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Distribution and Habitat in Mexico of *Dactylopius* Costa (Hemiptera: Dactylopiidae) and their Cacti Hosts (Cactaceae: Opuntioideae)

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Abstract

The distribution pattern of species of the genus *Dactylopius* Costa in Mexico was analyzed in relation to the distribution of their host plants (subfamily Opuntioideae) to evaluate the specificity of the insect-host association. The distribution of *Dactylopius* currently recognized is narrower than that of its hosts and probably is not representative. Therefore, a broader distribution of the *Dactylopius* species in correspondence with those of their hosts was hypothesized. Insects and their hosts were collected and georeferenced in 14 states of Mexico from 2005 to 2007. The distribution areas, maps, and habitat characteristics of *Dactylopius*, *Opuntia sensu stricto*, *Nopalea* and *Cylindropuntia* were determined on the basis of field collections and examination of museum collections. This information was complemented with information from the exhaustive examination of microscope slides from a local insect collection, plants from local herbaria, and literature reviews. The current distribution of the genus *Dactylopius* and its hosts included 22 and 25 states of Mexico, respectively, and *Dactylopius* had a continuous distribution according to its hosts, broader than recognized hitherto. The new georeferenced records of the five Mexican *Dactylopius* species are reported. Insects with morphological characteristics of *D. confusus* combined with those of *D. salmianus* were identified, as well as insects with characteristics of *D. opuntiae* combined with those of *D. salmianus*. These records suggest that the number of local *Dactylopius* species could be higher than previously thought or that possible new processes of hybridization between native and introduced species may be occurring.

Introduction

Insects of the genus *Dactylopius* Costa, the cochineals, and their cacti hosts *Opuntia*, *Nopalea*, *Cylindropuntia* and *Grusonia*, are endemic to the American Continent (Britton & Rose 1963, Bravo-Hollis & Sánchez-Mejorada 1978, Brummitt & Powell 1992, Anderson 2001). Interactions between these insects and cacti were known and profitably used for centuries by pre-Columbian Mesoamerican inhabitants for whom cacti were food and cochineals a source of dye (Casas & Barbera 2002, Chávez-Moreno *et al* 2009).

The genus *Dactylopius* includes nine species. *Dactylopius coccus* Costa, *D. ceylonicus* (Green), *D. confusus*

(Cockerell), *D. opuntiae* (Cockerell) and *D. tomentosus* (Lamarck) have been reported for North America (Portillo 2005), whereas *D. tomentosus* (Lamarck), *D. coccus* Costa, *D. ceylonicus* (Green), *D. confusus* (Cockerell), *D. opuntiae* (Cockerell), *D. austrinus* De Lotto, *D. confertus* De Lotto, *D. salmianus* De Lotto, and *D. zimmermanni* De Lotto have been reported for South America (Diodato *et al* 2004, Portillo 2005). Before our study, the five North American species of *Dactylopius* had been reported in the states of Baja California, Coahuila, Estado de México, Jalisco, Oaxaca, Puebla and Veracruz, in a large number of hosts belonging to *Opuntia*, *Cylindropuntia*, and *Grusonia* (Mann 1969, De Lotto 1974, Piña 1977, MacGregor & Sampedro 1983, Pérez-Guerra & Kosztarab 1992, Portillo & Zamarripa 1992, Miller 1996, Portillo & Vigueras-Guzmán 2003a,b). These *Dactylopius* hosts had also been reported in several other regions in Mexico (Britton & Rose 1963, Bravo-Hollis & Sánchez-Mejorada 1978, Colunga *et al* 1986, González *et al* 2001, Bravo-Hollis & Scheinvar 2002, Guzmán *et al* 2003, Scheinvar 2004, Reyes-Agüero *et al* 2005) (see Online Supplementary Material 1).

Studies by De Lotto (1974) and Pérez-Guerra & Kosztarab (1992) described the distribution of *Dactylopius* in Mexico, although they were mainly focused on taxonomic and ethno-biological aspects of the insects. Some reports (e.g., Pérez-Guerra & Kosztarab 1992, Portillo & Zamarripa 1992, Miller 1996) are catalogs or check lists of *Dactylopius* species and the states where they are localized, with scarce data about the features of their habitats (Pérez-Guerra & Kosztarab 1992, Miller 1996), with the most systematic, detailed report being the catalog of Mexican coccids of the family Dactylopiidae by MacGregor & Sampedro (1983). However, the distribution of host plants of the genera *Opuntia*, *Grusonia* and *Cylindropuntia* reported until now is wider than that of the insects (see Online Supplementary Material 2). However, information available on *Dactylopius* and their hosts lack precise descriptions of their distribution pattern and characteristics of their habitats.

Therefore, we aimed to determine the distribution pattern of *Dactylopius* in Mexico in relation to the distribution of *Opuntia*, *Grusonia* and *Cylindropuntia*, describing the main features of their habitats (altitude, vegetation, soil and climate). Our investigation was based on the hypothesis that the distribution of *Dactylopius* currently recognized is not representative and should be broader in correspondence with the distribution of their host plants and in accordance with the complex climate and biogeography of Mexico.

Material and Methods

A database for comparing the distribution areas of *Dactylopius* and their hosts was constructed based on: (1) an exhaustive literature review, (2) a meticulous examination of 262 specimens of opuntioids at Herbario Nacional de México (MEXU) and Herbario del Instituto de Botánica de la Universidad de Guadalajara (IBUG), (3) an examination of 367 microscope slides of *Dactylopius* at Colección Nacional de Insectos – Instituto de Biología, Universidad Nacional Autónoma de México (CNI-IB-UNAM) and (4) collected samples (see Online Supplementary Material 1-3). A geographic information system was constructed through ILWIS 3.3 mapping the geographic location of *Dactylopius* and their hosts data from our database.

Sampling area

To identify the interacting species and gather information on their distribution, species of cochineals and their hosts were sampled in the area enclosed between 98º and 104º northern latitude and 18º and 23º western longitude, comprising the states of Aguascalientes, Mexico City, Guanajuato, Hidalgo, Jalisco, Estado de México, Michoacán, Morelos, Oaxaca, Puebla, Querétaro, San Luis Potosí, Tlaxcala, Veracruz and Zacatecas. This area was chosen because it was considered to be the main reservoir of host species of *Dactylopius*.

Field collection of specimens

Dactylopius from 208 insect populations in 120 localities of 14 states of Mexico within the sampling area were collected on February, May to June and September 2005; April to June 2006 and February and November 2007. The number of collected samples was variable (from 25 to 100 specimens) depending on the size of the population. Male and female insects at different stages of development were collected. In the plants where insects were present in different portions of the same host, insects were collected separately from each portion. Samples were preserved in 70% ethanol. Samples of *Dactylopius* and their hosts were collected from wild populations, production and research centers, and urban and rural zones. Cladodes of *Opuntia*, *Nopalea* and *Cylindropuntia* were collected in triplicate for propagation. Specimens of *Dactylopius* were vouchered in the Hemiptera collection of CNI-IB-UNAM. Host plants, *Opuntia*, *Nopalea* and *Cylindropuntia* were vouchered in the area of desert-zone plants of the living collection of the Botanical Garden at the Centro de Investigaciones en Ecosistemas (CIEco-UNAM).

Identification of species of Dactylopius*,* Opuntia*,* Nopalea*, and* Cylindropuntia

Dactylopius specimens were identified using the taxonomic keys of De Lotto (1974), Pérez-Guerra & Kosztarab (1992) and de Haro & Claps (1995). The technique of de Haro & Claps (1995) was used to prepare 153 microscope slides with four to eight insects per slide. Slides were observed

under a light microscope (Olympus BX45, Olympus, Japan) coupled to a CDD camera (High Performance Pro-Series UTV 0.5 XC, model 1E08849, Japan) connected to a personal computer (Blue Code, Pentium IV). The captured images were analyzed with the program IPwin 32 (Image Pro version 4.5.1 XProf 22, 2000, for Windows 1998). The identity of *Opuntia*, *Nopalea* and *Cylindropuntia* was corroborated by comparisons to the literature (Britton & Rose 1963, Bravo-Hollis & Sánchez-Mejorada 1978, González *et al* 2001) and to specimens from the herbaria MEXU and IBUG. Some specimens were assigned their common name due to their morphological complexity.

Environmental database

The database included the following fields: the name of the insect species, host (portion of the plant where the insect was found), place of collection, i.e., the locality and state, geographic coordinates of localization, i.e., latitude, longitude and altitude, collection date and information reference. The data from our fieldwork, including new records, vegetation and soil types, were inserted into the previously generated database in a boldface typeset. The keys and descriptions of Peel *et al* (2007) were used to characterize the weather of the studied area.

Results

Dactylopius

The information from our database constructed from literature reviews, examination of opuntioids at MEXU and IBUG, observation of microscope slides of *Dactylopius* at CNI-IB-UNAM and collected samples, was used to draw the distribution maps of *Dactylopius* and their hosts of the genera *Opuntia*, *Nopalea*, *Cylindropuntia* and *Grusonia* (Fig 1). Specimens of the five *Dactylopius* species were collected: 175 of *D. ceylonicus*, 575 of *D. coccus*, 675 of *D. confusus*, 1200 of *D. opuntiae* and 200 of *D. tomentosus* (Fig 1). Our field observations are shown for each species (details of each species are given in the Online Supplementary Materials 1-3). As shown in Fig 2a, it was possible to obtain a larger number of records of populations with one or two species of insects and some other populations with three and four *Dactylopius* species and one state with the five species.

Dactylopius ceylonicus

The distribution of this species and its hosts is shown in Fig 1a. This species had been previously reported in six states of Mexico; on *O. fuliginosa* (Piña 1977) in Jalisco, on *O. ficus-indica* in Jalisco (MacGregor & Sampedro 1983) and Veracruz (Piña 1977), on *Opuntia* sp. in Estado de México, Morelos, Oaxaca, Veracruz (MacGregor & Sampedro 1983), Hidalgo (Piña 1977, MacGregor & Sampedro 1983) and Jalisco (MacGregor & Sampedro 1983, Portillo & Vigueras-Guzmán 2003a). Additionally, in this investigation, *D. ceylonicus* was collected for the first time in Mexico City and Hidalgo on *O. ficus-indica* and *Cylindropuntia imbricata*, respectively (Fig 1a). Like the rest of dactilopids, the cottony-white thin layer covering the insect's body characterizes this species.

Insect specimens were collected during April to June on the top portion of their hosts, on ripe cladodes of *Opuntia* with more than three levels of cladodes and on the areoles of prickly pears, in living fences with scarce vegetation and regosol. In November, *D. ceylonicus* was collected on the root nodules of *Opuntia* sp., in wild populations where xerophilous thickets and arenosol predominate. The presence of the insect is scarce without perceptible damage to its host. Specimens of this species collected in this work were localized within the previously reported altitude range of 950 m to 2650 m above sea level.

