Uses of invertebrates in two biocultural zones of the State of Veracruz, Mexico

Usos de invertebrados en dos zonas bioculturales del Estado de Veracruz, México

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Abstract

Invertebrates are the most diverse taxonomic group in the world. By recognizing their ecological and cultural values, use, management, and conservation programs can be established in a biocultural context. The objective of this research was to identify the uses, the intensity of use, and the cultural value of invertebrate ethnospecies in two indigenous communities located in protected natural areas and bodies of water in two biocultural zones of Veracruz, Mexico. Visits were made to two Nahuatl communities: Tuxpanguillo, in the municipality of Ixtaczoquitlán, and Huixtla, in the municipality of Zongolica, both in the state of Veracruz. A total of 200 residents were interviewed, and the Cultural Importance Index (CII) was estimated for each invertebrate species mentioned. Thirty-five species of invertebrates were reported with at least one mention and one use; the recognized uses were: food, commercial, medicinal, myths and legends, beneficial, and harmful. The species with the highest CII in Tuxpanguillo were *Automeris* (32.4), *Megalopyge opercularis* (25.4), *Periplaneta americana* (22.7), and *Elysius superba* (19.8), while in Huixtla they were *Pomacea catemacensis* (45.9), Stylommatophora (35.7), *Arsenura armida* (32.4), and *Centruroides* spp. (30.3). For the species with the highest CII, their use and conservation can be planned through the registration of a Wildlife Management Facility (PIMVS, Predio o Instalación para el Manejo de Vida Silvestre), which would allow the commercialization and conservation of these species in the biocultural regions studied.

Keyswords: ethnozoology; cultural Importance Index; indigenous communities; traditional knowledge; wildlife management; biodiversity conservation

Resumen

Los invertebrados son el grupo taxonómico más diverso del mundo. Al reconocer sus valores ecológicos y culturales, es posible establecer programas de uso, manejo y conservación en un contexto biocultural. El objetivo de esta investigación fue identificar los usos, la intensidad de uso y el valor cultural de las etnoespecies de invertebrados en dos comunidades indígenas ubicadas en áreas naturales protegidas y cuerpos de agua en dos zonas bioculturales de Veracruz, México. Se realizaron visitas a dos comunidades nahuas: Tuxpanguillo, en el municipio de Ixtaczoquitlán, y Huixtla, en el municipio de Zongolica, ambas en el estado de Veracruz. Se entrevistó a un total de 200 habitantes, y se estimó el Índice de Importancia Cultural (IIC) para cada especie de invertebrado mencionada. Se reportaron treinta y cinco especies de invertebrados con al menos una mención y un uso; los usos reconocidos fueron: alimenticio, comercial, medicinal, mitos y leyendas, benéfico y nocivo. Las especies con mayor IIC en Tuxpanguillo fueron *Automeris* (32.4), *Megalopyge opercularis* (25.4), *Periplaneta americana* (22.7) y *Elysius superba* (19.8), mientras que en Huixtla fueron *Pomacea catemacensis* (45.9), Stylommatophora (35.7), *Arsenura armida* (32.4) y *Centruroides* spp. (30.3). Para las especies con mayor IIC, su uso y conservación podrían planificarse mediante el registro de un Predio o Instalación para el Manejo de Vida Silvestre (PIMVS), lo que permitiría la comercialización y conservación de estas especies en las regiones bioculturales estudiadas.

Palabras clave: Etnozoología; índice de Importancia cultural; comunidades indígenas; conocimiento tradicional; Manejo de vida silvestre; Conservación de la biodiversidad

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Introduction

Invertebrates are the most diverse taxonomic group in the world (Ødegaard, 2000), with distribution in almost all biomes on the planet (Morris *et al.*, 1991). In addition to the extensive knowledge that exists in their identification as a taxonomic group, invertebrates have been studied to rescue the knowledge of original groups (Gasca-Álvarez and González, 2021), describe their biology through genetic and phenotypic variability, life cycles, and the habitats where they are distributed (Guzmán-Mendoza, 2010). Likewise, invertebrates can be studied by using the term morphospecies for their identification and grouping in biocultural research (Guzmán-Mendoza *et al.*, 2016).

