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Agave salmiana
Abisaí Josué García Mendoza

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Correo electrónico: mrojas@ecologia.unam.mx

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The influence of land management in spatial distribution of forest community at the Sierra of "El Doctor", Queretaro, Mexico

Caiceros-Gallegos Alba[1], Hernández-Sandoval Luis[1],
Guevara-Escobar Aurelio[1] & Suzán-Azpiri Humberto[1*]

Abstract

In Central Mexico, a traditional alcoholic beverage (*pulque*) is obtained from wild and cultivated species of the genus *Agave*. We evaluated the spatial distribution of *Agave* plants under distinct management scenarios in Queretaro, Mexico. Six sites were selected: two in crop fields, three in natural managed areas, and one in a non-disturbed natural area. A variety of methods were used to suit the intricated relations between human management and species spatial disposition, such as the spatial analysis technique SADIE (Statistical Analysis with Distance Indices) for populations and communities; as well as the IVI (Importance Value Index), basal area, ordination analysis (DECORANA), and size frequency histograms for *Agave* species. Aggregation indices (I_a) obtained by SADIE for the majority of species were clustered ($I_a > 1$) with different arrangements responding to management intensity. Local associations (X_a) presented a tendency for dissociation in interspecific relationships, where artificial arrangements in crop fields, differed from those in natural and natural managed areas. Forest community spatial distribution agrees with IVI data. On the contrary, tree basal areas decreased in cultivars, being higher in the natural area. Finally, DECORANA analysis showed that human management is directly related to the amount, composition, and distribution of local forest species.
Abbreviations: I_a aggregation index, SADIE Spatial Analysis for Distance Index, X_a association index.
Keywords: *Agave*, El Doctor, maguey, management, pulque, SADIE.

Resumen

En el centro de México, una bebida alcohólica tradicional (pulque) se obtiene de especies silvestres y cultivadas del género *Agave*. Para evaluar la distribución espacial de especies de *Agave* bajo diferentes escenarios de manejo en Querétaro, México. Se seleccionaron seis sitios: dos en campos de cultivo, tres en áreas naturales bajo manejo y uno en zona no perturbada. Para estudiar las relaciones entre el manejo y la distribución espacial se utilizaron diversos métodos, tales como la técnica SADIE de análisis espacial de poblaciones y comunidades; el Índice de Valor de Importancia (IVI), áreas basales, análisis de ordenamiento (DECORANA) y análisis de tamaños para las especies de *Agave.* Los índices de agregación (I_a) obtenidos con SADIE para la mayoría de las especies fueron agrupados (I_a>1) indicando

[1] Laboratorio de Ecología Vegetal. Facultad de Ciencias Naturales,
Universidad Autónoma de Querétaro, Blvd. de las Ciencias S/N, Juriquilla, Querétaro. 76230, México.
*correspondence address: hsuzan@uaq.mx

diferentes arreglos respondiendo a cada manejo. Las asociaciones interespecíficas locales (X_a) tendían a la disociación, donde los arreglos artificiales en los cultivares difieren de aquellos en áreas naturales. La distribución espacial de la comunidad corrobora los análisis de los IVI. En contraposición los datos de área basal indican un decrecimiento en cultivares y valores altos en las especies en el área no perturbada, seguidos de un área manejada. Finalmente, DECORANA indicó que el manejo se encuentra relacionado con la cantidad, disposición y distribución de las especies forestales.
Abreviaturas: Análisis Espacial de Comunidades: SADIE, Índice de Agregación: I_a, Índice de Asociación: X_a.

Palabras clave: *Agave*, El Doctor, maguey, manejo, pulque, SADIE.

Introduction

"Pulque" is a traditional mild alcoholic beverage produced by the fermentation of "aguamiel", a liquid obtained from some cultivated and wild *Agave* (maguey or agave pulquero) species in the central highlands of Mexico (Gentry 1982). For the production of "pulque", the most commonly used species are *Agave salmiana* Otto ex Salm., *A. americana* L., *A. atrovirens* Karw. ex Salm.-Dyck, and *A. mapisaga* Trel. (José-Jacinto and García-Moya 2000) (Photos 1, 3 and 4). *A. salmiana* is the most cultivated *Agave* species in the Mexican highlands and adjacent mountain ranges (Parsons & Parsons 1990). Queretaro is one of the Mexican central states with important "pulque" production, even though its production is minor compared to the states of Hidalgo, Estado de Mexico, Puebla, and Tlaxcala (Casas *et al.* 2007). *Agave* species may also be utilized in marginal zones of Mexico as a primary source in human diet (Gonçalves de Lima 1978).

Guadalupe Malda

PHOTO 1. Adult plant of *Agave americana*.

Wild agaves at the Sierra "El Doctor" in Queretaro, are usually found in association with thorny shrub chaparral or dry forests dominated by trees of the genera *Quercus*, *Pinus*, and *Juniperus,* where management conditions are considered as *in situ*, while their incorporation into cultivated fields constitute *ex situ* management (Casas *et al.* 1999; Hernández, 2000). Nevertheless, some *Agave* species populations subjected to agricultural selection are also managed as crops with plants individuals mainly produced by asexual root propagules ("hijuelos") or ramets (Hernández 1988). Modules with the potential for separate existence are known as "ramets" (Begon *et al.* 2006). Hybrids among species and extensive ramet colonies are extremely common in areas under *in situ* management and in the preserved areas of the region (Caiceros 2010).

A tool for recognizing the structure in plants populations is the spatial distribution. This distribution of species under human management is the result of exploitation intensity (Schmitz *et al.* 2007), and management practices (Chumak *et al.* 2005), resulting in structural changes of the vegetation. Morphometric, anatomical, and even the genetic composition of particular populations are affected by *in situ* and *ex situ* management into a delimited region. Therefore, Schweik (1998) affirms human management of the land combined with foraging and proximity to cultivated areas, to be the main factors in which exploitation of certain wood and non-timber species affect their spatial distribution. In which case, from a plot level of analysis (spatial distribution) of a forest patch, conclusions may lead to show the degree of sustainability in terms of harvest production (Schweik 1998).

Thus, the spatial distribution of some populations and biological communities can be evaluated with the SADIE (Statistical Analysis by Distance Indices), a method and software created by Perry (1999). SADIE analyzes the spatial pattern of data that are written as counts (*i.e.* numbers of plants in quadrats) instead of a frequency count data such those used for Poisson adjustment techniques (Krebs 2000). SADIE software measures the clustering of the data as patches or gaps (Perry 1999; Perry 2002). Previous studies proved SADIE as an efficient technique for arid vegetation analysis. Zuñiga *et al.* (2005) analyzed the patterns of distribution of Queretaro's peyote (*Lophophora williamsii*) and its association with nurse plants; Suzán *et al.* (2011) determined the relationship between *Ariocarpus kotchoubeyanus* and the associated vegetation; Solís-Gracia (2007), and Solís and Suzán (2014) analyzed the hemiparasite *Phoradendron californicum* and its host species in the Sonoran Desert; and, Arce *et al.* (2016) studied the tropical mistletoe *Psittacanthus calyculatus* distribution in Queretaro, Mexico.

In the present study, we examined with SADIE the effects of certain management strategies showing the patterns of spatial distribution of "agave pulquero" ramets, and how individuals responded to a human induced gradient in the vegetation structure (Fig. 1). It is often more useful to study the distribution and abundance of modules (ramets) in plant populations, rather than examine a "genet" which is the genetic individual, the product of a zygote (Kays & Harper 1974; in Begon *et al.* 2006). Therefore, SADIE was the indicated tool to show the change in management intensities in a forest community, contrasting

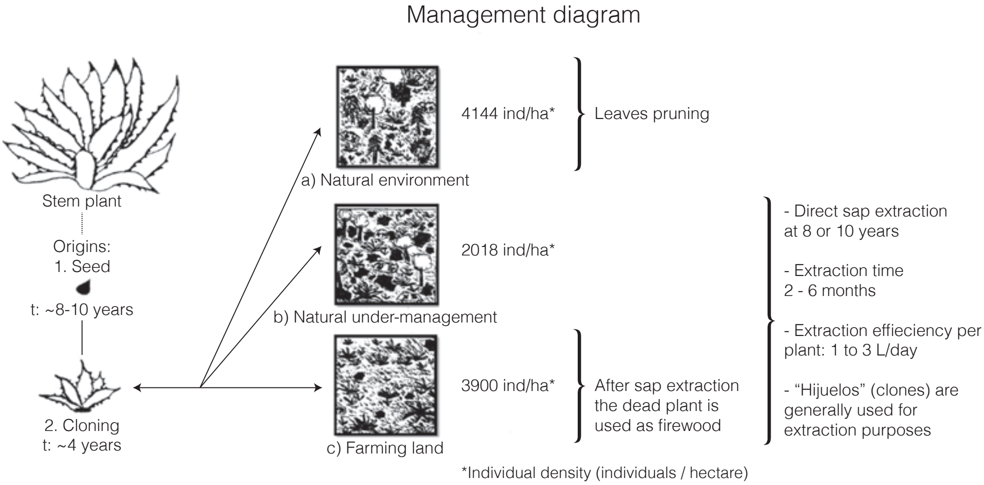

FIGURE 1. Management diagram for *Agave* species at the Sierra "El Doctor", Querétaro. The diagram is divided into the three examined management areas; which are: a) Natural area, b) Natural managed area, c) Crop fields. Plant distribution depends on human exploitation of resources.

with the previous focus on arid zone studies. The main objectives of the project were: a) to determine the spatial distribution of six populations in the Sierra of "El Doctor", ranging from cultivated fields to plots with complex vegetation structure; and, b) to analyze the patterns of "agaves pulqueros" distribution due to artificial selection.

