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TOWARDS BIOCULTURAL CONSERVATION OF STINGLESS BEES IN CÓRDOBA, VERACRUZ, MEXICO

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ABSTRACT

Based on biological and ethnobiological data from 2020 to 2022, this study provides a base line for the biocultural conservation of stingless bees. These bees in Mexico, like many other pollinators, are facing population declines and this biological loss impacts traditional human knowledge and its uses. This paper aims to record the traditional ecological knowledge about these bees to establish sustainable meliponiculture. Cultural values were obtained through participant observation, interviews, free listing, and structured questionnaires, and a bee inventory was conducted. Data were analyzed using Smith's Prominence Index and descriptive statistics using SPSS v. 25 software. Inhabitants recognized 21 floral visitors, including invertebrates, mammals and birds. 'Tenchales' (local term for *Scaptotrigona mexicana*), hummingbirds and butterflies are the most culturally prominent floral visitors. The meliponini belonging to S*captotrigona mexicana* were recognized as 'tenchal', although different common names were obtained for other meliponini, denoting morphological and behavioral differences among the following species: *Partamona bilineata*, *Plebeia pulchra*, *Scaptotrigona pectoralis*, *Scaura argyrea*, *Trigona corvina*, *Trigona fulviventris*, *Trigona fuscipennis* and *Trigona nigerrima*. Although the research area is located near a large city, there is substantial diversity of melliferous flora, floral visitors, and traditional ecological knowledge used by the inhabitants in their daily activities. Stingless bees are perceived as the primary pollinators that help maintain their forests and thus help sustain their lives. This paper promotes better awareness of bioculturally effective community conservation strategies.

Keywords: Meliponini, native bees, floral visitors, pollinators, biocultural richness.

INTRODUCTION

Human cognition implies adaptation and coevolution with the environment in which humans develop the knowledge that allows them to survive and ensure success for their descendants in future generations. This cultural process has been

named variously as: 'native', 'traditional', 'empirical', 'ancient', 'indigenous', 'folk', "rural', 'local' or 'traditional ecological' (Ellen, 2009). Also, Ellen and Harris (2000) refer to it as 'indigenous environmental knowledge' (IEK) and list some of its more commonly asserted characteristics. This reservoir of experience and biological and ecological information about species richness at the local level is transmitted between generations orally through cultural transmission, i.e., the emergence, acquisition, storage and communication of ideas and practices. This can be transmitted from parents to children (vertical transmission), between two individuals of the same generation (horizontal transmission), and/or from non-parental individuals of the parental generation to members of the filial generation (oblique transmission) based on Ohmagari and Berkes (1997).

Mexican ethnobiological studies regarding stingless bees (i.e. Simms and Porter-Bolland, 2021; Vásquez-García *et al*., 2021) describe traditional knowledge of bee biology, ecological relationships, morphology, behavior, nesting, handling and harvesting honey, wax, propolis, symbolic aspects and taxonomic determination of species. However, in the preceding studies the information obtained was based exclusively on the testimony of adult producers or beekeepers.

This paper arises from the interest of Colegio de Postgraduados' researchers in using this knowledge as a basis for a strategy for developing and conserving these bees and other pollinators in Cervantes y Lozada. It could be hypothesized that a base line of traditional-local knowledge rooted in this community will ensure acceptance and success in establishing colonies that can be used in a sustainable way.

It is recognized that insects in general and bees in particular have been gradually declining worldwide, mainly due to changes in land use, large-scale agriculture, deforestation, excessive use of agrochemicals, climate change, impacts of genetically modified organisms, pathogens, pests and exotic species, which have affected plant reproduction and crop yields (Hristov *et al*., 2020; Nava-Bolaños *et al*., 2022). From the ecological point of view, bees have importance as efficient pollinators of wild and cultivated plants, thus contributing to the maintenance of ecosystems and the conservation of biodiversity.

MATERIALS AND METHODS

Study area description

Cervantes y Lozada (CyL) is located at 18° 57′ 14.4″ N and 96° 55′ 35.04″ W with an average elevation of 1214 m (Figure 1), in the region called 'Sierra del Gallego', 12 km northeast of the nearby city of Córdoba, Veracruz, Mexico. The local climate is semi-warm and humid, with abundant rainfall in summer (1900-2100 mm annually) and a temperature range of 18-24 °C. The area has the following types of vegetation and land use: a) montane cloud forest in the highest parts of its territory; b) tropical evergreen forest in the lower parts, c) a transition strip or ecotone between the two, at the same elevation of the CyL community, d) secondary vegetation derived from these types