The wide diversity of morphotypes, colors, life forms, and biological traits of invertebrates has made them valued by humanity across cultures, as evidenced by their presence in decoration, myths and legends, music, art, games, breeding practices, and as a source of resources such as food, inks, medicines, poisons, and commercial products, among others (Costa-Neto *et al.*, 2012; Serrano-González *et al.*, 2011). More recently, invertebrates have also been studied to understand ecological relationships such as competition and parasitism for the management and biological control of populations (Altieri, 2002). Among their most outstanding uses, food consumption stands out (Kitsa, 1989; Ramos-Elordy and Conconi, 1994; Ramos-Elordy and Pino, 1989; Ramos-Elordy, 1997, 2008; Ramos-Elordy *et al.*, 1997) ; for example, Ramos-Elordy et al. (2009) identified 104 species of edible invertebrates distributed in 10 orders in the State of Mexico, of which Hymenoptera, Orthoptera, and Coleoptera are the most frequently consumed in different countries and sectors of society (Quirce *et al.*, 2013).

The study of the biocultural use of invertebrates from the ethnosciences has been framed within ethnoentomology and ethnozoology, disciplines that study the use and consumption of invertebrates from the principles of cosmos, corpus, and praxis (Gasca-Álvarez and González; 2021; Toledo, 2001). By applying these principles, different models are generated for biocultural education and the establishment of sociocultural bases for the conservation and sustainable use of biodiversity (Costa-Neto *et al.*, 2012). Studying their ecological and cultural values allows generating information that can be used for the design and establishment of conservation programs for species and their habitats, in both an ecological (species and interactions) and sociocultural (rural communities) context (Guzmán-Mendoza *et al.*, 2016). In this regard, the Cultural Importance Index (CII) has been widely applied in ethnozoological studies as a quantitative tool to assess the relative cultural significance of species within a community, based on the frequency of mentions and number of uses reported by local informants (Tardío and Pardo-de-Santayana, 2008).

In this sense, effective conservation strategies must currently consider culture, biodiversity, and their uses and management to achieve sustainability. Mexico is one of the most megadiverse countries in the world and harbors a remarkable overlap between biological and cultural diversity, with states such as Veracruz, Oaxaca, and Chiapas concentrating the highest levels of both species richness and linguistic diversity (Vidal and Brusca, 2020). The state of Veracruz maintains a great wealth in terms of cultural diversity, with the Nahuatl culture being predominant in the region (Secretaría de Finanzas y Planeación (SEFIPLAN), 2010). As described by Toledo et al. (2001), indigenous peoples play a fundamental role in safeguarding biodiversity, managing natural resources from a religious vision that gives nature a sacred character. In Veracruz, traditional ecological knowledge has been documented as a key tool for biocultural landscape restoration and resource management in indigenous communities (Velázquez-Rosas *et al.*, 2018). However, this knowledge is increasingly threatened by cultural change, acculturation, loss of indigenous languages, and the transformation of local economic systems, all of which contribute to the erosion of traditional ecological knowledge (Saynes-Vásquez *et al.*, 2013).

In this context, the objective of this research was to identify the uses, the intensity of use, and the cultural value of invertebrate ethnospecies in two indigenous communities located in protected natural areas and bodies of water in two biocultural zones of Veracruz, Mexico. The evaluation of biocultural importance through indicators such as the Cultural Importance Index (CII)

serves as a measure to explain the knowledge about different types of use of biodiversity as part of the biocultural heritage of indigenous peoples (Tardío and Pardo-de-Santayana, 2008). Their study can help understand changes in the richness and abundance of species at the local level, allowing the design of strategies for their management and sustainable use, including their registration under Wildlife Management Facilities (PIMVS), in balance with their biocultural value.

Materials and methods

Study area. This study was conducted in two Nahuatl communities located in the state of Veracruz, Mexico. The first community was Tuxpanguillo, in the municipality of Ixtaczoquitlán (longitude -97.012222, latitude 18.781111, 800 masl), with a population of 3,884 inhabitants (2,008 women and 1,876 men; INEGI, 2020). The community is surrounded by a network of tributary streams of the Río Blanco that flow down the mountain. The climate is temperate-humid with an average annual temperature of 18°C, and the predominant vegetation consists of subevergreen and secondary medium forest (Instituto Nacional de Estadística y Geografía (INEGI), 2020). It is located within the Cañón del Río Blanco National Park.

