Diversidad y estructura de la selva mediana subperennifolia de Acapulco, Gro., México.

Diversity and structure of the semi-evergreen tropical forest of Acapulco, Gro., México.

Diversidade e estrutura da subperennifolia floresta tropical de Acapulco, Gro., México.

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Resumen

Se analizó la estructura, composición, riqueza y diversidad de especies arbóreas en selva mediana subperennifolia en dos condiciones geográficas en Acapulco, Guerrero. Se monitorearon siete unidades de muestreo de 600 m^2, cuatro para el polígono oeste (POE) y tres para el este (PE).

Se reportan 46 especies, con un total de 398 árboles. Para ambos polígonos, *Peltogyne mexicana* fue la especie más importante (IVI= 46.11) seguida por *Ceiba pentandra* (31.63) y *Coccoloba* *barbadensis* (19.05). Los índices de diversidad calculados no se observaron valores significativamente diferentes (*t*, *p* > 0.05). El Índice de Shannon (H') 1.43 es mayor para el POE y para el PE fue de 0.86.

Los valores de diversidad fueron más altos en el POE, pero son bajos comparados con otras selvas de México; pudiéndose deber a las condiciones en las que se desarrolla, fuertes pendientes y alta rocosidad.

Palabras clave: Estructura, diversidad, selva mediana subperennifolia.

Abstract

The structure, composition, richness and diversity of tree species was analyzed in semi-evergreen tropical forest in two geographical conditions in Acapulco, Guerrero. Seven sampling units of 600 m2 were monitored, four for the West Polygon (POE by its name in Spanish) and three to the East Polygon (PE by its name in Spanish).

46 species are reported, with a total of 398 trees. *Mexican Peltogyne* was the most important species for both polygons (IVI= 46.11) followed by *Ceiba pentandra* (31.63) and *Coccoloba barbadensis* (19.05). No significantly different values where observed in the calculated indices of diversity (*t*, *p* > 0.05). The Shannon index (H') 1.43 is greater for the POE and the PE was 0.86.

Diversity values were higher in POE, but they are low compared with other jungles of Mexico; and it may be due to the conditions in which it develops, steep slopes and highly rocky terrain.

Key words: structure, diversity, semi-evergreen tropical forest.

Resumo

A estrutura, composição, riqueza e diversidade de espécies arbóreas em subperennifolia de florestas tropicais em duas condições geográficas, em Acapulco, Guerrero foi analisada. sete unidades de amostragem de 600 m2, quatro para o polígono Oeste (POE) e três para o leste (PE) foram monitorados.

46 espécies são relatados, com um total de 398 árvores. Para ambos os polígonos, mexicana Peltogyne foi a espécie mais importantes (IVI = 46,11), seguido de Ceiba pentandra (31,63) e Coccoloba barbadensis (19,05). Índices de diversidade calculados valores não significativamente

diferentes (t, p> 0,05). Índice de Shannon (H ') é mais elevado para o 1.43 POE e o PE foi de 0,86.

Os valores de diversidade foram maiores no POE, mas são baixos em comparação com outras florestas do México; É possível devido às condições em que se desenvolve, encostas íngremes e alta rockiness.

Palavras-chave: estrutura, a diversidade da floresta tropical perene.

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Introduction

Mexico is considered one of the five mega-diverse countries since it hosts fauna and flora within two biogeographical regions the neartic and neotropical. This biodiversity is due to the topography and varied terrain, these two elements influence the floristic composition and fauna, presenting high levels of diversity and endemism (Rzedowski, 1978).

Tropical Forests are among the most diverse ecosystems, SEMARNAT (2002) mentions that there are 17,792,279 ha for the type of vegetation and for the most recent forest inventory CONAFOR (2009) reported 14,062,206.58 ha, what makes evident the loss of these types of vegetation. These differences in surface are mainly attributed to the change of land use of forest usage, In addition, droughts have increased and accentuated in recent decades that has affected an increase of surfaces.

