https://doi.org/10.22319/rmcp.v15i2.6533

Article

Socio-ecological knowledge of the beekeeping activity in the Costa Chica region of Guerrero, Mexico

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Abstract:

Beekeepers need to identify melliferous flora (MF) in those areas where apiaries are established because bees (*Apis mellifera*) depend on these floral resources for food and honey production. The objective of the study was to analyze the socio-ecological aspects of beekeeping, considering the knowledge of the melliferous flora by the producers in the Costa Chica region of Guerrero (GCC), Mexico. A non-probabilistic convenience sampling was

carried out. The final sample consisted of 75 surveyed beekeepers. Descriptive statistics and cross-tabulations were used for data analysis; botanical collections were made to identify the species cited. Beekeeping is traditional (5-50 hives), the average age was 48 yr, with 10 years of schooling and 12 yr of experience. Producers mentioned 33 MF species (26 native and seven cultivated) belonging to 16 botanical families. In addition, they classified them by their use as nectapolliniferous (14 species), polliniferous (10), and nectariferous (9). It was recorded that native species flower during the winter (herbaceous) and spring (trees), coinciding with the honey harvest season, while cultivated species flower during the rainy season (summer) and are an important resource during the post-harvest season. GCC beekeepers registered low knowledge of the vegetation surrounding their apiaries, but have a high knowledge of the main MF species, finding that the older they are, the more knowledge they have about the MF species that bees use in their food (nectar or pollen).

Keywords: Beekeeper, Floral resources, Traditional knowledge, Vegetation.

Received: 18/07/2023

Accepted: 09/12/2023

Introduction

Beekeeping is an activity that is directly linked to the sustainable management of natural resources, as beekeepers depend on areas with native or introduced flora to install their hives and thus provide bees with food sources (nectar or pollen) for the production of honey[1,2]. This activity is compatible with biodiversity conservation and with the surrounding traditional crops, as they contribute to pollination and food sovereignty[3]. Beekeeping requires little investment and provides an important income for the economic stability of the producers in the rural communities where it is practiced[4].

In Mexico, beekeeping is a livestock activity that influences socioeconomic and ecological aspects because it generates a significant foreign exchange[5]. The country ranks ninth in the world in terms of production volume and eleventh in terms of number of beehives; at the continental level, it ranks third in both areas[6]. Despite being among the main honey producers in the world, Mexico has shown a downward trend in honey volume and hive inventories for the last two decades[7]. This decline in production is due to multiple factors, such as pests and diseases (varroasis, foulbrood, small hive beetle), technical-social issues (lack of training and organization, middlemen, and competition in the international market),

and ecological issues (variations in phenology and floral synchronization)[8]. These obstacles have caused instability in the Mexican beekeeping sector, mainly in the beekeeping regions of the country (North, Central Highlands, Pacific, Gulf, and Yucatan Peninsula)[5].

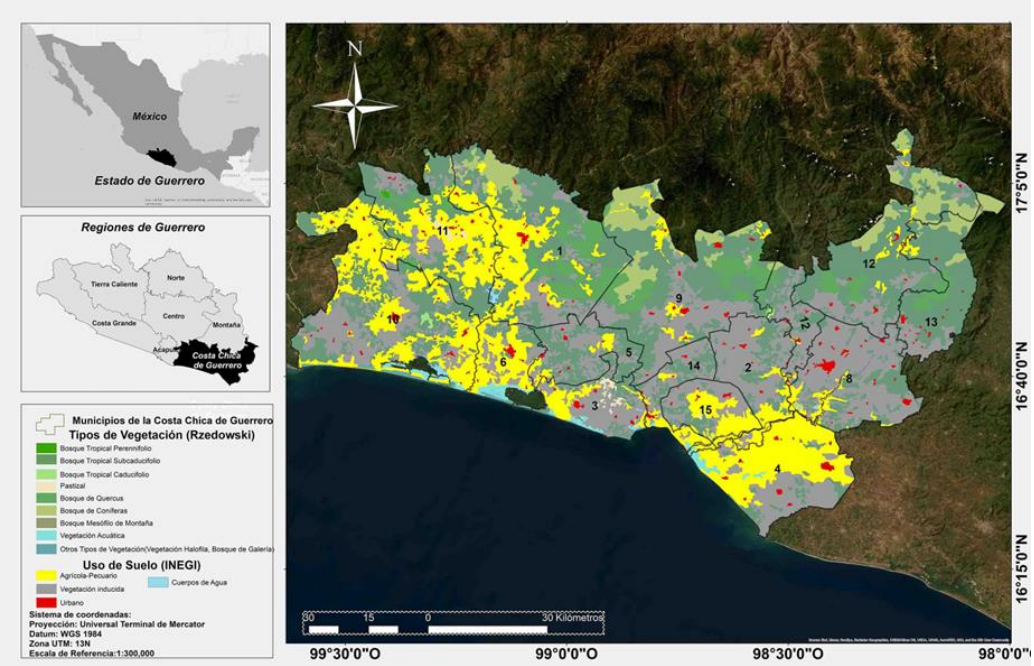
Beekeeping in Guerrero is favored by its geographic location and its diversity of climates and natural resources. The state is located in two beekeeping regions (Central Highlands and Pacific), which results in a high honey-production potential for the seven regions of the state (Acapulco, Costa Chica, Costa Grande, Centro, La Montaña, Norte, and Tierra Caliente)[10]. In 2021, Guerrero ranked as the tenth largest honey producer in the country, with 2,081 t; there has been a decline in this state's production in recent years[7] due to deforestation, land use change, and insecurity, which limits the development of this activity[10]. Costa Chica in Guerrero is the main honey-producing region at the state level, as it has a more extensive coverage of vegetation in low and medium tropical forests, where the supply of floral resources is more constant than in other regions; therefore, it is still necessary to expand the knowledge related to the melliferous flora (MF). This information can be useful to learn about the most important plant species for beekeeping, as well as to maintain established colonies and increase their development[11].