The second community was Huixtla, in the municipality of Zongolica (longitude -96.868056, latitude 18.575000, 100 masl), with a population of 245 inhabitants (127 women and 118 men; INEGI, 2020). This community is characterized by the birth of the Tonto River within its territory and forms part of the Mesoamerican Neotropical Mountain Region. The climate is temperate with an average annual temperature of 25.3°C. The predominant vegetation, according to the Rzedowski (2006) classification, is medium evergreen and subevergreen forest (Figure 1).

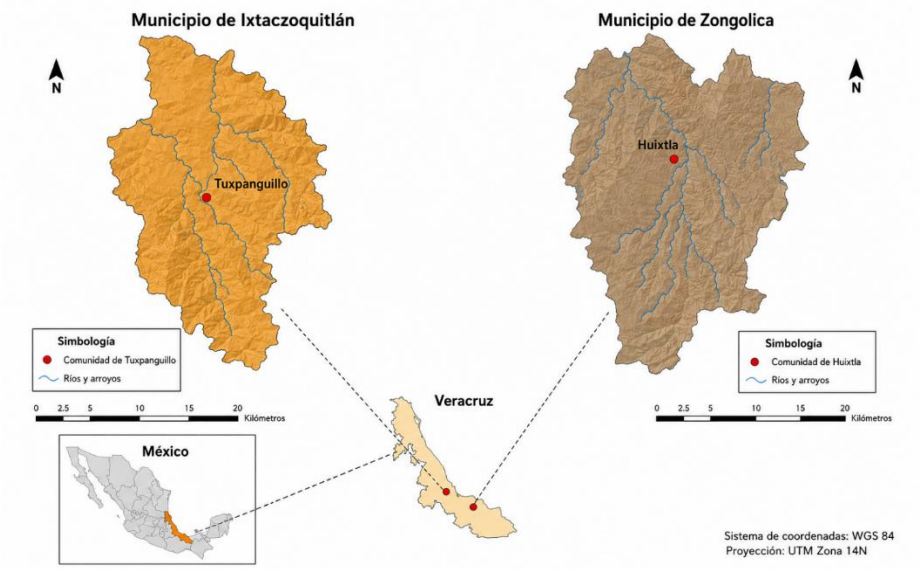


Figure 1. Location of the study communities, Tuxpanguillo and Huixtla, Veracruz, Mexico (Modified from Morales Carbajal, 2022).

Sample size calculation. Information was obtained through simple random sampling applied to ejidatarios (men and women) from both communities. The sample size was calculated based on the 2020 Population and Housing Census (INEGI, 2020), with a confidence level of 95 % and a margin of error of 6 %, using the following equation (Thompson, 1987):

$$n = \frac{N * Z_{\propto}^2 * p * p}{d^2(N-1) + Z_{\propto}^2 * p * q}$$

Where: n = Sample size; N = Population size; p = Expected proportion (5 % = 0.05); q= 1-p (1-0.05 = 0.95); d = Tolerable margin of error (0.06); z = Level of confidence or accuracy, expressed at 95 % (1.96).

Survey structure. Survey structure. Information was collected through a semi-structured questionnaire divided into three sections. The first section gathered general data from each respondent, including name, age, occupation, Nahuatl language proficiency, and religion, which allowed for a more reliable approach and served to assess the influence of cultural factors on use categories. The second section documented known wildlife species (mammals, amphibians, reptiles, birds, fish, and invertebrates), their perceived abundance, and whether each species had a name in the native language. The third section recorded ethnobiological uses attributed to each species and the respondents' knowledge of national parks and protected natural areas (ANPs).

A pilot test was conducted in May 2020 with two members of the study communities to validate the questionnaire items. The surveys were administered between June and September 2020. During each interview, respondents were shown a reference guide developed using the Naturalista and Enciclovida databases, CONABIO distribution maps, and published studies on species distributed in the region (de la Torre, 2018; Mezhua, 2022).

Data analysis. The information obtained from the interviews was captured in a general database in the Microsoft Excel program, later it was analyzed using frequency tables. The systematized data were used to calculate the Cultural Importance Index (IIC) proposed by Turner (1988) for plants, modified and applied to wildlife (Ávila-Nájera *et al.*, 2011):

$$\text{Cultural Importance Index (IICz)} = \Sigma\,(\text{Iuz} + \text{Fmz} + \text{Vutz}),$$

Where: Intensity of use (Iu): (Number of uses of the species z of all informants / Total number of uses of all species and of all informants) X 100.

