

Relationship between Use Value and Ecological Importance of Floristic Resources of Seasonally Dry Tropical Forest in the Balsas River Basin, México¹

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Relationship between Use Value and Ecological Importance of Floristic Resources of Seasonally Dry Tropical Forest in the Balsas River Basin, México. The use of seasonally dry tropical forest in the Balsas River Basin, Mexico was utilized as a model to study the relationship between the use value and the ecological importance of wild flora in nine study sites that have an indigenous-Mestizo cultural gradient. Ethnobotanical data from the area were used to obtain the use value per species and correlate it with the ecological importance value of the species found in 0.9 ha. We test the hypothesis that the most used species are the most ecologically important and that this relationship is affected by the changing cultural process that occurs in Mexican rural communities. We registered 320 species, 56.25 % of which are useful and fall into twelve use categories. The study sites showed similar percentages of useful plants. We found relationships between the use value of the species and of the main categories (medicinal, construction, firewood, and food) with the ecological importance value. The frequency was the ecological attribute that determined the use of species in the main categories of use, while the density and dominance attributes were related respectively to the medicinal and food categories. There were differences regarding cultural groups. Indigenous groups mentioned the use of medicinal, edible, and firewood plants more frequently, whereas the Mestizo group pointed out more species used for construction.

Relación entre valor de uso e importancia ecológica de los recursos vegetales del bosque estacional seco en la cuenca del Río Balsas, Mexico. El uso de la bosque tropical caducifolio de la Cuenca del Río Balsas, México, se utilizó como modelo para estudiar la relación entre el valor de uso y la importancia ecológica de la flora silvestre de nueve sitios de estudio que tienen un gradiente cultural indígena-mestizo. Se consideró información etnobotánica del área para estimar el valor de uso de las especies y se relacionó con el valor de importancia ecológica de las especies encontradas en 0.9 ha. Ponemos a prueba la hipótesis de que las especies más utilizadas son las de mayor importancia ecológica y que esta relación se ve

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afectada por el proceso de cambio cultural que se presenta en las comunidades rurales mexicanas. Se registraron 320 especies, 56.25 % de ellas son útiles y corresponden a 12 categorías de uso. Los sitios de estudio mostraron el mismo porcentaje de plantas útiles. Encontramos relación entre el valor de uso de las especies y de las principales categorías (medicinal, construcción, leña y alimentos) con el valor de importancia ecológica de las diferentes especies. La frecuencia fue el atributo ecológico que determinó el uso de las especies en las principales categorías, mientras que los atributos de densidad y dominancia se relacionan con las categorías de medicina y alimentos, respectivamente. Hubo diferencias con respecto a los grupos culturales, los grupos indígenas mencionan más especies con usos medicinal, alimenticio y para leña, mientras que el grupo mestizo señaló más especies usadas para construcción. En términos generales, las especies más notables son las más frecuentemente mencionadas como útiles.

Key Words: Useful plants, use value, ecological importance value, seasonally dry tropical forest, ethnobotany.

Introduction

What makes some plant species more important to people than others? Are there patterns of useful plants selection by humans? These are central questions in ethnobotany that have not been thoroughly answered. A number of scholars have addressed these questions from either biological or cultural perspectives. The influence of factors such as culture, palatability, smell, visibility, or quality of the plant have been widely stressed (Hanazaki et al. 2010; Holbrook et al. 1995; Pieroni 2001; Ramos et al. 2008; Turner 1988). Cultural consensus based mostly on the number of uses recorded for a plant species independently of its frequency of utilization have also been investigated (Phillips and Gentry 1993a, 1993b).

The importance of ecological variables related to the use of plants has been pointed out by other authors, including Phillips and Gentry (1993b), Galeano (2000), Cunha and Albuquerque (2006), and Thomas et al. (2009), and it has been often presumed that plant density or frequency determines plant accessibility to people. It has also been suggested that ecological salience of a species—for example, abundance, height, and diameter at breast height—have also influenced its recognition by humans (Hanazaki et al. 2010). A recent approach suggests the existence of a close relationship between the use value of a species and its ecological importance value (Cunha and Albuquerque 2006).

Studies about knowledge, use, and management of plant diversity in Mexico and other world regions show the existence of common patterns that local populations employ to select useful plants, and to classify and rank these plant resources (Berlin and Berlin 2005; Caballero et al. 2001; Moerman et al. 1999). However, Albuquerque et al. (2005) and Lucena et al. (2007) reported variations in the characteristics that affect patterns of use between

communities, even in areas of relatively close proximity. These differences in use patterns appear to be due to the heterogeneity of the flora of tropical ecosystems, and so are only valid within specific biocultural contexts. These patterns may be affected by the nature of the cultural processes of knowledge acquisition and transference, as well as by the local characteristics of the flora and the surrounding environment.

