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Knowledge and use of biocultural diversity by Nahua in the Huasteca region of Hidalgo, Mexico

Tania Vianney Gutiérrez-Santillán[1], Ángel Moreno-Fuentes[2], Arturo Sánchez-González[2] and Gerardo Sánchez-Rojas[2*]

ABSTRACT

In the Huasteca region, high biological diversity and diverse ethnic groups converge. The implementation of metrics for biocultural diversity was developed based on metrics used in analyzes of biological diversity. We compared the results of the diversity known and used by two communities of Nahuatl origin established in two types of vegetation (Tropical Semi Evergreen Forest [TSEF] and Mountain Cloud Forest [MCF]). The fieldwork was carried out from January 2011 to December 2012; the ethnobiological information was collected combining the methods: percentual and snowball, additional applying as an ethnographic tool: multiple free lists and semi-structured interviews to 125 informants. The ethnobiological information was analyzed by adapting indexes used in the evaluation of biological diversity and multivariate methods. The informants identified 409 ethnospecies for both communities, although they only correspond to 383 biological species, the several taxonomic groups. The TSEF presents a greater richness of species-ethnospecies concerning the MCF. Eleven categories of use were identified, with the edible category being the most mentioned. In general, local people have extensive knowledge of the biological diversity present in their territory, and there are distinct differences in knowledge between communities established in different ecosystems. However, there is much similarity in knowledge and use of biodiversity, since both populations belong to the same cultural group. We believe that our results show the relevance of using the metrics used in the evaluation of biocultural diversity.

Keywords: Index of Biodiversity; Multitaxonomic; Ethnobiology

1 Instituto de Ecología Aplicada, Universidad Autónoma de Tamaulipas, Av. División del Golfo #356. Col. Libertad. C.P: 87020, Ciudad Victoria Tamaulipas, México.

2 Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo, Apartado Postal 1-69, Plaza Juárez, C.P. 42001, Pachuca Hidalgo, México.

* Corresponding author. E-mail address: TVGS (tvgutierrez_santillan@yahoo.com), AMF (amoreno@uaeh.edu.mx), ASG (arturosg@uaeh.edu.mx), GSR (gsanchez@uaeh.edu.mx)

INTRODUCTION

A spatial co-occurrence among biological, ecological, environmental, geographical, linguistic and cultural components can be observed around the world; this co-occurrence show that indigenous groups mostly populate greatest biodiversity areas, this correlation is conceptualized as biocultural diversity (Maffi 2001; 2005; 2007; Loh and Harmon 2005; Harmon and Loh 2010; Stepp et al. 2004; 2005). This biocultural diversity establishes unique social-ecological relationships (Pretty et al.

2009); since it is recognized that each indigenous group appropriates the biodiversity present in their territories (Boege 2008; Toledo 2010).

Although biocultural diversity is recognized, there are semantic and conceptual gaps in the definition, additionally it has been seen that biological diversity and biocultural diversity are not entirely congruent in terms of the factors that generate them (Cardillo et al. 2015). A concept of biocultural diversity should be based on more than merely the sum of its components. For this reason, we contextualize biocultural diversity as "the variety of organisms that are known, named, classified, organized, used, exploited, domesticated and/or manipulated by different human societies; including the social-ecological systems of which this diversity forms a part at various spatiotemporal scales (Gutiérrez-Santillan 2018).

This conceptualization requires us to define the units that make up biocultural diversity, which are called ethnospecies. An ethnospecies corresponds to a biological species and its cultural identity. Indispensable attributes of an ethnospecies are the combination of the taxa itself (species or genus but not any higher category) with the cultural identity associated with the traditional unique name for that taxa as the cognitive basis for the recognition of the organism by human groups (Hunn 2011).

Assessing the richness and diversity known and exploited by human groups, that is, biocultural diversity, helps us to understand the degree of correlation with biodiversity and thus to evaluate other associated phenomena; for example; understand the spatial congruence between species richness and cultural evolution (Turvey and Pettorelli 2014) as well as the loss of both diversities (Sutherland 2003). The importance of maintaining the balance between nature-culture and how to sustain it is related to the proper development of future projects (Maffi and Woodley 2008), the use of natural resources as a way of connecting with nature (Grasser et al. 2012), the conservation of biocultural diversity as a goal (Hong 2013) and even as a response to the challenges faced by large cities (Elands et al. 2018).

Biocultural diversity should be used when designing priorities in conservation (Dunn 2008), and social-ecological research should be the link between human and natural aspects (Gavin et al. 2015; Saslis-Lagoudakis and Clarke 2013); integrating the new biocultural perspective into conservation biology (Gavin et al. 2015; Gorenflo et al. 2012; Huntington 2013; Luque and Doode 2010; Saslis-Lagoudakis and Clarke 2013; Wolverton et al. 2014). This is supported by successful conservation programs that integrate traditional knowledge and local practices (Huntington 2013; Maffi and Dilts 2014).

Mexico is one of the countries with high biological diversity (Neyra-González and Durand-Smith 1998), as well as cultural diversity (De Ávila 2008), which makes it one of the most propitious countries for ethnobiological research, from different approaches and themes, for example, the traditional classification (Berlin 1973; Berlin et al. 1973; Hunn 1998; 2008; Alcántara-Salinas et al. 2013), the evaluation of cultural importance (Garibay-Orijel et al. 2007).), the domestication of plants (Bye and Linares 1983), among many other examples. However, few studies comprehensively address the traditional knowledge of different taxonomic groups (Aldasoro-Maya 2012; Argueta-Villamar 2008; Cano 1988; Hunn 1998, 2008).

Because in general ethnobiological works have been developed by defined subdisciplines (ethnobotany, ethnomycology, and ethnozoology).

The Huasteca is a region located in central-eastern Mexico, where the territories of several indigenous peoples converge. It is characterized by high biological diversity (Olivier 2008; Ruvalcaba et al. 2004), associated to many different geographic and environmental condition. Various ethnobiological studies have been carried out in this region, focusing mainly on ethnobotany of the Teneek (Alcorn 1981a; 1981b; 1983; 1984), Nahuas (Andrade-Cetto 2009; Hernández 2003), Pames (Carbajal-Esquivel et al. 2012; Torres et al. 2015), Tepehuas (Álvarez 2002; López-Villafranco and Aguilar-Contreras 2010) and Totonacos (Cano 1988). A number of studies have examined the importance of the social-ecological relationship in terms of magical/religious aspects (Montoya 1968; Gallardo-Arias 2004; Piotrowska 2013a; 2013b), traditional medicine (Andrade-Cetto 2009) and the use of edible fungi (Bautista-Nava 2007; Isidoro-Reséndiz 2011).

The few ethnozoological studies in the region have documented knowledge, perception, classification and, zootherapy. The vertebrate groups studied were fish (Montaño et al. 2010; González et al. 2010), reptiles (Penguilly et al. 2010) and birds (Jaimes et al. 2014). Additionally, research in the Huasteca region has integrated ethnobiological data for multiple taxonomic groups; for example, in Hidalgo (Gutiérrez-Santillán 2013; Hernández and Bautista 2011), in Puebla (López del Toro et al. 2009), in San Luis Potosí (Alonso-Castro et al. 2011) and Veracruz (Cano 1988), which has contributed to recognition of the biocultural diversity of the region.

Considering that the Huasteca region is rich in biodiversity and has the presence of one of the most representative ethnic groups in Mexico the Nahuas, the work is approached as a case study on conceptual and methodological aspects of cultural diversity. We proposed the use of the most current metrics for the analysis of biological biodiversity, to propose it as a new approach to the measurement of biocultural diversity. The I study was designed with the following objectives: 1) to identify the ethnospecies of plants, fungi, and animals that the local people know and use, in order to document their degree of knowledge about local biodiversity; 2) to compare ethnospecies richness between the different vegetation types, in order to find out whether traditional knowledge is similar within a given cultural group or whether it may differ between different ecosystems; 3) to analyze the ethnospecies detected in the study by means of diversity indexes as an evaluation metric for use in biocultural diversity studies; 4) to evaluate the degree of correlation between taxonomic species and ethnospecies, in order to find the degree of culturally recognized biodiversity; and 5) to identify use categories, in order to find the association between taxonomic groups and use categories.

We expected to contribute to the subject of biocultural diversity by establishing ethnospecies as social-ecological units of study and their evaluation by using the most recent biodiversity metrics (Moreno et al. 2017); The study was carried out in two Nahua communities established in different types of vegetation in the Huasteca region in the state of Hidalgo, Mexico.

MATERIAL AND METHODS

Study area

The Huasteca is a region located in central-eastern Mexico that includes portions of the states of Hidalgo, Puebla, Querétaro, San Luis Potosí, Veracruz and Tamaulipas. The majority of the inhabitants of the Huasteca region are mestizos, but a number of native peoples share the territory; Nahuas, Huastecos, Pames, Otomíes, Tepehuas and Totonacos (Olivier 2008).

The present study involves Nahuas, as they are one of the most numerous indigenous peoples and among the most widely distributed in Mexico. In the Huasteca, Nahuas live in more than 50 municipalities (county equivalents) in the states of Hidalgo, San Luis Potosí, and Veracruz (INALI 2008). In the state of Hidalgo, they live in 13 municipalities in the northeast as well as a small group in the southwest (Báez et al. 2012). The Huasteca part of Hidalgo state mainly contains two types of vegetation; tropical semi-evergreen forest (TSEF) and montane cloud forest (MCF), the TSEF covering more area than the MCF (Puig 1991). In addition, there are extensive areas of farmland, both crop and livestock. The main crops are corn, coffee, beans, sugar cane and oranges (Barthas 1996).

The study areas were selected using the criteria 1) ethnic identity, 2) more than 80% indigenous language speakers, and 3) low disturbance of the vegetative cover. This approach allows a selection of study sites associated conditions of research interest and not a priori selection assigned by the investigator (Gutiérrez-Santillan et al. 2019a). Two communities were selected: a) El Barco, in the municipality of Lolotla (21°10'45.33" – 21°10'32.89" N, 98°43'26.58" – 98°43'13.90" W; 140 masl; vegetation type TSEF, annual temperature: 18°C to 25°C, annual precipitation: 1600–1900 mm; with a populations of 380 inhabitants (INEGI 2010). In this community, the main activity is agriculture, to lesser extent livestock and fishing as a recreational activity. Some informants mentioned working in the citrus groves near the community; Figure 1); b) Tlamamala, in the municipality of Huazalingo (20°58'15.27" – 20°58'0.64" N and 98°32'40.45" – 98°32'21.34", 960 masl, vegetation type MCF, annual temperature: 13°C to 21°C, annual precipitation 1500–2800 mm; with a population of 750 inhabitants (INEGI 2010; Figure 1). The main activity is family farming, coffee harvest (coffee under shade) and livestock. Some of the informants mentioned working in the nearby city of Huejutla de Reyes, Hidalgo (approximately 40 km), and even in other cities of the country.

Fieldwork

Before fieldwork commenced, the study proposal was submitted to local authorities and approved by a community assembly (International Society of Ethnobiology 2006; http://ethnobiology.net/code-of-ethics/). At each interview, consent was obtained from the informant, including consent for photography and participant observation (Albuquerque et al. 2014). The field research was carried out during a two-year period from January 2011 to December 2012, with a total of 20 visits to each of the two locations.

