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Species richness of noctuid moths (Lepidoptera: Noctuidae) from the State of Guanajuato, Mexico

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The greatest diversity of lepidopterans is found in the Neotropical region. Within this order, the family Noctuidae are striking for their dominance and great species richness with 35,000 species worldwide, of which 8,539 have been recorded in the Neotropics (Quimbayo et al. 2010). Dodd et al. (2011) found that noctuid species could reach up to 40% of the lepidopteran species richness, in both forests and fragmented landscapes, many with generalist feeding habits (Sánchez-Ramos et al. 1999). Gómez y Gómez & Beutelspacher (1999) indicated that Mexico has a wide diversity of lepidopterans, but the biological and taxonomic information is not enough. Of the studies from Mexico, MacGregor & Gutiérrez (1983), Pacheco-Mendivil (1985), and Beutelspacher & Balcázar-Lara (1999) reported 22, 20, and 19 species, respectively, of noctuid pests, which are widely distributed on many types of Mexican crops. *Spodoptera exigua* Hübner and *Helicoverpa zea* Boddie are among the most common. More research on the taxonomy of Lepidoptera is necessary, particularly on the Noctuidae (Llorente-Bousquets et al. 2014) because of the family's great species richness and the negative impact by some species on the agriculture of Mexico.

Guanajuato, located between the arid north of the country and the luxuriant south, is one of the most agriculturally productive states of Mexico. Likewise, Guanajuato is the most transformed by intensive agricultural activity, which makes it important to know what species are currently present in the region in order to identify potential crop pests. Faunistic lists and scientific collections are useful for recording faunal change, for understanding how disturbing events have caused changes, and for predicting future trends. In addition, the study of lepidopterans can be used as a bioindicator of environmental change and for prioritizing sites for the conservation of natural areas (Kir'Yanov & Balcázar-Lara 2007). Due to the lack of information on species richness of Noctuidae moths, the aim of this research was to record the species of noctuids from agricultural sites from the state of Guanajuato, Mexico, and to provide information about their distribution and their biogeographic affinities.

Collections of specimens were made at the experimental agricultural field of the Universidad de Guanajuato, Campus Irapuato-Salamanca (20°44'36"N, 101°19'35"W; 1,739 m asl) in Irapuato, Guanajuato, and at the experimental field of Universidad de La Salle Bajío (21°3'15"N, 101°36'42"W; 1,812 m) in León, Guanajuato. A 15 W blacklight trap 50 cm long (Cantelo 1990) was placed once a year in the middle of the fields during 2012. In addition, specimens from the entomological collection "Leopoldo Tinoco Corona" of Universidad de Guanajuato were examined. In total, 680 individual moths were subjected to mor-

phological analysis of the front and hind wings. The species taxonomic determination was performed according to keys of Chapman & Lienk (1981), Covell (1984), Kitching (1987), Mitchell & Zim (1994), Lafontaine & Poole (2010), and MEM (2012). All specimens identified at species level are in the "Leopoldo Tinoco Corona" collection. Biogeographic affinities of species that are consequence of taxa natural history and ecological adaptations (Rzedowski 1993; Halffter et al. 2008) were determined using distribution data from the systematic literature and online sources of MEM (2012), Nearctica (2013), and GBIF (2014). We also used the concept of Megamexico as a complete biogeographic region according to Rzedowski (1993).

