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Original Article

Effect of slope exposure on the structure and diversity of a submontane scrub in Northeast Mexico

Efecto de la exposición de laderas sobre la estructura y diversidad de un matorral submontano en el noreste de México

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ABSTRACT

Slope exposure is one of the environmental factors that influences vegetation characteristics. Although there are studies on this aspect in various types of vegetation, up to now submontane shrublands have not been extensively studied. In this work, the effect of slope exposure on the structure and composition of plant species in a state park in northeastern Mexico where the dominant vegetation is submontane scrub was evaluated. Ten 10 x 10 m exposure sites were sampled: northeast, southwest and northwest. Total height (*h*), basal diameter ($d^{0.10}$) and crown diameter (*k*) were measured for each individual. Our hypotheses were: 1) the northwestern exposure community will have greater basal area, canopy cover, volume, absolute abundance, and specific richness due to higher humidity, 2) each slope will present dissimilarity in species composition. As results, nine families, 17 genera and 17 species of vascular plants were recorded. Fabaceae was the best represented family with six species. The species with the highest importance value index were the endemic shrub *Neopringlea integrifolia* in the northeast exposure (21.52 %) and the exotic tree *Leucaena leucocephala* in the southwest (16.17 %) and northwest (27.16 %) exposures. It is concluded that the plant community of the northwest exposure has a greater basal area, crown cover, volume, absolute abundance and specific richness. However, there was no real difference in the species composition of the three exposures.

Keywords: floristic similarity, importance value, *Leucaena leucocephala*, richness, shrubs.

RESUMEN

La exposición de ladera es uno de los factores ambientales que influye sobre características de la vegetación. Aunque existen trabajos sobre este aspecto en diversos tipos de vegetación, hasta ahora los matorrales submontanos no han sido muy estudiados. En este trabajo se evaluó el efecto de la exposición de las laderas en la estructura y composición de especies de plantas en un parque estatal del noreste de México donde la vegetación dominante es matorral submontano. Se muestrearon 10 sitios de 10 x 10 m en exposición: noreste, suroeste y noroeste. A cada individuo se le midió la altura total (*h*), diámetro basal ($d_{0,10}$) y diámetro de copa (*k*). Nuestras hipótesis fueron: 1) la comunidad de la exposición noroeste tendrá mayor área basal, cobertura de dosel, volumen, abundancia absoluta y riqueza específica debido a la mayor humedad, 2) cada ladera presentará disimilitud en la composición de especies. Como resultados se registraron nueve familias, 17 géneros y 17 especies de plantas vasculares. Fabaceae fue la familia mejor representada con seis especies. Las especies con mayor índice de valor de importancia fueron la arbustiva endémica *Neopringlea integrifolia* en la exposición noreste (21,52 %) y la exótica arbórea *Leucaena leucocephala* en las exposiciones suroeste (16,17 %) y noroeste (27,16 %). Se concluye que la comunidad vegetal de la exposición noroeste tiene mayor área basal, cobertura de copa, volumen, abundancia absoluta y riqueza específica. Sin embargo, no hubo diferencia real en la composición de especies de las tres exposiciones.

Palabras clave: *Leucaena leucocephala*, matorrales, riqueza, similitud florística, valor de importancia.

INTRODUCTION

Structure, diversity and abundance are important ecological attributes to describe plant communities in any region (Alanís-Rodríguez *et al.* 2020). In general terms, the vegetation expresses the environmental conditions of the area where it develops. In this regard, slope exposure features among the various factors influencing the type of plant cover (López-Gómez *et al.* 2012; Albaba 2014). It is known that slope orientation modifies the microclimatic conditions, thus it is possible to have wetter or more xeric vegetation according to the solar radiation received (Sternberg & Shoshany 2001). In fact, this also has a direct effect on the composition of plant species (Zaady *et al.* 2001), as well as their distribution and abundance (Mazzola *et al.* 2008). However, these patterns have not been studied in relation to all vegetation types and species.

