



Diversidad y estructura de especies arbóreas en localidades rurales de Hualahuises, México

Diversity and structure of tree species in rural localities of Hualahuises, Mexico

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Abstract

In this study, the proportion of native vs. introduced tree species in urban forests of six rural areas of Hualahuises, Nuevo León (Northeast Mexico) was evaluated. For the analysis of variance, the proportions test was used with a confidence level of 0.95 through the `prop.test` command in R. 252 individuals of 32 species distributed in 29 genera and 19 families were recorded. The Fabaceae family was the largest represented with seven species. Of the 32 species, 19 are native (59.37 %) and 13 introduced (40.63 %). Based upon their origin, 77.79 % of the individuals are native and 22.21 % introduced. Regarding their dimensions, the percentage differences are greater: the native ones represent 91.69 % of the basimetric area, 92.36 % of the crown area, 92.22 % of the assumed crown area and 96.78 % of crown volume, while the non-natives present values lower than 9.00 %. At the species level, those with the highest structural values were *Prosopis laevigata* followed by *Vachellia farnesiana* and *Ebenopsis ebano*. The three species are native belonging to the Fabaceae family and together they represent 44.05 % of the abundance and 63.71 % of the Urban Importance Value Index. According to the analysis of variance, the native species turned out to have higher values of richness, basal area, and crown area than the introduced species in the assessed localities.

Key words: Urban trees, basimetric area, green areas, Urban Importance Value Index, *Prosopis laevigata* (Humb. & Bonpl. ex Willd.) M. C. Johnst., species richness.

Resumen

En este estudio se evaluó la proporción de especies arbóreas nativas respecto a las introducidas en bosques urbanos de seis zonas rurales de Hualahuises, Nuevo León (noreste de México). Para el análisis de varianza se utilizó la prueba de proporciones con un nivel de confianza de 0.95 mediante el comando `prop.test` en R. Se registraron 252 individuos de 32 especies distribuidas en 29 géneros y 19 familias. La familia Fabaceae fue la

mejor representada con siete especies. De todos los taxones, 19 son nativos (59.37 %) y 13 introducidos (40.63 %). De acuerdo con su origen, 77.79 % de los individuos son nativos y 22.21 % introducidos. Referente a sus dimensiones, las diferencias porcentuales son mayores: las nativas representan 91.69 % de área basal, 92.36 % de área de copa, 92.22 % de área superficial de la copa y 96.78 % de volumen de copa, mientras que las no nativas presentan valores inferiores a 9.00 %. *Prosopis laevigata*, seguida de *Vachellia farnesiana* y *Ebenopsis ebano* presentaron los valores estructurales más altos. Las tres son nativas pertenecientes a la familia Fabaceae y juntas conforman 44.05 % de la abundancia y 63.71 % del Índice de Valor de Importancia Urbano. Con base en el análisis de varianza, las especies nativas resultaron tener mayores valores de riqueza, área basal y área superficial de copa que las introducidas en las localidades evaluadas.

Palabras clave: Árboles urbanos, área basal, áreas verdes, Índice de Valor de Importancia Urbano, *Prosopis laevigata* (Humb. & Bonpl. ex Willd.) M. C. Johnst., riqueza de especies.

Abstract

In this study, the proportion of native vs. introduced tree species in urban forests of six rural areas of *Hualahuises, Nuevo León* (Northeast Mexico) was evaluated. For the analysis of variance, the proportions test was used with a confidence level of 0.95 through the `prop.test` command in R. 252 individuals of 32 species distributed in 29 genera and 19 families were recorded. The Fabaceae family was the largest represented with seven species. Of the 32 species, 19 are native (59.37 %) and 13 introduced (40.63 %). Based upon their origin, 77.79 % of the individuals are native and 22.21 % introduced. Regarding their dimensions, the percentage differences are greater: the native ones represent 91.69 % of the basimetric area, 92.36 % of the crown area, 92.22 % of the assumed crown area and 96.78 % of crown volume, while the non-natives present values lower than 9.00 %. At the species level, those with the highest structural values were *Prosopis laevigata* followed by *Vachellia farnesiana* and *Ebenopsis ebano*. The three species are native belonging to the Fabaceae family and together they represent 44.05 % of the abundance and 63.71 % of the Urban Importance Value Index. According to the analysis of variance, the native species turned out to have higher values of richness, basal area, and crown area than the introduced species in the assessed localities.

