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Estructura y regeneración natural de *Peltogyne mexicana* en el Parque Nacional el Veladero, Acapulco, Guerrero

Structure and natural regeneration of Peltogyne mexicana in the Veladero Nacional Park, Acapulco, Guerrero

Estrutura e regeneração natural de Peltogyne mexicana no Parque Nacional El Veladero, Acapulco, Guerrero

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Resumen

Peltogyne mexicana es una especie arbórea endémica de Guerrero, la cual se encuentra amenazada por la deforestación y tala clandestina. Dicho esto, la finalidad es conocer la estructura de la población forestal y los procesos ecológicos que ocurren en la población. Se efectuó un muestreo dirigido dentro de dos condiciones ecológicas en el Polígono Oriente del Parque Nacional el Veladero (A y B), cuyas diferencias son: altura, exposición, pendiente, rocosidad y cobertura, en cada condición ecológica se colocaron cuatro unidades de muestreo, se utilizó la técnica de muestreo lineal para análisis de la regeneración natural, cada cuadrante tiene una superficie total de 400 m^2 para fustales (individuos con DAP >= 10cm), subdividido en dos cuadrantes, el cuadrante de 10 x 10 m para latizales (plantas con DAP >2cm y <10cm, con altura >1.5m) y el cuadrante de 5 x 5m para brinzales (plántulas con altura menor a 1.5m); para analizar la estructura, se seleccionaron individuos mayores a 1.5 m.

No observándose diferencias significativas entre condiciones para las variables altura y diámetro, sin embargo, se observó que los valores más altos son para la condición A. La clase diamétrica dominante es de 0 a 25 cm para ambas condiciones ecológicas. Cerca del 70 % de la población corresponde a clases juveniles (brinzales y latizales), así la mayoría de individuos permanecen en estratos inferiores posteriormente convirtiéndose en individuos ecológicamente muertos. Con esto, la permanencia de *Peltogyne mexicana* está en riesgo, ya que la fuerte relación con las condiciones ambientales donde se desarrolla, la alta tasa de mortandad en categorías juveniles y presiones antropogénicas amenazan su permanencia.

Palabras clave: *Peltogyne mexicana*, estructura de la vegetación, regeneración natural.

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Abstract

Peltogyne mexicana is an endemic arboreal species of Guerrero, which is threatened by deforestation and illegal logging. That said, the purpose is to know the structure of the forest population and the ecological processes that occur in the population. A guided sampling was carried out within two ecological conditions in the Eastern Polygon of El Veladero National Park (A and B), whose differences are: height, exposure, slope, rockiness and coverage, in each ecological condition four sampling units were placed, the linear sampling technique was used for analysis of natural regeneration, each quadrant has a total area of 400 m2 for fustals (individuals with DAP> = 10cm), subdivided into two quadrants, the quadrant of 10 x 10 m for saplings (plants with DAP> 2cm and <10cm, with height> 1.5m) and the 5 x 5m quadrant for seedlings (seedlings with a height less than 1.5m); To analyze the structure, individuals older than 1.5 m were selected.

No significant differences were observed between conditions for the height and diameter variables, however, it was observed that the highest values are for condition A. The dominant diameter class is from 0 to 25 cm for both ecological conditions. Nearly 70% of the population corresponds to juvenile classes (saplings and seedlings), thus the majority of individuals remain in lower strata later becoming ecologically dead individuals. With this, the permanence of *P. mexicana* is at risk, since the strong relationship with the environmental conditions where it develops, the high death rate in juvenile categories and anthropogenic pressures threaten their permanence.

Keywords: *Pelogyne mexicana*, structure of vegetation, natural regeneration.

Revista Iberoamericana de las Ciencias Biológicas y Agropecuarias

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Resumo

Peltogyne mexicana é uma espécie arbórea endêmica de Guerrero, que é ameaçada pelo desmatamento e pela talha ilegal. Com base no acima, para conhecer a estrutura da população florestal, conheça os processos ecológicos que ocorrem na população. Uma amostragem guiada foi realizada dentro de duas condições ecológicas no Polígono Oriental do Parque Nacional El Veladero (A e B), cujas diferenças são: altura, exposição, inclinação, rocha e cobertura, em cada condição ecológica foram colocadas quatro unidades de amostragem, A técnica de amostragem linear foi utilizada para análise de regeneração natural, cada quadrante tem uma área total de 400 m2 para fustales (indivíduos com DAP> = 10cm), subdividido em dois quadrantes, o quadrante de 10 x 10 m para latizas (plantas) com DAP> 2cm e <10cm, com altura> 1.5m) e o quadrante de 5 x 5m para mudas (mudas com uma altura inferior a 1.5m); Para analisar a estrutura, foram selecionados indivíduos com mais de 1,5 m de idade. Não foram observadas diferenças significativas entre as condições para as variáveis de altura e diâmetro, no entanto, observou-se que os valores mais altos são para a condição A. A classe de diâmetro dominante é de 0 a 25 cm para ambas as condições ecológicas. Quase 70% da população corresponde a classes juvenis (mudas e latizais), assim a maioria dos indivíduos permanece em estratos mais baixos e se tornam indivíduos ecologicamente mortos. Com isso, a permanência da Peltogyne mexicana está em risco, uma vez que a forte relação com as condições ambientais onde se desenvolve, a alta taxa de mortalidade em categorias juvenis e as pressões antropogênicas ameaçam sua permanência.

