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Estudio etnozoológico de los vertebrados silvestres de la comunidad Bonifacio García, Morelos, México

Ethnozoological study of wild vertebrates of the Bonifacio Garcia community, Morelos, Mexico

Autores

Alejandro García Flores* [1]
alejandro.garcia@uaem.mx
https://orcid.org/0000-0002-1122-5059

Rafael Monroy Martínez [1]
ecologia@uaem.mx
https://orcid.org/0000-0003-3229-224X

José Manuel Pino Moreno [2]
jpino@ib.unam.mx
https://orcid.org/0000-0002-1193-6125

Institución / correspondencia

***Corresponding author**

1 Cuerpo Académico Unidades Productivas Tradicionales, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Morelos, Cuernavaca, Morelos, México.

2 Laboratorio de Entomología, Departamento de Zoología, Instituto de Biología, Universidad Nacional Autónoma de México, México.

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Resumen

El objetivo de la investigación fue analizar el conocimiento etnozoológico que conservan de los vertebrados silvestres los habitantes de la comunidad Bonifacio García en Morelos, México. Se aplicaron entrevistas semiestructuradas a 30 informantes clave, mediante la observación participante y recorridos guiados se buscaron rastros como huellas, excretas, madrigueras, pieles y observación *in vivo* para la identificación de las especies citadas y se calcularon los siguientes índices: valor de diversidad de uso para cada especie (VDE) y de uso medicinal (VDM), así como el índice de diversidad de las enfermedades tratadas (IVDE). Se reportan 41 especies de vertebrados que los entrevistados reconocen, de los cuales 28 son aprovechados: mamíferos 39.3%, aves 32%, reptiles 18%, peces 7.1% y anfibios 3.6%. Los principales valores de uso fueron alimentario (0.54), medicinal (0.46) y ornamental (0.43). El venado cola blanca, la iguana negra y la víbora de cascabel registraron 0.57 de VDE y un VDM de 0.19. Las principales enfermedades tratadas son: cáncer, afecciones respiratorias, enfermedades de la piel y reumatismo con un IVDE de 0.17. La apropiación de los vertebrados silvestres se lleva a cabo por medio de la cacería de subsistencia en el campo (50%), terrenos de cultivo (43%) y el traspatio (7%) utilizando con mayor frecuencia escopeta como arma de captura. Se concluye que la apropiación de vertebrados permite complementar necesidades básicas de alimentación y salud; por lo que los conocimientos etnozoológicos deben de integrarse a políticas públicas que permitan la conservación y manejo de la fauna silvestre en la comunidad.

Palabras clave:

Apropiación; cacería de subsistencia; conocimiento tradicional; fauna silvestre; valores de uso.

Abstract

The aim of this study was to analyze the ethnozoological knowledge that the inhabitants of the Bonifacio García community, Morelos, Mexico, conserve about wild vertebrate. Semi-structured interviews were applied to 30 key informants, through participant observation and guided tours, traces such as footprints, excreta, burrows and pelts and *in vivo* observation were researched for the identification of the mentioned species and the following indexes were calculated: value of diversity of use for each species (VDS) and of medicinal uses (DVM), as well as the diversity index of the treated diseases (DITD). The study recorded a total of 42 wild vertebrate species, of these 28 are used: mammals 39.3%, birds 32%, reptiles 18%, fish 7.1% and amphibia 3.6%. The main use values were alimentary (0.54), medicinal (0.46) and ornamental (0.43). The white-tailed deer, the black iguana and the rattlesnake registered 0.57 of VDS and a DVM of 0.19. The main diseases treated are cancer, respiratory and skin diseases and rheumatism with an DITD of 0.17. The animals are obtained by means of subsistence hunting in the fields (50%), croplands (43%) and backyards (7%), using most frequently shotguns as arms for capture. We conclude that the appropriation of vertebrates complements basic needs for food and health; therefore, ethnozoological knowledge must be integrated into public policies that enable the conservation and management of wild fauna in the community.

Keywords:

Appropriation; subsistence hunting; traditional knowledge; wild fauna; use values.

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Introduction

Indigenous and agricultural societies in Argentina (Cruz & Courtalon 2017), Brazil (Soares 2013), Colombia (Londono 2009), Mexico (Monroy & García 2013; Rodas et al. 2016); Panama (Contreras & Yanguez 2017), Peru (Costa et al. 2018), Venezuela (Ferrer et al. 2010), Costa Rica (Castillo et al. 2018) and Nicaragua (Gómez et al. 2014) preserve traditional knowledge that includes biological, ecological, cultural and historical aspects about wildlife and agricultural strategies (Barrera & Toledo, 2005) that enables them to establish an appropriation of species of wild fauna (Zavala et al. 2018) in territorial, time and cultural dimensions.

Subsistence hunting represents a very important activity in countries such as: Bolivia (Tejada et al. 2006), Brazil (Alves & Otavio, 2015), Colombia (Cuesta et al. 2007), Costa Rica (Altrichter2000) and Mexico (Guerra et al. 2010; Retana 2006), as in general for the american continent (Ojasti1993; Pérez & Ojasti 1996; Ojasti & Dallmeier 2000), because it has different use values such as foodstuff, medicine, pets, source of raw material for craftwork, tools, ornaments, clothing and as exchange value that enables the acquisition of economic income as well as being essential in their world view (García et al. 2018; Montiel et al. 1999; Pérez et al. 1996; Retana 2006; Stearman & Redford 1995). In Latin America, hunting wildlife contributes to alimentary security, as historically it has provided a source of protein and of fundamental micronutrients in the diet (Bennett 2002; Milner et al. 2003; Naranjo et al. 2004; Ojasti & Dallmeier 2000; Stearman & Redford 1995). In Mexico animal protein that comes from wildlife has contributed up to 70% (INE 1997) and in South American rural populations it has been estimated between 30-50% for Bolivia (Stearman & Redford 1995) and Ecuador (Zapata 2001). Wildlife also constitutes an important element within the structure and dynamics of ecosystems, because it participates in processes such as energy flow, nutrient recycling, pollination and plant seed dispersal, and it has ecological, cultural and economic importance (Medrano et al. 2014; Ulloa 2012; Viejo & Ornosa 1997).