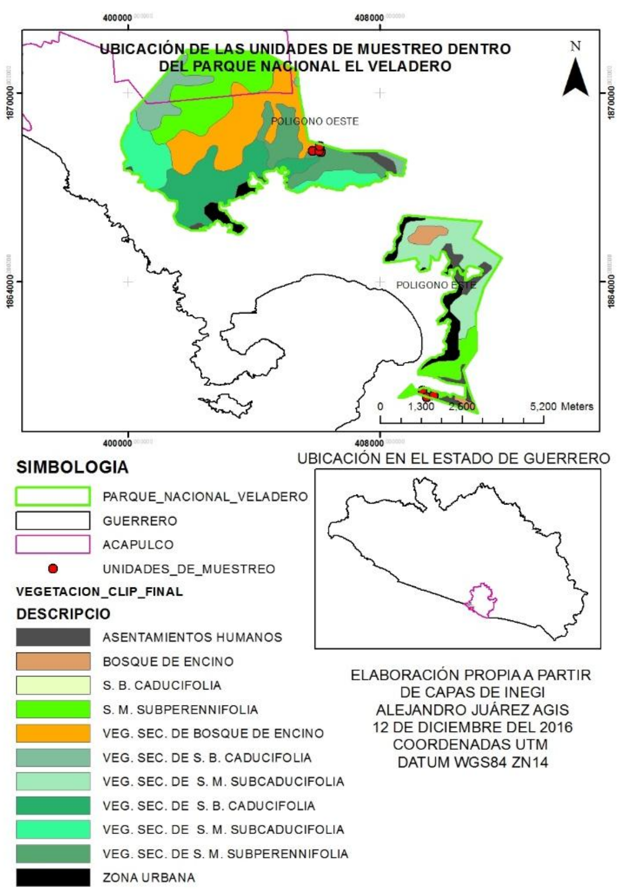
The present study is located in the National Park Veladero Acapulco, Guerrero, and it deals with the study of the Semi-evergreen Tropical Forest to document, learn about and register areas that can serve as biological, structural, and demonstrative referents; knowing this information is important to the unfavourable scenarios of loss of these ecosystems (Martínez, 2003). From this point of view, with the completion of the study we will have a more accurate picture of the state, uses, diversity, composition and structure of the vegetation, this will serve as a basis for decision-making for the conservation and restoration of the natural protected area.

Materials and methods

Location of the study area

The present study was carried out in the Natural Protected Area, El Veladero National Park (PNV by its name in Spanish) Acapulco de Juárez, Guerrero State. Four sampling units were conducted in the polygon identified as West Polygon (POE) and in the East Polygon (PE) three sampling units (Figure 1). These two sites were selected based on tours prior to identifying areas with vegetation of the semi-evergreen tropical forest.

Figure 1. Location of sampling units or study areas in red.



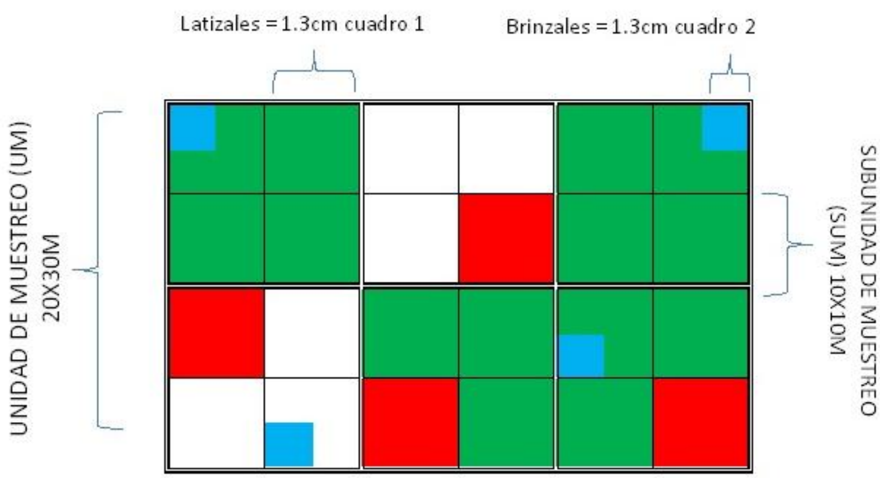
Source: own elaboration based on vector layers of INEGI 2010.

Establishment and location of sampling units (UM)

The UMs were located in the field and had the following characteristics, trying to represent all the age categories of the trees according to the methodology of Valdez-Hernández, 2002.

