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GEOGRAPHIC DISTRIBUTION AND CONSERVATION OF *CYANOPEPLA GRISELDIS* (LEPIDOPTERA: EREBIDAE: ARCTIINAE: CTENUCHINA) AN ENDEMIC WASP MOTH OF MEXICO

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ABSTRACT

Mexico contains a large diversity of Lepidoptera (14,385 spp.), but it is a contradiction that only two species of butterflies are officially protected and moths are not even contemplated for protection. Among the 240 known species of Mexican wasp moths 10 are endemic to the country. Herein we update the knowledge of the geographical distribution of the wasp moth, *Cyanopepla griseldis* (Druce 1884) (Lepidoptera: Erebidae: Arctiinae: Ctenuchina), which is endemic to the mountains of central Mexico. We also evaluated *C. griseldis*'s current vulnerability, using a method that allowed us to categorize it as "threatened" based on the corresponding equivalent designation in the Official Mexican Norm for Species Protection (NOM-059). We also propose that the taxon should be included in the Official Mexican Norm for Species Protection.

Key Words: biogeography, wasp moth, endemic species, biological conservation, endangered species

RESUMEN

México contiene una gran diversidad de Lepidoptera (14,385 spp.), de manera que es contradictorio que solo dos especies de mariposas están oficialmente protegidas, mientras que ninguna polilla está ni siquiera en planes para su protección. Entre las 240 especies conocidas de polillas avispa mexicanas 10 son endémicas del país. En este trabajo actualizamos los conocimientos sobre distribución geográfica de la polilla avispa *Cyanopepla griseldis* (Druce 1884), la cual es endémica de las montañas centrales de México. Igualmente, evaluamos su vulnerabilidad actual, usando un método previamente desarrollado, el cual nos permitió categorizarla como "amenazada" en su equivalencia en la designación en la norma oficial para la protección de especies (NOM-059). Proponemos, igualmente, la inclusión de esta especie en la mencionada Norma Oficial Mexicana de Protección.

Palabras Clave: biogeografía, polillas avispa, especie endémica, conservación de la biología, especies en peligro

Translation provided by authors.

México is known for its great biological diversity (Myers et al. 2000) and within this richness, the Lepidoptera is represented by 32 families and some 14,385 known species (Heppner 2002). However, even though the richness of butterflies and moths in Mexico is evident, its total amount of Lepidoptera species is not well known except for the Papilionoidea (Hernández-Baz et al. 2012).

Today, the wasp moths are included in the Noctuoidea: Erebidae: Arctiinae: Arctiini and have been divided into 2 subtribes Ctenuchina

y Euchromiina (Lafontaine & Fibiger 2006; Lafontaine & Schmidt 2010; Zahiri et al. 2010), and we (FH-B; JMG) consider them as such for the purpose of this work. However, others, including our co-author JBH do not agree with such classification, and leave Arctiidae as a separate family and Erebininae as a subfamily of Noctuidae. These species fly mainly during the day, although there are many species that are captured at lights (Hernández-Baz & Bailey 2006; Hernández-Baz 2013).

These moths are distributed in the Americas especially in the Neotropical region, and few species can be found in the Ethiopian region (Hernández-Baz 2012). The species richness of these wasp moths reaches some 2,532 species, with 2,496 being Neotropical (Heppner 1991), while only 36 are Nearctic (Lafontaine & Schmidt 2010). However, some authors have suggested that there might be a total of 3,000 species (Simmons et al. 2012). There are 240 species of the group known from Mexico (Hernández-Baz et al. 2012a, 2012b, 2013). One hundred and twenty eight of them are in 39 genera of Ctenuchina, while the remaining 112 species are within the 31 genera of Euchromiina, with 10 endemics (Hernández-Baz 1992, 2008, 2009, 2010, 2011a,b, 2012, 2013; Hernández-Baz et al. 2013).