In Mexico, works on the effect of exposure on hillside vegetation scrub are relatively scarce and have mostly taken place in xerophilous scrubs. Among these is the work of Del Castillo (2000), who studied the composition and structure of a xerophilous scrub in Zacatecas. Valverde-Padilla (2002) analyzed the changes in abundance, dominance and diversity in the semi-arid Valley of Zapotitlán, Puebla. López-Gómez *et al.* (2012) investigated the effect of slope orientation on the population structure and ecomorphology of the *Neobuxbaumia tetetzo* (F.A.C. Weber ex K. Schum.) Backeb. cactus, also in arid areas of Puebla. Recently, Luis-Martínez *et al.* (2020) studied the topographic and edaphic factors that influence the composition and ecological attributes of the flora of hillside succulents in the Central Valleys region of Oaxaca. Among the xerophilous scrubs are the so-called submontanes, which are very common in the lower areas of the mountain systems of Mexico. In northern Mexico, submontane scrub has been characterized in the northeast region, including Tamaulipas (Mora-Olivo *et al.* 2016) and Nuevo León (Canizales *et al.* 2009; Alanís-Rodríguez *et al.* 2015a). In both cases, the vegetation is threatened by the growth of urban areas despite the fact of being partially within protected natural areas.

Within the metropolitan area of the capital of the state of Nuevo León, there is a small protected area known as the Cerro del Obispado with the category of state public park (PO 2008). At present, this hill is frequently visited by tourists due to the historical character of the place and the view it provides of the city. Until now, this area has only been studied from the floristic point of view, since when the current management program was carried out, a list of species typical of the submontane scrub was released with some elements indicating disturbance (PO 2008).

Therefore, the objective of this work was to evaluate the effect of slope exposure on the structure and species composition of plants in the state public park *Cerro del Obispado*. The hypotheses are 1) that the plant community present in the northwest exposure has higher basal area, canopy coverage, volume, absolute abundance and specific richness due to greater available moisture 2) plant communities of different hillside exposures will present dissimilarity in species composition.

MATERIALS AND METHODS

Study area

The research was carried out in the State Natural Protected Area *Cerro del Obispado* on the top and the three slopes of the hill located in the municipality of Monterrey, Nuevo León (Northeast Mexico). The northwest and southwest slopes are wider and have a gentle slope, while the northwest slope is smaller, has a steeper slope and because it is more protected, it receives less radiation, having more humid conditions. This park, which was declared a Natural Protected Area (ANP) on June 13, 2005, has a total surface area of 18.38 ha and an altitude ranging from 600 to 675 m.a.s.l. Geologically, it has shale outcrops of sedimentary origin, and the dominant soils are lithosols, although there are also calaric regosols. The climate is warm semi-dry with summer rains (Bs1(h')hw), with a temperature that varies between 33 and 9 °C and precipitation from 30 to 475 mm (PO 2008).

Field evaluation

In March 2021, ten 10 x 10 m (100 m^2) sampling sites were randomly established on each exposure: northeast, southwest, and northwest. At the sampling sites, a census of all tree and shrub species greater than 3 cm in basal diameter ($d_{0.10}$m ≥ 3cm) and tall succulents and rosetophile scrub was carried out. Each individual was measured for overall height (*h*) (for calculating the volume m^3 ha^{-1}), basal diameter ($d_{0.10}$) and canopy diameter (*k*). The species were identified by qualified personnel of the Autonomous University of Nuevo León using the guide of Molina-Guerra *et al.* (2019).

Analysis of the information

To determine the number of sampling sites necessary to obtain representative information, a pre-sampling of 7 sites was carried out. With the information collected, the following mathematical model was used (Romahn & Ramírez 2010; Alanís *et al.* 2020), taking into account the volume variable. Here is the formula:

$$n = \frac{t^2 * CV^2}{E_{\%}^2}$$

Where n is the number of sampling sites to be established, t tabulated value of Student's t, CV the coefficient of variation and E the error (20 %). The use of this formula indicated that 10 sampling sites had to be established per exposure.