Key words: Urban trees, basimetric area, green areas, Urban Importance Value Index, *Prosopis laevigata* (Humb. & Bonpl. ex Willd.) M. C. Johnst., species richness.

Subject development

Urban forests are important ecosystems that provide numerous environmental services to humans and wildlife (Martínez-Trinidad *et al.*, 2021). Due to its importance, interest has arisen in studying said woodland to learn about some of its ecological aspects. Traditionally, works have focused on the structure and floristic composition of these ecosystems (Martínez-Trinidad *et al.*, 2021), but recently, others have been directed towards the origin of the species (native or introduced), based on the argument that the native flora is more recommendable than the exotic one, because, among other reasons, it can become invasive (Alanís-Rodríguez *et al.*, 2023).

It is still evident that exotic trees are more popular in public parks as shown by studies worldwide (Saavedra-Romero *et al.*, 2019). Particularly, in northeastern Mexico, research has been carried out in urban areas indicating that there is a higher proportion of introduced species and individuals, which have more species richness, basimetric area and crown area than the native ones (Leal *et al.*, 2018; Canizales *et al.*, 2020; Alanís-Rodríguez *et al.*, 2022). However, there is not much information about rural areas in this regard, despite the fact that the use of trees of both origins is increasingly common.

Therefore, the objective of this work was to evaluate the diversity and structure of native and introduced trees of the six most populated rural localities of *Hualahuises*, Mexico. It was based on the hypothesis that the introduced species will record higher values of species richness, Margalef index, Shannon index, basimetric area and crown surface area compared to native species.

The study was carried out in the six rural localities with the largest number of inhabitants in the *Hualahuises* municipality, *Nuevo León* State (Northeast Mexico). The localities have a population between 92 and 253 inhabitants (Secretaría de Economía, 2020). The area belongs to the North Gulf Coastal Plain province and to the *San Fernando-Soto la Marina* hydrological region. It has Vertisol soil and a semi-warm sub-humid climate with summer rains. The rainfall range goes from 700 to 900 mm (INEGI, 2010). Table 1 shows the names of the towns with data on their latitude, longitude and altitude.

Table 1. Name, latitude, longitude and altitude of the assessed localities.

Locality	Latitude	Longitude	Altitude (m)
<i>Magüiras</i>	24°54'51.363" N	99°37'37.916" W	372
<i>Paso de Lajas</i>	24°55'03.202" N	99°38'22.960" W	394

<i>La Laja</i>	24°54'46.960" N	99°41'10.280" W	414
<i>Cinco Señores</i>	24°52'20.967" N	99°37'34.191" W	363
<i>El Pinto</i>	24°54'39.460" N	99°42'38.473" W	431
<i>La Cruz</i>	24°50'21.430" N	99°40'14.463" W	436

In April 2022, a census of urban trees was carried out based on the tree species that were located in public parks, squares and ridges in six rural towns in the *Hualahuises* municipality, *Nuevo León*, Mexico.

The normal diameter ($d_{1.30}$) was determined with a 283D/5m Forestry Suppliers Inc® diameter tape, total height (h) and crown length (L_c) with the manual Haglöf Vertex® III hypsometer, and the crown diameter (k) with a TP50ME 50 m Truper® fiberglass tape. The correct nomenclature of species was based in Tropics (2022). For each species, its abundance, coverage and frequency were determined according to its presence in the sites of interest (Alanís *et al.*, 2020). To evaluate the crown, the surface area and its volume were calculated. With the aforementioned information, the Urban Importance Value Index (*UIVI*) was estimated according to Saavedra-Romero *et al.* (2019).

