Neuroptera Diversity from Tacaná Volcano, Mexico: Species Composition, Altitudinal and Biogeographic Pattern of the Fauna

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Abstract: Approximately 340 species of ten families of Neuroptera have been recorded from Mexico. The Tacaná volcano, reaching an elevation of 4092 m a.s.l., is the northernmost representative of the Central American Nucleus volcanic range. Recent survey efforts of the Neuroptera diversity of the Tacaná volcano, Chiapas, along an altitudinal gradient, increased the known fauna of this order in Mexico by 31 species and two genera: Biramus Oswald, 1993 (Hemerobiidae), and Titanochrysa Sosa & Freitas, 2012 (Chrysopidae), with extension of the known distributional range of 25 species of five families. Most of the new country records are from species previously known only from Central and South America. The lacewing fauna of Chiapas is updated from 91 to 147 species. The Neuroptera of the Tacaná volcano is mostly Neotropical with some taxa of Nearctic affinity restricted to medium and high elevations. More than 80% of the Tacaná volcano lacewing species also occur in the Brazilian subregion, especially the Mesoamerican and Pacific domains. Neuropteran species were recorded from 650 to more than 3500 m a.s.l. A higher species richness was present between 600 and 1700 m, with a few species occurring at altitudes above 3000 m. A species checklist and an identification key to the genera of Neuroptera of the Tacaná volcano are provided.

Keywords: lacewings; Central American Nucleus; biogeography; altitudinal gradient

1. Introduction

Neuroptera (lacewings) are widely distributed, holometabolous insects, present in most terrestrial biomes of the tropical and temperate regions. Lacewing adults can feed on plant material, nevertheless, most of them, and all their larvae, are predators of small soft-bodied invertebrates, which makes several families, such as Chrysopidae, Hemerobiidae, and Coniopterygidae, excellent biological control agents of agricultural pests [1,2]. This order includes ca. 5800 species distributed in 15 families [3], with 342 species and 10 families (Berothidae, Chrysopidae, Coniopterygidae, Dilaridae, Hemerobiidae, Ithonidae, Mantispidae, Myrmeleontidae, Rhachiberothidae, and Sisyridae) recorded from Mexico [3–11].

Studies on the Neuroptera fauna of Mexico have been scattered for decades, with infrequent works by European and American entomologists that collaterally built a record of the fauna. Notably, the Spanish Jesuit priest Longinos Navás described several species between 1911 and 1936, followed by the works of other American, European, and Latin American entomologists (Table 1).
Table 1. Relevant work on the Neuroptera fauna of Mexico.

| Type of Study                                      | Authors                  |
|---------------------------------------------------|--------------------------|
| Original species descriptions with type locality in Mexico | [6–8,12–78]              |
| Faunistics, species diversity and distribution    | [4,5,9,79–92]            |
| General studies on systematics and taxonomy        | [10,93–110]              |
| Studies on ecology and life history aspects        | [111–128]                |

Mexico is a mosaic of different climate and vegetation types, with a complex composition of biogeographic provinces [129], and not surprisingly a far from complete record of its insect fauna. The Volcán Tacaná Biosphere Reserve, located in the Central American Nucleus mountainous area, and part of the Mesoamerican Biological Corridor, is no exception, with a potential for high biodiversity and endemism. The Tacaná volcano straddles the state of Chiapas, Mexico, and the San Marcos Department, Guatemala. It delineates the international boundary between the two countries and, being 4092 m above sea level, represents the second-highest peak in Central America after the Tajumulco volcano (4220 m) in Guatemala [130]. The reserve area is characterized by a wide diversity of vegetation, and by a high volume of precipitation, with an average of 4438 mm. Based on the climatic classification of Köppen [131], modified by García [132], the reserve’s climate types are humid temperate with abundant rains in summer, semi-warm humid with abundant rains in summer, and warm humid with abundant rains in summer. As part of the Mexican Transition Zone, the volcano holds an assembly of biota of Nearctic and Neotropical origin [133].

Faunistic inventories, with associated georeferenced databases, are important to determine patterns of taxa distribution, locate areas of concentration of the biota, and help to carry out integrated analyses of a study site or a particular environment [134,135]. According to [79], the periodic publication of comprehensive checklists, especially those with a global scope, is an imperative and enabling step for the continued advancement of biodiversity research, providing important faunistic data to support ecological assessments at local and regional scales.

This study aims to increase the knowledge on the Mexican Neuroptera fauna, particularly along an altitudinal gradient of the Tacaná volcano; it is hoped that an updated checklist and an identification key will help reduce the taxonomic impediment for the country, as well as to contribute to understanding the local and general distribution pattern of the different lacewing species.

2. Materials and Methods

2.1. Biological Materials and Taxonomic Identification

All the biological material studied was obtained from field work, except some specimens from Colección de Insectos Asociados a Plantas Cultivadas en la Frontera Sur, Chiapas, Mexico (ECO-TAP-E). Most specimens were obtained from Tacaná volcano through one year of systematic sampling at five sampling points at different altitudinal levels, in addition to sporadic sampling at other localities of the volcano to obtain a more representative sample of the Neuroptera species.

A total of 2534 adult specimens of Neuroptera were examined and identified. For their identification, the specimens had their genitalic structures studied utilizing the following method: (1) the abdomen was cut between the 6th and 7th segments and cleared in a solution of 5% potassium hydroxide (KOH) (for Hemerobiidae, Coniopterygidae, Myrmeleontidae, Mantispidae, and Rhachiberothidae) at room temperature, or 10% KOH for 15 min at 80 °C in a water bath (for Chrysopidae); (2) the cleared terminalia were stained using Chlorazol Black E; and (3) the genitalic structures were observed and studied under a Discovery V8 Zeiss microscope. Posteriorly, genitalic structures were stored in micro vials with glycerin associated with its respective specimen.
Taxonomic identification was carried out using specialized literature: Chrysopidae [12–15, 80, 93, 94, 136–142]; Coniopterygidae [8, 16, 17, 143–146]; Hemerobiidae [18, 95–97, 147–151]; Mantispidae and Rhachiberothidae [19, 98, 99]; and Myrmeleontidae [20, 100, 101]. All the biological material collected by Cancino-López and Luna-Luna and most of the specimens were deposited at Colección Nacional de Insectos, Instituto de Biología, UNAM, Mexico City, Mexico (CNIN) (with some exceptions, indicated in Supplementary Material S2: Material Examined).

2.2. Sampling

Sampling was carried out monthly between February 2018 and January 2019, at different sites and altitudinal levels with different types of vegetation (evergreen tropical forest, coffee plantation, cloud forest, oak forest, and pine forest). Specimens were captured at each collecting station using a black and mercury vapor light trap (screen) and bucket (black light), two Malaise traps, five ground-level interception traps, five yellow plate traps at the tree canopy, and entomological net on vegetation (Figure 1). Sporadic sampling also was applied using light traps and entomological nets. Specimens were kept alive in plastic screw cap vials, transported to the laboratory, and then pinned or conserved in 80% ethyl alcohol.

Figure 1. Different types of sampling methods implemented in this study: (A) Malaise trap; (B) ground-level interception traps; (C) yellow plate traps; (D) black light trap; (E) white light trap; (F) entomological net.

Five sampling areas at different altitudes were established (Figure 2): (1) Municipality of Cacahoatán, Finca Alianza (650–810 m); (2) Municipality of Cacahoatán, Ejido El Águila (1050–1390 m); (3) Municipality of Cacahoatán, Ejido Benito Juárez El Plan (1400–1770 m); (4) Municipality of Unión Juárez, Cantón Chiquihuites (2000–2470 m); and (5) Municipality of Unión Juárez, Mirador Papales (2870–3360 m). Other sites belonging to the municipality of Unión Juárez were sporadically sampled in order to increase the Neuroptera species records: Finca San Jerónimo (altitude: 720 m); Finca Monteperla (926–988 m); Mirador Pico
del Loro (1221 m); Parador Cueva del Oso (3526–3683 m); and La Laguna (3651–3789 m) (Figure 3).

Figure 2. Different altitudinal levels sampled at the Tacaná volcano Biosphere Reserve (Chiapas, Mexico) and its vegetation characterization. PAE = Results of the Parsimony Analysis of Endemism using all Neuroptera species.

Figure 3. Map with the sampling sites at the Tacaná volcano Biosphere Reserve (Chiapas, Mexico). A1–A5: Annual systematic sampling sites; S1–S5: Sporadic sampling sites. Design of the wind rose was based on the Mayan symbol “the Four Sides of the Earth (Xocom Balumil)”; the rhombuses on the vertical axis joined to the central rhombus mean east and west, while the extreme lateral rhombuses represent the north and south [redrawn from [152].
2.3. Parsimony Analysis of Endemism (PAE)

To assist in a better understanding of the altitudinal distribution of the Neuroptera species from the Tacaná volcano, we performed different PAE analyses. PAE constructs cladograms based on the cladistic analysis of the presence–absence data matrices of species and supraspecific taxa [153]. In this analysis, a matrix was built with distributional units used as the “terminals”, and the taxa (species, genus, family, etc.) used as “characters”, so a parsimony analysis is performed, resulting in the most parsimonious cladograms used to describe a potential pattern of relationship of the distributional units (e.g., areas of endemism, altitudinal levels, etc.). Initially, we performed a PAE using the sites at the main five levels of sampling as terminals, and the Neuroptera species present as characters; additional PAE were carried out for each Neuroptera family in order to unravel possible altitudinal influences from each group; the exception was Rhachiberothidae, which has only a representative species in this study.

Species (“characters”) were codified as present (1) or absent (0) for each of the distributional units (“terminals”). A hypothetical distributional unit with absence of all species was used for rooting the tree. The matrices (Appendix A) were built with WinClada [154], and then exported as a Nexus file to perform phylogenetic analysis under the principle of parsimony in TNT (Tree Analysis using New Technology, version 1.5) [155]. The most parsimonious cladogram was obtained through heuristic algorithms using the tree bisec-tion and reconnection method (TBR), using as parameters the following: random seed = 0, hold = 3000, and hold/ = 50 of 60 replications. The most parsimonious topology (or the strict consensus of the most parsimonious topologies) was exported to Illustrator CS6 software to be edited.

2.4. Terminology

Morphological terminology of wing venation generally follows Reference [156]. General terminology for Coniopterygidae follows Reference [146], Chrysopidae follows Reference [93], Hemerobiidae follows Reference [150], Myrmeleontidae follows Reference [101], and Mantispidae and Rachiberothidae follow Reference [80].