During field work, 51 genera and 77 species of noctuids grouped into 10 subfamilies were identified. The subfamily with the most genera was Catocalinae ($n = 10$), followed by Amphipyridae ($n = 11$), Hadeninae ($n = 6$), Acontiinae ($n = 5$), Noctuinae ($n = 5$), Plusiinae ($n = 5$), Cucullinae ($n = 4$), Heliiothinae ($n = 2$), Acronictinae ($n = 2$), and Rivulinae ($n = 1$). The subfamily with the most species was Catocalinae ($n = 19$), followed by Amphipyridae ($n = 15$), Hadeninae ($n = 12$), Noctuinae ($n = 6$), Plusiinae ($n = 5$), Heliiothinae ($n = 4$), Cucullinae ($n = 4$), Acronictinae ($n = 2$), and Rivulinae ($n = 1$). The greatest numbers of species were found in the genera *Melipotis* ($n = 9$), *Tarache* ($n = 5$), *Spodoptera* ($n = 4$), *Lacinipolia* ($n = 4$), *Leucania* ($n = 4$) and *Heliiothis* ($n = 3$) (Table 1). Of the total species identified, 36.3% had a Megamexico I affinity, 33.7% Nearctic affinity, 16.8% were cosmopolitan, 11.6% corresponded to Megamexico III, and 1 species had a Megamexico II distribution. Due to Guanajuato's geographic position at the southern limit of the Chihuahuan Desert, these results suggest that the noctuid fauna of Guanajuato has greater affinity with the southern USA and northern Mexico than central or southern Mexico. The presence of species within Megamexico II and III might be a consequence of mountain ranges such as the Sierra Madre Oriental, the Sierra Madre Occidental, and the Transmexican Volcanic Belt, which are regions of relatively great endemism. Guanajuato can be considered to be a transition province between the Nearctic and the Neotropical biogeographic regions (Escalante et al. 2005). Also, 16.8% of the 13 cosmopolitan species were found in the Transmexican Volcanic Belt; their presence is probably due to the intense agricultural activity and transport of products into and out of the region for international trade. Our results present 30 new species records for Mexico together with data about their biogeographic affinity based on distribution data reported in the literature.

Four well-known noctuid pest species were recorded: *Peridroma saucia* Hübner, *Helicoverpa zea* Boddie, *Mythimna unipuncta*

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Table 1. List of noctuid species collected from Guanajuato, with (*) indicating new records for Mexico, and distribution according to MEM (2012) and Nearctica (2013).