To test the null hypothesis (H_0) of no difference in species richness, basal area, and crown surface area of native and introduced trees from the six rural locations, the proportions test was used with a confidence level of 0.95 using the command `prop.test` in R (R Core Team, 2021).

The total number of individuals was 252 of 32 species distributed in 29 genera and 19 families for the six rural locations that were evaluated. The Fabaceae family was the largest represented by seven species. Due to their origin, of the 32 taxa, 19 are native (59.37 %) and 13 introduced (40.63 %), 77.79 % of the individuals are native and 22.25 % introduced. Regarding their dimensions, the percentage differences are more pronounced: the native ones represent 91.69 % of the

basimetric area, 92.36 % of crown area, 92.22 % of crown surface area and 96.78 % of crown volume, while the exotic recorded numbers lower than 9.00 %.

At the species level, the most outstanding in structural terms were *Prosopis laevigata* (Humb. & Bonpl. ex Willd.) M. C. Johnst., followed by *Vachellia farnesiana* (L.) Wight & Arn. and *Ebenopsis ebano* (Berland.) Barneby & J. W. Grimes. The three species are native belonging to the Fabaceae family and together they represent 44.05 % of the abundance and 63.71 % of the Urban Importance Value Index (Table 2). The most abundant introduced species and *UIVI* are *Fraxinus americana* L., *Leucaena leucocephala* (Lam.) de Wit and *Cupressus sempervirens* L., adding 18.22 % abundance and 8.93 % of *UIVI*.

Table 2. Abundance, basimetric area, crown surface area, crown volume and Urban Importance Value Index of the species from the six evaluated localities.

Species	Abundance		Basimetric area		Crown surface area		Crown volume		UIVI
	Ab. (N)	Rel. (%)	Ab. (m ²)	Rel. (%)	Ab. (m ²)	Rel. (%)	Ab. (m ³)	Rel. (%)	
<i>Prosopis laevigata</i> (Humb. & Bonpl. ex Willd.) M. C. Johnst.	55	21.83	9.09	46.39	10 735.72	44.21	15 611.53	52.83	34.50
<i>Vachellia farnesiana</i> (L.) Wight & Arn.	38	15.08	4.17	21.29	6 035.78	24.86	8 453.81	28.61	20.23
<i>Ebenopsis ebano</i> (Berland.) Barneby & J. W. Grimes	18	7.14	2.39	12.19	2 461.71	10.14	2 738.36	9.27	8.98
* <i>Fraxinus americana</i> L.	37	14.68	0.71	3.61	1 329.01	5.47	646.31	2.19	6.79
<i>Cordia boissieri</i> A. DC.	32	12.7	0.88	4.51	508.63	2.09	80.00	0.27	5.21
<i>Ehretia anacua</i> (Terán & Berland.) I. M. Johnst.	20	7.94	0.77	3.92	844.18	3.48	330.31	1.12	4.71
<i>Havardia pallens</i> (Benth.) Britton & Rose	10	3.97	0.17	0.85	409.68	1.69	172.85	0.58	2.73
<i>Celtis laevigata</i> Willd.	2	0.79	0.13	0.68	479.73	1.98	848.43	2.87	1.79
<i>Quercus virginiana</i> Mill.	3	1.19	0.07	0.34	210.52	0.87	136.92	0.46	1.56
* <i>Leucaena leucocephala</i> (Lam.) de Wit	5	1.98	0.08	0.43	118.24	0.49	16.17	0.05	1.21
<i>Diospyros texana</i> Scheele	3	1.19	0.04	0.21	130.27	0.54	37.34	0.13	1.07

<i>Celtis pallida</i> Torr.	2	0.79	0.06	0.32	134.11	0.55	74.39	0.25	1.03
* <i>Cupressus sempervirens</i> L.	4	1.59	0.04	0.21	6.48	0.03	0.07	0.0002	0.93
<i>Tecoma stans</i> (L.) Juss. ex Kunth	3	1.19	0.02	0.1	66.04	0.27	11.73	0.04	0.65
<i>Zanthoxylum fagara</i> (L.) Sarg.	2	0.79	0.06	0.32	92.88	0.38	27.03	0.09	0.64
<i>Caesalpinia mexicana</i> A. Gray	2	0.79	0.00	0.02	35.12	0.14	5.22	0.02	0.52
Other species	16	6.40	0.89	4.63	683.76	2.81	361.24	1.20	7.48
Total	252	100	19.59	100	24 281.9	100	29 551.7	100	100

Species ordered according to their Urban Importance Value Index (*UIVI*). The species that presented an individual were grouped into "other species". Ab. = Absolute; Rel. = Relative; * = Introduced species.

