

Association Between Nurse Plants and Saguaros (*Carnegiea gigantea*) in the Western Sonora

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Abstract—The objectives in this work were to determine nurse species associated with the saguaro, as well as the diversity of plant species in the saguaro patch. We also recorded the presence of termites on saguaro green tissues to evaluate their existence and possible causes for their presence. At each site a point-centered quarter transect was used, where the data on the closest saguaros were taken for size and height, percent litter soil coverage, and termite activity, as well as floristic composition, plant species cover, and the dimension of the associated patch of vegetation. Data on 55 saguaros showed the most common nurse species were *Larrea tridentata*, *Olneya tesota*, *Parkinsonia microphylla*, and *Ambrosia deltoidea*. Twenty-one (21) saguaro individuals were found distributed in different patches where *Olneya tesota* and *Parkinsonia microphylla* showed the most species diversity. Termite activity was present in saguaros with little or no litter cover in the soil. This is the first work focusing on the causes for the increase of termite invasion of live saguaro tissues.

Introduction

Cacti are a diverse family and include about 2,000 species, which are often endemic and unique elements of the arid and semi-arid areas of America (Drezner and Lazarus 2008; Godínez-Alvarez and others 2003; Hunt and others 2006). For most cacti, facilitation is undoubtedly one of the ecological biotic interactions most widely documented. Different species of perennial plants tend to favor germination of seeds and survival of seedlings of various species of cacti, leading to patterns of patches of strongly clumped species. A well-studied example is the interaction of saguaro (*Carnegiea gigantea*) with perennial trees and shrubs, where they facilitate the establishment of seedlings of saguaro. However, when the saguaro is an adult it can affect and compete with the nurse plant. Within the Sonoran Desert in Sonora, some of the most important nurse plants have been used for fuel, fencing, and crafts for a long time (Castellanos and others 2010a), despite that not much is known and many ecological aspects of this interaction still need to be studied. For example, Castellanos and others (2010b) have documented the interaction of termites, affecting green tissues of living saguaros, and propose this may be an important cause in the death of saguaros and possibly affecting its population dynamics. For such reasons, our research questions were:

1. What is the importance of nurse plants to the populations of saguaros?
2. Do patchiness diminish adverse biotic interactions? and
3. Are there other indirect effects such as amount of litter under the nurse plant that contributes to the saguaro not being invaded by termites?

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Materials and Methods

Sampled sites were located in the northwestern region of the State of Sonora, near Puerto Libertad. We selected three sites that had been previously sampled (Castellanos and others 2010b), in which populations of saguaro are well represented. The selection of saguaros was along transects using the point-centered quarter method, with a separation of 50 meters between each of them. At each point we sampled the nearest saguaro in each of the four quadrants. This method was used in each of the three sampling sites. After that, we measured saguaro height, coverage of the patch, floristic composition under the canopy of nurse species, and the amount of litter cover in the soil close to the basal area around the saguaros. To determine the age of saguaro, we used the formula proposed by Drezner (2002) in which saguaro growth relates to their age. For the application of the formula we required the calculation of a saguaro growth factor, which differs according to the area to be analyzed and which consists in measuring the population of saguaro during one year. We assumed a factor of 0.85, that seems to fit most other studies, in order to reduce the error when applying the formula.

Results and Discussion

Characterization of Saguaro (*C. gigantea*) Patches

We found a total of 21 species within different patches associated with saguaro. The main nurse plants associated to saguaro in our study region were *Olneya tesota*, *Parkinsonia microphylla*, *Ambrosia deltoidea* and *Larrea tridentata*. The last plant species allowed the establishment of 11 other species, but presented a large variability among all patches. There were patches where *L. tridentata* was the only species associated with saguaro, and others where it was associated with two to three different species. Patches with the largest diversity of species were under *P. microphylla* and *O. tesota*, and were related to the larger canopy cover from those patches.

Description of the Saguaro (*C. gigantea*) and Its Nurse Plants Populations.

The three study sites showed a similar population density with an average of 58.8 plants per hectare. Our data indicated that the number of saguaros sampled per site was sufficient to estimate the population density. The saguaro population structure had a progressive pyramid-like shape. This indicates a young saguaro population with a constant growth, and it is noteworthy that the most abundant saguaro size range was for plants between 0 and 1.5 meters in height, which means that the saguaro populations are dominated by juveniles in the three study sites.

