Agrociencia

FLORISTIC INVENTORY AND ANNUAL AVAILABILITY OF MELLIFEROUS FLORA IN CERVANTES Y LOZADA, CORDOBA MUNICIPALITY, VERACRUZ, MEXICO

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Citation: Real-Luna N, Rivera-Hernández JE, Alcántara-Salinas G, Pérez-Sato JA, Zalazar-Marcial E, Delgado-Blancas MI, Díaz-Solís A. 2023. Floristic inventory and anual availability of melliferous flora in Cervantes y Lozada, Cordoba municipality, Veracruz, Mexico. **Agrociencia.** doi.org/ 10.47163/agrociencia.v57i8.3028

Editor in Chief:
Dr. Fernando C. Gómez Merino

Received: June 09, 2023.
Approved: September 10, 2023.
Published in Agrociencia: December 12, 2023.

ABSTRACT

Pollinators depend on the melliferous flora for food, in return, flowers are pollinated, which contributes for the maintenance of ecosystems and conservation of biodiversity, increasing food production and ensuring food security. This research aims to provide an inventory of melliferous flora and its annual availability in Cervantes y Lozada, Córdoba, Veracruz, Mexico. During 26 months, the plants interacting with bees were collected on defined rural roads; we also documented the resource provided by the flowers (pollen, honey, etc.), their origin (native or exotic), life form and flowering periods. From 122 collections, 76 melliferous species were inventoried, grouped in 74 genera and 35 botanical families, being Asteraceae (25 %) the family with more species, followed by Malvaceae (9.21 %) and Lamiaceae (7.89 %); 67.11 % are polliniferous, 7.86 % nectariferous, and 25 % provide both; 82.89 % are native and 17.11 % exotic; 15.79 % are trees, 28.95 % shrubs and 55.26 % herbs. Seven species provided resources for bees all year round, two for 10 months and the rest for shorter periods. The flora species that were inventoried have different uses, so it is important to protect and promote the sustainable management of the melliferous flora, which is essential for the conservation of the pollination service, which in turn is essential for agriculture and ecosystems, in addition to protecting species of social, ecological, and economic importance.

Keywords: bee flora, pollinators, nectar, pollen, flowering season.

INTRODUCTION

Bees depend on the melliferous flora for food and to obtain nesting sites; in return, flowers are pollinated for succeeding in reproduction that provides seeds and fruits for humans and other animals, thus contributing to food security and the ecological balance of ecosystems (Bonet and Vergara, 2016; Montoya-Bonilla *et al*., 2017).

Despite its importance, melliferous flora is under threat, mainly due to deforestation. In this regard, Mexico suffered an average annual gross deforestation of 212834 ha in 2021, caused primarily by changes in land use for agriculture, livestock, mining, tourism developments and/or real estate projects (CONAFOR, 2022). Other factors affecting the melliferous flora are the use of agrochemicals, the presence of invasive exotic species, diseases, pests, transgenic varieties, and climate change (Quezada-Euán and Ayala-Barajas, 2010). Climate change causes loss of biological corridors for pollinators, as it promotes habitat fragmentation, soil erosion, loss of biodiversity, and reduction of environmental services. All these problems result in small and isolated populations, increasing their probability of extinction (Aguilar *et al*., 2019; Ramírez-Bravo and Hernández-Santín, 2016; Von *et al*., 2021).

In Mexico, the state of Veracruz has an inventory of 63 families, 176 genera and 216 species of honey plants. Of that, Asteraceae and Fabaceae families have the largest number of species (Real-Luna *et al*., 2021). In Mexico, the Asteraceae is the most diverse botanical family, with approximately 3000 species, that means 14 % of Mexico´s flora as a whole (Villaseñor-Ríos *et al*., 2013). Thus, Mexico has 147 species of Asteraceae reported as significant for beekeeping (Cadena *et al*., 2019; Castellanos-Potenciano *et al*., 2012; Quiroz and Arreguín-Sánchez, 2008). Additionally, the families Fabaceae, Convolvulaceae, Combretaceae, Bignoniaceae, and Verbenaceae are also considered important sources of pollen and nectar (González *et al*., 2016). This research aims to provide an inventory of melliferous flora and its annual availability in Cervantes y Lozada, Córdoba, Veracruz. We expect to provide fundamental contribution of scientific knowledge for the implementation of effective and viable conservation strategies, both for pollinators and for the regional honey flora.

MATERIALS AND METHODS

Description of the study area

The study was carried out in the rural locality of Cervantes y Lozada located to the northeast of the municipality of Córdoba, in the "Sierra del Gallego" region; at 18° 57′ 14.4" N and 96° 55′ 35.04" W with an altitude average of 1214 m (Figure 1). It has a semi-warm humid climate with abundant rainfall in summer, and a temperature ranging from 18 to 24°C, and precipitation of 1900-2100 mm (Sistema de Información Estadística y Geográfica del Estado de Veracruz de la Llave, 2021).