The average canopy diameter and the canopy and basal areas were calculated using the following formulas (Alanís-Rodríguez *et al.* 2020):

$$\bar{k} = \frac{k_{N-S} + k_{E-O}}{2}$$

$$A = \frac{\pi}{4} * d^2$$

Where is the average diameter of the canopy, k_{N-S} the diameter measured in the north-south direction and k_{E-O} the diameter measured in the east-west direction. In the second formula *A* is the area (canopy or basal), *π a* constant value of 3.1416 and *d* the diameter.

The volume (*V*) of each individual was estimated by the formula:

$$V = g \times h \times CM$$

Where *g* is the assumed circular surface of the basal diameter ($d_{0.10\ m}$), *h* the total height of the individual and *CM* the morphic coefficient, which in the case of Tamaulipan thornscrub is 0.5 (Alanís-Rodríguez *et al.* 2020).

The ecological indicators of abundance (N ha^{-1}), dominance (m^2 ha^{-1}) and frequency were used in order to determine the importance value of the species making up the plant community of each hillside exposure (Magurran 2004). The following equation was used to measure abundance:

$$A_i = \frac{N_i}{S}$$

$$AR_i = \left(\frac{A_i}{\Sigma A_i}\right) * 100$$

Where A_i is the absolute abundance, AR_i is the relative abundance of species *i* with respect to total abundance, N_i is the number of individuals of species *i*, and *S* is the sampling area (ha).

Relative dominance was assessed by:

$$D_i = \frac{Ab_i}{S}$$

$$DR_i = \left(\frac{D_i}{\Sigma D_i}\right) * 100$$

Where D_i is the absolute dominance, DR_i is the relative dominance of species *i* with respect to total dominance, *Ab* the canopy area of species *i* and *S* the sampled area (ha).

The relative frequency was obtained with the following equation:

$$F_i = \frac{P_i}{NS}$$

$$FR_i = \left(\frac{F_i}{\Sigma F_i}\right) * 100$$

Where F_i is the absolute frequency, FR_i is the frequency of species *i* with respect to the total frequency, P_i is the number of sites where species *I* is present and *NS* the total number of sampling sites. The Importance Value Index (*IVI*) is defined as:

$$IVI = \frac{\sum (AR_i, DR_i, FR_i)}{3}$$

To estimate species richness, the Margalef index (D_{Mg}) was used and for alpha diversity the Shannon & Wiener index (*H'*) using the following equations(Magurran 2004):

$$D_{Mg} = \frac{(S-1)}{ln\ N}$$

$$H' = -\sum_{i=1}^{S} p_i * ln\ (p_i)$$

$$p_i = \frac{n_i}{N}$$

Where *S* is the number of species, *N* is the total number of individuals, p_i is the proportional abundance of the species *i* and n_i is the number of individuals of the species *i*.

Statistical analysis

The data analysis for basal area (AB), canopy area (AC) and volumen (Vol) was performed using a one-way ANOVA with which the effect of exposure was evaluated. For the ANOVA, a linear model was fitted with the *lm* function of the stats package in R (R Core Team 2021). When the effect of exposure was significant, a multiple comparison of means was made with the HSD.test function of the agricolae package (de Mendiburu 2020) with Tukey's adjustment (α = 0.05). In the case of AB, AC and Vol, a logarithm was used to transform the data since they did not comply with the normality assumption of the residuals. For the analysis of N, S and H', a generalized linear model was fitted using the *glm* function of the stats package, using a Quasi-Poisson distribution, which is a generalization of the Poisson that considers the overdispersion of variables. When the effect of exposure was significant, a multiple comparison of means was performed using the emmeans package (Lenth 2020) with a Tukey adjustment (α = 0.05).

