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Peniocereus serpentinus AND *Austrocylindropuntia subulata*, NEW HOSTS OF THE CACTUS WEEVIL (*Metamasius spinolae* Gyllenhal) IN THE STATE OF MEXICO

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ABSTRACT

The cactus weevil (*Metamasius spinolae*) is a pest of *Opuntia ficus-indica*. It can develop not only in *Opuntia* species but also in other cacti and members of the Asparagaceae family. In 2017, damage and presence of adult insects with characteristics similar to the cactus weevil were reported in two species of cacti, *Austrocylindropuntia subulata* and *Peniocereus serpentinus*. The objective was to identify the insect and determine if the two cacti species are hosts, field and laboratory research was conducted from 2017 to 2019 in the municipality of Axapusco, State of Mexico. Stems with larval damage were selected at four study sites, whic remained in field conditions until the emergence of adult insects. The behaviour of *M. spinolae* on the host plant, mating sites, incubation period and damage development over time were recorded. *M. spinolae* was identified and determined to fulfill its life cycle on *A. subulata* and *P. serpentinus*. Larvae cause the most damage by feeding on the internal part (pith) of the stems, which causes tissue rotting and death of the affected part. The adult feeds on tender buds and mature stems, causing deformation and weakening of the plant. The two cacti species proved to be host plants that can harbour populations of *M. spinolae* and, therefore, have a high potential to act as reservoirs of the pest, which can then migrate to prickly-pear cactus crop. This report expands the knowledge of hosts of the cactus weevil. The information obtained shall be useful for vegetable growers to apply phytosanitary measures in alternate hosts, combat reservoirs and avoid re-infestations of the pest.

Keywords: life cycle, pest, damage, insect, cacti.

INTRODUCTION

The cactus weevil (*Metamasius spinolae* Gyllenhal; Coleoptera: Curculionidae) is an economically important pest and limiting factor in the commercial production of the prickly-pear cactus (*Opuntia ficus-indica* [L.] Miller), intended for vegetable and fruit consumption (Rodríguez *et al*., 2012; Cobarrubias, 2017). This crop represents a means of economic sustenance for families and communities, mainly in the High Valleys of Mexico (Méndez, 1994). There are records of damage caused by the cactus weevil on other species of the Cactaceae family: *Opuntia cantabrigiensis* (Cárdenas-Ramos and Mandujano, 2021); *Cylindropuntia imbricata*, *Pereskiopsis diguetii* (Ruiz-Moreno, 2018); *Selenicereus hamatus* (López-Martínez *et al*., 2016a); *Stenocereus pruinosus* and *Stenocereus stellatus* (Bravo-Avilez *et al*., 2014); *Hylocereus undatus*, *H. undatus* subsp. *luteocarpus*, *H. purpusii*, *H. ocamponis* (Ramírez *et al*., 2011); *Cereus* sp. (Vaurie, 1967); *Cereus giganteus* and *Ferocactus* sp. (Anderson, 1948); and from the family Asparagaceae: *Agave* spp. (Romo and Morrone, 2012). Similarly, this pest represents a serious threat to pitaya (*Stenocereus queretaroensis*) production in central Mexico, whose ecological, cultural and economic importance is relevant in the region (Bravo-Avilez *et al*., 2014).

In 2017, insect damage and presence of adults with similar characteristics to the cactus weevil were reported in two species of cacti, *Peniocereus serpentinus* and *Austrocylindropuntia subulata.* There are no reports in the scientific literature of insects causing similar damage to that observed. Additionally, larvae were found inside the stems and adults feeding on the external tissues. These cacti have an ecological and ornamental importance, and in some cases also medicinal. However, there is greater concern about their role as a host and reservoir for *M. spinolae*. In view of this problem, this study was conducted with the objective to identify the insect species and determine if the two cacti are hosts.

MATERIALS AND METHODS

Location of the study area

The research was carried out in the municipality of Axapusco (19° 43′ 10″ N, 98° 47′ 50″ W, altitude 2350 m), State of Mexico, Mexico. Field and laboratory work was conducted from 2017 to 2019, at sites where *P. serpentinus* and *A. subulata* were present. Local residents reported the damage.

Field work

Four study sites were selected based on the presence of affected plants in Santa María Actipac, San Felipe Zacatepec, Santo Domingo Aztacameca and Axapusco. At each site, the percentage of affected stems was determined, and the internal and external damages were described. From each site, 50 cm long stem segments with larvae were selected. They were labelled and wrapped in mesh to retain the insects during their emergence. Observations were made every two weeks to determine the emergence and adult activity periods. The behaviour of *M. spinolae* on the host plant, mating sites, incubation period and damage development over time were recorded. All insects that emerged were collected and preserved in 96 % alcohol.