There are two types of vegetation in the area, according to Rzedowski's classification (1978): Cloud forest (deciduous forest or medium or low evergreen forest, according to Miranda and Hernández-X., 1963), and tropical evergreen forest (or medium sub evergreen forest, according to Miranda and Hernández-X., 1963), as well as a transition strip between these two vegetal communities and patches of secondary vegetation derived from these types of vegetation.

The location is considered highly marginalized with a population of 173 inhabitants provided of essential needs (drinking water, basic schools, electricity, etc.); the main

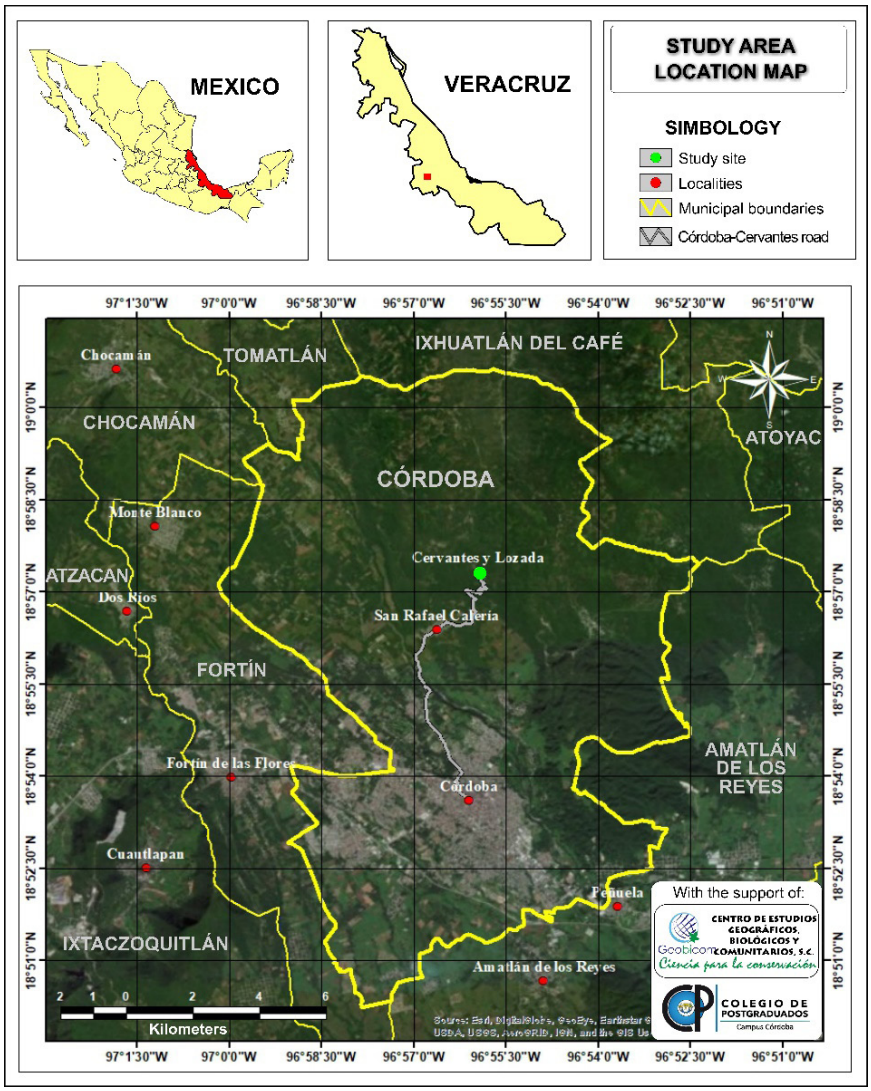

Figure 1. Location of Cervantes y Lozada, Córdoba, Veracruz, Mexico.

productive activity is agriculture, with coffee, banana, beans, corn, chili, and squash (Sistema de Información Estadística y Geográfica del Estado de Veracruz de la Llave, 2021). The inhabitants conduct an agroecological production system combining different kinds of crops in their plots, such as coffee (*Coffea arabica* L.), different varieties of banana (*Musa* x *paradisiaca* L.) and other ornamental species as the parlour palms (*Chamaedorea elegans* Mart. and *Ch. metallica* O.F. Cook ex H.E. Moore), cornstalk dracaena (*Dracaena fragrans* (L.) Ker Gawl.) and ti plant (*Cordyline fruticosa* (L.) A. Chev.).