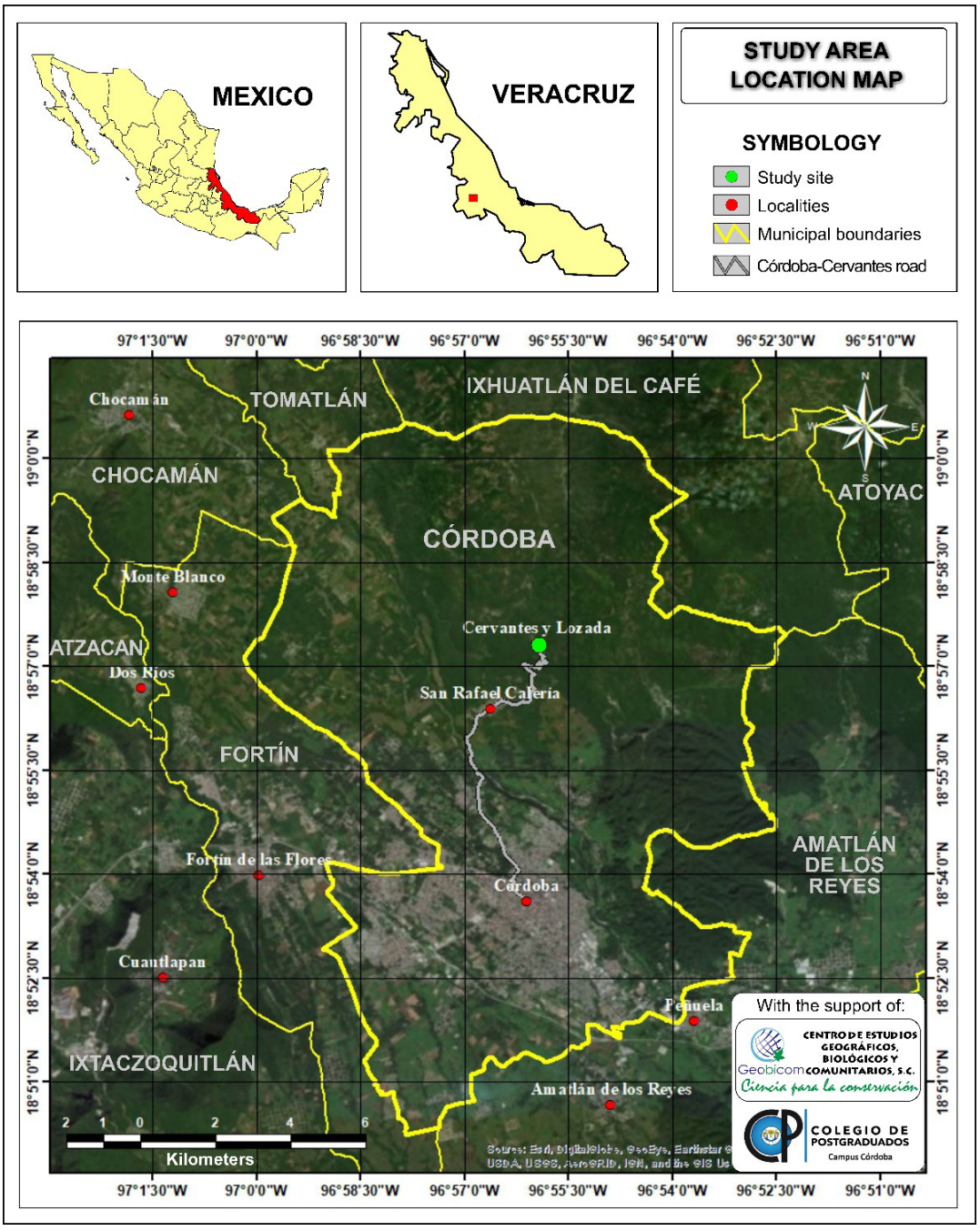

Figure 1. Location of Cervantes y Lozada, Córdoba, Veracruz, Mexico. Source: prepared by authors using Google Earth images.

of vegetation, and e) areas of different crops (Real-Luna *et al.,* 2021; 2024; Alcántara-Salinas *et al*., 2020).

Sociocultural context of Cervantes y Lozada

The community has a population of 173 inhabitants in 54 households. The basic dwelling usually consists of two main spaces, one that serves as a kitchen-dining room-living room and the other as a bedroom. These homes are constructed with cement materials with windows without a pitched roof, reflecting the kind of dwelling found in Córdoba city. Behind or around the dwelling are orchards with fruit-bearing trees, medicinal plants and spaces where the people raise domestic animals, mainly ducks, turkeys, chickens and, in a few cases, pigs. There is electricity and tap water. Some use gas for cooking (most dwellings use firewood) and most dwellings have a mobile phone.

The principal subsistence activity is agriculture, mainly carried out by older people with the participation of all family members. They harvest the main crops such as: 'coffee' (*Coffea arabica* L.), some maize, beans, chili and squash. Coffee farms are intercropped with different varieties of banana (*Musa* x *paradisiaca* L.) and ornamental species planted mainly for their foliage, such as: 'palma camedor' (*Chamaedorea elegans* Mart. and *Ch. metallica* O.F. Cook ex H.E. Moore), 'maicera' (*Dracaena fragrans* (L.) Ker Gawl.) and 'dracena' (*Cordyline fruticosa* (L.) A. Chev.). Some people earn a wage income by being hired at harvest time and as workers in Córdoba City; some migrate to the U.S.A. and Mexico City where wages are higher. Coffee is the main agricultural product traded outside CyL. Although this town is considered highly marginalized with a significant degree of illiteracy (CONAPO, 2021), members of the community have their own dwelling as private property and share rights and duties as citizens, such as the 'faena' (meaning 'work' or 'tribute'), wherein they perform communal labor on collective resources such as the maintenance of schools, fencing and roads.