Mention frequency (Fm) = (Number of mentions of species z from all uses and from all informants / Total number of mentions of all species for all uses and from all informants) X 100.

Value of use x (Vux) = (Number of mentions of the species z for a use of all the informants / Total number of mentions of all the species for a use x y of all the informants) X 100.

Total use value of the species z (Vutz) = Σ (Vux + Vuy + Vuz + ... + Vun).

Description of use categories. Six use categories were recognized: (1) Beneficial: species to which people attribute ecological, spiritual, or material benefits; (2) Food: species used as a source of protein for human consumption; (3) Commercial: species or their parts that are bought or sold, either live or as derivatives; (4) Harmful: species with negative cultural significance due to their potential danger to humans or their association with economic losses such as damage to livestock, goods, or property; (5) Medicinal: species or their derived products (body parts or organs) used therapeutically to treat diseases; and (6) Myths and legends: species that are part of the cultural and symbolic worldview of the community, associated with traditional stories, beliefs, and spiritual representations (Ávila-Nájera *et al.*, 2011; Ávila-Nájera *et al.*, 2018).

Species identification. Species were identified by local informants through their common and traditional names. In more conspicuous cases, identification was supported by reference guides. For species not identified through the guides, specimens were collected and compared with reference collections and known species distribution data. Taxonomic identification was

supported by specialized studies on invertebrates and arthropods in Mexican indigenous communities (Cahuich-Campos, 2013; Pinkus-Rendón, 2013), invertebrate zoology references, the biodiversity and taxonomy series of Mexican arthropods (Llorente-Bousquets and Morrone, 2002), as well as previous studies conducted specifically in the Zongolica region (De la Torre, 2018; Mezhua-Velázquez *et al.*, 2022; Ramos Elorduy *et al.*, 2008).

Results

In the Nahuatl community of Tuxpanguillo, 20 invertebrate species were identified with at least one mention and at least one use (Table 1), among which the following use categories were recorded: food, commercial, medicinal, myths and legends, beneficial, and harmful. In the Nahuatl community of Huixtla, 15 invertebrate species were identified with at least one mention and at least one use; within this community the following use categories were recognized: food, medicinal, commercial, and harmful.

Tabla 1. Comparative ethnozoological table: Tuxpanguillo and Huixtla.

Order / Family / Genus / Species / Common name in Mexico / Local name	**Tuxpanguillo**			**Huixtla**		
	Uses	Mentions	IIC	Uses	Mentions	IIC
Araneae						
Ctenidae						
Cupiennius salei (Keyserling, 1877) / araña	har	3	8.26			
Theridiidae						
Latrodectus mactans (Fabricius, 1775) / capulina o viuda negra	har	1	7.72	har	2	8.8
Architaenioglossa						
Ampullariidae						
Pomacea catemacensis (Baker, 1922) / tegogoles	food	2	8.3	food, com	10	45.9
Blattodea						
Blattidae						
Periplaneta americana (Linnaeus, 1758) / cucaracha	har	5	22.7			
Cucaracha de monte				med	1	8.4
Coleoptera						
Melolonthidae						
Phyllophaga tumulosa (Bates, 1888) / gallina ciega	food, har	2	15.24			
Chacoles				food	1	6.8
Araneae (cont.)						
Theraphosidae						

Order / Family / Genus / Species / Common name in Mexico / Local name	Tuxpanguillo			Huixtla		
	Uses	Mentions	IIC	Uses	Mentions	IIC
Tliltocatl vagans (Ausserer, 1875) / tarántula mexicana de cadera roja				med, har	5	27.8
Crassiclitellata						
Lumbricidae						
Amynthas gracilis (Kinberg, 1866) / lombriz de tierra	ben	3	16.9			
Diptera						
Culicidae						
Aedes aegypti (Linnaeus, 1762) / mosco o sancudo	har	9	10.51			
Hymenoptera						
Apidae						
Bombus medius (Cresson, 1863) / abejorro serrano	har	2	7.9	har	1	6.7
Formicidae						
Atta mexicana (F. Smith, 1858) / chicatana	food	5	10.5			
Dolichoderus sp. (Lund, 1831) / Henhen bobitogordo				har	2	16.6
Vespidae						
Polistes canadensis (Linnaeus, 1758) / avispa roja	har	2	7.9			
Polistes dorsalis (Fabricius, 1775) / huarachera	med, har	3	16.11			
Lepidoptera						
Crambidae						
Diatraea saccharalis (Fabricius, 1794) / gusano barrenador	har	2	7.9			
Erebidae						
Elysius superba (H. Druce, 1884) / gusano de palo mulato	m and l	1	19.76			
Megalopygidae						
Megalopyge opercularis (J.E. Smith, 1797) / oruga peluche o cabeza de pollo	med, har	11	25.46	med, har	2	15.1
Saturniidae						
Automeris spp. (Hübner, 1819) / borreguillo verde	food	11	32.4			
Borreguillo corazón de víbora				har	1	6.7
Automeris illustris / romerillo	med, har	8	18			
Arsenura armida (Cramer, 1779) / cuetla	Al	14	15.26	food	12	32.4
Hylesia nigricans (Cramer, 1775) / chinahuate	har	3	8.26			