Each UM was a rectangle of 600 m2 with dimensions of 20x30 m. In turn, each MU was subdivided into 10x10m frames which were called sampling subunits (SUM), four randomized Sums were sampled and individuals with a breast height diameter (DAP, 1.3 m from the ground) were measured Or greater than 2.5 cm: fustales (Figure 2).

Figure 2. Arrangement and distribution of sampling subunits (SUM: 10 x 10 m), tables 1 (5 x 5 m) and tables 2 (1 x 1 m) in a sampling unit (UM)



Source: (tomado de Valdez-Hernández, 2002).

Measurement of variables

The variables per individual were: species identification, total height, cup amplitude (major diameter and minor diameter), diameter breast height (1.3 m); Tree species were identified by guides (Pennington and Sarukhan, 1968) and later determined in with the support of the Herbarium of the Institute of Scientific Research, Area of Natural Sciences (UAGC) and were deposited in this collection.

The following indices were calculated.

Complexity index (CI) for shafts in each UM and in general. This index is an expression of species richness and abundance (Holdridge et al., 1971) to characterize different types of stands. And it is expressed as follows:

IC = s d b h 10-3

Where: s = number of species, d = fust density, b = basal area (m2) and h = average height (m).

Species richness (D_α) was calculated using the Margalef Index (1977):

$$D_{\alpha} = \frac{S-1}{\log N}$$

Where: $S =$ Number of species, N = Total number of individuals and A higher value of D higher species richness.

For fustales and latizales, the importance value index (IVI) was calculated. In each UM this was developed by Curtis and McIntosh (1951) to hierarchize the dominance of each species.

***IVI* = (*ABr* + *Dr* + *Fr*) / 3**

Where:

ABr = Relative basal area, Dr = relative density and Fr = relative frequency

These relative values or percentages are calculated by dividing the absolute value for one species by the sum of the values for all species and then multiplying by 100.

The relative dominance (biomass estimator: basal area, coverage) was calculated as follows:

$$\text{Dominancia relativa} = \frac{\text{Dominancia absoluta por especie}}{\text{Dominancia absoluta de todas las especies}}\ x\ 100$$

Where:

$$\text{Dominancia absoluta} = \frac{\text{Área basal de una especie}}{\text{Área muestreada}}$$

The relative density as follows:

$$\text{Densidad relativa} = \frac{\text{Densidad absoluta por cada especie}}{\text{Densidad absoluta de todas las especies}} \text{ x } 100$$

Where:

$$\text{Densidad absoluta} = \frac{\text{Número de individuos de una especie}}{\text{Área muestreada}}$$

The relative frequency as follows:

$$\text{Frecuencia relativa} = \frac{\text{Frecuencia absoluta por cada especie}}{\text{Frecuencia absoluta de todas las especies}} \text{ x } 100$$

Where:

$$\text{Frecuencia absoluta} = \frac{\text{Número de cuadros en los que se presenta cada especie}}{\text{Número total de cuadros muestreados}}$$

The basal area was calculated as follows:

$$\boldsymbol{AB = \pi/4\ \mathrm{DAP}^2}$$

The forest **value index (FVI)** proposed by Justavino et al. (2012), which considers the height of all individuals in the sampled area as well as the coverage density of their cups.

Unlike the IVI, which only involves variables in the horizontal sense, the IVF includes at least one parameter in the vertical direction:

IVF = DAPr + Ar + Cr

Where: *DAPr* = Diameter at the relative chest height, Ar = relative height and Cr = relative coverage.

The coverage (m2) is calculated as follows:

C = π a b

Where: π = 3.1416, a = Larger diameter of the cup projection and b = smaller diameter of the cup projection

Diversity of species

In order to know how homogeneous or heterogeneous are the sampling units and in general, the following diversity indexes were calculated:

Shannon-Wiener (H1 '). It measures the average degree of uncertainty to predict the species to which an individual randomly taken within UMs belongs.

$$H' = -\sum_{i=1}^{s} P_i \, In\,(P_i)$$

Where: $S =$ Number of species, Pi = Proportion of individuals of species i and A higher value of H 'greater diversity of species.