2.5. Distribution Map

Design of the study site map and the location of the sampling points was done using ArcGIS 10.2.2. The different layers (federative entities and municipalities) used for this map were obtained from the information provided by the Instituto Nacional de Estadística y Geografía (INEGI), Mexico. Statistical and geographical information is at a scale of 1:50,000. The projection of localities with geographical coordinates was carried out with UTM (Universal Transverse Mercator). Subsequently, a raster of the model of the Mexican Continuum of Elevations 3.0 [157] of the area of Chiapas was built, with a cut of the municipalities that were within the study area, using a layer of vectors of the municipal boundaries of the state. After the area of study was selected, adjustments were made to the elevation model with a reclassification of values of z (altitude) to be able to visualize the altitude difference within the area of interest. Within the reclassification, seven intervals ranging from 0 m to 4080 m were used. In addition, a shadow map (hillshade) was made that helped us to better visualize the slopes of the terrain where the study area was selected.

3. Results

A total of 2534 specimens from 109 species of 28 genera belonging to six families of Neuroptera were collected. Thirty-one species and two genera of Neuroptera, Biramus Oswald, 1993 (Hemerobiidae), and Titanochrysa Sosa & Freitas, 2012 (Chrysopidae), were recorded for the first time from Mexico; 25 species were recorded for the first time from Chiapas state. Such data increase the Mexican lacewing fauna from 343 species of 77 genera to 374 species of 79 genera belonging to 10 families. Chrysopidae, Coniopterygidae, and Hemerobiidae present most of the new records. Currently, the known fauna of Neuroptera
from Tacaná volcano is composed of 109 species of 28 genera in the families Chrysopidae, Hemerobiidae, Coniopterygidae, Mantispidae, Myrmeleontidae, and Rhachiberothidae.

3.1. Checklist of the Neuroptera from Tacaná Volcano, Chiapas State, Mexico

Checklist entries are formatted as follows. All entries for valid taxa are arranged alphabetically within the next-higher valid taxon. Entries for species include the currently valid combination.

Distributional information and remarks are also provided for each species; countries and Mexican states are listed in alphabetical order.

Neuroptera Linnaeus, 1758
Family Chrysopidae Schneider, 1851
Subfamily Chrysopinae Esben-Petersen, 1918
Tribe Chrysopini Schneider, 1851
Genus Ceraeochrysa Adams, 1982

Ceraeochrysa achillea de Freitas & Penny in de Freitas et al., 2009

Distribution: Panama, Venezuela [11,13], and Mexico (new record) (Chiapas).

Remarks: Ceraeochrysa achillea presents a Neotropical distribution. This record is the northernmost, ca. 1537 km north of the closest records (Taboga Island, Panama). They are present in evergreen tropical forest, coffee plantations, cloud forest, and on Inga spp. The flight period was in January to March, May, August, and November (mainly in the dry season). The previously known altitudinal distribution of this species was 1100 m [13]; herein, the altitudinal distribution was recorded from 687 to 1191 m. This is the lowest altitudinal record at the moment for the species. Variation: Individuals of this species usually have black gena and lack spots on the vertex, but some studied specimens had pale gena and a red spot on each side of the antennae.

Ceraeochrysa arioles (Banks, 1944)

Distribution: Costa Rica, Guatemala, Guyana, Honduras, Mexico (Chiapas, Nuevo León, Sinaloa), and Trinidad and Tobago [11,13,21,22,158,159].

Remarks: Ceraeochrysa arioles presents a wide distribution in the Neotropics. Herein, individuals were collected in evergreen tropical forest, cloud forest, oak forest, as well as on Citrus spp. and Inga spp. The flight period was from May to December (mainly in the rainy season). The altitudinal distribution of this species is unknown, in the present study the altitudinal distribution was recorded from 678 to 2081 m.

Ceraeochrysa sarta (Banks, 1914)

Distribution: Costa Rica, Mexico (Chiapas), and Panama [11,13,23,24,158,160].

Remarks: Ceraeochrysa sarta presents a Neotropical distribution. Herein, specimens were collected in evergreen tropical forest, cloud forest, oak forest, on Arachnothryx spp., Citrus spp., Inga spp., Muehlenbeckia spp., and Saurauia spp. The flight period of C. sarta was from January to December (dry and rainy seasons). The previously known altitudinal distribution of this species was 200 to 1550 m [13]; in this work, the altitudinal distribution was recorded from 673 to 2168 m, which represents the highest altitudinal distribution at the moment for this species. Recently, Sosa and Tauber [103] transferred Chrysopa sarta to Ceraeochrysa, and then synonymized Ceraeochrysa berlandi to this species. Variation: Individuals of this species may have or lack a postocular red spot, as well as tergites marked or unmarked with red; some studied specimens had faint postocular marks, with the intensity of the coloration of abdominal marks variable.

Ceraeochrysa cincta (Schneider, 1851)

Distribution: Argentina, Brazil, Costa Rica, Cuba, Dominican Republic, Ecuador, Guatemala, Guyana, Honduras, Jamaica, Mexico (Chiapas, Colima, Morelos, Nayarit, Nuevo León, Oaxaca, Sinaloa, Tamaulipas), Panama, Paraguay, Peru, Suriname, United States of America, and Uruguay [2,11,13,21,80,81,102,161–170].
Remarks: Ceraeochrysa cincta presents a wide distribution, with Nearctic and Neotropical records, including extensive distribution in Mexico. The specimens herein studied were present in evergreen tropical forest, cloud forest, and mixed oak–cloud forest. The observed flight period was in January to March, and June (mainly in the dry season). The previously known altitudinal distribution of C. cincta was 200 to 2373 m [13,80,170]; in the present study, the altitudinal distribution was recorded from 661 to 2110 m. Variation: Individuals of this species usually have a single dorsal stripe on the scape and pedicel, yet several studied specimens lacked this stripe.

Ceraeochrysa cubana (Hagen, 1861)

Distribution: Barbados, Bolivia, Brazil, Costa Rica, Cuba, Dominica, Dominican Republic, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico (Chiapas, Colima, Morelos, Oaxaca, Sonora, Tabasco, Tamaulipas, Veracruz), Nicaragua, Panama, Suriname, United Kingdom (Cayman Islands), United States of America, and Venezuela [11,13,21,24,25,80–82,104,137,158,169,171–176].

Remarks: Currently, C. cubana presents a wide Nearctic and Neotropical distribution. In Mexico, its distribution is mostly Nearctic. In this study, we record new distributional data within Mexico’s Chiapas state. The studied specimens were present in evergreen tropical forest and mixed oak–cloud forest, on Inga spp. The flight period was in February, March, and May (mainly in the dry season). The previously known altitudinal distribution of this species was from 152 to 1524 m [13]; herein, the altitudinal distribution was recorded from 680 to 2081 m, which is the highest distribution at the moment for this species.

Ceraeochrysa defreitasi Penny in Penny, 2002

Distribution: Costa Rica [11,80] and Mexico (new record) (Chiapas).

Remarks: Ceraeochrysa defreitasi presents a Neotropical distribution. Herein, we record its northernmost distribution, ca. 970 km north from previous records (Finca Las Cruces, Puntarenas, Costa Rica). The studied specimens were present in cloud forest; their flight period was in August (in the rainy season). The known altitudinal distribution of C. defreitasi was 1800 m [80]; in the present study, the recorded altitude for this species was 1590 m, which is the lowest known at the moment.

Ceraeochrysa derospogon de Freitas & Penny in de Freitas et al., 2009

Distribution: Guatemala and Mexico (Chiapas) [11,13].

Remarks: Ceraeochrysa derospogon presents a Neotropical distribution. The specimens herein studied were present in cloud forest, however one specimen was collected on Citrus sp. The flight period observed was in December (in the dry season). A previous altitudinal record of C. derospogon is 1782 m ([13]; calculated from geographical coordinates); in the present study, this species was recorded from 1185 to 1204 m, which is the lowest altitudinal distribution at the moment.

Ceraeochrysa effusa (Navás, 1911)

Distribution: Costa Rica, El Salvador, Guatemala, Honduras, and Mexico (Chiapas) [11,13,24,26,80,158,172,177].

Remarks: Ceraeochrysa effusa presents a Neotropical distribution. The specimens observed were from cloud forest; however, one specimen was collected on Psidium spp. The flight period was in May, June, and October (in the rainy season). Previous altitudinal records of C. effusa are from sea level and 1400 m [80]; in the present study, the altitudinal records were from 1111 to 1228 m.

Ceraeochrysa infausta (Banks, 1945)

Distribution: Costa Rica, Honduras [11,13,158], and Mexico (new record) (Chiapas).

Remarks: Ceraeochrysa infausta presents a Neotropical distribution. Herein, we provide its northernmost record, ca. 449 km north of the previous record (Peña Blanca, Cortés, Honduras). The specimens studied were from evergreen tropical forest and cloud forest. The flight period was in May, June, and September (in the rainy season). A previous altitudinal
record of *C. infausta* is from 112 m ([13]; calculated from geographical coordinates); herein, we collected this species from 664 to 2081 m, which is the highest altitudinal range.

**Ceraeochrysa lineaticornis** (Fitch, 1855)

*Distribution:* Canada, Honduras, United States of America [11,13,82,176,178–185], and Mexico (new record) (Chiapas).

*Remarks:* *Ceraeochrysa lineaticornis* is present in the Nearctic and Neotropics, with a wide Nearctic distribution. We record this species for the first time in Mexico, in the state of Chiapas, expanding its fragmented distributional range. Individuals studied were from cloud forest, although some specimens were found on *Psidium* spp. and Asteraceae spp. The flight period was in March, June, August, September, and October (mainly in the rainy season). Previous altitudinal range for *C. lineaticornis* is from 6 to 539 m [184]; specimens in this study were from 1075 to 1548 m, the highest altitudinal distribution record for this species.

**Ceraeochrysa sanchezi** (Navás, 1924)

*Distribution:* Brazil, Costa Rica, Cuba, Honduras, and Mexico (Baja California Sur, Chiapas (new record), Morelos, Oaxaca, Veracruz, Tamaulipas) [2,11,13,80,81,137,175,186].

*Remarks:* *Ceraeochrysa sanchezi* presents Nearctic and Neotropical distribution, with several Neotropical records. In Mexico, its distribution is mostly Nearctic. Specimens studied were from evergreen tropical forest, coffee plantations, and cloud forest. The flight period was in June, August, and December (mainly in the rainy season). Previous altitudinal records for *C. sanchezi* were in lowland areas, ca. 300 m or less [80]; herein, the altitudinal distribution was from 713 to 1185 m, which is the highest distribution at the moment.

