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Traditional Knowledge and Potential Use of Stingless Bees (Hymenoptera: Meliponinae) in the Manantlan Sierra, Jalisco, Mexico

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Abstract

Stingless bees (meliponines) play an important role in ecosystems; they pollinate different plant species, assist in the reproduction and conservation of floral biodiversity and their products can be obtained and sold, with the consequent economic benefit for stingless beekeepers. Surveys were conducted to find out how much knowledge inhabitants of two marginalized communities of the Manantlan Sierra in Jalisco, Mexico, have on the use and exploitation of stingless bees. In addition, several stingless bee species of this region were captured and identified, and wild nests of those bees were located and recorded in their natural habitats. Information about the knowledge and culture of stingless bees in the region was analyzed and based on that as well as on the most abundant species captured, those with more potential are suggested for management in a sustainable manner. Unlike other areas of Mexico where meliponiculture is practiced, in Jalisco there is no record of traditional culture of meliponines. However, a certain level of knowledge and a high degree of interest was found among the respondents for engaging in keeping and managing stingless bees, mainly because their management does not involve the risk of stinging incidents. Nine stingless bee species were identified in total. Of these, the most abundant were *Scaptotrigona hellwegeri*, Friese, *Trigona fulviventris* Guérin-Méneville, *Partomona bilineata* Schwarz, *Friseomelita nigra* Lepeletier and *Nannotrigona perilampoides* Cresson. It is recommended that studies are conducted to develop management practices for these bee species. The implementation of courses on how to keep these meliponines is also recommended, so that in the future, the inhabitants of these communities can benefit from the integral and sustainable use of stingless bees.

Introduction

Stingless bees or meliponines are eusocial bees that produce honey, wax, pollen and geopropoleo (Singh, 2016) and that live in warm, tropical or subtropical regions around the world, up to 30º North and South (Crane, 1994; Michener, 2007). Meliponines are relatively harmless because their stinger is atrophied, and so, their management is relatively easy compared to honey bees that have a stinger enabled for their defense (Crane, 1992; Vit et al., 2013). Meliponiculture or the cultivation of stingless bees was an activity of great importance for Mesoamerican cultures before the arrival of Spaniards to the Americas. The Mayans in particular, notably developed knowledge on how to manage and exploit different stingless bee species that inhabit the Yucatan peninsula, mainly *Melipona beecheii* Bennet (Weaver & Weaver, 1981;

Ruttner; 1988; Echazarreta et al., 1997; Quezada-Euán, 2005; Ramírez et al., 2014). The exploitation of stingless bees in Mexico was very important until the demand for honey and wax was no longer supplied by these bees, but by the European honey bee (*Apis mellifera* L), which was introduced to the Americas during the seventeenth century. European honey bees quickly surpassed the production of stingless bees, which resulted in a decline in their culture and colonies (Calkins & Collage; 1975; González, 1989). Nowadays, except for their culture by Mayan communities, the situation for stingless bees has worsened, due to the environmental deterioration caused by deforestation, competition for food resources with *A mellifera*, lack of knowledge of management techniques of the stingless bees colonies, as well as the abandonment of the field due to the lack of development opportunities. All this has led this activity to a sharp decline and risk of dissapearence (González-Acereto, 2008).