Based on the ecological apparency hypothesis for explaining herbivore behavior (Feeny 1976; Rhoades and Cates 1976), and its adaptation to ethnobotany by Phillips and Gentry (1993a, 1993b), various scholars have recorded human uses and collected the most abundant and conspicuous useful species (Albuquerque and Lucena 2005; Kristensen and Balslev 2003; Lawrence et al. 2005; Lucena et al. 2007; Thomas et al. 2009). The ecological apparency hypothesis has been tested in rainforests of South America and Mexico in different contexts (Cunha and Albuquerque 2006; Galeano 2000; Kristensen and Balslev 2003; Torre-Cuadros and Islebe 2003), but dry forest plants and their uses have received little attention (Albuquerque et al. 2005; Lucena et al. 2007). Albuquerque et al. (2005) and Lucena et al. (2007) suggested that people may follow different strategies for using plant resources in arid and semiarid regions in comparison to those in rainforests, since in dry environments they depend on water availability. This has been recently shown by Albuquerque (2010) in the case of medicinal plants. However, more data are needed in other seasonally dry tropical forests to determine whether this is a common pattern.

Mexico is a culturally and biologically rich country where human-plant interactions have developed intricately over time and space (Caballero et al. 2001). The accelerating loss of

ethnobiological knowledge by culture change raises the need for studies of specific ecological factors that relate to the uses of plants on the local, regional, and national scale.

Seasonally dry tropical forests (SDTF) are the most representative of Mexico's ecosystems (Dirzo and Ceballos 2010). These forests have been strongly affected by deforestation (Trejo and Dirzo 2000), and Murphy and Lugo (1986) consider the affinity of humans for these areas as a possible cause of extensive damage to their communities. For these authors, low canopy height facilitates clearings for conversion to agricultural land. Fertile soils and a relatively benign climate have made dry forest more suitable for livestock activities than those in tropical rain forests.

The interaction of human groups with SDTF in Mexico dates back to 6000–8000 B.C.E. During the Classical and Postclassical periods, several pre-Hispanic groups settled in the SDTF (Balvanera and Maass 2010). Currently, of the 54 ethnic groups known for Mexico, 23 live near or in the seasonally dry tropical forests, and those groups have shown a deep understanding of their environment (Bye 1995). More than 600 plant species have been reported to be used for medicine, food, construction, and many other purposes (Bye 1995; Maldonado 1997; Soto 2010). The SDTF is the vegetation type in which the population utilizes the largest proportion of its plant species (Maldonado 1997; Soto 2010).

The role of ecological factors in Mexican dry forest plant use has been investigated by several authors (Casas et al. 1996; Maldonado 1997; Monroy-Ortiz and Monroy 2004), but only in a limited capacity. This paper analyzes the ethnobotanical relationship between use value (UV) and ecological importance value (EIV) by means of a case study of seasonally dry tropical forests in Mexico's Balsas River Basin. We test the hypothesis that the most commonly used species are the most conspicuous regardless of the floristic heterogeneity of these forests. We also propose that this relationship is affected by the changing cultural situation that is occurring in Mexican rural communities.

Methods

STUDY AREA

The study was conducted in the Balsas River Basin (BRB), a depression with an east-west

direction, in the southern central part of Mexico that includes parts of the states of Tlaxcala, Puebla, Oaxaca, Estado de Mexico, Guerrero, Michoacán, Jalisco, and the entire state of Morelos. Just over 20 % of the country's forest cover is found on the BRB, of which seasonally dry tropical forests is the most common (Rzedowski 1978).

Nine sites that belong to the states of Guerrero, Morelos, and Puebla were selected mainly for their demographic composition and proximity to less disturbed SDTFs: Teocalcingo, Mezquitlan, and Temaxcalapa in Guerrero; El Limón de Cuachichinola, Santa Catarina, and Cuentepec in Morelos; and Quetzotla, Xochitepec, and Huehuepiactla in Puebla. All sites are situated in the upper and middle regions of the BRB (Fig. 1). Formerly inhabited by Olmecs, at present the region is occupied by Mestizos and indigenous Nahuatl speakers. These groups, in combination with the SDTF, comprise a biocultural matrix whose primary productive activities are rain-fed agriculture, cattle ranching, and extraction of timber and non-timber products.

