Catalog of Insects in Human Diets in Southern Campeche, Mexico[1]

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Abstract In Mexico, a large number of insects are used by indigenous groups for food, medicine, and the arts. The objective of this research was to review and identify edible insects in communities in the municipality of Escarcega, state of Campeche, Mexico. We conducted a literature review and interviewed residents of 12 communities in Escarcega. The interview consisted of questions about insects that they or others may have consumed, the location of collection of those insects, the times of the year when the insects appear, the methods of capture, and the ways that they were used. We determined that 25 insect species are consumed by humans in the 12 communities studied. In the communities of Constitución and Ej. Km. 74, *Brachygastra mellifica* Say (Hymenoptera: Vespidae) larvae are consumed year-round. Our results serve as a foundation for future research on the use and production of insects for food in rural and indigenous communities in southern Campeche and represent an initial approach to acquiring knowledge for the use of insects as a food source in Campeche to guarantee food security in such communities.

Key Words edible insects, *Brachygastra mellifica*, Campeche, Mexico

The various cultures that have emerged through the ages have related to their natural environment in unique ways and have developed ways of taking advantage of the natural resources that surround them. This knowledge acquired over time is usually studied both by traditional disciplines and by ethnosciences, in particular ethnobiology (Posey 1987; Toledo 1990, 1991; Challenger 1998; Albuquerque 1999). The use of natural resources by human groups has allowed the accumulation of knowledge about the biology of species and local ecological processes (Olsson et al. 2004). Making use of species of interest, whether for medical or nutritional purposes, among others, requires prior knowledge, such as knowing the biology, ecology, phenology, and even toxicity of the species that are used. Toledo (2002) mentions that the relationships between nature and culture have been the object of study in various disciplines of the natural and social sciences, leading to various avenues being created in attempts to study these relationships. Different investigations agree that various subdisciplines have been generated

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from ethnobiology. Such is the case of ethnoentomology, the study of the relationship of insects with and their use by humans (Gabdin 1973, Posey 1987, Costa-Neto 2002, González-Rivadeneira 2023). Ethnoentomological studies began with Wyman and Bailey (1952), who investigated the relationship of insects with the Navajo and proposed the use of the term ethnoentomology. Based on their research, numerous investigations have subsequently been conducted with different approaches because insects, in addition to being a great source of food and medicine, are also important in the cultural activities of communities, their symbolism that they have for some towns, and the dissemination and sharing of that knowledge (Aldasoro and Argueta 2013). There are many insect species that are beneficial to humans, whereas others are harmful; thus, as a group, insects receive considerable attention (Jiménez Martínez 2009, Loiacono et al. 2012, Margaría et al. 2018). The use of insects for food has been reported worldwide, especially in Asia, Africa, and the Americas. Approximately 2,000 species are used for food (Cartay 2018), with consumption largely focused on some 30 species (Cerda et al. 1999). Ramos-Elorduy and Viejo (2007) comment that insects are commonly consumed in 102 countries; Morris et al. (1991) agreed, noting that insects are the numerically dominant animal group globally. Costa-Neto (2002) observed that insects are present in practically all terrestrial habitats on the planet, where they have always played a significant role in human cultures, presenting an almost infinite variety of colors, shapes, sizes, ways of life, and sound production. They are sometimes even associated with divinities. On the North and South American continents, 699 species of edible insects have been reported (Ramos-Elorduy and Viejo 2007), whereas other authors mention approximately 800 terrestrial and aquatic insects (Blanco et al. 2020). In Mexico, the number of edible insect species is 504 (Ramos-Elorduy and Pino 2001a, 2004; Elorduy et al. 2006; Neto and Ramos-Elorduy 2006; Ramos-Elorduy and Viejo 2007; SADER 2016); however, Garcia et al. (2019) reported 104 species. The consumption of insects (entomophagy) in Mexico is considered a viable option in the food sector because different investigations address the issue from a biogeographic approach, species richness worldwide, sustainability, consumption in rural areas, and nutritional value. Insects are a good source of protein and an excellent food alternative for humans (Ramos-Elorduy and Pino 2001b, Moreno et al. 2006, Ambrosio-Arzate et al. 2010, Juárez Ortega et al. 2012, Cruz and Peniche 2018, Hernández-Ramírez et al. 2020, Durán-Galdo and Saavedra-Garcia 2022).