Palavras-chave: *Peltogyne mexicana*, estrutura de vegetação, regeneração natural.

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Introduction

Mexico is one of the countries with a high number of endemisms in tree species (Villaseñor, 2014). Within the list of endemic species is Peltogyne mexicana (Martínez, 1960) commonly known as palo morado, it is located in low and medium jungles in the municipalities of Acapulco de Juárez and Juan R. Escudero, although it covers some small areas south of the Municipality of Chilpancingo. The jungles being one of the types of vegetation that are severely affected by human activities (Rzedowski, 1978, Carreto-Pérez et al., 2015), which means that the ecosystem where they live is being degraded continuously. main causes is the change of land use, also, this timber species (precious wood) presents pressure for illegal logging, in addition, to be listed in the Official Mexican Standard NOM-059-SEMARNAT-2010 under the category of threatened species (Daily Official of the Federation, December 30, 2010).

The distribution of trees in space has a great influence on the density and structure of forests and is conditioned by the relationships between individuals and the regeneration strategy of different species (Moeur, 1993, Corredor 1981). Also know the importance of the natural regeneration and structure indicates how it is the renewal of the forest masses, before processes of illegal logging and climate change becomes relevant to know these processes. This is related to the permanence of the species, as well as the conservation of the diversity of ecosystems (Vázquez, 2017). The natural regeneration of plant populations is a cyclic process which consists of the production of seeds, dispersion, germination and establishment of seedlings, whose success or inhibition of each stage depends on the specific biotic and abiotic factors (Schemske et al., 1994, Barnes, Denton and Spurr, 1998, López, Barrera, Oliva, Reyes, Rodríguez, 2014).

Based on the above, it is necessary to identify the factors involved in the distribution, structure and natural regeneration of P. mexicana, as well as to analyze the phases of growth, to compare the dynamics of regeneration and spatial distribution, and to understand how these elements can influence in the permanence of P. mexicana, in this way, it is proposed to study and compare height, diameter and number of individuals in two ecological conditions within the eastern polygon (PO) of El Veladero National Park (PNV).

Revista Iberoamericana de las Ciencias Biológicas y Agropecuarias

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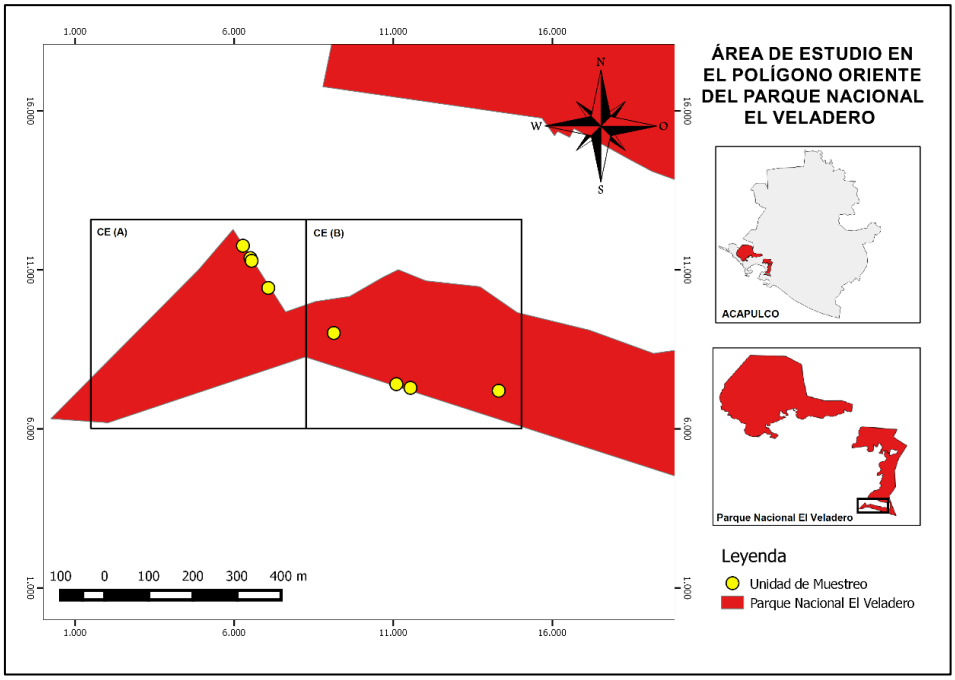
Materials and methods Study area

Figura 1. Localización de las CE dentro del PNV y ubicación de las unidades de muestreo.



Fuente: Elaboración propia a partir de datos vectoriales de INEGI.

The present study was carried out in the eastern polygon (879-48-14.312 ha) of the PNV, located at the coordinates UTM 14Q 410506.9357 E and 1863606.136N (Seanp, 2017). Being the only region within the park where P. mexicana is found, two sampling areas named ecological condition A and B (CEA and CEB respectively) were selected whose characteristics are shown in Table 1, in each condition four sampling units were located (UM) where the presence of P. mexicana was observed.