Order / Family / Genus / Species / Common name in Mexico / Local name	Tuxpanguillo			Huixtla		
	Uses	Mentions	IIC	Uses	Mentions	IIC
Pseudodirphia mexicana (Bouvier, 1924) / palomilla o gusano de palo	Al	4	9.47			
Orthoptera						
Pyrgomorphidae						
Sphenarium purpurascens (Charpentier, 1845) / chapulín	food	1	7.72			
Isopoda						
Porcellionidae						
Porcellio scaber (Latreille, 1804) / cochinillas				med	1	8.4
Stylommatophora						
Caracoles / Atexacame				com, food	5	35.7
Myriapoda						
Ciempiés gigante				har	1	6.6
Scorpiones						
Buthidae						
Centruroides spp. (Marx, 1890) / alacrán negro				har, med	9	30.3
Centruroides flavopictus (Marx, 1890) / alacrán rojo				har	1	6.7

Reported uses by species

Food. For food use, the following species of invertebrates are consumed, along with a description of how each species is prepared. Tegogolos (*Pomacea catemacensis*), also known as snails, can be prepared with chili, enchipotlados (chipotle-style) or boiled. To prepare them with chipotle, clean the chili, grind it with onion and garlic, add water and season; once it has boiled, add the tegogolos and let them rest. They can also be prepared in a tamale with holy grass (hierba santa), but first the tegogolos must be washed and boiled with onion and chili, then wrapped in the herb and cooked over coals.

The blind hen (*Phyllophaga tumulosa*) is prepared by cleaning the organisms, removing the excrement, and washing them thoroughly, before toasting them on a griddle with salt and lemon to taste. Similarly, the chicatana ant (*Atta mexicana*) is prepared fried in oil or toasted on a griddle.

The cuetla (*Arsenura armida*) is the larval stage of a moth; during this stage it is considered edible. They must first be washed, the excrement removed, and the body turned inside out. They can then be prepared fried, with a flavor similar to pork rinds, or cooked with chipotle chili. After cleaning, they are boiled; the chipotle is prepared by cleaning the chili, grinding it with onion and garlic, adding water and seasoning; once boiled, the larvae are added and left to rest. Other species with a similar preparation include the larvae of the moth or stick worm (*Pseudodirphia mexicana*). Finally, grasshoppers (*Sphenarium purpurascens*) are prepared fried in oil with salt to taste.

Beneficial. Only the earthworm (*Amynthas gracilis*) was considered a beneficial species, as it is used as fishing bait. Commercial. For commercial use, only one species was reported: the tegogolo or snail (*P. catemacensis*), which was sold by the kilogram at prices ranging from $20.00 to $50.00 Mexican pesos at a traditional market.Harmful. Harmful use is recognized in both communities. Species are classified as harmful if they can cause injury to the skin or body, including in some cases death, if they are considered pests or disease vectors, or if they damage crops. The species identified within the harmful use category are described below.

Spiders such as *Cupiennius salei* and Latrodectus mactans, and tarantulas such as *Tliltocatl vagans*, are considered harmful because contact with their bristles causes rashes and itching. In the case of *L. mactans*, its bite can be lethal.

