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ANTHROPO-ENTOMOPHAGY IN THE OTOMÍ COMMUNITY OF SAN PEDRO ARRIBA, TEMOAYA, ESTADO DE MÉXICO

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ABSTRACT

Edible arthropods are an important component of the diet in domestic units since Pre-Hispanic times; they supply proteins and are of easy extraction because they are harvested in the environment surrounding populations. The objective of the study was to identify the diversity and forms of consumption of edible arthropods in the Otomí community of San Pedro Arriba, Estado de México. The study was established by selecting informants, performing interviews, and collecting arthropods. The results show 11 ethnospecies of edible arthropods in two classes, Insecta with six orders and Malacostraca with one. The Insecta class had 10 families with the same number of species. Lepidoptera were the most abundant with four species, followed by Coleoptera with three. Anthropo-entomophagy is a millenary practice that has been conserved in the Otomí community. It is an alternative and a dietary complement for food security, which can be found in the environment, such as in milpa, forest and bodies of water. This knowledge ought to be documented before globalization processes lead to their extinction and the species that sustain it, and therefore affect the availability of foods for the local population.

Keywords: domestic units, edible arthropods, traditional knowledge.

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INTRODUCTION

The contemporary world faces an environmental, economic and cultural crisis, reflected in two specific aspects: the loss of biodiversity and of traditional knowledge associated to it. This situation is generated primarily by the increase in population and the modernization of society, which demands increasingly more goods and services for its development and survival (Bermúdez *et al.*, 2005; Ramírez, 2007). According to the World Bank, until 2021 slightly over 80% of the population in Latin America lived in urban zones.

In this context, the need to compile biocultural information of indigenous and peasant peoples becomes urgent, because they are at risk due to the civilizing process by the West (Sousa, 2017). This traditional knowledge is crucial for the survival of peoples. This ancestral knowledge is not only a vehicle for the satisfaction of primary needs, but it can also be a source of information, both biological and biocultural, which allows expressing their traditional lifestyles in the implementation of sustainable management plans and programs for the conservation of biocultural resources amidst native peoples (Morales-Hernández, 2004; Ramos-Elorduy and Viejo-Montesinos, 2007).

Among the most important natural resources that have been used by indigenous and peasant communities to complement their dietary needs, there are forests, whose wealth of non-timber and timber resources generates a diversity of traditional knowledge for their exploitation (Posey, 2004; da Silva *et al.,* 2016). The forests are also spaces for agriculture and livestock production, from which rural and indigenous in Mexico obtain food, fiber, fodder, among others, but in addition to their productive function they are host spaces of edible fauna and insects, which tend to be hunted and collected (Santos, 2016); in particular, arthropods are one of the most important non-timber edible resources.

The Arthropoda phylum is a megadiverse group of organisms on earth and an important element in ecosystems, which includes organisms such as arachnids, myriapods, crustaceans and insects. For their part, crustaceans are a broad group of organisms, almost completely aquatic, generally in sea or fresh water. Insects, however, have the greatest evolutionary success primarily due to their abundance, diversity and the broad spectrum of their habitats (Llorente-Bousquets *et al.*, 1996; Purvis and Héctor, 2000; Mattoni *et al.*, 2000). In Mexico, the consumption of arthropods dates from Pre-Hispanic times (Mariaca *et al.,* 2010). The Florentine Codex mentions that indigenous communities consumed maguey worms, *escamoles* (in immature state), grasshoppers, *ahuahutle* (eggs from different aquatic species of Hemiptera), *ezcahuhitli* (fly eggs), ants called *chicatanas*, aquatic bed bugs called *axayacatl*, and the *xamue* capsid which served as condiment (Sahagún, 1999; Ramos-Elorduy *et al.*, 2007; Guzmán-Mendoza, 2016). For the Yucatec Maya region from the 16th century, Mariaca *et al.*, (2012) report the existence of edible insects in family orchards. These data about the diversity of edible arthropods and insects shows the traditional knowledge about aquatic and land spaces to obtain foods.

