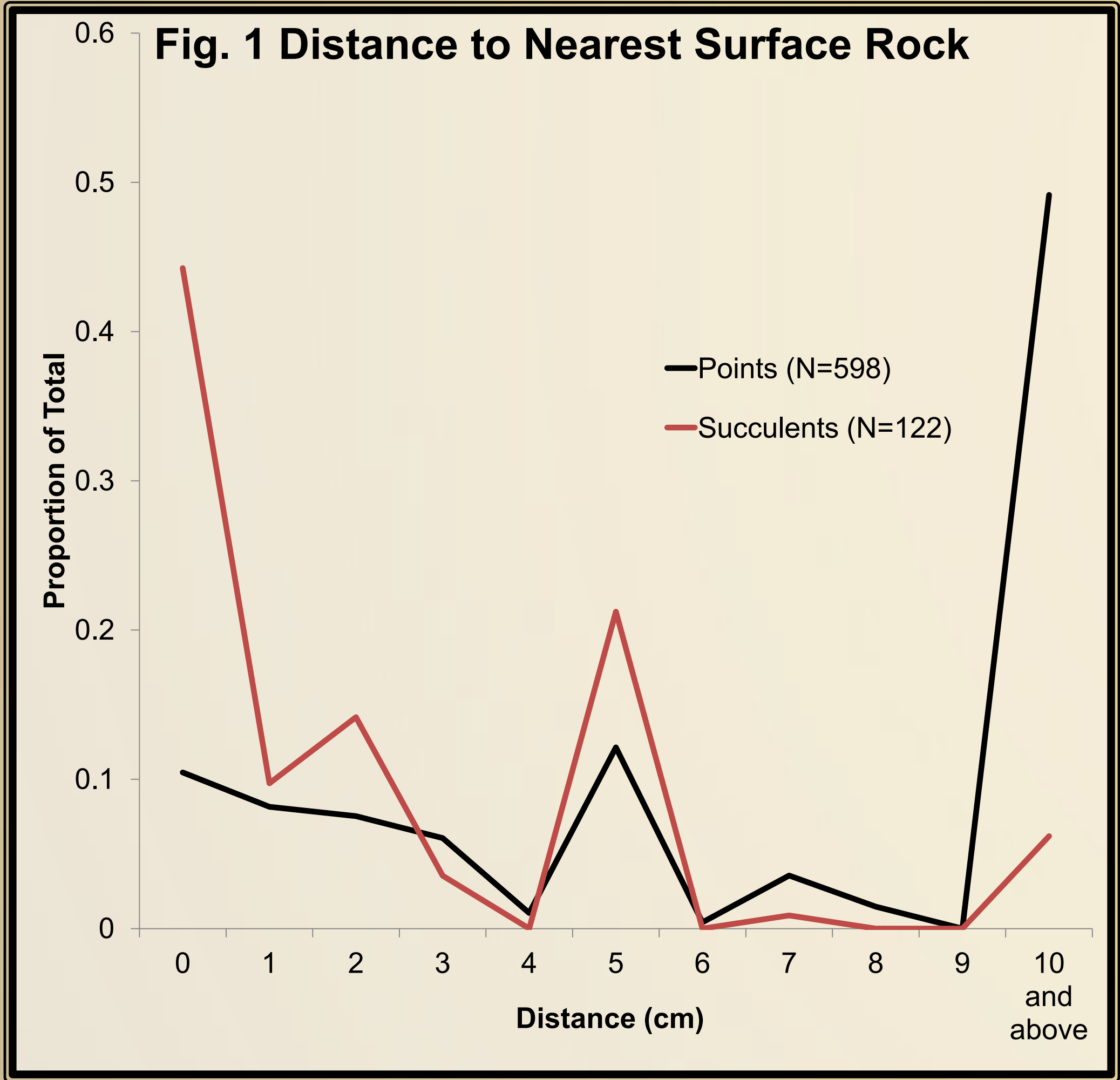


Figure 1. Proportion of succulents (red) or transect points (black) encountered relative to distance to a surface rock.

