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Geographical study and identification of plants with apicultural potential in Nayarit, Mexico

Estudio geográfico e identificación de plantas con potencial apícola en Nayarit, México

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ABSTRACT

Mexico is one of the main honey producing and exporting countries worldwide, this production depends on the quantity and botanical diversity found regionally, the characteristics of honey, its price and demand depend on it, hence the importance that beekeepers and authorities be aware of the geographical distribution and flowering times of plants with apicultural potential. This study aims to locate and to identify the plants with apicultural potential in Nayarit state. Given to this, a group of experienced beekeepers were surveyed. The producers reported type of flowers that bees regularly visit and their common local names for each plant. Every site and apiary were visited, locating them with geolocator and direct observations were made. Additionally, photographs of the flowers were taken, and samples of plants were collected for their identification. In the present study, 1,274 plant-samples were collected, and 82 different species were identified with the corresponding scientific name, common name, photograph, and geographic location, as well as 95 species were also identified with only common and scientific names. The work completed represents the first census of species whose flowering is of importance in the production of honey in the Nayarit region.

Keywords: bees, flowers, identification, honey.

RESUMEN

México es de los principales países productores y exportadores de miel a nivel mundial, esta producción depende de la cantidad y diversidad botánica encontrada regionalmente, de ella dependen las características de la miel, su precio y demanda, de ahí la importancia que los apicultores y autoridades tengan conocimiento, la distribución geográfica y épocas de floración de las plantas con potencial apícola. Por ello, el objetivo de este estudio fue localizar e identificar las plantas con potencial apícola en el estado de Nayarit. Con este fin, se realizaron encuestas a los apicultores del estado de Nayarit, para recopilar información sobre las plantas que las abejas visitan y los nombres comunes de cada una de ellas. Después se acudió a cada sitio donde estaban los apiarios y se realizó la observación directa de las flores, tomando registro fotográfico y ubicación georeferenciada para recolectar muestras de las plantas mencionadas para su futura clasificación e identificación. Se recolectaron 1274 muestras de plantas, y de estas se identificaron 82 especies diferentes de las que se cuenta con nombre científico, nombre común, fotografía y ubicación geográfica, además de otras 95 especies con solo nombre común y científico. El trabajo concluido resulta en el primer censo de especies cuya floración es de importancia en la producción de miel de abeja en la región nayarita.

Palabras clave: abejas, flores, identificación y miel.

INTRODUCTION

In the international honey market, the main producing countries are: China, United States of America, Mexico, Russia, Argentina, Canada, Germany and Japan, with 40%, but only the supply to the world market is provided by China, Argentina and Mexico, with 75% of total exports (García-Gómez and Meza-Ramos, 2013).

Mexico is one of the main honey producing and exporting countries worldwide, for this is important to study honey plants. To improve production, it is necessary for beekeepers and authorities to have knowledge of plants with beekeeping potential, their geographical distribution and flowering times. Studies have been carried out in various regions of the country for their location and type of plants (Araujo-Mondragón and Redonda-Martínez, 2019).

The melliferous flora of different regions has been studied, among them: Sierra de Mazatlán, Jalisco, Colima, Chiapas, Yucatán, the south of Valley of Mexico, Campeche, Zacatecas, Tabasco, the Valley of Mexicali and Baja California, among others. Campeche, Chiapas and Yucatán states are among the main honey producers in the country (Alaniz-Gutiérrez *et al.,* 2017; Araujo-Mondragón and Redonda-Martínez, 2019); so it is important to have this information in Nayarit.