Simpson (S). It measures the probability that two randomly selected individuals within UMs are of the same species.

$$S = \frac{1}{\sum \frac{n_i(n_i - 1)}{N\,(N-1)}}$$

Where: n_i = Number of individuals in the ith species, N = Total number of individuals. The higher the value of S the less dominance of one (or a group) of species (S).

The Margalef species richness index (DMg) (Magurran, 1988) which combines the number of species (S) and the total number of individuals (N) was calculated as follows:

$$DMg = (S - 1) / \ln N$$

Where: Ln = logaritmo natural (base *e*), (*S*) Number of species and (N) the total number of individuals

Fisher's alpha index (α) is a model of abundance derived from a logarithmic series and employs only the number of species (S) and the total number of individuals (N).

Its calculation is done by iterations with the equation:

$$S = \alpha \ln[1 + (N / \alpha)]$$

Where: *S* = Number of species in the sample and N = number of individuals in the sample.

Equity (E). Equity was calculated with the following equation:

$$E = \frac{H'}{In(S)}$$

Where: $H' =$ Índice de Shannon-Wiener, $S =$ Número total de especies.

Values close to 1 represent conditions towards equally abundant species and those close to 0 dominance of a single species.

To determine the existence of significant differences, a t-test was performed to see the difference between two samples, at p □ 0.05, for the diversity of tree species among the UMs.

Floristic similarity

The comparative analysis between the specific diversity or floristic similarity of pairs of samples (between UM and polygons) was made through two indices:

The Sorensen (SO) similarity coefficient relates the number of species in common with the arithmetic mean of the species in both sites compared (Magurran, 1988):

$$SO = 2C / (A + B)$$

Where: A = Number of species at site A, B = number of species at site B, C = number of species common at both sites.

The coefficient of similarity of Jaccard (JC):

$$JC = C / (A + B - C)$$

Where: A = Number of species at site A, B = number of species at site B and C = number of species common at both sites.

The range of values for these coefficients ranges from 0 when there are no species shared between both sites, up to 1 when the two sites have the same species composition (Magurran, 1988).

Results

From the field samples, 46 species of 29 botanical families were recorded, as shown in Table 1. In an area of 0.42 ha, 398 trees with DAP greater than 2.5 cm were recorded.

Value of importance (IVI)

Considering all trees sampled with DBH larger than 2.5 cm (fustales) in both polygons, Peltogyne mexicana was the most important species (IVI = 46.11) followed by Ceiba pentandra (31.63) and Coccoloba barbadensis (19.05); The species in general with low values of importance are Haematoxylon brasiletto (IVI = 1.54) followed by Acacia cochliacantha (IVI = 1.54) and Acacia cymbispina (1.53).

