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Sociodemographic characteristics and participation of women in meliponiculture from the Yucatán Peninsula, Mexico

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Abstract

Background Meliponiculture is the breeding of stingless bees (SB) or bees of the Meliponini tribe. In Mexico, this activity was practiced before the arrival of the Spaniards, with the Yucatan Peninsula (YP) (comprising the states of Campeche, Quintana Roo and Yucatan) being the most important region due to its link with the economic, cultural and medicinal aspects of the Mayan communities. The objective of this study was to compare the sociodemographic characteristics and the participation of women in meliponiculture practiced in the YP. Our hypothesis suggests that the participation of women in meliponiculture is lower compared to that of men due to their sociocultural responsibilities in the community.

Methods A total of 56 interviews were conducted between December 2021 and December 2023, using referral sampling (this procedure was used due to non-availability of any producer's list; and due the random nature of the information obtained from various producers belonging to different sociodemographic contexts). The interview form consisted of the following sections: basic information about the producer, gender, age, years of education, number of colonies, honey production and years of experience. The information collected was analyzed using a Student's t-test in the R program.

Results It was observed that 66% of meliponiculturists were men and 34% were women. Differences were observed in the average age and number of colonies, in men with 47.4 ± 3.24; years and 36.19 ± 10.28 colonies; while in women, it was 38.1 ± 2.80 (t = 2.14; p = 0.036; gl = 52) years and 14.00 ± 2.42 (t = 2.09; p = 0.042; gl = 40) colonies. No differences were observed between the years of education (8.84 ± 0.79; men and 8.74 ± 0.94 (women; t = 0.08; p = 0.935; gl = 45) and the honey obtained per colony (0.620 ± 0.04 kg/honey; men and 0.600 ± 0.08 kg/honey; women; t = 0.18; p = 0.853, gl = 26).

Conclusion Meliponiculture in the YP is an activity practiced in a greater proportion by men; who also have a greater number of colonies compared to women. On the other hand, women who practice honey production are younger than men. The performance of rural women in commercial beekeeping has been affected by their traditional role in household activities and child care. They do not have enough time dedicated to meliponiculture; although the income they can obtain from the sale of products could contribute to the financial support of the family.

Keywords Campeche, Quintana Roo, Stingless bees, Traditional knowledge, Yucatán

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Background

Currently, it is estimated that there are around 20,000 species of bees worldwide [1]; and they play a very important role in the pollination of wild plants and also in the commercial crop production [2]. In this regard, one of the groups of bees that fulfill this function and have a positive impact on meliponiculture is the stingless bees (SB), distributed across the tropics and subtropics [1]. Meliponiculture is an activity associated with the breeding of SB or bees of the Meliponini tribe [3, 4]; that are characterized by lack of a functional sting [5]. In Mexico, this activity was practiced before the arrival of the Spanish conquerors; the honey and wax produced by the Mayans were sold to Guatemala and Honduras [6]. In Mexico, the SBs were cultivated during the sixteenth and seventeenth centuries in regions such as: a) the Yucatán Peninsula (YP), b) the Coast of the Gulf of Mexico (mainly Veracruz and Tabasco), c) the Pacific Coast between Sinaloa and Jalisco and d) the Balsas River Basin in Guerrero and Michoacán [7]. Of these regions, YP was the most important since it was practiced before the arrival of the Spaniards and reached a high level of production comparable to the management of honeybees in medieval times in Europe, with densities of up to 500 colonies [8, 9].

In Mexico, out of a total of 46 species of SBs; 17 species are reported from the YP region [10, 11]. The most important species in the YP from a cultural point of view is *Melipona beecheii* Bennett, which was also cultivated in the states of Tabasco, Chiapas and Veracruz. There are other species that were also bred in other states of Mexico, such as *M. fasciata* Latreille in Chiapas and Guerrero, *Scaptotrigona mexicana* Guérin-Meneville in the Sierra Norte of Puebla and in the Papantla Region in Veracruz and *S. hellwegeri* Friese in Jalisco, Nayarit, Colima and Guerrero [12].

From the cultural perspective, meliponiculture is recorded in ancient codices, murals, stone monuments and ceramic objects [4, 8, 13]. In the Madrid or TroCortesiano codex, a section is dedicated to meliponiculture, with scenes about the way the Maya took care of bees and their reproduction, especially the bee *M. beecheii*, as well as iconography of honey, bee gods and their nests. The hobones or hollow trunks that function as nests and are placed inside the meliponary (in Maya, "Najil Kab") [4, 7, 8] are represented in the aforementioned codex in glyph forty-seven with worker bees and queen bees and with small differences between them [14].

With the arrival of the Spaniards in the YP, the Maya production system underwent gradual changes as traditional activities were replaced by new ones introduced by the Europeans. The rise of extensive livestock farming in the region that marked the beginning of a gradual process of forest fragmentation; coupled with the cultivation of henequen (*Agave fourcroydes* Lem.) and sugarcane (*Saccharum officinarum* L.) [4, 9, 14]. Furthermore, the introduction of the honeybee (*Apis mellifera* L.) at the beginning of the twentieth century in the YP also greatly influenced the abandonment of meliponiculture. The presence of the honeybee in the region is relatively recent, when compared to other areas of the American continent. But, where it was introduced with the arrival of the Spaniards is an important question that remains unanswered tilla date; while the first honeybee introduction in the YP occurred in 1911, with bee colonies introduced from the US [4].