The composition of nectar and pollen resources vary according to the distribution of different climates and flora. In Mexico, these differences allow defining defined areas with different degrees of development and variety of honeys, in terms of their characteristics of moisture, color, aroma and flavor. Therefore, the country is divided into five beekeeping regions: highlands, gulf, Pacific coast, north and Yucatan peninsula; which are: A) North Region: comprised of the entities of Baja California, Baja California Sur, Sonora, Chihuahua, Durango, Zacatecas, Coahuila, Nuevo León and northern part of Tamaulipas and San Luis Potosí highlands; which has the following characteristics: the production of excellent honey, mainly mesquite, which is an extra clear amber honey; B) Region of the Pacific Coast: formed by Sinaloa, Nayarit, west of Jalisco and Michoacán, Colima, part of Guerrero, Oaxaca and Chiapas states; its characteristics are: honeys of multifloral and mangrove origin, being mainly dark; C) Gulf Region: comprising Veracruz, part of the Tabasco states, Tamaulipas and the Huasteca Region of San Luis Potosí, Hidalgo and Querétaro; with the characteristics: derived from citrus honey, light amber honey produced mainly from the orange blossom, being highly appreciated internationally; D) Highland Region: made up of Tlaxcala, Puebla, Mexico, Morelos, Federal District, Guanajuato, Aguascalientes states, the eastern part of Jalisco states, Michoacán, Guerrero, Oaxaca and Chiapas; as well as the western part of Hidalgo and Querétaro, in the same way the middle region of San Luis Potosí, which has the characteristic of having amber honey and light honey (butter type), which is in demand in the European market; E) Southeast Region or Yucatan Peninsula: formed by Campeche, Yucatán and Quintana Roo and part of the states of Chiapas (Northeast) and Tabasco (East). The honey that is harvested is internationally recognized, being the most important for its production volume

and where most of the country's beekeepers are found (SAGARPA, 2018; García-Gómez and Meza-Ramos, 2013).

Nayarit is rich in honey and polyniferous plants, and this is used by beekeepers in the production of honey, generating an economy for their families. In addition to the fact that a large number of crops require the presence of bees for their pollination and improvement of production, plus the large number of mangroves, forests and jungles that depend on this insect for their conservation (Ulloa *et al.*, 2014).

The success of beekeeping depends on the plants that are around the apiaries, approximately with an approximate radius of 10 km, for this reason the beekeeper must accumulate experience and phenological knowledge, such as flowering dates, location, winds, excess of rains, water sources, fires; in addition to insecticides, fungicides, acaricides and herbicides that cause the death of pollinators or contaminate honey (SAGARPA, 2018; Vargas *et al*., 2020).

Data on the impact of human activities on flora reveal that 36.5% of these plants are affected by changes in land use, 35.5% are considered weeds, 7.5% suffered damage by pests and are also classified as weeds and 4.3% they are hosts of parasitic plants. Only 16.2% have no risk, since they are fruit trees or cultivated species (Hanan and Heike, 2015; Araujo-Mondragón and Redonda-Martínez, 2019). This information demonstrates the importance of preserving, protecting, including dissemination; which will result in a better environment.

The objective of this study was to locate and identify plants with beekeeping potential in the state of Nayarit.

MATERIAL AND METHODS

Nayarit state is located between the geographic coordinates of 20° and 23° of North Latitude and 103° and 106° of West Longitude, where the warm sub-humid climate predominates, with rains in summer; annual average temperature of 21.3 ºC, average rainfall of 1152.3 mm and altitude of 915 m above sea level. It is divided into 20 municipalities that make up six regions. The first region, called North, is made up of Acaponeta, Rosamorada, Ruiz, and Tuxpan municipalities; the second region, called Centro, is made up Tepic and Xalisco municipalities; the third region called South for its location, includes Ahuacatlán, Amatlán de Cañas, Ixtlán del Río, Jala, San Pedro Lagunillas and Santa María del Oro municipalities; the fourth region known as South Coast, groups together Bahía de Banderas and Compostela; the fifth region called Sierra, is made up of Huajicori, El Nayar and La Yesca; and finally the North Coast region, made up of San Blas, Santiago Ixcuintla and Tecuala (García-Gómez and Meza-Ramos, 2013).

A survey was conducted with the majority of the associated beekeepers in the Nayarit Beekeeping Product System, where they, with their experience, reported on the flowers that the bees visit and the common names of each plant. Afterwards, places where the

apiaries are settled were visited, locating them with a geolocator and direct observations, photographs of the flowers and collection of samples of the mentioned plants were made, for their future classification and identification according to the morphology and use of the keys. taxonomics in the Academic Unit of Agriculture of the Autonomous University of Nayarit, where the identification of the plants was carried out.