In order to assess the experience and knowledge generated by beekeepers in a specific area in regard to the vegetation and the diversity of MF species, with their flowering periods and their food utility (pollen and nectar) for bees, it is necessary to have the observations of the producers, information that is collected and validated through interviews, questionnaires or field studies, and which allows to know the flora of interest for honey production[12]. For this reason, the objective of the study was to analyze the socio-ecological aspects of the beekeeping activity, based on the knowledge of the MF of the producers of the Costa Chica de Guerrero (GCC), Mexico, in order to have updated information on the panorama of the beekeeping activity in this region.

Material and methods

The GCC region is made up of 15 municipalities: Ayutla de los Libres, Azoyú, Copala, Cuautepec, Cuajinicuilapa, Florencio Villarreal, Igualapa, Juchitán, Marquelia, Ometepec, San Luis Acatlán, San Marcos, Tecoanapa, Tlacoachistlahuaca, and Xochistlahuaca; the GCC is bordered to the north by the La Montaña and Central regions; to the south, by the Pacific Ocean; to the east, by the state of Oaxaca (Costa Chica region of Oaxaca), and to the west, by the Acapulco region[13] (Figure 1).

Figure 1: Municipalities where interviews with beekeepers were conducted in the Costa Chica region of Guerrero, Mexico



1= Ayutla de los Libres, 2= Azoyú, 3= Copala, 4= Cuajinicuilapa, 5= Cuautepec, 6= Florencio Villarreal, 7= Igualapa, 8= Juchitán, 9= Marquelia, 10= Ometepec, 11= San Luis Acatlán, 12= San Marcos, 13= Tecoanapa, 14= Tlacoachistlahuaca, 15= Xochistlahuaca.

The GCC has a predominantly warm-sub-humid climate, with temperatures ranging between 20 and 29 °C and rainfall of 1,100 to 2,200 mm from June to October. The topography varies from hilly terrain, in the municipalities of San Luis Acatlán and Ometepec, to flat or semi-flat, in the municipality of Marquelia. The vegetation is composed of a third of low and medium deciduous forests, and pine and oak forests in the areas near the Montain region[13].

A non-probabilistic convenience sampling[14] was carried out, where individuals were selected for their willingness to provide detailed information on beekeepers' knowledge and perception of MF in the GCC. A questionnaire was designed to collect the information, and a survey was administered during meetings of beekeepers' cooperatives and associations. The final sample consisted of 75 beekeepers surveyed during the period January to December 2021.

The questionnaire consisted of two sections: I) General data on the beekeeper (age, schooling, time in this activity, and main occupation) and on the beekeeping unit (land tenure, transhumance). II) Ecological knowledge of the flora of the region (acquisition of knowledge of the MF, reforestation, types of vegetation in the area surrounding the apiaries, main species close to their apiary and the contribution of nectar and pollen of the MF of the region); in

order to determine the beekeepers' knowledge of the flora, they were asked, of the total (100 %) of the plants in their region, what percentage they consider that they know.