Currently, meliponiculture is threatened by several cultural, economic and ecological changes [8]. Among these, the most noticeable is the subsequent reduction of its practice in the YP, since it represents one of the main regions in Mexico where SB breeding is practiced [9, 15, 16]. On the other hand, positive changes have also been observed in this activity, the entry of women into meliponiculture; which was traditionally practiced almost exclusively by the men since ancient times. Under these circumstances and in order to generate information to document the changes experienced; the present work aims to comparatively analyze the different sociodemographic characteristics such as: age, education, colonies owned, honey production and meliponiculture experience in the form of participation of women in the production process compared to men in the YP. The assumption has been that the women carry out all the breeding and harvesting activities of the SB, particularly when the meliponary has less than 20 colonies (due to their time devoted to household activities) or when women are integrated into some community-based work group as the social organization empowers women.

Materials and methods

Study area

The YP is located in the extreme southeast of the Mexican Republic between 18°N and 21°30'W. It is a region of low relief with altitudes less than 400 m above sea level. The central part of the YP represents the highest area, near the town of Zoh-Laguna and descends to the east and west; to the northwest, there is a medium altitude, to the south of the state of Yucatán is the Sierrita de Ticul, with an altitude of ~ 250 m above the mean sea level; but basically, most of the YP has altitude less than 50 m above the mean sea level [17]. The average annual temperature in the YP is 26°C; and the coolest months are December, January and February with temperatures lower than 22°C [18]. Based on the Köppen climate classification modified by García [19], in the YP warm climates gradually manifest themselves, with different

humidity levels, subhumid with summer rainfall regime Aw_0, Aw_1, Aw_2, with intermediate rainfall regime, Aw_0 (x'), Aw_1 (x'), Aw_2 (x'), in this case, the winter precipitation is greater than 10.2% of the annual total; until one reaches the dry climates BS1 and BS0, in which the decrease in precipitation due to the effect of the jet stream, which moves the wind from the continent to the sea [20].

The YP is made up of the state of Yucatán, which represents 2.0% of the total Mexican territory, with the capital city being Mérida. The state has a population representing 1.8% of the national Mexican population, with a total of 106 municipalities. Another state of the YP is Campeche with 2.9% of the national land and its capital being located at the San Francisco de Campeche, representing 0.7% of the national population with and a total of 13 municipalities. Finally, the YP region also constitutes the state of Quintana Roo (with the capital city being Chetumal), which represents 2.3% of the national territory; and 1.5% of the national Mexican population, and has 11 municipalities [21].

Interviews with producers

In the YP, there is no available documented list of meliponiculturists, so a referral or snowball sampling was used [22]; since it was not possible to determine the size of the sample according to the statistical principles. To analyze the importance of women in meliponiculture, an interview form was designed to collect basic information on the producer, gender, age of the producer, years of schooling, number of colonies in possession, volume of production, number of years of experience and the reasons that prompted their participation in meliponiculture. Interviews were conducted between December 2021 and December 2023 in several Mayan communities in rural and peri-urban areas in the region (Fig. 1).

Data analysis

The information collected in the field was recorded in a Microsoft Excel® spreadsheet. For the qualitative data, a chord diagram was made with frequency of responses, using the Origin Pro10.0.5.157 software. The information was analyzed using descriptive statistics (bar graph) and measures of central tendency (mean and standard deviation). A Student's t-test was also used to determine if there were differences between the two genders for each of the variables using the R program (R Statistical Software version 4.2.0).

Results

Producers (gender, age and education)

A total of 56 people who own SBs were recorded in the survey, distributed in the three states of the YP, 66% being men and 34% women (Figs. 2 and 3A). Of these producers, 25% are between the ages of 40–49 years, followed by 30–39 years (21%) and 20–29 years (19%) (Fig. 3B). The average age of the meliponiculturists in this study was higher in men (47.4 ± 3.24) compared to women (38.1 ± 2.80) and with a difference of 9 years ($t = 2.14$; $p = 0.036$; $gl = 52$), with the extremes being 18 and 92 and 20 and 60 (Min and Max) years, in men and women, respectively (Fig. 4A).

The predominant level of education was secondary school with 35% of the population, followed by primary and high school with 28 and 19%, respectively (Fig. 3C). But, an average of 8.84 ± 0.79 years of schooling was observed in men and 8.74 ± 0.94 years in women, no differences were founded between both groups ($t = 0.08$; $p = 0.935$; $gl = 45$), the extremes being 0–19 and 1–17 (Min and Max) years in men and women, respectively (Fig. 4B).

Meliponiculture (number of colonies, honey production and experience)

In the number of colonies, 39% of producers have 10–19 hives, followed by those who have 30–39 hives and 20–29 hives with 25 and 13%, respectively (Fig. 3D). The average number of hives per meliponiculturist was higher in men (36.19 ± 10.28) than in women (14.00 ± 2.42), with differences between both groups ($t = 2.09$; $p = 0.042$; $gl = 40$). The extremes were 1 and 350 and 1 and 40 (Min and Max) in men and women, respectively (Fig. 4C). In honey production per colony per year, male meliponiculturist obtained 0.620 ± 0.04 kg of honey and women 0.600 ± 0.08 kg of honey, with no differences between both groups ($t = 0.18$; $p = 0.853$, $gl = 26$). The extreme values were 1 and 350 and 1 and 40 (Min and Max) in men and women, respectively (Fig. 4C), and 0.10 and 1.00 and 0.25 and 2.00 (Min and Max) in men and women, respectively (Fig. 4D).

In terms of years of experience in meliponiculture, 66% of producers have less than 10 years, and the other 44% have more than 10 years of experience (Fig. 3E). However, men had a higher average experience (11.9 ± 2.30) than women (6.3 ± 1.20), with differences observed between both groups ($t = 2.29$; $p = 0.026$; $gl = 44$). The extreme values were 1 and 70 and 2 and 15 (Min and Max) in men and women, respectively (Fig. 4E).