Material and methods

Study zone

The Sierra of "El Doctor" is an area that forms part of the Sierra Madre Oriental which belongs to the Espolón-Cerro del Ángel area, located at the east-center of the Queretaro province in Mexico. This sierra is a calcareous massif from the Inferior Cretaceous Era (Carrillo-Martínez 1981). The climate of the region is $C(w_2)$ corresponding to temperate subhumid with an annual temperature of 14 °C and an annual precipitation of 874.6 mm (Fernández-Nava & Colmenero Robles 1997). The vegetation was a temperate dry forest dominated by the genus *Quercus*, *Pinus*, and *Juniperus* (Hernández 2000). The study area comprised six locations at the Sierra of "El Doctor", and the study was conducted between the months of May and November of 2009.

Classification of *Agave* management conditions was based on Casas *et al*. (2009), with three management intensities detected in the region: 1) Natural areas with minor management; 2) Wild populations under intense management with direct "aguamiel" extraction (*in situ* management), and 3) Areas with *ex situ* management characterized by planted agaves under intense management, constant sowing, clearing and replacement of old individuals. Six sites were selected: one in a natural area, three with wild *in situ* management, and two with *ex situ* management conditions (crop fields) (Fig. 1).

Sites description

Natural Area:

a) Sánchez-Maqueda (SM) (Photo 2a) This was a wild site where *Agave* plants inhabit with other

a) Oscar García
b) Guadalupe Malda
c) Guadalupe Malda

PHOTO 2. Sites description: a) Natural area (SM), b) Natural managed area (J), c) Crop field (D).

forest species, such as *Pinus cembroides*, *Quercus greggii*, and *Juniperus monosperma*. *Agave* plants were found as the stem plant along with their propagules with no sign of removal from either propagules or adult plant. Aguamiel production was considered unlikely in this site.

Natural area with management:

In the following three sites were located wild propagules with replacement

a) Los Hernández I (H1). *Agave* plants were located in the *Pinus-Quercus* community. Seeded plants of agaves were evident due to poor soil conditions where large, abundant calcareous stones persisted. The site was characterized as a mixed forest community including non-timber plant species (NTPS). Aguamiel extraction occurred at this site.

b) Los Hernández II (H2). Agaves were also found in a *Pinus-Quercus* forest. This site had the presence of calcareous stones too with an important steepness slope. Aguamiel production was not observed, nonetheless there was evidence of *Agave* extraction in the past.

c) Los Juárez (J) (Photo 2b) *Agave* was detected in a *Pinus-Juniperus* forest. Aguamiel production was not part of the household main income. This site was considered disturbed because of absence in pine recruitment (Suzán *et al.* 2011).

Cultivated areas:

a) "El Doctor" (D) (Photo 2c) was a site where planting and re-planting occurred. A daily production of aguamiel was observed which constituted one of the main household products. The ecosystem was heavily disturbed with *Pinus-Quercus* remnant nearby forests. The area was a mono-cultivated *Agave* plantation.

b) Chavarrías (C) was another crop field site with planted *Agave*. The main production for this household was also aguamiel which was harvested on a daily basis. The ecosystem was disturbed, however, not so dramatically as in "El Doctor", the evidence was given by other plant species besides agaves.

Vegetation Structure

Finally, community structure of shrubs and trees structure was estimated by the calculation of the importance value index or IVI, the following parameters were calculated: relative frequency ($_rf$), relative density ($_rd$), and relative cover ($_rc$), in order to obtain the IVI. The calculations were performed with the given formula: IVI = $(_rf + _rd + _rc) \times 100$ (Brower *et al.* 1988).

Description of the Vegetation

Woody flora at the Sierra of "El Doctor" basically consists of *Pinus cembroides*, *Quercus greggii*, *Juniperus flaccida*, and *J. monosperma*. Other forest species include: *Cupressus lusitanica* sp., *Opuntia robusta*, *Opuntia* sp., and *Yucca filifera* sp. Tree cover of the previous species was determined through the IVI and canopy diameter.

Basal Area

Vegetation density of the forest woody species at the study site was determined by the basal area (BA). Where *D* indicates a tree's diameter.

Ordination Analysis

A detrended correspondence analysis (DECORANA) was conducted with ordination purposes for the vegetation structure (obtained from the species IVI) and management scenarios (plots) (Gauch 1982). DECORANA is an eigen-analysis where the reciprocal average is estimated for gradient averages from one dimension, and avoids data distortions with an arch enlargement in the second axis, while the samples were evenly distributed in the first axis. PC Ord 6© software was utilized for DECORANA analysis with a reestablished scale by equalizing the variance weight and taxa scores through the axis segments (Holland 2008; Peck 2010). The interpretation for this analysis was based on the axes and their number of segments corresponding to environmental responses and species interactions (Oksanen 2010).

Size Structure of Agave species

A histogram of frequencies was performed based on some data from the spatial distribution analysis, such as the size from every *Agave* species, subspecies, and varieties. The utilized software was SigmaPlot (2001). The purpose of this analysis was to recognize the possible relationships among frequencies and the plants' size (height) (Carmona-Lara *et al.* 2008). The calculated data was obtained from every plot in the study, where every ramet and stem plant was located.

A histogram is a bar graph representation of data counting who belong to specific ranges. SigmaPlot software generated the frequency data, by specifying the class number or interval. Thus, SigmaPlot originated five classes of frequencies from the *Agave* species given data. Registered data were from 1-330 cm size height of all individuals. The program divided each class into the following classes: 1) 0-66 cm, 2) 67-132 cm, 3) 133-198 cm, 4) 199-264 cm, and 5) 265-330 cm. The range from every interval was identical; total range covered since the minimum to maximum data. The bars number was equal to the number of classes, five in this case. The *x* axis show data frequency, while *y* axis presents the classes in which total data was divided.

Spatial distribution analysis

The spatial distribution for the target and associated species were determined by 900 m^2 quadrats; each plot was subdivided in 100 plots of 3×3 m^2. Trees and shrubs in each plot were identified and calculated; for each *Agave* individual total height and diameter was determined; for the remaining trees and shrubs, their heights and two canopy diameters were recorded.

SADIE technique was utilized in order to determine the spatial distribution and associations of agaves with woody flora. Comparisons were made among the natural area with those under *in situ* and *ex situ* management. SADIE comprises a technique of presence/absence of individuals in a population ("Red-Blue Plots") quantifying the spatial pattern for data in two dimensions obtaining aggregation indices compared to random and uniform simulated patterns (Perry *et al*. 1999; Solís-Gracia & Suzán Azpiri 2014). For the SADIE analysis were used two software packages: the Sadie Shell version 1.22 (2002) (Conrad 2008) for statistical analysis, and Surfer 8.0 (2002) which arranged the analyzed data in Sadie Shell for the distribution and association maps.

The Sadie Shell software calculates the species spatial distribution with the mean distance (or movements in a grid) of individuals to reach regularity (uniform distribution), and then compared to random runs distances, obtaining an aggregation index (I_a). For every given analysis $I_a > 1$ indicates clustering, $I_a = 1$ randomness, $I_a < 1$ regularity. The associated probability of I_a will be given under the null hypothesis of a random distribution of the species (Perry *et al.* 1999; Zúñiga *et al.* 2005). As for the local association (X), it predicts the probability for two species to be whether: a) associated (>0; P <0.025), b) dissociated (<0; P> 0.975), or c) indifferent (=1) to each other (Perry *et al.* 1999).

Results

Vegetation Structure

The six evaluated plots exhibited low diversity (N = 18 species). The dominant species for the *in situ* management plots were agaves, followed by *Pinus cembroides*

TABLE 1. Importance Value Index (IVI) per Managed Areas of representative woody species from the forest community. These species were assembled in order to compare their abundance and IVI in counterposition to *Agave* species.