For the purpose of identifying the MF cited by beekeepers, 10 random walks were conducted in low and medium tropical rainforests in the study area, guided by a key beekeeper. Species identification was based on a joint analysis between researchers and beekeepers and documentary research available for the area[9,15,16]. Species that could not be identified in the field were collected according to the described technique[17] and were sent to the María Agustina Batalla Herbarium at the Faculty of Sciences (FCME) of the National Autonomous University of Mexico (Universidad Nacional Autónoma de México, UNAM), for identification.

Data analysis

Descriptive statistics were used for data analysis, and the information was processed using the SPSS statistical software, version 19. Frequency analysis and cross-table analysis[18] were performed to compare the means of the indicators between the two sections of the survey and to determine whether or not there is a relationship between the social variables and the ecological variables. The Chi-square test was used to detect the association of the variable age and knowledge of vegetation, experience, and land tenure with reforestation. Beekeepers were classified into three categories, according to the number of hives they own: 1) traditional, from 10 to 50 hives, 2) semi-technified, from 51 to 200 hives, and 3) technified, > 200 hives.

Results

General characteristics of beekeepers

The average age of the beekeepers was 48 yr, and their average experience in beekeeping was 12 yr (Table 1); their average schooling was 10 yr (Table 2). According to the classification, traditional beekeeping engaged the largest number of beekeepers (58.7 %); semi-technified beekeeping employed 45.3 %, and technified beekeeping, a mere 4 %), while the latter have more experience (17 yr) and age (59 yr).

Table 1: Main socio-demographic characteristics of beekeepers

Type of beekeeper	Experience (years)	Age (years)	Education level			
			Basic	High-school	Higher	Total
Traditional	9 ± 1.02	43 ± 1.1	18	13	7	38
Semitechnified	15 ± 1.44	53 ± 1.31	20	9	5	34
Technified	17 ± 2.01	59 ± 6.1	2	0	1	3
Average	12	48	-	-	-	-
Number of beekeepers	-	-	40	22	13	75
Total %			53.4	29.3	17.3	100

Fifty-six percent of the beekeepers said that their apiaries are located on land that they legally own, and the remaining 44 % indicated that their apiaries are located on borrowed or rented land (Table 2). Technified beekeepers (4 %) have more than 200 hives and need to rent land to establish their apiaries; therefore, most of them practice transhumant beekeeping, which is not very deeply rooted in this region: only 12 % of the beekeepers practice it, generally moving to areas in the "La Montaña" region.

Table 2: Economic activities of beekeepers and apiary ownership

Type of beekeeper	Land tenure		Main activity		
	Rented	Private	Beekeeper	Farmer	Salaried employee
Traditional	19	19	10	11	17
Semitechnified	13	21	6	20	8
Technified	1	2	0	2	1
Number of beekeepers	33	42	16	33	26
Total %	44.0	56.0	21.3	44.0	34.7

With respect to the main activity of the beekeepers, it was observed that 21.3 % are exclusively dedicated to beekeeping, which means that beekeeping is a complementary activity to other agricultural and livestock farming activities. However, technified beekeepers were considered entrepreneurs, as they add value to beekeeping and diversify their economic activities.

Melliferous flora

Beekeepers identified 31 MF species, composed of 16 botanical families, of which Fabaceae had the highest number of species[14], followed by Boraginaceae and Malpighiaceae, with two, respectively, while the other 13 families had only one species; two species could not be identified (Table 3).