Inventory of melliferous flora

We established a weekly collection of plants on the community roads for 26 months, following the periods of March to December 2020, January to December 2021 and January to April 2022, from 10:00-16:00 h, when bees present greater activity. All the species that were visited by bees were collected. The plants were herborized using traditional techniques of pressing, drying, and disinfecting (Lot and Chiang, 1986). Subsequently, they were taxonomically determined through the use of specialized literature (dichotomous keys), as well as by comparison of herbarium vouchers. Plant taxonomy was based on the Missouri Botanical Garden Tropics database proposal (Tropicos.org, 2023) and the International System established by the Angiosperm Phylogeny Group IV (Chase *et al*., 2016). Taxon authors were abbreviated according to the Tropicos database of the Missouri Botanical Garden (Tropicos.org, 2023). On the other hand, the resources provided by the plants to the bees (pollen, nectar, or both), its origin (native or exotic), the life form (tree, shrub, or grass) were documented through a bibliographic review of scientific articles published in databases such as Scopus, Web of Science Group, Academic Google, Elsevier and Springer Link, and the flowering periods were recorded through observations made during the field work.

Botanical specimens were deposited in the following herbaria: Herbarium of the Colegio de Postgraduados Campus Córdoba (CPC) (in Manuel León, Amatlán de los Reyes, Veracruz), Herbarium "Jerzy Rzedowski Rotter" of the Facultad de Ciencias Biológicas y Agropecuarias de la Universidad Veracruzana, Zona Córdoba-Orizaba (CORU) (in Peñuela, Amatlán de los Reyes, Veracruz), and Herbarium of the Instituto de Ecología (XAL) (in Xalapa, Veracruz).

RESULTS AND DISCUSSION

Inventory of melliferous flora

A total of 122 plant collections were made for a total of 76 species, distributed in 74 genera and 35 families. The most important family was Asteraceae with 19 species (25 %), coinciding with those reported by Granados-Argüello *et al.* (2020), González-Suárez *et al.* (2020) and Real-Luna *et al*. (2021). They are followed in order of importance by Malvaceae with seven (9.21 %), Lamiaceae with six (7.89 %), Fabaceae and Verbenaceae with three species each (3.95 %) and Acanthaceae, Amaryllidaceae, Cucurbitaceae, Euphorbiaceae, Ranunculaceae, Rubiaceae and Solanaceae with two species each (2.63 %) (Table 1).

The species of the Asteraceae family were the most visited by bees, since they have flowers that provide them with nectar and pollen, as well as being easily accessible, thus have the function of shelter sites. Asteraceae is one of the families with the largest number of species on the planet, being common and sometimes even dominating different regeneration sites, such as the edges of crops and roads. The importance of the Asteraceae family for bee foraging has been recorded in Argentina, Brazil, Colombia, and Mexico (Araujo-Mondragón and Redonda-Martínez, 2019; Chamorro-García *et al*., 2013).

Table 1. Botanical families that make up the melliferous flora of the Cervantes y Lozada location, in Córdoba, Veracruz, Mexico.

Families	Genus	%	Species	%	Families	Genus	%	Species	%
ANGIOSPERMS					Fabaceae	3	4.05	3	3.95
MONOCOTYLEDONS					Heliotropiaceae	1	1.35	1	1.32
Amaryllidaceae	2	2.70	**2**	2.63	Lamiaceae	5	6.76	6	7.89
Arecaceae	1	1.35	1	1.32	Loranthaceae	1	1.35	1	1.32
Asparagaceae	1	1.35	1	1.32	Lythraceae	1	1.35	1	1.32
Hypoxidaceae	1	1.35	1	1.32	Malpighiaceae	1	1.35	1	1.32
Iridaceae	1	1.35	1	1.32	Malvaceae	7	9.46	7	9.21
Orchidaceae	1	1.35	1	1.32	Meliaceae	1	1.35	1	1.32
EUDICOTYLEDONS					Myrsinaceae	1	1.35	1	1.32
Acanthaceae	2	2.70	2	2.63	Myrtaceae	1	1.35	1	1.32
Adoxaceae	1	1.35	1	1.32	Nyctaginaceae	1	1.35	1	1.32
Amaranthaceae	1	1.35	1	1.32	Onagraceae	1	1.35	1	1.32
Asteraceae	19	25.68	19	25	Petiveriaceae	1	1.35	1	1.32
Bignoniaceae	1	1.35	1	1.32	Polygalaceae	1	1.35	1	1.32
Bixaceae	1	1.35	1	1.32	Ranunculaceae	2	2.70	2	2.63
Campanulaceae	1	1.35	1	1.32	Rosaceae	1	1.35	1	1.32
Convolvulaceae	1	1.35	2	2.63	Rubiaceae	2	2.70	2	2.63
Cucurbitaceae	2	2.70	2	2.63	Solanaceae	2	2.70	2	2.63
Euphorbiaceae	2	2.70	2	2.63	Verbenaceae	3	4.05	3	3.95
					TOTAL	**74**	**100**	**76**	**100**

Of the total number of species recorded, 67.11 % are polliniferous, 7.86 % nectariferous and 25 % nectariferous-polliniferous. Regarding the origin, 82.89 % are native species and 17.11 % exotic. Indeed, we have expected such results, since Mexico has a lower number of exotic species than in other regions of the Americas. However, it is important to conduct more studies on exotic species, which are mostly herbaceous and can become invasive (Espinosa-García and Villaseñor-Ríos, 2017; Pérez-Postigo *et al*., 2021). Regarding the life forms of the melliferous flora, 15.79 % are trees, 28.95 % shrubs, and 55.26 % herbs. Similar results were reported for Tamaulipas, with 42.32 % herbaceous species identified (González-Suárez *et al*., 2020) (Table 2).