Ethnobiological data were obtained by combining the ethnographic percentage method (10% of the population; Bernard 2006) and the snowball technique (Brewer 1995; 2002; Trotter et al. 2001). The combination of both methods allowed us to

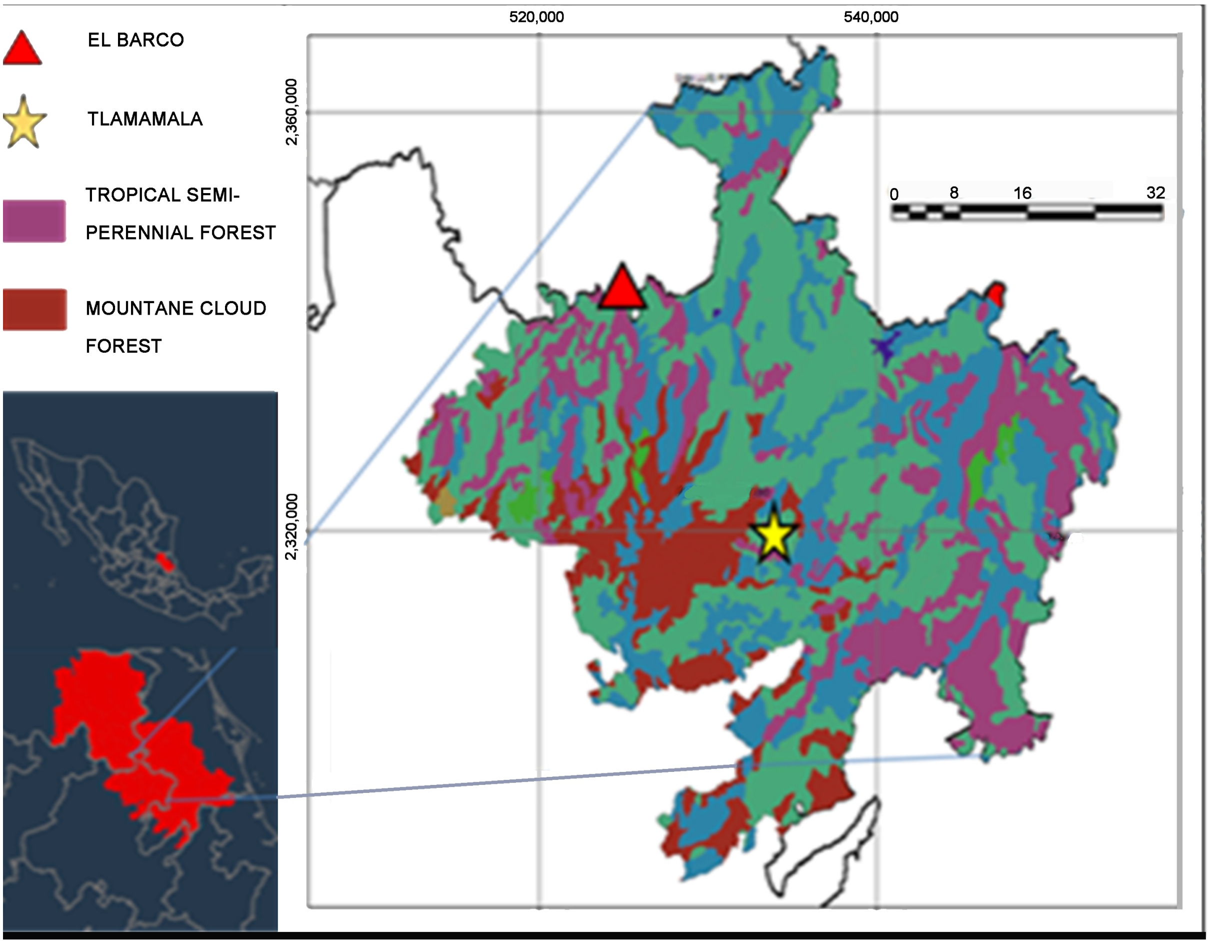

Figure 1. Location of study sites. The red zone on the left represents the Huasteca portion of the state of Hidalgo, Mexico. The triangle shows the location of El Barco (TSEF = tropical semi-evergreen forest, 140 masl) and the star shows the location of Tlamamala (MCF = montane cloud forest, 960 masl).

work with an ethnographic sample determined by chance, having informants in general and not only expert informants. During the development of the interviews in many of the cases, the same informant was interviewed several times. Also, it should be noted that no additional ethnographic data were obtained; only sex, age and yes, his mother tongue was Nahuatl.

A total, 125 interview combinations were applied; a) 50 informants in the town of El Barco of whom 50% were women and 50% men, with age between 21 and 72 years and 94% are speakers of the indigenous language. B) 75 informants in the locality of Tlamamala of which 38% were women and 62% men, with ages between 20 and 84 years, and 88% are speakers of the indigenous language.

Ethnographic tools were also used by combining: multiple free listings (Brewer 1995; 2002) and semi-structured interviews (Bernard 2006; Albuquerque et al. 2014). First, informants were asked about plants, fungi, and animals are known in the area (multiple free listing in Spanish and Nahuatl); Later using the semi-structured interview, the use of the referred ethnospecies was asked. The interview data organized in databases, for a) plants, b) and c fungi) animals, is organized by last taxonomic group (fish, amphibians/reptiles, birds and mammals).

Each database consisted of several sets of information: a) information the informant (name, gender, age, indigenous language speakers), b) taxonomic data (order, family, genus, species), c) nomenclature traditional (name in Nahuatl and Spanish) and d) category of use.

Collection, processing and identification of ethnobiological material

The biological material was processed and identified according to the taxonomic group in general; they had a) collections of fungi and plant specimens were collected in the field during the trips with the inhabitants to their daily activities (participative observation; Bernard 2006). The collections were processed and dehydrated adequately, later in the laboratory they were identified with the use of taxonomic keys. Fungal specimens are deposited in the collection ethnomycology "Dr. Teófilo Herrera Suárez" at the Center for Biological Research, the Autonomous University of the State of Hidalgo, Mexico. The deposit of the plants was not possible in an official collection because you do not have an herbarium of ethnobotany.

For different groups of animals fieldwork was based primarily on: b) animals or parts of animals donated by the informants; c) photographs of animals or parts of animals; d) visual stimuli – pictures based on the design of posters of species already reported in the region (Bernard 2006; Albuquerque et al. 2014), and e) field guides, e.g., birding guides (Albuquerque et al. 2014). In general, for all taxonomic groups, it has been made f) traditional nomenclature associated (documented by us) with bibliographic ethnobiological information for the region; and g) the association of the species (identified by us) concerning published regional taxonomic lists.

Species were identified to the lowest possible taxonomic level, based on the respective literature for the group; fungi (Bautista-Nava 2007; Isidoro-Reséndiz 2011), plants (Andrade-Cetto 2009; Luna et al. 1994; Pennington and Sarukhán 2005; Pérez-Escandón et al. 2003; Puig 1991; Villavicencio 2005; Villaseñor 2016), crustaceans (Álvarez et al. 2012), mollusks (Correa-Sandoval 2003), millipedes (Bueno 2012) and vertebrates (fish: González et al. 2010; Miller 2009; amphibians and reptiles: Ramírez-Bautista et al. 2014; birds: Howell and Webb 1995; Peterson and Chalif 2000; Martínez-Morales 2007; Martínez-Morales et al. 2007; and mammals: Ceballos and Oliva 2005).

In addition, lists of species reported for the respective taxonomic groups in the Huasteca Hidalguense were used (Ramírez-Bautista et al. 2017). In the MCF, 336 species of plants have been recorded (Luna et al. 1994), 181 bird species (Martínez-Morales 2007), 34 mammal species (Mejenes-López 2008; Mejenes-López et al. 2010), 73 amphibian and reptile species (Ramírez-Bautista et al. 2014), and 22 species of fish (González-Rodríguez et al. 2010). For the TSEF, 274 species of plants have been recorded (Puig 1991; Villavicencio 2005; Villaseñor 2016), 173 bird species (Martínez-Morales et al. 2007), 35 mammal species (Mejenes-López 2008; Mejenes-López et al. 2010), 32 amphibian and reptile species (Ramírez-Bautista et al. 2014) and 28 species of fish (González-Rodríguez et al. 2010).

The categories of use were established through the use reported by informant (emic categories for region) additionally other proposals in the literature were consulted

(Farfán et al. 2007; Lira et al. 2009; Monroy-Vilchis et al. 2008). Eleven categories were identified: ceremonial, fuel, edible, construction, timber, pets, medicinal, ornamental, commercial/sale, agricultural use and other (which contained any other uses which were mentioned only once in the interviews).

Data analysis

The inventory of biocultural diversity was measured by means of indexes adapted from metrics used to analyze biological diversity. To determine whether the number of selected informants was sufficient to obtain a complete inventory of known and exploited diversity (frequency of mention, FM), an accumulation curve was plotted using the non-parametric first-order Chao index (Chao1), calculated by means of the Estimates 8.0 program (Corwell et al. 2004). The Chao1 estimator is a method that uses abundance data and is based on the number of species that occur only once or in one sample and the number of species that occur exactly twice or in two samples (Escalante 2003).

In this case, the abundance data of the species in a sample was replaced by FM data; that is, the number of times a species i is mentioned in a sample (Pineda and Verdú 2013). An approximation of the expected number of ethnospecies was calculated, to estimate whether the number of interviewees (sampling effort) was sufficient for a complete inventory. Nonparametric estimators have their statistical basis in techniques for estimating the number of classes from samples and capture–recapture techniques (Chao and Lee 1992; Jiménez-Valverde 2003). In the present case, this corresponds to informants–mentioned ethnospecies, considering each interviewee as a sampling unit. An assumption of these nonparametric estimators is that the probability of capture – here the probability that an ethnospecies is mentioned – must remain constant throughout the period of ethnographic sampling.

The analysis of biocultural diversity was calculated based on the diversity formula proposed by Jost (2006), which is known as a zero-order and first-order measure of diversity (Hill 1973), using the formula:

$$^{q}D=\left(\sum_{i=1}^{S} p_i^{q}\right)^{\frac{1}{(1-q)}}$$

where p_i is the abundance of species *i* divided by the total sum of the abundances of the *S* (species), and the exponent *q* is the order of diversity. The order of diversity (*q*) is influenced by the relative abundance of the species in the index; that is, the predominance of common species or of rare species. In the present case, the relative abundance values in the ecological inventories are replaced by the values obtained for the FM of the reported ethnospecies.

Zero-order (^{0}D) and first-order (^{1}D) diversity values were calculated. Zero-order diversity (^{0}D) is based on the number of incidences of the species in the sample, which is equivalent to species richness, or in our case ethnospecies richness. In first-order diversity (^{1}D), all the species in a sample are aggregated with a value exactly proportional to their relative abundance, without overvaluing the rare or common species (Hill 1973; Jost 2006; Moreno et al. 2011; Moreno et al. 2017). First-order diversity (^{1}D) can be interpreted as the number of effective species, these being understood as units corresponding to the numbers of species with the abundances that would theoretically coexist in a community with maximum equality (Moreno et al. 2017). Using this index facilitates comparing the numbers of species between communities and quantifying the differences between them (Hill 1973; Jost 2006; Moreno et al. 2011).

To compare the sites in terms of ethnospecies composition, the Sørensen similarity index (I_s) was used. The degree of association between the species recorded in the literature for the region (independent variable) and the ethnospecies reported in this study (response variable) was tested by linear correlation using the Past 3.20 program (Hammer et al. 2001).

In order to describe the association between use categories and biological groups, a correspondence analysis (CA) was carried out in the Statistica program (StatSoft 2004). A data matrix was created, where the variables correspond to biological groups and the cases to use categories. The chi-square statistic (X^2) and the percentage of variation explained between the first and second dimensions were calculated.

RESULTS

Analysis of Biocultural Diversity

A total of 408 ethnospecies that integrate the biocultural diversity recognized by the Nahuas of the Huasteca region in the state of Hidalgo were recorded. These correspond to 383 species distributed in 343 genera belonging to 160 families (Supplementary Material). The biological groups recorded overall were plants (59%), birds (16%), mammals (9%), fish (8%), amphibians and reptiles (5%), fungi (3%), and invertebrates (molluscs, crustaceans and millipedes >1%). The biological group with the most recorded taxonomic families was plants (58%), followed by birds (16%) and mammals (9%) (Table 1). In addition, 342 ethnospecies were mentioned in some use category; 304 species used in the TSEF and 290 species used in the MCF, a difference of 14.

The ethnospecies accumulation curves for the TSEF showed that 82% of the expected ethnospecies were represented (Chao1 = 291), and for the MCF, 79% were

Table 1. Species–ethnospecies data for biological groups listed by inhabitants of two Nahua communities in the state of Hidalgo, Mexico. There was a strong relationship overall between the species and their cultural counterparts (ethnospecies); however, in the case of invertebrates, taxonomic identification was only made to the level of gender and family. TSEF = tropical semi-evergreen, MCF = montane cloud forest.

Biological group	Number of families	Total number of species	Number of ethnospecies TSEF	Number of ethnospecies MCF
Invertebrates	2	0	2	2
Fish	10	31	24	8
Amphibians & Reptiles	10	21	22	13
Birds	27	61	57	44
Mammals	17	34	31	34
Fungi	7	13	12	8
Plants	87	223	207	199
TOTAL	**160**	**383**	**355**	**308**

represented (Chao1 = 275). In both cases, the actual ethnographic sampling effort (number of interviews) is located in the asymptote of the curve, which suggests that the inventory of known and used biodiversity was very few interviews short of a complete inventory (Figure 2).