Formal education is available for children, which consists of preschool and grades 1 to 6 in a primary school with one teacher. The primary school has two classrooms with a playground area. If a family should decide to educate their children further, San Rafael Calería, 4.3 km from CyL, is the nearest town with a secondary school. For undergraduate studies youths must leave CyL.

On the main street there is a Catholic church, an evangelical temple, and a community house which serves as a place for meetings and training programs. As in other communities of the region, CyL faces changes in land use for agriculture (mainly coffee and banana) and deforestation for firewood. To raise agricultural production, some people use herbicides for weed control or other chemical products affecting wildlife. There is also the problem of poaching of game by people outside the community.

In 2017 researchers from the Colegio de Postgraduados initiated biological studies and training of local participants for community bird monitoring in CyL (Alcántara-Salinas *et al*., 2020). The Colegio de Postgraduados also established meliponini nests for research proposes and some for reintegration. Given the community relationship

fostered by the doctoral thesis developed by Natalia Real Luna in 2020, this site was considered ideal for promoting the establishment of bee nests as a biocultural conservation strategy. In addition, the Colegio de Postgraduados joined The National Strategy for Conservation of Pollinators in 2021 (Secretaría de Agricultura y Desarrollo Rural-SADER and Secretaría de Medio Ambiente y Recursos Naturales-SEMARNAT, 2021) to provide experience on patented box construction (Salazar-Vargas *et al*., 2019) and sustainable management of meliponini.

Data collection

This research was conducted by using a combination of biological and ethnobiological techniques. Researchers adopted a broadly participatory approach and, as far as possible, joined in local subsistence and cultural activities.

Information was obtained in two kinds of data: 1. Data on pollinators (floral visitors) emphasizing meliponini, collected and analyzed from the perspective of scientific entomology and biology; and 2. Ethnographic data to address the research questions concerning differences and similarities regarding traditional knowledge of pollinators (floral visitors) within the CyL population, especially meliponini, where individual respondents engaged with a combination of approaches and elicitation techniques, such as interviews, free listing, questionnaires and participatory workshops, the last mainly at the primary school. The research work began in March 2020, paused due to the Covid-19 pandemic from April to November 2020, then continued from December 2020 until March 2022, with weekly visits to the community.

During the first incursion into the field, researchers established contact with local authorities and citizens to request approval to conduct workshops with children. Overall, the norms established in the Code of Ethics of the International Society of Ethnobiology (ISE, 2020) were adopted.

Data on stingless bee inventory

Stingless bees were collected *in situ* from February 2021 to March 2022. When species determination was problematic, the specimens were collected with an entomological net on roadsides and in the community gardens from 10:00 am to 4:00 pm. For bee collection the usual preservation process was followed, with specimens being individually labelled and mounted in special boxes. Taxonomic determination was made using published keys for stingless bees developed by Arnold *et al.* (2018), Ayala (1999) and Bonet and Vergara (2016). The collected specimens are kept in the wildlife laboratory of the Colegio de Postgraduados Campus Córdoba.

Traditional knowledge

Participant observation was used as the default qualitative research strategy, as well as different kinds of interviews such as 1) free interviews, 2) *ad hoc* or informal interviews, and 3) structured interviews (see Alcántara-Salinas *et al.*, 2013 for details), in addition to workshops with children at the school where interviews were conducted. All these techniques were carried out in different contexts while people were doing

daily activities. Quantitative methods were used to analyze free listing and structured questionnaire data.

Free listing was employed to generate data about the cultural prominence of floral visitors organized at the same level of contrast. Free lists were solicited from 25 randomly chosen people from the community. The frequency, average rank and the value of Smith's Prominence Index of items listed were calculated (Alcántara-Salinas, 2021; Puri, 2011; Quinlan, 2017).

The local knowledge regarding floral visitors was determined for different age and gender groups to differentiate traditional-local ecological knowledge between age groups. Then stingless bees were used for formal questionnaires, as these were the highest-ranking type of floral visitors elicited.

The questionnaire was formulated with the following topics: 1. Common name, 2. Biology, 3. Colony products, 4. Uses of colony products, and 5. Oral tradition. These topics were obtained through a pilot test carried out at the beginning of the fieldwork. Questionnaires were conducted at each individual's home to avoid crowding and distractions. For children, questionnaires were applied individually after a workshop held in the classroom.

The analysis divided age categories into three main groups, following the protocol of Alcántara-Salinas (2013): children (6 to 13 years), youths (14 to 39 years), and adults (40 to 96 years).

All responses were systematized and coded in a Microsoft Office 365 Excel worksheet, then the information was analyzed. We also analyzed by percentages, by gender and by age to relate traditional ecological knowledge of meliponini with the questionnaire responses by constructing a 9 x 75 matrix (nine questions by 75 individuals) using SPSS v. 25 software SPSS (IBM, 2017).

The questionnaire was applied to a total of 75 people, another 65 individuals were interviewed to obtain information about pollinators and stingless bees, and 13 primary school children were included for the ethnobiological approach.