Edible arthropods are a nutritious alternative to conventional protein sources of high costs, so that they are an element of food security of indigenous and peasant domestic units (Abreu and Corette, 2010; Huis *et al.*, 2013; Guzmán-Mendoza, 2016) given their variety and availability throughout the year, because their life cycles are alternate; different types of insects are consumed in each season (Ramos-Elorduy and Pino, 2003). Some are more appreciated due to their flavor, nutritional value, abundance and easy access, as for example grasshoppers, maguey worms and ants, which in some sectors of society are considered gourmet dishes (Juárez *et al.,* 2012). These local practices, for the conservation of some species, allow having foods available, particularly in times of the year when their abundance decreases (Ramos-Elorduy and Viejo-Montesinos, 2007; Viesca *et al.*, 2012).

The ethno-entomology, anthropo-entomophagy and entomophagy studies use the term "insect", covering different groups, both insects and crustaceans and sometimes arachnids (Viesca *et al.*, 2012; Juárez *et al.*, 2012; Puga and Escoto, 2015; Rivas-García *et al.*, 2017). In this study, the term arthropod was used to include the edible organisms of the Insecta and Malacostraca classes in the community of San Pedro Arriba Temoaya; the term anthropo-entomophagy is used, which is defined as the consumption of animals that belong to the Insecta class by human beings, including products produced from insects,

such as honey and propolis. In addition, anthropo-entomophagy involves millenary knowledge and people who practice it know when, how and where the different types of entomophagy resources can be collected, the various forms of preparing and conserving them to have food in times of scarcity (Costa-Neto *et al*., 2006).

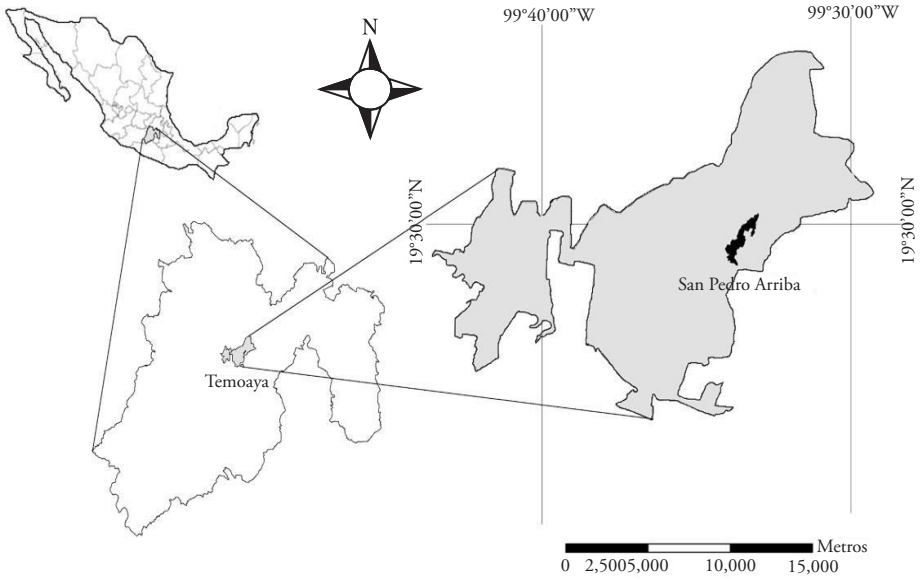
Rivas-García *et al*. (2017), in their ethno-entomological work in Yucatán, place the word insect between quotation marks, due to the presence of an arachnid and eight insects in their studies. In another study carried out in Yucatán, Pinkus (2013) uses the word arthropod. The author includes with this term the species of insects, scorpions and spiders that presented some use in the community: in total they refer 45 different categories for arthropods. For their part, Viesca *et al*. (2012) use the term insect in their study in the community of Toluca; they include insects and crustaceans, which are sold and purchased in the community, under this term.

The Otomí culture is among the native peoples from Mexico that maintain their traditions, customs and uses of natural resources, with settlements in central states of the country like Estado de México, Guanajuato, Hidalgo, Michoacán, Puebla, Querétaro, Tlaxcala and Veracruz (COESPO, 2018). Particularly in Estado de México, in the municipality of Temoaya, the Otomí population has biocultural wealth and traditional knowledge related to the use of their environment. This wealth, as in other communities, is in danger from civilizing process by the West (Morales-Hernández, 2004; Balcazar *et al.,* 2021). Therefore, the rescue of the biocultural wealth as part of the scientific endeavor is primordial to avoid the loss of species and knowledge associated to them. Within this context, the use and management of arthropods as a nutritional alternative, is important in the diet and the economic income of domestic units (Puga and Escoto, 2015). As a result of this, the objectives were established of identifying and describing the diversity of arthropods, as well as their use, in the Otomí community of San Pedro Arriba, municipality of Temoaya, Estado de México.