The primordial use that the Mayans gave to honey from meliponines was as a medicine for therapeutic purposes (Quezada-Euán & González-Acereto; 1994; Echazarreta et al., 1997; Vit, 2015; Singh, 2016). On this regard, there is evidence of inhibitory effects of geopropoleo from stingless bee nests in some types of malignant cancer cells. Geopropoleo has antioxidant activity, which could be part of the reason for its anticancer properties (Milind et al., 2013). Additionally, stingless bees are considered potential pollinators of wild plants and commercially important crops such as achiote (*Bixa orellana*), chayote (*Sechium edule*), coconut (*Cocos nucifera*), carambola (*Averrhoa carambola*), macadamia (*Macadamia integrifolia*), mango (*Mangifera indica*), strawberry (*Fragaria vesca*), rambutan (*Nephelium lappaceum*), tomato (*Lycopersicon esculentum*), cucumber (*Cucumis sativus*), avocado (*Persea americana*), coffee (*Coffea arabica*) and others that have been successfully pollinated by these bees (Heard, 1999; Slaa et al., 2006; Giannini et al*.,* 2012). Stingless bees nest in cavities, preferably those of tree trunks (Wille, 1983), which allows meliponine keepers to move them to locations near their homes, to keep them, protect them and to obtain their products. In this way, knowledge and tools to manage these bees have been generated over time, as well as ideas and beliefs related to religious festivals, which are still practiced in various settlements (González-Acereto, 1989; González-Acereto, 2008).

Meliponines belong to the subfamily Meliponinae, which is composed of the Meliponini tribes (Ayala et al., 1996; Ayala, 1999, Michener, 2007). At present, about 500 species of stingless bees are known worldwide (Crane, 1992; Vit, 2015), 70% of which have been described for the Americas, although only about 14 species of the *Melipona* genus and 21 of the *Trigona* genus are currently managed. In Mexico, 46 species of meliponines have been described (Ayala, 1999), and out of these, only the genera *Melipona* and *Trigona* and the subgenera *Scaptotrigona*, *Plebeia* and *Tetragonisca* have been cultured. The richness of stingless bee species in Mexico is threatened by problems of deforestation and changes of land use, which result in habitat loss derived from the reduction of nesting sites that are usually hollow trees (Wille, 1983; 1993; Ramírez et al., 2014; Macias-Macias et al., 2016).

In the state of Jalisco, there are no references to the use of stingless bees in the past, which is surprising, because these bees could provide economic and ecological benefits for inhabitants of these regions. Therefore, there is opportunity to divulge and promote their use and exploitation (Contreras, 2008). According to Ayala (1999), 11 species of stingless bees can be found in Jalisco. Of these, two are endemic in temperate zones that are part of the neovolcanic axis of the Sierra Madre Occidental, between the Sierra del Tigre, the Nevado de Colima national park and the Sierra de Manantlán (19°83’ 31. N,- 102° 98’31’’ 10°37’53’’ N-103°32’82’’ W and W, 19° 26’ 40’’ N-104°12’57’’ W, respectively). Due to the importance and potential development of meliponiculture in the study region, an analysis of the knowledge and use of these types of bees by local inhabitants was conducted. Additionally, different species of stingless bees were captured and identified in two communities of Jalisco’s Manantlan Sierra. The data and information on traditional management, as well as the knowledge of the species that are most abundant in the region, will allow to suggest strategies for their sustainable use.

Materials and Methods

The study was carried out in the rural communities of Cuzalapa and Zenzontla, which are considered marginal zones within the Manantlan Sierra’s Biosphere Reserve (SMBR). The SMBR is located in southern coastal region of the state of Jalisco. The community of Cuzalapa is located between the coordinates 19°26’40” to 19°36’51” North and 104°12’57” to 109°22’49” West. Cuzalapa belongs to the municipality of Cuautitlán de García Barragán with an altitude between 550 and 2,260 masl, and a rainfall between 1,500 and 1,700 mm. The climate is warm, with temperatures ranging from 18 to 22 °C, and it is the largest sub-basin within the SMBR, with an area of 24,057 ha, of which 17,700 correspond to the Reserve. It consists of 40% of valley area and 60% mountainous area, which makes it the largest flat agricultural area, with 307 ha of artificial irrigation and 1,893 ha of natural rain irrigation (Jardel, 1992; Vázquez et al., 1995). The community of Zenzontla belongs to the municipality of Tuxcacuesco, Jalisco, and it is located northeast of the SMBR witin the geographic coordinates 104°04’37” to 104°04’52” North, and 19°34’30” West. It has an area of 4,344 ha, with a semi-warm climate and average annual temperatures between 18 and 22 °C. It has an annual rainfall of 900 mm. This zone presents a very rugged topography with altitudes ranging from 800 masl at the edge of the Ayuquila river that runs through Zenzontla from Northwest to Southeast, up to 2,000 masl at the elevations to the North and South of the community (Jardel, 1992; Vázquez et al., 1995; Delcombel et al., 1996). The geographic location of these zones can be seen in Figure 1.