RESULTS AND DISCUSSION

Stingless bee inventory

Mexico has 46 species of stingless bees; 25 of them have been recorded in the state of Veracruz and 11 species have been recorded in the municipality of Córdoba (Ayala, 1999; Bonet and Vergara, 2016). Nine species were recorded in Cervantes y Lozada: *Partamona bilineata* (Say, 1837), *Plebeia pulchra* Ayala, 1999, *Scaptotrigona mexicana* (Guérin, 1845), *Scaptotrigona pectoralis* (Dalla Torre, 1896), *Scaura argyrea* (Cockerell, 1912), *Trigona corvina* Cockerell, 1913, *Trigona fulviventris* Guérin, 1845, *Trigona fuscipennis* Friese, 1900 and *Trigona nigerrima* Cresson, 1878 (Figure 2).

Figure 2. Species of stingless bees found in Cervantes y Lozada, Córdoba, Veracruz, Mexico.

Traditional knowledge

Free listing was conducted with 25 individuals (12 men and 13 women) representing 15 % of the population, which generated 155 answers. Twenty-one species were mentioned as feeding on nectar or otherwise related to flowers: arthropods (86 %), birds (9 %) and mammals (5 %). Figure 3 shows the Smith's Prominence Index results: bee (*Apis mellifera*), butterfly (various species), hummingbird (various species), 'tenchal', 'jicote' (bumble bee), and wasp were the most frequently mentioned floral visitors.

Free listing results emphasize the perception of insects as floral visitors, but also recognize other flower visitants, whether for feeding purposes or some other form of interaction, such as for predation (birds, ants, spiders, small beetles, dragonflies) or herbivory (crickets, worms, stick insects) similar to the food networks reported in Crespo-Pérez *et al.* (2020). In general, people recognized the value and function of pollinators to maintain the surrounding forests by providing environmental services, such as air pollution reduction, biological control, plant regeneration, etc.

Perception of floral visitors among individuals by gender showed that women mentioned 17 of the 21 animals listed, while men mentioned 16. The highest Smith's Prominence Index values (Figure 4) by gender indicated that women and men

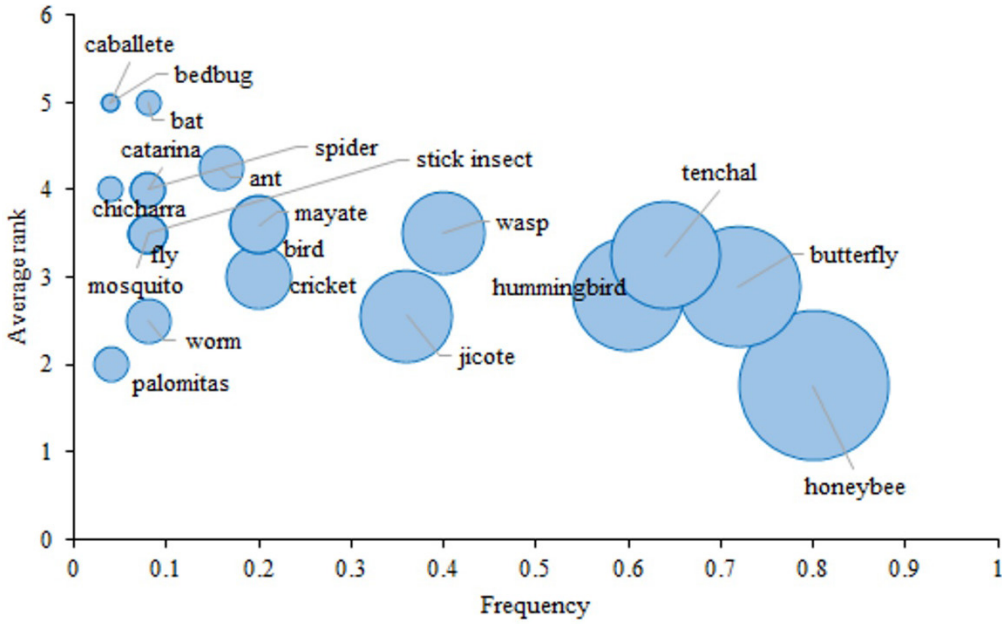

Figure 3. Plot of average rank versus frequency; the size of the sphere shows the value of Smith's Prominence Index with respect to the floral visitors mentioned in free listing data.