The similarity of the species composition between the different hillside exposures was determined using the Sörensen similarity index (Magurran 2004), which relates the number of shared species with the arithmetic mean of the species present at all sites. Values of 0 indicate that there is no similarity between the areas, 1 total similarity, values of 0 - 0.25 low similarity, 0.26 - 0.50 moderate, 0.51 - 0.75 high and 0.76 - 1 total similarity (Rarlif 1993). The analysis was carried out using the MVSP 3.12 c program (Kovach 2004).

RESULTS

Considering the three hillside exposures, a total of nine families, 17 genera and 17 species of vascular plants were recorded (Annex 1). The family with the highest representation was Fabaceae with six species. Of the 17 species, 16 are native and one is an introduced species: *Leucaena leucocephala* (Lam.) de Wit.

The species with the highest absolute abundance in the three exposures was the succulent *Opuntia engelmannii* Salm-Dyck ex Engelm. (Table 1), with 500, 470 and 530 individuals ha^{-1} in the northeast, southwest and northwest exposure, respectively. In relation to dominance (canopy area), the species with the highest values were the shrubby *Havardia pallens* (Benth.) Britton & Rose (1,955 m^2 ha^{-1}) in the northwest exposure and the exotic arboreal *Leucaena leucocephala* in southwest (2,898 m^2 has^{-1}) and northwest (10,621 m^2 has^{-1}) exposures. The most common species were shrubby *Neopringlea integrifolia* S. Watson in the northeast exposure (eight of the 10 sites) and the shrubby *Zanthoxylum fagara* Sarg. in the southwest (nine of the 10 sites) and northwest (eight of the 10 sites) exposures.

The species with the highest index of importance values were the shrubby *Neopringlea integrifolia* in the northeast exposure (21.52 %) and the exotic arboreal *Leucaena leucocephala* in the southwest (16.17 %) and northwest (27.16 %) exposures. It is important to mention that the shrubby *Zanthoxylum fagara* presented the second highest value in the southwest (15.17 %) and northwest (12.43 m^2 ha^{-1}) exposures and the third in the northeast (16.33 %).

According to the variance analysis, slope exposure has a significant effect on basal area (F = 11.3, p < 0.001), canopy cover (F = 4.30, p = 0.024) and absolute abundance (X^2 = 7.40, p = 0.024) of vegetation. In all cases, the northwest exposure presented the highest values, in contrast to the northeast exposure which presented the lowest value. The southwest exposure presented intermediate values between the other two exposures (Fig. 1A, 1B, 1D).

Table 1. Absolute (N ha^{-1}) and relative abundance, absolute (m^2 has^{-1}) and relative dominance, relative frequency and value of importance index of species in the three slope exposures. / Abundancia absoluta (N ha^{-1}) y relativa, dominancia absoluta (m^2 ha^{-1}) y relativa, frecuencia relativa e índice de valor de importancia de las especies en las tres exposiciones de ladera.

