New Records of Species and Locations of Parasitoids of the Pepper Weevil in Mexico

Author(s): Esteban Rodríguez-Leyva, J. Refugio Lomeli-Flores, Jorge M. Valdez-Carrasco, Robert W. Jones and Philip A. Stansly
Published By: Society of Southwestern Entomologists
DOI: http://dx.doi.org/10.3958/059.037.0109
URL: http://www.bioone.org/doi/full/10.3958/059.037.0109

BioOne (www.bioone.org) is a nonprofit, online aggregation of core research in the biological, ecological, and environmental sciences. BioOne provides a sustainable online platform for over 170 journals and books published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Web site, and all posted and associated content indicates your acceptance of BioOne’s Terms of Use, available at www.bioone.org/page/terms_of_use.

Usage of BioOne content is strictly limited to personal, educational, and non-commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.
New Records of Species and Locations of Parasitoids of the Pepper Weevil\(^1\) in Mexico

Esteban Rodríguez-Leyva\(^2\), J. Refugio Lomeli-Flores\(^2\), Jorge M. Valdez-Carrasco\(^2\), Robert W. Jones\(^3\), and Philip A. Stansly\(^4\)

Abstract. The pepper weevil, *Anthonomus eugenii* Cano (Coleoptera: Curculionidae), is a key pest of cultivated peppers (*Capsicum* spp.) in the southern United States, Mexico, Central America, and on some islands of the Caribbean. Control of the pest is difficult and dependant on insecticide, with no effective biological control program yet developed. New species and records of parasitoids collected from various localities within the probable regions of origin of the pepper weevil in Mexico are listed. In total, 102 parasitoid specimens of six genera were collected. Of these, *Eupelmus cushmani* (Crawford) and *Baryscapus hunteri* (Crawford) were recorded for the first time as primary parasitoids of the pepper weevil. A key to identify the genera of hymenopteran parasitoids attacking pepper weevil is also presented.

Resumen. El picudo del chile, *Anthonomus eugenii* Cano (Coleoptera: Curculionidae), es la plaga más importante en chiles cultivados (*Capsicum* spp.) en el sur de Estados Unidos, México, Centroamérica, y algunas islas del Caribe. El control de esta plaga es complejo, depende de insecticidas y no se ha logrado desarrollar ningún tipo de control biológico para su combate. En este trabajo se recolectó material dentro de las probables regiones de origen del picudo en México, y se presentan nuevos registros de especies y localidades de parasitoides de esta plaga. Se recolectaron 102 especímenes de parasitoides dentro de seis géneros; de estos se identificó a *Eupelmus cushmani* (Crawford) y *Baryscapus hunteri* (Crawford) como parasitoides primarios de *A. eugenii*, también se elaboró una clave para identificar a los himenópteros parasitoides de éste.

Introduction

The pepper weevil, *Anthonomus eugenii* Cano (Coleoptera: Curculionidae), is a key pest of cultivated varieties of pepper (*Capsicum* spp.) in the southern United States, Mexico, Central America, and some Caribbean islands (Elmore et al. 1934, Burke and Woodruff 1980, Abreu and Cruz 1985, Riley and King 1994, Arcos et al. 1998). In the United States, damage caused by this pest was estimated in...
1994 to cost $23 million (Riley and King 1994). However, present losses are greater because of increasing prices of peppers. In Mexico where 150,000 ha of peppers are grown each year (SIAP 2011), the problem is even greater and losses are calculated at $70 to 80 million annually (E.R.L. unpublished data).

Biology, control tactics, distribution, and sampling methods for pepper weevil have been studied (Elmore et al. 1934; Wilson 1986; Patrock and Schuster 1992; Riley et al. 1992 a,b; Toapanta et al. 2005). Despite these advances, control by insecticide is necessary once the pest is present in pepper crops (Riley and King 1994, Riley and Sparks 1995). Unfortunately, the use of insecticide as the principal method of control can provoke many adverse effects such as marketing restrictions, exposure of non-target organisms, environmental contamination, resistance to insecticide, and outbreaks of secondary pests within the crop (Doutt and Smith 1971, Van Driesche and Bellows 1996). The cultural- and insecticide-dependent control tactics for the pepper weevil are analogous to the situation with the related species, the cotton boll weevil, Anthonomous grandis grandis Boheman (Cate et al. 1990).