**Ceraeochrysa squama** de Freitas & Penny, 2001

*Distribution:* Brazil [11,13,137] and Mexico (new record) (Chiapas).

*Remarks:* *Ceraeochrysa squama* presents a Neotropical distribution. We present its northernmost record, ca. 6200 km north from the previous record (Jaboticabal, São Paulo, Brazil). Specimens studied were from evergreen tropical forest and cloud forest. Flight period was in January and August (in both seasons). There are no previous altitudinal records for *C. squama*; herein, altitudinal records were from 680 to 1050 m. Variation: Individuals of this species usually have antennal scape golden yellow, with a small brown spot at the apical dorso-lateral margin, but a few specimens lacked a stripe or marks on the scape.

**Ceraeochrysa tacanensis** Cancino-López & Contreras-Ramos, 2019

*Distribution:* Mexico (Chiapas) [6,11].

*Remarks:* *Ceraeochrysa tacanensis* presents a Neotropical distribution, and was described from the Tacaná volcano, in the state of Chiapas. Herein, we provide new locality records. Specimens studied were from cloud forest and mixed oak–cloud forest; however, some specimens were found on *Alnus* spp., *Saurauia* spp., and *Quercus* spp. Flight period was in January, May to August, and October to November, but Cancino-López and Contreras-Ramos [6] mentioned this species is present during all year (in both seasons). The known altitudinal range for *C. tacanensis* is 1194 to 2430 m (including data from [6]).

**Ceraeochrysa sp.**

*Distribution:* Mexico (Chiapas).

*Remarks:* *Ceraeochrysa* spp. was collected in cloud forest. Flight period was in July and August (in the rainy season), and the altitudinal range was from 1092 to 1462 m. This species is morphologically close to *Ceraeochrysa elegans* Penny, 1998, and *Ceraeochrysa taubeare* Penny, 1997.

**Genus Chrysoperla** Steinmann, 1964

*Chrysoperla asoralis* (Banks, 1914)
Distribution: Argentina, Colombia, Guatemala, Peru, United Kingdom (Bermuda Island), Venezuela [11,12,21,83,160,187–189], and Mexico (new record) (Chiapas).

Remarks: Chrysoperla asoralis presents a wide Neotropical distribution. We report its northernmost record. The specimens were present in cloud forest and mixed oak–cloud forest; however, some specimens were collected on *Citrus* spp. Flight period was in January to March, May, and June (mainly in the rainy season). Previous altitudinal records of *C. asoralis* are from 853 to 2743 m [21,188]; specimens studied were recorded from 1111 to 2081 m.

*Chrysoperla externa* (Hagen, 1861)

Distribution: Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Guatemala, Haiti, Honduras, Mexico (Baja California Sur, Chihuahua, Chiapas, Colima, Durango, Guerrero, Jalisco, Ciudad de México, Michoacán, Morelos, Nayarit, Oaxaca, Puebla, Sinaloa, San Luis Potosí, Tamaulipas, Yucatán), Paraguay, Peru, Puerto Rico, Trinidad and Tobago, United Kingdom (Bermudas, Cayman Islands), United States of America, Uruguay, and Venezuela [2,11,21,80,82,83,137,169,170,175,176,189–200].

Remarks: *Chrysoperla externa* presents a broad Nearctic and Neotropical distribution. We report the finding of only one specimen in evergreen tropical forest. Flight period was in March (in the dry season). Previous altitudinal records for *C. externa* are from 150 to 2200 m [21,80,169,170]; herein, the specimen was collected at 694 m.

Genus *Chrysopodes* Naváš, 1913

Subgenus *Chrysopodes* Naváš, 1913

*Chrysopodes* (*Chrysopodes*) *crassinervis* Penny, 1998

Distribution: Costa Rica [201] and Mexico (new record) (Chiapas).

Remarks: *Chrysopodes* (*C.* *)crassinervis* was previously known from Costa Rica. This is the northermost record for the species, ca. 1064 km north from previous records (Finca Las Cruces, Puntarenas, Costa Rica). This species, together with *Chrysopodes* (*Chrysopodes*) *varicosus* (Naváš, 1914), conform the first records of the subgenus *Chrysopodes* for Mexico. Specimens were collected in coffee plantations and cloud forest. Flight period was in January to March and May to December (in both seasons). Previous altitudinal records are between sea level and 1280 m [80,201]; herein, the altitudinal distribution was from 1062 to 1479 m, the highest altitudinal record.

*Chrysopodes* (*Chrysopodes*) *varicosus* (Naváš, 1914)

Distribution: Costa Rica, Guatemala [80,172], and Mexico (new record) (Chiapas).

Remarks: *Chrysopodes* (*C.*) *varicosus* was previously recorded from Costa Rica and Guatemala. This is the northermost record for this species, ca. 117 km north from previous records (Atitlán Volcano, Guatemala). The specimens were collected in evergreen tropical forest, coffee plantations, cloud forest, and mixed oak–cloud forest. Flight period was from January to November (in both seasons). The previously known altitudinal distribution was between 400 to 2000 m [80,172]; herein, specimens were collected between 704 and 2157 m, the highest altitudinal distribution at the moment for this species. Variation: Individuals of this species typically have a small cluster of veinlets in the middle of the inner gradate series of the forewing evident, but some specimens had this cluster of veinlets reduced or not very evident.

*Chrysopodes* (*Chrysopodes*) sp. 1

Distribution: Mexico (Chiapas).

Remarks: The specimen of *Chrysopodes* sp. 1 was collected in cloud forest. Flight period was in July (in the rainy season) and its altitudinal record was 1194 m. This female specimen was difficult to identify; its morphology does not agree with any of the previously described species within the subgenus *Chrysopodes*. Its spermatheca differs from the rest of the *Chrysopodes* species present in the volcano.
Chrysopodes (Chrysopodes) sp. 2

Distribution: Mexico (Chiapas).

Remarks: As with the former Chrysopodes species, this one was collected in cloud forest. Flight period was in February (in the dry season), and its altitudinal record was 1487 m. This is also a female specimen, and as such, difficult to identify. Similarly, its morphology does not correspond to any other described species within the subgenus Chrysopodes and its spermatheca differs from the rest of the Chrysopodes species so far recorded from the volcano.

Genus Meleoma Fitch, 1855

Meleoma macleodi Tauber, 1969

Distribution: Honduras, and Mexico (Chiapas, Estado de México, Hidalgo, Ciudad de México, Michoacán, Puebla) [4,11,14].

Remarks: Meleoma macleodi presents a Nearctic and Neotropical distribution. Specimens studied were from cloud forest and oak forest, with some specimens collected on Quercus sp. Flight period was in February and May (in both seasons). Previous altitudinal records of M. macleodi are from 1554 to 1768 m [14]; herein, altitudinal distribution records were from 1582 to 2081 m, which is the highest altitudinal record for this species.

Meleoma titschacki Navás, 1928

Distribution: Costa Rica and Mexico (Chiapas) [11,14,80].

Remarks: Meleoma titschacki presents a Neotropical distribution. Specimens were from cloud forest and oak forest, with some specimens found on Quercus spp. and Saurauia spp. Flight period was from January to December (in both seasons). Previous altitudinal distribution records were between 640 and 1990 m [80]; herein, altitudinal records were from 1222 to 2142 m, the highest altitudinal distribution recorded for this species.

Meleoma sp.

Distribution: Mexico (Chiapas).

Remarks: Specimens of Meleoma sp. were collected from cloud forest, oak forest, and pine forest, with one specimen found on Alnus spp. Flight period was in September and November (in both seasons); altitudinal distribution records were from 2453 to 3088 m. Only female specimens were collected, which are morphologically similar to Meleoma pipai Tauber, 1969; a careful revision is required to corroborate whether they belong to the latter species.

Genus Plesiochrysa Adams, 1982

Plesiochrysa brasiliensis (Schneider, 1851)

Distribution: Argentina, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Guyana, Haiti, Honduras, Jamaica, Mexico (Chiapas, Jalisco, Nayarit, Sonora, Veracruz, Morelos, Yucatán), Nicaragua, Panama, Trinidad and Tobago, United Kingdom (Cayman Islands), United States of America, and Venezuela [4,11,21,80,82,83,137,158,160,166,167,175,202–207].

Remarks: Plesiochrysa brasiliensis has a broad Nearctic and Neotropical distribution. Specimens were collected in evergreen tropical forest, cloud forest, and mixed oak–cloud forest. Flight period was in January to March, May to July, October, and November (in both seasons). Previous altitudinal distribution records are between sea level and 1800 m [80]; herein, specimens were collected from 661 to 2060 m, the highest altitudinal record for P. brasiliensis.

Plesiochrysa sp. 1

Distribution: Mexico (Chiapas).

Remarks: Specimens were collected in cloud forest and oak forest, with flight period in May, July, and October (in the rainy season), and an altitudinal record at 2081 m. These female specimens present a longer pronotum and spermatheca different from P. brasiliensis and P. sp. 2, being more flattened at the base and with wider vela.
**Plesiochrysa sp. 2**

*Distribution:* Mexico (Chiapas).

*Remarks:* Specimens were collected in evergreen tropical forest and cloud forest, with flight period from January to March (in the dry season), and altitudinal records from 661 to 1217 m. These female specimens are similar to *Plesiochrysa* sp. 2 of Sosa [208], a species not yet formally described by this author.

**Genus Titanochrysa Sosa & de Freitas, 2012**

**Titanochrysa annotaria** (Banks, 1945)

*Distribution:* Costa Rica, Panama [11,139,142,158,201], and Mexico (new record) (Chiapas).

*Remarks:* *Titanochrysa annotaria* was previously recorded from Costa Rica and Panama. This is the northernmost record for the species, ca. 1178 km north from previous records (La Amistad International Park, Puntarenas, Costa Rica). This species, together with *T. simpliciala* Tauber et al., 2012a, confirm the first occurrence of the genus *Titanochrysa* in Mexico. Specimens were collected in cloud forest, with some specimens found on *Citrus* spp. and *Saurauia* spp. Flight period was in January and June to November (mainly in the rainy season). Previous altitudinal distribution records are between 1500 and 1600 m [201]; herein, specimens were collected from 1250 to 1577 m, which is the lowest altitudinal record. Variation: Individuals usually have the small cluster of veinlets in the middle of the inner gradate series of the forewing evident, but some studied specimens had this cluster of veinlets reduced or not very evident.

**Titanochrysa simpliciala** Tauber et al., 2012

*Distribution:* Costa Rica [11,139,142] and México (new record) (Chiapas).