Species	Northeast (NE)							Southwest (SW)							Northwest (NW)						
	A_a	A_i(%)	D_{to}	$D_{i.}$(%)	F_a	F_i(%)	IVI (%)	A_a	A_i(%)	D_{to}	$D_{i.}$(%)	F_a	F_i(%)	IVI (%)	A_a	A_i(%)	D_{to}	$D_{i.}$(%)	F_a	F_i(%)	IVI (%)
Acacia farnesiana	0	0	0	0	0	0	0	60	2.47	1192	12.04	3	6.12	6.88	110	4.15	320.5	1.62	4	8.7	4.82
Agave lechuguilla	80	4.26	88.5	1.15	1	3.03	2.81	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amyris texana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	240	9.05	2429	12.29	5	10.87	10.74
Cordia boissieri	120	6.38	1333	17.34	2	6.06	9.93	160	6.58	581	5.87	3	6.12	6.19	130	4.9	543	2.75	3	6.52	4.72
Cylindropuntia leptocaulis	110	5.85	173.4	2.26	2	6.06	4.72	100	4.12	39.83	0.4	2	4.08	2.87	170	6.41	172	0.87	2	4.35	3.88
Dasylirion berlandieri	fifty	2.66	33.9	0.44	1	3.03	2.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eysenhardtia texana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	3.77	167.4	0.85	2	4.35	2.99
Forestiera angustifolia	70	3.72	180.5	2.35	2	6.06	4.04	80	3.29	597.4	6.04	3	6.12	5.15	30	1.13	89.46	0.45	1	2.17	1.25
Gochnatia hypoleuca	0	0	0	0	0	0	0	fifty	2.06	16.59	0.17	1	2.04	1.42	0	0	0	0	0	0	0
Havardia pallens	130	6.91	1955	25.44	2	6.06	12.80	40	1.65	374.7	3.79	2	4.08	3.17	210	7.92	2468	12.49	5	10.87	10.43
Leucaena leucocephala	30	1.6	227	2.95	1	3.03	2.53	170	7	2898	29.28	6	12.24	16.17	390	14.71	10621	53.74	6	13.04	27.16
Leucophyllum frutescens	140	7.45	375.4	4.89	2	6.06	6.13	400	16.46	1108	11.19	7	14.29	13.98	240	9.05	472.5	2.39	4	8.7	6.71
Neopringlea integrifolia	370	19.68	1587	20.65	8	24.24	21.52	380	15.64	457.6	4.62	5	10.2	10.15	190	7.17	423.5	2.14	2	4.35	4.55
Opuntia engelmannii	500	26.6	739.6	9.63	5	15.15	17.13	470	19.34	142.8	1.44	5	10.2	10.33	530	twenty	434.1	2.2	4	8.7	10.30
Parkinsonia aculeata	0	0	0	0	0	0	0	30	1.23	1117	11.29	1	2.04	4.85	0	0	0	0	0	0	0
Prosopis glandulosa	0	0	0	0	0	0	0	60	2.47	439.4	4.44	2	4.08	3.66	0	0	0	0	0	0	0
Zanthoxylum fagara	280	14.89	990.3	12.89	7	21.21	16.33	430	17.7	932.8	9.43	9	18.37	15.17	310	11.69	1622	8.21	8	17.39	12.43
Sum	1880	100	7684	100	33	100	100	2430	100	9897	100	49	100	100	2650	100	19762	100	46	100	100

The timber volume in the plant community also presented differences (F = 9.4, p = 0.001). The value of the northeast and southwest exposures were lower and presented statistical equality, while the northeast exposure showed a higher volume (Fig. 1C). Finally, species richness (X^2 15.50, p < 0.001) and Shannon index (X^2 = 7.40, p = 0.024) of the community plant study also showed differences. The values of the southwest and northwest exposures were larger and showed statistical equality, while the values in the northeast exposure were lower (Fig. 1E, 1F).