Environment	Plot	Life Form	Abundance	IVI
Natural	SM	Tree a) *Juniperus flaccida* b) *Juniperus monosperma* c) *Pinus cembroides* d) *Quercus greggii* e) *Yucca filifera* sp.	104	101.708
		Shrub *Salvia regla*	13	57.124
		Agave	372	141.167
Natural managed	H1	Tree a) *Juniperus flaccida* b) *Juniperus monosperma* c) *Quercus greggii* d) Rosaceae e) *Yucca filifera* sp.	39	121.904
		Agave	316	178.095
	H2	Tree a) *Cupressus lusitanica* sp. b) *Juniperus flaccida* c) *Quercus greggii* d) Rosaceae e) *Yucca filifera* sp.	61	133.557
		Shrub *Baccharis conferta*	11	29.614
		Agave	196	136.828
	J	Tree a) *Juniperus flaccida* b) *Juniperus monosperma* c) *Pinus cembroides*	57	176.747
		Agave	103	123.252
Crop field	C	Tree a) *Juniperus flaccida* b) *Juniperus monosperma* c) *Quercus greggii* d) Rosaceae e) *Yucca filifera* sp.	39	121.904
		Agave	316	178.095

TABLE 2. Managed areas of woody species are shown with their total basal area calculated in m^2/ha. The basal area was calculated from every plot with woody species, according to every species' diameters.

Area	Plot	Basal area (mm/ha)
Natural	SM	1117.64
	H1	471.76
Natural managed	H2	310.19
	J	1019.33
Crop field	C	135.24

(IVI average 86.6) and with decreasing IVI values for *Q. greggii* (25.8 average for three plots), *Juniperus flacida* (15.0 average for four plots), and *J. monosperma* (42.6 average for two sites) (Table 1).

In the crop fields, agaves were the most abundant species for obvious reasons. At "El Doctor" (D), *Agave* plants were the only detected species, suggesting they were actively selected by farmers. In contrast with Chavarrías (C) *Agave* species were the dominant, but intergraded with *Opuntia robusta* with an IVI = 60, a greater value compared to *A. salmiana* var. *salmiana* (IVI = 27.5) located in the same plot (Table 1).

As in the natural managed areas, inside the forest community the dominant species were agaves and the co-dominant were the tree species; however, in table 1, the community structure showed a greater tree (176.7) IVI in J than the *Agave* (123.3) populations. In Los Hernández (H1), after *A. salmiana* var. *ferox* and *A. salmiana* var. *salmiana*, the next dominant species were *J. monosperma*, *J. flaccida*, and *Q. greggii* respectively. Then, in Los Hernández 2 (H2) after *A. salmiana* var. *salmiana*, *Q. greggii* was the second dominant species in the plot. Finally, at Juárez site (J), the main species was *Pinus cembroides* (IVI = 115.7), followed by *A. salmiana* var. *ferox* (IVI = 80.5) and *J. monosperma* (IVI = 51.7).

In comparison with J, H1 and H2 show a greater abundance for *A. salmiana* var. *salmiana* (H1 = 153.6 IVI, H2 = 136.8 IVI). Both locations owned seven species, while site J had five species. Community structure was similar among the three natural managed sites. H1 and H2 shared five species (71.4% of similarity).

In the natural area (SM) eight species were detected. The dominant species was *A. salmiana* with its ten morphotypes (IVI = 141.2). The following notable species were *P. cembroides* (IVI = 55.6), *Salvia regla* (IVI = 42.6), and *J. monosperma* (IVI = 32.2). The structure for this community was of a greater richness in *Agave* species. Richness in *A. salmiana* morphotypes might imply a greater genetic flow and a possible hydration process.

Basal Area

According to data (Table 2), the natural area has the largest tree species basal area (BA = 1117.64 m^2/ha). While, J a natural managed plot (BA = 1019.33 m^2/ha) followed the natural site. The smallest tree species basal area was detected in the C plot (BA = 135.24 m^2/ha) which corresponds to a crop field.

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PHOTO 3. Flowering plant of *Agave salmiana*.

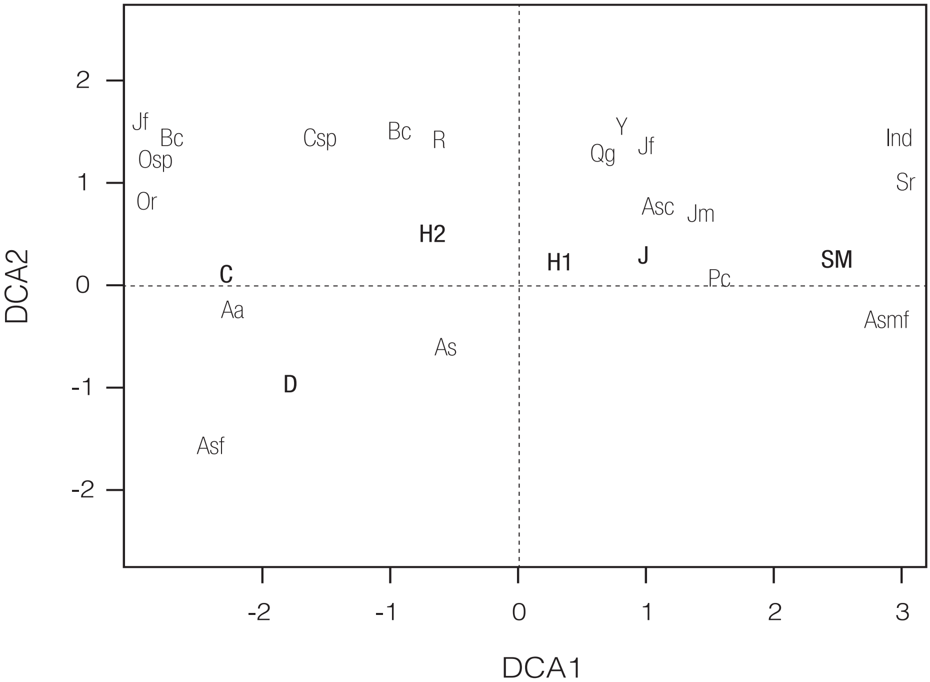

FIGURE 2. Ordination Analysis. DECORANA showed the three management intensities along axis DCA2 (C and D correspond to crop fields; H2, H1, and J belong to natural managed areas; and, SM matches with the natural plot). Close to every site the studied detected species are shown with a determined distribution. The species are the following: Aa *Agave americana*, As *Agave salmiana* var. *salmiana*, Asc *Agave salmiana* ssp. *crassispina*, Asf *Agave salmiana* var. *ferox*, Asmf *Agave salmiana* morphotypes, Bc *Baccharis conferta*, Csp *Cupressus lusitanica*, Ind Indetermined species, Jf *Juniperus flaccida*, Jm *Juniperus monosperma*, Or *Opuntia robusta*, Osp *Opuntia* sp., Qg *Quercus greggii*, Pc *Pinus cembroides*, R Rosaceae, Sr *Salvia regla*, Y *Yucca filifera*.

Ordination Analysis

The first eigenvalue of DECORANA analysis represented 78% of the variance, with lower contributions for the second and third eigenvalues. A gradient from the crop fields, *in situ*, and the natural area, is displayed in the first axis (eigenvalue of figure 2), which revealed the differences among the three management intensities. The crop fields and the natural area showed the highest unlikeness between plots; while natural managed sites were located at the center of the graph. Crop fields had negative values in DCA1 where they associated with representative species; *in situ* managed sites owned negative and positive values in DCA1 (-1 to +2) and acquired several representative species. Hence, species were correlated with the management intensity. Representative species for each management intensity and plot were as it follows: for the crop fields were *A. americana* and *A. salmiana* var. *ferox*; for natural managed zones were *A. salmiana* var. *salmiana*, *A. salmiana* var. *ferox*, *J. monosperma*, and *P. cembroides*; and in the natural area was *A. salmiana* with its ten morphotypes.

Size structure of Agave species

Figure 3 shows the size from the identified *Agave* species per management intensity and per plot. Each histogram represents the structure of each *Agave* population. If the histogram presented a J shape, then the population will be considered as young and growing; if it shows a bell shape, the population will have a tendency to the adult phase and with recruitment; finally, if the graph proves an inverted J shape, thus an adult population and with poor recruitment will appear which will make it difficult to persist in time.

In figure 3b, the natural area shows a greater presence of genets (stem plant and clones), but it has an uneven distribution. The histogram presented a bell shape, which indicates the persistence in medium size classes (2, 3, and 4). This tendency showed a regeneration of the population without reaching an adult phase. Therefore, it was considered a young population with active recruitment.

On the contrary, in Figure 3a, the natural managed plots with *A. salmiana* populations portrayed a greater frequency in the first two classes; which indicated a J shape in the histogram. Presenting a young population with poor adults' presence. In contrast, *A. salmiana* populations had a preference for class two frequency in the crop field C, and for the first class in D; both presented young populations with high recruitment.