STUDY AREA

The municipality of Temoaya is located in the center-north of Estado de México, occupying part of the Monte Alto Sierra. It borders north with Jiquipilco and Nicolás Romero; south with Toluca and Otzolotepec; east with Isidro Fabela, Jilotzingo and Otzolotepec; and west with Ixtlahuaca and Almoloya de Juárez. The municipality has an extension of 222.46 Km^2, with altitude of 2,800 MASL, and it is integrated by 53 delegations. Its orography is characterized by a flat part and a mountainous part, and it is among the municipalities with most sources of water, its climate is temperate sub-humid, with summer rains (Figure 1).

The predominant vegetation is forests with different species of *Pinus* sp. and *Abies* sp. Arbutus, ash and oak grow on the slopes and hills, and in the low parts there are weeping willow, wicker, privet and coral tree. In the low parts there are fruit trees such as pear, apple, peach, tejocote (Mexican hawthorn) and pecan; there are also medicinal plants such



Source: Mexico (INEGI, 2009; Clave geodésica 15087).
Figure 1. Location of San Pedro Arriba in the municipality of Temoaya, Estado de México.

as *pextó*, wormwood, starflower, white horehound, *prodigiosa*, *estafiate*, etc. Among the fauna the following can be found: cacomistles, squirrels, moles, rabbits, hares, opossums, barn owls, owls, sparrows, chameleons, lizards, among other types of reptiles and insects (Arzate, 1999).

The Otomí community of San Pedro Arriba has 7,040 inhabitants; its main activities are the production of *pulque* and hand-weaving of wool rugs (Tomasini, 2003). They cultivate corn, fruit trees and various vegetables in greenhouses, orchards and agricultural lands (Garduño *et al.*, 2022), and they collect *quelites*, fungi, medicinal and ornamental plants, as well as breed domestic animals (Balcázar-Quiñones *et al.*, 2020).

METHODOLOGY

For the study of traditional knowledge of anthropo-entomofauna, the Otomí community of San Pedro Arriba was visited. The collaboration of people who sell and collect arthropods in the community was requested. The selection of collaborators was through the "snowball" non-probabilistic sampling (Cea, 2001), which allowed the localization of 20 harvesters and sellers of edible entomofauna in San Pedro Arriba: nine women and 11 men between 34 and 61 years old. During the months of February and October, 2019, guided visits were conducted (Albuquerque *et al.*, 2014) with informants from the collection sites in the forest, the milpa and the borders and dams.

Semi-structured interviews were conducted with the help of a questionnaire where general data of the informant were included such as name, sex and occupation. Information was

also obtained about the traditional knowledge of arthropods such as their name in Otomí, forms of preparation, and regularity of consumption, as well as information about the spaces to harvest and the seasons of the year when harvesting is performed.

The collection of arthropods was carried out through visits with the key informants and through participant observation, with the aim of identifying and documenting the different species of arthropods that they use and are found in their territory. The name of the arthropods and place of harvest were recorded in the field notebook; photographs were also taken during the visit for their harvesting.

Once collected, the arthropods were identified and labeled with the following data: scientific name, family, order, stage of development in which they are collected, habitat (terrestrial or aquatic), whether they are fliers, swimmers or walkers, and plant where they were harvested. Then they were placed in the Facultad de Ciencias of UAEMex.

RESULTS AND DISCUSSION

Traditional knowledge of edible arthropods

The consumption of arthropods in indigenous domestic units is part of their culture and their traditional knowledge about nature. This relationship of the indigenous community of San Pedro Arriba with their surrounding environment allows them to assign each edible arthropod a name in Spanish and one in Otomí. Presently the population calls the arthropods *gusanitos* (*zügu, zu'ue*), which are on land or they fly.