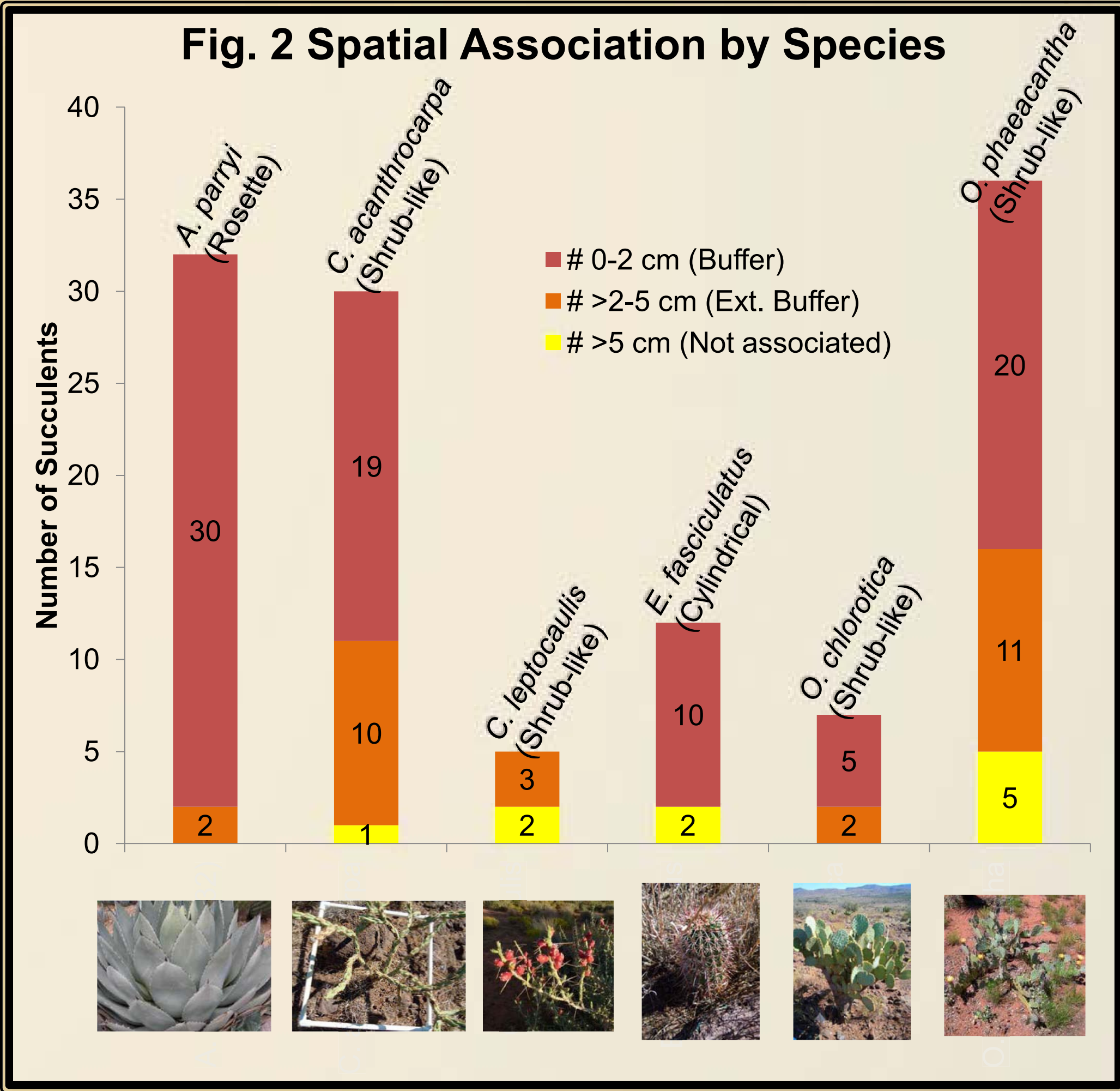


Figure 2. Strength of the spatial association between succulent species and surface rocks.