For *A. salmiana* var. *ferox* (Fig. 3c), the largest frequency in the natural managed areas (H1, J) was in class 2, while in the crop fields it was in class one. The histogram presented a bell shape in the in situ plots, and a J shape in the crops. However, in both management intensities *A. salmiana* var. *ferox* populations were young. The difference relied in the crop fields where adults prevailed.

On the other hand, *A. americana* populations (Fig. 3d) showed a higher frequency in class one in the natural managed areas and in D crop field, while in the crop C class two was the preferred. *A. americana* populations were young in every plot, and with a high recruitment frequency with adult persistency.

Finally, for *A. salmiana* ssp. *crassispina* populations (Fig. 3e), the frequency preference was for class one. Meaning a young and active recruiting population, with presence of medium and adult size individuals. The observation lead to a tendency of predilection in crop field plot D.

Spatial distribution

The *Agave* species found in the study zone were: *Agave salmiana* represented by four varieties (*A. salmiana* var. *salmiana*, *A. salmiana* ssp. *crassispina*, *A. salmiana* var. *ferox*, and *A.* cf. *salmiana* with ten morphotypes), and *Agave americana* only represented by one subspecies in the area. *A. salmiana* var. *ferox* was the most abundant variety in every site while *A. americana* was the less abundant, but differences in abundance among species were only significant ($P<0.05$) at the C cultivated site, suggesting the landholder´s preference for this species (Table 4).

Agave salmiana varieties showed a tendency for a clustered distribution according to the aggregation index (I_a). However, clustering was not significant at all sites although the cluster distribution was similar among *in situ* and *ex situ* plots (Table 3). In the natural area (SM), *A. salmiana* morphotypes had a tendency for a clustered and patchy distribution. At the natural managed area (J), *A. salmiana* also had the tendency for clustered distribution.

A. salmiana var. *ferox* was the most abundant plant at the *in situ* plots, compared to other *Agave* species, having a clustered distribution too (Fig. 1c). *Agave*

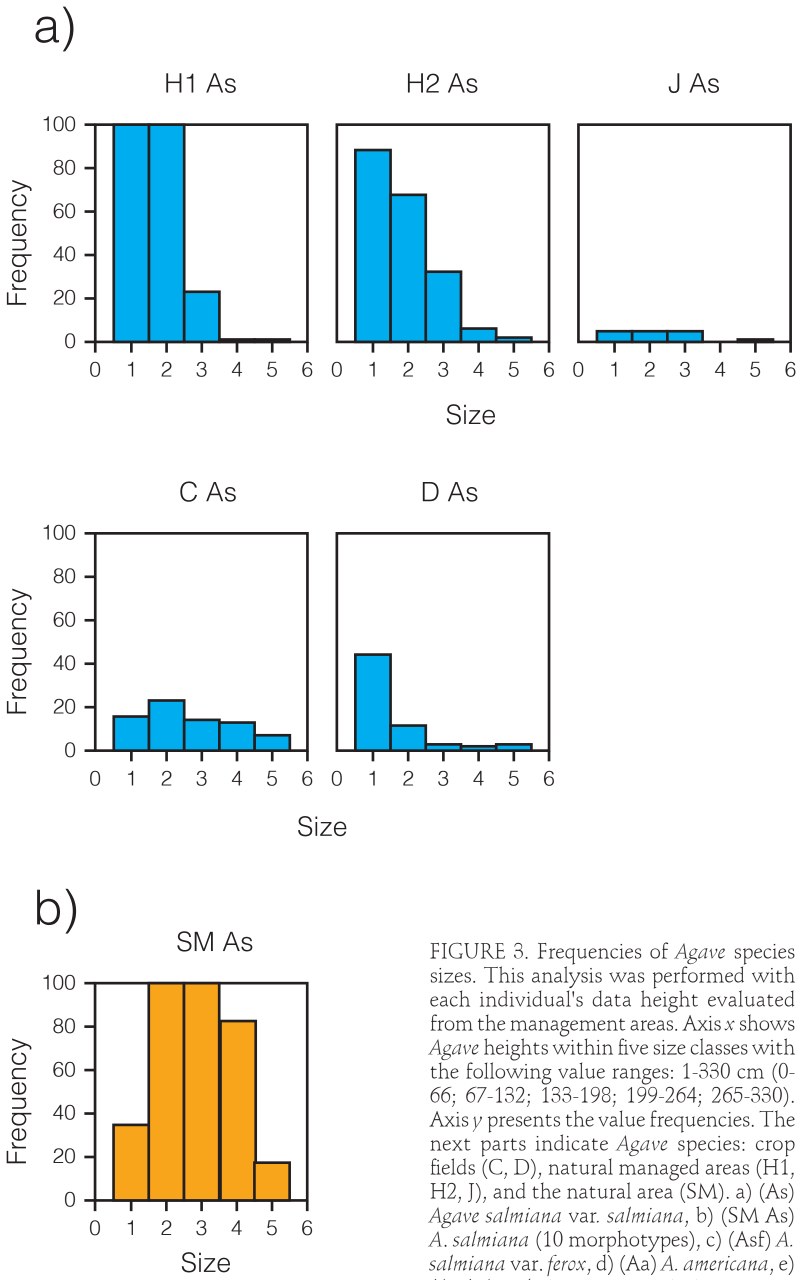

FIGURE 3. Frequencies of *Agave* species sizes. This analysis was performed with each individual's data height evaluated from the management areas. Axis *x* shows *Agave* heights within five size classes with the following value ranges: 1-330 cm (0-66; 67-132; 133-198; 199-264; 265-330). Axis *y* presents the value frequencies. The next parts indicate *Agave* species: crop fields (C, D), natural managed areas (H1, H2, J), and the natural area (SM). a) (As) *Agave salmiana* var. *salmiana*, b) (SM As) *A. salmiana* (10 morphotypes), c) (Asf) *A. salmiana* var. *ferox*, d) (Aa) *A. americana*, e) (Asc) A. *salmiana* ssp. *crassispina*.

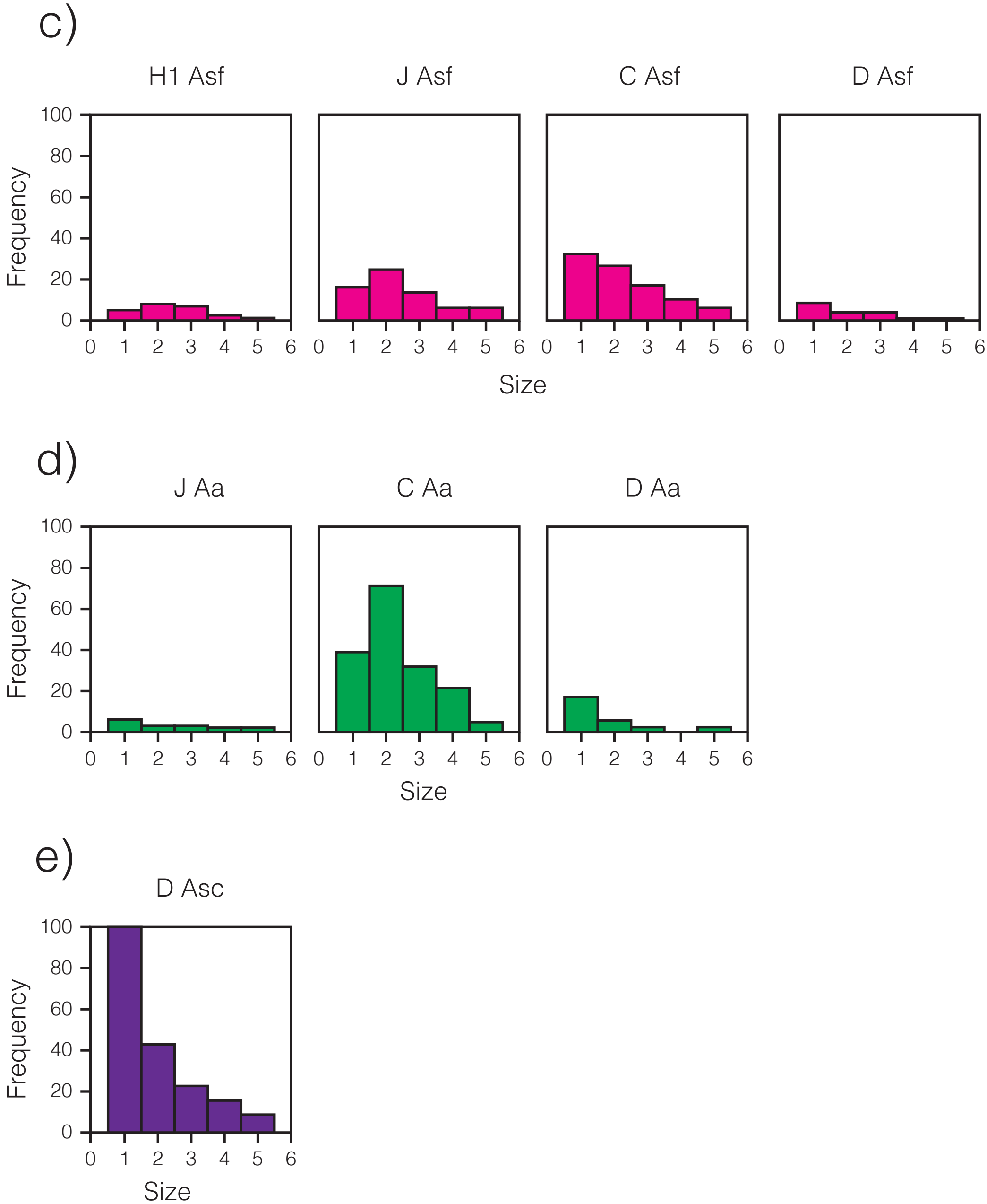
c)
H1 Asf
J Asf
C Asf
D Asf
Frequency
100
80
60
40
20
0
0 1 2 3 4 5 6
Size
d)
J Aa
C Aa
D Aa
Frequency
Size
e)
D Asc
Frequency
Size