Although wildlife is highly significant for indigenous and agricultural communities because of the environmental goods and services it renders, diverse socio-environmental problems persist in Mexico that jeopardize this resource, for example, intense urbanization and territorial fragmentation favors the loss of wildlife habitats (Monroy-Ortiz & Monroy 2012; Rodríguez et al. 2017), impoverishment and decline in the life quality of the communities (Monroy & García 2013) and the loss of traditional knowledge linked to fauna resources.

The aim of this study was to analyze the ethnozoological knowledge about wild vertebrates that the inhabitants of the community of Bonifacio García in Morelos, Mexico, preserve.

Material and methods

Study area.- The community of Bonifacio García is situated in the Tlaltizapan municipality, in the center of the state of Morelos, Mexico. Geographically, it is located at 18°43'08"N and 99°07'10"W (Figure 1), at an altitude of 955 meters above sea level. The agricultural population of the community is made up of 2151 inhabitants.

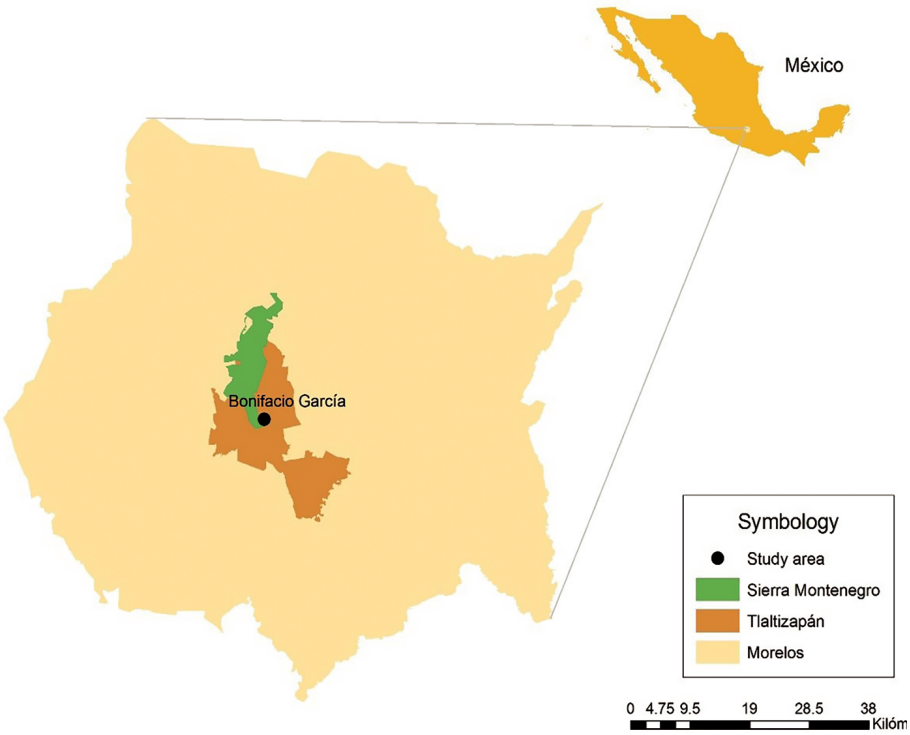

Figure 1. Geographic location of the study area, the Bonifacio García community.

The main economic activities are agriculture and animal husbandry (INEGI 2010). The community limits with the nature reserve of the Sierra de Montenegro. The climate in the region is warm and subhumid with summer rains (Taboada et al. 2009), with an average annual temperature of 23.5° and an average annual precipitation of 840 mm (INAFED 2017). The vegetation of the region is a low elevation deciduous forest where species with use value like "tepeguaje" *Lysiloma spp*, "palo dulce" *Eysenhardtia polystachya* (Ortega) Sarg., "copales" *Bursera* spp., "guamúchil" *Pithecellobium dulce* (Roxb.) Benth., "ciruelo" *Spondias purpurea* Lineo, "cuachalalate" *Amphipterygium adstringens* (Schltdl.) Schiedeex Standl., "guaje" *Leucaena esculenta* (Moc. Et Sessé ex Dc.) Benth, "casahuate" *Ipomoea* spp, "cuahulote" *Guazuma ulmifolia* Lam. and "mezquite" *Prosopis* spp., can be found.

Methodology.- This study was performed based on the Ethics Code for research principles, action-research and ethnoscientific collaboration of Latin America of the Latin American Ethnobiological Society (Cano et al. 2014).

In the first phase, we looked for access to the study area with the help of a "doorman" which was a native person, who collaborated in the tours through the community. This led afterward to the establishment of familiarity with the inhabitants, such as is recommended by Taylor and Bogdan (1984). Several meetings to explain the project and its objectives were carried out with the community. We had the approval and permission from the local authorities to put in practice the project from August 2016 to September 2018.

In the second phase, we selected 30 key informants according to the following criteria: availability and knowledge about wildlife with them, we consolidated a focal group and to each one, we applied an open interview (Taylor & Bogdan 1984) to obtain common names, use-values, places and hunting techniques of wild vertebrates. To corroborate the information thus obtained we applied the technique of participant observation (Schensul et al. 1999; Taylor & Bogdan 1984) and guided tours (Dos Santos 2009). The taxonomical determination of the wild vertebrates was done by the observation of tracks, excreta, dens, pelts, or specimens "in vivo", which were identified with field guides and specialized literature on vertebrates (Aguilar et al. 2003; Aranda 2012; Howell & Webb 1995; Pérez et al. 2007; Urbina & Morales 1994).