Morphological identification

Adults were identified up to species following the keys and morphological characteristics described by Vaurie (1967), Romo and Morrone (2012), and compared with reference insects. The weevils were studied with a Quasar Qm25 microscope at 30-90 X magnification. Images were processed using CombineZP 1.0 software (alan-hadley.software.informer.com).

RESULTS AND DISCUSSION

Characterization of sampling sites

The greatest number of sites with the presence of *M. spinolae* was in the locality of Santa María Actipac, followed by San Felipe Zacatepec. In both localities, damage caused by *M. spinolae* was identified in both cacti *A. subulata* and *P. serpentinus*, the former being the species most affected by the weevil. Regarding the percentage of affected stems, *A. subulata* was the species with the most damage, with a range of 10 to 20 %. Damaged *P. serpentinus* were only found in three locations, with 10 to 18 % of the stems affected.

Damage description

Stems of *A. subulata* and *P. serpentinus* affected by *M. spinolae* larvae showed black coloration and dark brown to black secretion of viscous consistency and unpleasant odour (Figure 1A). Inside, galleries in the pith (Figure 2B) and rotten collenchyma (Figure 2C) were observed. In all cases, *M. spinolae* larvae were observed feeding on the pith in both hosts (Figure 2D). Only one larva per affected stem was found.

As a result of adult feeding, destruction of the epidermis and part of the collenchyma was observed, leaving the internal tissue exposed (Figure 2). Damage was detected most frequently during the months of September to November and was caused mainly by the larvae, due to the feeding process. Adults were identified as *Metamasius spinolae*

Figure 1. External and internal damage caused by the larva of *Metamasius spinolae*. A: stem of *Austrocylindropuntia subulata* with black coloration and dark brown to black secretion of viscous consistency; B: *Peniocereus serpentinus* stem with galleries in the pith; C: rotten collenchyma; D: larva feeding on the pith.