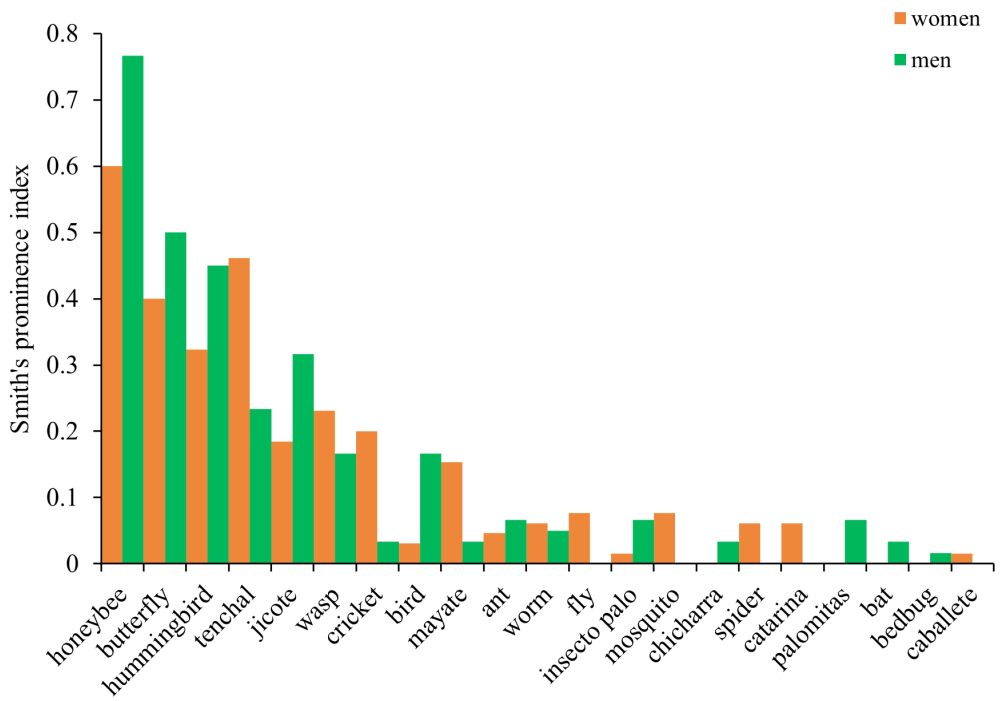

Figure 4. Smith's Prominence Index for floral visitors mentioned in the free listing by women and men.

mentioned bee (*Apis mellifera*), butterfly (several species), hummingbird (several species), 'tenchal', 'jicote' (bumble bee), and wasp as the most frequent floral visitors. Since stingless bees appeared as one of the most represented in free listing, the questionnaire was focused on them.

Questionnaires focused on stingless bees as the highest ranked floral visitor species and were completed by 75 people: 52 % by men and 48 % by women, 17 % by children, 39 % by youths, and 44 % by adults.

Common names of stingless bees

Most of the people can clearly differentiate similar insects. For instance, European bees (*Apis mellifera*) are never confused with native bees, and it is recognized that their swarms or hives are different from those of stingless bees by their morphological and behavioral characteristics. In fact, most of the people in CyL recognize the term 'tenchal' for the species *Scaptotrigona mexicana* (Guérin, 1845); this term has an important cultural prominence. 'Tenchal' was the response of 58 % of adults against 38.5 % of children in the questionnaire applied.

Although the term 'tenchal' is used for *S. mexicana*, some people preferred other terms, such as 'comejé', 'abeja negra', 'mosquito', 'abeja real' and 'melipona', to distinguish it from other meliponini species like: *Partamona bilineata* (Say, 1837), *Plebeia pulchra* Ayala, 1999, *S. pectoralis* (Dalla Torre, 1896), *Scaura argyrea* (Cockerell, 1912), *Trigona corvina* Cockerell, 1913, *T. fulviventris* Guérin, 1845, *T. fuscipennis* Friese, 1900 and *T. nigerrima* Cresson, 1878.

All the terms and meliponini species mentioned above were corroborated *in situ*, while doing interviews, collecting bees and performing participative observation. The fact that people recognize species by different terms stresses some multidimensional principles of classification (Alcántara-Salinas *et al*., 2013), where some aspects like habitat, morphology, color, or the relationship with humans are involved in naming meliponini.

Also, the fact that some species are given different descriptive common names can be explained, as Ellen (1999) noted: 'that knowledge of names ('lexical' knowledge) is unevenly distributed within the community (presumably mainly among older people); or that knowledge of names in themselves does not always reflect 'substantive knowledge' or a combination of both'. The task of obtaining local names of species of interest has great importance for maintaining a clear dialogue with local people, as it allows participants to manage the same cultural codes, not only in the use of the language, but also in cultural perception, and to have direct access to people's psyches for their conceptual words (Alcántara-Salinas, 2021). Common names are evidence of traditional knowledge transmission (Alcántara-Salinas *et al*., 2022; Geng *et al*., 2016) and are needed to repatriate traditional-local knowledge to the community to facilitate projects or elements to promote biocultural conservation.

Stingless bee biology

Common names not only encode useful recognition of biological species of bees, but also encode features such as color, size, and behavior. In this regard, CyL inhabitants distinguish bees 50.7 % by color and 30.7 % by size. In addition, people encode more detailed aspects of bee size; for example, 'they are like an ant' or 'smaller than bees or wasps'. They also stress their color: 'some are black' as is *Scaptotrigona Mexicana*; 'brown, yellow or orange' as is *Scaptotrigona pectoralis*; 'some are small, glittery, have brown heads and legs', 'some have white wing tips', a characteristic of *Trigona nigerrima*; 'there is a little bee with a yellow tail', referring to how the abdomen appears in *Trigona fulviventris*. Some of the above affirmations are also mentioned in Zamudio and Hilgert (2012). There is no doubt that morphological characteristics such as size and color are predominant features used by people to identify stingless bees (Figure 5).

Defensive behavior is another characteristic of these bees to protect their nest, described by 64 % of the individuals surveyed. When people find these bees in the field while doing their activities, they noted they 'are not dangerous', 'bees do not sting', although 'they bite' and 'get tangled in the hair', 'they leave like wax on the skin', 'they buzz', and 'they bother the eyes and try to enter the nose and ears', which is also described by Michener (2007) and Shanahan and Spivak (2021).