The pepper weevil shares many similarities with its congener the cotton boll weevil: Mesoamerica as the likely origin, damaging the host by feeding and developing inside fruits, and a history of dispersal into the United States during early years of the 20th Century (Burke et al. 1986). However, differences in acreage and economic importance of cotton, Gossypium hirsutum L., compared to pepper in the United States explain why the pepper weevil has not received the same attention as the boll weevil, and why more than 100 years after the original detection in Mexico (Cano y Alcacio 1894) and the USA (Walker 1905), there is relatively little information about biogeography, evolution, and biological control of the pepper weevil (Riley and King 1994, Rodríguez-Leyva et al. 2007).

Recently two published surveys of native parasitoids of the pepper weevil from Mexico (Mariscal et al. 1998, Rodríguez-Leyva et al. 2007) provide a better understanding of diversity and distribution of pepper weevil parasitoids, with some parasitoid species having potential as biological control agents (Rodríguez-Leyva et al. 2000, 2007; Seal et al. 2002; Schuster 2007). In the present work, new records of species and localities, together with a key to the hymenopteran parasitoids associated with pepper weevil in Mexico are provided. We hope this key will aid in identification of parasitoids associated with the pepper weevil and stimulate further exploration and laboratory research on aspects of biological control of this important pest.

Materials and Methods

Parasitoids were obtained from various projects and people from various institutions including: the Colegio de Postgraduados, Mexico, with Eugenio Mariscal and Jorge Leyva (1996-1997), the University of Florida as a part of a biological control program funded for projects of Philip Stansly and David Schuster (1998-2006), and recently, through Kopperit Mexico S. A. de C. V., and the Colegio de Postgraduados (2011). To obtain pepper weevil parasitoids, Capsicum annuum L. of different varieties, especially ‘Serrano’, ‘Serranillo’, ‘Cola de rata’, ‘Caloro’, ‘Jalapeño’, ‘Poblanito’, ‘Chile de agua’, ‘Solterito’, and ‘Habanero’ (C. chinense Jacquin), were collected from the field. Peppers were collected from several localities along the Pacific Coast and the Gulf of Mexico (Rodríguez-Leyva et al. 2007) and recently from the states of Guanajuato, Morelos, Nayarit, Oaxaca,
Puebla, Queretaro, and Yucatan. Weevil-infested pepper fruits were collected from the field into containers and shipped to Colegio de Postgraduados in Texcoco and held at room temperature (25°C). Parasitoids emerging in the containers were stored in 70% ethanol.

Keys by Gibson et al. (1997), Wharton et al. (1997), and Burks (2003) were used to identify all parasitoid specimens to genus. Species within each genus were identified by using specific keys as noted. An identification key to pepper weevil parasitoids was expanded by using original descriptions, taxonomic revisions, identification keys, specimens collected recently in Mexico, and specimens available at the Colegio de Postgraduados insect collection. The key was constructed using terminology for Braconidae based on work by Sharkey (1997), Sharkey and Wharton (1997), and Wharton and López-Martínez (2000). Terminology from Gibson et al. (1997) was used for Chalcidoidea in the key. Images were obtained using incident illumination of optic microscopy. Voucher specimens were deposited in the Insect Biological Control collection at the Colegio de Postgraduados at Texcoco, Mexico.

Results and Discussion

In total, 102 parasitoid specimens of six parasitoid species were collected from fields in seven states (Table 1). All localities represented new records for pepper weevil parasitoids from Mexico. Rosamarada, Nayarit, was the locality where the largest number of parasitoid species (six) was collected, followed by Axochiapan, Morelos, with four. Catolaccus hunteri Crawford was the parasitoid most often collected.