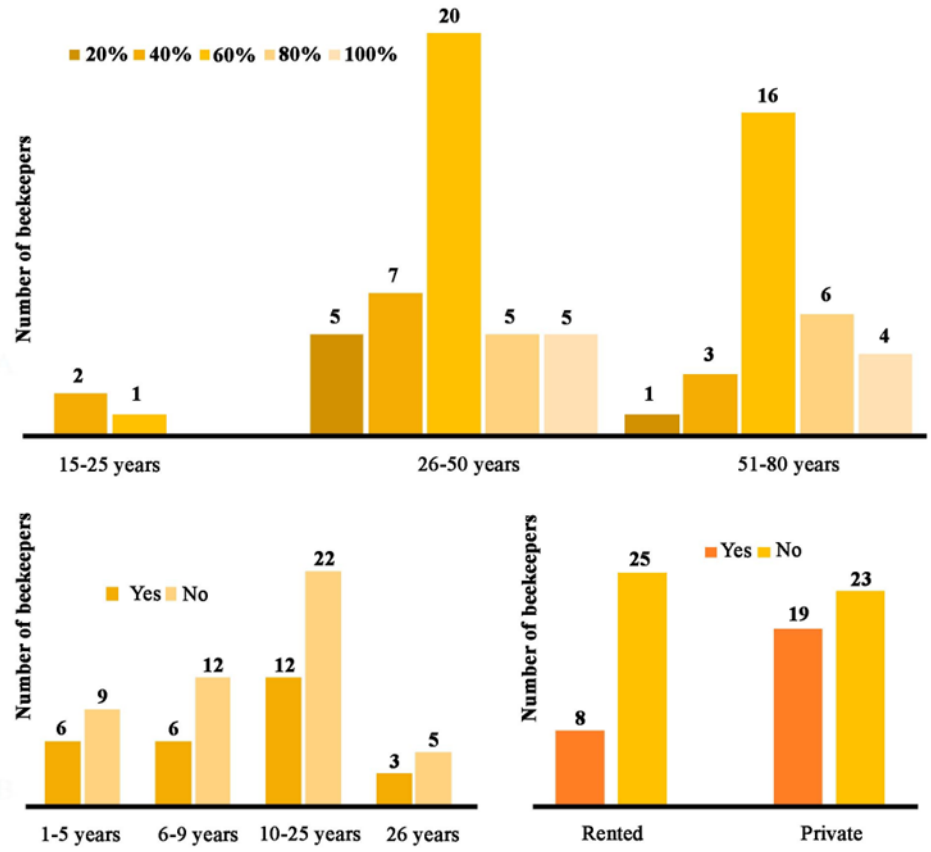
According to the knowledge of beekeepers, 14 species are considered nectariferous, 11 produce nectar and pollen, and 8, pollen; of all these species, 26 are wild and 6 are cultivated, the most prominent being *Mangifera indica* L., *Citrus* × *aurantiaca* (L.) Swingle and *Cocos nucifera* L., as they are widely cultivated in the region (Figure 2). Although sesame (*Sesamum indicum* L) is another important crop in the region, only two beekeepers mentioned it.

Figure 2: Vegetation and melliferous flora

A) Secondary vegetation, Vista Hermosa, Ometepec. B) *Ceiba pentandra* (L.) Gaertn. C) *Enterolobium cyclocarpum* (Jacq.) Griseb. D) *Pithecellobium unguis-cati* (L.) Benth. E) *Bauhinia pauletia* Pers. F) Vista panorámica, Selva mediana subcaducifolia. G) *Senna mollissima* (Humb. & Bonpl. ex Willd.) H.S. Irwin & Barneby.

In order to know the perception of the MF of the region, cross tabulations were generated with age and knowledge of the vegetation, finding that 24 % of the beekeepers identify or know 40 % of the vegetation, and 12 % of the beekeepers know between 80 % and 100 % of the vegetation (Figure 3). Knowledge of the flora increases with age; beekeepers in the 26-50 age group know 60 % of the region's flora, while the 15-25 age group knows only 30 % of the flora.

Figure 3: Cross-tablulation. **A.** Between age and knowledge of the flora of the region. **B.** Experience and reforestation. **C.** Land tenure and reforestation



* The Chi-square test showed that there was no correlation (P>0.05) between these three cross-tabulations

As for the beekeepers' years of experience and practice on reforestation, 40 % were shown to have 1 to 5 yr of experience, while only 33 % had between 6 and 9 yr of experience in reforesting. Likewise, it was observed that 45 % of the beekeepers with legal ownership of the land reforested, and 76 % who rented land did not do so.

Discussion

According to the historical national average number of hives per beekeeper[19], beekeeping in Mexico can be classified as traditional (1-50), semi-technified (51-200), or technified (more than 201).

The average age of beekeepers in the region was 48 yr, with an interval of 23 to 75 yr, similar to that recorded in other entities such as Yucatán[20]; the central-southern region of Jalisco[21], with 49 yr, and Campeche[22], with 57 yr. Consequently, the average age of beekeepers in the study region suggests that a generational changeover is occurring in the beekeeping activity; this is an advantage because older and more experienced beekeepers are less willing to change their traditional forms of production and to learn new techniques, compared to younger beekeepers[23].

The experience of beekeepers at the national level varies between 21 and 23 yr; these data are similar to those reported in the State of Campeche[20], where a value of 21 yr in the activity was reported; an average of 22 yr of experience was found in the Sierra Centro-Norte region of Veracruz[24], while a value identical to that of this study, of 23 yr of experience, was found in the south-central region of Jalisco[23]. The similarity of these results indicates that, at the national level, beekeepers have acquired knowledge, skills, and competencies for the practice of this activity.