SELECTION OF SAMPLING SITES

We chose seasonally dry tropical forest sites that were perceived by the researchers and the local residents to be the least disturbed, so as to eliminate as much as possible the effect of ongoing human vegetation management. Human populations were selected that were in close proximity to the vegetated study sites. Selected sites represented a gradient of cultural change with varying proportions of indigenous and Mestizo individuals. Three main groups were recognized. The first group comprises indigenous villages where over 50 % of the population speaks Nahuatl and whose settlement dated from pre-Hispanic times. Less than 50 % of the second group speaks the language, but the settlement has existed for over 100 years. The third group includes towns less than 100 years old and whose inhabitants speak only Spanish. Nine localities, three sites in each group, were studied (Table 1).

Approval from the local authorities was obtained before the study began. Once the participation of the community was approved, the sampling area was jointly defined by researchers, local authorities, and owners of the chosen properties. The active participation of experienced

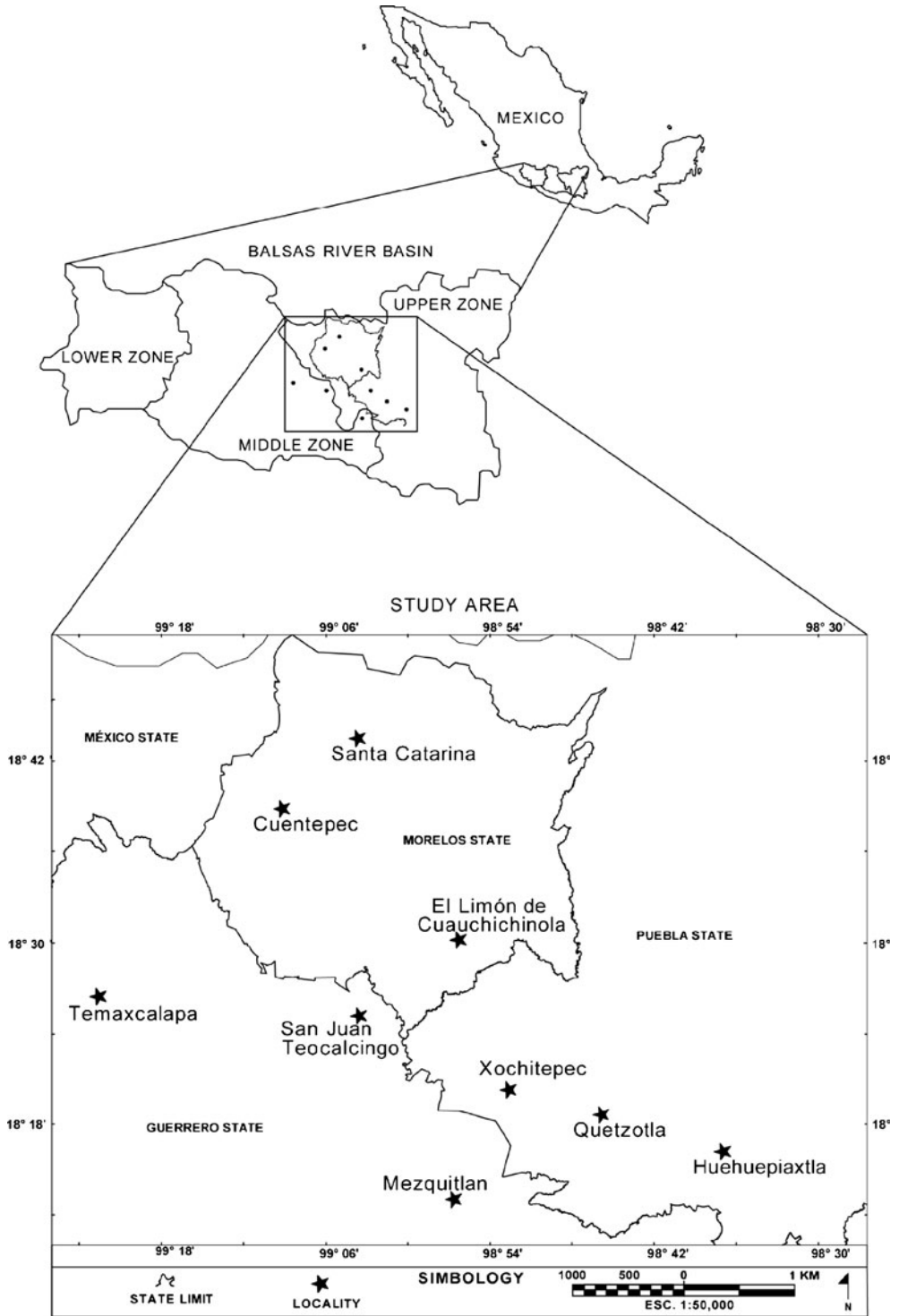


Fig. 1. Geographical location of the study area in the Balsas River Basin, México; the BRB has traditionally been divided as upper, middle, and lower regions, our study sites are located in the upper and middle regions, comprising localities in the states of Guerrero, Morelos, and Puebla.

Table 1. LOCATION OF STUDY SITES FOR EACH LOCALITY, MUNICIPALITY, AND STATE, TOTAL POPULATION, TOTAL NUMBER AND PERCENTAGE OF NAHUATL-SPEAKING INDIVIDUALS, SETTLEMENT TIME, AND CULTURAL GROUP.

Sites	Locality/Municipality/State	Total Population	Total of Nahuatl-speaking Individuals	Percentage of Nahuatl-speaking Individuals	Time since Settlement (years)	Cultural Group
I	Cuatepec, Temixco, Morelos	3105	2596	70	350	Indigenous
II	Mezquitlán, Copalillo, Guerrero	333	190	60	300	Indigenous
III	Xochitepec, Jolalpan, Puebla	1092	611	68	300	Indigenous
IV	Huehuetzi, Axutla, Puebla	338	19	15	220	Heterogeneous
V	Sta. Catarina, Tepoztlán, Morelos	4144	798	20	200	Heterogeneous
VI	Teocalcingo, Atenango del Río, Guerrero	713	54	10	180	Heterogeneous
VII	Temaxcalapa, Taxco, Guerrero	770	0	0	85	Mestizo
VIII	El Limón de Cuauichinola, Tepalcingo, Morelos	171	0	0	75	Mestizo
IX	Quetzotla, Chiautla, Puebla	292	1	0	48	Mestizo

informants, chosen by the community, was also agreed upon.

ESTIMATING THE ECOLOGICAL IMPORTANCE VALUE OF THE SPECIES