TABLE 4. *Agave* species spatial distribution observed in different management areas. The sites are as follow: SM (Sánchez-Maqueda), H1 (Hernández 1), H2 (Hernández 2), J (Los Juárez), C (Chavarrías), D ("El Doctor"). Ia corresponds to the Aggregation Index, while Pa shows the aggregation probability. The figures in bold indicate significant data.

Areas	Site	Species	I_a	P_a
Natural	SM	*Agave salmiana* aff. *ferox*	1.249	0.744
Natural managed	H1	*A. salmiana* var. *salmiana*	0.885	0.7504
		A. salmiana var. *ferox*	1.501	**0.008**
	H2	*A. salmiana* var. *ferox*	1.773	**0.0003**
		A. americana	1.004	0.4234
	J	*A. salmiana* var. *salmiana*	1.192	0.1255
		A. salmiana var. *ferox*	1.268	0.0622
Crop field	C	*A. americana*	1.507	**0.0068**
		A. salmiana var. *salmiana*	0.973	0.5003
		A. salmiana var. *ferox*	1.546	**0.0038**
		A. americana	0.76	0.9694
	D	*A. salmiana* var. *salmiana*	0.885	0.7279
		A. salmiana spp. *crassispina*	1.169	0.1544

americana clustering was significant only ($P>0.05$) at the *ex situ* plot (C) (Table 3). Agaves establish themselves naturally in a patchy form because of their modular architecture (Lott & García-Mendoza 1994; Gentry 1982). Farmers from the study zone maintained a similar architecture in their crop fields resembling natural clusters.

Local Association

The associations (X) among *Agave* species showed they were dissociated or had a tendency for dissociation (Fig. 4d). Actually, the management intensities implied a different disposition in the species from the natural area. The studied plots, as in the crop fields and the natural managed ones differed from the natural site. Figure 4 (a, b, c) presented the dissociation tendency of *Agave* species with *Quercus greggii* or *Pinus cembroides*. Data from X values were negative but not significant ($P > 0.05$). This dissociation tendency was consistent in the natural managed areas, as well as in the natural area plot.

Discussion

Vegetation Structure

The IVI analysis showed agaves as the most abundant and dominant species for the majority of studied plots. *A. salmiana* ssp. *crassispina* and *A. salmiana* var. *ferox* were the most representative varieties in the crop fields and in situ areas. Maguey rosettes had a successful asexual propagation via roots favoring the maintenance of a single genotype in a given surface (Martínez-Salvador *et al.*

2012). Farmer's preferences were kept along crop fields and *in situ* areas. Then, agaves obtained a reproductive advantage from roots propagation (hijuelos). In every examined plot, maguey plants preserved the plant community structure as a result of the presence of mature tree species (Angeles *et al.* 1997).

The forest community analysis showed notable features in terms of structure. The Importance Value Index (IVI) demonstrated how balanced were plant community interactions. Only in one plot, in the natural managed site (J) had *Agave* and *Pinus* a similar IVI value. Other community species did not possess that vegetative reproduction advantage; some examples of those species are: *Quercus*, *Pinus*, and *Juniperus*. Abundance, cover, density, and frequency were greater in solely agaves than in every tree species. Nonetheless, when the addition of all tree species versus all *Agave* species was executed a shift occurred; tree species in the natural area was greater, meaning a denser woody population in the plant community.

As for the land management, the intensity of human intervention showed a gradient in vegetation structure. Plants community for each management scenario changed depending on human´s purposes and land objectives. All crop fields were dominated by *Agave* species populations. In situ areas mainly had *Agave* populations, but one of them (J) had a greater IVI in *O. robusta*. The natural area proved a largest abundance in *Agave* populations, but maintained considerable populations of tree species (*Pinus*, *Quercus*).

Finally, the natural area showed differences in leaf morphology in *A. salmiana*. Specifically, ten leaf shapes were recorded. This information was valuable because it implied a high degree of hybridization. According to Casas (1999), hybrids are likely to be detected in natural managed areas (in situ), but higher abundance of hybrids were recorded for the natural area plot. Further investigation must be considered on this topic.

Ordination

DECORANA analysis explained the relationships among the management intensities, plant community, and artificial (farmer´s) selection. Some ecological attributes of *Agave* plants, such as their architecture, distribution, and abundance prevailed depending on the artificial selection. Trees identity and density could obey to farmer's selective criteria, given by the original's forest density and composition (Guevara *et al.* 1994).

As soon as farmers assumed the role of control in their plots, plants composition and abundance was established according to their particular set of production. Plants individual proximity showed in the analysis the above pattern described for human crop selection. In crop fields, *Agave salmiana* along with its variants or *A. americana* plants were highly promoted; meanwhile, in situ areas had in general a more diverse composition that included *A. salmiana* var. *salmiana*, *A. salmiana* var. *ferox*, and *Pinus cembroides*. The three types of land management intensity showed how farmers shaped and created ecological trends inside the forest community; so, modifications happened in their structure, composition, and plants distribution.

Species relationships were associated with plants composition. Somehow, the verticality of trees and *Agave* plants architecture created an assemblage of species at the Sierra of “El Doctor” forest, which showed a higher diversity in the natural area. By analyzing the level of assemblage

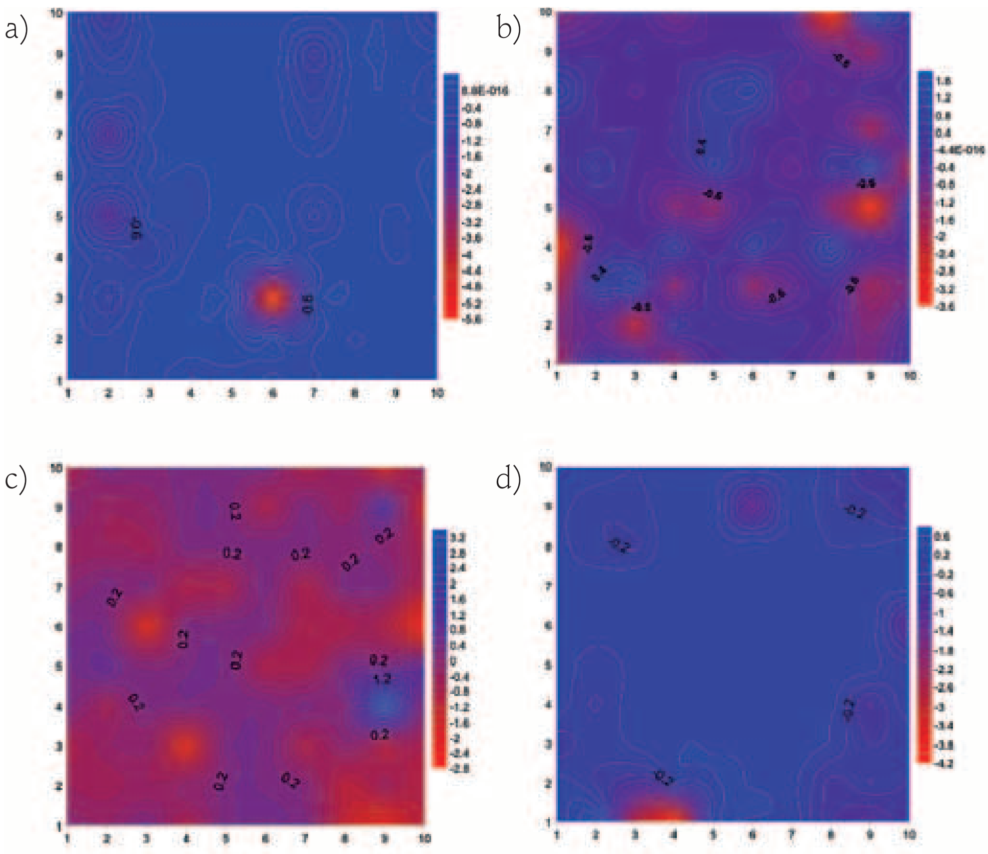

FIGURE 4. Maps of spatial association of *Agave salmiana* with other species. Positive interactions appear in blue tones (local association), and negative in red (dissociations). a): Local association in site **D** between *Agave salmiana* and *Agave salmiana* var. *ferox* (*X*:-0.0870, *P*:0.8385); b): association in site SM between *A. salmiana* var. *ferox* and *Pinus cembroides* (*X*:-0.3025, *P*:0.9993); c): association in site **H2**. Between *A. salmiana-ferox* and *Quercus greggii* (*X*:-0.1440, *P*:9296); d): association in site **J** between *A. salmiana* var. *ferox* and *P. cembroides* (*X*:-0.0612, *P*:0.6763).

between the types of land intensity and plants composition in each plot, it assisted in the clarification of ecological interactions among plants (González-Tagle *et al.* 2006). Relationships of environmental factors and the distribution of species are strictly correlative (Lei 1999). Therefore, species proximity and local management are closely related.