The average schooling of the surveyed beekeepers was 10 yr, which is equivalent to the first year of high school, similarly to the average schooling of beekeepers in Jalisco[21], of 9 yr, but higher than the average schooling (5 yr) registered in Yucatán[25]. The low level of education is one of the main factors why field records or logs are not kept, a fact that limits the possibility of managing information, maintaining traditional practices, and applying new technologies[21].

Land ownership conditions are very different in the study region, since 44 % of the beekeepers rent the land where the apiary is established —compared, for example, to the state of Yucatán[22], where 74 % are privately owned and only 26 % are on rented land. This reflects regional and intergenerational contrasts in social land ownership and is related to the changes brought about by the 1992 agrarian reform, which encouraged the fragmentation of communal lands and led to disruptions among deeply rooted indigenous and peasant cultures[26]. This phenomenon of forest fragmentation forces beekeepers to move their hives to places with preserved vegetation in search of suitable species.

In this regard, transhumant beekeeping was carried out by only 12 % of beekeepers in the GCC. These results are similar to those recorded in the Central and Northern Region of Veracruz, where beekeepers with more than 150 hives (20 %) are the ones who practice transhumance[24]. On the other hand, the inadequate location of the apiary causes a lower honey yield per hive; therefore, transhumance implies maximizing the productive efficiency in function of the MF density, reducing the bee's foraging route and counteracting the investment of economic resources[27].

Beekeeping in the GCC is a complementary activity for traditional and semi-technified beekeepers. In the state of Yucatán, beekeeping is the main economic activity for 19 % of beekeepers; the percentage rises to 25 % if the apiary has between 50 and 100 hives[25]. The greater the number of apiaries, the more beekeepers perceive beekeeping as their main economic activity.

Community participation is a way to obtain reliable and useful results to solve issues and improve situations or the collective knowledge of their region[28]. This knowledge of the region's flora, especially that which has melliferous potential, serves as a tool for the beekeepers themselves, allowing them to better manage their apiaries, decide when to supplement the bees' nutrition or change their apiaries to places with adequate MF for the bees to forage for pollen and nectar, which contributes to the production of quality honey[1].

Mention by the surveyed beekeepers of certain species that are not important for the beekeeping activity (*Tamarindus indica* L., *Ehretia tinifolia* L., and *Persea americana* Mill.) confirms that beekeepers' perceptions are biased in favor of culturally influenced landscape species, both cultivated and wild[29]. The 72 % of beekeepers are familiar with 80 % of the vegetation in their surroundings; such familiarity with these landscapes makes it difficult to identify other types of species present in the vegetation of the forests.

Beekeepers in the municipality of Hopelchén, Campeche, recorded 50 species, three subspecies, and three varieties of MF, distributed in 26 botanical families[12] —a higher number than that found in this study, where 33 species of MF were recorded.

In regions with a strong change in land use and where agricultural landscapes predominate, the remnants of natural vegetation are mainly dominated by tree species that become important for beekeeping[30]. Similar values to those of this study were registered in a tropical dry forest in Ecuador[31], where 28 MF species were identified by the beekeepers. However, these questions addressed only those species they consider important for the bees, and not all vegetation in general. Similarly, another study carried out in Nicaragua[32] identified 89 species, but without specifying whether or not all of them correspond to MF.

Also, of the 33 species recorded in this study, seven are cultivated; however, the flowering period for bees is concentrated from November to May, while during the rest of the year, according to certain authors, nectar and pollen resources are harvested from monoculture plots[33]. In the study region, plantations such as sesame, citrus, hibiscus, coconut, mango, etc., play an important role as floral resources for beekeeping, due to their established surface area and to flowering periods that are not simultaneous with those of the wild vegetation. A noteworthy fact is that the beekeepers did not mention any introduced grass species, despite the fact that these are abundant in the region's tropical dry forests. This is because beekeepers associate grasslands with pollen production and do not consider them as an important floral resource for bees. However, in other parts of the Caribbean, such as the Dominican Republic[29], beekeepers have identified such invasive species as *Leucaena leucocephala* (Lam.) de Wit, *Syzygium jambos* (L.) Alston and *Prosopis juliflora* (Sw.) DC. as plants of beekeeping interest.

Finally, when asked about the level of knowledge of the flora around the apiaries, only 12 % of the beekeepers considered that they knew between 80 % and 100 % of the MF, a lower value than that registered in Campeche[12], where they found that 60 % are familiar with the vegetation of their apiaries as a result of the transmission of knowledge through generations.