For the TSEF, zero-order diversity (^0D) was 355 ethnospecies (invertebrates 2, fish 24, amphibians and reptiles 22, birds 57, mammals 31, fungi 12 and plants 207) and first-order diversity (^1D) was 234.2 ethnospecies (invertebrates 1.9, fish 21.5, amphibians and reptiles 19.9, birds 44.7, mammals 23.7, fungi 9.9 and plants 136.7). For the MCF, the ^0D was 308 ethnospecies (invertebrates 2, fish 8, amphibians and reptiles 13, birds 44, mammals 34, fungi 8 and plants 199) and ^1D was 202.3 ethnospecies (invertebrates 1.8, fish 6, amphibians and reptiles 8.6, birds 31, mammals 23.5, fungi 5.8 and plants 131). The observed difference between the TSEF and the MCF was 47 ethnospecies for ^0D and 31.95 ethnospecies for ^1D (Figure 3).

We found a similar composition of known and used ethnospecies in the two Nahua communities even though they are in different vegetation types. The Sørensen similarity between the TSEF and the MCF was 84%, indicating that a large percentage of ethnospecies are shared between the two sites. In addition, a positive correlation was found between the number of species reported in the literature for the different taxonomic groups and the number of ethnospecies documented in the present study (r= 0.8424, p= 0.0037). This indicates that most species have their cultural counterpart and that much of the knowledge about biodiversity is shared, independently of vegetation type, a phenomenon associated with the cultural origin of the human group and the fact that both communities are in the same geographical region.

Use Trends

A total of 11 use categories were identified for both communities. The categories containing the highest number of ethnospecies are commercial trade or sale (28.7%), edible uses (17.5%) and medicinal uses (14.1%); followed by the categories with moderate values: ornamental (11.1%),

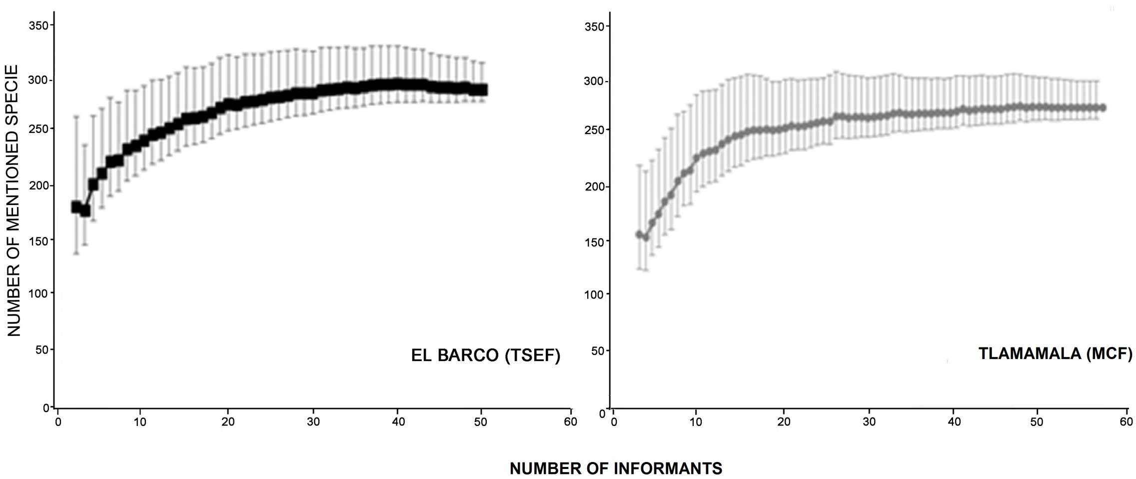

Figure 2. Accumulation ethnospecies curve based on the number of interviews and the non-parametric Chao first-order accumulation function (Chao1). On the x-axis, the number of informants is shown by community, while the y-axis shows the cumulative number of mentioned species (FM). The bars at each point represent the 95% confidence interval. TSEF = tropical semi-evergreen, MCF = montane cloud forest.

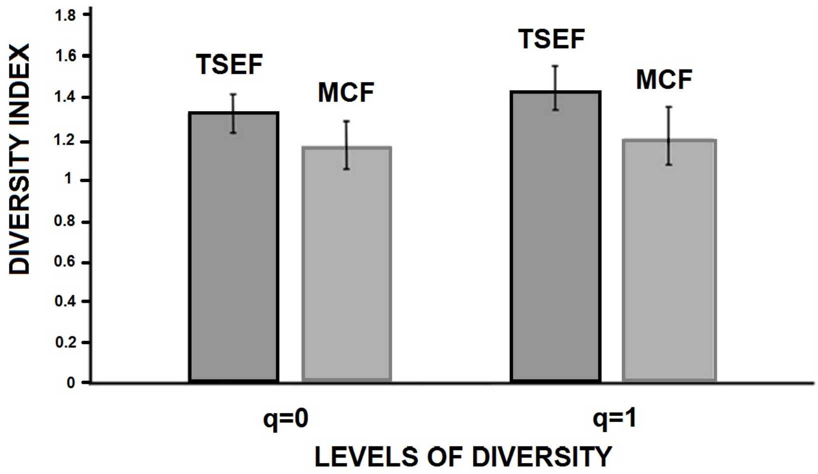

Figure 3. Diversity values of order zero (0D) and first order (1D) by vegetation type. To graph the values, the Shannon index was used in both levels of diversity. The data were the number of ethnospecies by biological group for zero-order diversity and the inverse of the Shannon index for first-order diversity. This procedure enabled the confidence intervals to be obtained. TSEF = tropical semi-evergreen, MCF = montane cloud forest.

fuel (6.3%) and pets (5.3%). The categories with the lowest values are ceremonial and construction with 4.5% each, timber (2.0%) and agricultural use (1.8%). Four of the categories (fuel, construction, timber, agricultural use) only contained plant species, and the pet category was exclusive to animals, mainly birds and mammals (Table 2).

The correspondence analysis (CA) showed the association between biological groups and anthropocentric categories, including ethnospecies that are used in different ways in the two communities. There is a significant relationship between biological group and use category (x^2= 537.35, df= 50, p <0.05). The two dimensions explain 81% of the variation in the data. In the first dimension, plants contribute the most to the variance (eigenvalue= −0.4621), followed by birds (eigenvalue= 0.2648) and mammals (eigenvalue= 0.1520). In the second dimension, the main contributions to the variance are from fish (eigenvalue= −0.1816), fungi (eigenvalue= −0.0570) and amphibians and reptiles (eigenvalue= 0.0330).

We can observe in the graph (Figure 4) that certain categories of use are exclusive of certain biological groups. For example, the categories of agricultural uses, fuel, construction, and wood are exclusive to the plants; while the pet category with birds, mammals and reptiles. In turn, birds and mammals are more related to ornamental use and as pets, while reptiles with ceremonial uses. Some generic categories are more associated with vertebrates than with plants (e.g., ornamental and ceremonial), or, for example, the edible category (which should be generic) has a more significant relationship for fungi and fish; this is due to the fact that the ethnospecies that form these two biological groups generally only fulfill alimentary functions (Figure 4). The association of the biological groups and the categories of use, in this case, is given by the frequency of mention of each one of the ethnospecies for each one of the categories; so, the relationship shown in the chart (Figure 4) is specific for these two study communities.

Table 2. Relationship between number of ethnospecies mentioned and categories of use. Plants are the group with greatest diversity of categories, invertebrates and fish are the group with the least.

Biological group	I Construction	II Timber	III Agriculture	IV Fuel	trade	VI Others	Ceremonial	Ornamental	IX Medicinal	X Pets	XI Edibel
Invertebrates									2		3
Fish								2	11		31
Amphibians & Reptiles						8	4		7	3	2
Birds					25	1	17	37	32	29	16
Mammals					20	4	4	27	20	17	21
Fungi					6						11
Plants	42	19	17	58	236	21	17	36	58		77
Total	42	19	17	58	287	34	42	102	130	49	161

Legend: Relationship between number of ethnospecies mentioned and categories of use. Plants are the group with greatest diversity of categories, invertebrates and fish are the group with the least.

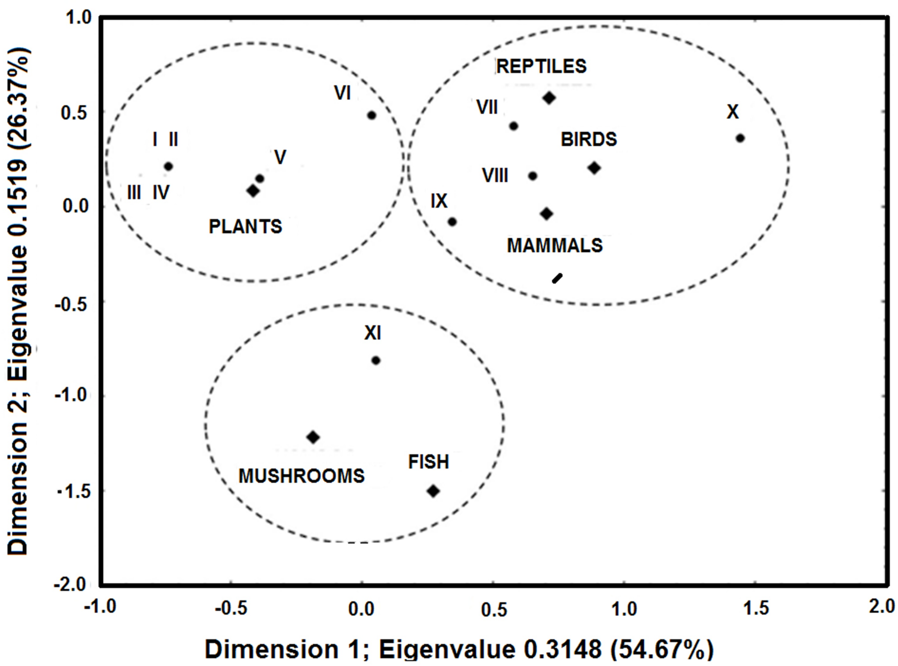

Figure 4. The correspondence analysis shows the association between the biological groups; mammals, birds, reptiles, fish, fungi and plants, with respect to the use categories: I= construction, II= timber, III= agricultural use, IV= fuel, V= sale or commercial trade, VI= others, VII= ceremonial, VIII= ornamental, IX= medicinal, X= pets, and XI= edible. In some cases, a specific relationship is observed between biological groups and certain categories; for example, fish and fungi are associated with the edible category because fungi are normally only harvested for food, and fish can only be sold sometimes, so their main use is as food. In contrast, mammals, birds and reptiles are mostly related to ceremonial, medicinal, ornamental and pet uses, while plants are associated with uses such as timber, agriculture, construction, fuel and commercial use.

DISCUSSION

Biocultural diversity of the Nahua

The Nahuas of the Huasteca region in Hidalgo state have extensive knowledge about the biodiversity in their environment. In this study, 408 ethnospecies were reported. They are associated with 383 species belonging to a variety of biological groups (invertebrates, amphibians and reptiles, fish, birds, mammals, fungi and plants). This is a higher number of ethnospecies than were found by other comparable ethnobiological studies (Caballero and Mapes 1985; Farfán et al. 2007; Nabhan et al. 1982). Other studies have generally not addressed all three main ethnobiological subdisciplines; ethnomycology, ethnobotany and ethnozoology. Our research is a contribution from a comprehensive ethnobiology perspective, combining the three subdisciplines integrating various biological groups and evaluating social-ecological biodiversity knowledge held by a specific indigenous group. In addition, this study contributes to the analysis of biocultural diversity by treating ethnospecies as units of analysis, as has been done in ecology (Moreno 2011; Moreno et al. 2017) and shows how metrics used in the analysis of biological diversity can be adapted to the analysis of biocultural diversity.

Comprehensive ethnobiology research has been previously addressed by Toledo et al. (1983) who documented 410 species for the Pu'rhépechas, Hunn (2008) who recorded a total of 1,379 species (fungi, plants, invertebrates and vertebrates) known and used by the Zapotecs, and Aldasoro-Maya (2012) who reported 264 species known and used by the the Tlahuica. However, there are few such ethnobiology studies using a comprehensive approach, for reasons such as lack of availability of time, funding, access to communities, or lack of transdisciplinarity, among others. It is more common to find multitaxonomic research addressing two or three biological groups (Nabhan et al. 1982; Caballero and Mapes 1985; Farfán et al. 2007).