Farmers in the area apparently preserved traditional land management by creating a balance in plant-plant interaction. *Agave* populations enhanced forest structure and productivity by artificial selection. However, tree forest species must predominate if that is their natural case. Artificial selection at the Sierra of "El Doctor" can eliminate those tree species in crop fields.

Hence, future land management procedures should focus on these studies as a reference in developing conservation and management programs in developing countries by the establishment of long-term plots and having experimental approaches at ecosystem and plot levels.


Abisaí Josué García Mendoza

PHOTO 4. Adult plants of *Agave mapisaga.*

Size Structure of Agave species

Asexual reproduction generates a great amount of individuals in early stages at a short period of time. This affirmation happened to the studied populations of *Agave* in la Sierra of "El Doctor"; the frequency histograms proved it. In this manner, they guarantee their survival under adverse conditions, by keeping them closer to the stem plant in juvenile stages (Infante *et al.* 2003).

Then, *Agave* populations' sizes depended on the management intensity. The relationship among the natural area, the natural managed areas, and the crop fields was similar because: a) in the natural plot there was a larger genets presence and a young, recruiting population of *A. salmiana* and its morphotypes; b) in the natural managed areas, every *Agave* showed a tendency for young populations and recruitment; c) as for the crop fields, *Agave* had young, with recruitment populations too; the exception was *A. americana* in C, which was a stable population.

Eight out of the nine examined populations of *Agave* were young and active in recruitment. The sole different population was a stable one, located in the crop field C, which had the largest *A. americana* population. Hence, the human intervention in the studied plots might function properly in the natural managed areas, nonetheless, in the crop fields the monoculture extraction could lead towards a negative effect in agaves genetic and morphological diversity.

Spatial Distribution

Agave distribution

Recent studies, supports clustered *Agave* species distribution (Gentry 1982; Arizaga & Ezcurra 2002; Martínez-Salvador *et al.* 2012). The patchy and highly aggregated distribution in *A. macroacantha* and *A. salmiana* is a response to the asexually reproduced propagules by the maguey plants

(Martínez-Salvador *et al.* 2012; Arizaga & Ezcurra 2002).

Agave salmiana var. *salmiana* produced important amounts of root propagules, which conforms its main reproductive strategy; 98% of parental plants in *A. salmiana* var. *salmiana* invested in vegetative propagation via roots, instead of sexual reproduction (Martínez-Salvador *et al.* 2012). In the examined plots other *Agave* species exhibited mainly the asexual reproductive mechanism via root propagules ("hijuelos"), yet there was not performed an analysis for ramet - parent plant relationship. Further research should focus on clumps (ramets) and how *Agave* stem plants are interrelated.

For this study, the *Agave* variety with greatest and highest abundances was *Agave salmiana* var. *ferox*, which was also the fastest in sap (aguamiel) production (Gentry 1982). This implied a possible economic and dietary benefit to the landholders (Parsons and Parsons, 1990; Goncalves de Lima 1978). Martínez-Salvador *et al.* (2012) reported similar conditions for *A. salmiana* ssp. *crassispina*. Gentry (1982) identified *A. salmiana* and *A. americana* as the main species for pulque production who are mainly located in crop fields and home gardens. On the contrary, *A. salmiana* ssp. *crassispina* and *A. salmiana* var. *ferox* prevailed as presumably wild and cultivated plants, this given by the plot they were found.

Therefore, plant spatial distribution was the result of complex interactions among farmers, plants community, and the level of intervention or management in natural or human transformed environments (Schmitz *et al.* 2007). Wild maguey plants and associated species resulted in a species gradient in richness and ecological intricacies within areas of larger richness and diversity in the natural plant community from the crop fields to the natural area.

Aggregation Index (I_a) and Local Associations
Local association analysis was conducted in pairs of *Agave* species and with other elements from the plant community. Within the area, there were only detected tendencies toward dissociations, without significant positive or negative associations, implying lower or minimum competition for nutrients or space (Maestre 2002).

Agaves spatial disposition was patchy; maguey rosettes grew in modules which are common for this species. In contrast, pines, oaks, and juniper trees developed vertically who reached greater heights and narrower diameter's architecture (Angeles *et al.* 1997); thus, suggesting a shift in the use of space and nutrients, resulting in a tendency for dissociation among *Agave* species and/ or *Pinus*, *Quercus*, or *Juniperus* trees. Each maguey plant species owned a certain sap flavor, sap abundance, and maguey maturity which made them more or less desirable for farmers that induce certain spatial distribution (Caiceros *et al.* 2010).

Conclusions

The *Agave* populations located at the Sierra of "El Doctor" exhibited distinct spatial conditions, responding to artificial selection. Farmers preserved *Agave* populations' distribution as patches, perpetuated a specific genotype of selected "hijuelos" (clones), and depleted forest tree species where they settled their crop fields.

Tendencies to competition between *Agave* and tree species were detected. Also, relationships among community plants and human intervention was confirmed. Plants composition in these forest plots changed depending on human's intervention, where agaves played a key role in the assemblage of the forest community.

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Reseña del libro
Peyote: History, Tradition, Politics, and Conservation

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Compilación editada por Beatriz Caiuby Labate y Clancy Cavnar, 2016.
25 páginas introductorias+280 pp.

Búrquez Alberto[1]


Alberto Búrquez

FOTO 1. Individuo adulto de *Lophophora williamsii* en floración.

Por sus propiedades psicoactivas, el peyote (*Lophophora williamsii*), una cactácea endémica del Desierto Chihuahuense y casi endémica de los confines del Megaméxico 1 de Rzedowski (1991), ha tenido un papel central en el desarrollo social y religioso de la mayoría de las culturas indígenas de Mesoamérica y Aridoamérica (Fotos 1 y 3). Más recientemente, ha jugado un papel central en las culturas del Desierto de la Gran Cuenca y las Grandes Planicies en los Estados Unidos y Canadá. Sin embargo, en el actual esquema de desarrollo económico, en las políticas relacionadas con la conservación y en las formas de utilización de este recurso –importante en términos de diversidad biológica y de patrimonio biocultural– se ha cultivado un

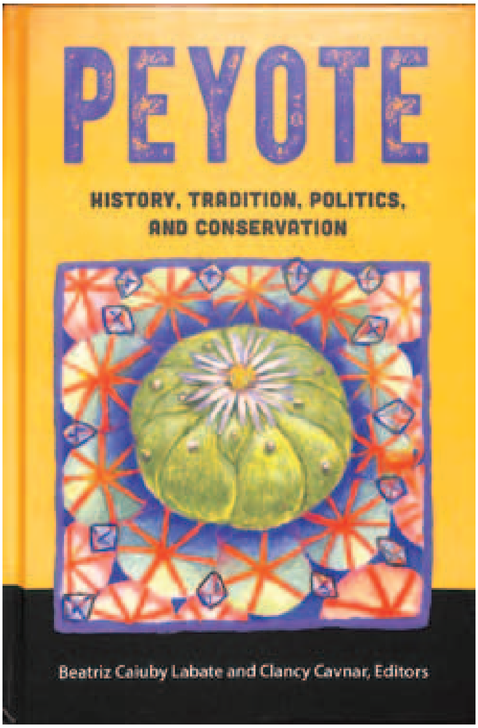

FOTO 2. Portada del libro *Peyote: History, tradition, politics and conservation*.

[1] Laboratorio de Ecología de Zonas Áridas y Semiáridas, Instituto de Ecología, Campus Hermosillo, Universidad Nacional Autónoma de México, Apdo. Postal 1354, 83000 Hermosillo, Sonora
*Correo electrónico: montijo@unam.mx

Indice del libro *Peyote: History, tradition, politics and conservation*.