Ten 50×2.0 m plots (0.1 ha each), distributed within the area occupied by the seasonally dry tropical forest, were established in the nine sites (0.9 ha in total). The information gathered in these plots was the diameter at breast height (DBH) (>1.0 cm of all woody individuals) and the basal diameter (BD) of all lianas rooted within the plot (Gentry 1982, 1988, modified by Trejo and Dirzo 2002). Data on the basic structural parameters, density, dominance, and frequency were also recorded. Using the relative value of these parameters, we estimated the ecological importance value (EIV) according to Mueller-Dombois and Ellenberg (1974), by using the following formula,

$$\text{EIV} = \text{Relative Dominance} + \text{Relative Density} \\ + \text{Relative Frequency}/3$$

A matrix of presence and absence and a similarity analysis (Jaccard index) were developed for each of the species using the floristic richness from each site. Botanical specimens collected in

each of the sites were taxonomically identified and deposited in the HUMO Herbarium (Universidad Autónoma del Estado de Morelos) and in MEXU Herbarium (Universidad Nacional Autónoma de México).

ESTIMATING THE USE VALUE

In each of the study sites we selected six experienced informants (54 in total), all native to the study area. All were men over 40 years old who, according to the community, had experience in the use of plants and were engaged in primary productive activities.

The informants were asked about Spanish and/or Nahuatl common names of each plant, as well as their use(s) from a random sample of plant individuals in the forest plots. With this information and the use of the algorithm proposed by Phillips and Gentry (1993a, 1993b), as modified by Rossato et al. (1999), we calculated the use value (UV) of the species used. This index was estimated as the sum of the uses recognized by each informant for each species divided by the total number of informants according to the following formula: $UV_s = (U_{is})/N$, where U_{is} equals the number of uses mentioned by informant i , for species s . N is the total number of

informants interviewed for each species. Thus, the use value is the average of uses reported for each species by the 54 informants. For the purpose of the analysis, these species then were grouped according to their main use categories.

A non-parametric Kruskal-Wallis test was used to assess the differences between the number of reported species and the percentage of useful species, and a Mann-Whitney test was used to calculate the differences between number of species per use category among the most contrasting cultural groups (indigenous and Mestizo).