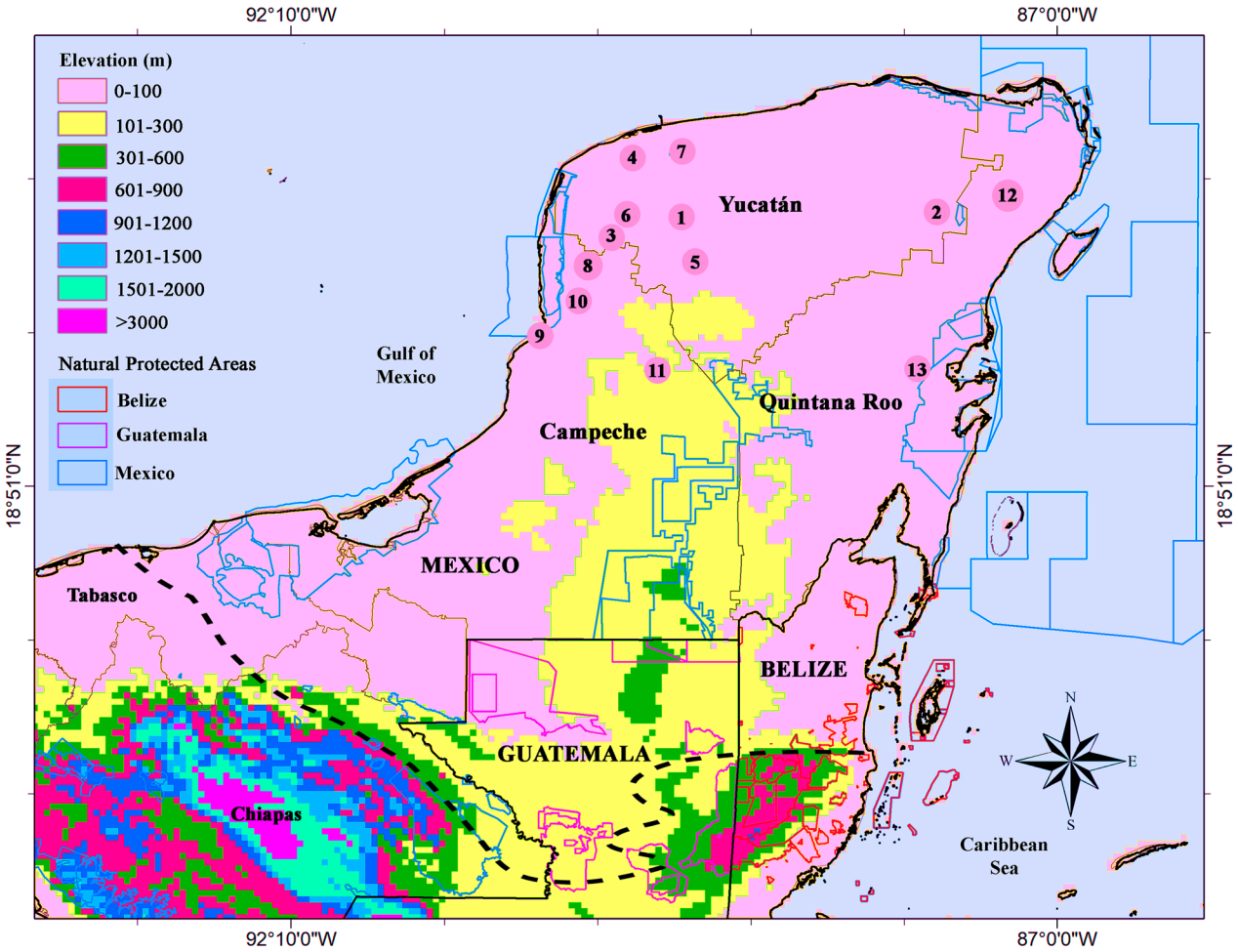

Fig. 1 Location and number of interviews per site of meliponiculturists in the Yucatán Peninsula, Mexico. Yucatán: 1 = abalá (3), 2 = Chemax (16), 3 = Halachó (1), 4 = Hunucmá (3), 5 = Maní (6), 6 = Maxcanú (1) and 7 = Mérida (2). Campeche: 8 = Calkiní (6), 9 = Campeche (2), 10 = Hecelchakán (4) and 11 = Hopelchén (3). Quintana Roo: 12 = Felipe Carrillo Puerto (9) and 13 = Lázaro Cárdenas (2). Total = 56 meliponiculturists (numbers in parentheses represent the total number of meliponiculturists per location)

(See figure on next page.)

Fig. 2 Beekeeping in the Yucatan Peninsula. **A** Beekeeping with traditional bees. **B** Beekeeping with technologically advanced boxes. **C** Beekeeping with technologically advanced boxes. **D** *Melipona beecheii* guardian bee at the entrance of a beekeeping nest. **E** Beekeeping nest located in Hunucmá, Yucatan, where beekeeping is not only a source of income but also an activity that serves as a form of family coexistence. **F** Beekeeping nest. **G** Group of beekeepers from the municipality of Calkiní, Campeche. **H** Traditional beekeeping nest with exclusive use with bees located in the town of Maní, Yucatan

Beginning and organization of women in meliponiculture

Three main ways of involving women in meliponiculture have been identified; the most important being the organization of women in working groups, generally promoted by Non-Governmental Organizations (NGOs) and Federal Government agencies (such as the National Institute of Peoples). Around 60% of women participation in beekeeping has been successfully achieved as a result of support extended by these agencies. The second approach has been the inheritance granted to a woman in the family (25%); since this family activity can be successfully performed along with agricultural production. The third approach in which women participate in meliponiculture has increased by acquiring hives on their own initiative to form a bee colony. This is an excellent strategy to contribute to the income generation to support their family. However, this is the least common way, since 15% of the women

Fig. 2 (See legend on previous page.)