Mariana Rojas Aréchiga

FOTO 3. Plantas adultas de *Lophophora williamsii* en Real de Catorce, San Luis Potosí.

modelo legalista, esencialmente de carácter punitivo que ha probado ser poco efectivo y se ha dejado de lado la conservación del hábitat y la preservación de prácticas bioculturales ancestrales.

En este libro (Foto 2), se exploran con gran profundidad los conflictos derivados del uso del peyote en el mundo prehispánico y también en las experiencias neo chamanísticas del siglo XXI. Se describen los aspectos relacionados con la distribución y abundancia de esta cactácea y también el marco legal actual relacionado con su posesión y consumo en Canadá, los Estados Unidos de América y México. Asimismo, se aborda la problemática asociada a la recolecta de plantas silvestres, el posible cultivo para disminuir la presión sobre las poblaciones silvestres tanto con propósitos rituales, como para el uso recreativo, y se discute el impacto ecológico, económico y social en los centros de recolecta ancestral y en regiones donde históricamente no existía cosecha. Finalmente, se analiza, desde diferentes ópticas la importancia del uso sacramental y religioso del peyote y las consecuencias jurídicas asociadas con las libertades individuales que van mucho más allá que la propia libertad de culto e inciden transversalmente en el marco legal asociado con los derechos humanos.

En el capítulo introductorio, las editoras de este excelente compendio nos presentan una panorámica sobre los usos pasados y presentes del peyote y proyectan escenarios futuros sobre la utilidad, aprovechamiento y conservación de este recurso. A la vez, nos ofrecen una breve semblanza de cada uno de los 12 capítulos. Beatriz Caiuby Labate, es ampliamente reconocida por sus trabajos sobre el uso ritual y terapéutico de la ayahuasca en el Brasil contemporáneo, mientras que Clancy Cavnar, una psicóloga clínica estrechamente asociada a Caiuby Labate, ha estudiado los aspectos terapéuticos y rituales del uso de la ayahuasca con un énfasis en la identidad de género.

La experiencia previa de las editoras estudiando la ayahuasca en Brasil, les permitió aterrizar un libro balanceado que brinda una visión panorámica que combina los campos de la antropología, sociología, ecología, estudios políticos, economía, religión y jurisprudencia en un volumen pleno de información. Por sus líneas de investigación, las editoras heredan la tradición de Richard Evans Schultes, en particular su hallazgo sobre el uso de la ayahuasca (la liana *Banisteriopsis caapi*, en combinación con extractos de otras plantas, especialmente de *Psicotria viridis*) usada, al igual que el peyote, con motivos sacramentales entre los indígenas, en este caso, de la Amazonia. Como bien anotan las editoras en el capítulo introductorio, este compendio resume la extraordinaria resistencia social en torno a la libertad sobre el uso religioso, terapéutico y recreativo de este pequeño cactus y las consecuencias de los esfuerzos por perseguir y controlar a los usuarios, por un lado, y de exterminar a la planta por el otro, desde la época colonial. En muchos sentidos, la resistencia, llevada a cabo por pequeños grupos, cambió la naturaleza de los derechos religiosos en los Estados Unidos de América y como consecuencia, ha influido en las decisiones globales sobre el control y la regulación del uso de esta planta. Asombrosamente, los derechos religiosos obtenidos por los peyotistas, ahora representan un bastión de las causas sociales que abogan, por ejemplo, por los derechos de las minorías de género mostrando así el intrincado tejido que une al mundo natural y social.

Este libro, es un bien logrado intento multidisciplinario que ofrece al lector una

FOTO 4. Peyotes colectados ("Peyote plants on wooden board, San Andrés, Jalisco, Mexico, 1895," AMNH Digital Special Collections, accessed June 28, 2017, http://lbry-web-007.amnh.org/digital/index.php/items/show/27157)

Fotografía de Carl Lumholz, Coloreada por A. Búrquez

gama de opiniones desde muy diferentes perspectivas hacia el mismo objeto de estudio: el peyote. En un formato compacto y a través de 12 capítulos, 18 autores exploran las diferentes vertientes relacionadas con la ecología y utilización de este recurso. La presentación del libro, a cargo de James Bauml y Stacey Schaefer, conduce al lector por un breve viaje sobre la relevancia del uso tradicional del peyote y también sobre el impacto ecológico y social de su utilización. Se transita desde el mundo de los huicholes (wixaritari) y el de Amada Cárdenas, la famosa proveedora de peyote para la Iglesia Nativa Americana, hasta el uso psicodélico de los no-indígenas a partir de los años cincuenta y la reciente emergencia del neo chamanismo que usa plantas y animales enteogénicos como vínculo con el mundo metafísico. Todos los capítulos están bien estructurados y aportan ideas innovadoras al conocimiento del complejo escenario biológico, social, jurídico y religioso que representa el consumo del peyote (Foto 4).

La relación de los capítulos es muy diversa. Cada capítulo representa una opinión independiente con estilo y contenido muy distinto. Su lectura, permite al lector ir desde los aspectos puramente botánicos hasta los históricos y sociales. Lo mismo aplica al nivel de detalle de las diferentes contribuciones: algunas de orden general, mientras que otras realizan un angosto análisis de problemáticas particulares. Un referente que apenas se cita en el capitulado, pero que es omnipresente, es el trabajo de Richard Evans Schultes de 1938. Schultes, menciona ya en ese entonces, que los antropólogos llevan ya más de 50 años estudiando al peyote. Ochenta años después, esta compilación aborda una realidad muy lejana del academicismo de la primera mitad del siglo XX e incursiona a profundidad en disciplinas que Schultes y sus colegas quizá nunca habrían pensado resultarían centrales para el uso actual de los enteógenos.

Los trabajos reunidos en este libro pueden separarse en cuatro secciones bien diferenciadas, aunque complementarias. En la primera, se establece el entorno ecológico y se esboza apenas el trasfondo social y religioso. La segunda sección incluye trabajos sobre el cambio en la percepción del uso del peyote durante la colonia y después la asimilación de conceptos cristianos, un tema que Basset retoma en el capítulo 10 al abordar el conflicto entre el turismo y los aspectos religiosos. En la tercera sección,

FOTO 5. Chamanes huicholes ("Five Huichol shamans, Mexico, 1890-1898," AMNH Digital Special Collections, accessed June 28, 2017, http://lbry-web-007.amnh.org/digital/index.php/items/show/24686)

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debido a la inclusión del peyote dentro de las drogas controladas por el estado, se tratan los asuntos relacionados con el marco legal. Finalmente, la obra cierra con las consideraciones de los editores, Beatriz Caiuby-Labate y Kevin Feeney, en el capítulo 11 y de Mauricio Guzmán Chávez en el Capítulo 12, que sintetizan y redondean el contenido del libro a la luz del conflicto entre la aplicación de leyes pobremente construidas y el legado cultural y religioso del México profundo.

Los trabajos en el capítulo 1 de Keeper Trout y Martin Terry sobre los jardines de peyote del río Grande (en México, río Bravo) en Texas y en el capítulo 2 de Mariana Rojas-Aréchiga y Joel Flores sobre la ecología y ecofisiología de este cactus mágico, nos ubican en el plano biológico. El primero nos lleva a un mundo desaparecido tanto por el desarrollo regional, como por la colecta indiscriminada derivada de una creciente demanda. Los autores nos describen una tierra pródiga con jardines de peyote tan extensos que era imposible no pisarlos al caminar y cierran con diversas especulaciones, algunas a mi ver muy aventuradas, sobre la distribución y ecología del peyote. Más balanceado es el capítulo de Rojas-Aréchiga y Flores que nos ofrece un resumen del estado del arte del conocimiento de la ecología del peyote. Los autores marcan bien las lagunas de información y destacan el fragmentario conocimiento de las poblaciones naturales que apenas han sido estudiadas en unas cuantas localidades de San Luis Potosí y de Coahuila. Al igual que en el capítulo precedente, señalan el marcado descenso numérico de las poblaciones mexicanas debido al cambio de uso del suelo, el sobrepastoreo y la recolecta indiscriminada.