On the other hand, regarding the knowledge and use of biocultural diversity, a high similarity is determined even though the communities are established in two different types of vegetation (TSEF and MCF). The similitude may be given because they share common species, which are generally widely distributed or introduced. It also suggests that this phenomenon is associated with the cultural memory or bio-cultural patrimony of both communities, as it belongs to the same indigenous group (Olivier 2008), as well as geographic proximity (see map). So, when studying two types of dominant vegetation in the Huasteca region (Puig 1999), it is likely that the social-ecological relationships for the Nahuas are similar.

The biocultural diversity reported here indicates a high degree of recognition and use of the natural environment in communities where the traditional language and many of the customs are still preserved. This is confirmed by the significant positive correlation between the number of ethnospecies and the number of species reported in the literature for the various taxonomic groups (Ramírez-Bautista et al. 2017).

Conceptual contribution

We propose that Biocultural diversity as: “the variety of organisms that are known, named, classified, organized, used, exploited, domesticated and/or manipulated by different human societies; including the social-ecological systems of which this diversity forms a part at various spatiotemporal scales (Gutiérrez-Santillan 2018). But this concept also must be referred to the correlation between its biological, ecological, environmental, geographical, cultural and linguistic components; include a regional or global spatial scale (Maffi 2005; 2007; Loh and Harmon 2005; Harmon and Loh 2010; Stepp et al. 2004; 2005; Turvey and Pettorelli 2014). However, in *sensu stricto* has been seen that biological diversity and biocultural diversity are not entirely congruent in terms of the factors that generate them (Cardillo et al. 2015).

However, the design of a conceptual framework in the metric of cultural diversity analogous to that of biological diversity will not only allow us to understand it, but also to confirm that its identification and evaluation are adequate (Maclaurin and Sterelny 2008). Currently, the existence of biocultural diversity as a real and inherent property of the social-ecological relationship is not discussed, however, semantic, conceptual and analytical gaps are detected; for which different approaches can be useful to generate new research perspectives as in ecology (Moreno et al. 2011).

One of the fundamental bases for the conceptual development of biocultural diversity is the establishment of real and identifiable social-ecological units or entities, as for example in ecology, that operational taxonomic units have been used (Krell 2004). Although ethnobiology has sought to develop research on the knowledge and use of biodiversity, some of the previous studies do not discriminate between species and ethnospecies, or do not consider this criterion as a rule in ethnobiological research; taking both as an independent record or identifiable entity. We consider it essential to establish the units of analysis, referring to the ethnospecies, which must be integrated by the taxonomic identity of the species plus their corresponding culture; this criterion should apply regardless whether the investigation has a qualitative or quantitative approach. In addition, the establishment of ethnospecies as units of analysis, as has been done in ecology (Moreno et al. 2011; Moreno et al. 2017) favors the adaptation of current metrics used in the analysis of biological diversity to the analysis of biocultural diversity.

The identity of the social-ecological units is critical to begin to understand biocultural diversity from a more local and analogous view to biodiversity. Our study allows us to observe another pattern more like those of biological diversity, such as the recognition of common species, as well as rare species (Turner et al. 2011). As examples of common species we have the coyote/coyochichi (*Canis latrans*), the pigeons/singuilotl (*Claravis pretiosa, Leptotila verreauxi, Geotrygon albifacies*), the fungus orejita-de-viejita/cuapetachiquinte (*Auricularia auricula, A. delicata, A. fuscosuccinea*), and trees such as guava (*Psidium guajava*) and framboyán/ framboyánxuchitl (*Delonix regia*). And as rare species we have the anguila/coatlmichi (*Anguilla rostrata*), the jaguar/tecuani *(Panthera onca*) and, the perro-de-agua/atlchich (*Lontra longicaudis*), these recently reported species for the state of Hidalgo (Aguilar-López et al. 2015; Morales-García and Acosta-Rosales 2015). Or tree species that are very scarce in the surrounding forests, but culturally highly valued as the palo-escrito (*Dalbergia palo-escrito*) or the palo-varón/tlacacuahuitl (*Ulmus mexicana*). Even the documentation of a locally extinct species was obtained: the mono/chango (*Ateles geoffroyi*), which is estimated to have been extirpated from northeastern Mexico (Ceballos and Oliva

2005).

Biocultural diversity is part of the memory or biocultural heritage of indigenous peoples, their documentation, analysis and evaluation; it can be appreciated by biologists of conservation, by documenting traditional knowledge and practices historical and currently conducted on biodiversity, helping to understand changes in local biodiversity and designing appropriate conservation strategies (Brook and McLachlan 2008, Saslis-Lagoudakis and Clarke 2012). In addition, under the perspectives projected in this research, we seek to open a way for conceptualization and the establishment of methodologies that help to understand biocultural diversity from the low level to more complex analyzes, such as, for example, macro-ethnobiological (Gutierrez-Santillán et al. 2019b), the evolutionary ethnobiology (Albuquerque y Ferreira-Junior 2017), the niche construction theory and ethnobiology (Albuquerque et al. 2018); and the development of the social-ecological theory of maximization (Albuquerque et al. 2019).

The use of new metrics for the analysis and evaluation of biocultural diversity

The comprehensive analysis of biocultural diversity (multitaxonomic and quantitative) generates a clearer picture of social-ecological knowledge. To do so, it is essential to evaluate biocultural diversity using metrics, which give greater robustness to the results and allow for comparisons, as has been done in ecology (Moreno et al. 2017).

It is, of course, important that the theoretical assumptions required for the chosen metrics be met. In this case, we evaluate whether the ethnographic sampling effort is enough using accumulation curves (Alves et al. 2016). The curves showed that the number of interviews was enough for the inventory. This suggests that when the percentage ethnographic method, which generally implies sampling 10% of the inhabitants of a population (Bernard 2006) is applied in combination with the snowball method (Trotter et al. 2001), it is possible to obtain a robust inventory of ethnobiological information. In addition, selecting informants using the snowball method enables a random sample to be drawn (Trotter et al. 2001). In addition, the combination of ethnographic tools (multiple free lists and semi-structured interviews) also allow an adequate collection of information.

These metrics can be used to corroborate the completeness of the ethnobiological data, since the accumulation curves and estimates of chosen species (non-parametric) are good indicators of the quality of the sample (Albino-García et al. 2011; Benz et al. 2000; Hopkins and Stepp 2012; Lozada et al. 2006; Pineda and Verdú 2013), in our case indicating proper ethnographic sampling.

In the accumulation curves, frequency of mention is used, considering each informant as a sampling unit, and the mentions of ethnospecies represent their cultural importance, not their abundance in nature. In ethnographic sampling there are ethnospecies that are constantly mentioned, or common, and ethnospecies that are mentioned only occasionally or rarely. However, it is important to assess in which cases to apply the accumulation curve or not, since the curve may be indicating that our inventory is close to the optimum; that is, increasing the sampling number maintains the asymptote constant (Alves et al. 2016; Moroy-Vilchis et al. 2008); but other methodological aspects must be adhered to, such as ensuring random and homogeneous sampling.

For the implementation of these and other metrics, it is essential to keep in mind that the methods used in the analysis of biological diversity are constantly being updated (Moreno et al. 2011; 2017), making it necessary to evaluate their usefulness in ethnobiological or biocultural diversity studies. For example, the zero-order (^0D) and first-order diversity index (^1D) are in current use (Hill 1973; Jost 2006). The advantage of using these indices is that the results are comparable within a study and with other studies in the same region whether intra- or inter-ethnically; and across time spans to evaluate cultural changes in knowledge or uses; that is, to evaluate local knowledge at different space and time scales (Gutiérrez-Santillán et al. 2019b).

In this study we use only the ^0D and ^1D diversity indices, because the zero-order diversity data corresponds to species richness, in our case ethnospecies richness, while first-order diversity includes all species with a weight precisely proportional to their abundance in the community (Hill 1973; Jost 2006; Moreno et al. 2011). In ethnographic sampling, all species reported by the inhabitants correspond to a site, and they have the same representation in the sample regardless of their frequency of mention, so this proportion is maintained. For this index, second-order diversity (^2D) is also calculated, but its application is not recommended for the present case, because this measure is based on the dominance of the species present in a sample (Jost 2006; Moreno et al. 2011; 2017). In ethnobiological data we have ethnospecies that are represented with a high frequency of mention, which may be biased towards some cultural or even economic preference that strongly influences its frequent mention, which we consider could cause bias.

We suggest that the suitability of biodiversity metrics should be evaluated for use in ethnobiological studies, in order to determine whether an ethnographic sample behaves in a similar way to an ecological sample. The relevance of other indexes should be considered as well; not only those that are based on incidence but also those that take abundance values into account. We consider that using ethnobiological or social-ecological units (taxonomic species + cultural assignment) and making comparisons between the degree of biological diversity and the diversity of ethnospecies are sufficient reason to apply more refined forms of analysis to evaluate biocultural diversity. However, it is essential to ensure the quality of the methodological design such that it involves proper collection of sufficient data, to avoid a subjective interpretation.

Trends of use

One of the most important characteristics of biocultural diversity is its use by human groups. Studies in other regions of Mexico have documented various use categories for different taxonomic groups (Lira et al. 2009; Monroy-Vilchis et al. 2008). In this study, 11 categories, which contribute to satisfying a wide range of human needs, were identified. Different indigenous groups use species in different ways for different purposes, which reflects the importance of nature in contemporary societies (Alonso-Castro et al. 2011; Carbajal-Esquivel et al. 2012; Toledo 1994).

In addition to the application of appropriate metrics, the use of multivariate statistical methods provides a broader view of the social-ecological relationships in the study area. In this case, implementing CA enabled a graphical association to be made between use categories and the various taxonomic groups. Several authors have used these methods, finding structural relationships between the study groups; e.g., between taxonomic families and habitat types (Molares and Ladio 2009), species management types (Parra et al. 2012), species (Zamudio and Hilgert 2012) and knowledge among several indigenous groups (Núñez-García et al. 2012). We found that certain biological groups are associated with specific categories, as a characteristic of the biological group and its use.

CONCLUSIONS

The Nahuas of the Huasteca region in the state of Hidalgo have extensive knowledge and make widespread use of the biodiversity in their territories. This study has shown that each of the vegetation types contributes particular characteristics in terms of social-ecological relationships at the cultural level, a phenomenon associated with the presence of unique species of the tropical semi-evergreen forest and the montane cloud forest. However, since the two study communities belong to the same indigenous group, are located in the same geographical region and are in contact with the same widely distributed and introduced species, there are strong similarities in their knowledge and use of these species. In addition, it was found that each of the biological groups contributes in a particular way and in some cases exclusively in their respective use categories, especially in the case of plants and animals.

This study contributes to a comprehensive view of the multitaxonomic analysis of biodiversity known and used by a indigenous group, by combining the three main ethnobiological subdisciplines: ethnobotany, ethnomycology and ethnozoology (Figure 5). It is suggested that the conceptualization of biocultural diversity be extended beyond its cultural and biological components. We propose that biocultural diversity be considered as "the variety of organisms that are known, named, classified, organized, used, exploited, domesticated and/or manipulated by different human societies"; including the social-ecological systems of which this diversity forms a part at various spatiotemporal scales (Gutiérrez-Santillán 2019b).

It is composed essentially of ethnospecies, which consist of a taxonomic entity (species) together with its cultural counterpart (traditional name). When the basic units of biocultural diversity are defined, they can be analyzed using the new metrics used for the analysis of biological diversity, enabling a better assessment of biocultural diversity and more robust data to be generated, which can be compared on the intra- or interethnic level, between regions, ecosystems, or other divisions. In addition, this approach can be used to generate and provide sociocultural data for the implementation of conservation strategies under a biocultural approach.