Dactylopius coccus

Its pulverulent white cover and a size larger than the rest of the species of the genus distinguish *D. coccus*. The distribution of this species and its hosts is shown in Fig 1b. It had been reported in five states of Mexico on *N. cochenillifera, O. atropes* (Portillo & Zamarripa 1992, Portillo & Vigueras-Guzmán 2003a,b), *O. ficus-indica,* and *O. jaliscana* (Portillo & Vigueras-Guzmán 2003a). In Jalisco on *N. cochenillifera* (Piña 1977, Miller 1996), *O. ficus-indica* (Piña 1977, MacGregor & Sampedro 1983), *O. pilifera* (Piña 1977), *O. hyptiacantha* and *O. tomentosa* (MacGregor & Sampedro 1983, Pérez–Guerra & Kosztarab 1992, Portillo & Vigueras-Guzmán 2003a,b). On *O. ficus-indica* in Oaxaca and Puebla (Mann 1969), on *Opuntia* sp. in Puebla, Veracruz (MacGregor & Sampedro 1983), Hidalgo (Piña 1977, MacGregor & Sampedro 1983), and Oaxaca (MacGregor & Sampedro 1983, Pérez–Guerra & Kosztarab 1992); another hosts, *O. crassa*, *O. fuliginosa, O. megacantha, O. streptacantha* and *O. undulata* in unspecified localities (Portillo & Vigueras-Guzmán 2003b), within the altitude range of 1250 m to 2200 m. In this study, *D. coccus* was collected from February to June, in research and production centers: Tlapanochestli in Santa María Coyotepec, Oaxaca; Nopaltepec A.L.P.R. in Nopaltepec, Estado de México and Campo Carmín S.P.R. de R.L. in Tetecalita, Morelos, where the species *O. ficus-indica* is used as the main host for culturing and processing the insect. Additionally, specimens were collected in localities close to those centers. The presence of *D. coccus* in wild localities of Estado de México, Mexico City on *O. ficus-indica* and *O. streptacantha* and in San Luis Potosí on *O. ficus-indica, O. robusta* spp. *larreyi* and *O. tomentosa* is reported here for the first time. The most frequent habitat of these cochineals was formed

by intensive cultures of *O. ficus-indica*, on rain-watered lands with the presence of nopale where the types of soil included vertisol, calcisol, xerosol, regosol, leptosol, and foezem, within the previously reported altitude range of 1654 m to 2845 m.

Dactylopius confusus

The distribution of this species and its hosts is shown in Fig 1c. The species had been previously reported in 11 states of Mexico, on *O. fuliginosa* in Jalisco (Portillo & Vigueras-Guzmán 2003a), on *O. pumila* in Oaxaca (Pérez-Guerra & Kosztarab 1992), on *Opuntia* sp. in Chihuahua (Mann 1969), Estado de México, Guanajuato, Guerrero, Hidalgo, Jalisco, Mexico City, Oaxaca, Puebla, San Luis Potosí, Tamaulipas (MacGregor & Sampedro 1983) and Morelos (MacGregor & Sampedro 1983, Pérez-Guerra & Kosztarab 1992); another hosts are *G. grahamii*, *C. imbricata, C. kleiniae, C. leptocaulis* and *C. tunicata* (Mann 1969), within the altitude range of 1100 m to 2200 m. In this work, examination of the morphological characteristics of specimens of *D. confusus* species resulted in two separate groups, designated here as *D. confusus* and *D. confusus* biotype 1, whose descriptions are as follow.

Dactylopius confusus - *description*

Insects with the typical morphology of this species were designated by this name (De Lotto 1974, Pérez-Guerra & Kosztarab 1992). They were collected from April to June, on *O. ficus-indica* in Mexico City, Hidalgo, Morelos and Puebla and on *O. ficus-indica* and on *O. fuliginosa*, *O. jaliscana, O. joconostle*, *O. spinulifera*, and *O. streptacantha* in Jalisco. Their presence in the states of Veracruz

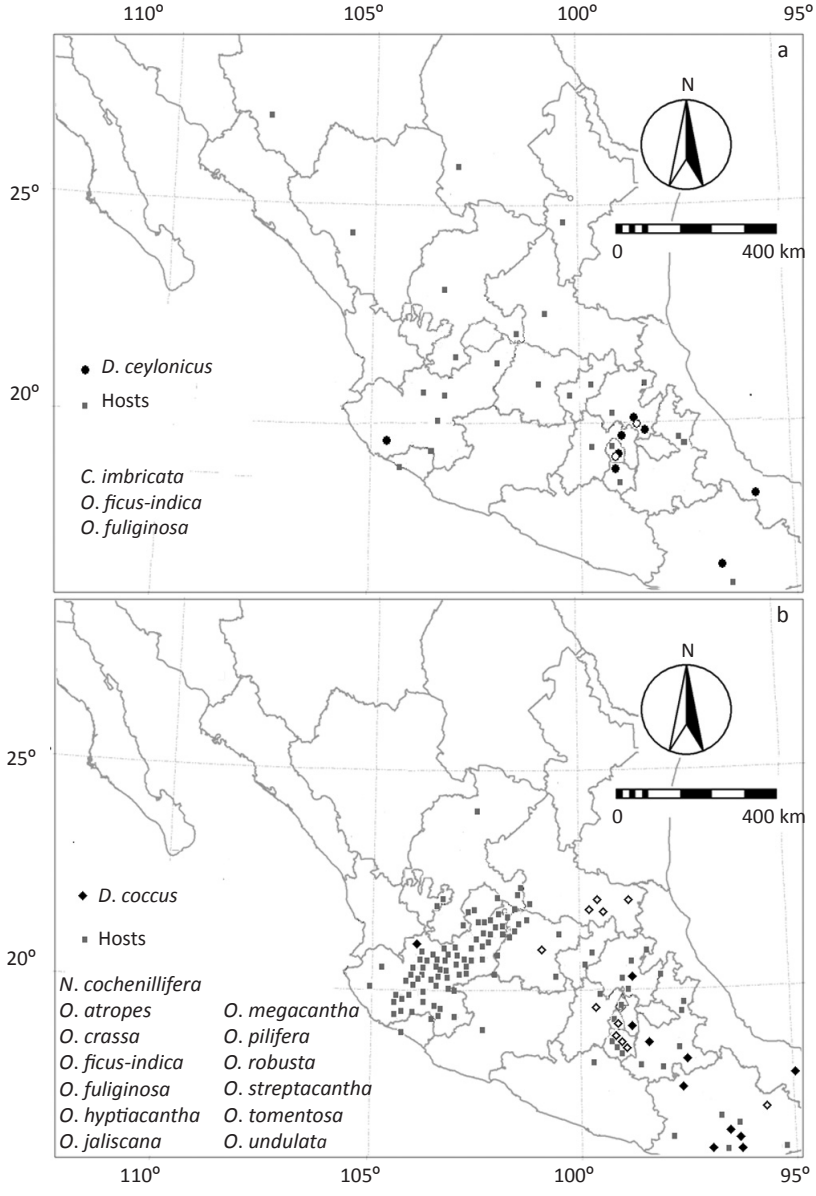

Fig 1 Records of distribution of *Dactylopius* and their hosts: *D. ceylonicus* (a), *D. coccus* (b), *D. confusus* (c), *D. opuntiae* (d) and *D. tomentosus* (e). Data compiled from Britton & Rose (1963), Bravo-Hollis & Sánchez-Mejorada (1978), González *et al* (2001), Guzmán *et al* (2003), and herbaria MEXU and IBUG. Insect records from Mann (1969), De Lotto (1974), Piña (1977), MacGregor & Sampedro (1983), Pérez-Guerra & Kosztarab (1992), Portillo & Vigueras-Guzmán (2003a,b) and new records (empty symbols) from the sampling area described in this study.