Traditional knowledge about anthropo-entomofauna in San Pedro Arriba is reflected in their diet, which includes a wealth of 11 ethnospecies that are obtained from three spaces; milpa, mountain and bodies of water (Table 1). The 11 different types of edible arthropods were divided into two classes, Insecta and Malacostraca; six orders were found within the Insecta class, and only one within Malacostraca. The insects are grouped into 10 families with the same number of species, while the Malacostraca class had one family and one species. Within the Insecta class, the Lepidoptera order is the most abundant with four species (36.36%), followed by the Coleoptera order, with three species (27.27%). Only one species of each were found in the rest of the orders (Orthoptera, Hymenoptera and Odonata) (Table 1).

Traditional knowledge about arthropods allows consumption of between 549 (Ramos Elorduy *et al.*, 2011) and 504 species (Ramos-Elorduy and Pino, 2003) in Mexico. Specific studies at the state level allow us to see the importance of arthropods as a food resource and as part of the biocultural diversity by the different names that are assigned in indigenous language and/or Spanish. For example, Puga and Escoto (2015) report 32 species of edible arthropods for Aguascalientes. In their study of useful insects in Chiapas, Lopez de la Cruz *et al.* (2015) report 33 linguistic designations (ethnospecies), where six are edible insects: three Lepidoptera, one Orthoptera, one Coleoptera, and one Hemiptera. Likewise, studies conducted in Yucatán show a total level of nine useful arthropods of which three Hymenoptera are for dietary use (Rivas-García *et al.*, 2017).

Table 1. Distribution of orders, families and species consumed in the Otomí community of San Pedro Arriba.

Spanish name	Indigenous name	Scientific name	Family	Order	Intake phase	Habitat	Form of consumption
Gusano de maguey	*Huada*	*Aegiale hesperiaris*	Hesperiidae	Lepidoptera	Larva	Agaves (milpa)	Roasts
Sacamiche	*Shu*	*Hylesia nigricans*	Saturniidae	Lepidoptera	Larva	Grasses (milpa)	Roasts
Gusano de madera	*Moi Huada*	*Mallodon spinosus*	Cerambycidae	Coleoptera	Larva	Woods (mount)	Roasts
Acociles	*Yangamoy*	*Cambarellus* sp.	Cambaridae	Decapoda	Adult	Water bodies	Boiled
Gusano de mariposa	*Moi Ga Tumb*	*Eucheira socialis*	Pieridae	Lepidoptera	Larva	Madroño (milpa)	Roasts
Gusano de tepozán	*Moiga Natza*	*Phassus triangularis*	Hepialidae	Lepidoptera	Larva	Tepozán (milpa)	Roasts
Chapulines	*Nkôto*	*Sphenarium* sp.	Pyrgomorphidae	Orthoptera	Adult	Corn (milpa)	Roasts
Padrecito	Mooc Ja	*Aeshna* sp.	Aeshnidae	Odonata	Larva	Water bodies	Boiled
Abeja	*Bz Bz*	*Apis mellifera scutellata.*	Apidae	Hymenoptera	Larvae	Dead agaves (mount)	Crude
Gusano de tierra	*Suêga Joy*	*Agriotes lineatus*	Elateridae	Coleoptera	Larva	Soil (milpa)	Fried
Chicuil	*Moi*	*Scyphophorus acupunctatus*	Curculionidae	Coleoptera	Larva	Agaves (milpa)	Roasts

Source: prepared by the authors.

The data presented at the national level contrast with what was obtained in this study; the Otomí community of San Pedro Arriba presents 2% of the edible insects of the country, which corresponds to 11 species. For Yucatán, three species are reported (Rivas-García *et al*., 2017) and six for Chiapas (Lopez de la Cruz *et al*., 2015); they are below what was found in the Otomí community. For Estado de México, Pino *et al*. (2006) record 105 edible species, representing nearly 20% of the arthropods at the national level. This allows demonstrating the importance of arthropods in the diet of rural domestic units in Estado de México.