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Figure 5. A) Pet boar (*Tayassu tajacu*, MCF); B) Striped (lowland) paca meat (*Cuniculus paca*, TSEF); C) Child with preserved margay (*Leopardus weidii*, MCF); D) Pet red-billed pigeon (*Patagioenas flavirostris*, TSEF); E) Informant with preserved emerald toucanet (*Aulacorhynchus prasinus*, MCF); F) Child fisherman (TSEF); G) crayfish (*Procambarus* sp., TSEF); H) cosol, river crayfish trap (TSEF); I) Cross decorated with cycad leaves (*Zamia herrerae*, MCF); J) Itztacnanacatl fungus on papatla leaf (*Pleurotus albidus, Heliconia collinsiana*; MCF); K) yam and squash *(Ipomoea batatas, Cucurbita maxima*; TSEF); L) two species of marigold (cempoal) in ceremony for festival of Our Lady of Guadalupe (Dec. 12) (*Tagetes coronopifolia, Tagetes erecta*; TSEF). TSEF = tropical semi-evergreen, MCF = montane cloud forest.

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Supplementary Material

List of biocultural diversity for two communities of the Huasteca, Hidalguense; the type of vegetation is tropical semi-evergreen forest (TSEF) and montane cloud forest (MCF). The table contains the following data: family, gender and species, local name in spanish and nahuatl, vegetation type (TSEF / MCF) and category of use and utilization (ceremonial= **I**, fuel= **II**, edible= **III**, IV= construction, V= timber, VI= pet, V**II**= medicinal, V**III**= ornamental, **IX**= others, X= agricultural use, XI= trade).

Family	Specie	Traditional name spani/náhuatl	Type of vegetation	Category of use and utilization
MOLLUSCA				
* Gastropoda	?	caracoles	TSEF/MCF	VII
CRUSTACEA				
*Cambaridae	*Procambarus* sp.	burritos / *techichis*	TSEF/MCF	III, XI
*Palaemonidae	*Macrobranchium* sp.	acamayas	TSEF/MCF	III, XI
	?	*cosoles*	TSEF/MCF	III, XI
DIPLOPODA				
	?	milpies	MCF	VII
PISCES				
Anguilidae	*Anguilla rostrata* Lesueur, 1821	*coatlmichi*	TSEF	I, III, VII, VIII, XI
Lepisosteidae	*Lepisosteus osseus* Linnaeus, 1758	pez aguja / *huitzilmichi*	TSEF	III, VIII, XI
Calostomide	*Ictiobus labiosus* (Meek, 1904)	trompa de puerco / *pitzolmichi*	TSEF	III, XI
Characidae	*Astyanax mexicanus* De Filippi, 1853	poxta	MCF	III, XI
	Cichlasoma labridens (Pellegrin, 1903)	mojarras / *tecoxitle, xomaquictle, xumaquictle*	TSEF	III, VII, XI
	Ciclastoma steindachneri (Jordan & Snyder 1899)	mojarras / *tecoxitle, xomaquictle, xumaquictle*	MCF	III, XI
	Herichthys cyanoguttatus Baird y Girard, 1854	mojarras / *tecoxitle, xomaquictle, xumaquictle*	MCF	III, XI
	Herichthys tamasopoensis (Artigas Azas, 1993)	mojarras / *tecoxitle, xomaquictle, xumaquictle*	TSEF/MCF	III, VII, XI
Cichlidae	*Amatatlania nigrofasciata* (G□nther, 1867)	mojarras / *tecoxitle, xomaquictle, xumaquictle*	TSEF/MCF	III, VII, XI
	Oreochromis aureus (Steindachner 1864)	tilapia / *xumaquictli*	TSEF/MCF	III, XI
	Oreochromis niloticus (Linnaeus, 1758)	tilapia / *xumaquictli*	TSEF/MCF	III, XI
Cyprinidae	*Cyprinella lutrensis* S. F. Baird & Girard, 1853	sardina	TSEF	III, XI
	Cyprinus carpio communis (Linnaeus, 1758)	carpa / *olomichi*	TSEF/MCF	III, XI
	Diona erimyzonops Hubbs & Miller 1974	charal / *poxta*	MCF	III, XI
	Diona ipni (Alvarez & Navarro 1953)	charal / *poxta*	TSEF/MCF	III, VII, XI
	Diona rasconis (Jordan & Snyder 1900)	charal / *poxta*	TSEF	III, VII, XI
	Notropis tropicus (Hubbs & Miller, 1975)	charal / *poxta*	MCF	III, XI
Eleotridae	*Gobiomorus dormitor* Lacep□de, 1800	huavina, guavina / *tocoxite, tocoxitli*	TSEF/MCF	III, XI
Ictaluridae	*Ictalurus mexicanus* (Meek, 1904)	bagre / *xolotl, miquecuani, xolomichi*	TSEF/MCF	III, VII, XI
	Ictalurus puntatus (Constantine Samuel Rafinesque-Schmaltz)	bagre / *xolotl, miquecuani, xolomichi*	TSEF/MCF	III, XI
	Pylodictis olivaris (Rafinesque, 1818)	bagre / *xolotl, miquecuani, xolomichi*	TSEF/MCF	III, VII, XI
Mugilidae	*Agonostomus montícola* (Bancroft, 1834)	trucha / *itztacmichi*	TSEF/MCF	III, VII, XI
Poeciliidae	*Gambusia vittata* Hubbs, 1926	charal / *poxta*	TSEF/MCF	III, XI
	Heterandrai bimaculata (Heckel, 1848)	charal / *poxta*	MCF	III, XI
	Poecilia latipunctata Meek, 1904	charal / *poxta*	MCF	III, XI
	Poecilia mexicana Steindachner, 1863	charal / *poxta*	MCF	III, XI
	Poeciliopsis gracilis (Heckel, 1848)	charal / *poxta*	MCF	III, XI
	Xiphophorus birchmanii	charal / *poxta*	MCF	III, XI
	Xiphophorus continens Rauchenberger, Kallman & Monzot, 1990	charal / *poxta*	TSEF/MCF	III, XI
	Xiphophorus malinche Rauchenberger, Kallman & Monzot, 1990	charal / *poxta*	TSEF/MCF	III, XI
	Xiphophorus variatus (Meek, 1904)	charal / *poxta*	MCF	III, XI
AMPHIBIA				
Bufoniadae	*Incilius nebulifer* (Girard, 1843)	ranas, ranitas y sapos	TSEF/MCF	VII
	Incilius occidentalis (Camerano, 1879)	ranas, ranitas y sapos	TSEF/MCF	VII
	Rhinella marina Linnaeus, 1758	ranas, ranitas y sapos	TSEF/MCF	VII
Caudata	?	*axolotl, xolotl*	TSEF/MCF	
REPTILIA				
Kinosternidae	*Kinosternon herrerai* Stejneger, 1925	tortuga / *coxuali*	TSEF/MCF	III, VI, VII, VIII, XI
Anguidae	*Gerrhonotus ophiurus* Cope, 1866	escorpi□n / *axilis*	TSEF/MCF	
Corytophanidae	*Corytophanes hernandesii* Wiegmann, 1828	lagartija verde / iguana	TSEF	VI, XI
Gekkonidae	*Hemidactylus frenatus* Schlegel, 1836	lagartija g□era, huija / *axilispitzilzilzitl*	TSEF	
Iguanidae	*Ctenosaura acanthura* (Shaw, 1802)	lagartija negra	TSEF	VI, XI
Boidae	*Boa constrictor* (Linnaeus, 1758)	venadillo / *mazatlcoatl*	TSEF/MCF	III, VIII, XI
Colubridae	*Coniophanes imperialis* (Bair y Girard, 1859)	v□bora de agua	TSEF	

	Drymarchon melanurus (Duméril, Bibron y Duméril, 1854)	víbora negra / *tepetlcoatl*	TSEF/MCF	VIII, XI
	Drymobius margaritiferus (Schlegel, 1837)	chirrionera / *chacuatla*	TSEF/MCF	
	Lampropeltis triangulum (Lacépède, 1788)	coralillo / *zicatena*	TSEF/MCF	IX
	Spilotes pullatus (Linnaeus, 1758)	apachite / *apaxcoatl*	TSEF/MCF	VII, VIII, XI
	Tantilla rubra (Cope, 1876)	coralillo / *zicatena*	TSEF/MCF	IX
Dipsadidae	*Tropidodipsas sartorii* Cope, 1863	coralillo / *zicatena*	TSEF/MCF	IX
Elapidae	*Micrurus diastema* (Duméril, Bibron y Duméril, 1854)	coralillo / *zicatena*	TSEF/MCF	IX
Natricidae	*Nerodia rhombifer* (Hallowell, 1852)	víbora de agua	TSEF	
Viperidae	*Agkistrodon taylori* Burger y Robertson, 1951	cola blanca / *xochicuitlapilli*	TSEF/MCF	I, IX
	Atropoides nummifer (Rüppell, 1845)	metlapil / *metlapilli*	TSEF/MCF	I, IX
	Bothrops asper (Garman, 1884)	*mahuaquite*	TSEF/MCF	I, VII, IX, XI
	Crotalus sp. Linnaeus, 1758	víbora de cascabel	TSEF/MCF	I, VII, IX, XI
AVES				
Tinamidae	*Crypturellus cinnamomeus* (Lesson, 1842)	perdiz / *xacoyotl*	TSEF/MCF	III, VI, VII. VIII, XI
Anatidae	*Cairina moschata* (Linnaeus, 1758)	pato negro / *patox*	TSEF/MCF	I, VI, VIII, XI
Cracidae	*Ortalis vetula* (Wagler, 1830)	chachalaca / *ecuetlacte*	TSEF/MCF	III, VI, VII, VIII, XI
	Penelope purpurascens Wagler, 1830	cojolite / *cojolictli*	TSEF/MCF	III, VI, VII, VIII, XI
	Crax rubra Linnaeus, 1758	faisán, paisán, pájaro paisana, pájaro del cerro o pavo real / *tepetltototl*	TSEF	I, III, VI, VII, VIII, XI
Odontophoridae	*Dendrortyx barbatus* Gould, 1846	godorniz, codorniz / *tzoli*	TSEF/MCF	III, VI, VIII, XI
	Colinus virginianus (Linnaeus, 1758)	godorniz, codorniz / *tzoli*	MCF	III, VI, VIII, XI
	Dactylortyx thoracicus (Gambel, 1848)	godorniz, codorniz / *tzoli*	MCF	III, VI, VIII, XI
Ciconiidae	*Mycteria americana* Linnaeus, 1758	cigüeña	TSEF	
Pelecanidae	*Pelecanus erythrorhynchos* Gmelin, 1789	pelícano	TSEF	
Ardeidae	*Ardea alba* (Linnaeus, 1758)	garza, garza blanca	TSEF/MCF	
	Egretta caerulea (Linnaeus, 1758)	garza negra	TSEF	
	Cochlearius cochlearius (Linnaeus, 1766)	cucharita	TSEF	
Cathartidae	*Coragyps atratus* (Bechstein, 1793)	zopilote / *zapilotl*	TSEF/MCF	I, VII
	Cathartes aura (Linnaeus, 1758)	zopilote rojo / *zapilotl*	TSEF	I, VII
Accipitridae	*Rupornis magnirostris* (Gmelin, 1788)	pollero	TSEF/MCF	VI, VII, VIII, XI
	Buteo plagiatus (Schlegel, 1862)	águila, gavilán / *cuatoctle*	TSEF	VI, VII, VIII, XI
	Buteo jamaicensis (Gmelin, 1788)	águila, gavilán / *cuatoctle*	TSEF/MCF	VI, VII, VIII, XI
Columbidae	*Patagioenas flavirostris* (Wagler, 1831)	turcaza, torcaza	TSEF/MCF	III, VI, VII, VIII
	Columbina inca (Lesson, 1847)	tortolita	TSEF/MCF	VI
	Claravis pretiosa (Ferrari-Pérez, 1886)	paloma	TSEF/MCF	III, VI, VII, VIII
	Leptotila verreauxi Bonaparte, 1855	paloma	TSEF/MCF	III, VI, VII, VIII
	Zentrygon albifacies Sclater, 1858	paloma	TSEF/MCF	III, VI, VII, VIII
	Zenaida asiática (Linnaeus, 1758)	paloma blanca / *singuilotl*	TSEF/MCF	III, VI, VII, VIII
Tytonidae	*Tyto alba* (Scopoli, 1769)	lechuza, tecolote lechuza / *tecolotl*	TSEF/MCF	I, VII, VIII, XI
Strigidae	*Glaucidium sanchezi* Lowery & Newman, 1949	tecolote chico / *cuxcux*	MCF	I, VII, VIII, XI
	Ciccaba virgata (Cassin, 1849)	tecolote grande / *tecolotl*	TSEF/MCF	I, VII, VIII, XI
Caprimulgidae	*Nyctidromus albicollis* (Gmelin, 1789)	tapacaminos / *poxuaca*	MCF	I, VII
	Antrostomus vociferus (Wils.)	tapacaminos / *poxuaca*	TSEF	I, VII
Trochilidae	?	chuparrosas, colibrí / *huitzil*	TSEF/MCF	I, VII
Trogonidae	*Trogon caligatus* Gould, 1835	pájaro amarillo bandera	MCF	VIII
	Trogon mexicanus Swainson, 1827	pájaro rojo bandera	MCF	VIII
Momotidae	*Momotus momota* (Linnaeus, 1766)	gorrobano / *motmot*	TSEF/MCF	
Alcedinidae	*Megaceryle torquata* (Linnaeus, 1766)	martín pescador	TSEF/MCF	VIII
	Chloroceryle amazona (Latham, 1790)	martín pescador	TSEF/MCF	VIII
Ramphastidae	*Aulacorhynchus prasinus* (Gould, 1834)	tucaneta	TSEF/MCF	I, VIII, XI
	Ramphastos sulfuratus Lesson, 1830	tucán, pito rial, pico rial	TSEF	I, VIII, XI
Picidae	*Melanerpes aurifrons* (Wagler, 1829)	pájaro carpintero / *cuatzurepetl*	TSEF/MCF	VII, VIII
	Dryocopus lineatus (Linnaeus, 1766)	pájaro carpintero / *cuachenche*	TSEF/MCF	VII, VIII
	Campephilus guatemalensis (Hartlaub, 1844)	pájaro carpintero / *cuachenche*	TSEF/MCF	VII, VIII
Falconidae	*Herpetotheres cachinnans* (Linnaeus, 1758)	*guactli*	TSEF/MCF	VI, VIII, XI
	Micrastur semitorquatus (Vieillot, 1817)	vaquero	TSEF/MCF	VI, VIII, XI
	Caracara cheriway (Jacquin, 1784)	*huatzi*	TSEF/MCF	I, VI, VII, VIII, XI
	Falco sparverius Linnaeus, 1758	halcón	TSEF	VI, VIII, XI
Psittacidae	*Psittacara holochlorus* (Sclater, 1859)	cotorritos / *quilime*	TSEF/MCF	III, VI, VII, VIII, XI
	Pionus senilis (Spix, 1824)	perico / *coyo*	TSEF/MCF	III, VI, VII, VIII, XI
	Amazona viridigenalis (Cassin, 1853)	perico / *cutcho*	TSEF	III, VI, VII, VIII, XI
	Amazona autumnalis (Lesson, 1842)	perico / *cutcho*	TSEF	III, VI, VII, VIII, XI
Furnariidae	*Xiphorhynchus sp.* Swainson, 1827	*cuanextototl*	TSEF	
Tyrannidae	*Pyrocephalus rubinus* (Boddaert, 1783)	cardenal	TSEF/MCF	VI
	Myiozetetes similis (Spix, 1825)	*huiliquitzo*	TSEF/MCF	
Corvidae	*Psilorhinus morio* (Wagler, 1829)	*chichiltente*	TSEF	
	Cyanocorax yncas (Vigors, 1829)	*papán*	TSEF/MCF	
	Corvus imparatus Peters, 1929	cuervo / *cacalotl*	TSEF/MCF	I, VII, XI