USE VALUE AND ECOLOGICAL IMPORTANCE VALUE

The relationship between use value and ecological importance value was estimated by first doing a simple regression analysis using all the UV data as the responsive variable and the EIV of the species as the explanatory variable. This same comparison was done after separating the data by site. A multiple regression analysis was carried out to estimate the relationship between UV and EIV, but using the four use categories listed as the most important according to the number of useful species. A multiple regression analysis was used to assess the contribution of each ecological attribute (frequency, density, and dominance) to the UV by category.

A linear model of mixed effects was used to determine if the UV is affected by the EIV in the different communities studied. The fixed components of the model were the cultural groups; the random components were the EIV variables for each site. The UV and the EIV were transformed to their natural logarithm to normalize the residuals. The *lme* procedure (Pinheiro et al. 2009) of the R program version 2.8.1 (R Development Core Team 2009) with the maximum verisimilitude option was used to adjust the mixed model. The statistical significance of the terms of the fixed model was tested with the χ^2 values, and the differences in degree of freedom were obtained by comparing the adjustment between the more complex models with the simplest one.

Results

FLORISTIC RICHNESS AND SIMILARITY BETWEEN SITES

There were a total of 320 species belonging to 187 genera and 61 botanical families in the nine

sites. According to the number of species, the most representative families were: Fabaceae (51), Burseraceae (20), Asteraceae (14), Euphorbiaceae (10), Malpighiaceae (9), Cactaceae (8), Convolvulaceae (8), Anacardiaceae (7), Apocynaceae (7), and Rubiaceae (6). The nine sites were floristically very heterogeneous, and the similarity analyses revealed that only sites I and VII were similar, sharing 35 % of species. Additionally, all sites shared only five species, three trees—*Bursera copallifera* (DC.) Bullock, *Comocladia engleriana* Loes, *Lysiloma divaricatum* (Jacq.) J.F. Macbr., and two lianas—*Cissus sicyoides* L. and *Serjania triquetra* Radlk.

Of the species recorded, 180 (56.25 %) were useful plants corresponding to twelve use categories. Of these, 94 fell into a single use category and 86 had multiple uses. The most important use categories from the number of species reported for all sites were as follows: medicinal (48.8 %), construction (34.4 %), firewood (25 %), and food (17.7 %).

The Kruskal-Wallis test showed no significant differences between sites ($p < 0.63$) compared to the number of species reported per site and to the number of species listed as useful per cultural group. Each case involved the use of about 60 % of the species found. The same was true when comparing the number of categories present per site using this same test. However, when considering use categories and the two contrasting groups, the Mann-Whitney test showed significant differences between groups ($p < 0.05$) in the medicinal, construction, firewood, and food use categories. Indigenous peoples mentioned more species for medicine, food, and firewood than the Mestizo informants, whereas the latter reported more species for construction than the indigenous informants (Table 2).

USE VALUE AND ECOLOGICAL IMPORTANCE VALUE OF SPECIES

The regression of UV related to the EIV of each species per site showed a significant relationship ($p < 0.05$) between both factors in only four of the nine sites, three belonging to the indigenous group and one to the Mestizo group (Table 3). In addition, when all sites were analyzed together, a significant relationship was found between the UV and the EIV of all useful species and the four main use categories (Fig. 2).

Table 2. AVERAGE AND STANDARD DEVIATION OF THE NUMBER OF SPECIES PER USE CATEGORY AND PER CULTURAL GROUP IN THE NINE STUDY SITES AND THE SIGNIFICANCE VALUES ($P < 0.05$), USING THE MANN-WITNEY TEST BETWEEN THE TWO CONTRASTING GROUPS (INDIGENOUS AND MESTIZO). *COMPARISON WAS ONLY MADE FOR THE MAIN CATEGORIES BECAUSE MORE DATA ARE NEEDED FOR THE REMAINDER.