Table 1. *Values of structural importance (IVI) for the west and east polygons.*

Nombre científico	Nombre común	Densidad		Frecuencia		Área Basal		IVI
		(Ind ha-1)	Absoluta	(m2 ha-1)	(m2 ha-1)	Absoluta	(%)	
Peltogyne mexicana	Morado	76	19.1	42.86	3.03	3.97	23.99	46.11
Ceiba pentandra	Pochote	24	6.03	42.86	3.03	3.73	22.57	31.63
Coccoloba barbadensis	Cocoloba	32	8.04	57.14	4.04	1.15	6.97	19.05
Plumeria rubra	Plumeria	12	3.02	128.57	9.09	0.66	4.01	17.82
Bursera simaruba	Mulato	18	4.52	42.86	3.03	0.9	5.45	13
Astronium graveolens	Culebro	14	3.52	85.71	6.06	0.34	2.03	11.6
Desconocida	Cascarudo	22	5.53	42.86	3.03	0.37	2.21	10.77
Nectandra ambingens	Laurelillo	8	2.01	114.29	8.08	0.04	0.26	10.35
Spondias purpurea	Ciruelo	12	3.02	57.14	4.04	0.43	2.61	9.67
Vitex mollis	Azulillo	14	3.52	71.43	5.05	0.1	0.59	9.16
Heliocarpus occidentalis	Calagua	8	2.01	14.29	1.01	0.72	4.33	7.35
Hymenaea courbaril	Guapinol	4	1.01	28.57	2.02	0.43	2.59	5.61
Guazuma ulmifolia	Cuahulote	6	1.51	42.86	3.03	0.15	0.92	5.46
Swartzia simplex var. *continentalis*	Frutillo	8	2.01	28.57	2.02	0.18	1.09	5.12
Eugenia avicenniae Standl		14	3.52	14.29	1.01	0.05	0.3	4.83
Mangifera indica	Mango	4	1.01	28.57	2.02	0.28	1.69	4.71
Jacquinia macrocarpa	Alma en pena	6	1.51	42.86	3.03	0.02	0.13	4.67
Couepia polyandra	Fraile	12	3.02	14.29	1.01	0.09	0.56	4.58
Ficus cotinifolia	Amate	8	2.01	14.29	1.01	0.24	1.47	4.49
Tabebuia rosea	Roble	4	1.01	28.57	2.02	0.21	1.27	4.3
Ficus cotinifolia	Amate	2	0.5	14.29	1.01	0.46	2.77	4.28
Diospyros xolocotzii	Zapotillo	4	1.01	28.57	2.02	0.12	0.74	3.77
Sideroxylon persimile	Boludo	2	0.5	14.29	1.01	0.36	2.19	3.7
Inga vera	Jinicuil	4	1.01	28.57	2.02	0.11	0.67	3.7
Byrsonima crassifolia	Nanche	4	1.01	28.57	2.02	0.1	0.62	3.65

Annona muricata	Anona	4	1.01	28.57	2.02	0.07	0.42	3.45
Acacia collinsii	Conizuelo	4	1.01	28.57	2.02	0.01	0.04	3.06
Parmentiera aculeata		6	1.51	14.29	1.01	0.09	0.52	3.04
Achatocarpus nigricans		4	1.01	14.29	1.01	0.17	1.02	3.03
Brosimum alicastrum	Ramón	2	0.5	14.29	1.01	0.23	1.37	2.88
Eugenia pleurocarpa	Guayabillo	6	1.51	14.29	1.01	0.06	0.35	2.87
Randia sp.	Peludo	6	1.51	14.29	1.01	0.06	0.34	2.85
Nectandra martinicensis	Verdoso	6	1.51	14.29	1.01	0.05	0.32	2.84
Desconocida	Cascarudo	2	0.5	14.29	1.01	0.18	1.1	2.61
Jacaratia mexicana	Bonete	6	1.51	14.29	1.01	0.01	0.04	2.56
Trece especies más		30	7.52	185.77	13.13	0.42	2.43	23.15
TOTAL		398	100	1414.2	100	16.54	100	300

Sourcee: elaboración propia a partir de datos en campo.

Structure

The mean basal area was 2.1 m2 ha-1 for the POE and 2.3 m2 ha-1 for the PE. The height of the arboreal vegetation was superior in the east polygon with 10.5 m for the west polygon was 5.95 m. The canopy cover is higher in the east polygon (60.00 m2 m-2) than in the west (33.7 m2 m-2). Regarding the diameter at breast height, the POE has a mean diameter of 0.18 m being lower than that observed in the PE of 0.22 m (Table 2).

Table 2. *Structural attributes of tree vegetation*.

Atributo	Polígono Oeste (UM 1-4)	Polígono Este (UM 5-7)
Área Basal (AB, m^2 ha^{-1})	2.1	2.3
Diámetro (DAP) (m)	0.18	0.22
Altura total (m)	5.95	10.50
Cobertura (m^2 m^{-2})	33.7	60.0

Source: elaboración propia a partir de datos en campo.

Diversity of species

The diversity indexes calculated for both polygons did not present significantly different values (t, p> 0.05) of richness (DMg) and diversity (H ') (Table 4). Equity index (E) was not significantly different (t, p> 0.05) between conditions and indicated that dominance in the community was distributed in several species (Table 4). Considering the data in the table to calculate t values and degrees of freedom (gl), species diversity (H ') in the west and east polygon conditions was not significantly different (Table 3).

Table 3. *Wealth, diversity and equity measures of species per sampling unit*.