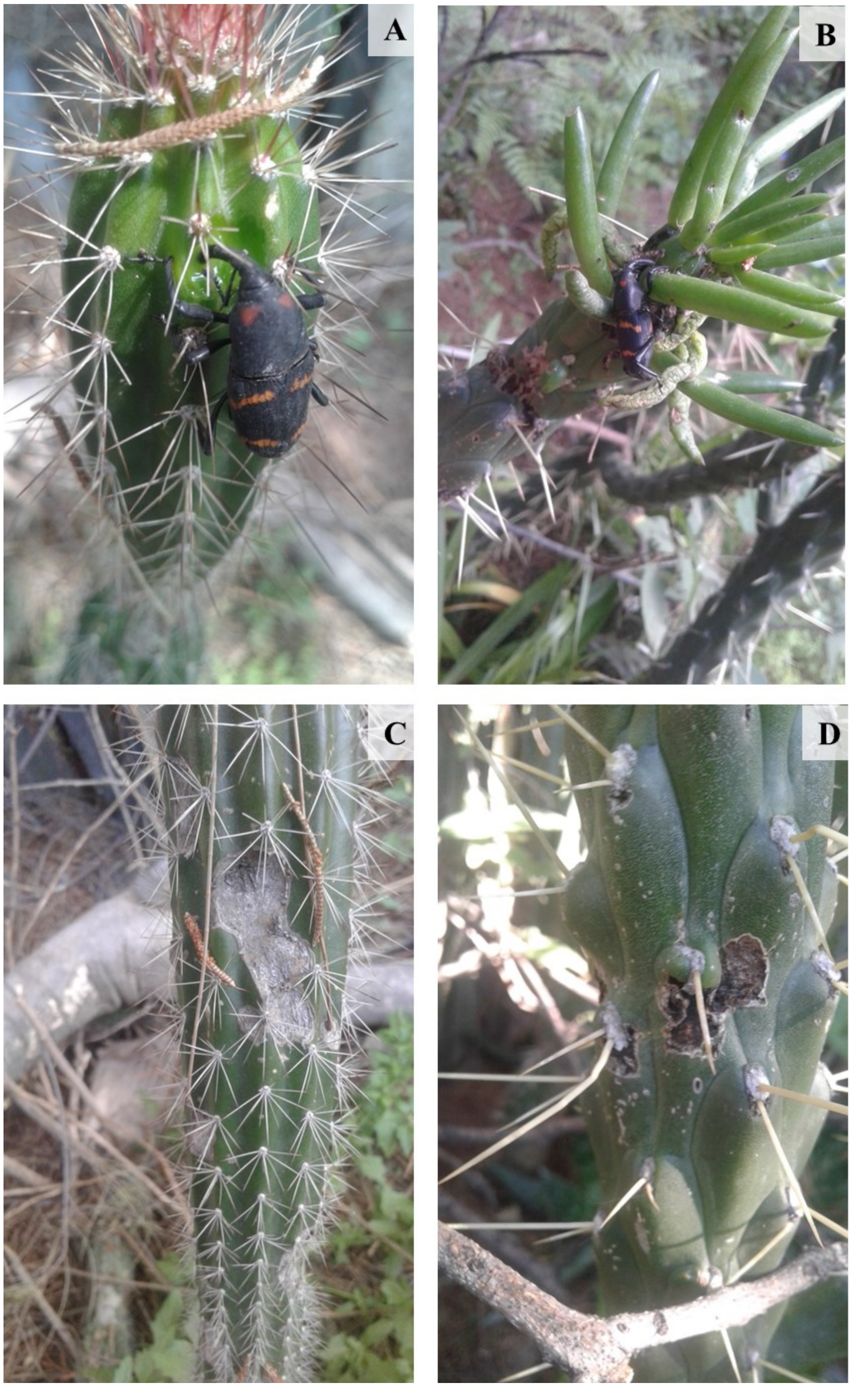

Figure 2. External damage caused by feeding of adult *Metamasius spinolae*. A and B: destruction of the epidermis and part of the collenchyma in stems of *Peniocereus serpentinus* and *Austrocylindropuntia subulata*; C and D: scars caused by adult feeding.

based on their key characteristics: black specimens, with four orange-red spots on the elytra, two on the front part of the prothorax and two more on the notopleural angle; the characteristics of the antenna, rostrum, pronotum, scutellum, elytra, legs and pygidium (Figure 3) corresponded to those reported by Vaurie (1967), and Romo and Morrone (2012).

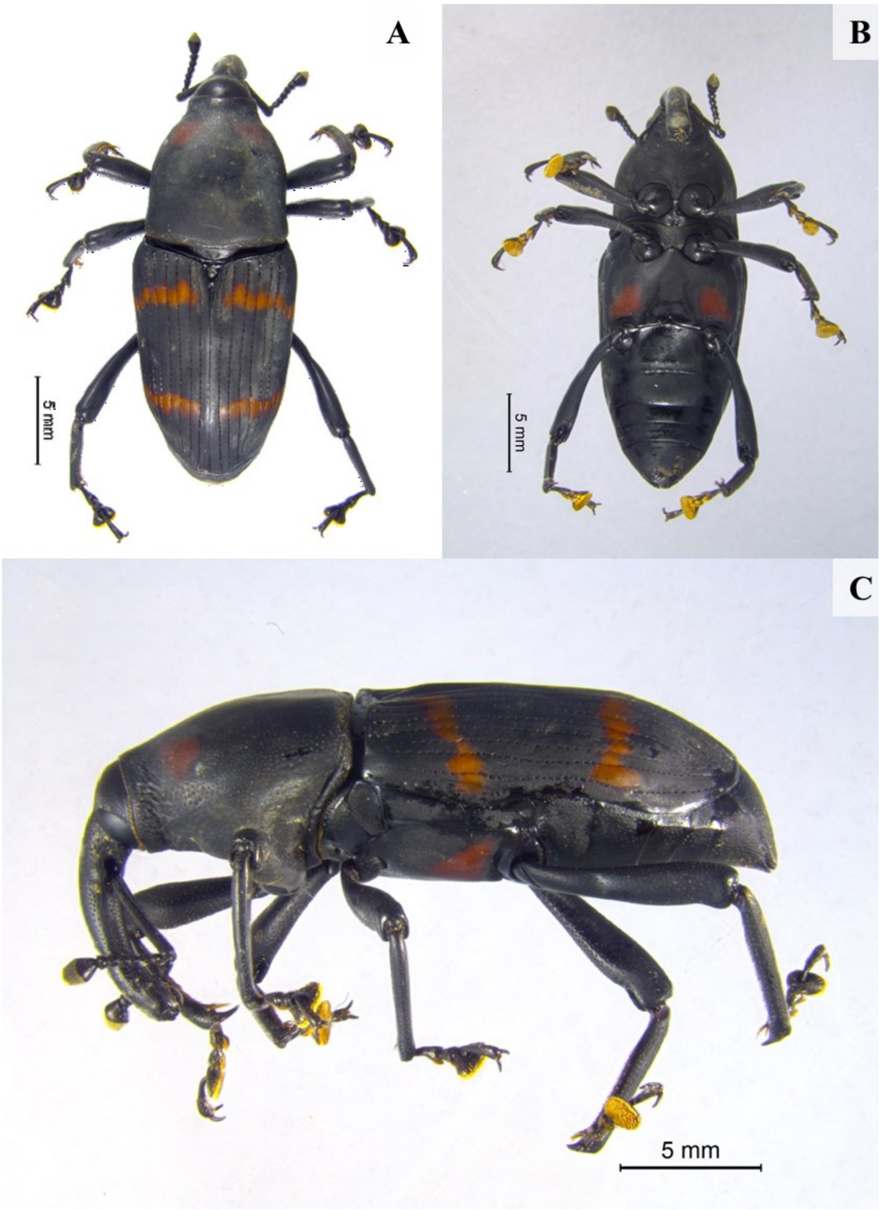

Figure 3. Adult *Metamasius spinolae*. A: dorsal view; B: ventral view; C: side view.