Many studies have focused on the use of insects as food for humans. Ramos-Elorduy et al. (2009) compared the knowledge and traditional use of bee species in the Sierra de Zongolica, Mexico, and in the Sierra de Jibóia, Brazil. In the Mexican locality, cultures of *Apis mellifera mellifera* L. were observed, and there was almost no production of stingless species. Protocultures of wasps, stingless bees, and larvae of two lepidopteran species also were reported, with some of these species being sold in the municipal market. In the Brazilian locale, six species of stingless bees that are cultivated for food were identified, whereas *A. mellifera* is not cultivated. Likewise, Ramos-Elorduy et al. (2009) found that the procedure for cultivating bees with and without sting is the same in both locales and that the production of bees with and without sting impacts peoples' diet.

Studies related to the use of insects have also been conducted in the Yucatan Peninsula where special attention has been on the economic resources for families that market *Zopherus chilensis* Gray (Coleoptera: Zopheridae; locally known as ma'kech), used mainly as live handicrafts and it is sold in tourist places in the state of Yucatán (Domínguez 2011). In this region of Mexico, it is not the only species that is used for commercial purposes. Stingless bees are managed ancestrally and similarly to the cultivation of *A. mellifera*, and they are considered to be part of the of the Mayan culture in the Yucatan Peninsula (Euán 2005). Furthermore, Ayala (1999) reports 46 species of stingless bees in Yucatan, with some species having outstanding honey production: *Melipona beecheii* Bennett in the Yucatan Peninsula, *Scaptotrigona mexicana* Guérin-Méneville in the Gulf Coast and Central Mexico, and *Scaptotrigona hellwegeri* (Friese) in Guerrero; they also are excellent pollinators of various agricultural crops (Cortopassi-Laurino et al. 2006).

Different species of edible insects have been reported from the states in Mexico, with Mexico having the highest record of edible insects (160 species) followed by Chiapas (155) and Hidalgo (145; Ramos-Elorduy 2009). In the Yucatán Peninsula, Yucatán has 8 species (Ramos-Elorduy and Pino 2004) and Campeche has 25 species (Ramos-Elorduy 2009). Our objective with this investigation was to identify the edible insects in communities of the municipality of Escarcega, state of Campeche, Mexico, by conducting a review of literature and interviewing residents of 12 communities in the municipality.

Materials and Methods

The municipal territory of Escárcega is divided into 2 municipal boards, 6 municipal police stations, 38 municipal agencies (including ranches), and 27 registered neighborhoods (including those of recent creation). The study consisted of two phases: field and laboratory. The field phase was carried out with the support of second-semester bachelor's degree in tourism students at the Instituto Tecnológico Superior de Escárcega, where >50% of the student community are from rural communities in the municipality. Edible insects in communities of Escárcega were tracked, collected, and identified. This phase included talking with people from the main communities (Altamira de Zináparo, Centenario, División del Norte, Don Samuel, Escárcega, Haro, Justicia Social, La Libertad, La Victoria, Luna, Matamoros, and Silvituc). The interview, the instrument for data collection, was an open design and semistructured with general questions about insect consumption and specific questions for about the species consumed (if applicable). The interview was carried out by asking residents (both sexes, 12–70 years old) of a community what insects they consumed in their locality or whether they knew someone who consumed them. For insects consumed in the community, they were asked to show the place where the insects were collected; the time(s) in which these insects appeared and were found in abundance; and the ways of capture, use, preservation, and conservation. Insects were collected with entomological nets and placed in labeled bottles containing 70% alcohol.

Fig. 1. Nest of *Brachygastra mellifica* in the community of Constitución, Escárcega, Campeche, Mexico.

The laboratory phase consisted of taking the material preserved in alcohol to the laboratory of the Instituto Tecnológico Superior de Escárcega. There, the samples were sorted and identified to taxonomic levels by using dichotomous keys.

A review of the literature on edible insects in Mexico was also conducted. This review included scientifically based books, documents, and publications in the Journal Citation Reports, Latindex, and Scielo. The review also included reports of local studies in Mexico and databases available worldwide. The review included only records at the genus level for the country. Any omission from the relevant literature was unintentional.