The data obtained was systematized in Excel sheets and their analyze and descriptive statistics was performed with Statistica Program version 10 for Windows. Intending to recognize the importance of each species with use-value for the inhabitants, we made use of the indexes proposed by Phillips and Gentry (1993):

$$VDE = nU/Ntu$$

Where:

VDE = Value of diversity of use of each species

nU = Number of use values of a given species

Ntu = Total use values registered

The importance of each use value was estimated by means of the diversity value for each use (VDU):

$$VDU = nE/nTE$$

Where:

VDU= Diversity value for each use value

nE= Number of species per use value

nTE= Total of species registered

The importance of each species according to the parts or products that are used was analyzed with the value of use diversity of parts or products of each animal (VDP):

$$VDP = nPU/nTP$$

Where:

VDP= Value of diversity use according to parts or products used

nPU= Numbers of parts of each animal that are used

nTP= Total of parts registered

The importance of the species with medicinal use value was estimated by means of the following indexes proposed by Enríquez et al. (2006):

$$VDM = EA/nE$$

Where:

VDM= Diversity value for each animal

EA= Total number of ailments that the animal cures

nE= Total of ailments treated

The value of diversity of the ailments treated by the species (IVDE) was estimated by means of the following formula:

$$IVDE = AE/nA$$

Where:

IVDE= Value of diversity of the ailments treated by the species

AE= Number of species that cure certain ailment

nA= Total of species with registered medicinal properties

Results and discussion

The 80% of the interviewees were men dedicated to agriculture and/or animal husbandry and 20% were women, housewives without a salary. The 66% are native of the community, while 34% became neighbors having come from the state of Guerrero and Mexico City. During the application of the questionnaires, the men recognized the highest number of wild vertebrates (n=40), a fact that can be explained because the family chief carries on the primary productive activities, such as agriculture, animal husbandry, collection, fishing, and subsistence hunting, therefore they maintain daily contact with wild animals. Factors such as gender and occupation that influence the recognition of the species of wild animals

and their traditional knowledge have been discussed by García (2008); Amador and De la Riva (2016), in Mexico and Salcedo et al. (2018) in Colombia, mention that men have higher access to animal natural resources because of labor division and social roles. Machado et al. (2016) registered age, schooling, residence time, and type of activity as the factors that influence the traditional knowledge about the local resources that an individual within a social group can have, among them occupation and gender were recorded in the community of Bonifacio García.

Ethnozoological knowledge.- Interviewees identified 42 species of wild vertebrates (Table 1), this represents the 17% of the 250 vertebrates reported for the natural reserve of the Sierra de Montenegro, Morelos, Mexico (Barreto 2010). Wild mammals (40%) stand out as the group of fauna most recognized by the interviewees (Figure 2) and in other studies carried out in Mexico (Barrasa 2012), Brazil (Barbosa et al. 2018) and Panama; (Contreras & Yanguez, 2017;). An 88% of the species are classified by the International Union for Conservation of Nature as in the level of Least concern (Table 1).

Table 1. Taxonomy of the vertebrates recognized by the inhabitants of the Bonifacio García community, Tlaltizapan, Morelos, México. (IUCN: International Union for Conservation of Nature, NE: Not evaluated, LC: Least concern).

Order	Family	Specie	Local name	IUCN
SILURIFORMES	**Ictaluridae**	*Ictalurus balsanus* (Jordan y Snyder, 1899)	Catfish	NE
PERCIFORMES	**Cichlidae**	*Cichlasoma istlanum* (Jordan y Snyder, 1899)	Mojarra	NE
ANURA	**Bufonidae**	*Rhinella marina* (Linnaeus, 1758)	Toad	LC
TESTUDINES	**Kinosternidae**	*Kinosternon integrum* (LeConte, 1854)	Turtle	LC
SQUAMATA	**Iguanidae**	*Ctenosaura pectinata* (Wiegmann, 1834)	Iguana	
	Phrynosomatidae	*Sceloporus horridus* (Wiegmann, 1834)	"Chintete"	LC
		Phrynosoma taurus (Duges,1874)	Chameleon	LC
	Helodermatidae	*Heloderma horridum* (Wiegmann, 1829)	Scorpión	LC
	Boidae	*Boa constrictor* (Daudin, 1803)	"Mazacuata"	
	Colubridae	*Oxybelis aeneus* (Wangler, 1824)	"Flechilla"	
		Drymarchon melanurus (Smith, 1941)	"Tilcuate"	LC
	Elapidae	*Micrurus laticollaris* (Peters, 1869)	Coral viper	LC
	Viperidae	*Crotalus culminatus* (Klauber, 1952)	Rattlesnake	LC
GALLIFORMES	**Cracidea**	*Ortalis policephala* (Wagler, 1830)	"Chachalaca"	LC
	Odontophoridea	*Colinus virginianus* (Linnaeus, 1758)	Quail	LC
		Phylortix fasciatus (Linnaeus 1758)	Quail	
COLUMBIFORMES	**Columbidae**	*Zenaida macroura* (Linnaeus, 1758)	"Huilota"	LC
		Columbina passerina (Linnaeus, 1758)	Lovebird	LC
CATHARTIFORMES	**Cathartidae**	*Cathartes aura* (Linnaeus, 1758)	Vultur	LC
		Coragyps atratus (Bechstein, 1793)	Vultur	LC
STRIGIFORMES	**Strigidae**	*Bubo virginianus* (Gmelin, 1788)	Owl	LC
FALCONIFORMES	**Falconidae**	*Caracara cheriway* (Miller, 1777)	Bonebreaker	LC
		Falco sparverius (Linnaeus, 1758)	Hawk	LC
PSITTACIFORMES	**Psittacidae**	*Myiropsitta monachus* (Boddaert, 1783)	Cotorro	LC
PASSERIFORMES	**Corvidae**	*Corvus corax* (Linnaeus, 1758)	Crow	LC
	Fringillidae	*Haemorhous mexicanus* (Statius Müller, 1776)	Sparrow	LC
DIDELPHIMORPHIA	**Didelphidea**	*Didelphis virginiana* (Kerr, 1792)	Tlacuache	LC
CINGULATA	**Dasyponidae**	*Dasypus novemcinctus* (Linnaeus, 1758)	Armadillo	LC
LAGOMORPHA	**Leporidae**	*Sylvilagus cunicularius* (Waterhouse, 1848)	Field rabbit	LC
CHIROPTERA	**Phyllostomidae**	*Artibeus jaimaicensis* (Leach, 1821)	Fruit bat	LC
CARNIVORA	**Canidae**	*Urocyon cinereoargenteus* (Schreber, 1775)	Bitch	LC
		Canis latrans (Say, 1823)	Coyote	LC
	Felidae	*Lynx rufus* (Schreber, 1777)	Wild cat	LC
		Puma yagouaroundi (Lacéped, 1809)	Cougar	LC
	Mustelidae	*Mustela frenata* (Lichtenstein, 1831)	Ferret	LC
	Mephitidae	*Mephitis macroura* (Lichtenstein1832)	Skunk	LC
		Conepatus leuconotus (Lichtenstein, 1832)	Skunk	LC
	Procyonidae	*Nasua narica* (Linnaeus, 1766)	Badger	LC
		Bassariscus astutus (Lichtenstein, 1832)	"Cacomixtle"	LC
		Procyon lotor (Linnaeus, 1758)	Raccoon	LC
ARTIDACTYLA	**Cervidae**	*Odoicoileus virginianus* (Zimmermann, 1780)	Deer	LC
RODENTIA	**Sciuridae**	*Spermophilus variegatus* (F. Cuvier, 1825)	Chipmunk	LC