Use Categories	Indigenous ($\bar{x} \pm SD$)	Heterogeneous ($\bar{x} \pm SD$)	Mestizo ($\bar{x} \pm SD$)	p
Medicinal	27.7 (± 2.08)	20.0 (± 4.58)	17.3 (± 4.73)	$p < 0.049$
Construction	12.7 (± 1.15)	16.7 (± 4.04)	17.0 (± 2.65)	$p < 0.046$
Firewood	16.0 (± 2.65)	12.7 (± 3.21)	10.0 (± 1.0)	$p < 0.049$
Food	10.7 (± 1.53)	8.7 (± 0.58)	5.3 (± 0.58)	$p < 0.046$
Live Fence	5.3 (± 1.15)	5.0 (± 3.61)	3.0 (± 1.0)	
Domestic	2.0 (± 0)	2.0 (± 1.0)	1.7 (± 0.58)	
Ornamental	1.7 (± 1.15)	3.3 (± 1.15)	1.3 (± 0.58)	
Fodder	1.3 (± 0.58)	1.3 (± 0.58)	2.3 (± 0.58)	
Crafts	2.3 (± 0.58)	0.3 (± 0.58)	0.3 (± 0.58)	
Toxic	1.0 (± 0)	1.0 (± 0)	1.0 (± 0)	
Rituals	3.3 (± 1.15)	2.3 (2.08)	3.0 (± 1.0)	
Tanning	0.0 (± 0)	0.3 (0.58)	0.3 (± 0.58)	

The multiple regressions between the UV per category and the relative values of frequency, density, and dominance of the species showed a significant relationship for species frequency in all categories, while the attributes of density and dominance were only significant for the medicinal plants and edible plants, respectively (Table 4).

The ten species with the highest EIV were *Lysiloma divaricatum*, *Bursera copallifera*, *Conzattia multiflora* (B.L. Rob.) Standl., *Euphorbia schlechtendalii* Boiss., *Heliocarpus terebinthinaceus* (DC.) Hochr., *Serjania triquetra*, *Pseudosmodingium perniciosum* (Kunth) Engl., *Amphipterygium adstringens* (Schltdl.) Standl., *Ceiba aesculifolia* (Kunth) Britten & Baker, and *Cyrtocarpa procera* Kunth. The species with the highest UV were *Bursera copallifera*, *Lysiloma divaricatum*, *Haematoxylum brasiletto* H.

Karst., *Lysiloma acapulcense* (Kunth) Benth., *Leucaena esculenta* (Moc. & Sessé ex DC.) Benth., *Plumeria rubra* L., *Senna skinneri* (Benth.) H.S. Irwin & Barneby, *Eysenhardtia polystachya* (Ortega) Sarg., *Bursera bipinnata* (DC.) Engl., and *Guazuma ulmifolia* Lam.. The five species common to all sites were reported as utilized for the same purposes. The list of 180 species recorded in the nine sites and their respective density, frequency, and dominance values, as well as their ecological importance and use values are listed in Appendix 1. (Electronic Supplementary Material).

The mixed model results showed no significant interaction between the degrees of cultural change (indigenous, Mestizo, and heterogeneous groups) and the EIV ($\chi^2 = 1.81$, $g.1 = 1$, $p = 0.40$), so they

Table 3. SIMPLE REGRESSIONS BETWEEN USE VALUES (UV) AND THE ECOLOGICAL IMPORTANCE VALUES (EIV) OF THE SPECIES FROM EACH OF THE NINE STUDY SITES AND OF ALL USEFUL SPECIES ANALYZED TOGETHER AND THE SIGNIFICANCE VALUES ($P < 0.05$).

Sites	Cultural Group	r^2	F	p
I	Indigenous	0.089	4.990	0.030
II	Indigenous	0.80	4.026	0.050
III	Indigenous	0.091	5.534	0.022
IV	Heterogeneous	0.047	1.886	0.177
V	Heterogeneous	0.46	1.363	0.248
VI	Heterogeneous	0.018	1.012	0.319
VII	Mestizo	0.041	1.330	0.569
VIII	Mestizo	0.42	0.169	0.583
IX	Mestizo	0.16	8.65	0.005
Total Usefulness		0.497	179.278	<0.001