Conclusions and implications

GCC beekeepers find it easier to adopt new technologies and diversify hive products due to their average age, which is lower than the national average. Transhumant beekeeping is carried out by technified beekeepers. Younger people have little knowledge of the environment and MF, but identify specific flora that provide nectar or pollen for bees, acknowledge that agricultural crops are important for bee activity, and recognize the importance of the environment for bee activity. On the other hand, the tenure of the land where the apiaries are located influences their reforestation, and because a high percentage of the land is rented, this practice is not carried out. Beekeepers' perception of the resources utilized by bees is an important source of knowledge about the flora of beekeeping interest, which increases with age and is an invaluable source of information.

Acknowledgments

The authors are grateful to the National Council for Science, Humanities, and Technology (Consejo Nacional de Humanidades, Ciencias y Tecnologías) for the financing of project 319942 Plants of "minor importance" for the survival of bees and the development of

beekeeping in the Costa Chica region of Guerrero), within the framework of the "2022 Call for Proposals on Basic Science or Frontier Science, Modality: Paradigms and Controversies of Science".

Literature cited:

1. Román L, Palma JM. Árboles y arbustos tropicales nativos productores de néctar y polen en el estado de Colima, México. AIA 2007;11:3–24.

2. Martínez-Virgen M, Ulloa-Castañeda R, Salgado-Moreno S, Carmona-Gasca C, Orozco-Benítez G, Martínez-González S. Estudio geográfico e identificación de plantas con potencial apícola en Nayarit, México. Abanico Agroforestal 2020;2:1–9.

3. CLAC. Comercio Justo en América Latina y el Caribe. La apicultura en el contexto de cambio climático. Manual de buenas prácticas en la apicultura en el contexto del cambio climático. 2016.

4. Dolores-Mijangos G, Santiago-Cruz M, Arana-Coronado J, Utrera-Quintana F. Estudio del impacto de la actividad apícola en el Istmo de Tehuantepec, Oaxaca, México. Agricultura, Sociedad y Desarrollo 2017;14:187–203.

5. Magaña-Magaña M, Sanginés-García J, Lara-Lara P, Salazar-Barrientos L, Leyva-Morales C. Competitividad y participación de la miel mexicana en el mercado mundial. Rev Mex Cienc Pecu 2017;8(1):43–52.

6. FAOSTAT. Base de datos estadísticos corporativos de la Organización para la Agricultura y la Alimentación. 2022.

7.SIAP. Servicio de Información Agroalimentaria y Pesquera. Cierre de la producción pecuaria por Estado. 2022.

8. Guzmán-Novoa E. Impacto de la africanización de las abejas en México. Imagen Veterinaria 2004;4:20–25.

9. Villegas-Durán G, Bolaños-Medina A, Miranda-Sánchez JA, González-Quintero U. Flora nectarífera y polinífera en el estado de Guerrero. 1ª ed. SAGAR. 2002:129.

10. Delgado DL, Eglée M, Galindo-Cardona A, Giray T, Restrepo C. Forecasting the influence of climate change on agroecosystem services: Potential impacts on honey yields in a small-island developing state. Psyche J Entomol 2012;2012:1-10.

11. Méndez MV, Sánchez AC, Flores FF, Lupo LC. Recurso polinífero utilizado por *Apis mellifera* (Hymenoptera: Apidae) en un área de bosque subtropical del noroeste de Argentina. Rev Biol Trop 2018;66:1182–1196.

12. Coh-Martínez ME, Cetzal-Ix W, Martínez-Puc JF, Basu SK, Noguera-Savelli E, Cuevas M. Perceptions of the local beekeepers on the diversity and flowering phenology of the melliferous flora in the community of Xmabén, Hopelchén, Campeche, Mexico. J Ethnobiol Ethnomed 2019;15:16.

13. INEGI. Instituto Nacional de Estadística y Geografía. Aspectos geográficos. Guerrero. 2012. https://en.www.inegi.org.mx/contenidos/app/areasgeograficas/resumen/resumen_12.pdf

14. Hernández-Sampieri R, Fernández-Collado C, Baptista-Lucio P. Metodología de la investigación. 6ª. ed. Mc Graw Hill. México; 2014.

15. Carreto-Pérez BE, Almazán-Juárez Á, Sierra-Morales P, Almazán-Núñez R. Estudio florístico de la cuenca baja del Río Papagayo, Guerrero, México. Polibotánica 2015;40: 1-27.

16. Morales-Saldaña S, Martínez-Ambriz E, Valencia-Á S. Estudio florístico y de la vegetación del municipio de Buenavista de Cuéllar, Guerrero, México. Bot Scien 2015; 93(1):73-95

17. Lot A, Chiang F. Manual de herbario: administración y manejo de colecciones, técnicas de recolección y preparación de ejemplares botánicos. Consejo Nacional de la Flora de México. A.C. México, D.F., México. 1986:142.