Taxa	Locality of collection	Distribution
Acontiinae		
<i>Acontia chea</i> Druce (*)	Irapuato	southern Arizona, Texas (Megamexico I)
<i>Bagisara laverna</i> (Druce) (*)	Irapuato	Arizona (Megamexico I)
<i>Lithacodia synochitis</i> Grote & Robinson (*)	Irapuato	northeastern USA to Texas (Nearctic)
<i>Tarache aprica</i> (Hübner)	Irapuato	northeastern USA to Texas and California (Nearctic)
<i>Tarache areli</i> Strecker	Irapuato, Dolores Hidalgo, León	California, Arizona, Nuevo Mexico, Peninsula of California (Megamexico I)
<i>Tarache bilimeki</i> (Felder & Roggenhofer)	Irapuato	southern California, Arizona, Texas, northern Baja California (Megamexico I)
<i>Tarache quadriplaga</i> Smith	Irapuato	southern Arizona, New Mexico, Texas, Tamaulipas (Megamexico I)
<i>Tarache tenuicola</i> (Morrison) (*)	Irapuato	central and southern Texas (Megamexico I)
<i>Tarachidia semiflava</i> Guenée	Irapuato, León	Arizona, New Mexico, states of the Gulf of Mexico (Megamexico I)
Acronictinae		
<i>Acronicta interrupta</i> Guenée (*)	Irapuato	southern Canada to Nebraska and California (Nearctic)
<i>Simyra insularis</i> (Henrich-Schaffer) (*)	Irapuato	widely distributed in USA (Nearctic)
Amphipyriinae		
<i>Amphipoea americana</i> Speyer (*)	Irapuato	both coasts and central USA, southern Canada (Nearctic)
<i>Callistege diagonalis</i> Dyar	Irapuato	southern Arizona, New Mexico (Megamexico I)
<i>Chalcopasta howardi</i> H. Edwards	Irapuato, León	southern Arizona, New Mexico, Texas (Megamexico I)
<i>Cirrhophanus dyari</i> Cockerell	Irapuato	southern Arizona, Texas (Megamexico I)
<i>Cirrhophanus pretiosa</i> Morrison (*)	Irapuato	Texas (Megamexico I)
<i>Condica mobilis</i> (Walker) (*)	Irapuato	southern Arizona, New Mexico, Texas, Atlantic coast of USA, Guatemala, the Antilles (Nearctic)
<i>Eulithosia papago</i> Barnes (*)	Irapuato	southern USA (Megamexico I)
<i>Magusa divaricata</i> (Grote)	Irapuato	from Canada to South America (Nearctic)
<i>Oslaria viridifera</i> Grote	Irapuato	southern Arizona, New Mexico, Texas (Megamexico I)
<i>Papaipema marginidens</i> Guenée (*)	Irapuato	northeastern USA to Louisiana (Nearctic)
<i>Spodoptera exigua</i> Hübner	Irapuato, Abasolo, Cortazar, Juventino Rosas, Yuriria, Manuel Doblado, León	Cosmopolitan
<i>Spodoptera frugiperda</i> Smith & Abbot	León, Irapuato	from southern USA to South America (Megamexico III)
<i>Spodoptera latifascia</i> Walker (*)	Irapuato	California, Texas, Florida, the Antilles, Guatemala (Megamexico III)
<i>Spodoptera ornithogalli</i> Guenée	Irapuato, León, Juventino Rosas	Cosmopolitan
<i>Stiria intermixta</i> Dyar	Irapuato	from Arizona to Morelos (Mexico) (Megamexico I)
Catocalinae		
<i>Alabama argillacea</i> (Hübner)	Irapuato	Cosmopolitan
<i>Anticarsia gemmatalis</i> Hübner	Irapuato, León	USA, Mexico (Nearctic)
<i>Ascalapha odorata</i> L.	Irapuato	Canada, USA, Yucatan, Antilles (Megamexico III)
<i>Bulia deducta</i> Morrison	Irapuato	Canada, USA, Mexico (Megamexico I)
<i>Bulia similaris</i> Richards	Irapuato, León	southern USA, Mexico (Megamexico I)
<i>Diphtera festiva</i> F.	Irapuato	east coast and southern USA, Sinaloa, Veracruz, Chiapas, Yucatan, Guatemala (Megamexico I)
<i>Gonodonta pyrgo</i> Cramer	Guanajuato, Irapuato, León	southern USA, Yucatan, Guatemala (Megamexico III)
<i>Heteranassa mima</i> (Harvey) (*)	Irapuato	southern California, Arizona, New Mexico, Texas (Megamexico I)
<i>Melipotis acontoides</i> Guenée	Irapuato, León	from Canada to South America and the Antilles (Megamexico I)
<i>Melipotis agrotoides</i> Walker	Irapuato, León	southern California, Arizona, New Mexico, the Antilles, Baja California, Guatemala (Megamexico III)
<i>Melipotis cellaris</i> Guenée	Irapuato	southern New Mexico, Texas, Florida, Brazil (Megamexico I)
<i>Melipotis contorta</i> Guenée	Irapuato	Florida, the Antilles (Megamexico III)
<i>Melipotis indomita</i> Walker	Irapuato, León, Pueblo Nuevo	Florida, southern USA (Megamexico I)
<i>Melipotis januaris</i> Guenée	Irapuato	Florida, the Antilles (Megamexico III)
<i>Melipotis jucunda</i> Hübner	Irapuato, Silao, Salamanca, León	Canada, USA (Nearctic)
<i>Melipotis novanda</i> Guenée	Irapuato	southern California, Arizona, New Mexico, Texas, Estado de México (Megamexico I)
<i>Melipotis perpendicularis</i> Guenée	León, Salamanca	Peninsula of Baja California, southern California, Arizona, New Mexico, Texas, Florida, the Antilles; Nuevo León (Megamexico I)
<i>Metria bilineata</i> (Smith) (*)	Irapuato	southern Texas and Florida to Central America (Megamexico III)
<i>Zale lunata</i> Drury (*)	Irapuato	east and west coasts and southern USA, the Antilles (Nearctic)
Cucullinae		
<i>Copitarsia incommoda</i> Walker	Abasolo, Irapuato, Salamanca, León	Mexico, Central America (Megamexico II)
<i>Cucullia similaris</i> Smith (*)	Irapuato	western USA (Nearctic)