Tabla 1. Características de las condiciones ecológicas A y B.

Características	CEA	CEB
Altura	150 a 200 m.s.n.m.	200 a 350 m.s.n.m.
Exposición	Sur	Norte-noreste
Pendiente	Media-baja (0 a 20°)	Alta-media (20 a 60°)
Rocosidad	Baja-nula	Alta-media
Cobertura (%)	25-50	50-75
Perturbación	Alta	Baja

Fuente: Elaboración propia.

Sampling design

A sampling developed by Silva (1991) and Rojas and Tello (2006) of linear type directed to the distribution areas of P. mexicana in the National Park, which consisted of four sampling units for each of the two ecological conditions, was used. . For the evaluation of natural regeneration, all age categories in forest species were evaluated, it was modified by increasing the size of the quadrants in order to have greater representativeness. The age classes were classified according to Beek (1992) in order to cover the largest number of P. mexicana individuals (Table 2). Each quadrant has a total area of 400 m2 (20 x 20) for fustales, so it was subdivided into 10 x 10 m subdivisions for latitudes and 5 x 5 m for saplings as shown in Fig.2.

Revista Iberoamericana de las Ciencias Biológicas y Agropecuarias
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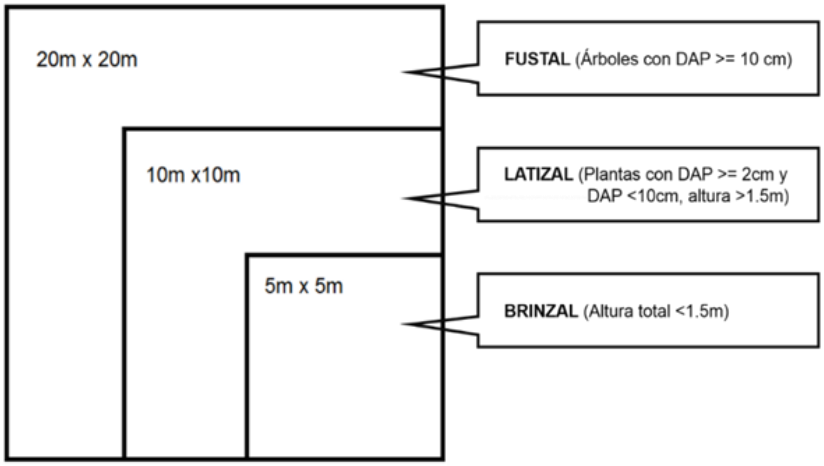
Figura 2. Diseño del muestreo lineal de regeneración natural 1, 2, 3, utilizado en la población de *P. mexicana*.



Fuente: Editada de Rojas y Tello (2006).

In each of the MUs, the total height (m) of each tree and seedling was measured using a Haga pistol or tape measure in each case and the diameter at breast height (m) with the help of a diametric tape. To analyze the vertical and horizontal structure of P. mexicana, specimens greater than 1.5 meters in height were chosen within the quadrant of 20 by 20 m. Likewise, to evaluate natural regeneration, vegetation was classified within the corresponding plot in accordance with the size and diameter required in fig. 2.

Tabla 2. Coordenadas UTM de la ubicación de las unidades de muestreo en las dos condiciones ecológicas.

	Clave	Latitud (X)	Longitud (Y)	Altitud (m.s.n.m.)
CEA	UM-A1	409263	1860637	154
	UM-A2	409179	1860703	125
	UM-A3	409162	1860731	198
	UM-A4	409191	1860705	176
CEB	UM-B1	409742	1860402	346
	UM-B2	409531	1860366	322
	UM-B3	409498	1860375	283
	UM-B4	409368	1860533	215

Fuente: Elaboración propia.

Analysis of data

The height and diameter of the individuals greater than 1.5 m were analyzed, in category intervals every three meters, starting at 1.5 m to 16.5 m, in the same way, the horizontal distribution of trees greater than 1.5 m was analyzed, the intervals in the diametric category were five centimeters starting from 0 to 0.55 m, a comparison was made in both ecological conditions. For the analysis of natural regeneration the number of individuals was analyzed in their entirety.

Average, minimum, maximum, standard deviation (SD) and coefficient of variation (CV) were calculated for height and diameter in each ecological condition. In addition, the nonparametric test of X2 was applied to determine if there is a relationship between the physiographic units and the size of individuals according to diameter (Ludwig and Reynolds, 1988). In the same way, the parametric test of Analysis of Variance (ANOVA) was applied for the data that fulfilled the assumption of normality, between the ecological conditions A and B and the variables brinzal, latizal and fustal with the purpose of determining if there are differences in the variables evaluated for each ecological condition.

Two estimators were used to know the type of spatial distribution through the variance / average relationship ($S^2 / \bar{x}$), of the Cox index and that of Morosita (Del Rio, 2003; Moret et al., 2008; Morisita, 1959), which evaluate the type of aggregate or random distribution of individuals.