*Remarks:* *Titanochrysa simpliciala* was previously recorded from Costa Rica. This is the northernmost record for the species, ca. 1032 km north from previous records (Quebrada Amistad, Heredia, Costa Rica). Specimens were collected in cloud forest, with some specimens found on *Miconia* spp. Flight period was in March and November (mainly in the dry season). A previous altitudinal distribution record is at 1920 m [139]; herein, specimens were collected from 1565 to 1625 m, which are the lowest altitudinal distribution records for this species.

**Genus Ungla Navás, 1914**

**Ungla sp. 1**

*Distribution:* Mexico (Chiapas).

*Remarks:* A female specimen of *Ungla* sp. 1 was collected in mixed oak–pine forest, with a flight period in May (in the rainy season), and an altitudinal distribution record at 3088 m. This specimen is morphologically close to *Ungla mexicana* Tauber in C. Tauber et al., 2017, but with evident differences in spermatheca and head structures.

**Ungla sp. 2**

*Distribution:* Mexico (Chiapas).

*Remarks:* A male specimen of *Ungla* sp. 2 was collected in mixed oak–cloud forest, with a flight period in May (in the rainy season), and an altitudinal distribution record at 2081 m. This specimen is morphologically close to *Ungla pallescens* Penny, 1998, and *Ungla pennyi* Tauber in C. Tauber et al., 2017, but with evident differences in genitalia.

**Tribe Leucochrysini Adams, 1978**

**Genus Leucochrysa McLachlan, 1868**

**Subgenus Leucochrysa** McLachlan, 1868

**Leucochrysa (Leucochrysa) clara** (McLachlan, 1867)

*Distribution:* Brazil, Colombia, Costa Rica, Ecuador, Guatemala, Panama [11,27,80,158,209], and Mexico (new record) (Chiapas).

*Remarks:* *Leucochrysa* (L.) *clara* has a Neotropical distribution. This is the northernmost record for the species. Specimens were collected in cloud forest. Flight period was in
January to February, May, and August to October (mainly in the rainy season). Previous altitudinal distribution records are from lowlands (7 to 458 m) [27,80]; herein, altitudinal distribution was from 1080 to 1705 m, which is the highest altitudinal distribution record.

**Leucochrysa (Leucochrysa) colombia (Banks, 1910)**

*Distribution:* Colombia, Costa Rica, Ecuador [11,80,190,206], and Mexico (new record) (Chiapas).

*Remarks:* *Leucochrysa (L.) colombia* presents a Neotropical and Nearctic distribution, with several Neotropical records. Herein, we record this species for the first time in Mexico, in the state of Chiapas. Specimens were collected in cloud forest and oak forest. Flight period was in April and May (mainly in the dry season). Previous altitudinal distribution records are between 1500 and 2700 m [80,190]; herein, specimens were collected between 1705 and 2079 m.

**Leucochrysa (Leucochrysa) lestagei Navás, 1922**

*Distribution:* Brazil, Costa Rica, Ecuador [11,80,210], and Mexico (new record) (Chiapas).

*Remarks:* *Leucochrysa (L.) lestagei* presents a Neotropical distribution. This is the northernmost record for the species, ca. 1182 km north from the previous record (La Amistad International Park, Puntarenas, Costa Rica). The studied specimen was collected in cloud forest, in June (in the rainy season). Previous altitudinal distribution records are from mid-elevations and lowlands [80]; herein, the altitudinal record of this species was 1440 m.

**Leucochrysa (Leucochrysa) pretiosa (Banks, 1910)**

*Distribution:* Belize, Colombia, Costa Rica, Ecuador, Guatemala, Mexico (Chiapas, Morelos), Nicaragua, Panama, Paraguay, Trinidad and Tobago, and Venezuela [11,80,81,137,141,158,190,211].

*Remarks:* *Leucochrysa (L.) pretiosa* presents a Neotropical distribution. Specimens were collected in evergreen tropical forest and coffee plantations, with some specimens found on *Coffea* sp. and *Inga* sp. Flight period was in January and July to December (mainly in the rainy season). Previous altitudinal distribution records are between sea level and 1300 m [80,190,211]; herein, specimens were collected between 661 to 809 m.

**Leucochrysa (Leucochrysa) varia (Schneider, 1851)**

*Distribution:* Argentina, Brazil, Ecuador, Peru [11,137,141,202,212,213], and Mexico (new record) (Chiapas).

*Remarks:* Tauber et al. [141] confirmed the presence of *L. (L.) varia* only in South America. Nevertheless, a single male specimen, collected in cloud forest, confirms the presence of this species in Mexico for the first time. This record expands the species range ca. 2460.55 km north from records of Tauber et al. [141]. Flight time was in July (in the rainy season) and the altitudinal record was 1254 m, higher than previous records (200 to 916 m) [141]. *Leucochrysa (L.) varia* was previously recorded in Mexico (Tabasco) by Navás [27] and Adams [28] also mentioned its probable occurrence in Mexico. However, Tauber et al. [141] sustained that such previous records are probably misidentifications. Herein, we confirm the presence of the species in southern Mexico.

**Leucochrysa (Leucochrysa) variata (Navás, 1913)**

*Distribution:* Mexico (Chiapas (new record), Veracruz) and Panama [11,27,141].

*Remarks:* *Leucochrysa (L.) variata* presents a Neotropical distribution. Specimens were collected in evergreen tropical forest, coffee plantations, and cloud forest, with some specimens collected on *Citrus* spp. Flight period was in January, October, and November (mainly in the dry season). Previous altitudinal distribution records are between 7 to 122 m [27]; herein, specimens were collected from 789 to 1585 m, which is the highest altitudinal record for this species.

**Subgenus Nodita Navás, 1916**
**Leucochrysa (Nodita) amistadensis** Penny, 2001

*Distribution:* Costa Rica [11,80] and Mexico (new record) (Chiapas).

*Remarks:* *Leucochrysa (N.) amistadensis* was previously known from Costa Rica. This is the northernmost record, ca. 1220 km north from previous records (La Amistad International Park, Puntarenas, Costa Rica). Specimens were collected in cloud forest and mixed oak–cloud forest. Flight period was in May, June, and September (mainly in the rainy season). Previous altitudinal distribution records are between 1500 and 1600 m [80,159]; herein, specimens were collected from 1440 to 2120 m, which is the highest altitudinal record for this species.

**Leucochrysa (Nodita) askanes** (Banks, 1945)

*Distribution:* Costa Rica, Guatemala, Honduras, and Mexico (Chiapas (new record), Oaxaca) [4,11,80,158].

*Remarks:* *Leucochrysa (N.) askanes* presents a Neotropical distribution. Specimens were collected in evergreen tropical forest, coffee plantations, and cloud forest, with some specimens collected on *Inga* spp. and *Coffea* spp. Flight period was in January and April to December (mainly in the rainy season). Previous altitudinal distribution records are between 40 and 1500 m [80,158]; herein, specimens were collected from 680 to 1085 m.

**Leucochrysa (Nodita) azevedoi** Navás, 1913

*Distribution:* Brazil [11,29,166,204] and Mexico (new record) (Chiapas).

*Remarks:* *Leucochrysa (N.) azevedoi* presents a Neotropical distribution. This is the northernmost record for the species, ca. 6885 km north of previous records (Est. Exp. PESAGRO, Campos dos Goytacazes, Rio de Janeiro, Brazil). A single male specimen was collected in evergreen tropical forest. Its flight date was in January (in the dry season) and its altitudinal record was 743 m, higher than the previous record for the species [29].

**Leucochrysa (Nodita) camposi** (Navás, 1933)

*Distribution:* Ecuador [11,29,214] and Mexico (new record) (Chiapas).

*Remarks:* *Leucochrysa (N.) camposi* was previously known from Ecuador. This is the northernmost record for the species, ca. 2343 km north from previous records (Guayaquil, Ecuador). Specimens were collected in cloud forest. Flight period was in June and December (in both seasons) and their altitudinal distribution records were from 1231 to 1620 m.

**Leucochrysa (Nodita) caucella** Banks, 1910

*Distribution:* Colombia, Costa Rica, Panama, Venezuela [11,21,80,158,190], and Mexico (new record) (Chiapas).

*Remarks:* *Leucochrysa (N.) caucella* presents a Neotropical distribution. Herein, we record this species for the first time in Mexico. This is the northernmost record for the species, ca. 1220 km north from previous records (La Amistad International Park, Puntarenas, Costa Rica). Specimens were collected in cloud forest, with some specimens collected on *Quercus* spp. Flight period was in February and October (in both seasons). Previous altitudinal distribution records are from 914 to 1982 m [21,80]; herein, specimens were collected from 1557 to 1582 m. Variation: The original description of *L. (N.) caucella* does not include characteristics of terminalia and genitalia, and mentions that the wing–mesothorax connection lacks a dark spot, but some specimens had dark spots on this area, as well as on the ectoprocts.

**Leucochrysa (Nodita) digitiformis** Tauber et al., 2008

*Distribution:* Brazil [11,138] and Mexico (new record) (Chiapas).

*Remarks:* *Leucochrysa (N.) digitiformis* was previously known from Brazil. This is the northernmost record for the species, ca. 6534 km north from previous records (Campos dos Guytacazes, Rio Grande do Sul, Brazil). Specimens studied were from coffee plantations and cloud forest. Flight time was in July (in the rainy season). Previous altitudinal distribution records are between 14 and 30 m [138]; herein, specimens were collected at 720 m, which is the highest altitudinal record for this species.
Leucochrysa (Nodita) lateralis Navás, 1913

**Distribution:** Brazil, Guatemala [11,27,137] and Mexico (new record) (Chiapas).

**Remarks:** Leucochrysa (N.) lateralis was previously known from Guatemala and Brazil. Herein, we record this species for the first time in Mexico, in the state of Chiapas. This is the northernmost record for the species, ca. 119.34 km north from previous records (Atitlán Volcano, Guatemala). Specimens were collected in evergreen tropical forest and coffee plantations, with some specimens found on Coffea spp. Flight period was in January, July, and October to December (mainly in the dry season). Previous altitudinal distribution records are between 7 and 1067 m [27]; herein, altitudinal distribution records were from 713 to 780 m. Variation: Specimens of this species typically have red gena, frons with short red bands below the antennal base, a completely dark dorsal surface of the scape, and a V- or Y-shaped dark mark behind the antenna on the vertex, but some studied specimens had pale gena, a scape with red spots, lack of marks on the frons, and reduced Y- or V-shaped marking on the vertex.