Development of *Metamasius spinolae* on *Austrocylindropuntia subulata* and *Peniocereus serpentinus*

Under field conditions, adults of *M. spinolae* (n = 50) emerged through a hole in the pupal chamber (cocoon) starting in April and continuing until June. Oviposition began in May, was more frequent between July and August, and ended until October. Females (n = 20) deposited eggs in cracks or crevices of healed wounds on stems and covered them with a dark brown viscous secretion that hardens and is similar to the colour of damaged host tissue, making it difficult to locate oviposition sites (Figure 4A).

The incubation period was 15 days. The larva was introduced into the stem up to the pith, on which it fed throughout its development, making secondary galleries to expel the excreta. In response, both species of cacti secreted a mucilaginous substance, resulting in dark brown to black viscous runoff with an unpleasant odour. The time to complete larval development is an average of 150 d, from July to December. Mature larvae constructed an elliptical chamber (pupal cell or cocoon) in the medulla of both hosts with host fibres (Figure 4B), where they remained as pupae for an average of four months, from December to April. However, it was observed that pupal development can begin in March and end in July.

Non-cultured species can maintain pest insect populations, becoming reservoirs for future crop infestations. Identification of naturally grown alternate host plants can be critical to prevent the development of polyphagous pests in a 'main' or 'focal' agricultural species (Saeed *et al*., 2014), and play an important role in pest management. Alternate host plants can also be beneficial to agriculture when they harbour populations of natural enemies (Naveed *et al*., 2007). This study identified two new hosts of *M. spinolae*, *Austrocylindropuntia subulata* and *Peniocereus serpentinus*, which are mainly used as ornamental plants. In other cases, they have been found near commercial *Opuntia ficus-indica* fields, without being exposed to insecticides or other phytosanitary measures to control the cactus weevil, which could act as reservoirs of *M. spinolae* and be an important source of transfer for *Opuntia ficus-indica*.

Regarding the life cycle, the behaviour of *M. spinolae* on *A. subulata* and *P. serpentinus* coincides with previous reports on other host species, mainly for *Opuntia ficus-indica* (Muñiz-Vélez, 1998; Baddi and Flores, 2001; López-Martínez *et al*., 2016b; Cobarrubias, 2017). In these two new hosts, an annual generation occurred; the male and female fed on young stems, and the females used the stems for oviposition. The eggs were covered with a dark brown secretion of viscous consistency, secreted by the ovipositor, an observation that differs from that reported by Cobarrubias (2017), who mentioned that the female seals the oviposition area with a mixture of food and regurgitated saliva.

With the report of *A. subulata* and *P. serpentinus*, the number of hosts for *M. spinolae* expands, which coincides with that reported by Bravo-Avilez *et al*. (2014) and López-Martínez *et al*. (2016a), who stated that the distribution of *M. spinolae* and the number of host plants is increasing. Ruiz-Moreno (2018) observed that the loss of spaces

Figure 4. *Metamasius spinolae*. A: the female lays eggs in cracks or crevices of healed wounds and coats them with a dark brown, viscous secretion (arrow); B: The mature larva builds an elliptical chamber (pupal cell or cocoon) in the medulla with host fibres.

occupied by primary hosts, mainly due to urbanization, may be the cause for *M. spinolae* is searching new hosts. Likewise, López-Martínez *et al.* (2016a) mentioned that due to the cultivation of new cactus species and the continuous transportation of wild species, the distribution of this weevil species and the number of its host plants would be expected to increase.

In this research, the inhabitants of the region mentioned an increase in the cultivated area of *O. ficus-indica* in areas previously used for growing corn, beans and barley, as a result of the decrease in precipitation and increase in temperature, a consequence of climate change. Producers opted for the prickly-pear cactus crop because it is more adaptable to the new conditions. We consider that the increase in the cultivated area of this cactus and the intensive management of insect pests such as the weevil have forced this pest species to look for new hosts, which indicates that *M. spinolae* has a great plasticity that allows it to complete its life cycle in other species of cacti such as *A. subulata* and *P. serpentinus*.

CONCLUSIONS

This study has shown that *A. subulata* and *P. serpentinus* are host plants that can harbour populations of *M. Spinolae.* Therefore, they have a high potential to act as reservoirs of the pest that can migrate to *O. ficus-indica* crops. Management strategies should be applied not only to the cactus crop but also to *A. subulata* and *P. serpentinus*, mainly those close to the cultivation area, without eliminating their populations, since these wild species have ecological, ornamental and, in some cases, medicinal importance.

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