Eupelmus cushmani (Crawford) (Hymenoptera: Eupelmidae) and Baryscapus hunteri (Crawford) (Hymenoptera: Eulophidae) were recovered for the first time on pepper fruits infested by pepper weevil. Specimens previously collected by P. Stansly at Culiapan de Guerrero, Oaxaca, and identified as Ceratoneura sp. in Rodríguez-Leyva et al. (2007) were identified as C. petiolata Ashmead (Hymenoptera: Eulophidae). The species was a new record as a parasitoid of the pepper weevil. Specimens collected by Rodriguez-Leyva at Santiago Ixcuintla, Nayarit, and identified as Eupelmus in the same paper belong to the species E. cushmani. Distribution and biology of most of the parasitoids reared in the present study were previously discussed (Rodríguez-Leyva et al. 2007); thus, only some features for the new species records are commented on here.

Eupelmus cushmani is a parasitoid distributed from Canada to South America (Noyes 2010). It is a primary parasitoid or hyperparasitoid of 34 insect species, including some species of Anthonomus (Gibson 2011). Clausen (1978) cited that this species was collected from Guatemala and released in Hawaii during 1934-1937, in a classical biological program against pepper weevil. Pérez and Bonet (1985) reported this species on Acanthoscelides obtectus (Say) in Morelos, Mexico.

We reared E. cushmani from Rosamarada, Nayarit, on pepper fruits infested with pepper weevils, which represents the first record of this species reared from pepper weevil in Mexico. It was possible to use the methodology by Vasquez et al. (2005) for C. hunteri to rear E. cushmani for one generation on cowpea weevil, Callosobruchus maculatus F., in the laboratory.
Table 1. New Records of Pepper Weevil Parasitoid Species and Localities in Mexico

<table>
<thead>
<tr>
<th>State</th>
<th>Locality and collection date (2011)</th>
<th>Collector</th>
<th>Cultivar</th>
<th>Pepper (kg)</th>
<th>Species reared (# specimens)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guanajuato</td>
<td>San Luis de la Paz (Carr. San Luis Potosí, Querétaro) 29 Jul</td>
<td>E. Flores</td>
<td>Jalapeño</td>
<td>3</td>
<td>Anthonomus eugenii (8) Catolaccus hunteri (6)</td>
</tr>
<tr>
<td>Morelos</td>
<td>Axochiapan Aug. 2010</td>
<td>N. Bautista</td>
<td>Jalapeño Not available</td>
<td>C. hunteri (1) Triaspis eugenii (2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Urosigalphus sp. (3) Bracon sp. (1)</td>
</tr>
<tr>
<td>Nayarit</td>
<td>Rosamorada (Las Pilas) 8 Apr</td>
<td>E. Mariscal</td>
<td>Cola de rata</td>
<td>1.5</td>
<td>A. eugenii (220) C. hunteri (35)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Triaspis eugenii (5) Eupelmus cushmani (10)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Baryscapus hunteri (15) Urosigalphus sp. (2)Bracon sp. (1)</td>
</tr>
<tr>
<td>Santiago Ixcuintla</td>
<td>18 Apr</td>
<td>E. Mariscal</td>
<td>Serrano</td>
<td>1.5</td>
<td>A. eugenii (139) C. hunteri (5)</td>
</tr>
<tr>
<td>Santiago Ixcuintla</td>
<td>28 Apr</td>
<td>E. Mariscal</td>
<td>Serrano</td>
<td>4.5</td>
<td>A. eugenii (47) C. hunteri (4)</td>
</tr>
<tr>
<td>Santiago Ixcuintla</td>
<td>5 May</td>
<td>E. Mariscal</td>
<td>Serrano</td>
<td>8</td>
<td>A. eugenii (12)</td>
</tr>
<tr>
<td>Santiago Ixcuintla</td>
<td>30 May</td>
<td>E. Mariscal</td>
<td>Serrano</td>
<td>3.6</td>
<td>A. eugenii (3)</td>
</tr>
<tr>
<td>Oaxaca</td>
<td>Abasolo (San Sebastián) 5-7 Oct</td>
<td>R. L-F &amp; E. R-L.</td>
<td>Chile de agua</td>
<td>12</td>
<td>A. eugenii (260), T. eugenii (3)</td>
</tr>
<tr>
<td>Puebla</td>
<td>Tehuacán y Tecamachalco 29 Jul</td>
<td>E. R-L.</td>
<td>Jalapeño</td>
<td>2.5</td>
<td>A. eugenii (6)</td>
</tr>
<tr>
<td>Querétaro</td>
<td>Ezquiel Montes (Rancho San Judas) 29 Jul</td>
<td>J. Luna</td>
<td>Jalapeño</td>
<td>3</td>
<td>A. eugenii (17) C. hunteri (1)</td>
</tr>
<tr>
<td>Yucatán</td>
<td>Chapab, 24 Apr</td>
<td>F. Irigoyen</td>
<td>Habanero Not available</td>
<td>Urosigalphus sp. (1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tekax (Alfonso Caso) 3 Aug</td>
<td>F. Irigoyen</td>
<td>Habanero Not available</td>
<td>Urosigalphus sp. (7)</td>
<td></td>
</tr>
</tbody>
</table>