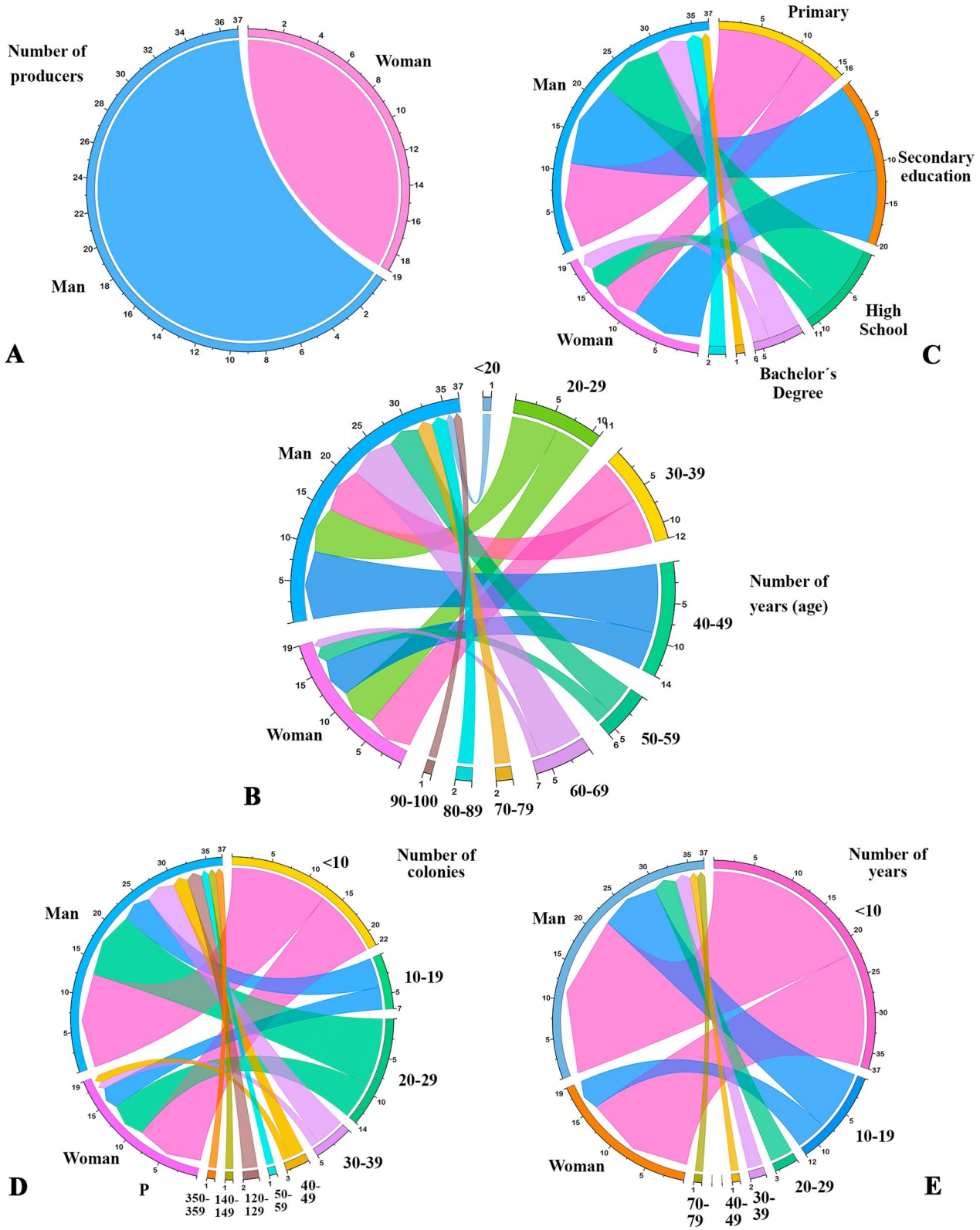

Fig. 3 Chord diagrams of meliponiculture interview results. **A** Number of producers. **B** Age of producers. **C** Years of schooling of the producers. **D** Number of colonies per producer. **E** Years of experience in meliponiculture