RESULTS AND DISCUSSION

1274 plant samples were collected, and from these 82 different species were identified, of which there are scientific names, common names, photographs and their location on independent maps, as a plant can be seen in figure 1. See Supplementary Information for all 82 species.

Figure 1*. Acacia pennatula* (Sclecht. y Cham.) Benth. Common name: tepame.

Below is a list of plant species, their common name, scientific name, number of places and percentage of the total places where they were found in Nayarit: guajillo (*Acacia angustissima* (Mill.) Kuntze) with 21 (2.77%), tepame (*Acacia pennatula* (Schltdl. and Cham.) Benth) with 9 (1.19%), capiro (*Albizia lebbeck* (L.) Benth.) with 2 (0.26%), cacanacuaste *(Apoplanesia paniculata* C. Presl) with 3 (0.40%), veintiunilla or venenillo or yerba del sapo (*Asclepias curassavica L*.) with 3 (0.40%), rosa de mayo or san miguel or san miguelito *(Antigonon leptopus* Hook. and Arn.) with 5 (0.66%), gigantillo or tendril *(Aeschynomene americana L*.) with 8 (1.06%), oreja de mula *(Asclepias glaucescens* Kunth) with 6 (0.79%), black mangrove (*Avicennia germinans* (L.) L.) with 19 (2.51%), annatto *(Bixa orellana* L.) with 10 (1.32%), tree chicalote or palo santo *(Bocconia arborea* S. Watson) with 11 (1.45%), capomo or ramón *(Brosimum alicastrum* Sw.) with 9 (1.19%), copalillo or corta pico (*Bursera penicillata* (DC.) Engl.) with 35 (4.62%), jiote (*Bursera simaruba* (L.) Sarg.) with 9 (1.19%), nanchi (*Byrsonima crassifolia* (L.) Kunth) with 18