The genus *Cyanopepla* (Clemens 1861) includes 34 Neotropical species and 4 of them have been reported from Mexico: *Cyanopepla arrogans* (Walker 1854); *Cyanopepla bella* (Guérin-Ménéville [1844]); *Cyanopepla griseldis* (Druce 1884); and *Cyanopepla submacula borealis* Rothschild 1912 (Hernández-Baz 2012).

All flora and fauna species that are protected in México are included in the Official Mexican Norm for Protection NOM-059, within the Mexican Native Species of Wild Flora and Fauna list of risk categories and specifications for inclusion, exclusion and change of risk categories (Semarnat 2010). Contrasting to the large richness of Lepidoptera in Mexico (*sensu* Heppner 2002), only 2 species of lepidopterans are actually under protection, i.e., *Papilio esperanza* (Beutelspacher) “Esperanza Swallowtail”, (Papilionidae), an endemic species, and *Danaus plexippus plexippus* (Linnaeus) “Monarch butterfly” (Nymphalidae) which is migratory. All other butterflies and moths, including many endemic species, are not included for protection.

The main aim of this study was to present geographical distribution and conservation information about the endemic species, *Cyanopepla griseldis* (Druce 1884) in Mexico in order to propose it for consideration for inclusion in the Official Mexican Norm NOM-059. A color photograph of this species can be seen online in Florida Entomologist 97(3) (September 2014) at <http://purl.fcla.edu/fcla/entomologist/browse>

MATERIALS AND METHODS

The information presented herein comes from 3 main sources: a) specimens collected by the first author (FHB), and deposited in the code collection: SEMARNAT/CITES/CP-0026-VER/05, Xalapa, Veracruz, Mexico (CPFHB); b) review of 5 institutional collections: Natural History Museum of the City of Mexico (MHNCM), National Collection of Insects, Biology Institute of the National University of Mexico (CNIIBUNAM), Natural His-

tory Museum, London, UK (BMNH), Lepidoptera Collection of the University of Colima (UCOL), and the entomological collection of the College of the Southern Border, Chiapas (ECO-SC-E), and c) review of literature with particular emphasis on Druce (1884), Hampson (1898), Draudt (1916), and Hernández-Baz (2012), which allowed us to obtain collecting data. One of the manuscript reviewers kindly provided us with information from 2 specimens within the insect collection of the United States National Museum (USNM), Washington, D.C. which were also included herein.

All records (data from bibliographic and collection sources) were organized in an Excel spreadsheet. Locality georeferencing was based on the INEGI catalogue of names and the 1:250,000 topographic map of Mexico edited by the Mexican National Institute of Statistics, Geography and Computer science (INEGI 2012), and every locality was verified via <http://www.Googleearth.com>. The georeferenced localities from information obtained at the revised insect collections were taken from the “Polilla” database and turned into sexagesimal data for inclusion in a geographical information system for the Arcview 2.0 program (ESRI 1998).

The criteria followed to determine the priority of conservation of *C. griseldis* have been previously established by Hernández-Baz (2012) considering the usage of the following 6 variables: 1) continental geographic distribution (CGD), 2) endemism (E), 3) habitat specificity (HS), 4) persistence (P), 5) rarity (R), and 6) extractive actions (EA). Each variable is hierarchized by using a numerical value from 0 to 3. Once the hierarchies for all of the variables have been added, then the level or category will be obtained as follows: Lack of Information (0-3), Low (4-8), Medium (9-13), High (14-17) and Extreme (18). The obtained value is added to the species, as well as its equivalent value in the NOM-059 (SEMARNAT 2010) established by the Secretary of Environmental and Natural Resources and Fisheries of Mexico.

RESULTS AND DISCUSSION

Material Examined

Below, sex of the specimens and all data contained in the labels attached to them are noted, including collection catalog numbers if available, as well as the collection (between parentheses) where they are hosted. Complementary information added by the authors is included within square brackets.

