Investigation note

New records of *Cylindrocopturus* and its association with new species of *Opuntia* in the State of Mexico

Alvaro Castañeda-Vildózola[1§]
Jesús R. Sánchez-Pale[1]
Omar Franco-Mora[1]
Jorge Valdéz-Carrasco[2]

[1]Faculty of Agricultural Sciences-Autonomous University of the State of Mexico. 'El Cerrillo' University *Campus*. El Cerrillo, Piedras Blancas, Toluca, State of Mexico, Mexico. ZC. 50200. (jrsanchezp@uaemex.mx; ofrancom@uaemex.mx). [2]Postgraduate in Plant Health, Entomology and Acarology-Postgraduate College. Montecillo, Texcoco, State of Mexico, Mexico. ZC. 56230. (jvaldez@colpos.mx).

[§]Corresponding author: acastanedav@uaemex.mx.

Abstract

Knowledge of the area of distribution of insects of agricultural interest is vital to evaluate their negative impact on agroecosystems focused on the production of crops of high commercial value. In this study, *Cylindrocopturus biradiatus* and *C. ganglbaueri* were reported for the first time in the municipalities of Toluca, Temascaltepec and San Felipe del Progreso, State of Mexico associated with *Opuntia* spp. *Opuntia robusta*, *O. huajuapensis* and *O. microdasys* are included as new hosts for *C. biradiatus* as well as *C. ganglbaueri*, expanding its distribution towards the Toluca Valley and the North of the State of Mexico. The incidence of damage attributed by *Cylindrocopturus* spp. towards the areolas of the nopal is documented in this study and is expected to contribute to the promotion of future studies that allow a more in-depth evaluation of the magnitude of its damage and the design of local strategies for integrated pest management.

Keywords: distribution, prickly pear, thorn borer weevils.

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To date, 11 species of insects classified as primary pests of the *Opuntia ficus-indica* (L.) Miller have been registered in the main producing areas of Mexico, included in the orders Lepidoptera, Coleoptera and Hemiptera (Mena-Covarrubias 2018).

Among the harmful and economically important species are *Cactophagus spinolae* Champion (Coleoptera: Curculionidae), *Dactylopius opuntiae* (Cockerell) (Hemiptera: Dactylopiidae) and *Hesperolabops nigriceps* Reuter (Hemiptera: Miridae) (Ruiz-Machuca *et al*., 2010; López-Martínez *et al*., 2016; Palafox-Luna *et al*., 2018). Other species such as *Loxomorpha flavidissimalis* (Grote) (Lepidoptera: Crambidae) (González-Hernández *et al*., 2019) and *Cylindrocopturus biradiatus* Champion and *C. ganglbaueri* Heller (Coleoptera: Curculionidae) (Vargas-Mendoza *et al*., 2008; Bautista-Martínez *et al*., 2016) depending on the region of the country, they can reach the status of a primary pest due to their relative abundance and harmful effects towards the cactus.

The Curculionidae family, better known as weevils, are a megadiverse group of coleopterans, with approximately 62 000 described species (Oberprieler *et al*., 2007). From the perspective of economic entomology, some species of weevils are of agricultural interest since they have a high specificity towards cultivated plants of high commercial value as an apparent result of coevolution with their wild ancestors, using them as a source of food for the development of their larvae (Jones *et al*., 2019). Many native plants of Mexico of commercial interest such as the nopal have curculionidae as pests (Bautista-Martínez *et al*., 2016; López-Martínez *et al*., 2016).

The genus *Cylindrocopturus* Heller (Coleoptera: Curculionidar) includes 41 species that are distributed from North America to Central America (O'Brien and Wibmer, 1989), 11 of which are reported for Mexico (O'Brien and Wibmer, 1989). Knowledge of the biological aspects of this genus of curculionidae is scarce, except for *C. adspersus*, *C. eatoni*, *C. furnissi* and *C. quercus*. The larvae are stem borers in plants included in the genera *Quercus* L. (Fagaceae), *Helianthus* L. (Asteraceae), *Pinus* L. (Pinaceae), *Pseudotsuga* Carrière (Pinaceae) and *Opuntia* Mill. (Cactaceae) (Eaton, 1942; Furniss, 1942; Piper, 1977; Charlet, 1983; Bautista *et al*., 2016).