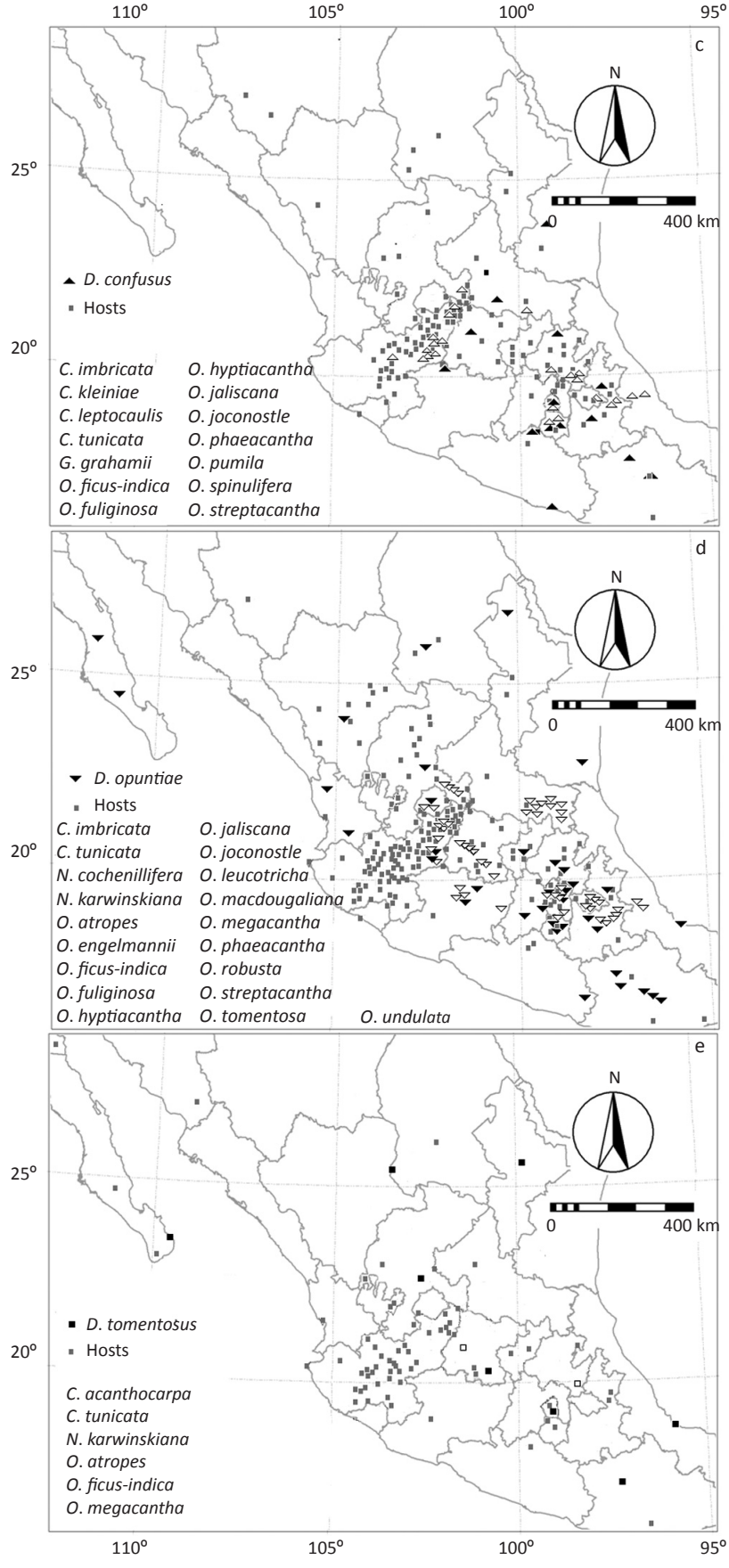

Fig 1 Continue

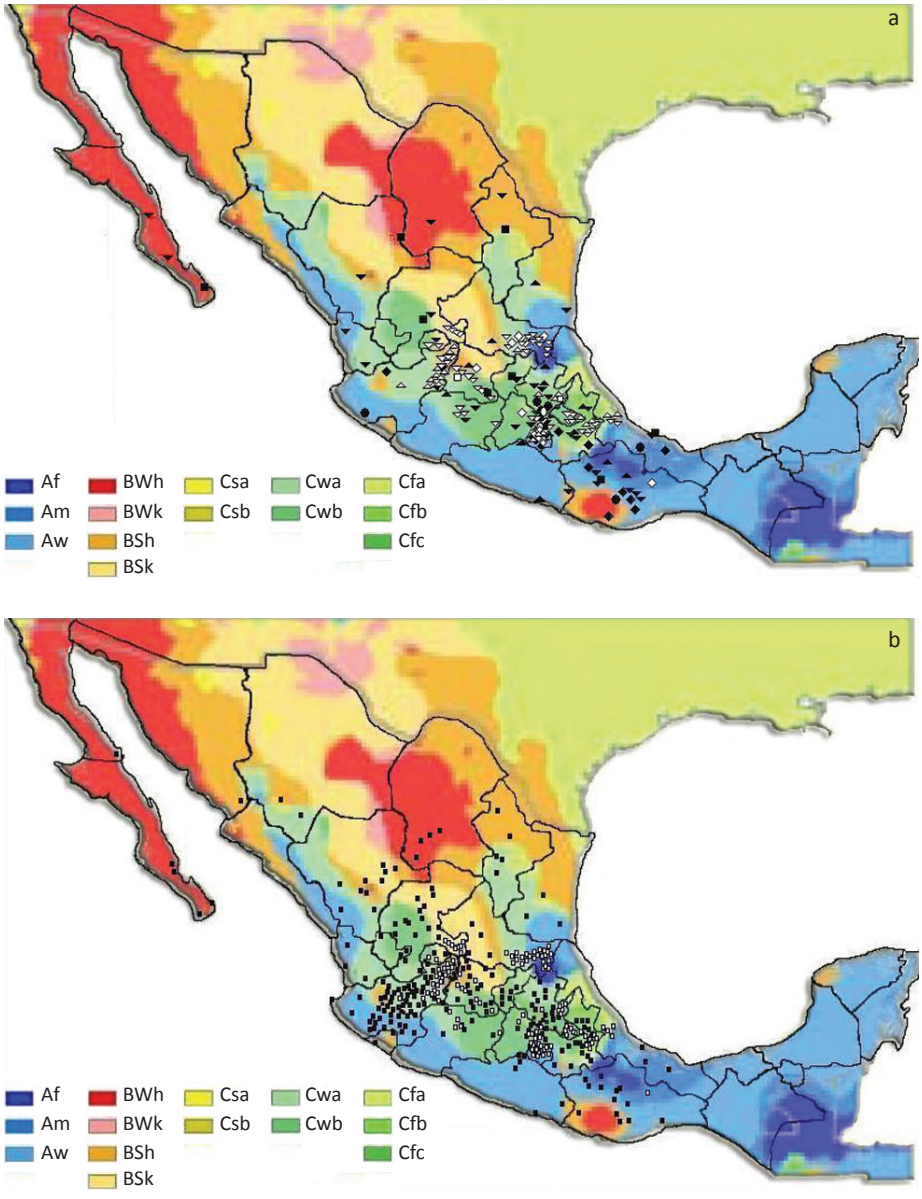

Fig 2 Distribution of (a) *Dactylopius ceylonicus* (circles), *D. coccus* (diamonds), *D. confusus* (triangles), *D. opuntiae* (inverted triangles), *D. tomentosus* (rectangles) and (b) *Dactylopius* hosts (squares) over the Köppen-Geiger climate type map of México (North America) extracted from Peel *et al* (2007). Data compiled from Britton & Rose (1963), Bravo-Hollis & Sánchez-Mejorada (1978), González *et al* (2001), Guzmán *et al* (2003) and herbaria MEXU and IBUG. Insect records from Mann (1969), De Lotto (1974), Piña (1977), MacGregor & Sampedro (1983), Pérez-Guerra & Kosztarab (1992), Portillo & Vigueras-Guzmán (2003a,b) and new records (empty symbols) from the sampling area described in this study.

on *Opuntia* sp. and Zacatecas on *O. hyptiacantha*, *O. phaeacantha* and *O. streptacantha* is reported here for the first time. Our field observations show that *D. confusus* grows mainly on the cladodes of tree and shrub cactus forms and on their prickly pear fruits in a predominantly desert habitat with scarce vegetation and arenosol, within the altitude range of 1200 m to 2547 m, which is higher than the previously reported altitude.

Dactylopius confusus *biotype 1 - description*

Insects with the morphological characteristics diagnosed for *D. confusus* (De Lotto 1974, Pérez-Guerra & Kosztarab 1992) combined with characteristics corresponding to the *D. salmianus* species were designated with this name. It is worth mentioning that *D. salmianus* has been reported only for South America (De Lotto 1974, Pérez-Guerra & Kosztarab 1992, de Haro & Claps 1995), without reports of its presence in Mexico. Insects were collected in the states of Hidalgo, Morelos, Puebla and San Luis Potosí on *O. ficus-indica* and Tlaxcala on *Opuntia* spp. and *C. tunicata*; additionally, *D. confusus* and *D. confusus* biotype 1 were collected in the states of Morelos cohabiting on the same host, *O. ficus-indica*.

Our field observations and records show that these insects promote changes in the color of cladodes and fruits, and when the insects are closely gathered at the trunk-stem and stem-fruit joints, these parts are damaged and may detach from the main plant body. Our data also show that *D. confusus* biotype 1 develops mainly on the cladodes of ripe tree or bush plants and prickly pear fruits in the urban zones and production cultures of *Opuntia* and on rain-watered lands in wild habitats where xerophilous

thickets growing on arenosol and calcisol predominate. The insects were localized within the altitude range of 1654 m to 2773 m.

Dactylopius opuntiae

The distribution of this species and its hosts is shown in Fig 1d. This species has the greatest number of records for the genus; it had been reported in 20 states of Mexico, on 17 species of Cactaceae. *D. opuntiae* on *N. cochenillifera*, *N. karwinskiana, O. atropes, O. ficus-indica, O. jaliscana, O. megacantha*, and *O. undulata* in Jalisco (Portillo & Vigueras-Guzmán 2003a); on *O. robusta* in Hidalgo and Veracruz (MacGregor & Sampedro 1983); on *N. cochenillifera* in Mexico City (Pérez-Guerra & Kosztarab 1992); on *N. cochenillifera, O. ficus-indica* and *O. tomentosa* in Oaxaca (MacGregor & Sampedro 1983); on *Nopalea* sp. in Michoacán (Piña 1977, Pérez-Guerra & Kosztarab 1992), Oaxaca and Tamaulipas (MacGregor & Sampedro 1983); on *Opuntia* sp. in Baja California, Durango, Estado de México, Michoacán, Oaxaca (MacGregor & Sampedro 1983, Pérez–Guerra & Kosztarab 1992), Morelos, Tamaulipas (Pérez–Guerra & Kosztarab 1992), Aguascalientes, Chiapas, Chihuahua, Mexico City, Guerrero, Hidalgo, Nayarit, Nuevo León, Puebla, Querétaro, Veracruz, Zacatecas (MacGregor & Sampedro 1983) and Jalisco (MacGregor & Sampedro 1983, González *et al* 2001); another hosts *O. vulgaris* (Pérez-Guerra & Kosztarab 1992), *O. engelmannii, O. fuliginosa*, *O. hyptiacantha, O. leucotricha*, *O. macdougaliana, O. streptacantha* (Mann 1969); within an altitude range of 25 m to 2678 m. Examination of the morphological characteristics of the insects of the species *D. opuntiae* resulted in two separate groups, designated here as *D. opuntiae* and *D. opuntiae* biotype 1, described as follows.

Dactylopius opuntiae – *description*

Insects with a typical morphology of this species (De Lotto 1974, Pérez-Guerra & Kosztarab 1992) were designated by this name. They were collected from February to September, on *O. hyptiacantha* in Aguascalientes, on *O. tomentosa* in Mexico City and Estado de México, on *O. hyptiacantha, O. jaliscana, O. joconostle, O. megacantha, O. robusta, O. streptacantha*, *O. tomentosa*, and *Opuntia* sp. in Jalisco, on *O. robusta* spp. *larreyi* in Puebla and on *O. albicarpa*, *O. hyptiacantha, O. robusta, O. robusta* spp. *larreyi*, and cultivars of *O. robusta* spp., *O. streptacantha*, *O. streptacantha* ssp. *aguirreana* Bravo and several cultivars in San Luis Potosí; in these localities and in Michoacán it was also collected on *O. ficus-indica*, on *O. joconostle, O. phaeacantha* and *O. streptacantha* in Zacatecas and on *Opuntia* sp. in Veracruz. Additionally, specimens and records of *D. opuntiae* in the states of Guanajuato and Tlaxcala on *O. ficus-indica* and *O. streptacantha* and *O. tomentosa*, respectively, are reported here for the first time.

Insects of this species develop on any portion of the plant, the cladodes, fruits, flower calyx and trunk, during any stage of host development. This is the most aggressive species of the genus; its development and invasive growth in the host plant promote changes in the color of the cladodes and fruits, the detaching of the cladodes and fruits when the insect grows on cladode-cladode, cladode-flower and cladode-fruit joints, and even death when the insects damage the trunk. The collected specimens were localized in all types of vegetation, soil and climates already reported for this genus, within an altitude of 750 m to 2845 m, which is higher than that reported by several sources.

Dactylopius opuntiae *biotype 1 – description*

Insects with typical morphological characteristics of *D. opuntiae* (De Lotto 1974, Pérez-Guerra & Kosztarab 1992), combined with characteristics corresponding to the species *D. salmianus,* were designated by this name. Unlike the species *D. confusus* and *D. opuntiae*, the species *D. salmianus* has a thinner and elongated body and the structures of the setae and pores are more elongated and more separated or dispersed over the insect body (De Lotto 1974, Pérez-Guerra & Kosztarab 1992). This insect was collected from February to September, on *O. atropes, O. ficus-indica* and *Opuntia* sp. in Guanajuato, *C. tunicata* in Jalisco, on *O. albicarpa*, *O. ficus-indica, O. streptacantha* and cultivars of *O. streptacantha* spp. in San Luis Potosí and on *O. ficus-indica* in Tlaxcala. Additionally, *D. opuntiae* and *D. opuntiae* biotype 1 were collected on *O. ficus-indica* in Mexico City and Michoacán cohabiting on the same host, *O. ficus-indica*. It was noticed that *D. opuntiae* biotype 1 was less aggressive than *D. opuntiae*. It develops mainly on cladodes and fruits and the aerial parts of its hosts. *Dactylopius opuntiae* biotype 1 was found in urban zones and production cultures of *Opuntia*, on rain-watered lands, in wild habitats where xerophilous thickets and other cacti growing on arenosol predominate, within an altitude range of 1663 m to 2773 m.