People know these bees are attracted to sweet smells: 'when we use perfume, [they] come closer', 'they like people's sweat'; bees are even known for some habits considered unhygienic, such as: 'they stand in dog excrement', 'they walk on dead animals' and some 'smell bad'.

Other characteristics recognized for these bees among local people is their gregarious behavior, also reported by Dos Santos *et al.* (2008) and Zamudio and Hilgert (2015): 'when they go to the nest [they] gather with their group', 'they do not live alone', 'they live in family'. Stingless bees are also recognized as restless and very active: 'When one arrives, more come after', 'went back to the nest, immediately came out again, doing that the whole day'.

Regarding their habitat, people mentioned that these bees can be found in different locations in their territory, such as: 'mainly in the field', 'in the bush', 'in the forest', 'in the coffee plantations', 'in areas where there is vegetation', 'where there are flowers and trees', 'in the village', 'in the gardens of houses', that is, bees interact with people constantly and in most of the places where people carry out their daily activities.

People in CyL recognize the nests of meliponini, with 70.7 % knowing that meliponini complete their life cycle in them. People know that these nests may be inside tree cavities, between tree branches, or just lying exposed on the ground. People distinguish species by the form of their nests, as can be seen in Figure 6. Their nest is described as a ball shape, 'with the color of the wood', and made of organic matter and soil; in addition, these nests have an entrance in a very peculiar shape, described as 'a little bugle or trumpet'. People also described not only the microhabitat, but also the characteristic materials of which the nest is made. Nests can be established on 'the ground', 'in rock crevices', 'in walls', 'in electric light poles', 'in active termite mounds' and 'in anthills'. All this has also been described by Shanahan and Spivak (2021).

Figure 5. Species of stingless bees that the inhabitants of Cervantes y Lozada recognize due to their morphological characteristics and nesting sites.

While doing fieldwork, the presence of several bee colonies accompanying inhabitants was confirmed. For example, a 52-year-old man had a 'nest within his house' for more than 20 years; another 45-year-old man also showed us a nest ready to be sold, as people from the city or surrounding localities do business with local residents, earning around $500.00 pesos ($25 USD) per colony. Another 40-year-old man mentioned that he gives the nests he finds to a person from another community.

Traditional knowledge indicates an important relationship recognized by age and gender between the habitat and behavior of meliponini. That may be explained by the fact that the local natural environment offers the same possibilities for learning and accumulation of traditional ecological knowledge to both men and women, as