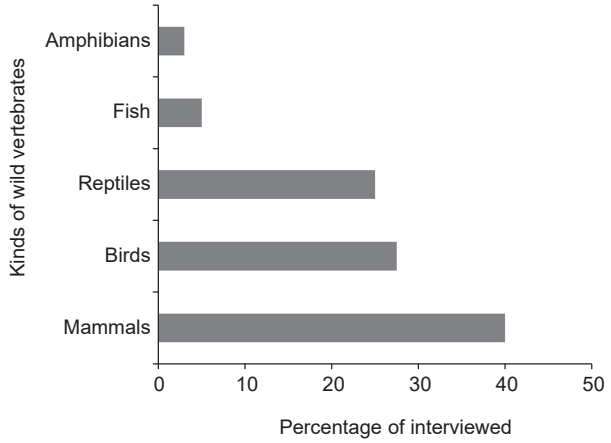

Figure 2. Types of wild vertebrates recognized by the interviewees.

Use value of wild vertebrates.- The 67% of the wild vertebrates (n=28) registered use value (Table 2) higher than reported for other communities in Mexico like Aguascalientes. Amador and de la Riva (2016) and Tabasco Hernández et al. (2013) reported 26 species, Velarde and Cruz (2015) in Morelos 16 species and in Panama, Contreras and Yanquez (2017) cataloged 26 species of wild vertebrates. The registered proportion of the groups of vertebrates with use value was: mammals 39%, birds 32%, reptiles 18%, fish 7% and amphibia 4%. Mammals are the class of wild vertebrates most used in Mexico (Santos et al. 2012; Cortes et al. 2013; Lira et al. 2014; Tejada et al. 2014; Buenrostro et al. 2016), Peru (Francesconi et al. 2018) and Brazil (Machado et al. 2016). The preference of use of this group of vertebrates is due, in voice of the interviewees, to the fact that "*mammals are bigger and have more meat*"; in this respect Monroy-Vilchis et al. (2008) indicate that mammals provide more biomass and therefore higher benefit by their capture.

Wild mammals and birds are the zoological groups better represented in the studies about the knowledge and use of wild vertebrates in local communities (Alves et al. 2012; Amador & de la Riva 2016; Farías et al. 2018; Puc & Retana 2012; Machado et al. 2016; Osbahr & Morales 2012; Zavala et al. 2018), this use pattern is recorded too in this investigation.

The families registered were 24, the most representative was Columbidae, as in certain rural communities in Brazil where it is mentioned as the most important for its number of species and for providing a higher quantity of protein (Da Silva 2013; Quirino et al. 2011); they are followed by Mephitidae y Procyonidae (7.4% each one).

Figure 3 shows the importance of each registered use value for the wild vertebrates; the alimentary (0.54), medicinal (0.46) and ornamental (0.43) uses stand out. The use values registered in this study have been reported too for other communities in Mexico (Estrada et al. 2018; García et al. 2018; Velarde & Cruz 2015), being salient the use value as foodstuff in Mesoamerica (Guerra et al. 2010), Colombia (Londono, 2009), Argentina (Cruz & Courtalon 2017) and Peru (Vela et al. 2017) just as we report for the community under study. Besides, the use of fauna species as foodstuff and as a resource in traditional medicine is a common practice in different parts of Latin America; particularly in rural communities, wild animals provide meat for the diet and an accessible and socio-culturally acceptable alternative for the treatment of diverse ailments (Alves & Alves 2011; Machado et al. 2016).

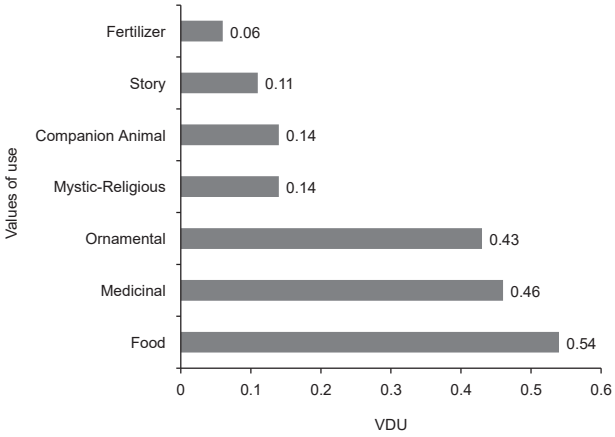

Figure 3. Use values of the wild vertebrates of the Bonifacio García community, Morelos, Mexico.