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

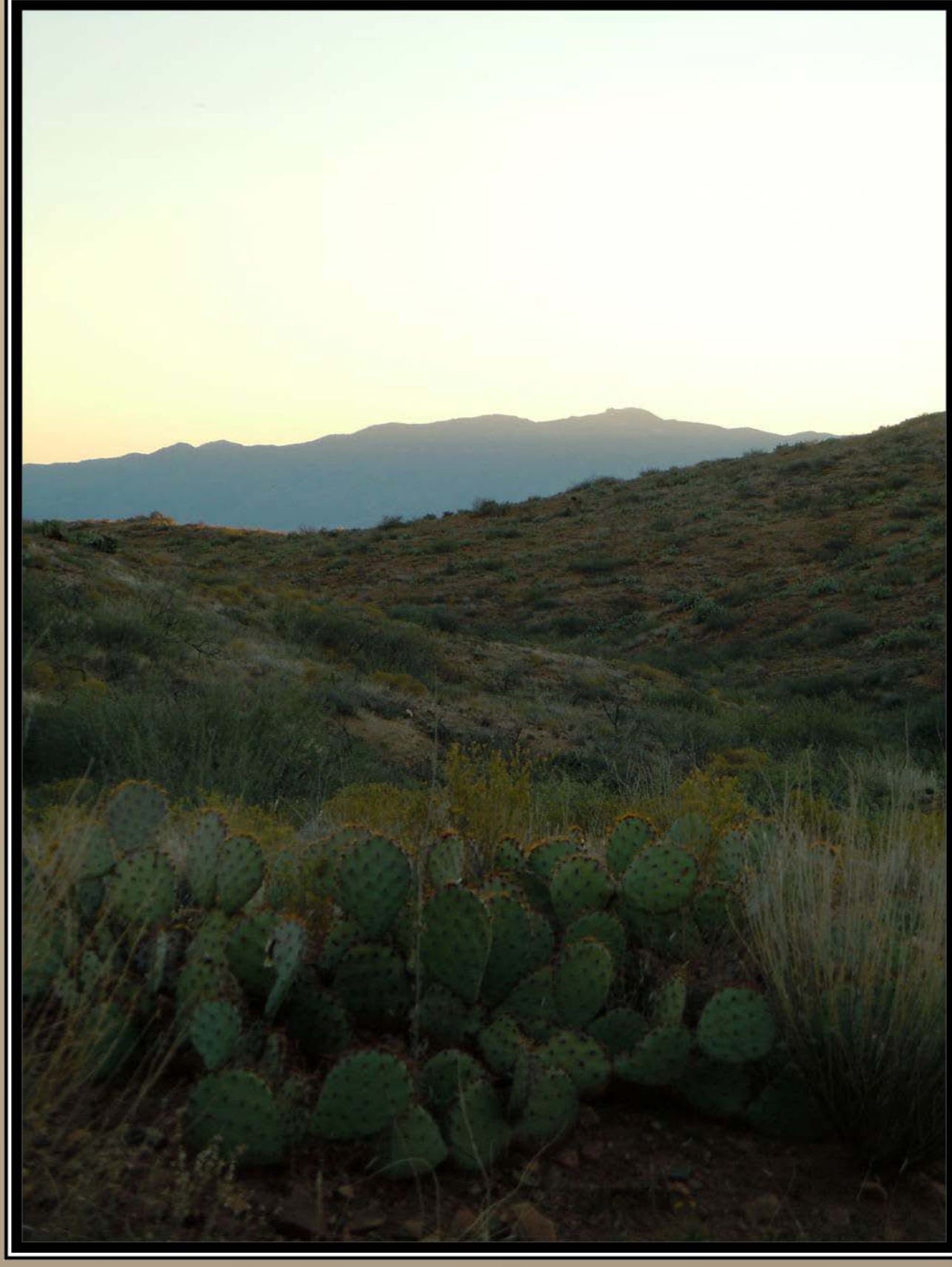
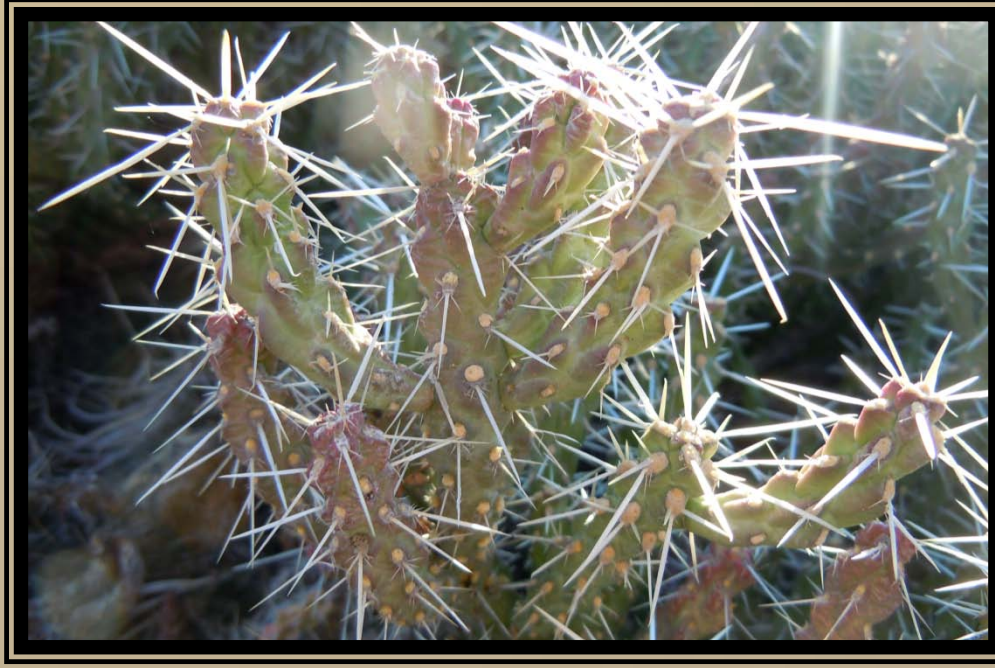
We plan to collect data from at least 15 hilltop-hillslope plot pairs before May, 2012. These data will be used to further support the potential role of surface rocks as nurses to facilitate succulent persistence in semi-arid grasslands.

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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