Table 1. (Continued) List of noctuid species collected from Guanajuato, with (*) indicating new records for Mexico, and distribution according to MEM (2012) and Nearctica (2013).

Taxa	Locality of collection	Distribution
<i>Opsigalea blanchardi</i> Todd (*)	Irapuato, León	southern Arizona, Texas (Megamexico I)
<i>Xanthopastis timais</i> Cramer	Irapuato	Peninsula of Florida, the Antilles, Central America (Megamexico III)
Hadeninae		
<i>Dargida procinctus</i> Grote	Irapuato, León	east coast of USA, Baja California (Nearctic)
<i>Himella fidelis</i> Grote (*)	Irapuato.	east coast of USA, Texas (Nearctic).
<i>Homorthodes rectiflava</i> Smith (*)	Irapuato	Arizona (Megamexico I)
<i>Lacinipolia implicata</i> McDunnough (*)	Irapuato	eastern USA, Texas (Nearctic)
<i>Lacinipolia marinitincta</i> Harvey (*)	Irapuato	Arizona, New Mexico, Texas (Megamexico I)
<i>Lacinipolia laudabilis</i> Guenée	Irapuato	eastern USA, Mexico, Central America (Nearctic)
<i>Lacinipolia olivacea</i> Morrison (*)	Irapuato, León	wide distribution in USA and Canada (Nearctic)
<i>Leucania extincta</i> Guenée (*)	Irapuato	Atlantic coast of USA (Nearctic)
<i>Leucania linita</i> Guenée (*)	Irapuato	Texas, eastern USA (Nearctic)
<i>Leucania multilinea</i> Walker (*)	Irapuato	wide distribution in USA (Nearctic)
<i>Leucania scirpicola</i> Guenée (*)	Irapuato	California, eastern USA (Nearctic)
<i>Mythimna unipuncta</i> (Haworth)	Irapuato, León, Apaseo el Grande, Celaya	Cosmopolitan
Heliiothinae		
<i>Helicoverpa zea</i> Boddie	Irapuato, León, Acambaro	Cosmopolitan
<i>Heliothis australis</i> Hardwick (*)	León	Arizona (Megamexico I)
<i>Heliothis subflexa</i> (Guenée)	Irapuato	Cosmopolitan
<i>Heliothis virescens</i> F.	Irapuato, León	Cosmopolitan
Noctuinae		
<i>Agrotis malefida</i> Guenée	Irapuato, León, Dr. Mora	Cosmopolitan
<i>Agrotis venerabilis</i> Walker	Irapuato	from Canada to Mexico (Nearctic)
<i>Dichagyris pyrsgamma</i> (Dyar)	León	Arizona, Sonora, Chihuahua, Durango, Hidalgo, Estado de Mexico (Megamexico I)
<i>Euxoa nostra</i> Smith (*)	Irapuato	western USA, Canada (Nearctic)
<i>Peridroma saucia</i> Hübner	Irapuato, Pueblo Nuevo, Dr. Mora, Abasolo, León	Cosmopolitan
<i>Striacosta albicosta</i> Smith	Irapuato, León, Pueblo Nuevo	central USA, northern, western and central Mexico (Nearctic)
Plusiinae		
<i>Autographa ampla</i> Walker (*)	Irapuato	wide distribution in USA (Nearctic)
<i>Chrysodeixis includens</i> Walker	Irapuato, Juventino Rosas	Cosmopolitan
<i>Megalographa biloba</i> (Stephens)	Irapuato	Cosmopolitan
<i>Rachiplusia ou</i> Guenée	Irapuato	Cosmopolitan
<i>Trichoplusia ni</i> Hübner	Irapuato, Huanimaro, León	Cosmopolitan
Rivulinae		
<i>Rivula propinqualis</i> Guenée (*)	Irapuato	Canada, eastern USA, Texas (Nearctic)