The whitetail deer *Odocoileus virginianus*, the iguana *Ctenosaura pectinata* and the rattlesnake *Crotalus culminatus* registered the highest index of diversity of use value (0.57) (Table 2), result that is similar to the one reported by Retana and Padilla (2018) who registered the whitetail deer as the species with the highest use importance (IVUs=0.4-0.6) for the indigenous Maya of Mexico and for the black iguana reported by Ávila et al. (2018b) and Bello (2015) the alimentary and medicinal use values have been mentioned for this species. Estrada et al. (2018) documented in the Mixteca Poblana, that the highest importance of the species is due to the benefits they provide by they use values, such as is reported in this study. Meanwhile, for Colombia, Parra et al. (2014) registered the "tejón" *Nasua narica* as the most important species. In Table 2 we show the different use values registered in the present study.

The alimentary use value registered 15 species of vertebrates whose meat is prepared in dishes such as: "adobo" (a kind of marinade), chili pepper-garlic, garlic sauce, in clear soups and on the coals. This use is the most mentioned in comparison with other use values; this result has also been registered in other communities of Mexico (Amador & de la Riva 2016; Barrasa 2012; Cortes et al. 2013; Hernández et al. 2013; Puc & Retana, 2012; Ramos et al. 2015; Zavala et al. 2018) and of Brazil (Farías et al. 2018; Machado et al. 2016).

The biological group with the highest representation in this use are the mammals (47%) such as: the whitetail deer, armadillo, badger, skunks and field rabbit, followed by the birds: "huilota" (a kind of pigeon), "chachalacas" (galliform birds), quails, lovebirds (27%), reptiles: iguana (13%) and fish: catfish and "mojarra" (tilapia fish) (13%).

Table 2. Value of diversity of use for each species (VDE) and diversity of use of parts and products of each species (VDPA) of the wild vertebrates registered in the Bonifacio García community, Morelos, Mexico. Simbology: A. Alimentary; M. Medicinal; Mt-Re. Mystic-religious; O. Ornamental. An Cm. Pets; R. Tale; Ab. Fertilizer.

Family	Genus and specie	Common Name	Use value	VDE	VDPA
Ictaluridae	*Ictalurus balsanus* (Jordan y Snyder, 1899)	Catfish	A	0.14	0.07
Cichlidae	*Cichlasoma istlanum* (Jordan y Snyder, 1899)	Mojarra	A	0.14	0.07
Bufonidae	*Rhinella marina* (Linnaeus, 1758)	Toad	M Mt-Re	0.29	0.13
Kinosternidae	*Kinosternon integrum* (LeConte, 1854)	Turtle	M O	0.29	0.13
Iguanidae	*Ctenosaura pectinata* (Wiegmann, 1834)	Iguana	A M O An Cm	0.57	0.27
Boidae	*Boa constrictor* (Daudin, 1803)	"Mazacuata"	O	0.14	0.07
Colubridae	*Drymarchon melanurus* (Smith, 1941)	"Tilcuate"	R	0.14	0.07
Viperidae	*Crotalus culminatus* (Klauber, 1952)	Rattlesnake	A M O Mt-Re	0.57	0.20
Cracidea	*Ortalis policephala* (Wagler, 1830)	"Chachala-ca"	A O	0.29	0.13
Odontophoridea	*Phylortix fasciatus* (Linnaeus, 1758)	Quail	A	0.14	0.07
Columbidae	*Zenaida macroura* (Linnaeus 1758)	"Huilota"	A	0.14	0.07
	*Columbina passerina (*Linnaeus 1758)	Lovebird	A	0.14	0.07
Cathartidae	*Coragyps atratus* (Bechtein, 1793)	Vultur	M R	0.29	0.13
	Cathartes aura	Vultur	M	0.14	0.07
Falconidae	*Falco sparverius* (Linnaeus, 1758)	Hawk	O An Cm	0.29	0.29
Psittacidae	*Myropsitta monachus* (Boddaert,1783)	Argentine cotorro	An Cm	0.14	0.07
Corvidae	*Corvus corax* (Linnaeus, 1758)	Crow	R	0.14	0.07
Didelphidae	*Didelphis virginiana* (Kerr, 1792)	Tlacuache	A M O	0.43	0.07
Dasypodidae	*Dasypus novemcinctus* (Linnaeus, 1758)	Armadillo	A M O	0.43	0.13
Leporidae	*Sylvilagus cunicularius* (Waterhouse, 1848)	Field rabbit	A	0.14	0.07
Phyllostomidae	*Artibeus jamaicensis (Leach,1821)*	Fruit bat	Ab	0.14	0.07
Canidae	*Canis latrans* (Say, 1823)	Coyote	M O Mt-Re	0.33	0.20
Mustelidae	*Mustela frenata* (Lichtenstein, 1831)	Ferret	An Cm	0.14	0.07
Mephitidae	*Mephitis macroura* (Lichtenstein, 1832)	Shunk	A M O	0.43	0.20
	Conepatus leuconotus (Lichtenstein, 1832)	"Zorrillo cadeno"	A	0.14	0.13
Procyonidae	*Nasua narica* (Linnaeus, 1766)	Badger	A M	0.29	0.13
	Procyon lotor (Linnaeus, 1758)	Raccoon	O	0.14	0.07
Cervidae	*Odoicoileus virginianus* (Zimmermann, 1780)	Whitetail deer	A M O Mt-Re	0.57	0.33

The consumption of mammals is a practice in different communities of the state of Morelos, Mexico (García et al. 2014; 2017; 2018; Monroy et al. 2011a; Reyna et al. 2015; Velarde & Cruz 2015).

In Mexico, the mammals most frequent use is as foodstuff (Ávila et al. 2018a). The mammals most prefered for consumption in the community under study were the whitetail deer *Odocoileus virginianus*, armadillo *Dasypus novemcinctus* and field rabbit *Sylvilagus cunicularius*; in both cases the first species mentioned were the most consumed (Ávila et al. 2018a), for example, the whitetail deer represents a complementary source in the diet of the rural and indigenous communities, it is therefore an important species in subsistence hunting just as Mandujano et al. (2010) point out; besides, a factor that favors its hunt is their meat's flavor (López et al. 2005).