Results and Discussion

In the sampling conducted in El Veladero National Park, a total of 446 individuals were recorded, divided into 29 species, as a result of the sampling of both ecological conditions; 207 specimens of Peltogyne mexicana were found (156 saplings, 13 latizales and 28 fustales).

Vertical structure

Of the 51 trees greater than 1.5 meters, a maximum height of 16 m was recorded in both conditions (A and B), the minimum height recorded was obtained in condition "A" (2.4 m), for the CEB the minimum height was 3 m. The vertical distribution is presented in Table 3, we observe that the largest number of trees are in category one (1.5 m to 4.5 m) with 16 units (31,373%), however, category two (range of 4.5 to 7.5) is where the smallest number of trees is presented (7.843%), category five (13.5 to 16.5 m) with 13 trees is the second class with the highest number of specimens (25.49%).

Two dominant canopies were observed in terms of height resulting from the height analysis for both ecological conditions, the lower one formed by trees smaller than 7.5 m and higher with trees larger than 7.5 m. The ecological condition A is constituted by the lower canopy with 52% of the individuals, while the dominant canopy in the ecological condition B is the superior with 75% of the trees.

Tabla 3. Distribución por categoría de altura en general y por condiciones ecológicas de la población muestreada.

		CEA		CEB		TOTAL	
Categoría de altura	Rango (M)	No. de árboles	%	No. de árboles	%	No. de árboles	%
1	1.5-< 4.5	12	44.444	4	16.667	16	31.373
2	4.5 -< 7.5	2	7.407	2	8.333	4	7.843
3	7.5 -< 10.5	3	11.111	6	25.000	9	17.647
4	10.5 -< 13.5	6	22.222	3	12.500	9	17.647
5	13.5 -< 16.5	4	14.815	9	37.500	13	25.490
TOTAL		27	100	24	100	51	100

Fuente: Elaboración propia.

The maximum recorded atura is 16 m for both ecological conditions, as minimum height 2.4 m in the CEA and 3 m in the CEB within the CEA classification has an average height of 8,059 m, standard deviation of 4,810 and coefficient of variation of 59.686%. The CEB has an average of 10,563 m, standard deviation of 4,256 and 40,296% of coefficient of variation.

These results are related to anthropogenic disturbances of the area and competition with other species, in the CEB the disturbance by human activity is minimal, however, competition with other species is greater, which affects the seedlings and young trees of P Mexicana that compete for space and resources to be able to develop (Carrascal and Pérez, 1998).

The analysis of the vertical structure of Peltogyne mexicana allows us to define two canopies: the lower one formed by trees <7.5 m and higher, trees> 7.5 m. The decrease of individuals in the second category of height allowed to identify the two arboreal strata (Ibarra y López, 2002; Zarco, 2010).

The ecological condition "A" is dominated by the lower canopy with 52%, while the remaining 48% belongs to the upper stratum, which means that the sampled population is represented by juvenile trees from 1.5 m to 7.5 m, however, the dominant canopy in the

ecological condition "B" is the superior with 75%, these are trees from 7.5 to 16.m that have reached or will reach the stage of maturity and the remaining 25% belong to juvenile categories.

These results are related to anthropogenic disturbances in the area and competition with other species. In the CEA, adult trees are cut totally or partially to obtain firewood, establishing openings of clearings and giving opportunity for the establishment of young foals, however, according to Uhl (1989) when the opening of clearings made by the forest use is very large changes the horizontal and vertical structure of a forest and therefore affects its natural processes. In the CEB the disturbance by human activity is minimal, however, competition with other species is greater and the opening of gaps naturally is low, which affects the seedlings and juvenile trees of P. mexicana competing for space and resources to be able to develop.

Horizontal structure

The diametric structure registered a maximum DAP of 55 cm, in the CEA the minimum recorded was 0.020 cm, average 0.222 cm, 0.157 standard deviation and 70.805% CV. For the CEB the average diameter was 0.215 cm, 0.030 cm at least 0.143 cm and CV 66.743%.

Tabla 4. Categoría diamétrica general y por CE de la población muestreada de *P. mexicana*.

		CE (A)		CE (B)		TOTAL	
Categoría Diamétrica	Rango (cm)	No. de árboles	%	No. de árboles	%	No. de árboles	%
1	0 -< 5	3	11.111	1	4.167	4	7.843
2	5 -< 10	4	14.815	5	20.833	9	17.647
3	10 -< 15	2	7.407	2	8.333	4	7.843
4	15 -< 20	4	14.815	5	20.833	9	17.647
5	20 -< 25	5	18.519	1	4.167	6	11.765
6	25 -< 30	2	7.407	4	16.667	6	11.765
7	30 -< 35	3	11.111	1	4.167	4	7.843
8	35 -< 40	0	0.000	1	4.167	1	1.961
9	40 -< 45	0	0.000	2	8.333	2	3.922
10	45 -< 50	1	3.704	1	4.167	2	3.922
11	50 -< 55	3	11.111	1	4.167	4	7.843
TOTAL		27	100	24	100	51	100