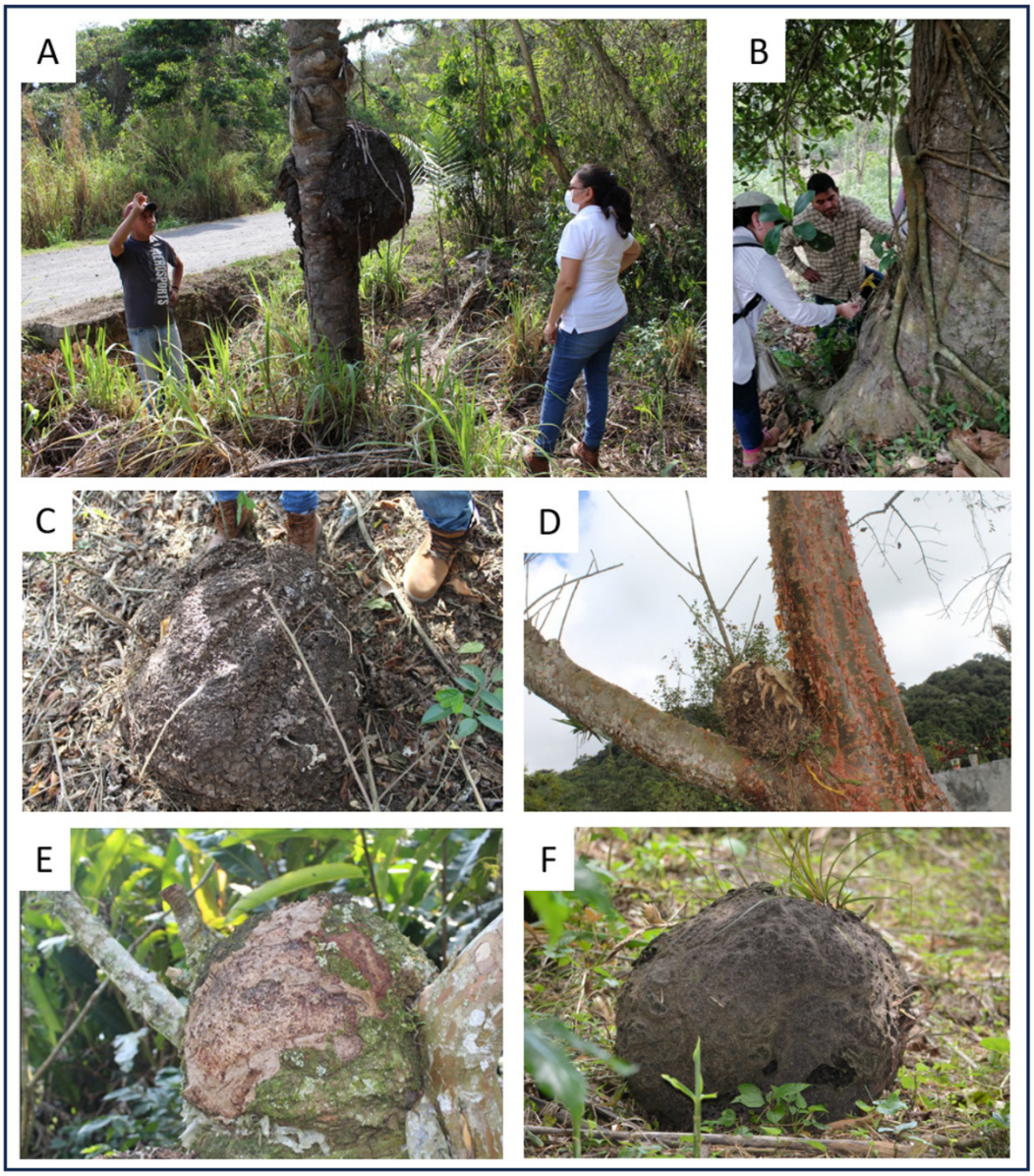

Figure 6. Stingless bee nests in Cervantes y Lozada. A) *Scaura argyrea*; B) *Scaptotrigona mexicana*; C) *Scaura argyrea*; D) *Trigona fuscipennis*; E) *Trigona nigerrima*; and F) *Trigona corvina.*

was likewise reported by Doyle *et al.* (2017) and Geng *et al.* (2016). Therefore, there is homogeneity of this knowledge by gender, which is mainly acquired in the conduct of their daily activities within the forest in the company of family.

Even though men and women have different roles in society, bees are present in most of the spaces where they carry out their daily activities.

In relation to age groups (children, youths, and adults), the results show that the children differ from youths and adults in the traditional knowledge of meliponini by making fewer distinctions among names and species; this is likely because they are building up their abilities and are in a learning process, reflecting limited experience and contact with the stingless bees found in the locality.

In addition, some children already have a mobile phone within their dwelling, spending more time on it or watching television instead of exploring their surroundings, limiting themselves to playing on the soccer field only on weekends or some afternoons; however, it could not be said that traditional knowledge of meliponini is being lost among children, since it tends to be transmitted gradually, as mentioned by Lima *et al.* (2021). It is important to mention that children who completed the questionnaire do not represent the community as a whole.

We noticed that cultural transmission of knowledge regarding meliponini and other floral visitors takes place when people cultivate coffee or when they harvest it.

Colony products

When people responded about the uses of the colony products, 16 % mentioned honey and 18.7 % wax; most of the people who answered the questionnaire showed ignorance of any product obtained from the nest of these bees. However, when we were doing fieldwork, we noticed that many of the people recognized honey, wax, pollen and larvae as principal products obtained from the nests of these bees.

Uses of colony products

Extracting honey from bee nests was referred to as 'castrar nidos' ('to castrate nests'), 'ordeñar nidos' ('to milk honey') or 'cosecha de miel' ('honey harvesting'). This activity is mainly performed by men, also mentioned by Athayde *et al.* (2016). Occasionally women help men with this activity. Both women and men use the same techniques in beekeeping. One person mentioned that he 'castrates' nests' at night, in order to avoid the bees' active defenses and to cause less disturbance; other people mentioned that they use smoke to make the bees disperse, while some people cut the tree to extract the nests.

Extracting nests by cutting down trees brings partial or total destruction of the nests; once it is exposed to the sun and air, bees abandon it or are prey to other animals, such as ants. Therefore, it is important to provide training for the sustainable management of these organisms and to ensure that the colonies remain in their original habitats, as well as to guarantee the honey harvest is carried out in a safe manner. It is also important to train women in this activity, in which all members of the family can participate, from children to the elderly.

Honey harvesting is mainly carried out during the spring, as this is the period in which most honey is produced and when it has the best flavor. This activity is pursued once a year to procure the honey that may be required for self-consumption. People also recognize stingless bee honey by its taste, texture, or color. It may be described

as having an acid or bittersweet taste and a liquid texture, but in CyL people more often mentioned the color of the honey, which may be dark yellow or bright yellow, depending on the species of meliponini.

The commercialization of honey is limited, as it is known for low annual productivity, e.g., one liter per year. When people extract honey for sale, they may earn $1,000.00 Mexican pesos ($50 USD) per liter. However, it is better appreciated by local people for their health by virtue of its medicinal properties, such as for treating respiratory tract diseases like the flu and coughing, for skin problems such as for healing wounds or as an anti-inflammatory for scrapes and bumps. The pure form of this honey is used for eye injuries known as cataracts (cloud vision). Other uses include oral infusions mixed with lemon, medicinal plants or garlic, as also reported by Zamudio and Hilgert (2011).

The medicinal use of meliponini honey may save money for medical consultation, also described by Carvalho *et al.* (2018). The use of honey in CyL contributes to maintaining traditional remedies for specific diseases and for maintaining familial and social ties, due to the fact that it is primarily shared with good wishes for good health to those who receive it (relatives, neighbors or friends).

Beeswax is known as "cera de Campeche" (Campeche wax). "Campeche" does not refer to the Mexican state of Campeche, but it is the most widely used term by which beeswax is recognized.