Birds are consumed in the community of Bonifacio García because their flavor is similar to that of poultry and they are easily available; in this case there is no need to climb a hill or walk to the fields to hunt them, as they can be captured in the trees thay have in their homes where they can be seen resting or eating fruits. The galliforms, like the "chachalacas" and quails, have historically been the object of local hunting by the rural population, this practically in all the countries where they are distributed (Chávez 2014) where they are used for self-sufficiency. The "chachalacas" are equally a source of food for the communities of the Mexican Southeast, where they are even reared in backyards (Vásquez et al. 2014). For the inhabitants of the rural zones where the dry forests of the Mexican Pacific are distributed, the "chachalacas", pigeons and lovebirds, also represent an important source of animal protein (Naranjo & Cuaron 2010).

In the case of the reptiles, the iguana and the rattlesnake are consumed, just as has been registered in other communities of Mexico (Pascual et al. 2014; Reyna et al. 2015).

In the community of Bonifacio García, in relation to medicinal use we registered 13 species that are employed in the treatment of 16 diseases (Table 3). Such richness represents 7% of the wild fauna reported in traditional medicine for Mexico (Alonso 2014) and 2% of the species reported in Latin America (Alves & Alves 2011). A 54% of the species of vertebrates registered with medicinal use corresponds to the mammals; among the reptiles we have 23%, birds 15% and amphibia 8%. The mammals are the taxonomic group that is employed for the treatment of the highest number of diseases in the study area; this observation has also been reported in other rural communities of Mexico (Dardon & Retana 2017; Guerrero & Retana 2012), Argentina (Hernández et al. 2015) and Brazil (Barros et al. 2012; Souto et al. 2018). Even in Mexico, of the 163 species of fauna registered as used in traditional medicine, the group of vertebrates that is best represented is that of the mammals (n=49) (Alonso 2014).

Table 3. Animals with medicinal use values VDM, treated diseases, part used and form of use.

Common Name	Diseases	Used part	Form of use	VDM
Armadillo	Cough	Carapace	Soak in alcohol and take	0.06
			Smeared	
Coyote	Rheumatism	Fat	Smeared	0.06
Iguana	Anemia	Blood	Soup	0.19
	Lack of energy			
	and appetite			
Toad	Skin problems	Live animal	Rub	0.06
Badger	Sexual impotence	Meat	Stew	0.06
Tlacuache	Indigestion	Tail	Dry, grind and place in water	0.13
	Full stomach			
Turtle	Dropsy	Blood	Smeared	0.06
Whitetail deer	Epilepsy	Blood	Drink	0.19
	Diabetes	Antlers	Crushed in water	
	Rheumatism	Fat	Ointment	
Rattlesnake	Cancer	Meat	Dry	0.19
	Scorpion sting		Place over the brite	
	Lack of energy		Soup	
	Cancer	Meat	Dry	0.06
			Soup	
Skunk	Eliminate acne	Meat	Soup	0.13
	Respiratory problems	Fat	Ointment	
"Zorrillo cadeno"	Eliminate acne	Meat	Soup	0.13
	Respioratory problems	Fat	Ointment	

The species with the highest use and importance for the community of Bonifacio García because they have a high (0.19) medicinal diversity value (VDM) were the iguana *Ctenosaura pectinata*, whitetail deer *Odoicoileus virginianus* and rattlesnake *Crotalus culminatus*, this because each one of them is used in the treatment of 3 diseases; this is different to what García et al. (2017) report, as those authors mention the skunk as the animal with the highest index (0.6) for Zacualpan de Amilpas, Morelos, Mexico. Enríquez et al. (2006) mention that the most important species are those that help for an specific disease, that is, with a lower VDM, which in the case of the community under study includes the following species: armadillo *Dasypus novemcinctus,* species used to treat cough, fact that is different from what is reported in Colombia where it is employed to manage asthma (Aldana et al. 2016).

The coyote *Canis latrans*, toad *Rhinella marina*, badger *Nasua narica*, turtle *Kinosternon integrum* and vulture *Coragyps atratus* each have a VDM of 0.06 (Table 3).

The 13 medicinal species and the 16 ailments reported in the present study represent a higher number than in the communities of the Selva Lacandona, Mexico where 12 ailments are treated with 11 species (Rodas et al. 2016) and in Brazil Soares (2013) reports 8 medicinal species. According to the estimated IVDE of 0.17, the diseases that stand out are: cancer, skin ailments, respiratory complaints, rheumatism, and lack of energy (Figure 4).

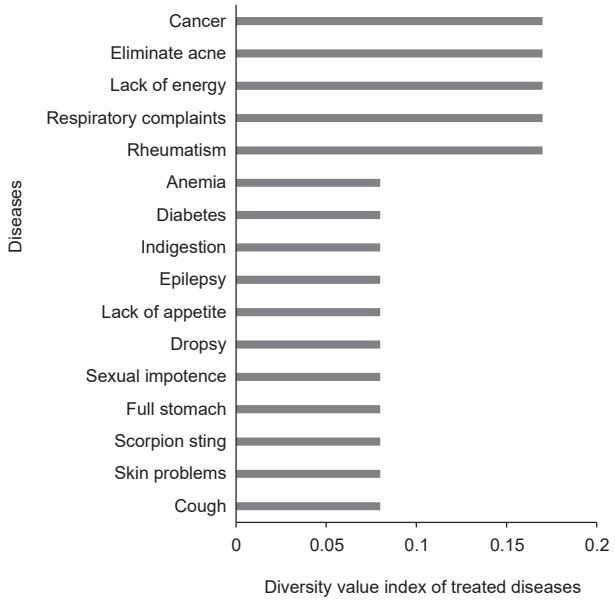

Figure 4. Value of diversity of the ailments treated by the species with medicinal use value.

In the state of Morelos, Mexico, the medicinal use of the following animals has been registered: whitetail deer, skunk, iguana, rattlesnake and coyote, this for the treatment of epilepsy, skin problems, anemia, cancer and rheumatism (García et al. 2014; García et al. 2018; Monroy et al. 2011b; Reyna et al. 2015; Velarde & Cruz, 2015). In communities of the Mixteca Poblana, Mexico, the cure of epilepsy is attributed to the whitetail deer (Estrada et al. 2018), just as is reported in the present study.

