



## First record of the cacao plume moth *Michaelophorus nubilus* (Felder & Rogenhofer) (Lepidoptera: Pterophoridae) in Mexico

Guillermo López-Guillén<sup>1\*</sup> , Fernando Hernández-Baz<sup>2</sup> , Jorge M. González<sup>3</sup> ,  
Carlos Hugo Avendaño Arrazate<sup>1</sup> , Moisés Alonso Báez<sup>1</sup> 

<sup>1</sup>Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP), Campo Experimental Rosario Izapa, Tuxtla Chico, Chiapas, México.

<sup>2</sup>Universidad Veracruzana, Facultad de Biología-Xalapa, Xalapa, Veracruz, México.

<sup>3</sup>Austin Achieve Public Schools, Austin, TX (Research Associate, McGuire Center for Lepidoptera & Biodiversity), USA.

### ARTICLE INFO

#### Article history:

Received 03 August 2020

Accepted 09 October 2020

Available online 16 November 2020

Associate Editor: Thamara Zacca

#### Keywords:

Theobroma cacao

Flushing

### ABSTRACT

We report field infestation under natural conditions by the cacao plume moth, *Michaelophorus nubilus* (Felder & Rogenhofer) on leaves of cacao (*Theobroma cacao* L.; Malvaceae) for the first time in Southern Chiapas, Mexico. The larvae of *M. nubilus* damages new “flushing” or light green leaves from buds, from either the main or lateral branches of cacao plants.

The pantropical family Pterophoridae (Insecta: Lepidoptera) includes around 1,136 described species contained within five subfamilies: Agdistinae, Ochyroticinae, Deuterocopinae, Macropiratinae, and Pterophorinae. The latter is the largest of the five subfamilies with 84 genera and 1,028 described species (Gielis, 2003, 2006, 2008, 2011; Gielis and Karsholt, 2009). Pterophorinae is characterized by the presence of a deep cleft on the outer margin of the forewing, the resting posture of adults resembles a “T”, and they have venous scales on the underside of the hindwing. This subfamily is also divided into five tribes, among them Platyptiliini contains the genus *Michaelophorus* Gielis, 1999 that includes the Neotropical species *M. bahiaensis* Gielis, 2006, *M. dentiger* (Meyrick, 1916), *M. hodgesi* Gielis, 1999, *M. indentatus* (Meyrick, 1930), *M. margaritae* Gielis, 2006, *M. nubilus* (Felder & Rogenhofer, 1875) and *M. shafferi* Gielis, 1999, all with nocturnal habits (Gielis, 1993, 2003, 2006).

In Mexico, cocoa (*Theobroma cacao* L.; Malvaceae) is cultivated in the states of Tabasco, Chiapas, Oaxaca, and Guerrero. Chiapas is the second producer in the country, with 16,708 ha planted with the crop and concentrating 26% of the national production (SIAP, 2019). Among

the most important phytosanitary problems of the region, there is a couple of diseases caused by fungi, such as *Moniliophthora roreri* (Cif.) H.C. Evans, Stalpers, Samson & Benny (Agaricales: Marasmiaceae) and *Phytophthora palmivora* Butler (Peronosporales: Peronosporaceae) (Phillips-Mora et al., 2006; Díaz-José et al., 2013). However, several other pests, many of them insects, affect the crops but had been poorly studied (López et al., 2003). *Toxoptera aurantii* (Boy.) (Hemiptera: Aphididae), *Xyleborus ferrugineus* Fabricius, *Xylosandrus morigerus* Blandford, *Hypothenemus birmanus* Eichhoff, *Corthylus minutissimus* Schedl, *Taurodermus sharpi* Lenis, *Hypothenemus interstitialis* Hopkins (Coleoptera: Curculionidae), *Selenothrips rubrocinctus* Giard (Thysanoptera: Thripidae), *Clastoptera laenata* Fowler (Hemiptera: Clastopteridae) are among the phytophagous insects reported from Chiapas (Hernández-Gómez et al., 2015).

In the Soconusco region of Chiapas, Mexico, records of insect pests and their damage to cocoa crops are practically nil. Therefore, it is essential to identify

and determine the damages caused in cocoa plantations, as well as the different life stages of any insect pest that will facilitate the development of integrated management strategies to reduce such pest populations. We are thus reporting for the first time the cocoa plume moth *M. nubilus* damaging new leaves of *T. cacao* in Mexico.

\* Corresponding autor:

E-mail: lopez.guillermo@inifap.gob.mx (G. López-Guillén)

Several plantations of *T. cacao* were surveyed in the Soconusco region, Chiapas, Mexico, during May 2018. After a careful visual inspection of new leaves and branches samples of leaves infested with larvae or pupae *M. nubilus* were manually collected. The visited and surveyed places are listed in Table 1.