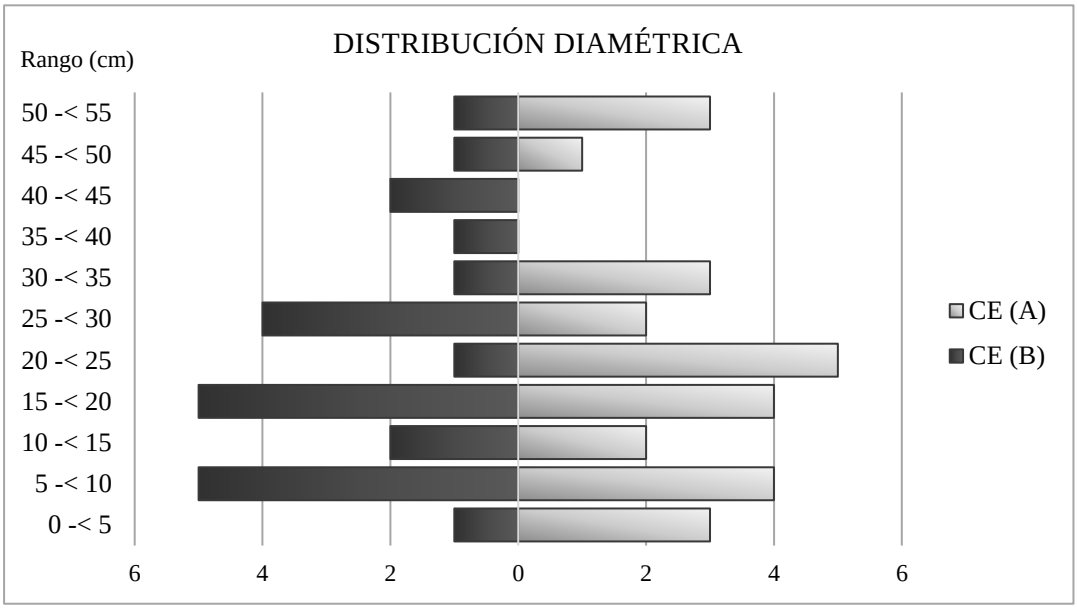
Fuente: Elaboración propia.

The distribution analysis by diametric category (Table 4) shows a higher abundance of trees with a diameter of less than 25 cm (for the CEA 66.6% and for the CEB 58.3%), this indicates that the sampled population is in a state of regeneration (Vázquez- Negrín, Castillo-Acosta, Valdez-Hernández, Zavala-Cruz and Martínez-Sánchez, 2011), however, in both EC, the first diameter class (0 to 5 cm) has a lower percentage of individuals, increasing in the following ranges and decreasing in the higher categories, this type of distribution is described by Ibarra and Mata (2002) in a subperennifolia forest of Veracruz, arguing that this type of pattern suggests the existence of areas with some disturbance and are in the regeneration phase.

This condition is observed in the CEA with an irregular distribution and in whose distribution of diametric frequencies (Fig. 3) it tends to be multimodal, in the CEB the distribution tends slightly to be regular. According to Olvera-Vargas and Figueroa-Rangel (2012), the inequality in the diametric sizes is an effect associated to competitive processes carried out by the species

during the different stages of the development of the stand, therefore, the diametric distribution in different sizes it allows them to share the resource proportionally to their size, as well as respond equitably to disturbances.

Figura 3. Histograma de la distribución diamétrica de *P. mexicana* de la CEA y CEB.



Fuente: Elaboración propia.

This type of distribution is described by Ibarra and López (2002) in a subperennifolia jungle of Veracruz, according to these authors this type of pattern suggests the existence of areas with disturbance that are in the regeneration phase. This is mostly seen in the CEA with an irregular distribution, the multimodal trend is observed, in the CEB the distribution tends to be a little more regular. According to Olvera and Figueroa (2012), the inequality in the diametric sizes is an effect associated with competitive processes carried out by the species during the different stages of the development of the stand, therefore, the diametric distribution in different sizes allows them to share the resource proportionally to its size, as well as responding equitably to disturbances.

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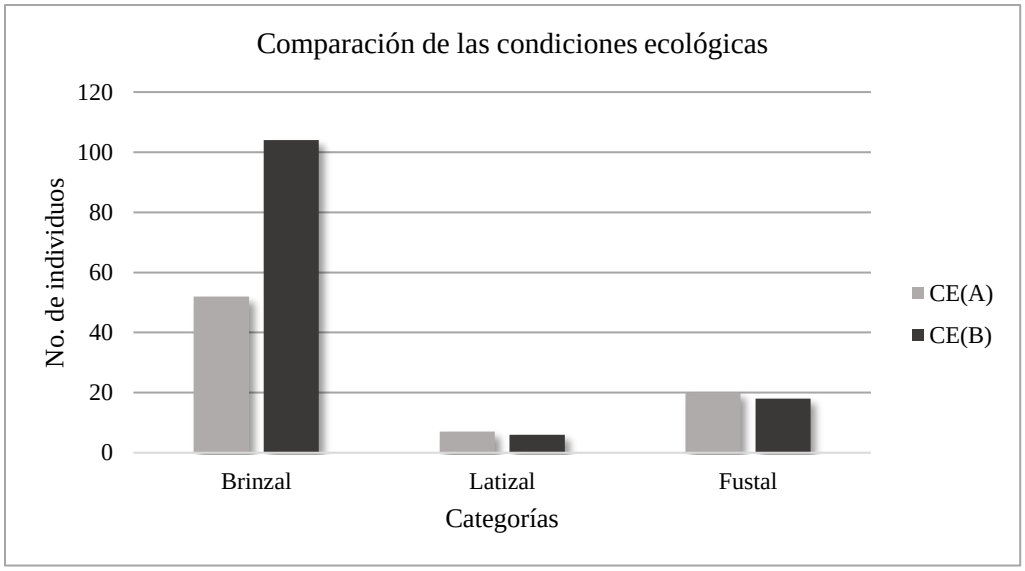
Regeneration analysis