Leucochrysa (Nodita) maculosa de Freitas & Penny, 2001

**Distribution:** Brazil [11,137] and Mexico (new record) (Chiapas).

**Remarks:** L. (N.) maculosa was previously known from Brazil. This record is the northernmost record for the species, ca. 6247 km north from previous records (Taquaritinga, São Paulo, Brazil). Specimens were collected in evergreen tropical forest and cloud forest. Flight period was from April to July, September, and December (mainly in the dry season). Previous altitudinal records are unknown. Specimens were collected from 753 to 1736 m. Variation: Individuals of this species typically have a pale maxillary palp basally, dark on the fourth and basal half of the apical segment, pale on the apical half, a pale clypeus, wine red marks below the antennal base from the eye margin, a mesonotum with a brick red mark along the lateral margin, and a red spot on the second tergite, but some studied specimens had a pale palp, clypeus with reduced marks, red spots in front of the antenna, without markings on mesonotum, and with a dark spot on 6th and 7th tergites.

Leucochrysa (Nodita) nigrovaria (Walker, 1853)

**Distribution:** Colombia, Costa Rica, Mexico (Chiapas, Morelos, Tabasco), Panama and Venezuela [11,21,24,26,30,31,80,81,158,171].

**Remarks:** Leucochrysa (N.) nigrovaria presents a Neotropical distribution. Specimens were collected in evergreen tropical forest and cloud forest, with some specimens collected on Citrus spp. Flight period was in January, April, July, September, and November (mainly in the dry season). Previous altitudinal distribution records are between 457 and 1500 m [21,80,171]; herein, specimens were collected from 678 to 1250 m. Variation: Individuals of this species typically have a pale green pronotum with a longitudinal lateral reddish-brown stripe, a meso- and metanotum mottled brown and green to completely dark brown, and large reddish-brown spots on tergites 4, 6, 7, and 8, but some studied specimens had lateral pronotum stripes thicker and darker, a meso- and metanotum more or less black pigmented, and an abdomen with large black spots throughout the tergites.

Leucochrysa (Nodita) squamisetosa de Freitas & Penny, 2001

**Distribution:** Brazil [11,137] and Mexico (new record) (Chiapas).

**Remarks:** Leucochrysa (N.) squamisetosa was previously known from Brazil. This is the northernmost record for the species, ca. 6905 km north from previous records (Birigui, São Paulo, Brazil). A single female specimen was collected in evergreen tropical forest. Its flight date was in June (in the rainy season) and its altitudinal record was 659 m. Previous altitudinal distribution of this species is unknown.

Leucochrysa (Nodita) tarini (Navás, 1924)

**Distribution:** Cuba [11,136,174] and Mexico (new record) (Chiapas).

**Remarks:** Leucochrysa (N.) tarini was previously known from Cuba. Specimens were collected in evergreen tropical forest, coffee plantations, and cloud forest, with some
specimens collected on *Inga* spp. and *Coffea* spp. Flight period was in January to March, May to July, and October (mainly in the rainy season). Previous altitudinal distribution of this species is unknown, herein its altitudinal records were from 661 to 1223 m.

**Leucochrysa (Nodita) sp. 1**

 Distribution: Mexico (Chiapas).

 Remarks: Specimens of *Leucochrysa* sp. 1 were collected in evergreen tropical forest, coffee plantations, and cloud forest; their flight period was in January, April, July, September, and October (mainly in the rainy season), and their altitudinal distribution records were from 741 to 1483 m. They are morphologically close to *Leucochrysa (Nodita) zayasi* Alayo, 1968 but with evident differences in genitalia.

**Leucochrysa (Nodita) sp. 2**

 Distribution: Mexico (Chiapas).

 Remarks: A single female specimen of *Leucochrysa* sp. 2 was collected in mixed oak–cloud forest, with flight time in September (in the rainy season), and an altitudinal record of 2149 m. The specimen is morphologically close to *Leucochrysa (Nodita) compar* Alayo, 1968, but with evident differences in spermatheca.

**Leucochrysa (Nodita) sp. 3**

 Distribution: Mexico (Chiapas).

 Remarks: A single female specimen of *Leucochrysa* sp. 3 was collected in evergreen tropical forest, with flight time in November (in dry season), and an altitudinal record of 713 m. The specimen is morphologically close to *L. (Nodita) azevedoi* Navás, 1913, but with evident differences in spermatheca.

**Leucochrysa (Nodita) sp. 4**

 Distribution: Mexico (Chiapas).

 Remarks: A single male specimen of *Leucochrysa* sp. 4 was collected in cloud forest, with flight date in February (in the dry season), and an altitudinal distribution record of 1195 m. The specimen is morphologically close to *Leucochrysa (Nodita) cerverai* (Navás, 1922) but with evident differences in genitalia.

**Leucochrysa (Nodita) sp. 5**

 Distribution: Mexico (Chiapas).

 Remarks: A single male specimen of *Leucochrysa* sp. 5 was collected in cloud forest, with flight time in April (in the dry season), and an altitudinal distribution record of 1192 m. The specimen presents genitalia similar to *Leucochrysa (Nodita) incognita* de Freitas & Penny, 2001, but with reduced gonocorns, and with pale palp and gena, a vertex with a reddish inverted U-shaped marking and thorax with dark markings on the meso- and metathorax.

**Leucochrysa (Nodita) sp. 6**

 Distribution: Mexico (Chiapas).

 Remarks: Specimens of *Leucochrysa* sp. 6 were collected in cloud forest, with the flight period in September and October (in the rainy season), and an altitudinal distribution record of 1479 m. These specimens present pale antenna and gena, frons with a reddish spot between the antennae, a vertex with two wine red lines in a V-shape, the pro-, meso-, and metanotum yellowish-green with two red spots on each side, a red mark on the anterior part of mesoscutum, and the posterior part of the meso- and metanotum reddish-orange, abdomen with reddish marks dorsally, also with particular characteristics in the genitalia.

**Family Coniopterygidae Burmeister, 1839**

**Subfamily Aleuropteryginae Enderlein, 1905**

**Tribe Fontenelleini Meinander, 1972**

**Genus Neoconis Enderlein, 1930**

**Neoconis dentata** Meinander, 1972
Distribution: Costa Rica, Guatemala [11,16], and Mexico (new record) (Chiapas).

Remarks: Neoconis dentata was previously known from Costa Rica and Guatemala. This is the northernmost record for the species. Specimens were collected in evergreen tropical forest, coffee plantations, cloud forest, oak forest, and pine forest, with some specimens collected on Saurauia spp. Flight period was in January and March to December (in both seasons). The previous altitudinal distribution of this species is unknown; herein, it was recorded from 693 to 3089 m.

Subfamily Coniopteryginae Burmeister, 1839
Tribe Coniopterygini Burmeister, 1839
Genus Coniopteryx Curtis, 1834
Subgenus Coniopteryx Curtis, 1834
Coniopteryx (Coniopteryx) latipalpis Meinander, 1972

Distribution: Mexico (Chiapas (new record), Tlaxcala) and United States of America [9, 11,16,32,143,215].

Remarks: Coniopteryx (S.) latipalpis presents a Nearctic distribution, with many North American records. This is the first record of the species for the Neotropical region, as well as its southernmost record, ca. 843 km south from previous records (Nanacamilpa, Tlaxcala, Mexico). Specimens were collected in mixed oak–cloud forest and pine forest, with some specimens collected on Fuchsia spp. and Pinus spp. Flight period was in February, April to July, and October (mainly in the rainy season). Previous altitudinal distribution records are between 336 and 3048 m [9,16,143]; herein, specimens were collected from 2079 to 3277 m, which is the highest altitudinal distribution record for the species. A wide distribution in Mexico is corroborated for this species, with an affinity for high-altitude and pine forest vegetation.

Coniopteryx (Coniopteryx) simplicior Meinander, 1972

Distribution: Bolivia, Brazil, Costa Rica, Jamaica, Mexico (Baja California Sur, Chiapas (new record), Colima), United States of America, and Venezuela [4,11,16,32,82,143,183,215–217].

Remarks: Coniopteryx (C.) simplicior presents a Nearctic and Neotropical distribution. Herein, we record this species for the first time in the state of Chiapas. Specimens were collected in cloud forest, mixed oak–cloud forest, and mixed oak–pine forest, with some specimens collected on Alnus spp., Celtis spp., Chaetoptelea spp., Morella spp., Saurauia spp., and Quercus spp. Flight period was in January to August, November, and December (in both seasons). Previous altitudinal distribution records are between 88 and 2012 m [143,216,218] (based on geographical coordinates); herein, specimens were collected from 961 to 3088 m, which is the highest altitudinal distribution record for this species.

Coniopteryx (Coniopteryx) westwoodii (Fitch, 1855)

Distribution: Canada, Mexico (Chiapas (new record), Querétaro), and United States of America [11,17,82,84,178,183,215,219].

Remarks: Coniopteryx (C.) westwoodii presents a generally Nearctic distribution. This is the southernmost record for the species, ca. 961 km south from previous records (Ajuchitlán, Querétaro, Mexico). Specimens were collected in coffee plantations, cloud forest, and mixed oak–cloud forest. Flight period was in February to March, and December (mainly in the dry season). Previous altitudinal distribution records are between 189 and 559 m ([218] based on geographical coordinates); herein, specimens were collected from 961 to 2454 m, which is the highest altitudinal distribution record for this species.

Subgenus Scotoconiopteryx Meinander, 1972
Coniopteryx (Scotoconiopteryx) fumata Enderlein, 1907

Distribution: Brazil, Colombia, Costa Rica, Dominican Republic, Venezuela [11,16,144,169], and Mexico (new record) (Chiapas).

Remarks: Coniopteryx (S.) fumata was previously known from Central and South America. This is the northernmost record for the species, ca. 1080 km north from previous records (Turrialba, Cartago, Costa Rica). A single male specimen was collected in cloud
forest. Flight time was in March (in dry season). Previous altitudinal distribution records are between 1000 and 1500 m [80]; herein, the specimen was collected at 1106 m.

Coniopteryx (Scotoconiopteryx) isthmicola Meinander, 1972

**Distribution:** Honduras, and Mexico (Chiapas (new record), San Luis Potosi), Nicaragua, Panama [11,16,144,220].

**Remarks:** *Coniopteryx* (S.) *isthmicola* presents a Central American, Neotropical distribution, with a few Nearctic records. Specimens were collected in coffee plantations and cloud forest. Flight period was from February and March (mainly in the dry season). Previous altitudinal distribution records are between 670 and 865 m ([16,144]; based on geographical coordinates); herein, specimens were collected between 958 and 966 m, which is the highest altitudinal record for this species.