In the specific case of the vultures *Coragyps atratus* and *Cathartes aura*, in this locality the consumption of their meat in a clear soup is used for cancer treatment, form of use that is similar to that registered in Colombia, where in addition to consuming the meat in clear soup, the blood or the dried meat are ingested too, being the belief that this medicinal property derives from the alimentary habit of the bird of eating carrion and thus possessing a "good immunological system" (Sánchez et al. 2012); in contrast, in the Sierra de Oaxaca, Mexico, the vulture is reported as used to treat epileptic problems (Núñez et al. 2012) and the indigenous Tzotziles and Tojolabales of Chiapas, Mexico, mention that this species is useful for treating rheumatism, "aire" (diverse symptoms due to physical or emotional stress) and for enhancing hearing (Serrano et al. 2011).

The badger *Nasua narica* is used in the treatment of sexual impotence, while in Argentina it is employed to "cure" blackheads, boils, carbuncles, mycosis and when there is sign of oncoming disease (Martínez 2013).

In the species with medicinal use, seven structures or tissues are reported as employed, this is lower than what is reported by Rodas et al. (2016) for the Selva Lacandona, but higher compared with the six animal "parts" registered for the treatment of diseases by the inhabitants of the Costa Grande of Guerrero, Mexico (Zavala et al. 2018). In this study the use of the meat with a 41%, animal fat or lard 33% and blood 25% stand out as the most used parts, in a similar way to what is reported for Bolivia (Tejada et al. 2006) and the north of Tanzania (Magige 2015). Furthermore, in this study we register antlers, tail and carapace, this last is registered too by Enríquez et al. (2006) in the Heights of Chiapas, Mexico, with medicinal purposes. In our community we registered 11 forms of use among which clear soups are salient as 42% of the species are prepared in this form, while the elaboration of ointments and rubbing account for 25% each. In Mexican traditional medicine, in the treatment with parts of wild animals, the use of tissues such as meat and fat predominate, as well as their administration in the form of soups and clear soups (Alonso 2014). On the other hand, the toad *Rhinella marina* is used rubbing the complete animal over the affected skin, this to cure erysipelas, as has been registered in Veracruz, Mexico (Morales & Villa 1998).

For the ornamental use value, we registered 12 vertebrate species that are those used to decorate homes, among them: the whole body, tanned or non-tanned skins, carapaces, feathers, bones or some extremities such as the legs; the mammals are the most used in this aspect (50%), then the reptiles (33%) and the birds (17%). The salient species are the whitetail deer, striped skunk, armadillo, boa and rattlesnake. In the case of the whitetail deer, different structures that include the head, skin and antlers are used, this being a common practice in diverse localities of Mexico (Amador & De la Riva

2016; Retana et al. 2015; García et al. 2018), as well as in Colombia (Chacón & Salcedo 2017).

The ornamental use of the armadillo is reported too in communities of Colombia (Parra et al. 2014) and in relation to the striped skunk, its register is uncommon, this due to the characteristics of the species, for example, the difficultly to tan the skin. Boa constrictor, known as "mazacuata", has ornamental use value for the inhabitants of the community under study, nevertheless in the municipality of Matiguás, Nicaragua, it has use value as foodstuff and to biologically control rodents (Gómez et al. 2014).

The animals with use value as pets are represented by those that are captured to keep them in the homes of the hunters. In this case we report four vertebrate species, standing out the iguana, fact that has also been registered in other communities of Morelos, Mexico, where the hunters keep them in fish tanks and pens inside their homes (Reyna et al. 2015). In regard to the species linked to tales, we report the "tilcuate" (a kind of terrestrial snake), the vulture and the crow. In comparison with other groups of vertebrates, the snakes have a higher presence in the social imaginary as they have been associated with diverse myths, legends and beliefs (Casas 2000); according to the interviewees, for example, the story that it "*has the capacity of sucking the milk of pregnant women and chasing people*" pertains to the "tilcualte". This aspect has been documented by García (2008) and Reyna et al. (2015) for communities in Morelos, Mexico. This use value for the vulture has been registered by Núñez et al. (2012) in Oaxaca, Mexico, who mention this species as a means of communication with the spirits. The mystic religious value of the whitetail deer refers to good luck, as in Yucatán (Herrera et al. 2018) and Campeche, Mexico (Retana & Padilla 2018).

Multiple use of wild fauna.- We registered 14 species of vertebrates with multiple use value (Figure 5), among them being salient the whitetail deer *Odocoileus virginianus*, the rattlesnake *Crotalus culminatus* and the black iguana *Ctenosaura pectinata,* that register four use values each; these species have been also reported with multiple use values by Cortés et al. (2013) in Sinaloa and Reyna et al. (2015) and García et al. (2018) in Morelos, México.

The whitetail deer is one of the species with multiple uses, for example, it is consumed in different regions of Mexico (López et al. 2005), its anatomical structures are also used as ornament and medicine (Mandujano 2004; Enríquez et al. 2006) and it provides raw material like skin and bones that are used to manufacture diverse products through activities that can be traced to Pre-Columbian times (Galindo & Weber, 1998; Montero & Varela, 2017). In the Bonifacio García community we report 36% of the uses that has been registered for Mexico for this Cervidae (n=11) (Ávila et al. 2018a).

The iguana is one of the reptiles with highest importance in Mexican culture as historically it has been used as an alimentary resource, in traditional medicine, as a source of income and as a pet for the people in rural communities (Arcos 2001). Such cultural importance is confirmed by Ávila et al. (2018b), who registered 5 uses in Mexico. We report in the community under study 80% of the uses that have been published for this species. In the present study the rattlesnake presents 57% of the total of uses registered for Mexico (n=7) (Ávila et al. 2018b).