To date, there are no studies that indicate the presence of curculionids associated with damage to the areoles of the nopal spines in municipalities not included as part of the main nopal producing area of the State of Mexico, as well as its association with other species of *Opuntia* spp. The objective of this note was to determine the species of *Cylindrocopturus* and its hosts in three municipalities of the State of Mexico.

At the end of March 2018, 102 plants of *O. ficus-indica* with damage attributed to nopal areola weevils (Figure 1a) were recorded in a plot of the experimental field of the Faculty of Agricultural Sciences, Autonomous University of the State of Mexico, located in the community of Cerrillo, Piedras Blancas (19° 14' 35.52" north latitude, 99° 24' 43.2" west longitude, 2 614 masl), Toluca, State of Mexico. On March 26 and 27, a random sample of 70 affected cladodes was taken and the damaged tissue was dissected with a scalpel and a camel hair brush to extract the development stages of the curculionids. The extracted insects were added in Petri dishes (9 × 1 cm) and transferred to the laboratory for their subsequent specific determination.

Figure 1. Observations of the interaction *Cylindrocopturus* spp. *Opuntia* spp. in the State of Mexico. a) damage by *Cylindrocopturus biradiatus* on *Opuntia ficus-indica*; b) cladode of *O. robusta* affected by *C. biradiatus*; c) damage by *C. biradiatus* in *O. huajuapensis*; d) *Opuntia microdasys* affected by *C. biradiatus*; e) *Cylindrocopturs biradiarus*; and f) *Cylindrocopturus ganglbaueri*.

In the cactus collection of the Faculty of Agricultural Sciences-UAEM, damage similar to that witnessed in *O. ficus-indica* was registered in the species cataloged as *Opuntia robusta* J.C. Wend. (Figure 1b), *O. huajuapensis* Bravo (Figure 1c) and *O. microdasys* (Lehm.) Pfeiff. (Figure

1d), 15 cladodes of each species were taken and dissected for the extraction of the insects involved with the damage. On April 14 and 15, nopaleras of *O. ficus- indica* grown in backyards without phytosanitary management were reviewed in the municipalities of Temascaltepec located southeast of the municipality of Toluca and separated by 52 km (19° 02' 56" north latitude, 100° 02' 35" west longitude; 1 802 masl) and San Felipe del Progreso located north of the municipality of Toluca, both separated by 79 km (19° 42' 35" north latitude, 99° 55' 55" west longitude; 2 561 masl).

In the two municipalities, only adult specimens are captured taking as reference the weevils collected in Toluca. The specific determination of the weevils collected in the three municipalities was carried out with a stereoscopic microscope (Nikon C-PSN, Tokyo, Japan) taking as reference the external morphological characters proposed by Champion (1902); Bautista-Martínez *et al*. (2016). All the revised specimens are deposited in the Insectarium of the Faculty of Agricultural Sciences of the Autonomous University of the State of Mexico.

The adult curculionids extracted *Opuntia* spp., in Toluca, as well as those captured in the municipalities of Temascaltepec and San Felipe del Progreso, State of Mexico corresponded to *Cylindrocopturus biradiatus* and *C. ganglbaueri*, *C. biradiatus* was the predominant species in the three municipalities reviewed. In Toluca, 91 adult specimens of *C. biradiatus* and three of *C. ganglbaueri* were extracted from *O. ficus-indica*.