Coniopteryx (Scotoconiopteryx) josephus Sarmiento-Cordero & Contreras-Ramos, 2019

**Distribution:** Mexico (Colima, Chiapas (new record), Morelos, Oaxaca) [8,11].

**Remarks:** *Coniopteryx* (S.) *josephus* is known only from Mexico. This is the southernmost record for the species, ca. 439 km south from previous records (Santa María Huatulco, Oaxaca, Mexico). A single male specimen was collected in evergreen tropical forest, with flight time in January (in the dry season). Previous altitudinal distribution records are between 88 and 940 m [8]; herein, the specimen was collected at 661 m.

Coniopteryx (Scotoconiopteryx) quadricornis Meinander in Meinander & Penny, 1982

**Distribution:** Brazil [11,32,145,215,217] and Mexico (new record) (Chiapas).

**Remarks:** *Coniopteryx* (S.) *quadricornis* was previously known from Brazil. This is the northernmost record for the species, ca. 5389 km north from previous records (Rondônia, Brazil). Specimens were collected in evergreen tropical forest, coffee plantations, and cloud forest. Flight period was in February, March, and May (mainly in the dry season). Previous altitudinal distribution records are unknown; herein, specimens were collected from 684 to 1230 m.

Tribe Conwentziini Enderlein, 1905

Genus Conwentzia Enderlein, 1905

**Conwentzia barretti** (Banks, 1899)

**Distribution:** Mexico (Baja California, Chiapas, Ciudad de México, Durango, Estado de México, Guanajuato, Hidalgo, Michoacán, Morelos, Puebla, Tlaxcala, Veracruz), and United States of America [4,11,33,143,206].

**Remarks:** *Conwentzia barretti* presents a Nearctic and Neotropical distribution, with a wide distribution in the Nearctic region. Specimens were collected in cloud forest, oak forest, and pine forest, with some specimens collected on *Quercus* sp. and *Alnus* sp. Flight period was from January to August, and November to December (mainly in the dry season). Previous altitudinal distribution records are between 441 and 2896 m [9,16,32,143,206]; herein, specimens were collected between 1705 and 3277 m, the highest altitudinal distribution record for this species.

Genus Semidalis Enderlein, 1905

**Semidalis boliviensis** (Enderlein, 1905)

**Distribution:** Bolivia, Brazil, Mexico (Chiapas, Veracruz), Peru, Trinidad and Tobago, and Venezuela [4,11,32,143].

**Remarks:** *Semidalis boliviensis* presents a Neotropical distribution. Specimens were collected in evergreen tropical forest and coffee plantations. Flight period was in April, June, August, October, and December (mainly in the rainy season). A previous altitudinal distribution record is from 1100 m [143]; herein, specimens were collected between 680 and 749 m, which is the lowest altitudinal record for the species.

**Semidalis hidalgoana** Meinander, 1975
Distribution: Colombia and Mexico (Chiapas (new record), Hidalgo, Michoacán, Nuevo León, San Luis Potosí) [11,17,32,84].

Remarks: *Semidalis hidalgoana* presents a Nearctic and Neotropical distribution. Specimens were collected in evergreen tropical forest, coffee plantations, and cloud forest, with some specimens collected on *Inga* sp. Flight period was in February to March, May to September, and December (mainly in the rainy season). Previous altitudinal distribution records are unknown; herein, specimens were collected between 677 and 1612 m.

*Semidalis manausensis* Meinander, 1980

Distribution: Brazil, Costa Rica, Mexico (Chiapas (new record), Veracruz), and Peru [4,11,144,217,221].

Remarks: *Semidalis manausensis* presents a Neotropical distribution. Specimens were collected in a mixed oak–cloud forest. Flight period was from July to October, and December (mainly in the rainy season). Previous altitudinal distribution records are between 1500 and 2100 m [144]; herein, specimens were collected from 2076 to 2444 m, which is the highest altitudinal record for this species.

*Semidalis problematica* Monserrat, 1984

Distribution: Mexico (Chiapas (new record), Veracruz) [11,32,34].

Remarks: *Semidalis problematica* is known only from Mexico. Specimens were collected in evergreen tropical forest, cloud forest, and mixed oak–cloud forest, with some specimens collected on *Lauraceae* spp., *Miconia* spp., and *Myricarpa* spp. Flight period was in January to December (in both seasons). Previous altitudinal distribution records of this species are unknown; herein, specimens were collected between 667 and 2436 m.

*Semidalis soleri* Monserrat, 1984

Distribution: Costa Rica, Mexico (Chiapas (new record), Veracruz) [4,11,34,144].

Remarks: *Semidalis soleri* is known from Mexico and Costa Rica. Specimens were collected in evergreen tropical forest and coffee plantations, with some specimens collected on *Saurauia* spp. and *Miconia* spp. Flight period was in January to February, and April to December (in both seasons). Previous altitudinal distribution records are between 1500 and 2000 m [80,144]; herein, specimens were collected from 673 to 799 m, which are considered the lowest altitudinal records for this species.

Family Hemerobiidae Latreille, 1802

Subfamily Hemerobiinae Latreille, 1802

Genus *Biramus* Oswald, 1993

*Biramus aggregatus* Oswald, 2004

Distribution: Costa Rica, Panama [11,150], and Mexico (new record) (Chiapas).

Remarks: *Biramus aggregatus* was previously known from Costa Rica and Venezuela. This is the northernmost record for the species, ca. 956 km north from previous records (Estación Biológica Monteverde, Puntarenas, Costa Rica). Specimens were collected in cloud forest. Flight period was from January to June (mainly in the dry season). Previous altitudinal distribution records are between 1300 and 1540 m [150]; herein, specimens were collected between 1657 and 1712 m, which is the highest altitudinal distribution record for this species.

Genus *Hemerobiella* Kimmins, 1940

Hemerobiella sinuata Kimmins, 1940

Distribution: Ecuador and Mexico (Chiapas) [4,11,83].

Remarks: *Hemerobiella sinuata* is known from Ecuador and Mexico. A single male specimen was collected in cloud forest. Flight time was in October (in the rainy season). A previous altitudinal distribution record is from 1000 m [222]; herein, the specimen was collected at 1586 m, which is the highest altitudinal distribution record for this species.

Genus *Hemerobia* Linnaeus, 1758
**Hemerobius alpestris** Banks, 1908

**Distribution:** Guatemala, Mexico (Chiapas, Ciudad de México, Durango, Estado de México, Jalisco, Michoacán, Oaxaca, Puebla, Tamaulipas, Tlaxcala, Veracruz), and United States of America [4,9,11,18,82].

**Remarks:** *Hemerobius alpestris* presents a Nearctic and Neotropical distribution. Specimens were collected in oak forest and pine forest, with some specimens found on *Pinus* sp. Flight period was in January, March to June, and August to December (in both seasons). Previous altitudinal distribution records are between 1219 and 3200 m [9,18]; herein, specimens were recorded from 3030 to 3789 m, which is the highest altitudinal distribution record for the species. Variation: Specimens of this species typically have body and wings with a reddish tinge, but some studied specimens had a much paler wing pigmentation.

**Hemerobius bolivari** Banks, 1910

**Distribution:** Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Mexico (Chiapas), Panama, Paraguay, Peru, Portugal (introduced), Uruguay, and Venezuela [4,11,18,35,83,192–230].

**Remarks:** *Hemerobius bolivari* presents a Neotropical distribution, although it was introduced to Portugal (Palearctic region). Specimens were collected in cloud forest, oak forest, and pine forest. Flight period was in January, March to April, June to August, and October to December (in both seasons). Previous altitudinal distribution records are between 300 and 2800 m [18,228]; herein, this species was recorded from 1123 to 3166 m, which is the highest altitudinal distribution record for this species.

**Hemerobius discretus** Naváš, 1917

**Distribution:** Canada, Costa Rica, Guatemala, Mexico (Aguascalientes, Baja California, Chiapas, Ciudad de México, Colima, Durango, Estado de México, Guerrero, Guanajuato, Hidalgo, Jalisco, Michoacán, Morelos, Nuevo León, Oaxaca, Puebla, Tamaulipas, Tlaxcala, Veracruz), Panama, and United States of America [4,9,11,18,36,37,82,227,231–233].

**Remarks:** *Hemerobius discretus* presents a Nearctic and Neotropical distribution. Specimens were collected in cloud forest, oak forest, and pine forest, with some specimens found on *Alnus* spp., *Licaria* spp., *Pinus* spp., and *Roldana* spp. Flight period was from January to December (in both seasons). Previous altitudinal distribution records are between 914 and 3000 m [9,18,232]; herein, specimens were collected between 1732 and 3580 m, which is the highest altitudinal distribution record for this species.

**Hemerobius domingensis** Banks, 1941

**Distribution:** Brazil, Cuba, Dominican Republic [11,18,229], and Mexico (new record) (Chiapas).

**Remarks:** *Hemerobius domingensis* presents a Neotropical distribution. Specimens were collected in cloud forest and oak forest, with some specimens found on Lauraceae sp. Flight period was in January, March to July, and September (mainly in the rainy season). Previous altitudinal distribution records are between 914 and 2133 m [18]; herein, specimens were collected from 1194 to 2438 m, which is the highest altitudinal distribution record for this species.

**Hemerobius gaitoi** Monserrat, 1996

**Distribution:** Brazil, Costa Rica, Dominican Republic, Ecuador, Guatemala, Mexico (Chiapas (New record), Veracruz), and Venezuela [4,11,18,229].

**Remarks:** *Hemerobius gaitoi* presents a Neotropical distribution. Specimens were collected in cloud forest and oak forest. Flight period was in January to September, and November to December (in both seasons). Previous altitudinal distribution records are between 870 and 2100 m [18]; herein, specimens were collected from 1155 to 2377 m, which is the highest altitudinal distribution record for this species.

**Hemerobius hernandezi** Monserrat, 1996
Distribution: Colombia, Costa Rica, Guatemala, Mexico (Chiapas, Oaxaca, Veracruz), Nicaragua, Panama, Paraguay, and Venezuela [4,11,18].

Remarks: Hemerobius hernandezi presents a Neotropical distribution. Specimens were collected in evergreen tropical forest, cloud forest, and oak forest, with some specimens found on Justicia sp., Miconia spp., and Quercus spp. Flight period was from January to December (in both seasons). Previous altitudinal distribution records are between 90 and 2200 m [18]; herein, specimens were collected from 661 to 2205 m.