We counted 207 individuals of P. mexicana, the largest number is in the category of Brinzal (76%), followed by the Fustales (18%) and the remaining 6% belongs to the latizales. Of the 79 individuals in the CEA, 66% belongs to the category of saplings, followed by the saplings (25%) and, finally, the latizales with 9%, the same occurs in the CEB, where 128 specimens of P. mexicana, most of the sampled population belongs to the category of saplings (81%) followed by the saplings with 14% and 5% for the saplings (Fig.4).

Figura 4. Abundancia de la regeneración natural por clase natural de edad (brinzal, latizal y fustal) de P. mexicana, entre la CEA y la CEB.



Fuente: Elaboración Propia.

In Fig. 5 we observe the distribution of natural age classes by UM, the UM-B1 is where the largest number of saplings are found and in the UM-A4 the lowest; Regarding latizales, the most considerable quantities are in the UM-A2 and B1, the lowest number is located in the UM-A1 and B3 with zero individuals; the UM-A3 has the largest number of the fustales and the lower one in the UM-A4. The analysis of regeneration, together with the results of the vertical and horizontal structure indicates the presence of a high potential for natural regeneration, especially in the CEB.

Revista Iberoamericana de las Ciencias Biológicas y Agropecuarias
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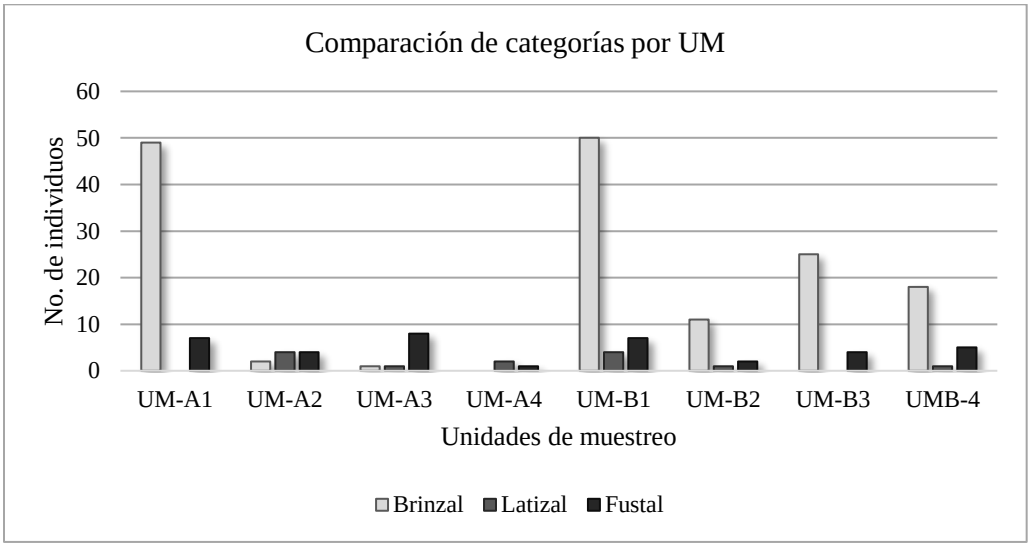
Figura 5. Abundancia de la regeneración natural por clase natural de edad (brinzal, latizal y fustal) de *P. mexicana*, entre la CEA y la CEB divididas en Unidades de Muestreo.



Fuente: Elaboración propia.

For both EC, the saplings are dominant with more than 60%, however, less than 10% is occupied by the latizales. Vilchez and Rocha (2006) suggest that this continuance of saplings may be characteristic of gender; These authors carried out a regeneration study on Peltogyne purpurea, where they found abundant seedlings with permanence in the forest and no growth, this is similar to that found by Nascimento and Proctor (1997) on Peltogyne gracilipes. Clark and Clark (1987), report that there are individuals who remain in lower strata and if after a time they do not have the capacity to grow they become ecologically dead beings, which would indicate that when going from saplings to saplings there is an inhibition of seedlings Natural way.

Spatial distribution of P. mexicana

According to the Cox index and the Morisita index (Is), in both ecological conditions the type of aggregate spatial distribution was observed (quotient greater than 1).