18. Mogni F, Tresoldi C, Senesi S, Palau H, Vilella F. Sustainable development in food and agribusiness: application of the theoretical model to the Argentine beekeeping sector. VII International PENSA 2009;1–16.

19. Gutiérrez L. Plan rector del sistema productivo apícola en Tamaulipas. Comité Sistema Producto Apícola de Tamaulipas, México. 2011.

20. Magaña-Magaña M, Aguilar-Arrieta A, Lara-Lara P, Sanginés-García, R. Caracterización socioeconómica de la actividad apícola en el Estado de Yucatán. México. Rev Agron 2007;15:17–24.

21. Sánchez-Gómez J, Vázquez-Alfaro M, Alaníz-Gutiérrez L, González-Álvarez VH, Saavedra-Jiménez L. Características y necesidades tecnológicas de los apicultores de la región centro-sur de Jalisco. Acta Universitaria 2022;32:e3493.

22. Martínez-Puc J, Cetzal-Ix W, González-Valdivia N, Casanova-Lugo, Basu SK. Caracterización de la actividad apícola en los principales municipios productores de miel en Campeche, México. J Selva Andina Anim Sci 2018;5:44–53.

23. Contreras-Escareño F, Pérez Armendáriz B, Echazarreta CM, Cavazos J, Macías-Macías JO, Tapia-González JM. Características y situación actual de la apicultura en las regiones Sur y Sureste de Jalisco, México. Rev Mex Cienc Pecu 2013;4:387–398.

24. Luna-Chontal G, Roque-Peña JG, Fernández-Echeverría E, Martínez-Mendoza E, Díaz-Zorrilla UA, Fernández-Lambert G. Caracterización apícola en la Región Sierra Centro-Norte de Veracruz: contexto y trashumancia. Rev Mex Cienc Agríc 2019;10:1339–1351.

25. Contreras-Uc L, Magaña-Magaña M, Sanginés-García J. Productividad de la apicultura en comunidades mayas del Litoral Centro de Yucatán, México. Rev Agroprod 2017;10: 46–50.

26. Morett-Sánchez J, Cosío-Ruiz C. Panorama de los ejidos y comunidades agrarias en México. Agricultura, Sociedad y Desarrollo. 2017;4:125–152.

27. Abou-Shaara HF, Al-Ghamdi AA, Mohamed AA. Suitability map for keeping honeybees under harsh environmental conditions using geographical information systems. World Applied Sci J 2013;22:1099–1105.

28. Melero-Aguilar N, Fleitas-Ruiz R. La investigación acción participativa en procesos de desarrollo comunitario: una experiencia de cooperación interuniversitaria en el barrio de Jesús María, La Habana Vieja (Cuba). Rev Interuniversitaria 2015;26:203–228.

29. May T, Rodríguez S, Rivas S. Especies de plantas de importancia apícola en la República Dominicana según la percepción de los apicultores. Moscosoa 2018;16:148–168.

30. Odoux JF, Aupinel P, Gateff S, Requier F, Henry M, Bretagnolle V. ECOBEE: a tool for long-term honeybee colony monitoring at the landscape scale in West European intensive agroecosystems. J Apic Res 2014;53:57–66.

31. Jiménez-González A, Cantos C, Cedeño MJ, Vera LM. Caracterización de la producción apícola en un sistema cooperativo asociado al bosque seco tropical. UNESUM-Ciencias: Rev Cient Multidisciplinaria 2021;5:47–60.

32. Aguilar-Cabrera CÁ, Aker-Narváez C, Pacheco-Flores SA. Caracterización florística de las especies de aprovechamiento apícola en el complejo volcánico “Pilas el Hoyo”. Rev Iberoam Bioecon Cambio Climático 2019;5:1164–1197.

33. May T. Apicultura y conservación de la biodiversidad en el caribe muchos intereses convergentes y algunos divergentes estudios de caso: República Dominicana. Ambiente y Sostenibilidad 2015;5:69–77.