MÉXICO: 1♀, México, [No date, No Coll.], USNM00835946 (USNM); DURANGO: 1♂, [La] Ciudad, [Durango], Mex.[ico], 8100 ft. [2468 m], Forrer, B.C.A. Lep. Het. *Charidea crisilda* Druce, Type. Sp. Figured, Godman-

Salvin Coll. 97.-52., Syntype, Kb-Dia-Nr. 976 B. Kreusel dok., BMNH(E)#1326071 (BMNH); 1♀, [La] Ciudad, [Durango], Mex.[ico], 8100 ft. [2468 m], Forrer, B.C.A. Lep. Het. *Charidea crisilda* Druce, Godman-Salvin Coll. 97.-52., Syntype, BMNH(E)#1326070 (BMNH); 1♀, [La] Ciudad, [Durango], Mex.[ico], 8100 ft. [2468 m], Forrer, B.C.A. Lep. Het. *Charidea crisilda* Druce, Presented by J.J. Joicey Esq. Brit. Mus. 1931-444. Syntype, BMNH(E) #1326072 (BMNH) [Druce (1884) mentions the following locality after the description of the species: "Mexico, Ciudad en Durango 8,100 feet, {Forrer}". Hampson (1894) uses Druce's (1884) data, listing two females and one male as the "type" of the species, and that they came from the "Godman-Salvin" Collection]; 1♂, N. O. Mexique, [La] Ciudad, [Durango], Forrer, Ex Oberthür Coll. Brit. Mus. 1927-3. BMNH(E) #1326073 (BMNH); STATE OF MEXICO: 1♂, Valle de Bravo, 1922 m, 28-IX-1990, N 19° 13' 57.73" W 100° 08' 54.59", F. Hernández-Baz, (Semarnat/Cites/CP-0026-Ver/05), (CPFHB); MORELOS: 1♂, Morelos, Mexico, 7,000 feet, [No date, No Coll.], USNMMENT00835945 (USNM).

Distribution, Biology and Behavior

Cyanopepla griseldis (Ctenuchina) (Fig. 1), a species rarely mentioned in the specialized literature, was described (as *Charidea griseldis*) by Druce (1884) based on specimens (1♂, 2♀)

collected in La Ciudad, in the state of Durango, Mexico. Even though Druce (1884) mentions this locality ("Mexico, Ciudad in Durango"), the state of Durango is omitted in the labels (see Material Examined above). However, it is clear in the labels that Mr. Alfonse Forrer, who sold large series of animals to the British Museum (Breninger 1899), was the collector of those specimens. Hampson (1898) in his catalogue of the Syntomidae of the British Museum mentions the specimens and locality, according to Druce's (1884) text adding that those specimens were the "type" and came originally from "Godman & Salvin Collection". However, while one male and one female Syntypes are from such collection, the second female was given to the Museum by J.J. Joicey (see Material Examined above). Curiously, a 4th specimen of the species, found in the Natural History Museum (BMNH) bears a label that states that it was also collected by Forrer from the same locality, but entered the BMNH via the Oberthür collection (see Material Examined above). Years later, Draudt (1916) indicates only "México" as a locality for the species he studied without adding any more geographical information. In the Semarnat/Cites/CP-0026-Ver/05 Collection (CPFHB), in Xalapa, Veracruz, there is a specimen collected in Valle de Bravo, in the state of Mexico. This locality is also in the Central Mountainous Region of Mexico, and is part of the Transmexican Volcanic Range (Fig. 2). Two specimens, one with



Fig. 1. Specimen of *Cyanopepla griseldis* (Druce, 1884) deposited at Semarnat/Cites/CP-0026-Ver/05 Scientific Collection, Mexico. Photo: F. Hernández-Baz