Other species whose sting or contact with the organism causes irritation, burns, fever, or bone pain include: the serrano bumblebee (*Bombus medius*), the henhen ant (*Dolichoderus* spp.), the red wasp (*Polistes canadensis*), the romerillo (*Automeris illustris*), the chicken head caterpillar (*Megalopyge opercularis*), the green sheep (*Automeris* spp.), the huarachera wasp (*Polistes dorsalis*), and the Veracruz scorpion (*Centruroides flavopictus*). The chinahuate (*Hylesia nigricans*) also causes a rash, itching, and burning upon contact, as does the giant centipede (Order Myriapoda), whose contact can cause high fever.

The cockroach (*Periplaneta americana*) is considered harmful by members of the community, as it has become a pest and disease carrier, and is regarded as unpleasant and unsanitary. Another disease-carrying species is the mosquito (Aedes aegypti). The sugarcane borer (*Diatraea saccharalis*) is considered highly harmful to farmers and their crops.

Medicinal. Most medicinal uses are based on the principle that the remedy for a bite or skin injury is derived from the same organism that caused it. For *Tliltocatl vagans*, the remedy consists of killing the specimen and applying its excrement to the affected area. Similarly, the romerillo (*Automeris illustris*), the chicken head caterpillar (*Megalopyge opercularis*), the green sheep (*Automeris* spp.), and the henhen or bobitogordo ant (*Dolichoderus* spp.) are used by crushing the insect and applying the remains, also referred to as slime, to the affected area. The Veracruz scorpion (*Centruroides flavopictus*) is prepared in brandy and taken as an infusion, serving as an antidote to its own sting. The huarachera wasp (*Polistes dorsalis*) is used in traditional medicine to treat bone pain.

Another medicinal use involves the pill bug (*Porcellio scaber*), which is used to relieve coughs. It is prepared as a tea with garlic and bougainvillea, using two or three pill bugs per preparation, and is also used for asthma. Likewise, the mountain cockroach (*Blaberus giganteus*) is used to relieve coughing: water is boiled, the insect is added, left to steep, and the infusion is taken three times a day.

Myths and Religion. The death moth (*Elysius superba*) is considered an omen of bad fortune, announcing death and misfortune.

Discussion

The use of invertebrates by local inhabitants was documented for food, commercial, medicinal, myths and legends, beneficial, and harmful purposes, with 35 identified species. In Tuxpanguillo, the green sheep (*Automeris* spp.) presented the highest CII (32.4), followed by the chicken head caterpillar (*Megalopyge opercularis*), with a CII of 25.46, which is considered both harmful and medicinal. In Huixtla, the tegogolo (*Pomacea catemacensis*) had the highest CII (45.9), being the only species reported for commercialization. These edible invertebrates are part of traditional food use practices recognized in the communities

(Ambrosio-Arzate *et al.*, 2010), a practice known as entomophagy, which refers to the ingestion of insects and includes the class Insecta (arthropods: chelicerates, myriapods, and crustaceans) and arachnids (Chelicerata: Arachnida; Quirce e*t al.*, 2013).

Regarding edible insects reported in Mexico, Ramos Elorduy *et al.* (2008) listed 549 species, while Cerritos (2009) reported 177 species in the country. Van Huis et al. (2013) reported that worldwide, the most consumed insects are beetles (Coleoptera) (31 %), caterpillars (Lepidoptera) (18 %), and bees, wasps, and ants (Hymenoptera) (14 %), followed by grasshoppers, locusts, and crickets (Orthoptera) (13 %), cicadas, leafhoppers, planthoppers, scale insects, and true bugs (Hemiptera) (10 %), termites (Isoptera) (3 %), dragonflies (Odonata) (3 %), flies (Diptera) (2 %), and other orders (5 %).

The fact that these species present higher CII values reflects that they have historically formed part of the cultural identity of the indigenous communities studied, since the tradition of consuming these and other insect species dates to pre-Hispanic times, with records of entomophagy among Nahua, Zapotec, Mixtec, Maya, and Purépecha groups, who have also used insects for the treatment of respiratory, digestive, nervous, circulatory, and bone diseases (Arzate *et al.*, 2010). The insects reported here can be consumed at different stages of their development, as occurs with other insect groups: communities consume Odonata and Ephemeroptera in their nymphal phase; Orthoptera, Hemiptera, and Homoptera in their nymphal and adult stages; Coleoptera, Lepidoptera, and Diptera in their larval phase; and Hymenoptera in their larval, pupal, and adult phases (Ramos Elorduy *et al.*, 2008).