Table 3: Species cited by beekeepers in the Costa Chica region of Guerrero

Family	Taxa	FR	QFR	SC	F	M	A	M	J	J	A	S	O	N	D	RSDH	NMSB
Anacardiaceae	*Mangifera indica* L.	P	Re	X	X	-	-	-	-	-	-	-	-	-	-	---	17
Arecaceae	*Cocos nucifera* L.	N-P	Re	-	-	-	-	-	-	X	X	X	X	X	-	---	2
Bignoniaceae	*Tabebuia rosea* (Bertol.) DC.	N-P	Ab	-	-	X	X	-	-	-	-	-	-	-	-	L. Alaniz *et al.* 1008 (FCME)	3
Boraginaceae	*Cordia dentata* Poir.	N-P	Re	X	X	X	-	-	-	-	-	-	-	-	-	L. Alaniz *et al.* 289 (FCME)	4
Combretaceae	*Combretum fruticosum* (Loefl.) Stuntz	N-P	Re	-	-	X	X	X	-	-	-	-	-	-	-	L. Alaniz *et al.* 715 (FCME)	5
Convolvulaceae	*Ipomoea trifida* (Kunth) G. Don	N	Ab	X	-	-	-	-	-	-	-	-	-	-	X	L. Alaniz *et al.* 611 (FCME)	30
Dilleniaceae	*Curatella americana* L.	N	Ab	X	-	-	-	-	-	-	-	-	-	-	X	L. Alaniz *et al.* 805 (FCME)	11
Fabaceae	*Andira inermis* (W. Wright) Kunth ex DC.	N	Ab	-	X	X	X	-	-	-	-	-	-	-	-	L. Alaniz *et al.* 1000 (FCME)	36
Fabaceae	*Enterolobium cyclocarpum* (Jacq.) Griseb.	N	Ab	-	-	-	X	X	-	-	-	-	-	-	-	L. Alaniz *et al.* 1002 (FCME)	2
Fabaceae	*Gliricidia sepium* (Jacq.) Kunth ex Walp.	N	Ab	X	X	-	-	-	-	-	-	-	-	-	X	L. Alaniz *et al.* 1003 (FCME)	29
Fabaceae	*Hymenaea courbaril* L.	N	Ab	-	-	X	X	X	-	-	-	-	-	-	-	L. Alaniz *et al.* 1004 (FCME)	46
Fabaceae	*Pterocarpus orbiculatus* DC.	N-P	Ab	X	-	-	-	-	-	-	-	-	-	-	X	L. Alaniz *et al.* 771 (FCME)	6
Fabaceae	*Bauhinia pauletia* Pers.	P	Re	-	-	-	X	X	X	-	-	-	-	-	-	L. Alaniz *et al.* 730 (FCME)	3

Fabaceae	*Senna mollissima* (Humb. & Bonpl. ex Willd.) H.S. Irwin & Barneby.	P	Re	X	X	-	-	-	-	-	-	-	-	-	-	L. Alaniz *et al.* 538 (FCME)	3
Fabaceae	*Tamarindus indica* L.	P	Re	-	-	-	X	X	-	-	-	-	-	-	-	---	2
Fabaceae	*Vachellia farnesiana* (L.) Wight & Arn.	P	Re	-	-	-	X	X	-	-	-	-	-	-	-	L. Alaniz *et al.* 547 (FCME)	2
Lauraceae	*Persea americana* Mill.	N	Ab	-	-	-	-	X	X	X	-	-	-	-	-	---	2
Malpighiaceae	*Byrsonima crassifolia* (L.) Kunth	N	Ab	-	-	-	X	X	X	-	-	-	-	-	-	L. Alaniz *et al.* 1001 (FCME)	15
Malpighiaceae	*Malpighia ovata* Rose	N-P	Ab	-	-	-	-	X	X	X	-	-	-	-	-	L. Alaniz *et al.* 1007 (FCME)	10
ND	*Gusanillo* (common name)	N	Ab	X	X	-	-	-	-	-	-	-	-	-	-	---	3
ND	*Tanalocote* (common name)	N	Ab	-	X	X	-	-	-	-	-	-	-	-	-	---	7
Pedaliaceae	*Sesamum indicum* L.	N	Ab	-	-	-	-	-	-	X	X	-	-	-	-	---	2
Polygonaceae	*Coccoloba barbadensis* Jacq.	N	Ab	-	X	X	-	X	X	-	-	-	-	-	-	L. Alaniz *et al.* 520 (FCME)	21
Rutaceae	*Citrus* × *aurantiaca* (L.) Swingle	N	Ab	-	-	-	-	-	-	X	X	X	X	-	-	---	7

FR= Floral resource: N= nectar, P= pollen, N-P= nectar-pollen. QFR= quantity of the floral resource: AB= abundant, SC= scarce, RE= regular. Floral calendar with months of the year (January-December). RSDH= representative specimen deposited in the FCME herbarium (based on Alaniz *et al.*, collection number). NMSB= number of mentions of the species by beekeepers.