Dactylopius tomentosus

The distribution of this species and its hosts is shown in Fig 1e. No records for this species exist at CNI-IB-UNAM. In the literature, it is reported in eight states of Mexico; on *C. acanthocarpa* (Pérez–Guerra & Kosztarab 1992) and *O. megacantha* (MacGregor & Sampedro 1983) in Baja California, on *N. karwinskiana* in Oaxaca (Piña 1977, MacGregor & Sampedro 1983), on *Cylindropuntia* sp. in Jalisco (Portillo & Vigueras-Guzmán 2003b), Chihuahua, Oaxaca (Pérez–Guerra & Kosztarab 1992, Portillo & Vigueras-Guzmán 2003a), Guanajuato and Nuevo León (MacGregor & Sampedro 1983), on *Opuntia* sp. in Baja California (MacGregor & Sampedro 1983, Pérez–Guerra

& Kosztarab 1992), Coahuila, Mexico City, Guanajuato, Nuevo León and Oaxaca (MacGregor & Sampedro 1983), within the altitude range of 0 to 2500 m. *Dactylopius tomentosus* was collected from April to November, on *O. atropes* in Guanajuato and on *C. tunicata* in Hidalgo on species of the genera *Opuntia* and *Cylindropuntia*, within the previously mentioned altitude range. The insects develop exclusively on the cladodes of their hosts and their tiny size makes them almost imperceptible. They do not damage or promote changes in the plant and develop in a desert habitat where xerophilous thickets predominate, on vertisol and arenosol. The presence of spiders was frequently observed with this species.

Opuntia, Nopalea *and* Cylindropuntia

Our fieldwork revealed the presence of *Dactylopius* only on the genera *Opuntia* and *Cylindropuntia* (see Online Supplementary Material 3) . The species of hosts identified and recorded were: *Opuntia ficus-indica* (variants and cultivars), *O. streptacantha* (variants and cultivars), *O. robusta* (variants and cultivars), *O. tomentosa*, *O. albicarpa* (cultivar), *O. joconostle*, *O. hyptiacantha*, *O. jaliscana, O. phaeacantha*, *O. megacantha, O. fuliginosa*, *O. spinulifera*, *O. atropes*, *Cylindropuntia imbricata* and *C. tunicata* and in 20 cultivars. Insects were not found on some of the hosts previously reported in the literature (Online Supplementary Materials 1 and 3). For instance, we collected the species *Nopalea cochenillifera, N. karwinskiana* and *N. auberi* in Jalisco without observing the presence of the insects during our complete period of fieldwork.

Dactylopius was mostly found on tree and shrub cactus forms. The parts of the plant where the insect was localized were mainly the areoles of cladodes and fruits and the stem commissures, during the months of April to June (aerial cycle) and the rest of the year on the root nodules (latency period). The insects were collected only in Mexico City and Estado de México, in their aerial cycle throughout the year on *O. ficus-indica*. Fifty-three species and varieties of opuntiods were vouchered in the living collection of the desert zone plants of the Botanical Garden at CIEco-UNAM.

Vegetation, soil and weather

Dactylopius and their hosts develop on diverse types of vegetation; xerophilous thickets, and tropical dry, tropical deciduous and coniferous forests, in which insects share habitats with columnar cacti (*Stenocereus* spp.), pirul (*Schinus molle*), huizache (*Acacia* spp.), izotes (*Yucca* spp.) and maguey (*Agave* spp.). They can also be found in pine-oak forests, natural grasslands with or without weed vegetation, living collections and intensive cultures of nopale in monocultures or in association with rain-watered lands, home gardens, orchards, ornamental plants, and fragmented and anthropogenic lands. Likewise, the types of soil included arenosol, vertisol, calcisol, xerosol, leptosol and foezem.

As shown in Fig 2, the distribution of *Dactylopius* and their host included different climate types, which according to Köppen-Geiger's climate classification are BSh, BSk, and BWh for xerophilous thickets and natural grasslands, and Cfa, Cfb, Cwa, Cwb and Cwc for tropical dry, tropical deciduous, temperate coniferous and pine-oak forests and Aw and Am for tropical savannah (Peel *et al* 2007). BSh, BSk, and BWh correspond to arid to semiarid dry climates, where precipitation is less than the evapotranspiration potential, i.e., a hydric deficit, and annual temperatures lie around 18°C. Cfb, Cf, Cwa, Cwb, and Cwc indicate warm and humid climates, where the average temperature is 10°C in the warmest months, between 0 to 18°C in the coldest months and Aw y Am where precipitation of the driest month is below and above 100 MAP/25 respectively according to Peel *et al* (2007). As indicated by our data, the distribution of *Dactylopius* matches the distribution of their cacti hosts, but it is wider than previously reported (Fig 2).

Species associated with the genus Dactylopius

In this work, the recorded species of *Dactylopius* were found sharing hosts with ants (Hymenoptera: Formicidae), the lady beetles *Chilocorus* sp. and *Hyperaspis* sp. (Coleoptera: Coccinellidae), spiders (Araneae), the weaver worm *Laetilia coccidivora* (Lepidoptera: Pyralidae), the needle worm *Symherobius* sp. (Neuroptera: Hemerobidae) and undetermined beetles.

Discussion

Our research shows that the five species of *Dactylopius* have a continuous distribution broader than previously reported. The insects are localized in correspondence with their hosts in different ecosystems of the northern and central plateau and southeastern regions of Mexico (Fig 2), *Dactylopius* hosts are distributed within an altitude of 0 to 3900 m, which is higher than the *Dactylopius* distribution altitude which is in the range of 0 to 2845 m. Our fieldwork made it possible to recognize localities where one species of *Dactylopius* is present on one or different hosts or shares hosts with different species of *Dactylopius*, or where two, three and four species of insects coexist (Fig 2a). According to our data, the distribution area of the host species *Opuntia, Nopalea* and *Cylindropuntia*, is broader than previously recorded for *Dactylopius* (Fig 2b), what suggests that these insects can be found distributed over a larger area, in correspondence with their hosts. *Opuntia ficus-indica* was the most common and most widely distributed host.

Insects of the genus *Dactylopius* and their cacti hosts *Opuntia*, *Nopalea*, *Cylindropuntia* and *Grusonia*, are endemic

to the American Continent (Britton & Rose 1963, Bravo-Hollis & Sánchez-Mejorada 1978, Brummitt & Powell 1992, Anderson 2001). The distribution of *Dactylopiidae* in this continent has been divided into Nearctic and Neotropical regions. *Dactylopius opuntiae*, *D. coccus*, *D. ceylonicus*, *D. confusus*, and *D. tomentosus* are considered Nearctic and Neotropical, whereas *D. austrinus*, *D. confertus*, *D. salmianus* and *D. zimmermanni* are considered Neotropical (Rodríguez & Niemeyer 2000, Portillo 2005).

Our study shows that in Mexico the five species of *Dactylopius* and their hosts are localized mainly in arid and semiarid climates, where they have diversified, i.e. they are present in different hosts and localities. This distribution corresponds to the xeric areas. Additionally, the five *Dactylopius* species identified and recorded in Mexico are also present in South America, i.e. taxa with Nearctic Andean affinities diversified in Mexico. Studies of diverse species present in Mexico indicated that when species are present in the xeric area, have diversified there and have affinities with South American taxa, their geographic distribution can been considered as Neotropical and Nearctic distribution pattern (Llorente-Bousquets *et al* 1996). Therefore, from previous reports together with our records presented here on the distribution of the genus *Dactylopius* in North America, specifically in Mexico, it can be said that the distribution of this genus comprises the Nearctic and Neotropical regions and a portion of the Mexican transition zone (Morrone & Llorente 2003, Morrone 2004, 2005, Portillo 2005).

The biogeographical region of Mexico is of special interest because of its geological, geographical and biotic complexity (Llorente-Bousquets *et al* 1996). In this area the characteristics of cultural importance and biotic diversity converge due to the genetic richness generated in an enormous variety of climates (Fig 2), in areas with irregular-surface topography where man has selected and promoted the variation of species, in this case *O. ficus-indica* (Reyes-Agüero *et al* 2005) and *D. coccus* (Portillo 2005). The main outcome of this is the presence of a great richness of hosts species, of diverse geographical affinities and ages, that have been proposed to include lineages evolved *in situ* during the Cenozoic (Llorente-Bousquets *et al* 1996, Anderson 2001) and the existence of many ecosystems with mixtures of flora and fauna of different origins, whose evolution in this area has allowed them to differentiate from each other (Fig 2). Llorente-Bousquets *et al* (1996) propose that in the case of insects all this has configured a hybrid biota comprising principally boreal and austral native lineages.

On the other hand, Southwood (1973) suggested that in Hemiptera the abundance of insects associated with plants was proportional to plant recent abundance. According to our observations in the collecting sampling area, this is the case of *Dactylopius* which is associated with their cacti hosts in several localities, for instance in Jalisco, San Luis Potosí and Mexico City (Fig 2).

The distribution of *Dactylopius* in Mexico is continuous, maintains correspondence with the host plants and is broader than previously known. Within the studied area, localized between 98° to 104° northern latitude and 18° to 23° eastern longitude, comprising the states of Aguascalientes, Mexico City, Guanajuato, Hidalgo, Jalisco, Estado de México, Michoacán, Morelos, Oaxaca, Puebla, Querétaro, San Luis Potosí, Tlaxcala, Veracruz and Zacatecas, and extending mainly from the northern and central plateau to the southeast of Mexico. These zones are characterized by xerophilous thickets, and temperate coniferous and pine-oak forests, with a wide variety of soils (arenosol, vertisol, calcisol, xerosol, regosol, leptosol and feozem), climates ranging from arid to semiarid dry to warm and humid, within the altitude range of 0 to 2845 m. This work provides new georeferenced records about the five species of *Dactylopius* and their hosts not reported previously, further describing the distribution areas of the insects.

The presence of species of *Dactylopius* with different morphological characteristics cohabiting in the same locality on different portions of the same host was reported here for the first time. Insects with morphological characteristics of *D. confusus* and *D. opuntiae* blended with characteristics of *D. salmianus*, named here as *D. confusus* biotype 1 and *D. opuntiae* biotype 1, respectively, were identified in this work for the first time. This suggests the presence of new species not yet studied or the possibility of interspecific hybridization between the identified species. It could be also the product of polymorphism or polyphenism within the *Dactylopius* species. Polymorphism implies having multiple alleles of a gene within a population, usually expressing different phenotypes, while polyphenism implies the existence of a trait for which multiple, discrete phenotypes can arise from a single genotype as a result of differing environmental conditions (Southwood 1973). However, the presence of these characteristics should be the object of further studies.

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Online Supplementary Material 1

Chávez-Moreno CK, Tecante A, Casas A, Claps LE (2011) Distribution and Habitat in Mexico of *Dactylopius* Costa (Hemiptera: Dactylopiidae) and Their Cacti Hosts (Cactaceae: Opuntioideae).

Distribution of the species of *Opuntia*, *Nopalea*, *Cylindropuntia* and *Grusonia* in Mexico.