Species that were found in bloom throughout the year represent 7.89 % (*Bidens alba*, *Cuphea hyssopifolia*, *Holmskioldia sanguinea*, *Eriobotrya japonica*, *Malvaviscus arboreus*, *Melampodium divaricatum* and *Thunbergia alata*); those that were in bloom for 10 months were 2.63 % (*Teucrium vesicarium* and *Aldama dentata*); eight months, 3.95 % (*Bougainvillea glabra*, *Salvia xalapensis* and *Anoda cristata*); seven months, 6.58 % (*Ageratum houstonianum*, *Salvia lasiocephala*, *Melanthera nivea*, *Solidago altissima* and *Hamelia patens*); six months, 7.89 %; five months, 5.26 %; four months, 3.95 %; three months, 6.58 %; two months, 18%; and one month, 36.84 %.

During fieldwork, January had the lowest number of flowering species (15) and the months with the most floral resources were May (32), July (29), November (28), and December (29) (Figure 2).

Table 2. List of melliferous plant species from the community of Cervantes y Lozada, Córdoba, Veracruz, Mexico. Origin: N = Native, E = Exotic. Life form: H = Herb, S = Shrub, T = Tree. Product for pollinator: P = Pollen, N = Nectar, P/N = Pollen/Nectar. Flowering Period: JA = January, FB = February, MC = March, AP = April, MY = May, JN = June, JL = July, AG = August, SP = September, OC = October, NV = November, DC = December, AY = all year. Collectors: NRL = Natalia Real-Luna, JERH = Jaime Ernesto Rivera-Hernández and MAJC = Marco Antonio Juárez-Calderón. Herbaria: CPC = Herbarium of the melliferous flora of Veracruz, Colegio de Postgraduados Campus Córdoba, Manuel León, Veracruz; CORU = Jerzy Rzedowski Rotter Herbarium of the Facultad de Ciencias Biológicas y Agropecuarias, Zona Orizaba-Córdoba, Peñuela, Veracruz; and XAL = Herbarium of the Instituto de Ecología, Xalapa, Veracruz.

Family/ Scientific name	Local common name	Origin	Life form	Product for pollinator	Flowering period	Collector (herbarium)
AMARYLLIDACEAE						
Agapanthus africanus (L.) Hoffmanss	"ciento en uno", "agapando africano"	E	H	P	MY-JL	NRL 55 (CPC, CORU)
Zephyranthes miradorensis (Kraenzl.) Espejo y López-Ferrari	"mañanitas", "mañanitas veracruzanas"	N	H	P	MY	NRL 61 (CPC) NRL 66 (CPC)
ARECACEAE						
Syagrus romanzoffiana (Cham.) Glassman	"palma coyolera", "palmera pindó"	E	H	P	AP-AG	JERH 6329 (CPC, CORU)
ASPARAGACEAE						
Cordyline fruticosa (L.) A. Chev.	"gracena morada", "banderilla"	E	S	P	JA	JERH 6330 (CPC, CORU)
HYPOXIDACEAE						
Molineria capitulata (Lour.) Herb.	"palma acordeón"	E	H	P	MY	NRL 60 (CPC, CORU)
IRIDACEAE						
Trimezia steyermarkii R.C. Foster	"íris ojo de tigre"	N	H	P	MY-JL	NRL 53 (CPC, CORU)
ORCHIDACEAE						
Oncidium sphacelatum Lindl.	"flor de mayo", "orquídea dama amarilla"	E	H	P	MY	NRL 54 (CPC, CORU)
EUDICOTYLEDONS						
ACANTHACEAE						
Odontonema callistachyum (Schltdl. & Cham.) Kuntze	"vara babosa", "canutillo"	N	H	P	DC-MC	NRL 1 (CPC, CORU, XAL) NRL 34 (CORU)
Thunbergia alata Bojer ex Sims	"manto", "hierba africana del susto"	E	H	N	AY	NRL 27 (CORU) NRL 87 (CPC, CORU)
ADOXACEAE						
Sambucus nigra L.	"sauco", "sauco negro"	N	T	P	JL-AG	NRL 79 (CPC, CORU)
AMARANTHACEAE						
Chamissoa altissima (Jacq.) Kunth	"bejuco de agua"	N	H	N	DC	NRL 29 (CPC, CORU)
ASTERACEAE						
Ageratum houstonianum Mill.	"chichán", "yerba del zopilote"	N	H	P	OC-AP	NRL 18 (CORU) NRL 30 (CORU) NRL 90 (CPC, CORU)

Table 2. Continue.