Regarding the immature stages, 18 larvae and 41 pupae were collected, all of *C. biradiatus*. In *O. robusta*, 11 adults, seven larvae and three pupae of *C. biradiatus* were obtained, while in *O. microdasys* 21 adults of *C. biradiatus* were recorded. From the cladodes of *O. huajuapensis*, 13 adults, two larvae and 20 pupae of *C. biridatus* were obtained. In San Felipe del Progreso, 25 specimens of *C. biridatus* and seven of *C. ganglbaueri* were collected, while in Temascaltepec 17 specimens of *C. biradiatus* were captured.

Bautista-Martínez *et al*. (2016), mentioned that both species of *Cylindrocopturus* can be differentiated by the following characteristics: *Cylindrocopturus biradiatus* reaches a length of 3.32 mm, has the frontal and lateral areas of the pronotum of orange color and with light brown lines that run parallel with the internal margin of the elytra, there are also small perpendicular brown lines that intersect, but do not reach the outer margin of the elytra (Figure 1e). *Cylindrocopturus ganglbaueri* is larger, with a length of 4.82 mm, predominantly dark in color and with a well-marked black dorso-transverse line in the elytra (Figure 1f).

Mann (1969) reported that *C. biridatus* larvae have *Opuntia ficus-indica, O. streptacantha* Lem as hosts. and *O. tomentosa* Salm-Dyck. The present study adds *O. robusta, O. huajuapensis* and *O. microdasys* as new hosts for *C. biradiatus* in Mexico. According to the evidence indicated in the literature and in this study, it is suggested that *C. biridatus* has an oligophagous behavior, adapting to the availability of host plants of the *Opuntia* genus present in its local environment. The information on *C. ganglbaueri* suggests a monophagous behavior closely linked with *O. ficus-indica*, as confirmed by this study and the one reported by Bautista-Martinez *et al*. (2016), however, future studies on the entomofauna associated with *Opuntia* spp., commercial and local exotics will probably reveal new *Opuntia-Cylindrocoptus* interactions in Mexico.

The nopal areola weevil complex is endemic to Mexico (Champion, 1902). *Cylindrocopturus biradiatus* occurs in Mexico City, Guanajuato, Michoacán, Morelos, Querétaro, Puebla, San Luis Potosí and Zacatecas (Mann, 1969; Jones and Luna-Cozar, 2007; Salas-Araiza *et al*., 2001; Soto-Hernández *et al*., 2016), while *C. ganglbaueri* is distributed in Mexico City, State of Mexico, Guanajuato and Veracruz. This report contributes to the expansion of the state distribution area of both curculionids towards the Toluca valley and north of the State of Mexico and complements Bautista-Martínez *et al*. (2016) who pointed out the coexistence of both species in the municipality of Teotihuacan.

Field observations taken in Toluca and San Felipe del Progreso, confirm that the adults of *Cylindrocopturus* spp. are active on sunny days from 10:00 to 16:00, the females pierced the areolas of the mature cladodes that originate the spines to introduce an egg (Figures 1e and 1f). Each cladode infested by *C. biradiatus* presented from one to more than 40 damaged areoles (Figure 1a). After hatching, the larvae consume the internal tissue of the areola, externally the damage is manifested by the presence of secretions of crystallized mucilage accumulated at the base of the spines (Figures 1a to 1d).

A high incidence of damage can interfere with the development of cladodes (Vargas-Mendoza *et al*. 2008). Mena-Covarrubias (2011) pointed out that *C. biradiatus* larvae can also feed on flower buds causing their destruction and fall. Last-instar larvae built a pupation chamber under the base of the spine. To emerge, the adults chewed the inner wall of the pupation chamber, making a circular hole 2 mm in diameter. The emergence of adults occurred at the end of March until the beginning of May.

Conclusions

This note reports new distribution sites and the incidence of damage attributed by *Cylindrocopturus* spp. towards the areolas of *Opuntia* spp. It is expected to contribute to the promotion of future studies at the state level to know aspects related to its bioecology that allow evaluating the magnitude of its damages for the design of local strategies for integrated pest management.

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