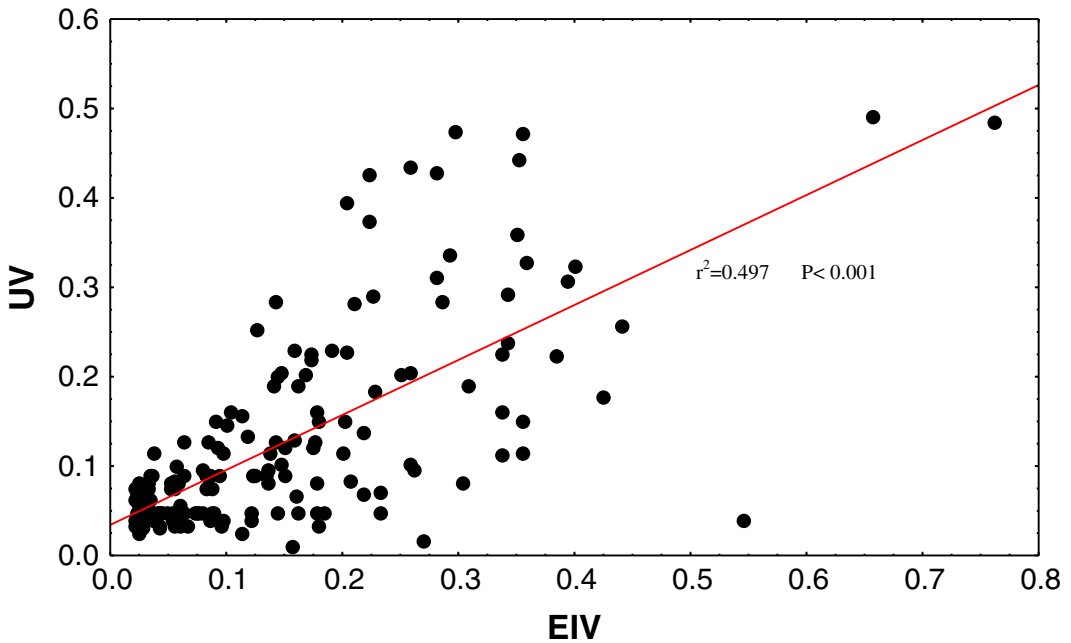


Fig. 2. Linear regression between use values (UV) and ecological importance values (EIV) of useful species in seasonally dry tropical forest in the Balsas River Basin.

were removed from the model. The simplified model indicated a highly significant positive relationship between the EIV and the UV ($\chi^2=22.00$, $d.f.=1$, $p<0.001$), as well as a marginally significant difference between cultural groups and UV ($\chi^2=5.37$, $d.f.=1$, $p=0.058$).

Discussion and Conclusion

Our results support the hypothesis that the seasonally dry tropical forest species most used by people in the Balsas River Basin are those that are ecologically most important. This is true despite the high β diversity of these forests and the fact that there are few species with high ecological importance (Trejo 2005). No differences were

observed in the number of species mentioned by indigenous and Mestizo peoples. There were differences between the two groups, however, in terms of use categories. Indigenous people reported more species used as medicine, food, and firewood than Mestizos, whereas the latter reported more species used for construction. This is similar to the results reported by Lawrence et al. (2005) for a tropical rain forest use in Peru. In dry and humid forests, Albuquerque et al. (2005) and Cunha and Albuquerque (2006) reported that more than half of the species (52.25 %) were useful, and that the most important use categories were medicinal, construction, firewood, and food. The results of the present study are also consistent with those reported by Bye (1995) for this forest

Table 4. MULTIPLE REGRESSION ANALYSIS BETWEEN THE MAJOR CATEGORIES' USE VALUE (UV) AND FREQUENCY, DENSITY, AND DOMINANCE OF THE SPECIES IN ALL SITES.

Use Category	Frequency		Density		Dominance		r^2
	F	p	F	p	F	p	
Medicinal	158.93	<0.001	5.09	0.049	1.54	0.220	0.70
Construction	101.83	<0.001	0.30	0.585	0.60	0.443	0.63
Firewood	115.22	<0.001	0.41	0.524	0.36	0.552	0.71
Food	116.52	<0.001	1.41	0.245	4.24	0.027	0.80

type in Mexico. Other authors (Galeano 2000; Torre-Cuadros and Islebe 2003) found that in humid forests the larger number of useful plants were those used for construction. Similarly, species with multiple uses were fewer than those with a single use in both humid and dry forests of Mexico (Caballero et al. 2001; Toledo et al. 2003; Torre-Cuadros and Islebe 2003). Moreover, other studies demonstrated that multiple-use species are culturally more important (Caballero et al. 2001; Casas et al. 1996; Phillips and Gentry 1993a, 1993b; Pieroni 2001; Turner 1988), and our results show that multiple-use species also possess higher EIV values.

The most important families (in terms of number of species) in this study are the same ones shown by floristic studies in other Mexican SDTFs—Fabaceae, Burseraceae, Asteraceae, Euphorbiaceae, Cactaceae, and Anacardiaceae (Lott and Atkinson 2006; Trejo and Dirzo 2002). These have also been reported as most frequently used species in the habitat (Bye 1995). The Fabaceae family, for example, is the most speciose family in this type of vegetation and it has the highest number of useful species. These species are mainly used in traditional house construction, manufacture of farm tools, and as firewood, as noted elsewhere by Lucena et al. (2007) in Brazilian Caatinga, and by Casas et al. (1996) and Maldonado (1997) in the Balsas River Basin. The Burseraceae family, represented by the genus *Bursera*, is also widely used, with 13 of its 20 reported species having one or more uses. This is in agreement with Lucena et al. (2007), who reported that plant use value (UV) is strongly related to the botanical family.