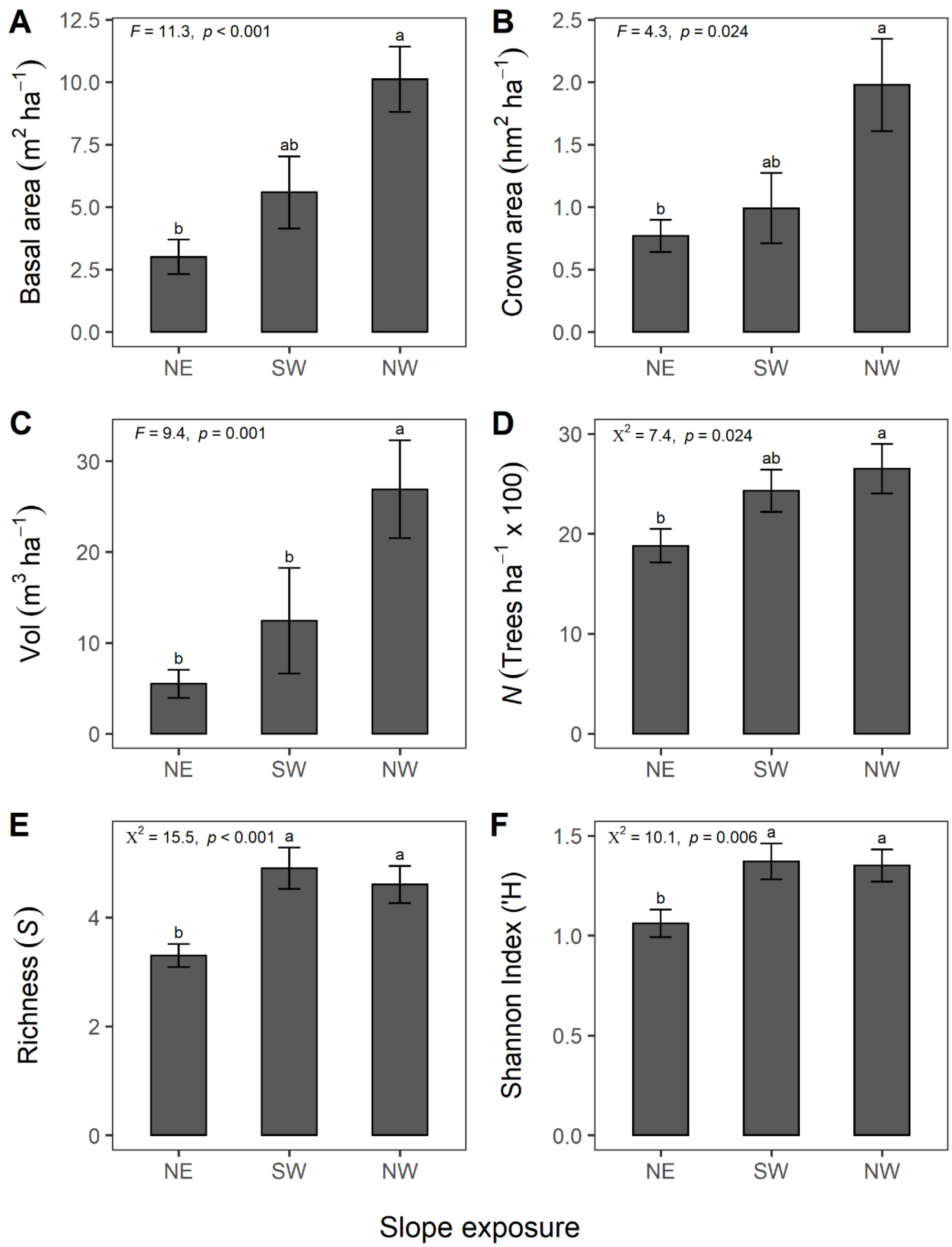

Figure 1. Mean and standard error of basal area (A), canopy cover (B), volume (C), absolute abundance (D), species richness (E) and Shannon index (F) of the three hillside exposures. Bars with the same letters do not present significant differences (P > 0.05). / Promedio y error estándar del área basal (A), cobertura de copa (B), volumen (C), abundancia absoluta (D), riqueza de especies (E) e índice de Shannon (F) de las tres exposiciones de ladera. Barras con letras iguales no presentan diferencias significativas (P > 0,05).

According to the analysis of similarity in the composition of species, the Sörensen index showed that the plant communities of the southwest and northwest exposures present a similarity of 0.80 (80 %), while the north area was separated from the rest. with 0.76 (76 %). According to the classification proposed by Ratlif (1993), the plant communities present in the three hillside exposures present total similarity (Fig. 2).