(Haworth), and *Spodoptera frugiperda* Smith & Abbot (Table 1). In addition, other potentially important economic species were recorded, which included *Chrysodeixis includens* Walker, whose larvae were seen feeding on tomato under greenhouse conditions in Irapuato; *Anticarsia gemmatalis* Hübner, pest of many crops, whose larval stage was observed feeding on alfalfa; *Autographa ampla* Walker, a defoliator of various species of trees and shrubs in Canada and the USA (Chapman & Lienk 1981), which has been observed feeding on lettuce in Guanajuato (personal observation of the first author M. D. S. A.); and *Striacosta albicosta* (Smith), which was reported to feed on transgenic *Bt* maize crop in the northern USA (Tooker & Fleischer 2010). In contrast, *Dargida procinctus* Grote was caught on “alpisto” or reed canarygrass (*Phalaris arundinacea* L.; Poales: Poaceae), an important weed in Guanajuato; this interaction could be interesting for a study of this noctuid’s potential as a biological control of reed canarygrass.

Although the numbers of individuals of the various taxa caught during sampling were not recorded systematically, the most abundant species were clearly *S. frugiperda*, *H. zea*, and *M. unipuncta*, likely because of the great expanse of sorghum and maize crops grown in the

region. Similar to the findings of Sei-Woong & Jeog-Seop (2013), the pattern of species richness of Noctuidae was one in which the majority of species were represented only by a few individuals. Nevertheless, more precise determinations of abundance patterns and total species richness of noctuids in Guanajuato are required, and more rigorous statistical and systematic field sampling is needed.

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Summary

The Noctuidae are a family with many species worldwide, but in Mexico, there is little information about their species richness despite noctuids being very important pests in agriculture. With data obtained from fieldwork and specimens from the Entomological Collection of Universidad de Guanajuato, a list of species found in Guanajuato was made, taking into account distribution and biogeographic affinity data.

The results showed 77 species, of which 36.3% had a distribution of Megamexico I affinity, 33.7% had Nearctic affinity, and 16.8% were cosmopolitan, whereas the rest of the species had distributions that corresponded to Megamexico II and III. The high percentage of northern species suggests that the biogeographic affinity of the noctuids from Guanajuato is close to the southern USA and northern Mexico. This research reports 30 new species records for Mexico, and 1 species may be a potential agent for the biological control of reed canarygrass, a major weed species.

Key Words: richness; biogeography; biological control; reed canarygrass; Megamexico

Sumario

Noctuidae es una familia de palomillas con muchas especies reconocidas alrededor del mundo, pero en México hay poca información disponible sobre su riqueza a pesar de que los noctuidos se consideran plagas en la agricultura. Con datos obtenidos en campo y de la revisión de ejemplares de la Colección Entomológica de la Universidad de Guanajuato, se elaboró un listado de especies tomando en cuenta la distribución y la afinidad biogeográfica. Se encontraron 77 especies, 36.3% de afinidad Megamexico I, 33.7% de afinidad Neártica y 16.8% cosmopolitas, el resto de las especies tienen distribución que corresponde a Megamexico II y III. El alto porcentaje de especies norteamericanas sugiere que Guanajuato es más parecido al sur de Estados Unidos y Norte de México. En esta investigación se reportan 30 nuevos registros de especies para México, una con el potencial de usarse como control biológico de malezas en cultivos.

Palabras Clave: riqueza; biogeografía; control biológico; malezas en cultivos; Megamexico

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