In Toluca, Estado de México, Ramos Elorduy *et al*. (1989) identified 10 species and Juárez *et al*. (2012) reported 16 species of edible arthropods in four municipalities of the state, including Toluca and Temoaya. The following were recorded for Temoaya: *sacamiches*, grasshoppers, *padrecitos*, white worms, maguey worms, and *gusanos de los palos*. Likewise, some names of arthropods in Otomí are mentioned, such as *shuu* for *sacamiches*, *moi* and *mooc ja* for *padrecitos de agua*. Although there are advances in the research about edible insects in Mexico, more studies about anthropo-entomophagy are still pending, particularly in indigenous communities (Guzmán-Mendoza, 2016), due to the cultural, economic, social and environmental importance in relation to the availability of this varied source of food.

Relationship of edible arthropods with the environment

The interaction between the community and its environment, in the case of edible arthropods, is observed clearly in the sites where they are collected and the tools that use

to obtain and transport them. The harvest is done in three sites: milpa, mountain, and bodies of water. Of the arthropods, 82% are terrestrial organisms; they are collected in the milpa and the mountain using axes, knives, mattocks, or simply with the apical spines of the maguey leaves. They are transported in what is called locally "capucha de maguey", which are rolled agave leaves (Figure 2).

On the other hand, 18% are aquatic organisms, such as *acociles* (freshwater shrimps) and *padrecitos*; these organisms are present in bodies of water located in San Pedro Arriba. The arthropods are transported in bags or plastic containers when they are harvested (Figure 3).

Terrestrial arthropods collected in the milpa are present in agaves and shrubs such as *tepozán* (*Buddleja* sp.), which are used as borders of the agricultural plot. However, these plants not only serve as borders on the milpas, they have other uses; for example, *pulque* is obtained from the agaves in the community, which is a beverage that is quite appreciated locally, especially in festive occasions.

Aegiale hesperiaris is a Lepidoptera known as maguey worm or *huada,* it lodges in its larva state in the ribs, from where it is harvested. The presence of maguey worms (Esparza-Frausto *et al*., 2008), also called white worm (Ramos *et al*., 2012) in maguey plants is considered non-destructive and minimally disturbing of natural maguey groups (Esparza-Frausto *et al*., 2008).

Other host arthropods of agaves in San Pedro Arriba are *chicuil*, (*Scyphophorus acupunctatus*) and larvae of *bz bz* (Hymenoptera larvae). The first is also called "botija del maguey"

Photograph by Daniel Victoria.
Figure 2. Transport of the maguey worm (*Aegiale hesperiaris*) in a "capucha de maguey".

Photograph by Daniel Victoria.
Figure 3. Trasport of *acocil* (*Cambarus sp.*) and *padrecitos* (*Anax sp*).

(Ramos-Elorduy *et al*., 2006) and "picudo" (Solís *et al*., 2001). Contrary to the maguey worm (*Aegiale hesperiaris*), *picudo* is one of the main pests of the agave crop, particularly of *Agave tequilana* (Solís *et al*., 2001); this arthropod is used habitually to flavor mezcal.

On the other hand, *tepozán* (*Buddleja* sp.) is also an important plant for the collection of edible arthropods. The *tepozán* worm (*Phassus triangularis*), also called *gusanillo* (Escamilla-Prado *et al*., 2012), is a Lepidoptera associated to *Buddleja* sp., which is a plant that grows both on the edges of the milpas and on paths and slopes of hills. In Veracruz, the *tepozán* worm also lodges in coffee plantations (Escamilla-Prado *et al*., 2012).

Another example is the arthropod called in Otomí *Moi ga tumb* (*Eucheira sociales*), Lepidoptera associated to *Arbutus* sp., which is present in the forests of San Pedro Arriba. During the field work, the presence of grasshoppers (*nkôto)* associated to *Zea mays* was also found, which is why in order to preserve or promote their existence it is a necessary condition to cultivate milpa.

In the forest, arthropods are also harvested such as *Mallodon spinosus*, which is found in dead wood; and there are also Coleoptera called *Moi Huada* or buried, such as *Agriotes lineatus (Suêga Joy,* soil worm).

Studies conducted by Ramos-Elorduy and Pino (2003) state that more than 80% of edible arthropods are terrestrial organisms, while 17% come from continental aquatic ecosystems, data that agree with those obtained in this study.

The land use in San Pedro Arriba is agricultural and forestry, which allows the existence of different ecosystems in which arthropods grow and develop. This is why it is important to conserve both the agroecosystems and natural spaces such as forests, for the existence of this food resource and component of biodiversity and local biocultural heritage.