Results and Discussion

From the interviews with residents of the different communities, we learned that in two communities—Constitución, belonging to the H. Junta de Centenario, and Ejido. Km 74, belonging to the H. Ayuntamiento de Escárcega—the residents consume larvae of a wasp known locally as Ek, *Brachygastra mellifica* Say (Hymenoptera: Vespidae; Fig.1), with several published common names (Ramos and Pino 2001, Ramos-Elorduy and Pino 2001a, Ramos-Elorduy et al. 2002, Ramos-Elorduy 2004, Acuña et al. 2011, Rivas-García et al. 2017). In the remaining communities, we were unable to identify the consumption of insects from the interviews. Some residents of those communities responded that they consume local fauna, mainly species of mammals and birds. The residents of the communities where the consumption of insects was reported stated that once a nest is identified, it is necessary to tie a rope to the branch on which the nest is attached to shake it and thus ensure

Table 1. Taxonomic orders, families, and genera of edible insects reported from Mexico, based upon a review of literature.

Order	No. of Families	No. of Genera
Anoplura	1	1
Blattodea	1	8
Coleoptera	21	70
Diptera	5	8
Ephemeroptera	3	3
Hemiptera	8	34
Homoptera	3	14
Hymenoptera	5	31
Isoptera	1	1
Lepidoptera	16	46
Megaloptera	1	1
Odonata	4	5
Orthoptera	39	39
Trichoptera	3	3

that the adult wasps exit the nest. Subsequently, the branch on which the nest is attached is cut and transported to the home, where the nest is removed from the branch and cut into pieces. The nest pieces are placed on a griddle over low heat for 10 min and when the pieces are shaken, the larvae emerge. The larvae are placed on the same griddle and roasted and served with a dish of choice. The residents interviewed added that these nests and the larvae are available year-round.

According to the literature review, 504 species of edible insects are reported in Mexico (Tables 1, 2), representing 14 taxonomic orders, 111 families, and 264 genera (Ramos-Elorduy and Pino 2001a, 2004; Elorduy et al. 2006; Neto and Ramos-Elorduy 2006; Ramos-Elorduy and Viejo 2007; SADER 2016). In Campeche, 25 species of edible insects prepared in different ways have been reported previously (Ramos-Elorduy 2009); however, the scientific names of these species were not reported in that study, with only common names listed. Grasshoppers, locusts, honeydew ants, brown bees, sorrel bees, black wasps, striped or juniper wasps, and guachichil are consumed in Campeche, but their taxonomic identity was not reported (Soto 1993, Viesca González and Romero Contreras 2009, GM 2016, SADER 2016, Alcides González 2023). Others cite *B. mellifica* as being consumed as an edible insect in Campeche (Ramos-Elorduy and Pino 2001a, Ramos-Elorduy 2004, Rivas-García et al. 2017), which corroborates the results of our investigation (Fig. 1). According to the literature review, *B. mellifica* has been reported as an edible insect in the states of Campeche, Chiapas, Hidalgo, Puebla, and Yucatán.

Table 2. List of taxonomic orders, families, and genera of edible insects in Mexico, based upon a review of literature.