To obtain a diagnosis of the knowledge and use of stingless bees by local inhabitants, interviews were conducted according to the requirements for descriptive studies proposed by Ibarra et al. (1988) and Hernández et al. (1998). Fifty questionnaires were applied between the two communities between November 2013 and February 2015. The selection of the interviewees was done completely at random, considering people over 18 years of age, including men and women. From the structured questionnaire, 13 questions were selected with which a descriptive analysis of the answers was carried out.

In addition to the above, and with the aim of identifying the species of stingless bees present in the region, specimens were captured in two ways. The first way was to capture bees directly from the nests that were located with the aid of inhabitants of the two communities; nests locations were also recorded. The second way was with the help of an entomological net to trap bees that were on the flowers of plants near the trails that are used by the inhabitants of the area. Bees were also collected in 26 transects of 1000 meters long, with a separation of 300 meters between them. Transects were drawn at random in the forest areas of the two communities. The captured specimens were sacrificed in lethal chambers with ethyl acetate and mounted in entomological pins for their subsequent identification, which was made based on the keys and descriptions by Ayala (1999) for stingless bees from Mexico.

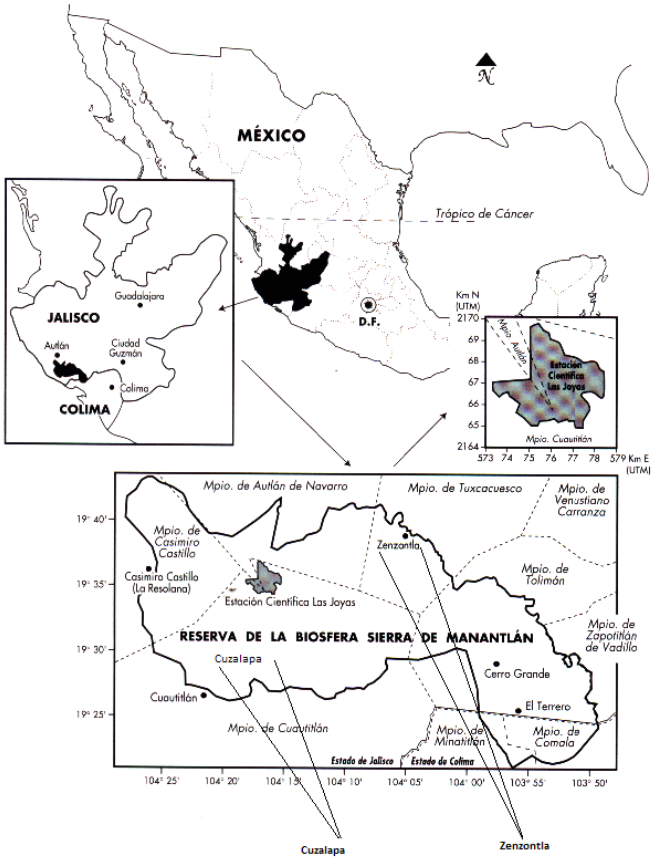

Fig 1. Geographic location of the study areas in Jalisco, Mexico.