(2.37%), tacote amarillo or manita de león *(Calea urticifolia* (Mill.) DC.) with 20 (2.64%), chivato *(Calliandra houstoniana* (Mll.) Standl.) with 10 (1.32%), obatel *(Casearia nitida* (L.) Jacq.) with 5 (0.66%), hierba de la golondrina (*Chamaesyce hirta* (L.) Millsp.) with 3 (0.40%), barbas de viejo or rabo de iguana (*Chamissoa altissima* (Jacq.) Kunth) with 3 (0.40%), barbas de chivo or clematis (*Clematis dioica* L.) with 5 (0.66%), yellow rose (*Cochlospermum vitifolium* (Willd.) Spreng.) with 8 (1.06%), botoncillo (*Conocarpus erectus* L.) with 20 (2.64%), mirasol amarillo (*Cosmos sulphureus* Cav.) with 9 (1.19%), cuastecomate or winged calabash (*Crescentia alata* Kunth) with 4 (0.53%), toloache or floripondio *(Datura stramonium* L.) with 5 (0.66%), guairaje *(Eugenia axillaris* (Sw.) Willd.) with 3 (0.40%), jarilla, chía real (*Galinsoga parviflora* Cav.) with 7 (0.92%), guásima *(Guazuma ulmifolia* Lam.) with 28 (3.69%), hincha huevos *(Hippomane mancinella* L.) with 5 (0.66%), thistle (*Hydrolea spinosa* L.) with 7 (0.92%), guapinol *(Hymenaea courbaril* L.) with 9 (1.19%), salvia or salvia real (*Hyptis albida* Kunth) with 21 (2.77%), *Hyptis suaveolens* (L.) Poit.) with 3 (0.40%), belén *(Impatiens balsamina* L.) with 2 (0.26%), campanilla or campanita (*Ipomoea batatas* (L.) Lam.) with 2 (0.26%), batatilla or. (*Ipomoea trifida* (Kunth) G. Don.), with 3 (0.40), campanilla *(Ipomoea triloba* L.) with 3 (0.40), sangregrado or sangre de grado *(Jatropha curcas* L.) with 5 (0.66%), nogal silvestre (*Juglans major* (Torr.) A. Heller) with 8 (1.06%), *Kallstroemia grandiflora* Torr. ex A. Gray with 2 (0.26%), alacate or bule (*Lagenaria siceraria* (Molina) Standl.) with 4 (0.53%), white mangrove *(Laguncularia racemosa* (L.) C. F. Gaertn.) with 20 (2.64%), Guachichil *(Loeselia mexicana* (Lamb.) Brand) with 8 (1.06%), hierba del golpe (*Lopezia racemosa* Cav.) with 8 (1.06%), *Ludwigia octovalvis (Jacq.) P.H. Raven* with 27 (3.56%), tepehuaje, palo fierro *(Lysiloma acapulcense* (Kunth) Benth.) with 2 (0.26%), manzanito *(Malpighia mexicana* A. Juss.) with 5 (0.66%), chilacayotillo or chilacayote *(Melothria pendula* L.) with 13 (1.72%), lechosa *(Mikania cordifolia (L.f.) Willd.)* with 4 (0.53%), cuatantillo or sierrilla (*Mimosa albida* Humb. and Bonpl. ex Willd.) with 6 (0.79%), coatante *(Mimosa pigra* L.) with 3 (0.40%), bálsamo *(Momordica charantia* L.) with 9 (1.19%), tabaco *(Nicotiana tabacum* L.) with 3 (0.40%), coquito de aceite *(Orbignya guacuyule* (Liebm. Ex Mart.) Hern.-Xol), palo de agua, zapote de agua or clavellina *(Pachira aquatica* Aubl.) with 2 (0.26%), *Paullinia sessiliflora* Radlk with 3 (0.40%), bean *(Phaseolus lunatus* L.) with 8 (1.06%), frijol blanco or white bean (*Phaseolus vulgaris* L.) with 12 (1.58%), *Phyla nodiflora* (L.) Greene with 2 (0.26%), guamúchil *(Pithecellobium dulce (Roxb.) Benth.)* with 7 (0.92%), Guamuchililo (*Pithecellobium lanceolatum* (Humb. and Bonpl. ex Willd.) Benth.) with 6 (0.79%), alinanché or salvia de playa (*Pluchea odorata* (L.) Cass) with 2 (0.26%), piojo (*Porophyllum punctatum* (Mill.) S.F. Blake) with 13 (1.72%), purslane (*Portulaca oleracea* L.) with 2 (0.26%), mammee *(Pseudobombax ellipticum* (Kunth) Dugand) with 7 (0.92%), guava tree *(Psidium guajava* L.) with 7 (0.92%), tapaojo or llamarada or mal de ojo *(Psittacanthus calyculatus* (DC.) G. Don) with 9 (1.19%), *Richardia scabra* L. with 5 (0.66%), higuerilla *(Ricinus communis* L.) with 4 (0.53%), *Salvia lasiocephala* Hook. and Arn. with 8 (1.06%), salvia morada *(Salvia mexicana* L.) with 18 (2.37%), *Sclerocarpus sessilifolius* Greenm with 5 (0.66%), chayotillo *(Sicyos deppei* G. Don.) with 8 (1.06%), malva amarilla (*Sida acuta* Burm. f.) with 18 (2.37%), huinar *(Sida rhombifolia* L.) with 23 (3.03%), primavera *(Tabebuia*

chrysantha (Jacq.) G. Nicholson) with 4 (0.53%), amapa or rosa morada *(Tabebuia rosea* (Bertol.) A. DC.) with 4 (0.53%), *Tagetes erecta* L. with 14 (1.85%), almond *(Terminalia catappa* L.) with 2 (0.26%), alolote (*Thevetia ovata* (Cav.) A. DC.) with 9 (1.19%), sunflower or girasol (*Tithonia tubiformis* (Jacq.) Cass.) with 4 (0.53%), asapescado (*Trichilia hirta* L.) with 6 (0.79%), (*Verbesina greenmanii* Urb.) with 9 (1.19%), *Vernonanthura patens* (Kunth) H. Rob. with 10 (1.32%), ahualamo *(Vitex mollis* Kunth) with 7 (0.9%2), malva de monte *(Waltheria indica* L.) with 10 (1.32%) and zinnia (*Zinnia angustifolia* Kunth) with 28 (3.69%).