*Baryscapus hunteri* has been collected only in North America and Mexico (Noyes 2002). *A. grandis* Boheman is the only host record for this species in Mexico and in the USA (Burks 1943, Cross and Mitchell 1968, Cross and Chestnut 1971). The latter authors reported rearing the parasitoid from boll weevil larvae. In the present study, the species was collected only in Rosamorada, Nayarit. Observations suggested this species is a gregarious parasitoid on pepper weevil larvae, whereas Cross and Chestnut (1971) reported it as an endoparasitoid on boll weevil. It might be gregarious and endoparasitic, but further studies are needed to study the biology of *B. hunteri* on pepper weevil.

*Ceratoneura petiolata* Ashmead is a New World species and has been collected in different Mexican states including: Baja California Sur, Chiapas,
Guerrero, Oaxaca, Nuevo León, Tabasco, and Veracruz (Ikeda 2001). Hosts include a Curculionidae (Hypurus sp.) and the Cecidomyiidae Stenodiplosis sorghicola (Coquillett). It was also recorded as a hyperparasitoid on the eulophid Aprostocetus diplosidis Crawford (Noyes 2010). In the present study, the species was identified from pepper weevils collected by P. Stansly at Culiapan de Guerrero, Oaxaca. Thus, the present study is the first record of C. petiolata reared from this species.

The following key includes the most common and important parasitoid genera recorded for pepper weevil in Mexico. Excluded were four genera: Euderus, Syempiesis, Chelonus, and Lyrcus. Specimens of Euderus and Syempiesis (Hymenoptera: Eulophidae) were reported by Mariscal et al. (1998) to have been reared from pepper weevil, but we were unable to obtain specimens. Because the two genera are not known to attack Anthonomus and were not found in field collections, it was decided not to include them in the key. The third genus Chelonus was also not included because this seems to be an erroneous record; all recorded species of the genus are well known egg-larval parasitoids of Lepidoptera (Rodríguez-Leyva et al. 2007). The last parasitoid species not included in the key was Lyrcus incertus Ashmead (Pteromalidae), which is probably a synonym of Catolaccus incertus and/or Zatropis incertus (Noyes 2002), and thus, also excluded from the key.

The key was constructed assuming basic knowledge of Hymenoptera anatomical terminology, although the key is accompanied by figures showing many of the structures. Those not trained in this area will find useful information in Gibson (1997), Sharkey and Wharton (1997), and the key to boll weevil parasitoids by Krauter and Jones (2004).