Hirundinidae	*Hirundo rustica* Linnaeus, 1758	golondrina	TSEF/MCF	
Turdidae (16)(5)	*Myadestes occidentalis* Stejneger, 1882	jilguero	TSEF/MCF	VI
	Myadestes unicolor Sclater, 1857	clar□n	MCF	VI
	Turdus grayi Bonaparte, 1838	primavera	TSEF/MCF	VI
Parulidae	?	chikchik / *zehualtotometl*	TSEF/MCF	
Icteridae	*Quiscalus mexicanus* (Gmelin, 1788)	tordo / *acatzana*	TSEF/MCF	I, VII
	Molothrus aeneus (Wagler, 1829)	tordo de ojos rojos / *pixpix*	TSEF/MCF	I, VII
	Molothrus ater (Boddaert, 1783)	tordo / *acatzana*	TSEF/MCF	I, VII
	Icterus sp. Brisson, 1760	calandria, p□jaro del sol / *tonaltototl*	TSEF/MCF	
	Psarocolius montezuma (Lesson, 1830)	pap□n real	TSEF/MCF	VIII
Fringillidae	*Spinus psaltria* (Say, 1823)	dominico	TSEF/MCF	
MAMMALIA				
Didelphidae	*Didelphis marsupialis* Linnaeus,1757	tlacuache / *tlacuaquilotl*	TSEF/MCF	III, VI, VII, VIII
	Didelphis virginiana Kerr, 1792	tlacuache grade / *itztatlacuaquilotl*	TSEF/MCF	III, VI, VII, VIII
	Philander opossum (Linnaeus,1758)	*zehuantele*	TSEF/MCF	
	Marmosa mexicana Merriam, 1897	rat□n tlacuache / *quimichitlacuaquilotl*	TSEF/MCF	
Dasypodidae	*Dasypus novemcinctus* Linnaeus,1758	armadillo / *aitoche*	TSEF/MCF	I, III, VII
Myrmercophagidae	*Tamandua mexicana* (de Saussure, 1860)	oso mielero, oso hormiguero / *xopa miel*	TSEF/MCF	VII, VIII
Orden Soricomorpha	?	rat□n / *quimichi*	TSEF/MCF	
Orden Chiroptera	?	murci□lago / *calzozoth, tzotzo*	TSEF/MCF	I, VII,
**Atelinae	***Ateles geoffroyi* Kuhl, 1820	*mono	MCF	
Leporidae	*Sylvilagus brasiliensis* (Linnaeus, 1758)	conejo / *cuatochi*	TSEF/MCF	III, VI, VII, VIII, IX, XI
Sciuridae	*Sciurus aureogaster* (Cuvier, 1829)	ardilla, ardilla colorada / *tecomate*	MCF	III, VI, VII, VIII
	Sciurus deppei (Periers, 1864)	ardilla, ardilla negra / *tecomate*	TSEF/MCF	III, VI, VII, VIII
Geomyidae	*Orthogeomys hispidus* (Le Conte, 1852)	tuza, tuza de tierra, tuza raicera / *tlaltuza*	TSEF/MCF	III, IX
Erethizontidae	*Coendu mexicanus* (Kerr, 1792)	puerco esp□n / *xompi*	TSEF/MCF	III, VI, VII, VIII, XI
Cuniculidae	*Cuniculus paca* (Linnaeus, 1776)	tuza real / *cuatuza, tuza rial*	TSEF/MCF	III, VI, VII, VIII, XI
Cricetidae	?	rat□n / *quimichi*	TSEF/MCF	
Felidae	*Herpailurus yagouaroundi* (Lec□p□de, 1809)	onza / *sacamixtle*	TSEF/MCF	VII, VIII, XI
	Leopardus pardalis (Linnaeus, 1758)	ocelote, leoncillo / *ocelotl*	TSEF/MCF	VI, VII, VIII, XI
	Leopardus wiedii (Schinz, 1821)	tigrillo / *cuametamixto*	TSEF/MCF	III, VI, VII, VIII, XI
	Lynx rufus (Schreber, 1777)	gato mont□s, gato de monte, gatillo / *coametamixto*	TSEF/MCF	VI, VII, VIII, XI
	Puma concolor (Linnaeus, 1771)	le□n / *tecuani*	TSEF/MCF	VIII, XI
	Panthera onca (Linnaeus, 1758)	tigre / *tecuaquetl, tecuani*	TSEF/MCF	VIII, XI
Canidae	*Canis latrans* Say, 1823	coyote, perro coyote / *coyotl, coyochichi*	TSEF/MCF	I, III, VII, VIII, IX, XI
	Urocyon cinereoargenteus (Schreber, 1775)	zorro / *cayochi, itzcayuchi*	TSEF/MCF	III, VII, VIII, IX, XI
Mephitidae	*Conepatus leuconotus* (Lichtenstein, 1832)	zorrillo / *epa*	TSEF/MCF	III, VII, VIII, XI
	Mephistis macroura Lichtenstein, 1832	zorrillo / *epa*	TSEF/MCF	III, VII, VIII, XI
	Spilogate gracilis Merriam, 1890	zorrillo / *epa*	TSEF/MCF	III, VII, VIII, XI
Mustelidae	***Lontra longicaudis* (Olfers, 1818)	*perro de agua / *atlchich*	MCF	
	Eira barbara (Linnaeus, 1758)	perro de cerro, perro de monte / *tepechichi*	TSEF/MCF	I, VIII, XI
	Galictis vittata (Schreber, 1776)	gris□n	TSEF/MCF	VIII
	Mustela frenata Lichtenstein, 1831	hur□n	TSEF/MCF	VI, VIII
Procyonidae	*Potos flavus* (Schreber, 1774)	marta / *tancho*	TSEF/MCF	III, VI, XI
	Nasua narica (Linnaeus, 1776)	tej□n / *pezoctle*	TSEF/MCF	III, VI, VII, VIII, XI
	Procyon lotor (Linnaeus, 1758)	mapache / *coaticuamizto, mapachi*	TSEF/MCF	III, VI, VIII
Tayassuidae	*Dicotyles angulatus* (Cope, 1889)	jabal□ / *coapitzotl*	TSEF/MCF	III, VI, VIII, XI
Cervidae	*Mazama temama* (Kerr, 1792)	venado chico / *cuachacal, chacal*	TSEF/MCF	III, VI, VIII, XI
	Odocoileus virginianus (Zimmermann, 1780)	venado / *mazatl*	TSEF/MCF	III, VI, VII, VIII, XI
FUNGI				
Auriculariaceae	*Auricularia auricula* (L.: Fr.) Underw.	oreja, oreja de viejita, nalga de la abuelita / *cuapetachiquinte, cualeleshtli*	TSEF/MCF	III
	Auricularia delicata (Fr.) Henn.	oreja, oreja de viejita, nalga de la abuelita / *cuapetachiquinte, cualeleshtli*	TSEF/MCF	III
	Auricularia polytricha (Monnt.) Sacc.	oreja, oreja de viejita, nalga de la abuelita / *cuapetachiquinte, cualeleshtli*	TSEF/MCF	III
Lycoperdaceae	*Calvatia excipuliformis* (Pers: Pers.) Perdeck	pelotitas, huevos de venado / *mazatltequistle, mazatlnanacatl*	MCF	III
Pleurotaceae	*Pleurotus djamour* (Fr.) Boedj.	hongo blanco / *totomoshchiquinte, totomoshnanacatl*	TSEF/MCF	III, XII
	P. albidus (Berk.) Pegler	hongo pat□n blanco / *itztacnanacatl*	TSEF/MCF	III, XII
Schizophyllaceae	*Schizophyllum commune* Fr.	*chiquinte*	TSEF/MCF	