Species[a]	States[b] [references[c]]	*Dactylopius*[d] states[b] [references[e]]
C. acanthocarpa Engelm. & Bigelow	26[I, II]	E: 2,3[V]
C. imbricata Haworth	6, 10, 11, 12, 14, 17, 19, 24, 32[I]; 7[I, II]; 22[I, VI]	C: 7[I]; D: 33[I]
C. kleiniae D.C.	13[I, II]; 14, 24, 28, 32[I]	C: 7[I]
C. leptocaulis D.C.	14, 22[I]; 21[II]	C:7[I]
C. tunicata Link & Otto in Pfeiffer	7, 22[I] and center of Mexico [I, II]	C: 7[I]
G. grahamii Engelm	6[I, II]	C: 7[I]
N. cochenillifera (L.) Salm-Dick	15[IV]; 20[I]; 22[VI]	B: 15[VI]; 20[III, VII]; 33[IX]; D: 9[V]; 15[VIII]
N. karwinskiana Salm-Dick	8[I, II, V]; 15[I, IV, V]; 13, 16, 18, 20, 25, 26[I, V]	D: 15[VIII]; E: 20[III, IV]
O. amyclaea	cultured [I, II]	B: 33[IX]
O. atropes (Rose) Smith	1, 10, 22, 24 [VI]; 11[I, II, V]; 12[III]; 13, 17 [I, V]; 14[I, VI]; 15[IV, V]; 16[V]	B: 15[VI, VIII], 33[IX] D: 15[VIII]
O. crassa Haworth	9[I]; 11[II]; 12[III]	B: 33[IX]
O. engelmannii (*O. cantabrigensis**) Salm-Dick ex Engelm	11[II]; 14, 22, 24 [I, II, V]; 15[IV, V]	D: 33[I]
O. ficus-indica (L.) Mill.	1[II]; 11, 20[I]; 12[III]; 15[IV]; 21[I, VI]; 22[VI]	A: 15[IV]; 30[III]; B: 15[VIII]; 20[III, IV]; 21[I]; 33[IX]; D: 15[VIII]; 20[IV]; 33[I,IV]
*O. vulgaris** Tenore	cultured [II]	D: 33[VIII]
O. fuliginosa Griffiths	8,16[I]; 12[III]; 15[I, II, IV]; 22[VI]	A: 15[III]; B: 33[IX]; C: 15[VIII]; D: 33[I]
O. hyptiacantha F.A.C. Weber	1, 32 [I, V]; 11, 12, 14, 21, 24, 29[V]; 15[IV, V]; 20[II, V]; 22[V, VI]	B: 20[IV]; D: 33[I]
O. jaliscana Bravo	12[I, II, III, V]; 15[I, IV, V]; 16[I, II, V]	B: 15[VIII]; 33[IX]; D: 15[VIII]
O. leucotricha D.C.	10, 12, 14, 24, 32[I, V]; 11[II]; 15[IV, V]; 22[I, V, VI];	D: 33[I]
O. megacantha Salm-Dick	1[I, II, V]; 12[I, III, V]; 15[IV, V]; 24, 32[I, V]	B: 33[IX]; D: 15[VIII]; 33[I]; E: 2,3[IV]
O. pilifera F.A.C. Weber	20[I, V]; 21[I, II, V]; 29[V]	B: 20[III]; 33[IX]
O. pumila (Rose) Smiths	13, 20, 21[I]; 15[IV]; 17[I, II]; 22[VI]	C: 20[V]
O. robusta Wendland	6, 9, 10, 11, 13, 26[V]; 12[I, II, III, V]; 14[I]; 15[IV, V]; 16, 24[I, V]; 22[I, V, VI]; 32[I, II, V]	D: 14[IV]; 33[I]
O. streptacantha Lem.	1[II]; 9, 10, 11, 20, 21, 29 [V]; 12[II, III, V]; 14[II, V]; 15[IV, V]; 22[I, V, VI]; 24[I, II, V]; 32[I, V]	B: 33[IX]; D: 33[I]
O. tomentosa Salm-Dick	9[II, V]; 11[I, V]; 12[III, V]; 13, 14, 16, 17, 20, 21, 24[V]; 15[IV, V]; 22[V, VI]	B: 20[IV,V,VIII]; 33[IX] D: 20[IV]; 33[I]
*O. hernandezii** D.C. (Bravo)	cultured [II]	B: 20[VIII]; D: 20[IV]
*O. macdougaliana** (Rose) Bravo	20 [I] , 21[I, II]	D: 33[I]
O. undulada Griffiths	1[I, II]; 12[III]; 15[IV]	B: 33[IX]

Continue

[a]Nomenclature based on Anderson (2001), * = synonyms;
[b]1 = Aguascalientes, 2 = Baja California Norte, 3 = Baja California Sur, 4 = Campeche, 5 = Chiapas, 6 = Chihuahua, 7 = Coahuila, 8 = Colima, 9 = Mexico City, 10 = Durango, 11 = Estado de México, 12 = Guanajuato, 13 = Guerrero, 14 = Hidalgo, 15 = Jalisco, 16 = Michoacán, 17 = Morelos, 18 = Nayarit, 19 = Nuevo León, 20 = Oaxaca, 21 = Puebla, 22 = Querétaro, 23 = Quintana Roo, 24 = San Luis Potosí, 25 = Sinaloa, 26 = Sonora, 27 = Tabasco, 28 = Tamaulipas, 29 = Tlaxcala, 30 = Veracruz, 31 = Yucatán, 32 = Zacatecas, 33 = unknown;
[c]I = Bravo-Hollis and Sánchez-Mejorada (1978); II = Britton and Rose (1963); III = Colunga *et al*. (1986); IV = González *et al*. (2001); V = Guzmán *et al*. (2003); VI = Scheinvar (2004);
[d]A = *Dactylopius ceylonicus*, B = *D. coccus*, C = *D. confusus*, D = *D. opuntiae* and E = *D. tomentosus*;
[e]I = Mann (1969); II = De Lotto (1974); III = Piña (1977); IV = MacGregor and Sanpedro (1984); V = Pérez-Guerra and Kosztarab (1992); VI = Portillo and Zamarripa (1992); VII = Miller (1996); VIII = Portillo and Vigueras (2003a) and IX = Portillo and Vigueras (2003b).

Online Supplementary Material 2

Chávez-Moreno CK, Tecante A, Casas A, Claps LE (2011) Distribution and Habitat in Mexico of *Dactylopius* Costa (Hemiptera: Dactylopiidae) and Their Cacti Hosts (Cactaceae: Opuntioideae).

Consulted records of herborized species of *Opuntia* hosts to *Dactylopius*. Altitude in meters above sea level.

Locality (state[a])	Altitude	Collect No.[b]	Date	Reference
		O. atropes		
La mina (1)	1700	40007	30/08/1983	MEXU-UNAM
Tonalapa (13)	1000	3017	11/12/1972	MEXU-UNAM
Acatic (15)	1600	160	27/07/2002	IBUG-UDG
	1700	141574	08/04/1990	IBUG-UDG
	1700	6	04/04/1990	IBUG-UDG
Arandas (15)	2150	N/A	02/04/1977	IBUG-UDG
	2150	24984	22/03/1980	MEXU-UNAM
Atoyac (15)	1500	66	01/05/1986	IBUG-UDG
	1500	65	01/05/1986	IBUG-UDG
	1400	69	02/05/1986	IBUG-UDG
Cerro gordo (15)	1400	1279	20/04/1977	MEXU-UNAM
Cocula (15)	1400	248	09/03/1986	IBUG-UDG
	1700	261	09/03/1986	IBUG-UDG
	1600	247	09/03/1986	MEXU-UNAM
	1400	257	09/03/2006	MEXU-UNAM
Cuquio (15)	1800	56989	12/02/1986	IBUG-UDG
	1800	56989	12/02/1986	IBUG-UDG
	1700	1331	24/04/1993	IBUG-UDG
El Grullo (15)	900	1020	16/03/1984	IBUG-UDG
	1600	48	01/02/1986	IBUG-UDG
Juanacatlán (15)	1600	49692	18/03/1985	IBUG-UDG
	1600	49680	18/03/1985	IBUG-UDG
	2550	49683	18/03/1985	MEXU-UNAM
La Manzanilla de la Paz (15)	2100	177	22/06/1985	IBUG-UDG
Lagos de Moreno (15)	2000	1266	15/07/1991	IBUG-UDG
	2000	146835	22/07/1997	IBUG-UDG
Mascota (15)	1300	39045	13/04/1982	MEXU-UNAM
Nevado de Colima (15)	1500	40004	06/10/1983	IBUG-UDG
Nevado de Colima (15)	1500	40005	06/10/1983	IBUG-UDG
Ocotlán, Poncitlán (15)	2000	30124	08/03/1981	MEXU-UNAM
Poncitlán (15)	1600	41663	22/05/1984	MEXU-UNAM
Sn. Martín Hidalgo (15)	1900	766	21/04/1990	IBUG-UDG
Tamazula (15)	1700	30405	22/03/1981	MEXU-UNAM
	1700	30402	22/03/1981	MEXU-UNAM
Tecolotlán (15)	1200	46373	02/02/1985	MEXU-UNAM
Tenamaxtlan (15)	1500	46376	03/02/1985	IBUG-UDG

Continue

Locality (state[a])	Altitude	Collect No.[b]	Date	Reference
Tlajomulco (15)	1600	30125	01/03/1981	IBUG-UDG
Tolimán (15)	1200	1181	27/05/1990	IBUG-UDG
Tuxpan (15)	1150	49693	17/03/1985	IBUG-UDG
	1100	49689	17/03/1985	MEXU-UNAM
Barranca Huentitán (15)	N/A	1499	13/06/1986	IBUG-UDG
Cuernavaca (17)	2350	2391	06/03/1970	MEXU-UNAM
O. engelmannii				
La Paz (3)	50	1134	14/03/1994	MEXU-UNAM
Moyahua (32)	1200	888	28/04/1996	MEXU-UNAM
O. ficus-indica				
Zacatecas-Aguascalientes (1)	1400	6257	02/10/1983	MEXU-UNAM
Coyoacán (7)	N/A	6538	17/08/1999	MEXU-UNAM
El Cordonal (14)	300	964120	18/08/1998	MEXU-UNAM
Ameca (15)	1300	1267	10/06/1976	MEXU-UNAM
Tala (15)	1400	49682	18/03/1985	MEXU-UNAM
Zapopan (15)	2200	57004	--/03/1986	MEXU-UNAM
San Juan Mixtepec (20)	1600	OAX903	07/03/1997	MEXU-UNAM
Oyameles (21)	2850	3678	Undated	MEXU-UNAM
Cadereyta (22)	2100	3678	02/07/1984	MEXU-UNAM
O. fuliginosa				
Guadalajara-Nogales (15)	1200	29451	Undated	MEXU-UNAM
O. hyptiacantha				
Ecatepec de Morelos (11)	2400	2167	30/04/1976	MEXU-UNAM
Texcoco (11)	2300	1036	30/03/1973	MEXU-UNAM
O. jaliscana				
José de García (1)	2700	6200	31/10/1983	IBUG-UDG
Penjamo (12)	1700	652	03/09/1995	IBUG-UDG
Atemajac de Brizuela (15)	2350	45	01/07/1989	IBUG-UDG
Atoyac (15)	1500	70	02/05/1986	IBUG-UDG
Atoyac (15)	1400	68	02/05/1986	IBUG-UDG
Sayula-San Gabriel (15)	1400	1347	05/05/1993	IBUG-UDG
Concepción Buenos Aires (15)	1900	1250	10/06/1976	IBUG-UDG
	2100	74	20/05/1990	IZTA
El Picacho (15)	2100	2747	14/05/1992	IBUG-UDG
	2100	2748	14/05/1992	IBUG-UDG
Encarnación Díaz (15)	2300	239	27/04/1986	IBUG-UDG
Ixtlahuacan (15)	1300	1334	24/04/1993	IBUG-UDG
Jala (15)	2000	1254	14/06/1991	IBUG-UDG
Jesús María (15)	2050	2286	02/02/1986	IBUG-UDG
Jocotepec (15)	2000	44	01/02/1986	IBUG-UDG
Lagos de Moreno (15)	2100	390	04/07/1986	IBUG-UDG
	1600	590	27/09/1986	IBUG-UDG