The plants with the highest number of registered places were: copalillo or short pico (*Bursera penicillata* (DC.) Engl.) With 35 (4.62%), guásima (*Guazuma ulmifolia* Lam.) with 28 (3.69%), zinnia (*Zinnia angustifolia* Kunth) with 28 (3.69%) and calavera (*Ludwigia octovalvis* (Jacq.) PH Raven with 27 (3.56%).

Other 95 species with beekeeping potential found in Nayarit are hawthorn (*Acacia berlandieri* Benth.), Huizache, huinol (*Acacia farnesiana* (L.) Willd.), Cocoyul (*Acrocomia mexicana* Karw. Ex Mart.), *Agave americana* L., cashew (*Anacardium occidentale* L.), olive oil (*Bidens pilosa* L.), belladonna (*Atropa belladonna* (L.), mustard (*Brassica nigra* (L.) WDJ Koch), *Bursera graveolens* (Kunth) Triana and Planch, *Cajanus cajan* (L.) Huth, frijolillo (*Calopogonium caeruleum* (Benth.) C. Wright), palo blanco (*Casearia sylvestris* Sw.), White sapote (*Casimiroa edulis* La Llave and Lex.), Ceiba, pochote (*Ceiba aesculifolia* (Kunth) Britten and Baker F.), ceiba (*Ceiba pentandra* (L.) Gaertn.), *Citrullus vulgaris* Schrad., alcachofa cimarrona (*Cleome spinosa* Jacq.), coconut (*Cocos nucifera* L.), coffee (*Coffea arabica* L.), *Coleus blumei* Benth., *Cordia alba* (Jacq.) Roem. and Schult., amapa boba (*Cordia alliodora* (Ruiz and Pav.) Oken), huaché (*Cordia globosa* (Jacq.) Kunth), *Croton fragilis* Kunth, *Cryptostegia grandiflora* R. Br., *Cuscuta americana* L., *Erythroxylum havanense* Jacq., flor de noche buena (*Euphorbia pulcherrima* Willd. ex Klotzsch), *Funastrum clausum* (Jacq.) Schltr., *Genipa americana* L. jagua, algodón (*Gossypium hirsutum* L.), lirio del arroyo (*Hedychium coronarium* J. Koenig), hibisco (*Hibiscus rosa-sinensis* L.), *Ipomoea* nil (L.) Roth, *Lippia alba* (Mill.) NE Br. Ex Britton and *P. Wilson*, *Lonicera japonica* Thunb. Ex Murray, *Macfadyena unguis-cati* (L.) A.H. Gentry, *Baccharis trinervis* Pers., bejuco loco (*Cissus sicyoides* L.), malva cubierta (*Corchorus siliquosus* L.), water melon (*Cucumis melo* L.), mota (*Dalea tomentosa* (Cav.) Willd.), bejuco de jiote (*Gouania polygama* (Jacq.) Urb.), palo del Brasil (*Haematoxylon brasiletto* H. Karst.), *Hamelia patens* Jacq., salvia prieta (*Hyptis rhytidea* Benth), bastón de san Francisco (*Leonotis nepetifolia* (L.) R. Br.), guaje (*Leucaena macrophylla* Benth), monacillo (*Malvaviscus arboreus* Cav.), *Melanthera nivea* (L.) Small, paraíso (*Melia azedarach* L.), *Merremia aegyptia* (L.) Urb., basil (*Ocimum basilicum* L.), palo verde (*Parkinsonia aculeata* L.), guaco (*Parthenocissus quinquefolia* (L.) Planch.), avocado (*Persea americana* Mill.), *Piscidia piscipula* (L.) Sarg, cruz esína (*Pisonia aculeata* L.), bejuco huico (*Pithecoctenium echinatum* (Jacq.) Baill), llantén (Plantago major L.), chililllo (*Polygonum punctatum* Elliott), mareño (*Prosopis juliflora* (Sw.) DC.), Sugar cane or cane (*Saccharum officinarum* L.), cola de pato (Sagittaria lancifolia L.), amole (*Sapindus saponaria* L.), bejuco cuadrado (*Serjania triquetra* Radlk), zacate de agua (*Sesbania*