The main plant species found as nurse plants of saguaro were *Larrea tridentata*, *Ambrosia deltoidea*, *Olneya tesota* and *Parkinsonia microphylla*, in decreasing importance. In addition we calculated the occurrence of facilitation by these four species and found that *Larrea tridentata* had the highest percentage (30.4%) on the three sites.

Percentage Litter Cover in Soil and Calculated Age of Saguaro (*C. Gigantea*) Studied

Litter cover in soil surrounding the base of saguaro of different ages changed or was not present, so there was no specific pattern or influence of the age of the saguaros with respect to percentage soil covered with litter even though that could have been influenced by the nurse plant to which it is associated. However, we found that older saguaros did not have any litter on the soil, perhaps because they do not already have a nurse plant that could provide such litter material, unlike the juvenile saguaros that had higher litter soil cover.

Absence or Presence of Termites at Saguaro (*C. gigantea*) Sites

We evaluated the susceptibility to invasion of termites in relation to the age of saguaros, and found that termite activity was higher between the age of 30 to 80 years. In the limits of the population of saguaros (13-118 years) did not show invasion by termites. This may be because young saguaros are sheltered and protected under the canopy of the nurse plants.

Based on the average from four measurements of percent soil litter cover, we found that individuals with low percent soil litter cover (0 to 30%) were more susceptible to invasion in the tissues of the saguaro by termites. It was further noticed that there was a 1:1 ratio for individuals with low percent soil litter cover, indicating that termites do not always tend to invade the saguaro that does not have a noticeable percentage of soil litter cover. Also, we found that the main nurse plants species (*Olneya tesota*, *Parkinsonia microphylla*,

Ambrosia deltoidea and *Larrea tridentata*) did not present difference on the organic matter despite the form of life (tree or shrub) and its canopy coverage.

Conclusions

The main nurse plants for saguaro in our study area were *Olneya tesota*, *Parkinsonia microphylla*, *Ambrosia deltoidea* and *Larrea tridentata*, which differ in their role within the studied populations. Their nurse contribution depends mainly on the size of the patch and therefore, the diversity of species associated with nurse plants. We found 21 species primarily associated with the evergreen plants *Olneya tesota* and *Parkinsonia microphylla* including saguaro. *Larrea tridentata* was a common nurse plant species for saguaro in the three sites. The ecological and ecophysiological relations of a nurse species to the saguaro population dynamics are a focus of more studies to understand the many details about these interactions that occur in arid and semiarid lands. The percentage litter cover in the soil provided by the nurse plant, and the species under it, seem to work as a defense mechanism for saguaros against herbivore attack by termites. It was found that termites do not invade saguaros with larger litter cover of soil at their base, meaning that the absence of litter is related to the invasion of termites, although other mechanisms may also be responsible for termite invasion to living green tissues of saguaro.

References

- Búrquez-Montijo, J. A. 2009. Distribución, estructura poblacional y utilización del saguaro (*Carnegiea gigantea* (Engelm.) Britt & Rose) en México. Universidad Nacional Autónoma de México. Instituto de Ecología. Informe final SNIB-CONABIO proyecto No. ES008. México D.F.
- Castellanos, A. E., Castillo, R. A., Quijada, A. 2010. Termite activity on green tissues of saguaro (*Carnegiea gigantea*) in the Sonoran Desert. In: Halvorson, W., C. Schwalbe and C. van Riper (eds.) Southwestern Desert Resources. University of Arizona Press, Tucson, AZ. p. 171 - 180.
- Castellanos-Villegas, A. E., L. C. Bravo, G. W. Koch, [and others] 2010. Impactos Ecológicos por el Uso del Terreno en el Funcionamiento de Ecosistemas Áridos y Semi-Áridos de Sonora. En: F. E. Molina-Freaner y T. Van Devender, eds. Diversidad Biológica del Estado de Sonora. UNAM - CONABIO, México, D. F. pp 157-186.
- Drezner, T. D. and B. L. Lazarus. 2008. The population dynamics of columnar and other cacti: a review. *Geography Compass*. 2:1-29.
- Drezner, T. D. 2002. Saguaro (*Carnegiea gigantea*, Cactaceae) age-height relationships and growth: the development of general growth curve. *American Journal of Botany*. 90:911-914.
- Godínez-Álvarez, H., Valverde, T. & P. Ortega-Baes. 2003. Demographic trends in the Cactaceae. *Botanical Review*. 69: 173-203.
- Hunt, D. R, Taylor N. P. and G. Charles. 2006. The new cactus lexicon. Volumes I. International Cactaceae Systematics Group, DH Books, Millbourne Port. p. 373