Family/ Scientific name	Local common name	Origin	Life form	Product for pollinator	Flowering period	Collector (herbarium)
Aldama dentata La Llave	"acahual"	N	H	P	MC-DC	NRL 8 (CPC, CORU) NRL 11 (CPC, CORU) NRL 85 (CPC, CORU)
Baccharis trinervis Pers.	"cortadillo"	N	S	P/N	FB-AP	NRL 5 (CPC, CORU) NRL 38 (CORU) NRL 44 (CORU)
Bidens alba (L.) DC.	"amor seco", "amozote", "acahual blanco"	N	H	P/N	AY	NRL 3 (CORU) NRL 14 (CORU) NRL 16 (CORU) NRL 86 (CPC, CORU)
Chromolaena odorata (L.) R.M. King & H. Rob.	"albahaquilla"	N	S	P/N	MC-AP	NRL 4 (CPC, CORU)
Critonia morifolia (Mill.) R.M. King & H. Rob.	"hoja de San Nicolás", "árbol de Santa María"	N	S	P	JA-JN	NRL 114 (CPC) MAJC 4 (CPC)
Fleischmannia pycnocephala (Less.) R.M. King & H. Rob.	"cruz dulce chica"	N	H	P	MC-AP	NRL 2 (CPC, CORU) NRL 42 (CPC)
Heliopsis buphtalmoides (Jacq.) Dunal	"botoncillo"	N	H	P	AP-JL	NRL 9 (CORU) NRL 41 (CPC) NRL 68 (CPC, CORU XAL) NRL 84 (CPC, CORU) MAJC 5 (CPC)
Melampodium divaricatum (Rich.) DC.	"cabezona", "acahual amarillo"	N	H	P/N	AY	NRL 10 (CPC, CORU) NRL 43 (CORU) NRL 83 (CPC, CORU, XAL) NRL 99 (CPC, CORU, XAL)
Melanthera nivea (L.) Small	"capitaneja", "totolquelite"	N	H	P	MY-NV	NRL 59 (CPC, CORU) NRL 95 (CPC, CORU)

Table 2. Continue.

Family/ Scientific name	Local common name	Origin	Life form	Product for pollinator	Flowering period	Collector (herbarium)
Montanoa grandiflora (DC.) Sch. Bip. ex Hemsl.	"cecilia", "acahual"	N	S	P/N	NV-DC	NRL 15 (CPC, CORU, XAL) NRL 100 (CPC, CORU, XAL) NRL 103 (CPC, CORU, XAL) NRL 109 (CPC, CORU, XAL) NRL 104 (CPC)
Schistocarpha bicolor Less	"polocote", "margarita"	N	S	P	FB-MC	NRL 7 (CORU) NRL 37 (CORU)
Smallanthus maculatus (Cav.) H. Rob.	"polocote morado", "conquelite"	N	H	P	JL-DC	NRL 71 (CPC, CORU) NRL 81 (CPC, CORU)
Solidago altissima L.	"vara de oro"	E	H	P/N	MY-NV	NRL 63 (CPC, CORU) NRL 98 (CPC, CORU, XAL)
Tithonia diversifolia (Hemsl.) A. Gray	"gigantón", "acahual", "árnica"	N	H	P	NV	NRL 102 (CPC, CORU, XAL)
Verbesina turbacensis Kunth	"lengua de vaca", "capitaneja"	N	H	P	NV	NRL 106 (CPC)
Vernonanthura patens (Kunth) H. Rob.	"chiquite", "flor de cuaresma"	N	S	P/N	MC	NRL 6 (CPC, CORU) NRL 45 (CPC, CORU) NRL 46 (CORU)
Viguiera cordata (Hook. & Arn.) D'Arcy	"jabalí", "mozote amarillo"	N	H	P	DC-JA	NRL 20 (CPC)
Zinnia elegans Jacq.	"viuda", "flor de San Miguel"	N	H	P/N	JL-NV	NRL 93 (CPC, CORU, XAL)
BIGNONIACEAE						
Podranea ricasoliana (Tanfani) Sprague	"campana rey sudafricana"	E	S	P	FB-JL	NRL 111 (CPC) MAJC 3 (CPC)
BIXACEAE						
Bixa orellana L.	"achiote"	N	S	P	JL-AG	NRL 22 (CORU) NRL 78 (CPC, CORU)
CAMPANULACEAE						
Lobelia xalapensis Kunth	"berros", "barba de guajolote"	N	H	P	OC-DC	NRL 13 (CPC, CORU) NRL 97 (CPC, CORU, XAL)
CONVOLVULACEAE						
Ipomoea hastigera Kunth	"bejuco", "campanillas"	N	H	N	AP	NRL 49 (CPC, CORU)

Table 2. Continue.