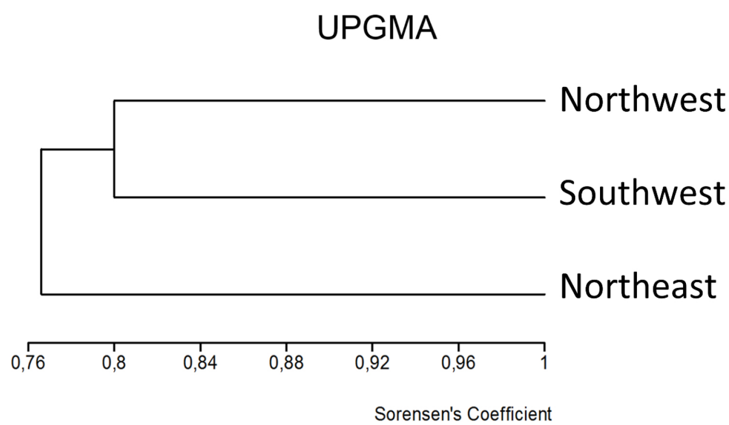

Figure 2. Similarity dendrogram of the Sörensen coefficient between the evaluated plant communities. / Dendrograma de similitud del coeficiente de Sörensen entre las comunidades vegetales evaluadas.

DISCUSSION

The family with the highest number of species was Fabaceae. These results agree with those reported by various authors (Jiménez-Pérez *et al.* 2009; Mora Donjuán *et al.* 2013, Alanís-Rodríguez *et al.* 2018) who found this family to be the most representative of different mature and regenerated plant communities of Tamaulipan thornscrub. González Rodríguez & Cantú Silva (2001), López Hernández *et al.* (2010) and González-Rodríguez *et al.* (2011) mentioned that the importance of this family in Tamaulipan thornscrub is attributable to the wide range of responses that exist in the Fabaceae to support and escape limiting factors, such as ecophysiological responses to water stress, as well as the presence of different requirements for germination (Jurado *et al.* 2006).

Opuntia engelmannii was the species with the highest absolute abundance in the three hillside exposures. This species has been reported as the most abundant shrub in Tamaulipan thornscrub in northern Mexico (Foroughbakhch *et al.* 2013) and also has high absolute abundance in the microphyllous desert scrub and rosetophilic desert scrub of northeastern Mexico (González-Rodríguez *et al.* 2013). As a member of the succulent group, the species is of ecological importance in hillside areas since the environmental conditions and runoff tend to create arid conditions conducive to its establishment (Luis-Martínez *et al.* 2020).

Neopringlea integrifolia was the species with the highest IVI value in the northeast exposure. This species is considered an arboreal characteristic of the submontane scrub and endemic to the Sierra Madre Oriental (Mora-Olivo *et al.* 2016). It has been documented to have a preference for growing on limestone slopes (Calderón de Rzedowski 1996), in addition to being dominant in Tamaulipan thornscrub (Graciano-Ávila *et al.* 2018) and submontane scrub communities (Estrada-Castillón *et al.* 2012). The most frequent species in the southwest and northwest exposures was the shrub *Zanthoxylum fagara*. This species has been documented as one of the most dominant in submontane scrub and the transition area with Tamaulipan thornscrub (Estrada *et al.* 2005; García-Hernández & Jurado 2008; Domínguez *et al.* 2013; Reyna-González*et al.* 2021).

The plant with the highest value in the southwest and northwest esposures was *Leucaena leucocephala*, a non-native species (for this region, in the northeast of Mexico) that is considered among the 100 most harmful invasive alien species worldwide (Lowe *et al.* 2004). In reality, the *Leucaena* species has a natural distribution in southern Mexico (Zárate, 1994; Peralta-Juárez *et al.* 2017). However, its potential for use as a forage plant has meant that it is now located globally in all tropical and subtropical areas where it quickly forms dense populations due to its malezoid behavior (Ramirez*et al.*2000; Ledesma 2002; Campbell *et al.* 2019). *Leucaena leucocephala* has also been documented in the northeast of the country, both in urban riparian communities with disturbances (Mata-Balderas *et al.* 2020; Canizalez-Velázquez *et al.* 2021), experimental plantations (Jurado *et al.* 1998) and urban areas (Leal *et al.* 2018). In this sense, it is advisable to take action to control or eradicate this exotic and invasive species in the state public park *Cerro del Obispado* as it is an area for conservation of natural resources.