	POLIGONO OESTE					POLIGONO ESTE			
	UM1	UM2	UM3	UM4		UM5	UM6	UM7	
Riqueza específica (*S*)	18	13	12	17	**37**	12	5	9	**17**
número de individuos (*N*)	54	30	62	98	**244**	64	54	36	**154**
Equidad (*E*)	0.30	0.30	0.25	0.28	**0.37**	0.23	0.16	0.15	**0.22**
Índice de Margaleg (*DMg*)	26.55	31.14	25.66	23.10	**19.27**	25.47	26.55	29.56	**21.03**
Índice de Simpson (*D-1*)	14.46	22.90	8.64	10.40	**20.91**	5.20	2.47	3.54	**3.76**
Índice de Shannon (*H'*)	1.17	1.14	0.98	1.09	**1.43**	0.88	0.61	0.59	**0.86**
Alfa de Fisher (*α*)	9.45	10.22	4.43	5.94	**12.14**	4.36	3.08	1.58	**5.29**

Prueba de t para dos muestras sin diferencias significativas. Fuente: elaboración propia a partir de datos en campo.

The specific richness for the western polygon was 37, presenting higher value than the east 17 polygon, the equity index was 0.37 for POE and 0.22 PE.

For the Margaleg Index (DMg) the POE had a value of 19.27 and the EP was 21.03 being greater for the EP. In a different way, the Simpson Index (D-1) 20.91, Shannon Index (H ') 1.43 and Fisher's Alpha (12.14) were found to be larger for the west polygon,) Was 3.76, the Shannon Index (H ') was 0.86 and Fisher's Alpha was 5.29, indicating greater diversity for the POE. From the analysis by unit of sampling in general the highest values of diversity were shown by the UM1 and UM2 of the POE, on the contrary the lowest values were presented by the UM 6 and 7 as shown in table 4.

Floristic similarity

For the POE and PE the similarity conditions were low (11% Sorensen), while the Jaccard index was 5% (Table 4).

Table 4. *Coefficients of floristic similarity between two ecological conditions*.

Unidades comparadas		Riqueza en POE	Riqueza en PE	Especies compartidas	Coeficiente de semejanza	
					Sorensen	Jaccard
POE	PE	37	17	3	0.11	0.05

Fuente: elaboración propia apartide datos en campo.

In reference to the similarity coefficients, for the POE the similar UMs were 1 and 2 (*JC*: 68.42%), la UM 4 y 3 (*JC*: 20.83%) y la UM 3 y 2 (*JC*: 18.18%), para el PE fue la UM 6 y 7 (*JC*: 16.66%) y las UM 5 and 7 (*JC*: 13.33%) as shown in Table 5.

Table 5. *Floristic resemblance coefficients between sampling units*.

	UM1	UM2	UM3	UM4	UM5	UM6	UM7
UM1	*	**68.42**	**20**	9.37	11.11	8	4.54
UM2	*	*	18.18	6.89	13.04	9.52	5.55
UM3	*	*	*	**20.83**	**20**	10.52	6.25
UM4	*	*	*	*	3.57	4	4.76
UM5	*	*	*	*	*	**40**	13.33
UM6	*	*	*	*	*	*	**16.66**
UM7	*	*	*	*	*	*	*

Source: elaboración propia apartide datos en campo.

Discussion

*Peltogyne mexicana w*as dominant in the eastern polygon conditions, while Coccoloba barbadensis was in the western polygon conditions. These species were reported for the medium subperennifolian forests of Yucatan, the Gulf slope, Guerrero and Quintana Roo (Pennington and Sarukhán, 1968).

Based on estimated wealth estimates for each UM, Chao 1 (estimator of number of possible species on a sampled area): is an estimator based on abundance, which attempts to predict the number of probable species to be found in an area . This indicates that the sampling area was insufficient to find the maximum number of species (Chao et al, 2004). This calculation only considers the species present and their incidence, but does not consider the physical or biological characteristics of the surfaces, based on the above the slope in the study areas was greater than 35% and a medium-high rocky, the Which are factors that restrict the abundance of species (Mazzola, 2008).

These can be one of the factors of discrepancy with what is projected by the Chao 1 estimator and what is found in the sampling units as shown in Table 6.