For the sampling in condition A, a Cox index of 1.025 was obtained and for B, of 2.111, the Cox index in both conditions is greater than one, which indicates that the distribution pattern for P. mexicana is aggregation. This result is corroborated with the Morisita index, obtaining as a quotient for CEA 1.003 and for the CEB the result was 2.112.

Statistic analysis

The result of the statistical value X2 (Chi-square) is 14.401 and causes a bilateral asymptotic significance of 0.276, with a level of significance P> at 0.05, no significant differences being observed between the two ecological conditions in relation to the height of the trees . Also, the variables in ecological condition A and B in terms of diameter, the statistical value of X2 is 25,833 and the bilateral asymptotic significance is 0.309, with a level of significance P> to 0.05, so there are no significant differences between the two ecological conditions in relation to the diameter of the trees.

Variance tests were carried out in the sampling units in relation to the natural age classes (brinzal, latizal and fustal). Table 5 shows the normality tests of Kolmogorov-Smirnov (K-S) and Shapiro-Wilk (S-W). The variables in the population have a normal distribution with the exception of the saplings of the CEA where the result of the significance of S-W is 0.004, which indicates the difference between ecological conditions and in the class of saplings.

Tabla 5. Pruebas de normalidad para las CE A y B con las variables: brinzal, latizal y fustal.

	Condición	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
	Ecología	Estadístico	gl	Sig.	Estadístico	gl	Sig.
Brinzales	CEA	0.427	4	.	0.662	4	0.004
	CEB	0.273	4	.	0.903	4	0.447
Latizal	CEA	0.192	4	.	0.971	4	0.850
	CEB	0.364	4	.	0.840	4	0.195
Fustales	CEA	0.236	4	.	0.940	4	0.653
	CEB	0.155	4	.	0.998	4	0.995

Fuente: Elaboración propia.

Table 6 shows the result of the ANOVA test (Analysis of Variance), indicates that there are no differences in latitudes and fustales, but there are differences in seedlings.

Tabla 6. Comparación entre las condiciones fisiológicas A y B y las variables: brinzal, latizal y fustal.

		Suma de cuadrados	Gl	Media cuadrática	F	Sig.
Brinzal	Inter-grupos	2443.000	3	814.333	6.634	0.049
	Intra-grupos	491.000	4	122.750		
	Total	2934.000	7			
Latizal	Inter-grupos	4.375	3	1.458	0.432	0.742
	Intra-grupos	13.500	4	3.375		
	Total	17.875	7			
Fustal	Inter-grupos	25.500	3	8.500	1.889	0.273
	Intra-grupos	18.000	4	4.500		
	Total	43.500	7			

Fuente: Elaboración propia.

Conclusions

Trees with greater height and diameter in ecological condition B are observed, however, derived from the statistical analysis, no significant differences were observed in these variables. The type of distribution is aggregated based on the Cox and Morisita indices, responding to specific environmental conditions.

The natural regeneration is greater in the ecological condition B presenting significant differences (sig.0.049), indicating that the ecological conditions of this area (higher and higher conservation status) suggest that the establishment of the saplings is favored. It is observed the existence of the inhibition of seedlings to move to higher diameter and height categories in both ecological conditions, this indicates that the inability of the saplings of this species to occupy higher strata or move to larger categories, which puts risk the permanence of this species, thus

not only the anthropic factors limit the development and density, also the biological conditions (incapacity of growth), physical and natural.

Bibliography

Barnes, B. V., Zak, D., Denton, S. R., Spurr, S. H. (1998). Regeneration Ecology. *Forest Ecology* (94-121). N.Y. New York. John Wiley, Sons, Inc.

Beek, R. (1992). *Manejo forestal basado en la regeneración natural del bosque. Estudio de caso en los Robledales de altura de la cordillera de Talamanca, Costa Rica*. (Informe técnico Nº 200). Turrialba, Costa Rica: CATIE.

Carrascal, Eurosia, & Pérez Villegas, Graciela. (1998). Ocupación territorial y deterioro ambiental ocasionado por la expansión urbano-turística en Acapulco, Guerrero. *Investigaciones geográficas*, (37), 111-124. Recuperado de http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0188-46111998000300009&lng=es&tlng=es.

Carreto-Pérez, Blanca Estela, Almazán-Juárez, Ángel, Sierra-Morales, Pablo, & Almazán-Núñez, R. Carlos. (2015). Estudio florístico de la cuenca baja del río Papagayo, Guerrero, México. *Polibotánica*, (40), 01-27. Recuperado de http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1405-27682015000200001&lng=es&tlng=es.

Clark, D., Clark, D., (1987). Análisis de la regeneración de árboles del dosel en bosques muy húmedo tropical: Aspectos teóricos y Prácticos. *Rev. Biol. Trop. 35* (Supl.1) 641-658.

Corredor, J. (1981). *El establecimiento de la regeneración natural de especies arbóreas en fajas previamente acondicionadas del bosque experimental Caimal (Barrancas Edo. Barinas)*. Universidad de Los Andes. Facultad de Ciencias Forestales y Ambientales. Trabajo de Ascenso. Mérida, Venezuela.