Hemerobius hirsuticornis Monserrat & Deretsky, 1999

Distribution: Costa Rica, Ecuador, Honduras, and Mexico (Chiapas (new record), Tamaulipas) [4,11,222,234].

Remarks: Hemerobius hirsuticornis presents a Neotropical distribution. Specimens were collected in evergreen tropical forest, coffee plantations, and cloud forest. Flight period was in January and March (mainly in the dry season). Previous altitudinal distribution records are between 550 and 1500 m [80,222]; herein, specimens were collected from 743 to 1194 m.

Hemerobius jucundus Navás, 1928

Distribution: Costa Rica, Guatemala, Mexico (Chiapas, Ciudad de México, Estado de México, Guerrero, Hidalgo, Jalisco, Michoacán, Oaxaca, Puebla, Tamaulipas, Tlaxcala, Veracruz), and Panama [4,9,11,18,31].

Remarks: H. jucundus is known from Mexico and Central America. Specimens were collected in evergreen tropical forest, cloud forest, oak forest, and pine forest, with some specimens found on Alnus spp., Clethra spp., Fuchsia spp., Licaria spp., Pinus spp., and Roldana spp. Flight period was from January to December (in both seasons). Previous altitudinal distribution records are between 1219 and 2896 m [9,18]; herein, specimens were collected from 736 to 3358 m, which are the lowest and highest altitudinal distribution records for this species.

Hemerobius martinezae Monserrat, 1996

Distribution: Costa Rica, Guatemala, and Mexico (Chiapas, Guerrero, Michoacán, Oaxaca, Tlaxcala, Veracruz) [4,9,11,18].

Remarks: Hemerobius martinezae is known from Mexico and Central America. Specimens were collected in cloud forest, oak forest, and pine forest, with some specimens found on Alnus spp. and Roldana spp. Flight period was in January to July, and September to December (in both seasons). Previous altitudinal distribution records are between 1219 and 2900 m [9,18]; herein, specimens were collected from 1470 to 3128 m, which is the highest altitudinal distribution record for this species.

Hemerobius nigridorsus Monserrat, 1996

Distribution: Costa Rica, Venezuela [11,18,228], and Mexico (new record) (Chiapas).

Remarks: Hemerobius nigridorsus was previously known from Costa Rica and Venezuela. This is the northernmost record for this species, ca. 1220 km north from previous records (La Amistad International Park, Puntarenas, Costa Rica). Two male specimens were collected in cloud forest. Flight period was in April to May, and October to November (mainly in the rainy season). Previous altitudinal distribution records are between 1500 and 1600 m [18,80]; herein, specimens were collected from 1705 to 1712 m, which is the highest altitudinal distribution record for this species.

Hemerobius withycombei (Kimmins, 1928)

Distribution: Colombia, Costa Rica, and Mexico (new record), Tabasco, Veracruz) [4,11,18].

Remarks: Hemerobius withycombei presents a Neotropical distribution. Specimens were collected in evergreen tropical forest and coffee plantations. Flight period was in March, July, and August (mainly in the rainy season). Previous altitudinal distribution records are between 550 and 1000 m [18,80,167]; herein, specimens were collected from 663 to 717 m.
Subfamily Megalominae Krüger, 1922
Genus Megalomus Rambur, 1842

Megalomus minor Banks in Baker, 1905

**Distribution:** Bolivia, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Mexico (Chiapas, Colima, Jalisco, Morelos, Nayarit, San Luis Potosí, Tabasco, Tamaulipas, Veracruz), Nicaragua, Panama, Peru, Saint Vincent and the Grenadines, Trinidad and Tobago, United States of America, and Venezuela [11,35,82,83,95,136,169,203,226,235–239].

**Remarks:** Megalomus minor presents a Nearctic and Neotropical distribution. Specimens were collected in evergreen tropical forest, coffee plantations, and cloud forest, with some specimens found on Clidadium spp., Eupatorium spp., Inga spp., and Saurauia spp. Flight period was from January to September (mainly in the rainy season). Previous altitudinal distribution records are between sea level and 1500 m [95]; herein, specimens were collected from 657 to 1209 m.

Megalomus pictus Hagen, 1861

**Distribution:** Costa Rica, Guatemala, Honduras, and Mexico (Chiapas (new record)) [4,11,35,239].

**Remarks:** Megalomus pictus is known from Mexico and Central America; it was previously reported for Mexico, however a specific locality was unknown. Specimens were collected in mixed oak–cloud forest and pine forest. Flight period was in May, June, and September (mainly in the rainy season). Previous altitudinal distribution records are between 2200 and 3200 m [80,95,239]; herein, specimens were collected from 2081 to 3187 m, which includes the lowest altitudinal distribution record for this species.

Megalomus sp.

**Distribution:** Mexico (Chiapas).

**Remarks:** Two male specimens were collected in mixed oak–pine forest, with their flight period in June and November (in both seasons), and from elevations between 3219 and 3235 m. Specimens are morphologically close to Megalomus nigratus (Navás, 1929) but with evident differences in genitalia.

Subfamily Microminae Krüger, 1922
Genus Micromus Rambur, 1842

Micromus subanticus (Walker, 1853)

**Distribution:** Canada, Costa Rica, Cuba, Dominican Republic, Haiti, Mexico (Baja California, Baja California Sur, Chiapas (new record), Chihuahua, Coahuila, Estado de México, Guanajuato, Jalisco, Morelos, Nuevo León, Sinaloa, Sonora), United Kingdom (British West Indies), and United States of America [4,11,30,82,136,148,169,200,207,219,240–245].

**Remarks:** Micromus subanticus presents a Nearctic and Neotropical distribution. A single female specimen was collected in cloud forest. Flight time was in April (in the dry season). Previous altitudinal distribution records of this species are unknown; herein, a specimen was collected at 1479 m.

Genus Nusalala Navás, 1913

Nusalala championi Kimmins, 1936

**Distribution:** Mexico (Chiapas (new record), Veracruz), Costa Rica, Guatemala, and Panama [11,96].

**Remarks:** Nusalala championi is known from Mexico and Central America. Specimens were collected in evergreen tropical forest, coffee plantations, cloud forest, and mixed oak–cloud forest, with some specimens found on Psidium spp. Flight period was in January to August, and October to December (in both seasons). Previous altitudinal distribution records are between 610 and 1524 m [80,96,246]; herein, specimens were collected from 775 to 2174 m, which is the highest altitudinal distribution record for this species. Variation: Individuals of this species typically have forewings with 5–7 radial sector branches, but some specimens had only four branches.
**Nusalala irrebita** (Navás, 1929)

*Distribution:* Mexico (Chiapas [new record], Michoacán, Veracruz), Costa Rica, El Salvador, Honduras, Nicaragua, and Panama [11,96,226,247].

*Remarks:* *Nusalala irrebita* is known from Mexico and Central America. Specimens were collected in cloud forest and oak forest. Flight period was in March, May, July, October, and December (in both seasons). Previous altitudinal distribution records are between 1300 and 1600 m [80,96]; herein, specimens were collected from 1194 to 2452 m, which are the lowest and highest altitudinal distribution records for this species.

**Nusalala tessellata** (Gerstaecker, 1888)

*Distribution:* Argentina, Bolivia, Brazil, Colombia, Costa Rica, Dominica, Ecuador, Guatemala, Honduras, Mexico (Chiapas, Veracruz), Panama, Paraguay, Peru, Trinidad and Tobago, United Kingdom (British Virgin Islands), United States of America, Uruguay, and Venezuela [11,35,96,167,248–254].

*Remarks:* *Nusalala tessellata* presents a Nearctic and Neotropical distribution. One female specimen was collected in evergreen tropical forest. Flight time was in June (in the rainy season). Previous altitudinal distribution records are between 250 to 2743 m [96,246]; herein, the specimen was collected at 722 m.

**Nusalala unguicaudata** Monserrat, 2000

*Distribution:* Mexico (Chiapas [new record]), Nayarit), Costa Rica, and Guatemala [11,96].

*Remarks:* *Nusalala unguicaudata* is known from Mexico and Central America. Specimens were collected in evergreen tropical forest and coffee plantations, with some specimens found on *Eupatorium* spp. Flight period was in January to February, April, and December (mainly in the dry season). Previous altitudinal distribution records are from 1500 m [80,96]; herein, specimens were collected from 678 to 774 m, which are the lowest altitudinal records for this species.

**Subfamily Notiobiellinae Nakahara, 1960**

**Genus** Notiobiella Banks, 1909

**Notiobiella cixiiformis** (Gerstaecker, 1888)

*Distribution:* Argentina, Bolivia, Brazil, Colombia, Costa Rica, El Salvador, Honduras, Panama, Paraguay, Peru, Venezuela [11,35,37,213,248], and Mexico (new record) (Chiapas).

*Remarks:* *Notiobiella cixiiformis* presents a Neotropical distribution. This is the northernmost record for this species. A single female specimen was collected in mixed oak–cloud forest. Flight time was in May (in the rainy season). A previous altitudinal distribution record is from 1000 m [35]; herein, the specimen was collected at 2060 m, which is the highest altitudinal distribution record for this species.

**Notiobiella mexicana** Banks, 1913

*Distribution:* Costa Rica and Mexico (Chiapas [new record], Jalisco, San Luis Potosí) [4,11,80].

*Remarks:* *Notiobiella mexicana* is known from Mexico and Costa Rica. Specimens were collected in evergreen tropical forest, with some specimens collected on *Inga* spp. Flight period was in April and May (in both seasons). Previous altitudinal distribution records are between sea level and more than 1000 m [80]; herein, specimens were collected from 670 to 693 m.

**Subfamily Sympherobiinae Comstock, 1918**

**Genus** Sympherobius Banks, 1905

**Sympherobius axillaris** Navás, 1928

*Distribution:* Mexico (Chiapas [new record], Ciudad de México) [11,31].

*Remarks:* *Sympherobius axillaris* is only known from Mexico (Nearctic). Herein, we record this species after 93 years of its original description. This is the southernmost record of the species, ca. 800 km south from previous records (Peñón Viejo, Mexico). Specimens were collected in cloud forest, oak forest, and pine forest. Flight period was from March...
to May, August to September, and November (in both seasons). Previous altitudinal
distribution records for this species are unknown; herein, specimens were collected from
2406 to 3205 m.

**Sympherobius distinctus** Carpenter, 1940

*Distribution*: Mexico (Guerrero, Chiapas (new record)) and United States of
America [4,11,243,255].