La narrativa cambia de ámbito en el capítulo 3 que en voz de Alexander Dawson resume el complicado tránsito del peyote en el imaginario popular y la creciente satanización a la que es sometido su uso desde el periodo colonial. Un periodo histórico en el que se establece la diferencia entre lo indígena, lo mestizo y lo criollo en clases que aún persisten casi inalteradas. El peyote (al igual que otras plantas), de acuerdo a Dawson "*…está inextricablemente ligado al indigenismo y marca una variedad de casos: de atraso, de espiritualidad orientalista, o de sanación holística… enraizadas en la experiencia indígena…*" Desde la colonia, el peyote y otras plantas enteogénicas polarizaron la discusión religiosa demonizando las prácticas indígenas y reafirmando el cristianismo como la verdadera fe. Este tema es retomado por Varun Soni en el capítulo 4 donde contrasta lo que él llama la "paradoja de la asimilación" para explicar el surgimiento de la Iglesia Nativa Americana (NAC). Esta paradoja, explica el papel del idioma inglés como *lingua franca* que brinda estructura a los grupos indígenas de los Estados Unidos, y del sincretismo religioso utilizado por algunos de estos grupos indígenas para proponer la creación de la NAC; una iglesia que tiene como eje central el consumo sacramental del peyote. En México, el idioma español actuó también como enlace entre grupos indígenas que hablaban otras lenguas; un papel que sigue activamente desempeñando. Asimismo, al igual que con los grupos indígenas de los Estados Unidos, en México el sincretismo religioso se llevó a cabo a través de la incorporación de una delgada costra contextual cristiana a las prácticas indígenas ancestrales. Una estrategia de sobrevivencia que trasladó figuras como las de moros y cristianos a las celebraciones públicas indígenas, pero qué en el fondo, sólo para mencionar unos casos, mantuvo la peregrinación a Wirikuta, la Danza del Venado y el consumo de hongos en Huautla. En este sentido, en el capítulo 7, Bob Prue, quien se reconoce como indígena Sioux de Dakota del Sur, retoma la idea de la opresión como agente de cambio y ofrece sus reflexiones acerca del significado de la religión con raíces indígenas, de la peregrinación como ritual unificador y del consumo sagrado del peyote como elemento central de muchas culturas indígenas norteamericanas actuales. Prue concluye, después de discutir la notable ausencia de autoridades centrales en la NAC, que es urgente la regulación del peyote por su papel central en la NAC, incluyendo el cultivo como una forma de conservación del sacramento y la exclusión de la agencia de control de drogas de los Estados Unidos en los marcos regulatorios.

Así como Dawson, Soni y Prue representan una progresión temporal en la percepción social del uso del peyote, cuyo común denominador es la estigmatización de los usuarios del peyote, en el capítulo 10, Vincent Basset nos introduce a la reciente revalorización del uso de los enteógenos en la que …*el chamanismo pasa de la máxima otredad como religión del demonio, a la casi perfecta identidad de símbolo cultural, o como una nueva forma de espiritualidad o "terapia de grupo" en el mundo occidental*. Esto sucede gracias al floreciente turismo de *New Age* que tiene una de sus expresiones en el llamado neo-chamanismo y que se inserta en la utópica vuelta al mundo natural que se asocia con una forma romántica de *ecología*. El neo-chamanismo resulta un producto natural de la psicodelia de la segunda mitad del siglo XX y como narra Erika Dyck en el capítulo 8, el peyote es uno de los elementos centrales de la cultura psicodélica. Aun cuando figuras como Jean-Paul Sartre habían tomado mescalina a fines de los años veinte y Aldous Huxley escribiría su famoso ensayo *Las Puertas de la Percepción* en 1954, no fue sino hasta los años cincuenta cuando personalidades como Albert Hofmann, Aldous Huxley, Humphry Osmond y Timothy Leary hicieron públicos los efectos de los enteógenos que Humphry Osmond después llamaría psicodélicos. Es fascinante la narrativa de como Ernest Nicotine, un curandero hijo del jefe de la banda del Faisán Rojo de Saskatchewan, reconoció la relevancia de apoyarse en el gremio científico y convenció a importantes científicos de la época a experimentar y en algunos casos a probar en sí mismos los efectos del peyote. La estrategia de Nicotine, basada en la búsqueda del respaldo científico, fue decisiva para apoyar a la NAC de Canadá en sus batallas legales para obtener el reconocimiento gubernamental.

La protección legal del uso del peyote y la conservación y derechos indígenas en los Estados Unidos, se discuten a profundidad en los capítulos 5 de Forren y 6 de Feeney. Ambos autores destacan la importancia de la jurisprudencia en establecer la legalidad de la NAC. Kevin Feeney provee datos estadísticos relacionados con la recolecta y comercialización, el tamaño y la demanda creciente de botones de peyote, y sugiere medios para disminuir las presiones sobre las poblaciones silvestres, mientras que John Forren y también Varun Suni en el capítulo 4, discuten la saga de la NAC que impulsó el uso del peyote como sacramento, una saga que culmina con resoluciones de la Suprema Corte de Justicia de Estados Unidos, pero que no acaba pues su consumo y transporte es aun sujeto de penas federales. Los capítulos 9, 11 y 12 son esencialmente mexicanos. Maria Benciolini y Arturo Gutiérrez del Ángel contrastan la complejidad entre el mundo religioso de los grupos indígenas cora y huichol (Foto 5). Los huicholes, dicen los autores, tienen una relación "solar" con el peyote, mientras que, para los coras, la asociación es velada y "nocturna". Los autores, nos proveen de una narrativa con datos de asombroso detalle e historias sorprendentes de intenso contenido onírico y sexual, como la asimilación en el imaginario huichol de un Jesucristo edípico que es acusado por su propia madre ante los judíos.

Los dos capítulos que cierran este compendio pueden bien englobarse en lo que Caiuby Labate y Feeney llaman las paradojas de la regulación. El castigo por la posesión y consumo del peyote es enorme. Basta poseer una cantidad insignificante de 0.015 mg de peyote, para recibir una pena entre 4 y 7 años de cárcel. La extracción y transporte de plantas conlleva una pena entre 1 y 9 años de cárcel. Sin embargo, también se le considera –como Guzmán Chávez muestra– un patrimonio biocultural. En este escenario, es obvio que es necesaria una regulación de un recurso que representa una intersección de intereses de muy diversa índole; desde religiosos y culturales, hasta de conservación de la biodiversidad. También en su capítulo, Guzmán Chávez concluye que es necesaria una revisión del estatus legal del peyote que incluya como elemento central la legalización del uso para todos los segmentos de la sociedad. Una revisión que soporte una política de desarrollo con estrategias de conservación, propagación, comercialización y turismo.

En la actual situación, no sólo se está erosionando el patrimonio biológico a través de la extracción ilegal en las poblaciones silvestres de peyote, sino que se penaliza un modelo biocultural que fue capaz de mantener intacto al desierto; ese bioma sagrado por su diversidad biológica y por sus estrategias para enfrentar la sequía. Un jardín que es casi la mitad de México. Un jardín en el que todos debemos asumir la responsabilidad de asegurar su persistencia.

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Mammillaria nunezii (Britton & Rose) Orcutt

Es una cactácea globosa a cilíndrica, de ápice redondo, hasta 15 cm de altura y entre 6 y 9 cm de diámetro. Tubérculos cónicos de 9 mm de longitud, dispuestos en 13 y 21 series espiraladas, de color verde claro, presenta jugo semilechoso a lechoso con un ligero tinte rosado en cierta época del año. Axilas con lana blanca. Areolas elípticas, presentan lana. Espinas radiales 10 a 22 blancas con terminación basal ligeramente de amarillenta a marrón, rígidas, longitudes de 2 a 7 mm rectas, mostrando un patrón de distribución, las de la parte superior de la areola son más cortas. Espinas centrales de 2 a 4 marrones o amarillentas, oscureciéndose más en la punta, a veces una en forma de gancho, de 4 a 8 mm de longitud. Flores de 9 mm de diámetro, 15 mm de longitud, infundibuliformes, segmentos exteriores del perianto linear-lanceolados, de color castaño rojizo de intensidad variable, más pálido en el borde, segmentos interiores del perianto linear-lanceolados hasta lanceolados, de color rojo intenso hasta rojo magenta; filamentos blanquecinos hacia la base y rosados hacia arriba, anteras amarillo tenue; estilo blanco, lóbulos 5 ó 6 amarillo verdoso. Sus flores diurnas abren 3 días entre 6 y 7 horas. Fruto claviforme de 20 a 23 mm de longitud, 7 mm de diámetro, de color verde blanquecino con tintes rosados hacia el ápice. Semillas encorvado-periformes de 1.2 a 1.4 mm de longitud, hilo lateral, testa foveolada hasta muy ligeramente rugosa, brillante, de color castaño o castaño rojizo (Sánchez-Mejorada 1991, *Las Cactáceas de México*, Vol III; Hunt *et al.* 2006, *The New Cactus Lexicon*). Se encuentra en los estados de Guerrero, Jalisco, México, Michoacán y Morelos (Guzmán *et al.* 2003, *Catálogo de cactáceas mexicanas*).

Ríos-Jiménez Abimael[1], Reynoso-Eras Yurisel[1], Arroyo-Cosultchi G[2]
[1] Instituto Tecnológico de Ciudad Altamirano, Cd Altamirano, Gro.
[2] Universidad Autónoma Metropolitana-Xochimilco, Ciudad de México.
Correo electrónico: gcosultchi@gmail.com