Some larvae of Lepidoptera feeding on buds of cocoa plants were collected from all the previously mentioned plantations and sites. Ninety-five larvae were collected and brought to our lab at INIFAP where they were placed in groups of 10 larvae into 1-liter plastic containers covered with organdy fabric and fed daily with fresh new leaves of

*T. cacao* until pupation. After five days, 77 adults emerged and were mounted to be later identified using the keys and descriptions provided by Gielis (2006) and Meyrick (1916). All identified specimens were collected under the scientific collector license FAUT-0194 SEMARNAT-CITES and have been placed in the Lepidoptera Collection of the Faculty of Biology at Universidad Veracruzana, Xalapa, Veracruz, Mexico (Key SEMARNAT-CITES: DF-CC-276-13).

All emerged adults were identified as *M. nubilus*. This species is characterized by having a dark brown forewing, with a faint subterminal line on both lobes, a discal spot surrounded by pale scales and its

**Table 1**

Visited and surveyed sites with *Theobroma cacao* L. plantations, in the Soconusco region, Chiapas, Mexico.

Locality	Municipality	Geographical coordinates		Altitude (m)
		N	W	
Los Cacao	Acacoyahua	15° 23' 17"	92° 39' 12"	457
La Bendición	Acapetahua	15° 10' 52"	92° 41' 41"	6
Mixcum	Cacahoatán	15° 1' 24"	92° 8' 13"	630
Cd. Hidalgo	Suchiate	14° 40' 49"	92° 10' 15"	22
3 de May	Escuintla	15° 21' 3"	92° 30' 13"	502
Texcaltic	Frontera Hidalgo	14° 47' 58"	92° 11' 14"	79
Plan de Ayala	Huehuetán	14° 58' 39"	92° 29' 11"	11
El Cedral	Huixtla	15° 5' 11"	92° 31' 53"	28
Nueva Costa Rica	Mapastepec	15° 28' 6"	92° 48' 37"	347
Cuatro Caminos	Mazatán	14° 51' 25"	92° 24' 57"	26
Los Hules	Metapa de Domínguez	14° 51' 32"	92° 11' 19"	142
Fracción Hermosillo	Tapachula	14° 59' 31"	92° 11' 39"	461
2a. Sección de Guillén	Tuxtla Chico	14° 52' 32"	92° 9' 7"	170
Islamapa	Tuzantán	15° 4' 10"	92° 26' 24"	24
Trinidad	Unión Juárez	15° 2' 18"	92° 7' 6"	819
Monte Flor	Villa Comaltitlán	15° 19' 36"	92° 34' 4"	506



**Figure 1** Larvae of *Michaelophorus nubilus* feeding on leaves of *Theobroma cacao* L. (A); larvae in the last instar (B); black arrow showing pupae (C); adult of *Michaelophorus nubilus* (D).

abdomen is white (Gielis, 2006). The last instar larvae have a translucent cuticle and are mainly whitish or yellowish-green. The most relevant feature of the larvae is the length of their D2 setae on their abdominal segments. However, all D2 are long but notably shorter in A2, A4, A6, and A8 than in the adjacent segments. The pupae are anchored to leaves or branches (Fig. 1) and have a lime-green body, but their head, thorax, and appendages become dark brown before emergence (Matthews and Miller, 2010).

Damage and presence of larvae were observed throughout every month of the year in most locations with cocoa plantations that were monitored in southeast Chiapas, Mexico, regardless of the genetic group to which the plant belongs to (criollo, trinitario or forastero). The larvae of *M. nubilus* specifically feeds on new “flushing” or light green leaves from buds, from either the main or lateral branches (Fig. 1A). Some of the new leaves were found with up to 15 larvae feeding on them. Even though we were unable to measure foliar consumption, we noticed that in several shoots, over 50% of the leaf blade was consumed. Larvae close to pupation, were not very active when disturbed and they rested on the pedicel or the shoots’ stem (Fig. 1B).

The pupae can be dark green or brown and are located mainly on mature leaves and branches, rarely on the main vein of young leaves (Fig. 1C). Some adults (Fig. 1D) were observed in orchards with a lot of shade and little agronomic management. The cacao plume moth has been previously reported in cocoa from Honduras, Costa Rica, Trinidad, Colombia, Venezuela, Ecuador, Peru, and Brazil (Lamont and Callan, 1950; Brito Silva, 1980; Gielis, 1999; Matthews and Miller, 2010). However, this is the first report of *M. nubilus* from Mexico attacking plants of *T. cacao*, its only known host so far (Gielis, 2006; Matthews and Miller, 2010).

In conclusion, *M. nubilus* deserves more studies in the cocoa plantations of Chiapas, Mexico, to learn more about its bioecology to propose management measures.

## Acknowledgments

This work was supported by Secretaría de Agricultura y Desarrollo Rural (SADER) and Consejo Nacional de Ciencia y Tecnología (CONACYT) [Fondo Sectorial (SADER-CONACYT)] grant number: 2017-02-291417.