Results

Of all participants interviewed, 68% mentioned that they had some knowledge of stingless bees, either from talks with their grandparents or parents, or because they have direct contact with them. However, no evidence was found of traditional colony management of stingless bees that had been practiced in the past or in the present. The average age of the interviewees was 45 years, with young people showing little interest in these bees, opposite to older people. Ten people had worked with honey bees (*A. mellifera*), eight with stingless bees and 16 with both. Of 100% of the interviewees who knew about honey bees, 24 of them said that they had harvested honey from wild nests of stingless bees without keeping them or taking care of them, and they had never tried to capture a nest. The procedure they follow to obtain honey from stingless bees is to open a hole in the trunk of the tree where the nest is located. To do that, they use an ax or a machete, and in some cases, a chainsaw (usually they do not cut the tree). Afterwards, they harvest the honey pots and place them in a container to later separate the honey from the wax. Sixteen people claimed to have obtained between 250 and 1000 ml of honey per year in two harvest seasons (April-May and November-December). Honey is always used for own consumption as a sweetener. Despite the fact that stingless bees are not purposely kept and managed by the inhabitants of the Manantlan Sierra, 80% of respondents expressed enthusiasm and interest in knowing more and in learning about the cultivation and sustainable use of these bees.

A total of 60 bee specimens were collected in the study sites, of which nine species were identified: *S. hellwegeri*, *F. nigra*, *T. fulviventris*, *P. bilineata*, *N. perilampoides*, *Lestrimelitta chamelensis*, *Plebeia pulchra*, *Plebeia moureana* and *Plebeia parkeri*. The number of specimens collected from each species, the name as they are known in the area and the percentage of total specimens are shown in Table 1.

Table 1. Scientific name, number of collected specimens, common name and percentage of all specimens collected for each stingless bee species in the communities of Cuzalapa and Zenzontla at the Manantlan Sierra in Jalisco, Mexico.

SCIENTIFIC NAME	NUMBER OF SPECIMENS	COMMON NAME	% OF TOTAL
S. hellwegeri	15	Alazana	25
F. nigra	10	Alitas blancas o zopilota	16.7
T. fulviventris	10	Calzon cuero o jocoquillas	16.7
P. bilineata	10	Negritos	16.7
N. perilampoides	5	Doncellitas	8.3
L. chamelensis	4	Limoncilla	6.7
P. pulchra	2	Mosquitos	3.3
P. moureana	2	Mosquitos	3.3
P. parkeri	2	Mosquitos	3.3
TOTAL	60		100.0

The number of wild nests of the different species that were located in the two communities can be seen in Table 2.

The bee species with the most individuals captured coincided with the species from which more wild nests were located, the majority of which were found housed in hollow trees. So, it was determined that the most abundant species with the greatest potential for cultivation are: *S. hellwegeri*, *T. fulviventris*, *P. bilineata*, *F. nigra* and *N. perilampoides*.

Table 2. Species name and number of nests of stingless bees found in the communities of Cuzalapa and Zenzontla at the Manantlan Sierra in Jalisco, Mexico.

SPECIES	NESTS CUZALAPA	NESTS ZENZONTLA	TOTAL NESTS
S. hellwegeri	6	8	14
T. fulviventris	6	4	10
P. bilineata	0	10	10
F nigra	7	2	9
N. perilampoides	3	2	5
TOTAL	22	26	48

Discussion

According to the surveys results, it is not possible to affirm that cultural and traditional management of meliponines has existed in the past in Cuzalapa and Zenzontla, Jalisco. In Mexico, the Mayan culture developed a traditional system to keep, manage and exploit stingless bees, by housing their colonies in hollow trunks called jobones. The Mayans were the only people who developed sophisticated methods of meliponiculture in the Americas (Ordetx & Espina; 1966, Weaver & Weaver, 1981; Ruttner, 1988; Gonzalez-Acereto, 2008). Another place in Mexico where meliponiculture is practiced is in the northern highlands of the state of Puebla, where the Nahuas cultivate the species *Scaptotrigona mexicana* Guérin-Meneville, bees that they lodge in clay pots, which are placed one on top of the other and are sealed with ash moistened with water (Márquez, 1994; Gonzalez-Acereto, 2008).