Table 6. *Chao 1 wealth estimator per POE and PE sampling unit.*

UM	Riqueza	Chao 1
1	18	12.6
2	13	19
3	12	30.6
4	17	34.8
5	12	39.6
6	5	43
7	9	47

Source: elaboración propia apartide datos en campo.

As for the degree of conservation in the EP, there are no species introduced in the sampled area which indicates a lower degree of disturbance, for the POE introduced species are observed, which shows the degree of alteration in this type of vegetation.

In the two forest development conditions, fewer individuals per hectare were observed in 906 (D, ind. Ha-1), which was lower than that obtained by Toledo (2008), in a medium-growing forest of Chiapas with Densities of 2046, but different from that mentioned by Godínez and López (2002) in a subperennifolia low forest of Veracruz obtaining densities of 4919, thus, the PNV densities are low where the rockiness can be an important factor.

Of the four species with the highest value of importance (IVI), only one species coincides with that reported by Zamora et al. (Justavino et al., 2012), considering the environmental differences between the Iberian peninsula and the Iberian peninsula, in the middle sub-deciduous jungle of Yucatan, where B. simaruba is considered to be due to the estimation of each index. Yucatan and the PNV.

The results in terms of dominance, number of species and similarity between sites, considering the physical characteristics of the east polygon, the values are lower in diversity. Compared with the PNV and other medium-sized forests of Mexico, the physical and environmental characteristics of this National Park could restrict the distribution of the species and with this the values of diversity and composition; So that species such as P. mexicana and B. simaruba are adapted to conditions of high rockiness and strong slopes.

Reviewing the POE, diversity values are relatively higher than in the EP but are still low compared to other forests in Mexico. The characteristic of this polygon is that the forest is restricted to creeks and inaccessible places, with the consideration that the proximity of the Community of Carabali, the construction of roads and grazing activities are factors that have modified, restricted and altered the Distribution of this type of vegetation. The low diversity indices found represent the conditions of the sampled areas as the medium subperennifolia forest develops under strong conditions of slope and rockiness which could limit growth and wealth.

In relation to the Shannon-Wiener diversity index, the values found in the present study (POE 1.43 and PE 0.83) were low compared to those obtained in other studies 3.09 in the medium subperennifolia forest of Veracruz (Godínez and López, 2002 and Villavicencio y Valdez, 2003), and 3.54 the estimated average for other jungles of Yucatan.

In the present study, the Shannon-Wiener index in both conditions showed to be low, because it represents a smaller number of individuals and species, due to the dynamics of the forest, since it is an area where the soil conditions And other environmental factors restrict the composition and structure of vegetation (Martínez and García, 2008).

The richness and diversity of species was higher in the SSE condition, in accordance with what was described by Ugalde et al. (2009) for communities with some degree of disturbance in their structure and composition. In contrast, lower dominance and equality in abundance of species was obtained for the EP condition, which coincides with later stages of succession or development in jungles (Zarco et al., 2010; López et al., 2012).

The value of the Simpson index (S) in the POE was similar to that obtained by Godínez and López (2002) in the medium subperennifolia forest of Vega de Alatorre, Veracruz and Zarco et al., (2010), in the mid- Macuspana Tabasco. And in the EP was lower than the previous authors reported, indicating these values that there is dominance of some species.

The Equity Index (E) was lower than that obtained by Villavicencio and Valdez (2003), in a medium subperennifolia forest of Amatlán de los Reyes, Veracruz, and also smaller than the median subcaducifolia forest that Zamora et al. (2008), estimated in Tuzcacab state of Yucatan.

CONCLUSIONS

In the sampled area there were 46 arboreal morphospecies: 37 in the POE and 17 in the PE sharing some species Astronium graveolens and Plumeria rubra, in a different way species like Peltogyne mexicana are only distributed in the PE having a restricted distribution.

The West polygon presented higher values of diversity and wealth; However, it presented values of minor structural attributes and a greater diversity of species, besides great floristic similarity between sites; In contrast, the EP showed higher structural values and lower species diversity and floristic difference.

Diversity values are low compared to other medium-sized forests in Mexico. However, no significant differences were observed in diversity values; in general, low values are compared with other forests in the southeast of the country, but distribution species Restricted and listed in NOM-059-SEMARNAT-2010, so they are important from the point of view of its conservation.