Continue

Locality (state[a])	Altitude	Collect No.[b]	Date	Reference
Lagos de Moreno (15)	2100	396	05/06/1986	IBUG-UDG
	1900	69	12/10/1984	IBUG-UDG
Laguna de Sayula, Tapalpa (15)	2100	566	27/10/1994	IBUG-UDG
Manzanilla de la Paz (15)	1850	171	22/06/1985	IBUG-UDG
Ocampo (15)	1200	53	14/07/1984	IBUG-UDG
San Miguel el Alto (15)	1900	1054	10/09/1988	IBUG-UDG
Tepatitlán (15)	1800	284	27/04/1986	IBUG-UDG
Venustiano Carranza (15)	1300	290	18/03/1986	IBUG-UDG
Zapopan (15)	1600	41417	09/06/1984	IBUG-UDG
O. joconostle				
Valle de Santiago (12)	(i)	61	03/06/1981	MEXU-UNAM
Corralejo, Penjamo (12)	1700	692568	03/09/1995	MEXU-UNAM
San Miguel Allende (12)	1900	940416	04/06/1994	MEXU-UNAM
Alfajayucan (14)	1900	2332	22/03/1979	MEXU-UNAM
Guadalcazar (24)	1600	763386	15/03/1997	MEXU-UNAM
O. megacantha				
Valle de Santiago (12)	1800	PC-28	15/06/1980	MEXU-UNAM
	1800	PC-18	13/06/1980	MEXU-UNAM
Tapalpa (15)	2100	381552	30/09/1983	MEXU-UNAM
O. robusta				
San Miguel Allende (12)	1900	584	30/07/1995	MEXU-UNAM
O. streptacantha				
Pilotos (1)	2150	1263	11/02/1965	MEXU-UNAM
Jilotepec de Abasolo (11)	2450	73	04/10/1986	IZTA
	2450	72	04/10/1986	IZTA
Jocotitán (11)	3900	145	18/10/1987	IZTA
San Luis de la Paz (12)	2000	T-126	21/02/1994	MEXU-UNAM
Ocampo (12)	2200	54	14/07/1984	MEXU-UNAM
Valle de Santiago (12)	2000	PC100	08/06/1981	IZTA
Arandas (15)	1800	152220	14/05/1992	MEXU-UNAM
El Cuarenta (15)	1750	1488	14/07/1997	MEXU-UNAM
	2150	1486	21/07/1997	MEXU-UNAM
Encarnación Díaz (15)	2200	289	27/04/1986	IBUG-UDG
Encarnación Díaz (15)	1750	1443	17/05/2001	MEXU-UNAM
Encarnación Díaz (15)	1950	289	27/04/1986	MEXU-UNAM
Lagos de Moreno (15)	1900	198	Undated	MEXU-UNAM
	2200	204	13/10/1984	MEXU-UNAM
	1800	599	28/09/1986	MEXU-UNAM
	1900	821	11/06/1987	MEXU-UNAM
	2000	430	15/06/1986	MEXU-UNAM
	2000	592	27/09/1986	MEXU-UNAM
	2000	347	22/05/1997	MEXU-UNAM

Continue

Locality (state[a])	Altitude	Collect No.[b]	Date	Reference
Lagos de Moreno (15)	2000	1491	22/07/1997	MEXU-UNAM
	2000	1484	21/07/1997	MEXU-UNAM
	2100	1488	21/07/1997	MEXU-UNAM
	2000	821	11/06/1987	MEXU-UNAM
Los Alpes (15)	1900	204	21/09/1985	MEXU-UNAM
Ojuelos (15)	2200	415	14/06/1986	MEXU-UNAM
	2200	200	22/09/1985	MEXU-UNAM
	2200	127	16/06/2000	MEXU-UNAM
	2200	132	16/06/2000	MEXU-UNAM
Picacho (15)	1900	2746	22/07/1992	MEXU-UNAM
San Juan de los Lagos (15)	2200	1273	15/05/1977	MEXU-UNAM
	1750	1276	01/05/1977	MEXU-UNAM
San Miguel el Alto (15)	2300	1053	10/09/1988	MEXU-UNAM
Villa de Hidalgo (15)	2300	1385	17/11/1989	MEXU-UNAM
Tequisquiapan (22)	1900	7867	19/03/1992	MEXU-UNAM
Corral de Palmas (24)	2300	18020	27/10/1983	MEXU-UNAM
Charoas (24)	2200	22179	08/12/1988	IZTA (100556)
El Alamillo (32)	1800	75	12/08/1989	MEXU-UNAM
		O. tomentosa		
Ixtapalapa (9)	2300	1100A	17/05/1973	MEXU-UNAM
Metztitlán (14)	1900	1800	05/11/2000	MEXU-UNAM
Xaltocan (29)	2500	2470	25/07/1980	MEXU-UNAM

[a]1 = Aguascalientes, 2 = Baja California Norte, 3 = Baja California Sur, 4 = Campeche, 5 = Chiapas, 6 = Chihuahua, 7 = Coahuila, 8 = Colima, 9 = Mexico City, 10 = Durango, 11 = Estado de México, 12 = Guanajuato, 13 = Guerrero, 14 = Hidalgo, 15 = Jalisco, 16 = Michoacán, 17 = Morelos, 18 = Nayarit, 19 = Nuevo León, 20 = Oaxaca, 21 = Puebla, 22 = Querétaro, 23 = Quintana Roo, 24 = San Luis Potosí, 25 = Sinaloa, 26 = Sonora, 27 = Tabasco, 28 = Tamaulipas, 29 = Tlaxcala, 30 = Veracruz, 31 = Yucatán, 32 = Zacatecas, 33 = unknown; [b]Herbarium number; N/A = Not available.

Online Supplementary Material 3

Chávez-Moreno CK, Tecante A, Casas A, Claps LE (2011) Distribution and Habitat in Mexico of *Dactylopius* Costa (Hemiptera: Dactylopiidae) and Their Cacti Hosts (Cactaceae: Opuntioideae).

Database for the genus *Dactylopius*: hosts, georeferenced distribution, collector, vegetation type and soil. Data from the fieldwork of this investigation are shown in boldface typeset. Altitude in meters above sea level.

Host [a] (plant portion [b])	Locality [c]	Altitude	Collect No. [d] (reference [e])	Date	Vegetation [f]/soil [g]
		D. ceylonicus			
17i	Chapingo (11)	2334	DTY-RMG 516(II)	09/09/1964	*
17i	Teotihuacan (11)	2300	DTY-RMG 1155(II)	23/11/1978	*
19	Tlapacoya (11)	1150	DTY-RMG 1309(II)	25/08/1981	*
17i	Acahuatlán (14)	1000	1391(II)	08/08/1961	*
17i	Actopan (14)	2000	DTY-RMG 1087(II)	14/04/1979	*
17	Actopan (14)	2000	DTY-RMG 1187(II)	14/04/1977	*
19	Meztitlán(14)	2000	1390(II)	05/11/1982	*
17i	Pachuquilla (14)	2400	DTY-RMG 848(II)	12/09/1970	*
17	Singuilucan (14)	2650	DTY-RMG 1192(II)	13/08/1979	*
6	Autlán Navarro (15)	950	DTY-RMG 1041(II)	02/07/1975	*
17i	Cuautla (17)	1300	DTY-RMG 516(II)	08/07/1961	*
19iii	Coixtlahuaca (20)	2100	DTY-RMG 1021(II)	18/07/1973	*
17i	Ejutla (20)	1450	DTY-RMG 1034(III)	09/02/1975	*
17i	Nochistlán (20)	2067	DTY-RMG 602	27/05/1966	*
19	Chacaltianguis (30)	1100	DTY-RMG 747(II)	06/08/1961	*
6 (C)	**Milpa Alta (9)**	**2459**	**DTY-ChM 110**	**28/06/2005**	**3 / I**
1 (C)	**Tepeapulco (14)**	**2364**	**DTY-ChM 127**	**29/06/2005**	**3 / III**
		D. coccus			
17	Meztitlán (14)	2000	DTY-RMG 1317(II)	10/07/1981	*
6	Amatengo (20)	1400	DTY-RMG 1157(II)	24/11/1978	*
19vi	Amatengo (20)	1400	DTY-RMG 115(II)	24/11/1978	*
*	Amatengo (20)	1400	RMG173(II)	27/02/1952	*
17i	Coixtlahuaca (20)	2200	DTY-RMG 1003(II)	08/05/1974	*
19iv	Coixtlahuaca (20)	2100	DTY-RMG 1016(II)	17/07/1973	*
19ii	Coixtlahuaca (20)	2100	DTY-RMG 1019(II)	18/02/1975	*
17	San Antonio Abad (20)	2200	DTY-RMG 1133(II)	08/08/1978	*
19v	Tepelmeme (20)	2100	DTY-RMG 1017(II)	18/02/1975	*
*	Tunillo (20)	2100	DTY-RMG 752(II)	09/01/1961	*
8	Zona Mixteca (20)	1250	DTY-RMG 1025(V)	06/02/1975	*
17	Cacaloapan (21)	1892	DTY-RMG 991	05/04/1973	*
19	Chacaltianguis (30)	1100	(II)		*
6 (C)	**Ajusco (9)**	**2898**	**DTY-ChM 115**	**28/06/2005**	**5,12,15 / I**
15	**IB-UNAM (9)**	**2309**	**DTY-ChM 117**	**28/06/2005**	**2 / IV**
6 (C)	**Milpa Alta-Oaxtepec (9)**	**2457**	**DTY-ChM 109**	**28/06/2005**	**3 / I, IV**