Order	Family	Genus
Anoplura	Pediculidae	*Pediculus*
Blattodea	Blattidae	*Blabera*, *Blaberus*, *Blattaria*, *Chorisoneura*, *Epilampa*, *Paratropa*, *Periplaneta*, *Pseudomops*
Coleoptera	Buprestidae	*Chalcophora*, *Euchroma*
	Carabidae	*Cicindela*
	Cerambycidae	*Acrocinus*, *Aplagiognathus*, *Arhopalus*, *Callipogon*, *Cerambyx*, *Cisa*, *Derobrachus*, *Eburia*, *Lagocheirus*, *Megacyllene*, *Ornithia*, *Polyrhaphis*, *Prosopocera*, *Stenodontes*, *Trichoderes*, *Aplagiognathus*
	Dryophthoridae	*Blepharida*, *Chrysomelidae*, *Lactica*, *Leptinotarsa*, *Metamasius*, *Rhyncophorus*, *Scyphophorus*
	Dytiscidae	*Cybister*, *Dytiscus*, *Laccophilus*, *Megadytes*, *Rhantus*, *Thermonectes*
	Elateridae	*Chalcolepidius*, *Pyrophorus*
	Erotylidae	*Dichomorpha*
	Gyrinidae	*Gyrinus*
	Haliplidae	*Haliplus*, *Peltodytes*
	Histeridae	*Hololepta*
	Hydrophilidae	*Berossus*, *Dibolocelus*, *Tropisternus*
	Lucanidae	*Lucanus*
	Meloidae	*Meloe*
	Melolonthidae	*Dynastes*, *Geotrupes*, *Goliathus*, *Isonychus*, *Macrodactylus*, *Megasoma*, *Melolontha*
	Notoridae	*Suphisellus*
	Passalidae	*Heliscus*, *Oileus*, *Passalus*, *Paxillus*, *Popilius*, *Verres*
	Rutelinidae	*Chrysina*
	Scarabaeidae	*Cyclocephala*, *Enema*, *Phyllophaga*, *Strataegus*, *Xylorictes*

Table 2. Continued.

Order	Family	Genus
	Staphylinidae	*Oxytelus*
	Tenebrionidae	*Eleodes*, *Tenebrio*, *Zophobas*
	Zopheridae	*Zopherus*
Diptera	Calliphoridae	*Macellaria*
	Ephydridae	*Ephydra*, *Eristalis*, *Gymnopa*
	Muscidae	*Musca*
	Stratyiomidae	*Hermetia*
	Syrphidae	*Campylostoma*, *Copestylum*
Ephemeroptera	Baetidae	*Baetis*
	Ephemeridae	*Ephemera*
	Leptophlebiidae	*Thraulodes*
Hemiptera	Belostomatidae	*Abedus*, *Belostoma*, *Lethocerus*
	Coreidae	*Acanthocephala*, *Anasa*, *Colophoserus*, *Mamurius*, *Pentascelis*, *Piezogaster*, *Sephina*, *Thasus*
	Corixidae	*Buenoa*, *Corisella*, *Graptocorixa*, *Hesperocorixa*, *Krizousacorixa*, *Trichocorixa*
	Lygaeidae	*Neacoryphus*
	Notonectidae	*Notonecta*
	Pentatomidae	*Acheta*, *Banasa*, *Brachymona*, *Chlorocoris*, *Edessa*, *Euschistus*, *Monomorpha*, *Mormidea*, *Nezara*, *Oebalus*, *Padaeus*, *Pharypia*, *Proxis*
	Pyrrhocoridae	*Dysdircus*
	Rhopalidae	*Jadera*
Homoptera	Cicadidae	*Cicada*, *Dactylopinae*, *Dactylopius*, *Dundubia*, *Fidicinoides*, *Odopoea*, *Proarna*, *Tibicen*, *Tympanotermes*
	Fulgoridae	*Fulgora*
	Membracidae	*Aethalion*, *Anthiante*, *Hoplophorion*, *Umbonia*
Hymenoptera	Apidae	*Apis*, *Bombus*, *Cephalotrigona*, *Lestrimelitta*, *Melipona*, *Nannotrigona*,

Table 2. Continued.