## Conflict of interest

The authors declare no conflict of interest in this research.

## Author contribution statement

All authors contributed to the study conception and design. The first author wrote a first version of the manuscript and all authors contributed equally reviewing critically the manuscript for important content. All authors approved the final version of this paper.

## References

- Brito Silva, A., 1980. Ocorrência de *Oxyptilus* sp. (Lepidoptera: Pterophoridae) em cacauais no Estado do Pará. Rev. Theob. 10 (4), 257-259. <https://doi.org/10.7550/rmb.26239>.
- Díaz-José, O., Aguilar-Ávila, J., Rendón-Medel, R., Santoyo-Cortés, V. H., 2013. Situación actual y perspectivas de la producción de cacao en México. Cien. Inv. Agr. 40 (2), 279-289. <https://doi.org/10.4067/s0718-16202013000200004>.
- Felder, R., Rogenhofer, A. F., 1875. Atlas der Heterocera. In: Reise der Österreichischen Fregatte Novara um die Erde in den Jahren 1857-1859. Zoology 2 (2), plate 140. Wien: aus der kaiserlich-königlichen Hof- und Staatsdruckerei. <https://doi.org/10.5962/bhl.title.1597>.
- Gielis, C., 2003. World Catalogue of Insects. Pterophoroidea & Alucitoidea. Vol. 4. Apollo Books, Stenstrup, 198 pp. <https://doi.org/10.1002/mmnd.20030500211>.
- Gielis, C., 1993. Generic revision of the superfamily Pterophoroidea (Lepidoptera). Zool. Verh. 290 (1), 1-139.
- Gielis, C., 1999. Neotropical Pterophoridae 13: *Michaelophorus*, a new name for *Shafferia*, Gielis, 1993, with a review of the genus and description of two new species (Lepidoptera). Ent. Ber. Amst. 59 (10), 149-156.
- Gielis, C., 2006. Review of the Neotropical species of the family Pterophoridae, part I: Ochyroticinae, Deuterocopinae, Pterophorinae (Platyptiliini, Exelastini, Oxyptilini) (Lepidoptera). Zool. Med. Leiden 80-2 (1), 1-290.
- Gielis, C., 2008. Ten new species of Afrotropical Pterophoridae. Zool. Med. Leiden 82 (6), 43-57.
- Gielis, C., 2011. Review of the neotropical species of the family Pterophoridae, part II: Pterophorinae (Oidaematophorini, Pterophorini) (Lepidoptera). Zool. Med. Leiden 85 (10), 589-824. <https://doi.org/10.33338/ef.84246>.
- Gielis, C., Karsholt, O., 2009. Additional records of Pterophoridae from the Cape Verde Islands, with description of a new species of Agdistis Hübner. Nota Lepid. 32 (2), 139-144.
- Hernández-Gómez, E., Hernández-Morales, J. J., Avenaño-Arrazate, C. H., López-Guillén, G., Garrido-Ramírez, E. R., Romero-Nápoles, J., Nava-Díaz, C., 2015. Factores socioeconómicos y parasitológicos que limitan la producción del cacao en Chiapas, México. Rev. Mex. Fitopatol. 33 (2), 232-246. <https://doi.org/10.31819/9783954878505-006>.
- Lamont, N., Callan, McC., 1950. Moths new to Trinidad, B.W.I. Zoologica 35 (17), 197-207.
- López, A. P., Delgado Núñez, V. H., Azpeitia Morales, A., López Arroyo, J. I., Jiménez Chong, J. A., Flores Rodríguez, A., Fraire Sierra, L., Castañeda Ceja, R., 2003. El cacao en Tabasco: manejo y producción, 2a ed. Instituto para el Desarrollo de Sistemas de Producción del Trópico Húmedo de Tabasco, Villahermosa, Tabasco, 42 pp.
- Matthews, D. L., Miller, J. Y., 2010. Notes on the cacao plume moth in Honduras and description of the larvae and pupae (Lepidoptera: pterophoridae). Trop. Lepid. Res. 20 (1), 28-34.
- Meyrick, E., 1916. Exotic Microlepidoptera. Vol. 1, No. 18. Taylor & Francis, London, pp. 545-576.
- Phillips-Mora, W., Coutiño, A., Ortiz, C. F., López, A. P., Hernández, J., Aime, M. C., 2006. First report of *Moniliophthora roreri* causing frosty pod rot (moniliasis disease) of cocoa in Mexico. Plant Pathol. 55 (4), 584. <http://dx.doi.org/10.1111/j.1365-3059.2006.01418.x>.
- Servicio de Información y Estadística Agroalimentaria y Pesquera – SIAP, 2019. Anuario Estadístico de la Producción Agrícola 2016 en México: estadísticas de producción del cultivo de cacao. Secretaría de Agricultura y Desarrollo Rural, Ciudad de México, México. Available in: <http://www.siap.gob.mx/> (accessed 22 February 2020).