Family/ Scientific name	Local common name	Origin	Life form	Product for pollinator	Flowering period	Collector (herbarium)
I. indica (Burm.) Merr.	"quiebra platos", "bejuco blanco"	N	H	N	AG-DC	NRL 32 (CPC, CORU) NRL 82 (CPC, CORU)
CUCURBITACEAE						
Polyclathra cucumerina Bertol.	"calabacilla", "chilacayotillo"	N	H	P	NV-DC	NRL 105 (CPC, CORU, XAL) NRL 107 (CPC) NRL 108 (CPC)
Sechium edule (Jacq.) Sw.	"chayote", "erizo"	N	H	P	JL-DC	NRL 75 (CPC, CORU)
EUPHORBIACEAE						
Croton draco Schltdl. & Cham.	"sangregado", "sangre de grado", "drago"	N	T	N	MC-AP	NRL 40 (CPC)
Jatropha podagrica Hook.	"botella", "tártago"	N	S	P	MY	NRL 62 (CPC, CORU)
FABACEAE						
Inga vera Willd.	"vainillo", "jinicuil", "aguatope"	N	T	P/N	AP-MY	NRL 47 (CORU, XAL)
Leucaena leucocephala (Lam.) de Wit	"guaje", "Tepehuaje dormilón"	N	T	P	MC	NRL 115 (CPC)
Mimosa albida Humb. & Bonpl. ex Willd.	"chomapique", "dormilona grande"	N	S	P	NV-JA	NRL 101 (CPC, CORU, XAL)
HELIOTROPIACEAE						
Tournefortia hirsutissima L.	"tlachichinole", "hierba rasposa"	N	S	P	AP	NRL 50 (CPC, CORU)
LAMIACEAE						
Holmskioldia sanguinea Retz.	"bugambilia extranjera", "sombrilla china"	E	S	P/N	AY	JERH 6331 (CPC, CORU)
Hyptis capitata Jacq.	"botoncillo"	N	H	P	DC-JA	NRL 24 (CORU)
Leonurus sibiricus L.	"mariguana cimarrona", "altamisa"	E	H	P	OC	NRL 91 (CPC, CORU, XAL)
Salvia lasiocephala Hook. & Arn.		N	H	P	SP-AP	JERH 6340 (CPC, CORU, XAL)
S. xalapensis Benth.	"salvia jalapeña"	N	H	P	MY-DC	NRL 72 (CPC, CORU, XAL)
Teucrium vesicarium Mill.	"mozote", "pega pega"	N	H	P	JA-OC	NRL 36 (CORU) NRL 51 (CPC, CORU)
LORANTHACEAE						
Struthanthus quercicola (Schltdl. & Cham.) Blume	"hiedra", "correhuela"	N	H	P	JL	NRL 73 (CPC, CORU, XAL)
LYTHRACEAE						
Cuphea hyssopifolia Kunth	"falso brezo mexicano"	N	S	P	AY	NRL 69 (CPC, CORU, XAL)

Table 2. Continue.

Family/ Scientific name	Local common name	Origin	Life form	Product for pollinator	Flowering period	Collector (herbarium)
MALPIGHIACEAE						
Byrsonima crassifolia (L.) Kunth	"nanche", "nananche"	N	T	P/N	MY	MAJC 2 (CPC); NRL 56 (CPC, CORU, XAL)
MALVACEAE						
Anoda cristata (L.) Schltdl.	"violeta de campo", "alache"	N	H	P	MY-DC	NRL 17 (CORU, XAL) NRL 21 (CORU, XAL) NRL 92 (CPC, CORU, XAL)
Bernoullia flammea Oliv.	"platanillo", "amapola"	N	T	P	AP	JERH 6332 (CPC, CORU)
Heliocarpus americanus L.	"jonote"	N	T	P	FB	NRL 39 (CORU)
Malvaviscus arboreus Cav.	"chochito", "tulipán corriente", "altea"	N	S	P/N	AY	NRL 77 (CPC, CORU); NRL 112 (CPC)
Pseudobombax ellipticum (Kunth) Dugand	"lele", "coquito"	N	T	P/N	AP	JERH 6333 (CPC, CORU)
Robinsonella lindeniana (Turcz.) Rose & Baker	"manzanillo", "jocorró"	N	T	P	NV-DC	NRL 19 (CORU, XAL) NRL 31 (CORU, XAL)
Triumfetta semitriloba Jacq.	"cadillo", "mozote"	N	S	P	DC	NRL 28 (CORU)
MELIACEAE						
Trichilia havanensis Jacq.	"rama tinaja", "palo de cuchara"	N	T	P	JA	NRL 113 (CPC)
MYRTACEAE						
Psidium guajava L.	"guayaba", "guayaba dulce"	N	T	P/N	AP-MY	NRL 48 (CORU, XAL)
NYCTAGINACEAE						
Bougainvillea glabra Choisy	"bugambilia"	E	S	P	AP-NV	NRL 58 (CPC, CORU)
ONAGRACEAE						
Oenothera rosea L'Hér. ex Ait.	"hierba del golpe"	N	H	P/N	OC	NRL 89 (CPC, CORU, XAL)
PETIVERIACEAE						
Rivina humilis L.	"bajatripa"	N	H	N	MY-AG	NRL 65 (CPC, CORU) NRL 70 (CPC, CORU)
POLYGALACEAE						
Polygala berlandieri S. Watson	"hierba de yódex"	N	H	P	OC-NV	NRL 96 (CPC, CORU, XAL)
PRIMULACEAE						
Ardisia compressa Kunth	"capulín", "capulín negro"	N	S	P	DC	NRL 110 (CPC, CORU)

Table 2. Continue.