**Key to Hymenopteran Parasitoids of the Pepper Weevil from Mexico**

1. Forewings with venation complete, with at least 3 closed cells (Fig. 1a); antenna filiform (Braconidae) ................................................................. 2

1’. Forewings with venation reduced (Fig. 1b); antenna geniculate (elbowed) (Chalcidoidea) ........................................................................................................... 5

2. Most of the body black; labrum exposed, not concealed by clypeus (Fig. 1e); hind wing M+Cu almost as long as 1M (Fig. 1d) (Helconinae) ........................................ 3

2’. Most of the body light colored (yellow to orange) with some black areas; labrum concealed by clypeus (Fig. 1f); hind wing M+Cu more than half as long as 1M (Fig. 1c) (Braconinae) ........................................................................................ Bracon

Two species are collected on this genus, B. mellitor and another not identified to species.

3. Metasomal carapace without complete transverse grooves (Fig. 2a); outer claw of hind tarsus larger than inner claw (Fig. 2c) ................................. Urosigalphus

   There are not available keys to Mexican species on this genus. It seems only one morphospecies is present.

3’. Metasomal carapace with two complete transverse grooves (Fig. 2b); outer claw of hind tarsus similar to inner claw ....................................................... 4

4. Metasomal terga 1 and 2 fused (Fig. 2f) ...................................................... Triaspis

   Only T. eugenii has been collected as A. eugenii parasitoid.

4’. Metasomal terga 1 and 2 not fused (Fig. 2g) ........................................ Aliolus

   This genus was reported only in Nayarit (3 specimens) by Mariscal et al. (1998), but those specimens were not available to check in the present study.
5. Width of prothorax in dorsal view greater than ½ width of mesothorax, rectangular, (Fig. 2d); head and thorax highly sculptured (Eurytomidae) .............. Eurytoma
   This genus has at least 701 species (Noyes 2010). Thus, it was not possible to identify the species.

5'. Width of prothorax in dorsal view less than ½ width of mesothorax, curved and not rectangular (Fig. 2e); head and thorax not highly sculptured .......... 6

6. Mesopleura large and oblong, half the length of thorax or more (Fig. 2h); mesotibial spine elongated with macrosetae (Eupelmidae) .............. Eupelmus
   
   E. cushmani is the unique species collected as A. eugenii parasitoid.

6'. Mesopleura smaller and quadrate, length much less than half the length of thorax (Fig. 2i); mesotibial spine not elongated, without macrosetae .......... 7

7. Tarsi with 4 tarsomeres; antennal flagella with 5 to 7 segments; antennal club usually with 3 segments; funiculus with 2 to 4 segments (Eulophidae) .......... 8

7'. Tarsi with 5 tarsomeres; antennal flagella with 5 to 7 segments; 2 ring segments, 6 in funiculus, and 3 in the club (Pteromalidae) ..................... Catolaccus
   Just one species has been collected in this genus, C. hunteri.

8. Supraclypeal area (face) with striae, merging at base (Fig. 1g) .......... Ceratonera
   Only C. petiolata has been collected as A. eugenii parasitoid.

8'. Supraclypeal area (face) without striae .................................. Baryscapus
   B. hunteri is the unique species collected as A. eugenii parasitoid.

Acknowledgment

We thank Trinidad Lomeli and Nadia Gómez for their assistance in the laboratory, and all people who participated in the field collections of pepper weevil-infested fruits. Much of the collected material was obtained during the Ph.D. studies of the first author, and his research was partially supported by the University of Florida and the Consejo Nacional de Ciencia y Tecnología (CONACYT), Mexico. This manuscript was supported by the Program of Incentives for Research, Technological Development and Innovation “INNOVAPYME CONACYT, MEXICO” Grant No. 2011-137255 to Koppert Mexico SA de CV.

References Cited


Fig. 1. Morphological structures of parasitoids of the pepper weevil. Forewing: a) *Bracon* sp., b) *Ceratoneura petiolata*. Hindwing: c) *Bracon* sp., d) *Triaspis eugenii*. Head frontal view: e) *Triaspis eugenii*, f) *Bracon* sp., g) *Ceratoneura petiolata*.


82