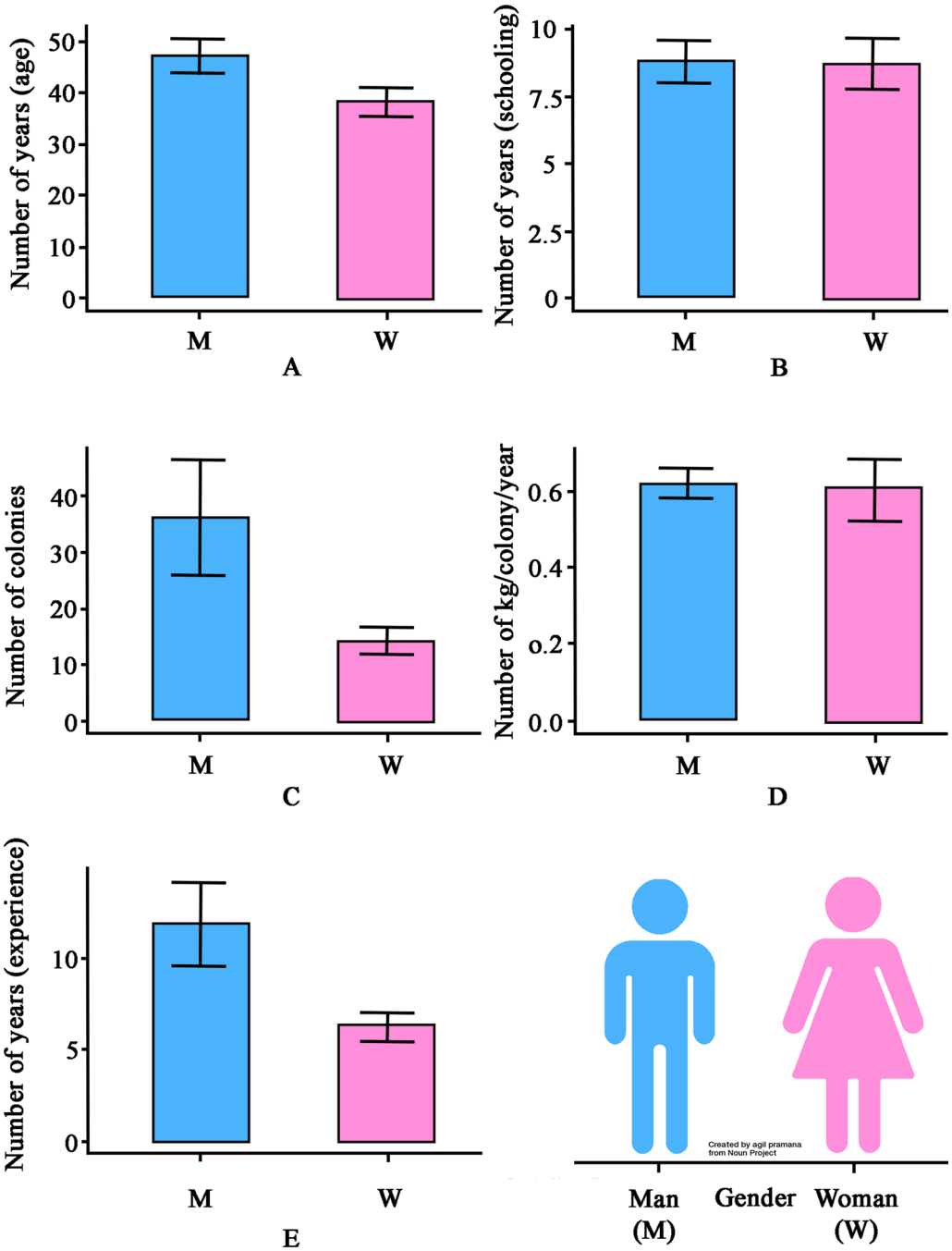

Fig. 4 Meliponiculture by gender. **A** Age of producers. **B** Years of schooling of the producers. **C** Number of colonies per producer. **D** Amount of honey harvested (kg/colony/year). **E** Years of experience in meliponiculture

interviewed have followed it as they have observed this practice in their immediate sociocultural environment.

Discussion

Gender-related beekeeping

The results obtained indicate that meliponiculture is practiced to a greater extent by men (66.1%), compared to women (33.9%), which is consistent with Pat-Fernández et al. [16], who reported that in the Petenes

Biosphere Reserve (PBR), Campeche, the proportion of men who practice meliponiculture is 80%, higher compared to women, with a participation level of 20%. Likewise, González-Acereto et al. [9] based on their study carried out in Yucatán, reported a higher percentage of men (78%) compared to women (22%), who practice beekeeping. This greater proportion of men who practice meliponiculture is also recorded in other states of Mexico, for example, Chan-Mutul et al. [23] reported that 73% are men, 22% women, and 5% is indistinct between men and women for Tabasco. The above data is based on the greater availability of economic resources on the part of men and their experience in productive field activities. On the other hand, women do not have sufficient economic resources and also have their family obligation of child children and their household responsibilities.

According to Redfield and Villa Rojas [24] in the Mayan communities in Mexico, the meliponiculturing men were in charge of the production of hive products that were used in religious practices. The honey used for the ceremonial drink is known as "balché" or "saka" (in Maya) along with wax for the candles for the purpose of religious offerings. It is also used in the Ch'a Cháak ceremony (in Maya); which is a formal divine request for adequate rainfall that is made every year in the YP to ensure the benevolence of the rain deities (Yuum Cháak) in order to have the water necessary for human survival [25]. In this ceremony, "balché" and "saká" were consumed, and only men participated [26]. This has also been observed in beekeeping, a family activity under the control of a male figure, since men generally carry out the activities in the apiary; and the women participate in the production of wax and in the diversification of beehive products.

Although meliponiculture is a male-dominated activity, a gradual increase in the participation of women has been observed. In this study, a higher percentage of women's participation was recorded (33.9%) when compared to other studies in the region, 22% in González-Acereto et al. [9] and 20% in Pat-Fernández et al. [16]. According to Parra-Arguello et al. [27], the practice and participation of women in meliponiculture has increased due to the benefits derived from income generation. Previously, before dedicating themselves to this activity, they only had the income that was provided by their spouses and other activities such as handicrafts (such as embroidery and making typical garments), which were not sufficient to cover family expenses. In this context, Martínez-Vázquez et al. [28] stated that beekeeping can be practiced on the plot of land, since the bee is not dangerous because it lacks a functional sting. In addition, the increase in women's participation in agricultural activities coincides with what has been reported by the Observatorio de Género de América Latina y el Caribe "Gender Observatory of Latin America and the Caribbean" [29], since the activity rate of women in rural areas has increased from 32.4 to 46.4% between the period between 1990 and 2005.

Producer age

The age difference between men (47 years) and women (38 years) observed in the present study was 9 years, which coincides with González-Acereto et al. [9] for Yucatán; where they reported that average age of men and women as 56 and 42 years, respectively, with a difference of 14 years. It is also consistent with Martínez-Vázquez et al. [28] for study on beekeeping activity, in the town of Suc Tuc (Hopelchén, Campeche); where the male beekeepers have been reported on an average about 54 years old and the women around 44 years. However, it differs from what was found by Pat-Fernández et al. [16] for PBR (Calkiní, Campeche); they recorded an average age of 63 years in men and 62 years in women meliponiculturists; this apparent similarity in age may be due to the focused origin of the informants. Recently, Uicab-Campos et al. [30] reported an average age of 44 years for a group of meliponiculturers in Yucatán, with a minimum age of 23 and maximum of 67 years. In contrast with what was observed, Martínez-Vázquez et al. [28] indicated that women enter the beekeeping activity at an older age than men, because they no longer have the responsibility for the care and education of their children.