Family/ Scientific name	Local common name	Origin	Life form	Product for pollinator	Flowering period	Collector (herbarium)
RANUNCULACEAE						
Clematis dioica L.	"barba de chivo"	N	H	P	DC	NRL 35 (CPC, CORU, XAL)
Ranunculus petiolaris Humb., Bonpl. & Kunth ex DC. subsp. *Petiolaris*	"aceitilla"	N	H	P	MY-OC	NRL 67 (CPC, CORU, XAL) NRL 94 (CPC, CORU, XAL)
ROSACEAE						
Eriobotrya japonica (Thunb.) Lindl.	"níspero", "níspero chino"	E	S	P	JL	NRL 76 (CPC)
RUBIACEAE						
Coffea arabica L.	"café", "cafeto"	E	S	P	MY	NRL 64 (CPC, CORU, XAL)
Hamelia patens Jacq.	"coralillo"	N	S	P/N	MY-NV	NRL 52 (CPC, CORU) NRL 74 (CPC) NRL 88 (CPC)
SOLANACEAE						
Brugmansia arborea (L.) Lagerh.	"florifundio", "florifundio sudamericano"	E	S	P/N	JL-DC	NRL 33 (CPC)
Capsicum annuum L.	"chile tabaquero", "chile"	N	H	P	MY	NRL 57 (CPC, CORU)
VERBENACEAE						
Lippia myriocephala Schltdl. & Cham.	"popotoca", "colpanchi blanco"	N	T	P/N	DC	NRL 26 (CORU)
Petrea volubilis L.	"rasca petate", "raspa sombrero", "bejuco de ajo"	N	H	P	FB-JN	JERH 6334 (CPC, CORU)
Verbena carolina L.	"verbena de perro"	N	H	P/N	DC	NRL 25 (CORU)

However, further studies on the availability of floral resources are needed, as climate change may affect plant phenology by bringing forward flowering and affecting plant-pollinator interaction, as there is no synchronization with pollinator emergence. Plants may also alter their nectar composition and pollen protein concentration, which may affect pollinator longevity. Another aspect that can be affected is foraging activity, since if temperatures increase, they can be critical and lethal for insects, which will impede foraging, resulting in a lack of pollination (Farias-Silva and Freitas, 2020).

During the fieldwork we could observe that the species with the greatest number of floral visitors were: *Heliopsis buphthalmoides*, *Aldama dentata*, *Bidens alba*, *Byrsonima crassifolia*, *Eriobotrya japonica*, *Hamelia patens*, *Melampodium divaricatum*, *Montanoa*

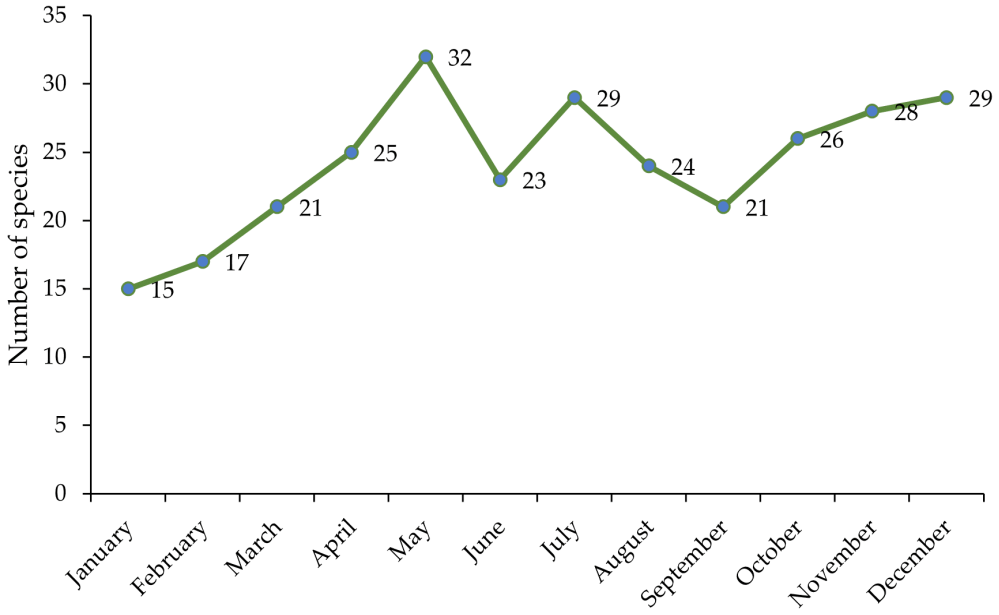

Figure 2. Number of flowering species during the year in Cervantes y Lozada, Córdoba, Veracruz, Mexico.

grandiflora and *Sechium edule*. Those that presented a regular number of visiting species were *Smallanthus maculatus*, *Odontonema callistachyum*, *Tithonia diversifolia* and *Viguiera cordata*, which coincides with the data reported by Araujo-Mondragón and Redonda-Martínez (2019).