Continue

Host [a] (plant portion[b])	Locality[c]	Altitude	Collect No.[d] (reference[e])	Date	Vegetation[f]/soil[g]
6 (C)	**Milpa Alta-Oaxtepec (9)**	**2166**	**DTY-ChM 113**	**28/06/2005**	**3 / I, IV**
6 (C)	**Milpa Alta-Oaxtepec (9)**	**2323**	**DTY-ChM 114**	**28/06/2005**	**3 / I**
6 (C)	**Nopaltepec (11)**	**2425**	**DTY-ChM 101**	**20/02/2007**	**3,12 /I**
6 (C)	**San Felipe (12)**	**1776**	**DTY-ChM 096**	**04/06/2005**	**1 / III**
6 (C)	**Tetecalita (17)**	**1203**	**DTY-ChM 188**	**20/02/2007**	**3,12 /I**
6 (C)	**Santa María Coyotepec (20)**	**1527**	**DTY-ChM 187**	**05/02/2005**	**3,12 / I**
6 (C)	**IIZD (24)**	**1654**	**DTY-ChM 087**	**04/06/2005**	**9,2 / I,IV**
13i (C)	**IIZD (24)**	**1654**	**DTY-ChM 087**	**04/06/2005**	**9,2 / I,IV**
16 (C,T)	**IIZD (24)**	**1654**	**DTY-ChM 087**	**04/06/2005**	**9,2 / I,IV**
18ii (C)	**INIFAP (24)**	**1663**	**DTY-ChM 067**	**03/06/2005**	**2 / I,III**
		D. confusus			
17	Cerro Chilicote (6)	1200	(II)	*	*
17	Distrito Federal (9)	2376	(II)	*	*
17i	Tacuba (9)	1700	DTY-RMG 323(II)	10/09/1953	*
17ii	Dolores Hidalgo (12)	1950	DTY-RMG 554(II)	04/10/1967	*
*	Río Papagayo (13)	100	(II)	*	*
17	Taxco (13)	1600	(II)	*	*
19	Ihuatlán (14)	2100	DTY-RMG 1018(II)	17/07/1973	*
*	Cuautla (17)	1300	(II)	*	*
*	Cuernavaca (17)	1450	(II)	*	*
19iii	Ihuatlán (20)	2100	DTY-RMG 1015(II)		*
*	Petlalcingo (20)	1367	(II)	*	*
17i	Tehuantepec (20)	1600	DTY-RMG 1158(II)	25/12/1978	*
17i	Tepelmeme (20)	2100	(II)	*	*
*	Cacaloapan (21)	1892	(II)	*	*
17i	Yautepec (21)	1200	(II)	*	*
17i	SLP-Matehuala (24)	1200	DTY-RMG 1170	30/03/1979	*
6 (C,T)	**Milpa Alta (9)**	**2469**	**DTY-ChM 108**	**28/06/2005**	**3 / I**
6 (C)	**Ciudad Sahagún (14)**	**2457**	**DTY-ChM 128**	**29/06/2005**	**3 / I,III**
6 (C)	**Tepeapulco (14)**	**2364**	**DTY-ChM 125**	**29/06/2005**	**8 / III**
6 (C,T)	**Lagos de Moreno (15)**	**1803**	**DTY-ChM 150**	**09/04/2006**	**9 / I,IV**
7 (C,T)	**Lagos de Moreno (15)**	**1689**	**DTY-ChM 148**	**09/04/2006**	**9 / I,IV**
9 (C,T)	**Lagos de Moreno (15)**	**1689**	**DTY-ChM 148**	**09/04/2006**	**9 / I,IV**
10 (C,T)	**Lagos de Moreno (15)**	**1828**	**DTY-ChM 152**	**09/04/2006**	**9 / I,IV**
14 (C)	**Ojuelos (15)**	**2166**	**DTY-ChM 167**	**10/04/2006**	**9 / III**
14 (C)	**Ojuelos (15)**	**2167**	**DTY-ChM 168**	**10/04/2006**	**9 / III**
15 (C)	**Ojuelos (15)**	**2166**	**DTY-ChM 169**	**10/04/2006**	**9 / III**
6 (C)	**Oaxtepec (17)**	**2323**	**DTY-ChM 114**	**28/06/2005**	**5,12,15 / I**
6 (C)	**Zayaleta (21)**	**2375**	**DTY-ChM 138**	**30/06/2005**	**3 / I, III**
17i (C)	**Perote (30)**	**2367**	**DTY-ChM 142**	**30/06/2005**	**3 / III**
17i (C)	**San Antonio Limón (30)**	**2547**	**DYT-ChM 138**	**30/06/2005**	**3 / III, V**
12 (C)	**Noria de Ángeles (32)**	**2196**	**DTY-ChM 176**	**11/04/2006**	**4,10 / III**

Continue

Host [a] (plant portion[b])	Locality[c]	Altitude	Collect No.[d] (reference[e])	Date	Vegetation[f]/soil[g]
15 (C)	**Villa Hidalgo (32)**	**2196**	**DTY-ChM 179**	**11/04/2006**	**4,10 / III**
8 (C)	**Villa Hidalgo (32)**	**2196**	**DTY-ChM 179**	**11/04/2006**	**4,10 / III**
			***D. confusus* Biotype 1**		
6 (C)	**Tepeapulco (14)**	**2364**	**DTY-ChM 127**	**29/06/2005**	**3 / III**
6 (C)	**Oaxtepec (17)**	**2323**	**DTY-ChM 114**	**28/06/2005**	**5,12,15 / I**
19 vii (C)	**Zayaleta (21)**	**2375**	**DTY-ChM 138**	**30/06/2005**	**7 / III**
6 (C)	**IIZD (24)**	**1654**	**DTY-ChM 087**	**04/06/2005**	**9,2 / I,IV**
2,17i (C)	**Huamantla (29)**	**2773**	**DTY-ChM 133**	**30/06/2005**	**3 / I,III**
			D. opuntiae		
17i	Aguascalientes (1)	1900	(II)	*	*
17i	La Paz (2)	25	DTY-RMG 805(II)	Undated	*
17	La Palma Distrito Sur (3)	250	(II)	*	*
17	San Cristóbal Casas (3)	350	DTY-RMG 464(II)	21/04/1954	*
17i	San Cristóbal Casas (3)	350	DTY-RMG 464(II)	21/04/1954	*
19	Distrito Federal (9)	2300	DTY-RMG 159(II)	14/02/1952	*
*	Contreras (9)	1650	(II)	*	*
19	San Ángel (9)	2600	DTY-RMG 50(II)	28/02/1951	*
17i	Tlalpan (9)	2600	DTY-RMG 1038(II)	18/04/1975	*
17	Xochimilco (9)	2245	DTY-RMG-438(II)	24/04/1960	*
17i	Durango (10)	1900	(II)	*	*
*	Acolman (11)	2300	(II)	*	*
17	Chapingo (11)	2334	DTY-RMG 461(II)	03/06/1954	*
*	Otumba (11)	2400	(II)	*	*
19	Teotihuacan (11)	2300	DTY-RMG 153(II)	16/02/1952	*
*	Tepenahuac (11)	2424	(II)	*	*
*	Tepozotlán (11)	1600	(II)	*	*
19	Texcoco (11)	2300	DTY-RMG 607(II)	18/08/1966	*
17i	Tlalmanalco (11)	2400	(II)	*	*
17i	Toluca (11)	2678	DTY-RMG 805	Undated	*
13	Dextiu (13)	2000	DTY-RMG 1425(II)	18/02/1983	*
19	Río Papagayo (13)	100	DTY-RMG 165(II)	20/02/1952	*
17i	Arenal (14)	2050	DTY-RMG 1079(II)	29/06/1977	*
13	Atocpan (14)	2000	1421(IV)	16/02/1983	*
17	Atocpan (14)	2000	1426(IV)	18/02/1983	*
13	Atocpan (14)	2000	DTY-RMG 1421(II)	18/02/1983	*
17i	Meztitlán (14)	2000	1392(II)	05/11/1982	*
17	Pachuca (14)	2419	DTY-RMG 1124	17/02/1978	*
17i	Pachuca (14)	2000	DTY-RMG 671(IV)	05/05/1967	*
17i	Pachuca (14)	2000	DTY-RMG 671(II)	05/05/1967	*
17	Atenquique (15)	2000	DTY-RMG 962(IV)	08/07/1972	*
17i	Ocotlán (15)	2200	(I)	*	*
3	Morelia (16)	1900	(II)	*	*

Continue

Host [a] (plant portion[b])	Locality[c]	Altitude	Collect No.[d] (reference[e])	Date	Vegetation[f]/soil[g]
17i	Acahuatlán (18)	1000	DTY-RMG 169(II)	29/02/1952	*
17i	Sabinas Hidalgo (19)	300	(II)	*	*
*	Amatengo (20)	1400	1392/(II)	*	*
16	Coixtlahuaca (20)	2100	DTY-RMG 1156(II)	24/02/1978	*
19	Coixtlahuaca (20)	2100	DTY-RMG 1022(II)	19/07/1973	*
19iii	Coixtlahuaca (20)	2100	DTY-RMG 1015(II)	17/06/1973	*
17i (C)	Ejutla (20)	1450	DTY-RMG 1004(II)	08/05/1974	*
16i	Ejutla (20)	1450	DTY-RMG 1004(II)	08/04/1974	*
17	Nochistlán (20)	2067	DTY-RMG 1030(II)	07/02/1975	*
17i	Oaxaca (20)	1600	DTY-RMG 1024(II)	02/11/1974	*
17	Sinaxtla (20)	2076	DTY-RMG 1028	07/02/1975	*
17	Tehuantepec (20)	1600	DTY-RMG 1031(II)	08/02/1975	*
17ii	Tehuantepec(20)	1600	DTY-RMG 1031(II)	08/02/1975	*
3	Tunillo (20)	2100	DTY-RMG 1032(II)	08/02/1975	*
17	Calpan (21)	300	DTY-RMG 736	20/08/1967	*
17	Xalitzintla (21)	2601	DTY-RMG 684	28/02/1951	*
17	Xalitzintla (21)	2601	DTY-RMG 684	17/06/1967	*
17i	Xalitzintla (21)	2601	DTY-RMG 684	17/06/1967	*
3	Ciudad Victoria (28)	350	(II)	*	*
6 (C)	**Aguascalientes (1)**	**2196**	**DTY-ChM 170**	**10/04/2006**	**3,12 / I**
8 (C)	**Aguascalientes (1)**	**2196**	**DTY-ChM 172**	**10/04/2006**	**3,12 / I**
16 (C)	**IB-UNAM (9)**	**2309**	**DTY-ChM 117**	**28/06/2005**	**2 / IV**
6 (C)	**Milpa Alta (9)**	**2469**	**DTY-ChM 030**	**05/05/2005**	**3 / I**
6 (C)	**Milpa Alta (9)**	**2845**	**DTY-ChM 115**	**28/05/2005**	**3 / I,IV**
17i (C)	**Acolman (11)**	**2260**	**DTY-ChM 118**	**29/06/2005**	**3 / I**
6 (C)	**Las Pirámides (11)**	**2304**	**DTY-ChM 124**	**29/06/2005**	**3 / I**
6 (C,T)	**Las Pirámides (11)**	**2364**	**DTY-ChM 125**	**29/06/2005**	**3 / I**
15 (C,T)	**Las Pirámides (11)**	**2439**	**DTY-ChM 119**	**29/06/2005**	**15 / I**
17i (C)	**Las Pirámides (11)**	**2439**	**DTY-ChM 119**	**29/06/2005**	**15 / I**
6 (C,T)	**Otumba (11)**	**2293**	**DTY-ChM 126**	**29/06/2005**	**3 / III**
15 (C)	**Teotihuacan (11)**	**2300**	**DYT-ChM 121**	**29/06/2005**	**7,11,13 / I**
17i (C)	**Teotihuacan (11)**	**2300**	**DTY-ChM 121**	**29/06/2005**	**7,11,13 / I**
6 (C)	**San Felipe (12)**	**1776**	**DTY-ChM 095**	**04/06/2005**	**1,3,4 / I,III**
6 (C)	**Silao (12)**	**1809**	**DTY-ChM 099**	**04/06/2005**	**15 / I**
6 (C)	**Silao (12)**	**1809**	**DTY-ChM 100**	**05/06/2005**	**1 / IV**
9 (C,T)	**Lagos de Moreno (15)**	**1924**	**DTY-ChM 153**	**09/04/2006**	**6 / II,III**
9 (C,T)	**Lagos de Moreno (15)**	**1950**	**DTY-ChM 154**	**09/04/2006**	**6 / II,III**
11 (C,T)	**Lagos de Moreno (15)**	**1950**	**DTY-ChM 155**	**09/04/2006**	**6 / II,III**
8 (C,T)	**Ojuelos (15)**	**2196**	**DTY-ChM 157**	**10/04/2006**	**6,14,16 / III,IV**
10 (C,T)	**Ojuelos (15)**	**2196**	**DTY-ChM 158**	**10/04/2006**	**6,14,16 / III,IV**
13 (C,T)	**Ojuelos (15)**	**2196**	**DTY-ChM 159,160**	**10/04/2006**	**6,14,16 / III,IV**
15 (C,T)	**Ojuelos (15)**	**2196**	**DTY-ChM 157**	**10/04/2006**	**6,14,16 / III,IV**