Years of schooling

In the years of schooling in this study, no differences were observed between men and women. These results are lower than those reported by INEGI [31] for the national level, which, according to the 2020 Census, shows that the average years of schooling in men were 9.84 years and 9.64 in women. In the YP, studies that indicate the schooling of meliponiculturists between men and women are scarce; however, Pat-Fernández et al. [16] reported that an average schooling of 4.1 years for the PBR, without differentiating between men and women. The results indicate that beekeeping is an activity dominated by men with low levels of education. On the other hand, Uicab-Campos et al. [30] interviewed 30 beekeepers in Yucatan and reported that 16.7% had not completed their primary education or had some level of illiteracy. Approximately 16.7% completed their primary studies, 36% had completed secondary school, 23% had completed high school or a technical degree and 6.7% had completed bachelor's level studies. Similarly, Parra-Arguello et al. [27] interviewed 15 female meliponiculturists in the municipality of Maní (Yucatán), reporting that 12% had not completed their studies at the primary level, 37% had

completed primary school, 38% had completed secondary school and 13% had completed with bachelor's degree. The level of education is an important indicator of the level of knowledge that are essential for improving the production process.

Number of colonies

The average number of hives per meliponicultor was higher in men, with differences observed between both groups (Fig. 3). These results differ from those reported by Uicab-Campos et al. [30], who found eight colonies on average for a group of female meliponiculturists in Yucatán. For their part, González-Acereto et al. [9] found on average 11 colonies per meliponiculturist in Yucatán. Both authors did not indicate the difference in the number of colonies owned by men and women.

Honey production

In case of honey production per colony per year, male meliponiculturists obtained 0.620 kg of honey and women 0.600 kg of honey; with no differences observed between both groups. The production volume recorded here is lower than that reported by González-Acereto et al. [9] and Quezada Euán et al. [8], with a honey production per colony per year of more than 2 kg. It is also lower when compared to Pat-Fernández et al. [16] who reported an average of 1.02 kg of honey per colony per year for the PBR. Recently, Magaña-Magaña et al. [32] reported for Yucatán, honey production of 0.568 kg per colony per year for a production system using technologically advanced boxes and, for a mixed system (technologically advanced boxes and hobones), a production of 0.635 kg per colony per year. The results presented here in relation to the previous studies show a reduction in honey production by the *M. beecheii* in the YP; it is important to consider that honey production depends on the floristic diversity surrounding the apiary [33], such as topography, climate, seasonality and density of flowering, location of the apiary, together with uncontrollable factors such as temperature, relative humidity, soil type, wind, sunlight, influence, etc. [34, 35].

The process of honey production and extraction is carried out entirely by women in beekeeping, as it does not require excessive use of physical strength, as occurs in beekeeping with the handling of supers in colonies made up of three bodies (honey supers), the movement for loading and unloading of drums with honey (about 300 kg) or other activities of the beekeeping production process. These differences in the management of the bee colony, coupled with the fact that it is traditionally located in the home's yard, allow women to participate in this primary activity more successfully.

Experience

In terms of years of experience in meliponiculture, men had a greater average of experience compared to women, with differences observed between both groups (Fig. 3). In this regard, Parra-Arguello et al. [36] reported for a group of female peanut meliponiculturists in Yucatan, that 37.5% of the women had less than 5 years of experience in the activity; and 62.5% had 5–10 years of experience. While Pat-Fernández et al. [16] found that PBR meliponiculturists had an average of 30 years of experience; but they did not indicate differences in experience between men and women. However, Luna et al. [37] reported that the average experience of beekeepers was 22 years and that those with the most experience are in the age range of 36–45 years. Although this is not necessarily an indicator of the degree of specialization and professionalization for the beekeeping chain; it does show that interest in the practice of beekeeping remains current.

According to Martínez-Vázquez et al. [28] since women are not the owners of the land; they must negotiate to obtain a rental or loan for some sites. This situation undermines their ability to participate in agricultural activities compared to men. Furthermore, women face mobility and time difficulties to tend to their beehives, and their cultural status as "housewife" instead of "producer" does not count on the collaboration of sons or daughters for the regular beekeeping activities. Therefore, they have to resort to a strategy of mutual support. For her part, Tiburcio-Cayetano [38] indicated that women get up earlier than men to carry out all the necessary domestic activities and organize the children to go to school. In fact, women carry out more activities during the day than men, without receiving any payment; and in many cases, their service is little valued and recognized by their family under the stigma that it is normal or an obligation of being a woman. In this regard, Uicab-Campos et al. [30] suggested that the involvement of the family is also key to the permanence of women within the production units. In most cases, the presence of the family nucleus is important from the support in the construction of the meliponary (in the past), the maintenance (in the present) and the training of children and family members in the system of production practice.

Beginning and organization of women in meliponiculture

Most of the meliponiculturists in the Yucatán area are predominantly concentrated in the municipality of Maní, with the Flor de Mayo and Lol-Ha (https://www.faceb

ook.com/p/Meliponario-Lool-h%C3%A0-100066574239412/) groups standing out; while in Campeche, the Miel de la Familia Pat group (https://www.facebook.com/mielpat/?locale=es_LA) is located in the municipality of Calkiní. It is important to emphasize that, at present, different NGOs have provided support for the acquisition and construction of bee colonies. The first type of support is carried out through the system of sharecropping, which consists of granting a certain number of colonies, after a certain time, the beneficiaries must return the same number of units received. The second type of support is carried out through the granting of a non-refundable economic resource. These organizations have provided necessary beekeeping training courses to groups made up of women, including the management of SB, safety in the process of extraction and packaging of honey, and preparation of colony products and marketing strategies [32].