In countries such as Brazil, Posey and Camargo (1985) mention the names of 56 species of stingless bees that were recognized by the Kayapó natives in the village of Gorotire. Of these, only nine species are considered "semi-domesticated" or managed in some way by the natives. The nests of these bees are continuously used year after year thanks to the fact that after they open one of them to extract a part of the honey, pollen, wax and brood, they are closed to avoid the attack of predators, which reflects an awareness of the conservation of bees, even if they are not technically cultivated. Nogueira-Neto (1997) also mentions several South American cultures that make use of native bees for the preservation and reconstruction of wild nests. This situation is different in Cuzalapa and Zenzontla, because the people who collect honey from a nest, usually do not care much about protecting it, and once harvested, leave the nest open, which results in its destruction due to the attack of various predators that inhabit the region (Guadalupe Alvarez, pers. com.). The same scenario has been reported from other regions, for example, Hendrichs (1941), mentioned that in the state of Guerrero, Mexico, there were people known as "mieleros" who worked in an inadequate way. They destroyed colonies of stingless bees by knocking down trees where they nested and then, obtained the honey in a rustic way, which resulted in the product beign mixed with dead bees, pieces of wax and wood. Likewise, Nates-Parra and Rosso-Londoño (2013), mention that in Colombia, some species of meliponines are used *in situ* by honey hunters and local inhabitants to obtain several products.

The fact that young people in Cuzalapa and Zenzontla show little interest in these bees is a situation that seems to be a constant at the national level. In places of Mexico where meliponines are still kept, only adults are interested in preserving these traditions and in taking care of stingless bees to obtain their products (González-Acereto, 1989; Reyes-González et al., 2014). However, the fact that 80% of the interviewees showed interest in knowing more about the care and management of these bees, demonstrates the potential they can have with the sustainable use of the most abundant species that were located in the region.

The diversity of species recorded in this study can be considered as evidence that stingless bees are an important biotic resource that is poorly exploited in these communities. This warrants the dissemination of techniques to manage and exploit them, just like it is done in other regions of Mexico (González-Acereto, 2008). Although the inhabitants of these communities consider stingless bees to be very delicate, they also consider them harmless because they do not have a functional stinger. This represents an advantage for their culture and use, since they could have them in the yards of their houses without representing any danger to their families. In addition, with the sale of their products they would help support household expenses (Rosas & Medellín, 1996; Nogueira-Neto, 1997; González-Acereto, 2008). The most abundant species of stingless bees could be managed for the production of honey, geopropoleo, wax, pollen and could also be used as alternative pollinators for crops of economic importance (Heard, 1999; Slaa et al., 2006). In particular, honey may represent the product with the greatest potential for sale, since in other places (Yucatán and Puebla) it is marketed for therapeutic and medicinal purposes, to control different conditions of human health (Medina, 1997; Vit et al., 2015). In other regions of Mexico, Central America and South America, some of these bee species have been referenced as beign easy to adapt to artificial habitats, as well as for having good breeding characteristics and for an integral use of their products (Nogueira-Neto; 1997; González-Acereto, 2008). The above evidence suggests that there is potential for successfully managing stingless bees if meliponiculture is developed in the area of the southern coast of Jalisco, Mexico.

The knowledge about stingless bees of the inhabitants of the communities under study is very limited and empirical, unlike that of the Mayas in the Yucatan peninsula, and that of the Nahuas from Puebla's North Sierra. Although there is no technical exploitation of stingless bees in the communities where this study was conducted, and although they are a resource that inhabitants exploit sporadically, there is interest in venturing into the use of these types of bees. This is why, it is necessary to carry out studies on aspects of the biology, nesting habits and foraging behavior of the most abundant species of stingless bees under the particular conditions of the Manantlan Sierra. Once the above studies are conducted and specific management techniques are developed, the implementation of practical courses on how to keep and manage these bee species will be recommended. Such strategy will establish meliponiculture as an alternative for the sustainable use of part of the region's biodiversity, which may lead to the improvement of the quality of life of the SMBR inhabitants.

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Authors' Contribution

F Contreras-Escareño and CM Echazarreta G conceived the study and wrote the manuscript; F Contreras-Escareño, E Guzmán-Novoa, and JO Macías-Macías, assembled and analyzed the data.

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