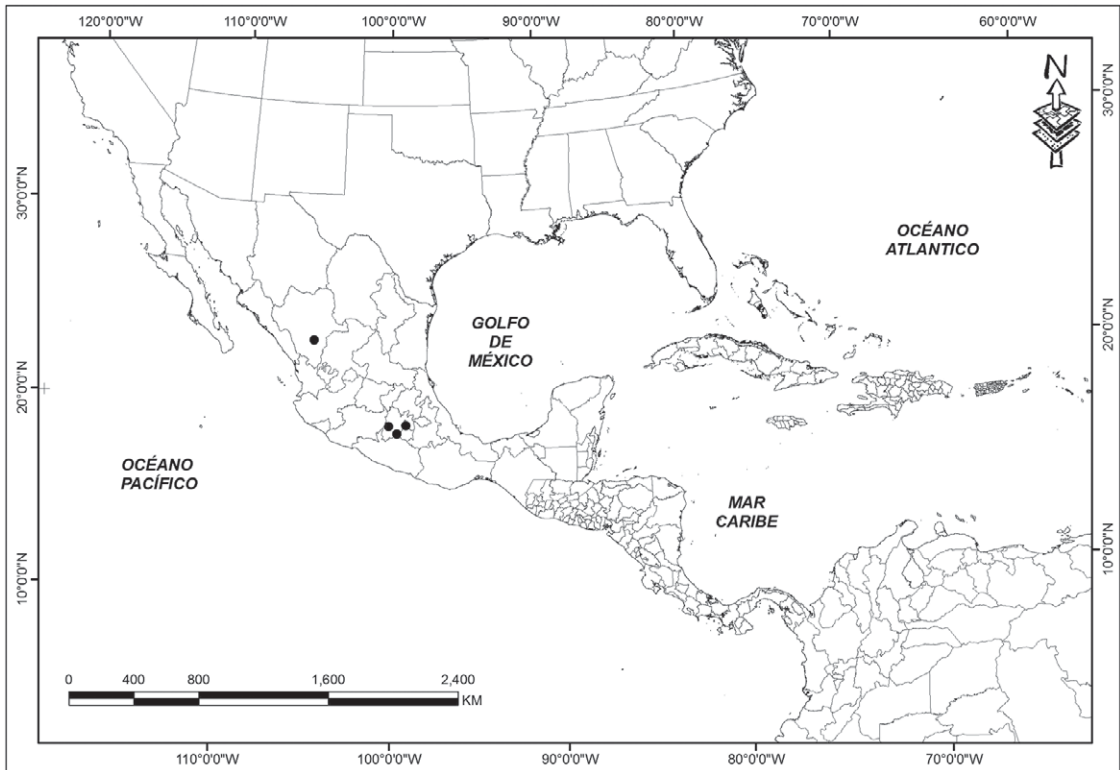


Fig. 2. Distribution of *Cyanopepla griseldis* present in the Americas. Dots represent all localities gathered from the database “Polilla”, annex to the Lepidoptera Collection, code: Semarnat/Cites/CP-0026-Ver/05, Mexico (CPFHB).

“Mexico” as locality and the other from “Morelos” with no more details, are in the insect collection of the US National Museum, Washington, D.C. (USNM). The state of Durango constitutes the northernmost locality, while the Morelos-Mexico region represents the southernmost one within the known range of the species (Fig. 2).

Based on geographic distribution registers found from the revised collections, and the information on *C. griseldis* contained in the database “Polillas” attached to the base collection Semarnat/Cites/CP-0026-Ver/05 (CPFHB), the species seems to prefer mountain habitats ranging from 1,900 to 2,470 m with cool climates, and pine-oak vegetation. Even though not much is known about the biology or ecology of the species, it has been collected during September flying at 1100 h, clearly indicating that it is a dayflying moth. Other species in the genus *Cyanopepla* Clemens (i.e. *C. bella* and *C. submacullata*) from Veracruz have similar flying habits.