macrocarpa Muhl. ex Raf.), *Sida abutifolia* Mill., huinar chino (*Sida spinosa* L.), *Sideroxylon salicifolium* (L.) Lam., caoba (*Swietenia macrophylla* King), pastorcita (*Tagetes patula* L.), *Talipariti tiliaceum* (L.) Fryxell, verde lucero (*Thouinia paucidentata* Radlk), *Thunbergia grandiflora* Roxb, arnica (*Tithonia diversifolia* (Hemsl.) A. Gray), acahual (*Tithonia rotundifolia* (Mill.) SF Blake), *Toxicodendron radicans* (L.) Kuntze, *Tradescantia zebrina* Heynh, *Tridax dubia* Rose, *Turbina corymbosa* (L.) Raf., Chamizo, andan chino (*Viguiera dentata* (Cav.) Spreng), *Viguiera helianthoides* Kunth and *Vitex pyramidata* BLRob.

Many plants are considered as weeds, as indicated by a study in Nayarit, where 127 species were recorded as weeds (Hanan and Heike, 2015), of the total angiosperm genera present in Nayarit, which according to Villaseñor (2003) are 1028 and according to Téllez 968, of which 182 families and 3650 species were reported (Téllez, 1995). Even more extreme, Villaseñor and Espinosa (1998) made a list of 821 species considered weeds, which are at risk of elimination every day.

The plants found in this work agree with that reported by SAGARPA, which indicates the presence in this region of multifloral and mangrove plants (SAGARPA, 2018); Since in Nayarit there are eleven types of vegetation: the tropical subdeciduous and deciduous forests, the mesophilic mountain forest, the coniferous and Quercus forests, the palm grove, the mangrove, the *Byrsonima* and *Curatella* savanna, the gallery forest, aquatic vegetation, halophilic vegetation and secondary associations. The flora belongs to the neotropical kingdom, without ceasing to have a boreal representation; It was also located in the Caribbean region, which belongs to the province of the Pacific Coast (Téllez, 1995).

In a study carried out in Pátzcuaro region, Michoacan, Mexico, it was found that *Apis mellifera* visits and takes advantage of 93 different species (Araujo-Mondragón and Redonda-Martínez, 2019). In a study in honeys produced in Baja California state, the presence of *Tamarix spp*. (pino salado), in 100% of the analyzed honeys, followed by *Prosopis spp*. (mesquite and tornillo), *Medicago sativa* (alfalfa), *P*. *sericea* (Cachanilla) and the *Chen-Am* type (Chamizos and quelites), present in 92%, 90% and 87% of the samples analyzed respectively. Other pollen types with a high frequency of occurrence were: *Myrtaceae* (eucalyptus and red brush), in 81%, followed by *W*. *filifera* (fan palm), *S*. *irio* (mostacilla), *Poaceae* (pasture), and *S.* gooddingi (sauz), each one present in 76% of the samples analyzed. Others found with low values in the samples were: *Gossypium hirsutum*, *Baccharis salicifolia*, *Acacia saligna*, *Cucumis melo*, *Malvella leprosa*, *Heterotheca*, *Heliotropium curassavicum*, *Opuntia*, and *Populus fremontii* (Alaniz-Gutiérrez *et al.,* 2017).

SAGARPA recommends that beekeepers carry out work to recover native flora with a wide variety of shrubs, trees and flowers, where they can collect nectar and pollen, such as: collecting, conserving and reproducing seeds; in order to disseminate them to increase honey plants and therefore crops, especially if they bloom alternately (SAGARPA, 2018).

CONCLUSION

The present study reports the first census of 177 plant species, which are found by bees in Nayarit state, Mexico; from these, 82 plants have a scientific name, common name, photograph and geographic location. Also 95 species with apicultural potential are described, with the common and scientific name according to the botanical diversity of natural plant species or artificial production in Nayarit state and of which bees forage, it may be higher.

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Supplementary Information.

File 1. Plants with scientific name, common name, photography and their geolocation on independent maps.

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