The similarity analysis showed a total similarity in the composition of species of the three exposures. This result is due to the fact that of the species present in each exposure (11 in the northeast, 13 in the southeast and 12 in the northwest) nine species are common all three exposures. Although they are the same species, environmental conditions determine their establishment (abundance and species richness) and growth (basal area, canopy cover and volume). A floristic similarity has also been observed in contiguous plant communities in northeastern Mexico such as the semi-thorn, thorny Tamaulipan and submontane scrub, where the shared species are many although the structural parameters may vary due to the ecological conditions present (Alanís-Rodríguez *et al.* 2015b; González-Medrano, 2004). In contrast, our similarity results differ from those of Alanís-Rodríguez *et al* (2012) who evaluated *Pinus-Quercus* plant communities from northeast Mexico with northeast and northwest exposures and registered low-medium similarities (44 %). They also differ from the findings of Reyes-Olivas *et al.* (2008) who evaluated the similarity of the insular vegetation in the coastal desert of Sinaloa, Mexico, evaluating the southeast, southwest and northwest exposures finding medium similarity (46-59 %).

Based on the analysis of variance, it was determined that slope exposure has an effect on basal area, canopy cover, volume, absolute abundance and species richness, the northwest slope showing the highest values. This effect has been documented in different localities, since southern exposures receive a greater amount of solar radiation throughout the year, causing maximum temperatures to increase in relation to north-facing sides (Holland & Steyn 1975; Valverde-Padilla 2002).

CONCLUSIONS

With the results of this research, the first hypothesis proposed is accepted, since the plant community present in the northwest exposure has greater basal area, canopy coverage, volume, absolute abundance and specific richness. On the other hand, the second hypothesis is rejected, since the similarity analysis in the species composition of the three exposures shows total similarity.

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Annex 1. List of species in the study area. / Lista de especies en la zona de estudio.

Species	Common name	Family	Biological form	Origin
Agave lechuguilla Torr.	Lechuguilla	Asparagaceae	Succulent	Native
Dasylirion berlandieri S. Watson	Sotol	Asparagaceae	Succulent	Native
Gochnatia hypoleuca (DC.) A. Gray	Ocotillo	Asteraceae	Shrub	Native
Cordia boissieri A. DC.	Anacahuita	Boraginaceae	Tree	Native
Cylindropuntia leptocaulis (DC.) F.M. Knuth	Tasajillo	Cactaceae	Shrub	Native
Opuntia engelmannii Salm-Dyck ex Engelm.	Nopal	Cactaceae	Shrub	Native
Acacia farnesiana (L.) Willd.	Huizache	Fabaceae	Tree	Native
Eysenhardtia texana Scheele	Vara dulce	Fabaceae	Bush	Native
Havardia pallens (Benth.) Britton & Rose	Tenaza	Fabaceae	Tree	Native
Leucaena leucocephala (Lam.) de Wit	Leucaena	Fabaceae	Tree	Introduced
Parkinsonia aculeata L.	Retama	Fabaceae	Tree	Native
Prosopis glandulosa Torr.	Mezquite	Fabaceae	Tree	Native
Forestiera angustifolia Torr.	Panalero	Oleaceae	Shrub	Native
Amyris texana (Buckley) P. Wilson	Chapotillo	Rutaceae	Shrub	Native
Zanthoxylum fagara (L.) Sarg.	Colima	Rutaceae	Shrub	Native
Neopringlea integrifolia (Hemsl.) S. Watson.	Corvagallina	Salicaceae	Shrub	Native
Leucophyllum frutescens (Berl.) I.M. Johnst.	Cenizo	Scrophulariaceae	Shrub	Native