Based on the analysis of proportions, it was determined that the native species registered higher values of species richness, Margalef index and Shannon index ($p < 0.001$) than those introduced in four evaluated rural locations, while in the remaining two it was found equality in species richness. Likewise, it was determined that there is a difference between the basimetric area and the surface area of the crown of the native and introduced trees of the evaluated rural localities, since the native species reached higher figures ($p < 0.001$).

In this study, 32 species were recorded, a value slightly lower than the 38 reported by Alanís-Rodríguez *et al.* (2022) in the center of *Hualahuises* municipality, 39 species in the center of *Linares* (Leal *et al.*, 2018) and 39 species on a university campus (Graduate School of Forest Sciences of the Autonomous University of *Nuevo León*) also in the *Linares* municipality (Alanís *et al.*, 2014). This slight decrease in the number of species can be explained by the fact that the other locations gather more exotic species and, therefore, increase the total species richness.

Fabaceae is the family with the largest number of species. This result is similar to those described by Alanís *et al.* (2014), Leal *et al.* (2018), Canizales *et al.* (2020) and Alanís-Rodríguez *et al.* (2022), who conducted their studies in urban forests in

northeastern Mexico. Legumes also have a wide presence in the submontane scrub (Mora-Olivo *et al.*, 2016) and in the Tamaulipan thorny scrub (Jiménez *et al.*, 2013), natural communities that grow in the studied municipality.

According to the comparison of native and introduced species, the results obtained differ from others that evaluate urban trees in the cities of northeastern Mexico; in these cases there is a higher proportion of introduced species and individuals, which have a greater basimetric area and crown surface area than the native ones and therefore, species richness (Alanís *et al.*, 2014; Leal *et al.*, 2018; Canizales *et al.*, 2020; Alanís-Rodríguez *et al.*, 2022). In this study, the native species behaved in the opposite way. This could be explained by the knowledge and use given to species showers in rural locations. Estrada-Castillón *et al.* (2022) mention that in these places the elderly people pass on traditions, ideas and experience in the use of plant species from generation to generation.

At the species level, *Prosopis laevigata* had the highest *UIVI*. This species is considered an important resource for arid and semi-arid zones in Mexico, due to the different uses that it is given such as fodder for cattle, human food in the form of flour, fermented drinks and in pods (Estrada-Castillón *et al.*, 2022). The three species with the most presence and *UIVI* are the native ones, in addition to the previous one, *Vachellia farnesiana* and *Ebenopsis ebano*, which can be proposed for use in reforestation programs in other rural and urban environments.

The proposed hypothesis is rejected, because a good adoption of native tree species is observed in the rural localities of *Hualahuises*, *Nuevo León*, as they had outstanding values of species richness, Margalef index, Shannon index, basimetric area and crown surface area than the exotic species in the localities that were assessed.

The native species show an outstanding size compared to the exotic, since they surpass them in 90 % in all the variables (91.69 % of basimetric area, 92.36 % of crown area, 92.22 % of crown surface area and 96.78 % of crown volume).

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Conflict of interests

The authors declare that they have no conflict of interest with the publication of this work.

Contribution by author

Víctor Manuel Molina Guerra and Eduardo Alanís Rodríguez: Conception of the research, generation and revision of the database and writing of the manuscript; Arturo Mora Olivo: interpretation of results and writing of the Introduction; Ernesto A. Rubio Camacho: data analysis and writing of the analyzes and part of the results; Andrés Tzolkin González Cuellar: field work, literature review and writing of the methodology. All authors reviewed the manuscript.

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