Forms of consumption of arthropods

Arthropods in the daily diet of peasant domestic units, of San Pedro Arriba, are not because of need or famine, but rather because they are part of the traditional knowledge there is about environmental management, as reported for other rural communities (Pieroni *et al*., 2016); they are also part of their local cuisines, and therefore part of their identity. This diet, as in other indigenous communities in Mexico, is complemented with agricultural products and with the harvest and consumption of fungi (Lara-Vazquez *et al*., 2013) and *quelites* (Balcazar-Quiñones *et al*., 2020), which shows on the one hand environmental knowledge for the exploitation of goods in nature and on the other the relevance that people place in cultivation areas for the harvest When it comes to its form of consumption, 82% of edible arthropods are consumed in immature stages (larvae); the rest (18%) are consumed in the adult stage, as is the case of *acociles* and grasshoppers. The larvae are consumed preferably roasted (64%), such as Lepidoptera and Coleoptera (*Mallodon spinosus* and *Scyphophorus acupunctatus*). The aquatic organisms such as *acociles* and *padrecitos* (*Cambarellus* sp. and *Anax junius*) are boiled (18%) and the rest are fried (*Agriotes lineatus*) or eaten raw such as the bee larvae (*bz bz)* (Figure 4).

Photograph by Daniel Victoria.
Figure 4. Extraction of *chicuil* (*Scyphophorus acupunctatus*) with ax.

In most of the studies of anthropo-entomophagy carried out in Mexico, the development phase of insects that is chosen most often for food uses is the larva. It should be mentioned that in this stage the organism has a higher amount of proteins, vitamins and fats, enough for the theory of optimal hunting/harvesting to be fulfilled (Harris, 2010), which mentioned that a minimum possible effort must be done to obtain food that can comply with the principles of diet and nutrition of people in the communities.

Of the species recorded for the world, Ramos-Elorduy and Viejo-Montesinos (2007) mention that 55.79% of edible arthropods are consumed in the immature stage (eggs, larvae, pupae, nymphs/naiads), while the remaining 44.21% in the adult stage. There are some species that are consumes in every stage of development. These data agree with what was reported by López de la Cruz *et al*. (2015) in their study in the state of Chiapas. The authors report that from the species harvested, 50% are consumed in the larva stage and 50% in the adult stage. In this study, 82% of the arthropods are consumed as larvae, while 18% as adults.

Likewise, Ramos-Elorduy and Viejo-Montesinos (2007) report that the great majority of arthropods are consumed roasted on *comal* (metallic plate), seasoned with salt and/or chili salsa, which, once roasted, are placed in tortillas forming a taco. In the community of San Pedro Arriba, the great majority of the species recorded are consumed in the larva stage, which agrees with what was described by these authors, as well as by López de la Cruz *et al*., (2015).

Juárez *et al*. (2012), in their study about the market in San Andrés Cuexcontitlán, of the Barrio de Tlaltenanguito, municipality of Temoaya, explain that the *sacamiches* are consumed cooked. Likewise, Viesca *et al*. (2012) mention that *padrecitos* are sold associated with *acociles* and offered in three forms: live, only cooked, or prepared in dishes, and they are traded throughout the year. These data show us that the *sacamiches* are also consumed cooked, although in this study they are consumed roasted.

CONCLUSIONS

In this study, 11 ethnospecies of edible arthropods were identified by the Otomí community of San Pedro Arriba. They are grouped into two classes, seven orders and 11 families, where the Lepidoptera order was the most abundant with four species, followed by Coleoptera with three species. Harvesting of these organisms is practiced primarily in the milpa and the forest, where 82% of the organisms were terrestrial. The consumption of these organisms is primarily in their larva stage (82%) and preferably roasted (64%). Anthropo-entomophagy is a millenary practice that has been preserved in indigenous domestic units in the Otomí community of San Pedro Arriba. This traditional knowledge in the use of arthropods in the diet of inhabitants is an alternative and a food complement for food security of indigenous peasant units. Arthropods are a non-timber forest resource that is available, accessible and free, and which only implies the energetic expense for its harvest, which can happen in the milpa, the forest and bodies of water.

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