Del Río, M., Montes, F., Cañellas, I., & Montero, G. (2003). Revisión: Índices de diversidad estructural en masas forestales. *Investigación agraria: Sistemas y recursos forestales*, *12*(1), 159-176.

Rojas R. & Tello R. 2006. Abundancia y stock de la regeneración natural de especies forestales en el bosque Varillal del CIEFOR, Iquitos-Perú. Universidad Nacional de la Amazonia Peruana. Iquitos, Perú. 19. Disponible en: http://www.investigacionfcf.galeon.com/articulos/Articulo_15.pdf

IBARRA, O. G., & López, L. (2002). Estructura, composición, riqueza y diversidad de árboles en tres muestras de selva mediana subperennifolia. *Anales del Instituto de Biología. Serie Botánica*, *73*(2), 283-314.

López, P. P., Barrera, F. L., Oliva, F. G., Reyes, P. C., & Rodríguez, A. G. (2014). Procesos de regeneración natural en bosques de encinos: factores facilitadores y limitantes. *Biológicas Revista de la DES Ciencias Biológico Agropecuarias Universidad Michoacana de San Nicolás de Hidalgo*, 18-24.

Ludwig, J. A., & Reynolds, J. F. (1988). *Statistical ecology: a primer in methods and computing* (Vol. 1). John Wiley & Sons.

Martínez, M. (1960). Una especie de *Peltogyne* en México. In *Anales del Instituto de Biología*. *Universidad Nacional Autónoma de México* Tomo XXXI., 123-131.

Mexicana, N. O. (2010). NOM-059-SEMARNAT-2010. *Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio. Lista de especies en riesgo. SEMARNAT. Diario Oficial de la Federación*.

Moeur, M. (1993). Characterizing spatial patterns of trees using stem-mapped data. *Forest science*, *39*(4), 756-775.

Moret, A. Y., Valera, L., Mora, A., Garay, V., Jerez, M., Plonczak, M., & Hernández, D. (2008). Estructura horizontal y vertical de Pachira quinata (Jacq.) WS Alverson (Bombacaceae), en el Bosque Universitario" El Caimital", Barinas, Venezuela. *Ecotrópicos*, *21*(2), 62-74.

Morisita, M. (1959). Measuring of the dispersion of individuals and analysis of the distribution patterns. *Memoirs of the Faculty of Science, Kyushu University, ser. E (Biology)*, *2*, 215-235.

Nascimento, M. T., & Proctor, J. (1997). Population dynamics of five tree species in a monodominant Peltogyne forest and two other forest types on Maracá Island, Roraima, Brazil. *Forest Ecology and Management*, *94*(1-3), 115-128.

Olvera-Vargas, M., & Figueroa-Rangel, B. L. (2012). Caracterización estructural de bosques montanos dominados por encino en el centro-occidente de México. *Revista Ecosistemas*, *21*(1-2).

Rzedowski, J. (1978). Vegetación de México. Ed. Limusa. 4 a. *Reimpresión. México, DF México*.

Schemske, D. W., Husband, B. C., Ruckelshaus, M. H., Goodwillie, C., Parker, I. M., & Bishop, J. G. (1994). Evaluating approaches to the conservation of rare and endangered plants. *Ecology*, *75*(3), 584-606.

Seanp.guerrero.gob.mx. (2017). *Sistema Estatal de Áreas Naturales Protegidas | SEMAREN*. [online] Recuperado de http://seanp.guerrero.gob.mx:8040/.

Silva, N. (1991). Silvicultura y manejo de florestas tropicais umidas de Amazonia Brasileira. *Porto Velho*.

Uhl, C., & Vieira, I. C. G. (1989). Ecological impacts of selective logging in the Brazilian Amazon: a case study from the Paragominas region of the state of Pará. *Biotropica*, 98-106.

Vázquez, J. S. S. (2017). El palo morado (*Peltogyne mexicana*), una leguminosa maderable con futuro incierto y parientes lejanos. *Revista Digital Universitaria*, *15*(4).

Vázquez-Negrín, I., Castillo-Acosta, O., Valdez-Hernández, J. I., Zavala-Cruz, J., & Martínez-Sánchez, J. L. (2011). Estructura y composición florística de la selva alta perennifolia en el ejido Niños Héroes Tenosique, Tabasco, México. *Polibotánica*, (32), 41-61.

Vílchez, B., & Rocha, O. (2006). Estructura de una población del árbol Peltogyne purpurea (Cesalpinaceae) en un bosque intervenido de la Península de Osa, Costa Rica. *Revista de biología tropical*, *54*(3), 1019-1029.

Villaseñor J.L. y Ortíz E. 2014. Biodiversidad de las plantas con flores (División Magnoliophyta) en México. *Revista Mexicana de Biodiversidad* **85**:134–135. Recuperado de https://doi.org/10.7550/rmb.31987

Zarco-E, V. Valdez-H., J., Ángeles-P., Castillo-A. (2010). Estructura y diversidad de la vegetación arbórea del parque estatal agua blanca, Macuspana, Tabasco. Universidad y Ciencia, 26, 1-17. Recuperado de http://www.redalyc.org/articulo.oa?id=15416251001

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