Continue

Host [a] (plant portion[b])	Locality[c]	Altitude	Collect No.[d] (reference[e])	Date	Vegetation[f]/soil[g]
17i (C,T)	**Ojuelos (15)**	**2196**	**DTY-ChM 158**	**10/04/2006**	**6,14,16 / III,IV**
6 (C)	**Morelia (16)**	**1964**	**DTY-ChM 105**	**27/06/2005**	**3 / I**
6 (C)	**Morelia (16)**	**1968**	**DTY-ChM 106**	**27/06/2005**	**3 / I**
6 (C)	**Las Casitas (21)**	**2369**	**DTY-ChM 135**	**30/06/2005**	**3 / I,III**
13i (T)	**Las Casitas (21)**	**2369**	**DTY-ChM 135**	**30/06/2005**	**3 / I,III**
17i (C)	**San Salvador (21)**	**750**	**DTY-ChM 147**	**30/06/2005**	**12 / III**
17i (C)	**San Salvador (21)**	**750**	**DTY-ChM 148**	**30/06/2005**	**12,3 / III**
6 (C)	**Tlacaloapan (21)**	**772**	**DTY-ChM 145**	**30/06/2005**	**3 /II,III**
13i (C)	**Tlacaloapan (21)**	**772**	**DTY-ChM 146**	**30/06/2005**	**3 / II**
6 (C)	**IIZD (24)**	**1654**	**DTY-ChM 087**	**04/06/2005**	**3 / III**
13i (C,F)	**IIZD (24)**	**1654**	**DTY-ChM 087**	**04/06/2005**	**2 / III**
15 (C)	**IIZD (24)**	**1654**	**DTY-ChM 087**	**04/06/2005**	**9,2 / I,IV**
15i (C)	**IIZD (24)**	**1654**	**DTY-ChM 087**	**04/06/2005**	**2 / III**
13ii (C)	**INIFAP (24)**	**1663**	**DTY-ChM 064**	**03/06/2005**	**2 /I,III**
13iii (C,F)	**INIFAP (24)**	**1663**	**DTY-ChM 065**	**03/06/2005**	**2 / I,III**
18i (C)	**INIFAP (24)**	**1663**	**DTY-ChM 066**	**03/06/2005**	**2 / I,III**
18iii (C)	**INIFAP (24)**	**1663**	**DTY-ChM 068**	**03/06/2005**	**2/ I,III**
18iv (C)	**INIFAP (24)**	**1663**	**DTY-ChM 069**	**03/06/2005**	**2 /I,III**
18v (C)	**INIFAP (24)**	**1663**	**DTY-ChM 070**	**03/06/2005**	**2 /I,III**
18vi (C)	**INIFAP (24)**	**1663**	**DTY-ChM 072**	**03/06/2005**	**2 / I,III**
18vi (C)	**INIFAP (24)**	**1663**	**DTY-ChM 073**	**03/06/2005**	**2/ I,III**
18vii (F)	**INIFAP (24)**	**1663**	**DTY-ChM 071**	**03/06/2005**	**2 / I,III**
18viii (C)	**INIFAP (24)**	**1663**	**DTY-ChM 074**	**03/06/2005**	**2 / I,III**
18ix (C)	**INIFAP (24)**	**1663**	**DTY-ChM 075**	**03/06/2005**	**2 / I,III**
18x (C,F)	**INIFAP (24)**	**1663**	**DTY-ChM 076**	**03/06/2005**	**2 / I,III**
18xi (C)	**INIFAP (24)**	**1663**	**DTY-ChM 077**	**03/06/2005**	**2 / I,III**
18xii (C)	**INIFAP (24)**	**1663**	**DTY-ChM 078**	**03/06/2005**	**2 / I,III**
18xiii (C,T)	**INIFAP (24)**	**1663**	**DTY-ChM 079**	**03/06/2005**	**2 / I,III**
18xiv (C,F)	**INIFAP (24)**	**1663**	**DTY-ChM 080**	**03/06/2005**	**2 /I,III**
18xv (F)	**INIFAP (24)**	**1663**	**DTY-ChM 081**	**03/06/2005**	**2 /I,III**
18xvi (C,F)	**INIFAP (24)**	**1663**	**DTY-ChM 081**	**03/06/2005**	**2 /I,III**
8 (C)	**Las tortugas (24)**	**1653**	**DTY-ChM 009**	**05/09/2005**	**9,2 / III,IV**
15 (C)	**Las tortugas (24)**	**1653**	**DTY-ChM 009**	**05/09/2005**	**9,2 / III,IV**
6 (C,T)	**Calpulalpan (29)**	**2488**	**DTY-ChM 131**	**29/06/2005**	**3 / I,III**
15 (C,T)	**Calpulalpan (29)**	**2460**	**DTY-ChM 129**	**29/06/2005**	**3 / I,III**
16 (C,T)	**Calpulalpan (29)**	**2587**	**DTY-ChM 130**	**29/06/2005**	**3 / I,III**
17i (C)	**Perote (30)**	**2367**	**DTY-ChM 142**	**30/06/2005**	**3 / III**
17i (C)	**Totalco (30)**	**2547**	**DTY-ChM 138**	**30/06/2005**	**7 / II,III**
10 (C)	**Las Pilas (32)**	**2196**	**DTY-ChM 176**	**11/04/2006**	**16,10 / III,IV**
15 (C)	**Las Pilas (32)**	**2196**	**DTY-ChM 176**	**11/04/2006**	**10,16 / III,IV**
15 (C)	**Pánfilo Nateras (32)**	**2196**	**DTY-ChM 180**	**11/04/2006**	**4,6,10,16 / I,II**
12 (C)	**Villa González (32)**	**2196**	**DTY-ChM 178**	**11/04/2006**	**4,6,10,16 / I,II**

Continue

Host [a] (plant portion[b])	Locality[c]	Altitude	Collect No.[d] (reference[e])	Date	Vegetation[f]/soil[g]
17i (C)	**Villa González (32)**	**2196**	**DTY-ChM 178**	**11/04/2006**	**4,6,10,16 / I,II**
12 (C)	**Zacatecas (32)**	**2196**	**DTY-ChM 179**	**11/04/2006**	**10,16 / III,IV**
		***D. opuntiae* biotype 1**			
6 (C,T)	**Milpa Alta (9)**	**2469**	**DTY-ChM 107**	**28/06/2005**	**3 / I**
5 (C)	**San Francisco Rincón (12)**	**1776**	**DTY-ChM 002**	**04/09/2005**	**4,6,7,10,16 / III**
17i (C)	**San Felipe (12)**	**2092**	**DTY-ChM 098**	**04/06/2005**	**3 /I**
6 (C)	**Valle Santiago (12)**	**1732**	**DTY-ChM 062**	**03/06/2005**	**1/I**
2 (C)	**Ojuelos (15)**	**2167**	**DTY-ChM 168**	**10/04/2006**	**9 / III**
6 (C,T)	**Morelia (16)**	**2368**	**DTY-ChM 028**	**05/02/2005**	**15 /I**
4i (C)	**INIFAP (24)**	**1663**	**DTY-ChM 067**	**03/06/2005**	**2 /I**
4ii (F)	**INIFAP (24)**	**1663**	**DTY-ChM 067**	**03/06/2005**	**2 /I**
6i (C)	**INIFAP (24)**	**1663**	**DTY-ChM 067**	**03/06/2005**	**2 /I**
15ii (C)	**INIFAP (24)**	**1663**	**DTY-ChM 067**	**03/06/2005**	**2 /I**
17i (C,T)	**Calpulalpan (29)**	**2587**	**DTY-ChM 130**	**29/06/2005**	**3/ I,III**
6 (C)	**Huamantla (29)**	**2773**	**DTY-ChM 133**	**30/06/2005**	**3/ I,III**
17i (C)	**Huamantla (29)**	**2773**	**DTY-ChM 133**	**30/06/2005**	**3/ I,III**
		D. tomentosus			
11	Ensenada (3)	0	(II)	*	*
17i	Los Cabos (3)	100	(II)	*	*
17i	Torreón (7)	1300	(IV)	*	*
17i	Distrito Federal (9)	2374	(II)	*	*
17i	Silao (12)	1800	(II)	*	*
20	Cadereyta (19)	300	(II)	*	*
17i	Ihuatlán (20)	2100	(II)	*	*
19iii	Nochistlán (20)	2067	(II)	*	*
17i	Alvarado (30)	0	(II)	*	*
17i	Zacatecas (32)	2500	(II)	*	*
5 (C)	**San Francisco Rincón (12)**	**1776**	**DTY-ChM 186**	**11/04/2006**	**4,6,7,10,16 / III**
2 (C)	**Tulancingo (14)**	**2000**	**DTY-ChM 190**	**10/11/2007**	**9 /II**

[a] 1 = *C. imbricata*, 2 = *C. tunicata*, 3 = *Nopalea*, 4 = *O. albicarpa* (i = Blanca 23, ii = Reyna 155), 5 = *O. atropes*, 6 = *O. ficus-indica* (i = Liso 48), 7 = *O. fuliginosa*, 8 = *O. hyptiacantha*, 9 = *O. jaliscana*, 10 = *O. joconostle*, 11 = *O. megacantha*, 12 = *O. phaeacantha*, 13 = *O. robusta* (i = var. *larreyi* Weber, ii = Camuesa, iii = Camuesa 58), 14 = *O. spinulifera*, 15 = *O. streptacantha*, (i = var. *aguirreana*, ii = Charola), 16 = *O. tomentosa* (i = var. *O. hernandezii*), 17 = *Opuntia* (i = *Opuntia* spp, ii = *Opuntia* nopal), 18 = Variants (i = Amarilla chapeada, ii = Anaranjada montecillos, iii = Bola de maza 77, iv = Calabazona 50, v = Cascaron 75, vi = Chapeada 21, vii = Cristalina 138, viii = L Coloradito 49, ix = Line 116, x = Mexicana 53, xi = Mieluda 10, xii = Pachón blanco, xiii = Pepino 136, xiv = Redonda 61, xv = Sandio Ñ, xvi =Virginia 66), 19 = nopal (i = prickly pear, ii = Castilla, iii = yellow prickly pear, iv = artona prickly pear, v = white prickly pear, vi = red prickly pear, vii = duraznillo), and 20 = Cactus;
[b] C = cladode, F = fruit (prickly pear), T = trunk; [(c)] see Online Supplementary Material 1;
[d] Taken from (CNI-IB-UNAM). Boldface typeset = collects presented in this document, collector Carla K. Chávez-Moreno;
[e] Reference: I = González (2001); II = MacGregor & Sampedro (1983); III = Pérez Guerra & Kosztarab (1992); IV = Portillo & Vigueras-Guzmán (2003a) and V = Portillo & Vigueras-Guzmán (2003b);
[f] vegetation 1 = living fence , 2 = collections, 3 = commercial plantation, 4 = *Cylindropuntia* spp., 5 = orchard, 6 = huizache (*Acacia* spp.), 7 = maguey (*Agave* spp.), 8 = weed vegetation, 9 = xerophitic scrubs; 10 = *Opuntia* spp.; 11 = columnar cacti (*Stenocereus* spp.), 12 = natural grassland; 13 = pine and oak forest, 14 = pirul (*Schinus molle*) 15 = ornamentation and 16 = izotes (*Yucca* spp.);
[g] I = foezem, II = vertisol, III = xerosol and arenosol, IV = regosol, V = calcisol and VI = leptosol. * = Not specified.