Cantharellaceae	*Cantharellus cibarius* Fr.	hongos amarillos , amarillo chiquinte / *xochilnanacatl, chipahuachiquinte,*	TSEF/MCF	III, XII
	Cantharellus friessi Peck	hongos amarillos , amarillo chiquinte / *xochilnanacatl, chipahuachiquinte*	TSEF/MCF	III, XII
	Cantharellus lateritius (Berk.) Singer	hongos amarillos , amarillo chiquinte / *xochilnanacatl, chipahuachiquinte*	TSEF/MCF	III, XII
	Cantharellus lewissi	moradito, moradito chiquinte / *xochilnanacatl, xocoyochiquinte*	TSEF/MCF	III, XII
	Cantharellus minor Peck	hongos amarillos , amarillo chiquinte / *xochilnanacatl, chipahuachiquinte*	TSEF/MCF	III, XII
Polyporaceae	*Lentinus* sp. Fr.	*tlanchinolchiquinte*	TSEF	III
Ustilaginaceae	*Ustilago maydis* (D.C.) Corda	hongo de milpa, hongo de ma□z / *cuitlacoche*	TSEF/MCF	III
PLATAE				
Acanthaceae	*Justicia spicigera* Schltdl.	*mahuite, mohuite*	TSEF/MCF	VII
Actinidiaceae	*Sauravia scabrida* Hemsl.	*acalama*	TSEF/MCF	
Agavaceae	*Agave* sp. L. 1753	Maguey	TSEF/MCF	
	Yucca sp. L.	isote cimarr□n	TSEF/MCF	VII
Amaranthaceae	*Amaranthus hybridus* L.	quelite / *quilitl*	TSEF/MCF	III
	Amaranthus acanthochiton J.D.Sauer	amaranto	TSEF	
	Celosia cristata L.	mano de le□n	TSEF/MCF	I, VIII, XI
	Gomphrena globosa L.	diente de le□n	TSEF/MCF	I, VIII, XI
Amaryllidaceae	*Allium glandulosum* Link & Otto.	cebolleja / *xonacate, xonacatl*	TSEF/MCF	III, VII, XI
Anacardiaceae	*Mangifera indica* L.	mango criollo, mango manila, mango petac□n	TSEF/MCF	II, III, VIII, X, XI
	Spondias mombin L.	jobo / *cuaxocotl*	TSEF/MCF	II, III, VII, X, XI
	Spondias purpurea L.	ciruela	TSEF/MCF	II, III, VII, X, XI
Annonaceae	*Annona cherimola* Mill.	anoana	TSEF/MCF	II, III, V, XI
	Annona muricata L.	guanabana	TSEF	II, III, V, XI
	Rollinia membranacea Triana & Planch.	anona	TSEF	II, III, V, XI
Apiaceae	*Coriandrum* sp. L.	cilantro / *colantro*	TSEF/MCF	III, XI
	Eryngium foetidum L.	cilantro extranjero / *viscolantro*	TSEF/MCF	III, XI
	Foeniculum vulgare Mill.	hinojo	TSEF/MCF	III, VII, XI
Apocynaceae	*Allamanda* sp. L.	copa de oro, copa de rey	TSEF/MCF	VIII
	Plumeria acutifolia Poiret	flor de mayo, flor de la cruz / *cacalotlxuchitl*	TSEF/MCF	I, II, VII, VIII, XI
	Plumeria rubra L.	flor de mayo, flor de la cruz / *cacalotlxuchitl*	TSEF/MCF	I, II, VII, VIII, XI
	Stemmadenia donnell-smithii (Rose) Woods.	coj□n de gato	TSEF/MCF	VII, XI
	Thevetia ahouai A. D.C.	huevos de toro	TSEF	VII, VIII
Araceae	*Syngonium podophyllum* Schott.	*chapis*	TSEF/MCF	VII, VIII
	Xanthosoma robustum Schott.	hoja de luna / *quequeshquilitl*	TSEF/MCF	III, VIII
	Zantedeschia aethiopica (L. Spreng.)	alcatraz	MCF	I, VIII, XI
Araliaceae	*Dendropanax arboreus* (L.) Dcne. & Planch.	*tamalcohuitl*	TSEF/MCF	II, IV, V, XI
Arecaceae	*Acrocomia aculeata* (Jacq.) Lodd. Ex Mart.	*coyol*	TSEF	III, XI
	Chamaedorea elegans Mart.	palmilla	TSEF	I, VIII, XI
	Chamaedorea liebmannii Martius	palmilla	MCF	I, VIII, XI
Asclepiadaceae	*Asclepias curassavica* L.	venenillo, quiebra muelas	TSEF/MCF	VII
	Gonolobus niger R.Br.	apayote / *cuahuayote*	TSEF/MCF	
Aspleniaceae	*Asplenium sphaerosporum* A.R. Sm.	pesma chico, pesmita	MCF	
Asteraceae	*Achillea millefolium* L.	plumajillo	MCF	VII, VIII
	Ageratum corymbosum Zucc. Ex Pers.	hierba del pasmo	MCF	VII, VIII
	Aldama dentata La Llave & Lex.	acahual	TSEF/MCF	IX
	Artemisa sp. L. 1753	ajenjo	TSEF/MCF	VII
	Artemisia ludoviciana Nutt.	estafiate	MCF	VII
	Baccharis conferta Kunth	escobilla / *tepetlapushtle*	TSEF/MCF	IX
	Bidens pilosa L.	*mozotl*	TSEF/MCF	IX
	Matricaria recutita L.	manzanilla	TSEF/MCF	VII, XI
	Senecio confusus Britten	□rnica	TSEF/MCF	VII
	Porophyllum ruderale (DC.) Cronquist	papalo quelite	TSEF/MCF	III, XI
	Tagetes coronopifolia Willd.	cempoal silvestre / *cempoalxuchitl*	TSEF/MCF	I
	Tagetes erecta L.	cempoal / *cempoalxuchitl*	TSEF/MCF	I, VII, VIII, XI
Begoniaceae	*Begonia heracleifolia* Schltdl. & Cham.	doncella / *mayahual*	MCF	
	Begonia nelumbiifolia Schltdl. & Cham.	bandejita / *mayahual del meco*	MCF	
	Begonia wallichiana Lehm	*xihuite amargoso*	MCF	
Bignoniaceae	*Crescentia cujete* L.	tima / *cuatecomate, cuatecomactli*	TSEF/MCF	IX
	Jacaranda mimosaefolia D. Don	jacaranda	TSEF/MCF	VIII
	Parmentiera aculeata (Kunth) Seemann	chote	TSEF/MCF	II, III, VII
	Spathodea campanulata Beauv.	San Josexuchitl	TSEF/MCF	I, VIII
	Tabebuia rosea (Bertol.) A. D.C.	palo de rosa	TSEF	II, VIII
	Tecoma stans (L.) HBK.	*ahuexuchicera*	TSEF/MCF	
Bombacaceae	*Ceiba pentandra* (L.) Gaert.	*ceiba*	TSEF/MCF	II, IV, V, XI
	Pseudobombax ellipticum (Kunth) Dugand.	cabello de □ngel / *tzotzocole*	TSEF	II, IV, VIII

Brassicaceae	*Brassica* aff. *Oleracea* L.	quelite de col / *colquilitl*	TSEF/MCF	III
	Aechmea bracteata (Sw.) Griseb.	*amoxco, tecolometl*	TSEF	
Bromeliaceae	*Ananas comosus* L. Merr.	piña	TSEF/MCF	III
	Tillandsia recurvata (L.) L. 1762	timbinche	TSEF/MCF	
	Tillandsia usneoides. (L.) L.	heno	MCF	I, VIII
Burseraceae	*Bursera penicillata* (Sessé & Moc.) ex DC. Engel	palo brujo	TSEF	II, IV
	Bursera simaruba (L.) Sarg.	chaca	TSEF/MCF	II, IV, VII
	Protium copal (Schltdl. & Cham.) Engl.	*copal*	TSEF/MCF	I, II, IV, X, XI
Cactaceae	*Acanthocereus* sp. (Engelm ex. A Berger) Britton & Rose	rama-nopal / *jacube*	TSEF/MCF	III, XI
	Hylocereus undatus (Haw.) Britton & Rose	pitaya	TSEF/MCF	III, XI
	Opuntia streptacantha Lem.	nopal	TSEF/MCF	III, XI
	?	órgano	TSEF	VII
Caprifoliace	*Sambucus mexicana* Presl.	sauco	MCF	II, X
Caricaceae	*Carica cauliflora* Jacq.	*ochonite, ochonictli*	TSEF/MCF	III
	Carica papaya L.	papaya	TSEF/MCF	III, XI
Cecropiaceae	*Cecropia obtusifolia* Bertol.	palo de canal, palo chiflón, hormiguillo / *cuaquiquistli*	TSEF/MCF	II, IV, VII
Chenopodiaceae	*Chenopodium ambrosioides* L.	epazote / *epazoctli*	TSEF/MCF	III, VII, XI
Clethraceae	*Clethra mexicana* DC.	aguacatillo	MCF	
	Clethra pringlei S. Watson	aguacatillo	MCF	
Combretaceae	*Terminalia catappa* L.	almendro	TSEF/MCF	II, VIII, X
Convolvulaceae	*Ipomoea batatas* Lam.	camote	TSEF/MCF	III, XI
	Ipomea purga (Wender.) Hayne	*zoyo*	TSEF/MCF	III
	Ipomoea sp. Sendth. Ex. Vell.	bejuco de flores azules, quiebra platos	TSEF/MCF	
Crasulaceae	*Kalanchoe pinnata* (Lamarck) Persoon	tronadora	TSEF/MCF	IX
Cucubitaceae	*Citrullus lanatus* (Thunb.) Matsum. & Nakai 1916	sandía	TSEF	III, XI
	Cucurbita maxima Lam.	calabaza	TSEF/MCF	III, XI
	Sechium edule (Jacq.) Sw.	chayote	TSEF/MCF	III, XI
Chrysobalanaceae	*Couepia polyandra* (Kunth) Rose	*olopillo*	TSEF	
Cyatheaceae	*Cyathea fulva* (M. Martens & Galeotti)	pesma grande	MCF	VII
Cyperaceae	*Cyperus odoratus* L.	zacate	TSEF/MCF	IX
Ebenaceae	*Diospyros digyna* Jacq. Pl. hort. schoenbr	zapote negro / *zapotl*	TSEF/MCF	III, X, XI
Euphorbiaceae	*Cnidoscolus aconitifolius* (Mill.) I. M. Johnst.	chaya / *chichacuahuitl*	TSEF/MCF	
	Cnidoscolus multilobus (Pax) I.M. Johnst.	*tesonquilitl*	TSEF/MCF	
	Croton draco Schltdl.	sangregado / *escuahuitl*	TSEF/MCF	II, VII
	Croton pulcher Müll. Arg.	soliman	TSEF/MCF	
	Euphorbia pulcherrima Willd. ex Klotzsch	flor de la virgen, noche buena / *tonantzinxiuhuitl*	TSEF/MCF	I, VIII, XI
	Jatropha curcas L. 1753	piñón	TSEF/MCF	II
	Manihot esculenta Crantz	yuca	TSEF/MCF	III, XI
	Ricinum communis L.	higuerilla	TSEF/MCF	
Equicetaceae	*Equisetum sp.* L.	cola de caballo / *aquiztopile*	TSEF/MCF	III
Fabaceae	*Acacia cornigera* L. Willd.	toro cuerno	TSEF/MCF	II
	Acosmium panamense (Benth.) Yakovlev	hueso de tigre, huesillo	TSEF	II, IV
	Amicia zygomeris DC.	*papaloxihuitl*	TSEF	
	Arachis hypogaea	cacahuate	TSEF/MCF	III
	Bauhinia divaricata L.	pata de buey	TSEF	II, IV, VIII
	Caesalpinia pulcherrima Benth.	árbol de rosal / *tabachín*	TSEF/MCF	VIII
	Cajanus cajan (L.) Millsp.	lentejilla, frijol grande	TSEF/MCF	III
	Cassia fistula L.	lluvia de oro	TSEF/MCF	II, IV, VIII
	Calliandra grandiflora (L´ Hér.) Benth.	cabello de ángel / *tzotzocole*	TSEF/MCF	
	Dalbergia palo-escrito Rzed. & Gundi-Gómez	palo escrito	TSEF/MCF	IV, V, XI
	Delonix regia (Bojer) Raf.	framboyán / flor de mayo / flor de las madres	TSEF/MCF	II, IV, VIII
	Diphysa senoides Benth.	quiebra hacha / *quebrache, quebrachi*	TSEF/MCF	IV, V
	Erythrina americana Mill.	pemuche / *pemuch*	TSEF/MCF	II, III, IV, VII, IX
	Erythrina lanata Rose	pemuche / *pemuch*	TSEF/MCF	II, IV, VII, IX
	Eysenhardtia platycarpa Pennell & Saff.	palo azul	TSEF	VII
	Cliricidia sepium (Jacq.) Steud.	*cacahuitl*	TSEF	
	Mucuna pruriens (L.) DC.	pica pica	TSEF/MCF	
	Phaseolus coccineus L.	frijol	TSEF/MCF	III, XI
	Phaseolus sp. L.	*cashtilán*	TSEF/MCF	III
	Piscidia piscipula (L.) Sarg.	chijol	TSEF	
	Pithecellobium dulce (Roxb.) Benth.	frijolillo / humo	TSEF/MCF	III, XI
	Tamarindus indica L.	tamarindo / *tamarindocuahuitl*	TSEF/MCF	II, III, IV, XI
	Trifolium sp. L.	quelite estrella	TSEF/MCF	
	Vicia faba L.	haba	TSEF/MCF	III, XI
Fagaceae	*Quercus affinis* Scheidw.	encino / *tiocuahuitl*	MCF	II, IV, V, XI
	Quercus ocoteaefolia Liebm.	encino / *tiocuahuitl*	MCF	II, IV, V, XI
	Quercur oleoides Cham & Schltdl.	encino / *tiocuahuitl*	TSEF	II, IV, V, XI
	Quercus sartorii Née	encino / *tiocuahuitl*	MCF	II, IV, V, XI
	Quercus xalapensis Humb. & Bonpl.	encino / *tiocuahuitl*	MCF	II, IV, V, XI