The results of this study also suggest that the use of a given species may be an important factor in the UV-EIV relationship. The species with the highest UV and EIV were *Lysiloma divaricata* and *Bursera copallifera*, which were also the most widely distributed species in the study region. As suggested by Benz et al. (1994), their abundance is a result of human disturbance. During our fieldwork we observed regenerating stumps of *L. divaricata* in sites that have been managed, thus favoring the presence of the species. Moreover, resin extraction from *B. copallifera* does not damage the trees, so their density does not decrease. The only exception to this is *Conzattia multiflora*, which, despite exhibiting high EIV, presents a very low UV. Although this species is abundant in the SDTF, it is said to have very brittle wood and therefore is not often used.

When the main use categories on a regional level were analyzed, we found a significant relationship between the UV and the EIV in the three sites with indigenous peoples and only one site with Mestizo people. This suggests that culture has a differential impact on selection patterns and resource use according to use categories. Indigenous groups use more species as medicine, food, and firewood, whereas Mestizo groups tend to use more species for construction (c.f. Berlin and Berlin 2005; Caballero et al. 2001; Lawrence et al. 2005; Toledo et al. 2003), which could be due to the latter group's knowledge still being "general." This possibly was the case in the single Mestizo group with a significant relationship between UV and EIV, which may be going through a specialization process. It could also reflect the strong interest in environmental conservation that these people have developed during the last decades. In other Mexican Mestizo groups, change in the primary productive activity toward secondary and tertiary activities, plus a higher degree in formal education, could be eroding their traditional ecological knowledge (see also González-Insuasti and Caballero 2007 and Martínez-Ballesté et al. 2006).

The species' frequency was the attribute that best predicted UV in the four main categories—medicine, construction, firewood, and food. Density and dominance were respectively significant only for medicinal and food species. This is in agreement with the findings in humid forests by Thomas et al. (2009) and Torre-Cuadros and Islebe (2003), which showed that density, frequency, and DBH are significantly correlated with the same use categories. In contrast, our results were not consistent with those of Lucena et al. (2007) in the Brazilian Caatinga, where frequency is associated only with the medicinal category, while dominance is related to the construction category. Furthermore, Albuquerque et al. (2005) found that in dry forest the most important useful plants to local people are not necessarily the most abundant or ecologically important.

In this study, frequency is the best predictor of the use value of plants. This could be because of the heterogeneity of these forests and because related species of the same taxon have a high likelihood of co-occurring in the same narrow geographical environment (Lavin 2006). This translates to increased availability, reducing the

investment in time and effort when harvesting, especially in regards to timber extraction. Because species used as food are mostly trees (75 %) whose fruits are gathered, they need to be easily found, which could explain why dominance is also a significant factor in this use category. The strong relationship between food use and dominance may also be explained by the fact that larger trees produce more edible fruits and are thus more highly valued by people (Thomas et al. 2009). In the case of medicinal plants in which the relationship between density and the UV was also significant, we suggest that a higher frequency together with a greater density of individuals of these species could facilitate harvesting time and consequently increase the total amount of harvested product. Other studies in the SDTF have already suggested that the use of plants depends on their relative density (Benz et al. 1994), but this had not been tested for each of the use categories.

This study shows that regardless of sociocultural differences, the most important useful plants for local populations are also the most ecologically important, especially those with the highest frequency. The highest ecological importance value of these species seems to be the end result of their evolutionary history, making them well adapted to colonize areas where seasonal drought is long and pronounced (Holbrook et al. 1995; Murphy and Lugo 1986; Trejo 2005). This favors a wide geographical distribution and allows these species to respond positively to human disturbance (Benz et al. 1994).

Based on current evidence from different regions of the Americas (Balée 1998; Clement 1999; Fedick 1996; Peters 2000), we suggest that the highest ecological importance of useful plants in the SDTF may not be only an ecological attribute of usefulness, but may also be a result of forest management and landscape transformation by humans over long periods of time. Although Murphy and Lugo (1986) and Trejo and Dirzo (2000) have stressed the negative impact of humans on these forests and that the long history of plant management of this vegetation may have induced significant modifications in forest composition, this remains to be investigated.

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