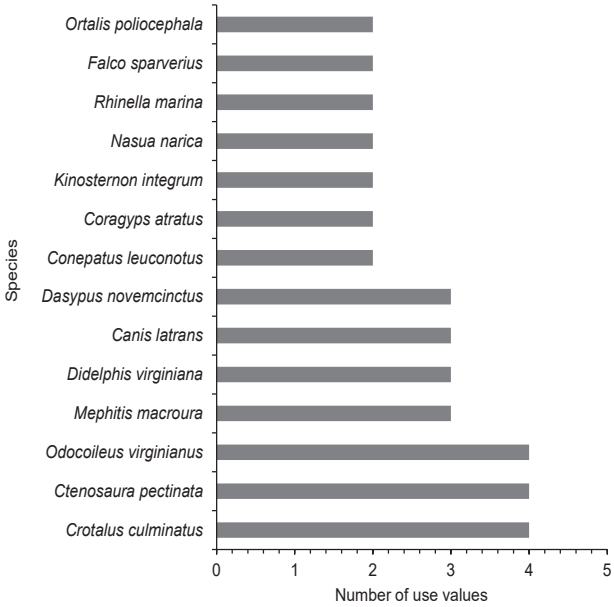

Figure 5. Wild vertebrates with multiple use value.

Wild fauna appropriation.- The appropriation of the vertebrates is achieved by means of subsistence hunting that is practiced mainly for the need of food or health (53%), just as has been registered by Ferrer et al. (2010) in the communities of the Reserva Forestal El Caura, Estado Bolívar, Venezuela, to protect crops (43%) and because circumstance favors it (4%); this aspect is different to that found in the Parque Nacional Barra Honda, Nicoya, Costa Rica, inasmuch as there the main motive for hunting is sport followed by subsistence and in a lower percentage its commercialization (Castillo et al. 2018). In communities of the semiarid region of northeastern Brazil, subsistence hunting is practiced to obtain food, as was registered in the community under study, but it is also practiced to protect crops or to control animals that are considered dangerous for humans, or simply as a leisure or entertainment activity (Alves et al. 2009).

According to the information offered by the interviewees, we registered three places where wild fauna appropriation takes place, 1. fields (50%) constituted by the vegetation known as low elevation deciduous forest, it is the main place where hunting takes place, similar to what Méndez and Montiel (2007) register for Campeche, Mexico, where they emphasize the role of forest areas as the main places for the utilization of the species, 2. croplands (43%) and 3. backyards (7%). León (2006) points out that the preference of hunting in the fields is due to reasons of convenience in what refers to the fact of finding the wild animals in their habitat and the help of the vegetation to hide while hunting. Nevertheless, Centeno and Arriaga (2010) mention that hunting prac-

ticed in croplands for damage control reduces the hunt energetic effort as croplands attract fauna because they represent an easily available food source and a refuge for the animals. The appropriation of fauna in this type of culturally modified environments has been a practice registered in Mesoamerica (Van Derwarker 2006; Manin & Lefévre 2016).

The instruments used for hunting are shown in figure 6, the shotgun stands out as the most used arm for animal hunting (34%), this has also been reported in Oaxaca, Mexico (Núñez et al. 2012) and Quindío, Colombia (Parra et al. 2014). Nonetheless, we registered the use of traditional arms such as crates and slings, just as has been reported by Centeno and Arriaga, (2010) and García et al. (2018). Likewise in the Maya rural communities of Yucatán, Mexico, an extensive use of firearms and an infrequent use of traps, particularly for the capture of certain species of fauna, is registered (Santos et al. 2012). Rifles or shotguns are the basic and predominant instruments in practically all the regions of Latin America and the use of traditional "tools" is every time less frequent even among indigenous groups (Alves et al. 2009). This hunting pattern can probably be explained because it enables the capture of the preys in a more effective and simple way.

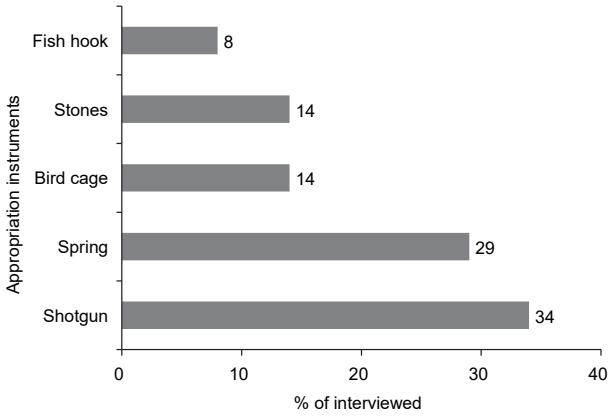

Figure 6. Instruments used for the appropriaton of the wild vertebrates in the Bonifacio García community, Morelos, Mexico.

Conclusion

In the territory of the community of Bonifacio García we registered a total of 41 species of wild vertebrates that the inhabitants recognize; of these 28 possess use values as foodstuff, medicine, mystic/religious objects, ornaments, pets and fertilizer. The most important use values were the alimentary and medicinal with 15 and 13 species, respectively, reported; the rural families that practice subsistence hunting obtain goods, such as meat that is prepared in various dishes that guarantee the consumption of protein in the family diet and in addition they treat different ailments that damage their life quality. In this context, the use of wild vertebrates contributes to alleviate alimentary insecurity and the health risks of the rural population studied.

The whitetail deer, the black iguana and the rattlesnake were the species with the highest VDE (0.57) for the community; this is why we recommend the participative implementation of community breeding centers that may enable, for example, the reproduction of the deer for its integral use, conservation and rational management. It is also important to carry out actions to recover the wild fauna habitat by using species pertaining to the low elevation deciduous forest, and to organize surveillance committees to regulate subsistence hunting by means of community rules and norms established both by those who appropriate wild fauna and the pertinent authorities.

The ethnozoological information we obtained examines species with cultural importance as defined by the use values bestowed by the community, because of this it is essential its integration into public policy dealing with management and conservation just as has been done in the nature reserve of the Sierra de Montenegro, area in which subsistence hunting of the species reported in this study is practiced.

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