In Cervantes y Lozada the main agricultural products obtained during the rainfed period are: coffee, banana, chili, beans, corn, and squash; as well as chayote, nanche, guava and loquat. Most of these crops require pollination by external agents for fruit production, so the presence of pollinators is important in this place. However, these crops have short flowering periods, thus, it is crucial to maintain pollinators for its ecological importance.

We observed in Cervantes y Lozada a great diversity of pollinator species such as those belonging to the orders Hymenoptera, Lepidoptera and Apodiformes. Regarding bees, there are different species, including nine species of meliponines (*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). In addition, there are some *Apis mellifera* L. hives brought to Cervantes y Lozada by people outside this place, as they found a perfect place with a high quantity of melliferous flora to assure honey production. The

Cervantes y Lozada inhabitants only rent their land to this foreign people, but do not produce their own honey.

We suggest further research studies on bees' biology as their flight capacity, which is a function of body size, for instance, small bees as *Plebeia droryana* (1.35 mm maximum forewing length) could become isolated in case of the distance between vegetation fragments are greater than 600 m. Species such as *Melipona compressipes* (3.25 mm) and *Melipona quadrifasciata* (2.90 mm), could be isolated if the forest fragments are more than 2 km apart (Meléndez *et al*., 2013). Therefore, the risk of extinction is greater in smaller species.

Another aspect worth considering is their behavior for dispersion within the research area; to do this, bees depend on the parental nest to provide the new nest with food and material for the construction of the new nest. In this sense, Cervantes y Lozada is immersed in the forest, supplying all the resources needed, and bees would not have to travel long distances to find the resources needed for their survival.

It is also important to emphasize that the melliferous flora supports ecosystem services, as the provisions for insects, birds, bats, etc., pollination, soil conservation, availability of food and habitat for the natural enemies of pests, as well as for the contribution of aesthetic and social services. On the other hand, these species have uses by humans, whether medicinal, food, coloring, ornamental, timber, fodder, agroforestry, fungicide, for restoration, ceremonies, fuel, construction, biofuel and/or handicrafts, which highlights the importance of the conservation of this flora, mainly composed of herbaceous plants (Albrecht *et al*., 2016; Hernández-Villa *et al*., 2020).

CONCLUSIONS

The melliferous flora of Cervantes y Lozada provided scientific knowledge of 76 species, distributed in 74 genera and 35 families. The most important families were Asteraceae, Malvaceae, Lamiaceae, Fabaceae, and Verbenaceae. Most species provide pollen as the principal resource for pollinators, 82.89 % are native and 55.26 % are herbaceous. Seven species provided resources for bees all year round, two for 10 months and the rest for shorter periods. The months with the most flowering species were May, July, November, and December.

The present study seeks to provide enough information about the melliferous flora; thus people would be able to promote their conservation, especially those that are generally considered weeds and normally grow in gardens, roadsides, and crops. Many of these plants are eliminated or prevented from growing, because we do not know how important they are for the ecosystem and indirectly to produce our food.

The species of melliferous flora have different uses, so this information will allow the development of strategies to protect and promote sustainable management for the conservation of the pollination service, which is essential for agriculture and ecosystems, as well as strategies to protect species that have social, ecological, and economic importance.

Based on the results and the knowledge that the inhabitants have about bees, an awareness campaign can be proposed to reduce the use of agrochemicals and avoid

the elimination of vegetation on roadsides and crop edges, which will contribute to a greater availability of resources for pollinators, favoring their conservation.

ACKNOWLEDGEMENTS

The valuable and active participation of the inhabitants of Cervantes y Lozada is gratefully acknowledged. The first author is grateful to the Doctoral Program in Natural Sciences for Development, coordinated by the Instituto Tecnológico de Costa Rica, the Universidad Nacional and the Universidad Estatal a Distancia. The second author thanks to the National Council of Humanities, Science and Technology (CONAHCyT) for the postdoctoral scholarship granted. Special thanks to the institutions that supported this work: Colegio de Postgraduados Campus Córdoba, and Centro de Estudios Geográficos, Biológicos y Comunitarios, S. C. (GEOBICOM). Finally, thanks to the anonymous reviewers who helped improve the manuscript.

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