Fajardo et al. (2009) reported that South American indigenous communities make use of the giant snail *Stropocheilus oblongus*, which, like the tegogolo (*P. catemacensis*) recorded in the present work, is used for food; however, the former species is additionally used in the preparation of home remedies in traditional medicine. Avilá et al. (2010) noted that the chicken head caterpillar (*Megalopyge opercularis*), which registered a high CII in both indigenous communities studied, can cause serious injuries due to the release of highly neurotoxic compounds from contact with its bristles, producing intense pain, swelling, chest discomfort, and headache in affected individuals.

The findings are consistent with the characteristics of ethnoentomology reported for the Maya culture, in which insects are used as food, medicine (treating more than 39 diseases of physical or magical-religious origin), games for children, and ornaments. Among the species used, Coleoptera, Hymenoptera, Lepidoptera, Mantodea, and Odonata are mentioned (Cahuich-Campos, 2013; Pinkus-Rendón, 2013; Rivas-García *et al.*, 2017). Another relevant study on invertebrate use is the work on the anthropoentomophageal diversity of the Sierra de Zongolica, which reports different edible insect species for Nahua municipalities of the Sierra de Zongolica (La Quinta, Ixcohuapa, La Laguna, Ixtapaluka, San Juan, Tequila, and Amatitlán), where caterpillars (*Arsenura armida*) stand out as the most frequently mentioned species (Ramos Elorduy *et al.*, 2008). The present work adds two indigenous localities with biocultural knowledge in the field of entomophagy, highlighting the need to develop management and conservation programs for insect populations so that these communities can achieve economic self-sufficiency through the production and commercialization of insects. However, the establishment and registration of Wildlife Management Facilities (PIMVS) and trained technical personnel are required for initial operation.

Comparing the six use categories identified in the two communities with those reported for the Mixteca region of Oaxaca, where five use categories were recorded, the most notable species belonged to Lepidoptera and Hemiptera, recognized primarily for their flavor. Other insects are associated with crop pests of cultural importance, while groups such as bees and grasshoppers are more commonly sought for medicinal purposes, with properties attributed to relieving coughs, influenza, and certain conditions in infants (Aparicio, 2018).

Insects also have ornamental value; they are fascinating organisms that can be easily preserved and stored for extended periods, with butterflies and beetles being the most common examples (Van Huis *et al.*, 2013). Additionally, the use of insects

as pets, such as crickets and bush crickets, is a centuries-old tradition in Asian cultures and has also been adopted in some Western societies, serving ornamental, recreational, and other purposes (Kitsa, 1989; Van Huis *et al.*, 2013).
Several factors were identified that affect the transmission of traditional ecological knowledge linked to the use, management, and exploitation of invertebrates: 1) the modernization of agriculture and its associated costs, including the use of agrochemicals, which has altered traditional knowledge about the management of plants and animals; 2) formal education, which prioritizes modern knowledge over traditional practices; 3) migration of individuals of productive age, who leave their communities without transmitting traditional ecological knowledge to younger generations; and 4) globalization, through which hegemonic cultural models tend to marginalize or exclude practices that do not conform to dominant norms (Rivas-García et al., 2017).

Knowledge of the potential of insects for food use is a field that must be further investigated and disseminated, particularly among indigenous and rural communities that manage agroecosystems. This information can be complemented by documenting community lifestyles, traditional knowledge systems, and the use of insects as a food source. Furthermore, traditional ecological knowledge (ethnoecology) can provide opportunities for the implementation of insect conservation programs and the promotion of human food security (DeFoliart, 2005; Gahukar, 2009; Van Huis, 2003).

Conclusions

The research objective was met: the uses were identified and the cultural value of 26 invertebrate species in Tuxpanguillo and Huixtla, Veracruz, was estimated. It is concluded that the species with the greatest use pressure are all those mentioned as being used for food and commercial purposes. This allows for the development of management and breeding plans for insects, such as *Pomacea catemacensis*, for food and commercial purposes. It is important for the communities to obtain proteins for the invertebrates, and it's given to the community economic help. Studies like this will help to visibility the importance of invertebrates, and it's important to generate a strategy for invertebrates' conservation.

Conflict of interest

The authors declare no conflict of interest.

Author contributions

Karim Coral Flores-Cruz, Betsabe Vázquez Ramírez, Ricardo Serna-Lagunes, and Dulce María Ávila-Nájera: data analysis, investigation, conceptualization, visualization, resources, and original draft writing.

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