Order	Family	Genus
		Partamona, *Plebeia*, *Scaptotrigona*, *Trigona*, *Trigonisca*
	Diprionidae	*Neodiprion*, *Zadiprion*
	Formicidae	*Acromyrmex*, *Atta*, *Azteca*, *Camponotus*, *Dolichoderus*, *Eciton*, *Liometopum*, *Pogonomyrmex*, *Tapinoma*
	Sphecidae	*Ammophila*
	Vespidae	*Apoica*, *Brachygastra*, *Epipona*, *Eulema*, *Mischocyttarus*, *Parachartegus*, *Polistes*, *Polybia*, *Sinoeca*, *Vespula*
Isoptera	Termitidae	*Microtermes*
Lepidoptera	Agaristidae	*Gerra*
	Arctiidae	*Amastus*, *Elysius*, *Estigmene, Pelochyta*, *Pseudodirphia*
	Bombycidae	*Bombyx*
	Castniidae	*Castnía*, *Cossidae*, *Xyleutes*
	Cossidae	*Comadia*
	Danaidae	*Danaus*
	Geometridae	*Synopsia*
	Hepialidae	*Phassus*, *Schausiana*
	Megathymidae	*Aegiale*
	Noctuidae	*Ascalapha*, *Guerrea*, *Helicoverpa*, *Latebraria*, *Spodoptera*, *Thysania*
	Nymphalidae	*Cynthia*, *Vanessa*
	Papilionidae	*Catasticta*, *Eucheira*, *Laniifera*, *Papilio*, *Protographium*
	Pieridae	*Phoebis*
	Pyralidae	*Laniifera*
	Saturniidae	*Actias*, *Antheraea*, *Arsenura*, *Eacles*, *Hemileuca*, *Hylesia*, *Paradirphia*
	Satyridae	*Pareuptychia*
	Sphingidae	*Clanis*, *Cocytius*, *Manduca*
Megaloptera	Corydalidae	*Corydalus*
Odonata	Aeschnidae	*Aeschna*, *Anax*

Table 2. Continued.

Order	Family	Genus
	Coenagrionidae	*Enallagma*, *Ischnura*
	Libellulidae	*Eritrodiplax*
Orthoptera	Acrididae	*Aidemona*, *Arphia*, *Boopedon*, *Chromacris*, *Encoptolophus*, *Homocoriphus*, *Locusta*, *Melanoplus*, *Ochetotettix*, *Opeia*, *Orphula*, *Orphulella*, *Osmilia*, *Pedies*, *Plectrottetia*, *Rhammatocerathus*, *Romalea*, *Schistocerca*, *Spharagemon*, *Sphenarium*, *Syrbula*, *Taeniopoda*, *Trimerotropis*, *Tropinotus*, *Xanthiphus*
	Blattidae	*Blaberus*
	Gryllidae	*Achaeta*, *Gryllus*
	Phasmidae	*Bacteria*
	Stenopelmatidae	*Stenopelmatus*
	Tettigonidae	*Conocephalus*, *Liparoscelis*, *Microcentrum*, *Neoconocephalus*, *Petaloptera*, *Pyrgocorypha*, *Scudderia*, *Stilphnnclora*
Trichoptera	Hidropsychiidae	*Leptonema*
	Leptoceridae	*Oecetis*
	Rhyacophilidae	*Atopsyche*

Sources: Ramos-Elorduy and Pino (2001, 2002, 2004), Ramos-Elorduy et al. (2008), Esparza-Frausto et al. (2008), Acuña et al. (2011), Sánchez-Salinas et al. (2010), Román et al. (2011), Rostro et al. (2012), Gómez-Utrilla et al. (2012), Juárez Ortega et al. (2012), de Luna-Valadez et al. (2013), Ayala and Rocha (2015), de la Cruz et al. (2015), Sosa Marcos et al. (2015), Rivas-García et al. (2017), Hernández-Ramírez et al. (2020).

Brachygastra mellifica has been reported from 21 states of the Mexican Republic and is one of the most widely distributed insect species in the country (Vanoye-Eligio et al. 2014, 2020). In addition to its use as food in different states of the country, it also is considered as a potential biological control agent in pest management programs (Reyes-Rosas et al. 2011, 2013). Similarly, it is considered an excellent pollinator of important food crops (Castañeda-Vildózola et al. 1999, Perez-Balam et al. 2012, Carabalí et al. 2021) and can be used for medicinal purposes (Perleberg et al. 2021).

In conclusion, our study aimed to identify edible insects in communities of the municipality of Escárcega, Campeche. We identified *B. mellifica* as a species that is consumed for food in southern Campeche. Our review of the literature identified a diversity of insects that are reportedly consumed in Mexico; at least 25 serve as edible insects in Campeche. Our results demonstrate efforts should be made to

identify the edible insects in Mexico to the taxonomic level of species as well as determine their seasonal occurrence and uses as food. This study represents a foundation for future research associated with the use and production of insects for food in rural and indigenous communities in southern Campeche. It is a first step in assimilating knowledge for the use of insects as a food source and establishing strategies for their use as food aimed at improving food security in communities.

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