Conclusions

Meliponiculture is an activity carried out mainly by men compared to women. However, despite the fact that the average age, the number of years of experience in meliponiculture and the number of colonies of male producers are greater compared to that of the female producers; but, no significant differences were found in honey production per colony between the groups. It was found that women mostly joined meliponiculture profession either through invitation from other women work groups driven by Non-Governmental Organizations or inheritance; or due to their own personal interest and/or initiative. The study population of meliponiculturists (men and women) reported here is lower when compared to other local/regional studies on beekeeping in the YP; considering the fact that many of the meliponiculturists are also beekeepers. This is limited by the lack of a Government census of meliponiculturists at the state and national level, coupled with the lower number of traditional and technical producers who self-identify as being part of this activity. Hence, the sample size can be an important factor for effective research and making inferences; extrapolating or generalizing conclusions in various productive aspects when comparing men and women.

Abbreviations

MF Melliferous flora
PBR Petenes Biosphere Reserve
SB Stingless bees
YP Yucatán Peninsula

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Author contributions

JFM-P, MAM-M and WC-I conceived the research and gathered the data. JFM-P, MAM-M, WC-I, GEM-A, ACS-V and SKB analyzed the data and drafted the manuscript. JFM-P, MAM-M, WC-I, GEM-A, ACS-V and SKB edited and gave input to the final version of the manuscript. All authors reviewed the manuscript.

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Ethics approval and consent to participate

Not applicable.

Consent for publication

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Competing interests

The authors declare no competing interests.

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References

1. Michener CD. The bees of the world. Baltimore: The Johns Hopkins University Press; 2007.
2. Kearns CA, Inouye DW, Waser N. Endangered mutualism: the conservation of plant-pollinator interactions. Annu Rev Ecol Syst. 1998;29:83–106. https://doi.org/10.1146/annurev.ecolsys.29.1.83.
3. Crane E. The past and present status of beekeeping with stingless bees. Bee World. 1992;73(1):29–42. https://doi.org/10.1080/0005772X.1992.11099110.
4. Echazarreta CM, Quezada-Euán JJG, Medina LM, Pasteur KL. Beekeeping in the Yucatan peninsula: development and current status. Bee World. 1997;78(3):115–27. https://doi.org/10.1080/0005772X.1997.11099346.
5. Quezada-Euán JJG. Taxonomy and diversity of the stingless bees. In: Stingless Bees of Mexico, The Biology, Management and Conservation of an Ancient Heritage. Cham: Springer International Publishing; 2018. pp. 1–40. https://doi.org/10.1007/978-3-319-77785-6_1
6. Pereira-Nieto A. Abejas ancestrales, una mirada a la apicultura en Yucatán. Revista de la Universidad Autónoma de Yucatán. 2005;5:86–91.
7. Martínez-Puc JF, Cetzal-Ix W, Magaña-Magaña MA, López-Castilla HM, Noguera-Savelli E. Ecological and socioeconomic aspects of meliponiculture in the Yucatan Peninsula, Mexico. Agro Productividad. 2022;15(2):57–65. https://doi.org/10.32854/agrop.v15i2.2108.
8. Quezada-Euán JJG, de May-Itzá WJ, González-Acereto JA. Meliponiculture in México: problems and perspective for development. Bee World. 2001;82:160–7. https://doi.org/10.1080/0005772X.2001.11099523.
9. González-Acereto JA, Quezada-Euán JJG, Medina-Medina LA. New perspectives for stingless beekeeping in the Yucatan: results of an integral program to rescue and promote the activity. J Apic Res. 2006;45(4):234–9. https://doi.org/10.1080/00218839.2006.11101356.
10. Ayala R. Revisión de las abejas sin aguijón de México (Hymenoptera: Apidae: Meliponini). Folia Entomol Mex. 1999;106:1–123.
11. Ayala R, González VH, Engel MS. Mexican stingless bees (Hymenoptera: Apidae): diversity, distribution, and indigenous knowledge. In: Vit P, Pedro S, Roubik D, editors. Pot-Honey. New York: Springer; 2013. p. 135–152. https://doi.org/10.1007/978-1-4614-4960-7_9
12. González-Acereto JA, De Araujo Freitas JC. Manual de meliponicultura mexicana. Mérida: Impresos Gramma; 2005.