Bibliography

Chao A., Chazdon L. R., Colwell K. R. y Tsung-Jen S. (2004). Un nuevo método estadístico para la evaluación de la similitud en la composición de especies con datos de incidencia y abundancia. Traducción del artículo publicado en: *Ecology Letters*, 8, 148-159.

Comisión Nacional Forestal, (CONAFOR). (2009). Inventario nacional forestal y de suelos. (2005-2009). Extraído el 16-01-2015. http://www.cnf.gob.mx/.

Curtis, J. T. y R. P. McIntosh. (1951). An upland forest continuum in the prairie-forest border region of Wisconsin. *Ecology* 32, 476-496.

Godínez I., O. y L. López M. (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.

Holdridge, L. R., W. Grenke, W. H. Hatheway, T Liang y J. A. Tosi. (1971). Forest environments in tropical life zones: a pilot study. *Pergamon Press*. Oxford.

Justavino, F. C., Hernández, J. I. V., Alcalá, V. M. C., Cossio, F. V. G., Santos, A. T., & Rivera, J. R. A. (2012). Estructura forestal de un bosque de mangles en el noreste del estado de Tabasco, México. *Revista Mexicana de Ciencias Forestales*, *26*(90).

Magurran, A. E. (1988). Ecological diversity and its measurement. Princeton, New Jersey: *Princenton University Press*.

Margalef, R. (1977). Ecología. Barcelona: Ediciones Omega.

Martínez R., M. y X. García O. (2008). Demografía de plantas y regeneración de selvas en campos degradados. En: Sánchez V., L.R., J. Galindo G. y F. Díaz F. (Eds). Ecología, manejo y conservación de los ecosistemas de montaña en México. México, D.F.: CONABIO, Universidad Veracruzana y Mundi-Prensa.

Martinez, D. (2003). Protected areas, indigenous peoples and the western idea of nature. *Ecological Restoration* 21, 247-250.

Mazzola, M. B. (2008). Efecto del gradiente altitudinal sobre la vegetación de las sierras de Lihue Calel (La Pampa, Argentina). *Bol. Soc. Argent. Bot.* (43),1-2, 103-109.

Norma Oficial Mexicana 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.

Pennington, T.D. y Sarukhan, J. (1968). Arboles Tropicales de México (5ª ed.). México: INIF y FAO.

Rzedowski, J. (1978). Vegetación de México. México, D. F.: Ed. Limusa.

Secretaría de Medioambiente Recursos Naturales, (SEMARNAT). (2002). Subsecretaría de Gestión para la Protección Ambiental, Dirección General de Federalización y Descentralización de Servicios Forestales y de Suelo, México.

Toledo L., J. F. (2008). Estructura e Importancia Cultural de la Vegetación Arbórea en la Mica, Chiapas. Tesis para obtener el grado de maestro en ciencias. Colegio de Postgraduados. Montecillo, Texcoco, México.

Ugalde L, S., J. I. Valdez H., G. Ramírez V, J. L. Alcántara C. y J. Velázquez M. (2009). Distribución vertical de aves en un bosque templado con diferentes niveles de perturbación. *Madera y bosques*, 15 (1), 5-26.

Valdez-Hernández, J. I. (2002). Aprovechamiento forestal de manglares en el Estado de Nayarit, Costa Pacífica de México. *Madera y Bosques* Núm. especial: 129-145.

Villavicencio E., L. y J. I. Valdez H. (2003). Análisis de la estructura arbórea del sistema agroforestal rusticano de café en San Miguel, Veracruz, México. *Agrociencia*. 37, 413-423.

Zamora C. P., G. García G., J. S. Flores G. y J. J. Ortiz. (2008). Estructura y composición florística de la selva mediana subcaducifolia en el sur del estado de Yucatán, México. *Polibotánica*. 26, 36-66.

Zarco E. V. M., J.I. Valdez H., G. Ángeles P. y O. Castillo A. (2010). Estructura y diversidad de la vegetación arbórea del Parque Estatal Agua Blanca Macuspana, Tabasco. *Universidad y Ciencia Trópico Húmedo*. 26(1), 1-17.