Conservation

Most of the practical conservation surveys are focused on rare species (New 2014). Species

with limited geographic distribution fall in this sort of category and are much more inclined to be vulnerable than species with a wide distribution and many collecting records. Our priority was to try to identify the possibility of endemism at the national scale by carefully studying the known biogeographical information. The importance of the database “Polillas” has been bolstered by curatorial information from at least the last 150 years and consistently generates valuable information about the geographic distribution of moth species from Mexico, and the Americas. Such a database can help in finding endemic species and to precisely determine the rarity of species in any region, as was the case for *C. griseldis*. After such a thorough analysis, we can firmly state that this is an endemic species.

Hernández-Baz (2012) developed a system of variables to evaluate the vulnerability of moths. The included variables were: continental geographic distribution (CGD), endemism (E), habitat specificity (HS), persistence (P), rarity (R), extractive actions (EA). Each variable had hierarchies with values from 0 to 3, being 0 the lowest hierarchy and 3 the highest. Once all the variables are analyzed for each species, the numbers

obtained for each variable are added and four levels of vulnerability will be obtained: Lack of Data (0-3); Low (4-8), Medium (9-13), High (14-17) and Extreme (18). To each category the threat equivalence for the IUCN and the Official Mexican Norm for Flora and Fauna Species Protection "NOM-059-Ecol-2010" are also added. After overlaying the above information with the Hernández-Baz (2012) method to determine conservation priorities, we found the following scores: (CGD) = 3, (E) = 2, (HS) = 2, (P) = 1, (R) = 2, and (EA) = 0, for a total of 10 units. Such results allow us to consider that *C. griseldis* should be included in the "moderate" threat category. Furthermore, such information clearly indicates that we should consider it as a "threatened" species. All gathered evidence allows us to propose that the species should be included within the Official Mexican Norm for Flora and Fauna Species Protection "NOM-059" of SEMARNAT (2010). By having such a legal designation the federal government might help to stimulate further research and to institute practical conservation measures (New 2014). However, we should mention that more than just protecting any species, the current legislation also requires the promotion of protection of diverse ecosystems where vulnerable species are found. If we "protect" any species but fail to care for its native ecosystem, then establishing "species protection lists" will be of no use.

Concluding Remarks

Our knowledge on geographical distribution of the wasp moths in Mexico and the Americas is incomplete for historical, political and economic reasons, which to a great extent have encouraged us to pursue such studies within each national territory (Hernández-Baz 2012). Several wasp moth species (Erebidae: Ctenuchina and Euchaerini) with distribution patterns similar to *C. griseldis* have been detected. Among them we can mention *Apeplopoda mecrida* (Druce 1889), which flies in pine and oak forests (Hernández-Baz et al. 2012a); *Coreura albicosta* Draudt, 1916, which prefers mountainous mesophyll forests (Hernández-Baz et al. 2012b); and *Scena propylea* (Druce 1894), which is found along the mountainous region of the Trans-Mexican Volcanic Range, and it is also endemic to Mexico (Hernández-Baz et al. 2013).

The mountain ranges of Mexico play a relevant function in the distribution of the country's entomofauna (Halffter 1987). It appears that this is also as important for *C. griseldis*, which inhabits between 1,900 and 2,470 m. This indicates that higher elevations are one of the main components that will either favor or limit the distribution of this wasp moth.

To determine the current state of conservation of any species, this type of study is a step neces-

sary step to: a) know their geographic distribution ranges, which will allow to determine endemism, among other things; b) determine limiting climates; c) find the preferred vegetation types; d) detail their life cycles; e) analyze their persistence; and f) know the anthropogenic extractive activities in detail. This information is critically important in preserving the biodiversity of any region (Hernández-Baz 2012). The information about geographical distribution of the species is of major importance in defining priorities of conservation (Graham 1989; Fairbanks et al. 2001), there are several documented cases where such information was applied, or where the information was detailed enough to carry out actions of conservation (Danielsen & Treadaway 2004), especially with Lepidoptera (Peterson et al. 1993; Hernández-Baz 2012).

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