People said that "cera de Campeche" was used as glue and sealant for leaks in pipes or holes in the roof, to make candles, even as glue for small pieces of ceramic. Some of those uses are also reported by Dos Santos and Antonini (2008). In CyL bee nests can also be used as ornaments inside the dwellings, as can wasp nests (Figure 7).

Pollen and larvae are consumed as a source of protein in CyL. Bee larvae could be an ideal food due to their nutritional composition of proteins, fatty acids and minerals, so they could improve food security. It seems that children acquire traditional knowledge gradually over the time, for which reason they are separated from youths and adults. We consider that stingless bees are among the most salient pollinator species. The analysis helps us to see adults as the principal social group maintaining significant traditional knowledge concerning colony products, particularly honey use and harvesting. This traditional ecological knowledge seems to be transmitted either directly from parents to children or youths (vertically) or between individuals not necessarily belonging to the same descendent group (horizontally or obliquely), following Ohmagari and Berkes (1997). Horizontal transmission is increasingly limited as there is less time available for organized games and leisure time in the field, as young people may prefer interacting on social networks or watching television. However, some children lacking those technologies acquire skills they may use later, especially when involved in a wide range of activities in the field during the year.

Oral tradition and importance of stingless bees

Stingless bees are represented in local oral traditions; however, only a few individuals (8 %) mentioned that these bees may be beneficial when they build their nests in

Figure 7. Wasp and stingless bee nests used as decorative artefacts in dwellings

the forest or near houses where people are working, as bees may warn of snakes approaching. Some believe that bees serve as omens, announcing weather changes, such as thinking that a strong wind will come if the bee guardians do not appear to defend their nest.

Most local people appreciate stingless bees as suppliers of honey and wax, but mainly as an elemental protagonist as pollinators, given that they maintain the ecological functions of the forest. Some described them as 'part of nature', valued 'because God created them', or asserted that 'every little animal has its function', and 'they produce medicinal honey for us'.

Finally, when including all responses of all individuals, there is a strong relationship overall between the questionnaire responses of all the individuals. However, when looking in detail, we can see three main groups: 1) women show more agreement on ecological importance, bee morphology, and cultural aspects of stingless bees, while 2) men are correlated with biology and uses of colony products as they are the ones who most often extract nests and their products, and 3) children are more correlated with the answer "do not know", but, as we mentioned before, children who participated

in the questionnaire do not represent most of the children of CyL, and they may also simply be in the process of acquiring traditional knowledge. We are not able to attest that they have lost traditional knowledge. Youths fall in the middle of adult men and women, but not on the side of the children, which suggests they have acquired some but not all aspects of traditional knowledge.

Further actions for biocultural conservation of stingless bees in Cervantes y Lozada

When it was mentioned during workshops and interviews in CyL that the intention of the Colegio de Postgraduados as an institution is to provide the community with stingless bees colonies along with the technical advice for their sustainable harvesting, some people manifested interest by saying: 'I like it', 'I find it interesting', 'I want to know more', 'to help nature', 'I want to learn', 'to know what we have in the community', or 'to produce honey'.

We believe that by providing colonies of these bees to a certain number of people in CyL, we may help establish biocultural strategies for their conservation, such as: to avoid the extraction of wild colonies, to promote traditional uses of the products of the colonies, to motivate children to learn about harvesting bee products and their uses, and to increase family income by selling honey and other products.

The Colegio de Postgraduados may also provide people with technical information for commercialization of honey, pollen or wax in their natural form, dehydrated or as a supplement for meals.

Meliponiculture would be useful to promote awareness of biodiversity conservation consistent with local needs, avoiding the loss of traditional knowledge due to social changes, such as out-migration that disrupts the line of knowledge transmission and contributes to an increasing detachment from the communities' own traditional rural activities. Extinction of species and reduction of biodiversity also contribute to a 'cascade effect', not only in terms of natural resources depletion, but in terms of social and cultural indices. Therefore, there is a need for pollinator and bee conservation to safeguard local knowledge and to promote sustainable subsistence strategies that are essential for local agriculture, local ecosystems, and traditional knowledge (Alcántara-Salinas, 2021)

CONCLUSIONS

The perception of bees' value and diversity among the inhabitants of Cervantes y Lozada highlights the fact that each species is culturally salient by virtue of its size, color, habitat and behavior, among other distinctive aspects. People consider the main pollinators to be stingless bees, bees, butterflies, hummingbirds, tenchales, jicotes and wasps.

Adults maintain traditional knowledge of stingless bees, such as their common names and the morphological, behavioral, ecological and utilitarian characteristics of the

colony's products; it is important to continue transmitting this traditional knowledge to new generations so that it is preserved and may endure. There was no clear division of responsibilities between women and men; it is gender neutral, as women and men work together in agriculture, leading to a sharing of knowledge between men and women for all participants.

Ethnobiological studies on stingless bees are important for projects that promote the sustainable use of natural resources and the conservation of cultural aspects. Based on this research, the people of CyL have enough traditional knowledge to sustain a progressive program of technical training to establish a communitarian meliponary. The training and the Meliponini colonies may be provided in the near future by the Colegio de Postgraduados to promote their biocultural conservation.

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