13. Morales-Damián MA. La meliponicultura Maya en el Códice Trocortesiano. Arqueol Mex. 2023;183:52–7.
14. Quezada-Euán JJG. 2018b. The past, present, and future of meliponiculture in Mexico. In: Stingless Bees of Mexico, The Biology, Management and Conservation of an Ancient Heritage. Cham: Springer International Publishing; 2018. pp. 243–269. https://doi.org/10.1007/978-3-319-77785-6_9
15. Villanueva-Gutiérrez R, Roubik D, Colli-Ucán W. Extinction of *Melipona beecheii* and traditional beekeeping in the Yucatán península. Bee World. 2005;86(2):35–41. https://doi.org/10.1080/0005772X.2005.11099651.
16. Pat-Fernández L, Anguebes-Franceschi F, Pat-Fernández JM, Hernández-Bahena P, Ramos-Reyes R. Condición y perspectivas de la meliponicultura en comunidades mayas de la reserva de la biósfera Los Petenes, Campeche, México. Estudios de cultura maya. 2018;52:227–54. https://doi.org/10.19130/iifl.ecm.2018.52.939.
17. Bautista F, Palacio G. Península de Yucatán. In: Geografía de suelos de México. México, Universidad Nacional Autónoma de México; 2012. pp. 355–406
18. Vidal-Zepeda R. 2005. Las regiones climáticas de México. 1.2.2. Temas selectos de Geografía de México. Mexico: Instituto de Geografía, Universidad Nacional Autónoma de México.
19. García E. Modificaciones al sistema de clasificación climática de Koopen. Mexico: Instituto de Geografía-Universidad Nacional Autónoma de México; 2005.
20. Orellana R, Balam M, Bañuelos I, García E, González-Iturbe JA, Herrera F, Vidal J. Evaluación climática. In: García A, Córdoba J, editors. Atlas de procesos territoriales de Yucatán. Mérida: Universidad Autónoma de Yucatán; 1999. p. 163–82.
21. INEGI. Instituto Nacional de Estadística Geografía e Informática. https://cuentame.inegi.org.mx/monografias/default.aspx?tema=me. 2020
22. van Meter KM. Methodological and design issues: techniques for assessing the representatives of snowball samples. NIDA Res Monogr. 1990;98:31–43.
23. Chan MGA, Aldasoro MEM, Sotelo SLE, Vera CG. Retomando saberes contemporáneos. Un análisis del panorama actual de la meliponicultura en Tabasco. Estudios de Cultura Maya. 2018;53:289–325. https://doi.org/10.19130/iifl.ecm.2019.53.947.
24. Redfield R, Villa-Rojas A. Chan Kom, a Maya Village. Chicago: University of Chicago Press; 1962.
25. Ruz MH. Cha'a Cháak. Plegaria por la lluvia en el Mayab contemporáneo. Arqueología Mexicana. 1992;96:35–9.
26. Meehan P. Putting out the fire: Tracing continuity and change in the maya tup k'ak' ceremony. Mexicon. 2013;35(2):37–42.
27. Parra-Arguello FY, Martin-Calderón EV, Navarrete-Cante RA. La meliponicultura una práctica tradicional para el desarrollo regional de la comunidad de Maní, Yucatán. In: Dinámica económica y procesos de innovación en el desarrollo regional. Mexico: Universidad Nacional Autónoma de México y Asociación Mexicana de Ciencias para el Desarrollo Regional A.C; 2018. pp. 1–19.
28. Martínez-Vásquez E, Vázquez García V, Porter-Bolland L, Valtierra Pacheco E, Molina Rosales D, Manzo-Ramos F. Transformaciones productivas e incursión femenina en la apicultura comercial en San Francisco Suc Tuc, Hopelchén, Campeche, México. In: Agroecología en femenino: Reflexiones a partir de nuestras experiencias. La Paz: SOCLA/CLACSO; 2018. pp. 93–106.
29. Observatorio de género de América Latina y el Caribe. Las mujeres rurales trabajan más y ganan menos. https://oig.cepal.org/sites/default/files/nota_para_la_igualdad_3_mujer_rural_version_final_esp.pdf. 2009
30. Uicab-Campos EM, Monforte-Méndez GA, Sarmiento-Franco JF. Mujeres meliponicultoras: situación, perspectivas y oportunidades de una red de productoras. Rev Cent Grad Investig, Inst Tecnol Mérida. 2022;37(95):97–105.
31. INEGI. Instituto Nacional de Estadística Geografía e Informática. https://www.inegi.org.mx/app/tabulados/interactivos/?pxq=Educacion_Educacion_05_2f6d2a08-babc-442f-b4e0-25f7d324dfe0. 2020.
32. Magaña-Magaña MA, Ek Ek JF, Leyva-Morales CE. Estrategias de comercialización de la miel de abeja melipona y sus derivados en el Estado de Yucatán. Revista de Geografía Agrícola. 2024;72:1–26. https://doi.org/10.5154/r.rga.2022.72.11.
33. Ríos-Oviedo AJ, Tucuch-Tun R, Cetzal-Ix W, Martínez-Puc JF, Basu SK. Flora associated with stingless bees (Apidae: Meliponini) in the Yucatan Peninsula, Mexico. J Apic Res. 2024. https://doi.org/10.1080/00218839.2024.2309766.
34. Roque PJG, Luna CG, Fernández LG, Tiburcio AI, Hernández GTA. Enfoque de estudio territorial apoyado de sistemas de información geográfica para definir territorios apícolas en Misantla. Veracruz: Congreso Interdiciplinario de Ingenierias; 2016. pp. 22–26.
35. Zúñiga-Díaz D, Cetzal-Ix W, López-Castilla HMJ, Noguera-Savelli E, Tamayo-Cen I, Martínez-Puc JF, Basu SK. A review of the melliferous flora of Yucatan peninsula, Mexico, on the basis for the honey production cycle. J Ethnobiol. 2024. https://doi.org/10.1186/s13002-024-00681-0.
36. Parra-Argüello FY, Navarrete-Cante RA, Leal-Osorio AJ, Cool-Chi FJ. Retos y desafíos de las mujeres en la meliponicultura de Maní Yucatán. Rev Cent Grad Investig Inst Tecnol Mérida. 2022;37(94):49–57.
37. Luna G, Peña J, Echeverría E, Martínez-Mendoza E, Zorrila U, Fernández-Lambert G. Caracterización apícola en la región sierra centro-norte de Veracruz: contexto y trashumancia. Rev Mexicana Cienc Agric. 2019;10(6):1339–51. https://doi.org/10.29312/remexca.v10i6.1689.
38. Tiburcio-Cayetano H. Mujeres indígenas y desarrollo. El estado del desarrollo económico y social de los pueblos indígenas de guerrero. Mexico: Universidad Nacional Autónoma de México; 2009.

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