Gramineae	*Lasiacis divaricata* (L) A. S. Hitch.	bamb□	TSEF	II, IV
Hamemelidaceae	*Liquidambar macrophylla* Oerst.	suchiate / *suchiatl*	TSEF/MCF	II, IV
Heliconiaceae	*Heliconia collinsiana* Griggs.	*papatla*	MCF	III, VIII
	Heliconia schideana Klotzsch.	*papatla*	TSEF	III, VIII
Lamiaceae	*Agastache mexicana* (Kunth) Linton et Epling	toronjil	MCF	VII
	Clerodendrum thomsoniae Balf.	velo de novia	TSEF	VIII, IX
	Mentha spicata L.	hierba buena	TSEF/MCF	VII
	Ocimum basilicum L.	albahaca	TSEF/MCF	I, III, VII
	Origanum mejorana L.	mejorana	TSEF/MCF	VII
	Origanum vulgare L.	or□gano	TSEF/MCF	III, VII, XI
	Rosmarinus officinalis L.	romero	TSEF/MCF	I, VII
	Salvia leucantha Cav.	cordoncillo	MCF	
	Salvia mexicana L.	*tlanchichinole*	MCF	
	Sesamum indicum L.	ajonjol□	TSEF/MCF	III, XI
	Stachys parvifolia Martens & Galeotti	*talachia*	MCF	
Lauraceae	*Cinnamomum camphora* L.	alcanfor	TSEF/MCF	VII
	Cinnamomum verum J. Presl	canela	TSEF/MCF	III
	Licaria capitata (Cham. & Schdtl.) Kosterm.	*xolime*	MCF	
	Persea americana Miller	aguacate / *aguacatl*	TSEF/MCF	II, III, IV, VII, X, XI
	Persea americana var. *drymifolia* (Schldl. & Cham.) S. F. Blake	aguacate oloroso / *aguacatl tlapanilli*	TSEF/MCF	II, III, IV, VII, X, XI
	Persea schiedeana Nees	pahua / *pahuatl*	TSEF/MCF	II, III, IV, VII, X, XI
Liliaceae	*Allium sativum* L.	ajo	TSEF/MCF	III, VII
Lophosoriaceae	*Lophosoria quadripinnata* (J. F. Gmel.) C. Chr.	pesma	MCF	
Loranthaceae	*Struthanthus crassipes* (Oliver) Eichler	seca palo	TSEF/MCF	
Magnoliaceae	*Magnolia grandifolia* L.	magnolia	TSEF	VIII
	Talauma mexicana (DC.) Don	*yoloxuchitl*	TSEF	VII, VIII
Malpighiaceae	*Bunchosia palmeri* S. Watson	*huasha*	TSEF/MCF	
	Byrsonima crassifolia (L.) Kunth	*nantzi*	TSEF	II, III, XI
Malvaceae	*Hibiscus rosa-sinensis* L.	tulip□n	TSEF/MCF	VIII
	Hibiscus sabdariffa L.	jamaica	TSEF/MCF	III, VII, XI
	Malvaviscus arboreus Cav.	manzanita	TSEF/MCF	VIII
	Quararibea funebris (La Llave) Vischer	*cacahuaxochitl*	TSEF/MCF	
Melastomataceae	*Conostegia xalapensis* (Bonpl.) D. Don ex DC.	*teshua*	MCF	
	Arthrostemma ciliatum Pav. ex D. Don	quelite agrio / *xocoquilitl*	TSEF/MCF	III
Meliaceae	*Azadirachta indica* A. Juss.	nin	TSEF	
	Cedrela odorata L.	cedro, cedro rojo / *tiocuahuitl*	TSEF/MCF	IV, V, XI
	Guarea glabra Vahl	palo blanco / *itztaccuahuitl*	TSEF	
	Melia azedarach L.	*pioche*, piochi	TSEF/MCF	II, IV
	Swietenia macrophylla King	caoba	TSEF/MCF	IV, V, XI
Menispermaceae	*Cissampelos owariensis Beauvais ex DC.*	*cintzo*	MCF	
	Calliandra grandiflora (L´ H□r.) Benth.	cabello de □ngel / *tzotzocole*	TSEF/MCF	VIII
Mimosaceae	*Inga jinicuil* Schltdl. & Cham. Ex G. Don	chalahuite / *chalahuixtli*	TSEF/MCF	II, IV
	Inga vera Willd.	chalahuite / *chalahuixtli*	TSEF/MCF	II. IV
Moraceae	*Brosimum alicastrum* Sw.	*ojite*	TSEF/MCF	
	Castilla elastica Cerv.	palo de hule / *olicuahuitl*	TSEF	IV
	Ficus padifolia H.B.K.	jalamate / *xalamatl*	TSEF/MCF	
	Maclura tinctoria (L.) D. Don ex Steud	mora	TSEF/MCF	II, IV, V
Muntingiaceae	*Muntingia calabura* L.	capul□n pujhua	TSEF	III
Musaceae	*Musa paradisiaca* L.	pl□tano	TSEF/MCF	III, XI
	Musa balbisiana Colla	pl□tano macho	TSEF/MCF	III, XI
Myrsinaceae	*Myrica cerifera* L.	*ahuaxochitl*	MCF	
	Eucapyotus sp. L. Her.	eucalipto	MCF	
Myrsinaceae	*Stylogyne* sp. A. DC.	capul□n / *capolín*	TSEF	III
Myrtaceae	*Eugenia capuli* (Cham. & Schldl.) O. Berg	piste	TSEF	
	Pimenta dioica (L.) Merr.	pimienta	TSEF/MCF	II, III, IV, V, X, XI
	Psidium guajava L.	guayaba / *chalchocotl*	TSEF/MCF	II, III, VII, X, XI
Mictagynaceae	*Bougainvillea glabra* Choisy	bugambilia	TSEF/MCF	VIII
Onagraceae	*Fuchsia microphylla* Kunth	aretillo	TSEF/MCF	
Orchidaceae	*Oncidium sphacelatum* Lindl.	flor de la santa cruz, flor de mayo, flor de cuaresma	TSEF/MCF	I, VIII
	Vanilla planifolia Jacks.	vainilla	TSEF	III, VIII, XI
Oxalidaceae	*Averrhoa carambola* L.	carambola	TSEF	III, XI
Pinaceae	*Pinus greggii* Englem.	pino	MCF	II, IV
	Pinus patula Schlecht et Cham.	pino	MCF	II, IV
Piperaceae	*Piper auritum* Kunth	tequelite / *acoyo, tequequilitl*	TSEF/MCF	III
	Peperomia sp. Ruiz & Pav.	verdolaga de monte	TSEF/MCF	III
Platanaceae	*Platanus mexicana* Moric.	□lamo / *acuahuitl*	TSEF	II, IX
Poaceae	*Arundo donax* L.	carrizo	TSEF/MCF	IV, IX
	Echinochloa colona (L.) Link	zacate colorado	TSEF/MCF	IX
	Digitaria decumbens Stent.	pasto pangola	TSEF/MCF	IX
	Guadua amplexifolia J.Presl	*otate*	TSEF/MCF	II, IV, IX
	Pennisetum purpureum Schumach.	pasto taiw□n	TSEF/MCF	IX
	Saccharum officinarum L.	ca□a de az□car	TSEF/MCF	II, III, IX, XI

Polypodiaceae	*Phlebodium aureum* (L.) J. Smith	costilla de le□n / *tehuancachiticuahuitl*	MCF	
	Rumex sp. L.	lengua de vaca	TSEF/MCF	III
Pteridaceae	*Adiantum* sp. L.	pesmita	TSEF/MCF	
Rhamnaceae	*Karwinskia humboldtiana* (Roemer & Schultes) Zucc.	capul□n de zorra, capul□n cimarr□n	TSEF	III
Rosaceae	*Eriobotrya japonica* (Thunb.) Lindl.	n□spero, n□sfero	MCF	III
	Prunus persica (L.) Batsch.	durazno	TSEF/MCF	III
	Prunus serótina Ehrh.	capul□n	TSEF/MCF	III
Rubiaceae	*Coffea arabica* L.	caf□	TSEF/MCF	III, VII, IX, XI
	Hamelia patens Jacq.	maduro zapote / *cacahuaxochitl*	TSEF/MCF	VII
	Galium mexicanum Kunth	pegarropa	MCF	
Rutaceae	*Casimiroa edulis* Llave & Lex.	zapote blanco / *iztaczapotl*	TSEF	
	Citrus aurantifolia (Christm.) Swingle	naranja cimarrona	TSEF/MCF	III
	Citrus □ sinensis Osbeck	naranja	TSEF/MCF	III, IX, XI
	Citrus limetta Risso	lima	TSEF/MCF	III
	Citrus maxima (Burm. ex Rumph.) Merr.	lim□n	TSEF/MCF	III, VII, XI
	Citrus reticulata Blanco	mandarina	TSEF/MCF	III, IX, XI
	Citrus x paradisi Macfad.	toronja	TSEF/MCF	III
	Murraya paniculata Jokoening Ex L.	limonaria	TSEF	VIII
	Ruta chalepensis L.	ruda	TSEF/MCF	VII
Salicacaea	*Salix humboldtiana* Willd.	sauce	TSEF	X
	Zuelania guidonia (Sw.) Britt. & Millsp.	volar□n	TSEF	I
Sapindaceae	*Litchi chinensis* Sonn.	lichi	TSEF/MCF	III, XI
	Sapindus saponaria L.	jaboncito	TSEF	IX
Sapotaceae	*Manilkara zapota* (L.) van Royen	chicozapote / *xicotlzapotl*	TSEF/MCF	II, III, X, XI
	Pouteria campechiana (Kunth) Baehni	zapote amarillo	TSEF/MCF	III
	Pouteria sapota (Jacq.) H.E. Moore & Stearn.	zapote mamey / *zapotl*	TSEF/MCF	II, III, IV, VII, X, XI
Simaroubaceae	*Simarouba glauca* DC.	pistache	TSEF	II, IV
Solanaceae	*Capsicum annuum* L.	chiltep□n	TSEF/MCF	III
	Capsicum sp. L.	chile	TSEF/MCF	III
	Brugmansia □ *candida* Pers.	*xochilcampana*	TSEF/MCF	VII, VIII
	Nectandra sanguínea Rottb.	aguacachile	TSEF/MCF	
	Nicotiana tabacum L.	tabaco	TSEF/MCF	I, VII, IX, XI
	Solanum nigrescens Mart. & Gal.	tomatillo	TSEF/MCF	III, XI
Sterculiaceae	*Guazuma ulmifolia* Lam.	guasima / *aquiche*	TSEF/MCF	II
	Theobroma cacao L.	cacao	TSEF	III, VIII
Tiliaceae	*Heliocarpus donnell-smithii* Rose	jonote	TSEF/MCF	X
Ulmaceae	*Aphananthe monoica* (Hemsl.) J.F. Leroy	*ajuate, ajuactli*	TSEF	
	Ulmus mexicana (Liebm.) Planch.	palo var□n, palo de hombre / *tlacacuahuitl*	TSEF/MCF	IV, V
	Trema micrantha (L.) Blume	guinda, capol□n	TSEF	III
Urticaceae	*Urera caracasana* (Jacq.) Griseb.	ortiga real	TSEF/MCF	VII
	Urtica mexicana Liemb.	ortiga	TSEF/MCF	VII
Verbenaceae	*Petrea volubilis L.*	raspasombrero	TSEF/MCF	II, III, VII, VIII
Vitaceae	*Vitis tiliifolia* Humb. & Bonpl. ex Roem. & Schult.	mecate de uva / *cuaxocomecatl*	TSEF/MCF	III
Zamiaceae	*Zamia herrerae* Calder□n & Standl.	zompollo	TSEF/MCF	
Zingiberaceae	*Costus mexicanus* Liebm.	ca□a de jabal□ / *cuapitzoatl, acatlcuapitzxihuitl*	TSEF/MCF	VII
	Zingiber officinale (L) Roscoe.	jengibre	TSEF/MCF	III, VII, XI