*Remarks*: *Sympherobius distinctus* presents a Nearctic and Neotropical distribution. A
single male specimen was collected in mixed oak–cloud forest. Flight time was in May (in
the rainy season). A previous altitudinal distribution record is from 2750 m [97]; herein,
the specimen was collected at 2060 m, which is the lowest record for this species.

**Sympherobius marginatus** (Kimmins, 1928)

*Distribution*: Guatemala [11,36], Mexico (new record) (Chiapas).

*Remarks*: *Sympherobius marginatus* was previously known only from Guatemala. Herein,
we record this species after its original description 92 years ago. This is the northernmost
record for this species, ca. 82 km north from previous records (Cerro (Volcán) Zunil,
Guatemala). Specimens were collected in cloud forest, oak forest, and pine forest. Flight
period was from February to June (mainly in the dry season). Previous altitudinal distribu-
tion records are between 1220 and 1524 m [36]; herein, specimens were recorded from 1568
to 3176 m, which is the highest altitudinal record for this species. Variation: Individuals
of this species typically have forewings with membranes that are dark brown, but some
specimens had forewings with pale pigmentation.

**Sympherobius similis** Carpenter, 1940

*Distribution*: Colombia, Costa Rica, Mexico (Chiapas, Michoacán, Morelos, Nuevo
León, Veracruz), Panama, Peru, and United States of America [4,11,80,243,255].

*Remarks*: *Sympherobius similis* presents a Nearctic and Neotropical distribution. Spec-
imens were collected in cloud forest and oak forest. Flight period was in March and
April (in the dry season). Previous altitudinal distribution records are between 1000 and
1768 m [243]; herein, specimens were collected from 1168 to 2079 m, which is the highest
altitudinal record for this species.

**Sympherobius subcostalis** Monserrat, 1990

*Distribution*: Mexico (Chiapas, Jalisco, Veracruz, Yucatán) [4,11,35,80].

*Remarks*: *Sympherobius subcostalis* is known only from Mexico (Neotropical). Specimens
were collected in evergreen tropical forest and coffee plantations. Flight period was in
January and September (in both seasons). Previous altitudinal distribution records are
between sea level and 630 m [35,80]; herein, specimens were collected from 700 to 748 m,
which is the highest altitudinal record for this species.

**Sympherobius sp.**

*Distribution*: Mexico (Chiapas).

*Remarks*: A single male specimens was collected in pine forest, with flight time in May
(in the rainy season), at an altitude of 3181 m. The specimen is morphologically similar to
*Sympherobius angustus* Banks, 1904, and *Sympherobius killingtoni* Carpenter, 1940.

**Family Mantispidae Leach, 1815**

**Subfamily Calomantispinae Navás, 1914**

**Genus Nolima** Navás, 1914

**Nolima infensa** Navás, 1924

*Distribution*: Costa Rica, Guatemala, Guyana, Honduras, and Mexico (Chiapas, More-
los, Oaxaca, Veracruz) [11,80,99,256].

*Remarks*: *Nolima infensa* presents a Neotropical distribution. Specimens were collected
in cloud forest, with some specimens collected on *Clibadium* spp. Flight period was in
February and October (in both seasons). Previous altitudinal distribution records are between 396 and 1500 m [99]; herein, specimens were collected from 1250 to 1479 m.

**Nolima victor** Navás, 1914

*Distribution:* Guatemala and Mexico (Chiapas, Guerrero, Oaxaca, Hidalgo, Jalisco, Morelos, Puebla, Querétaro) [11,38,99].

*Remarks:* *Nolima victor* is known from Mexico and Guatemala (Nearctic and Neotropical). Specimens were collected in cloud forest. Flight period was in October and November (in both seasons). Previous altitudinal distribution records are between 244 and 2775 m [38,99]; herein, specimens were collected at 1479 m.

**Subfamily Mantispinae Leach, 1815**

**Genus Dicromantispa** Hoffman in Penny, 2002

**Dicromantispa sayi** (Banks, 1897)

*Distribution:* Bahamas, Belize, Canada, Costa Rica, Cuba, Dominican Republic, El Salvador, Guatemala, Honduras, Mexico (Campeche, Chiapas, Chihuahua, Durango, Guerrero, Jalisco, Morelos, Nuevo León, Quintana Roo, Sinaloa, Tabasco, Tamaulipas, Veracruz), Panama, and United States of America [4,11,80,82,83,85–87,136,169,219,257–260].

*Remarks:* *Dicromantispa sayi* presents a Nearctic and Neotropical distribution. Specimens were collected in evergreen tropical forest, coffee plantations, and cloud forest, with some specimens found in *Coffea* spp. Flight period was in January and August to September (mainly in the rainy season). Previous altitudinal distribution records are between 11 and 1239 m [80,85,169,261]; herein, specimens were collected from 659 to 775 m. Variation: Individuals of this species typically have a yellow-brown body coloration, but some specimens had a red-brown body coloration.

**Genus Leptomantispa** Hoffman in Penny, 2002

**Leptomantispa pulchella** (Banks, 1912)

*Distribution:* Belize, Canada, Cuba, Mexico (Baja California Sur, Chihuahua, Chiapas, Hidalgo, Jalisco, Michoacán, Nuevo León, Oaxaca, Sinaloa, San Luis Potosí, Tamaulipas, Veracruz), Nicaragua, and United States of America [4,11,85].

*Remarks:* *Leptomantispa pulchella* presents a Nearctic and Neotropical distribution. A single male specimen was collected in evergreen tropical forest. Flight time was in February (in the dry season). A previous altitudinal distribution record is from 1500 m [85]; herein, the specimen was collected at 694 m, which is the lowest altitudinal record for this species.

**Genus Zeugomantispa** Hoffman in Penny, 2002

**Zeugomantispa compellens** (Walker, 1860)

*Distribution:* Belize, Brazil, Colombia, Costa Rica, El Salvador, France (French Guiana), Guatemala, Honduras, Mexico (Campeche, Chiapas, Oaxaca, Quintana Roo, Veracruz, San Luis Potosí), Nicaragua, Panama, Suriname, Trinidad and Tobago, United States of America, and Venezuela [4,11,80,85,98,262–267].

*Remarks:* *Zeugomantispa compellens* presents a Nearctic and Neotropical distribution. Specimens were collected in evergreen tropical forest, coffee plantations, and cloud forest. Flight period was in January, April, and November (in the dry season). Previous altitudinal distribution records are between sea level and 950 m [80,85,98,264–266]; herein, specimens were collected from 748 to 1462 m, which is the highest altitudinal record for this species.

**Zeugomantispa minuta** (Fabricius, 1775)

*Distribution:* Argentina, Bahamas, Belize, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico (Campeche, Chihuahua, Chiapas, Coahuila, Colima, Guerrero, Hidalgo, Jalisco, Morelos, Nayarit, Nuevo León, Oaxaca, Puebla, Querétaro, Sinaloa, San Luis Potosí, Tabasco, Tamaulipas, Veracruz, Yucatán), Nicaragua, Panama, Peru, Suriname, United States of America, Uruguay, and Venezuela [4,11,82,83,85,136,167,169,204,244,250,256,261,265,266,268–271].
Remarks: Zeugomantispa minuta presents a Nearctic and Neotropical distribution. Specimens were collected in cloud forest and oak forest. Flight period was in January, April, June, and July (in both seasons). Previous altitudinal distribution records are between sea level and 2300 m [80,85,169,261,265,266]; herein, specimens were collected from 1194 to 2081 m.

**Family Myrmeleontidae Latreille, 1803**
**Subfamily Ascalaphinae Rambur, 1842**
**Tribe Haplogleniini Newman, 1853**
**Genus Haploglenius Burmeister, 1839**
**Haploglenius flavicornis** McLachlan, 1873

*Distribution*: Mexico (Chiapas, Hidalgo, Jalisco, Quintana Roo, Sinaloa, Veracruz, Yucatán), Costa Rica, Guatemala, and Panama [4,11,39,80,83].

*Remarks*: *Haploglenius flavicornis* is known from Mexico and Central America (Neotropical). A single female specimen was collected in cloud forest, with a flight time in September (in the rainy season). Previous altitudinal distribution records are between 10 and 1520 m [80]; herein, the specimen was collected at 926 m.

**Tribe Ululodini Van Der Weele, 1908**
**Genus Ululodes Smith, 1900**
**Ululodes bicolor** (Banks, 1895)

*Distribution*: Mexico (Baja California, Baja California Sur, Chiapas, Jalisco, Michoacán, Nayarit, Nuevo León, Oaxaca, San Luis Potosí, Sinaloa, Sonora, Veracruz, Tamaulipas), Honduras, Costa Rica, Panama, and France (French Guiana) [4,11,40,80,272].

*Remarks*: *Ululodes bicolor* presents a Nearctic and Neotropical distribution. A single male specimen was collected in evergreen tropical forest. Flight time was in July (in the rainy season). Previous altitudinal distribution records are between sea level and 500 m [80]; herein, the specimen was collected at 696 m, which is the highest altitudinal record for this species.

**Ululodes sp.**

*Distribution*: Mexico (Chiapas).

*Remarks*: A single female specimen was collected in evergreen tropical forest, with flight time in November (in the dry season), at an altitude of 661 m. The specimen is morphologically similar to *Ululodes cajennensis* (Fabricius, 1787), but with evident differences in size, color patterns, and genitalia.

**Subfamily Myrmeleontinae Latreille, 1803, Tribe Myrmeleontini Latreille, 1802**
**Genus Myrmeleon Linnaeus, 1767**
**Subgenus Myrmeleon Linnaeus, 1767**
**Myrmeleon (Myrmeleon) immaculatus** De Geer, 1773

*Distribution*: Mexico (Chiapas (new record), Zacatecas) and United States of America [4,11,82,219,244,273–276].

*Remarks*: *Myrmeleon (M.) immaculatus* presents a Nearctic and Neotropical distribution. This is the southernmost record for this species. Larval specimens, which were reared to adults, were collected in cloud forest and oak forest in February, March, May, December (mainly in the dry season), and one adult specimen in August (in the rainy season). Larval specimens became pupae between February and June, and emerged as adults between April and June. The altitudinal distribution of this species is unknown; in the present study, the altitudinal distribution was recorded from 955 to 1749 m.

**Myrmeleon (Myrmeleon) timidus** Gerstaecker, 1888

*Distribution*: Chile, Costa Rica, Ecuador, Honduras, Mexico (Chiapas, Colima, Nayarit, Oaxaca, San Luis Potosí, Sonora, Veracruz), Panama, and Peru [4,11,80,101,165,168,211,248, 277,278].
Remarks: *Myrmeleon (M.) timidus* presents a Nearctic and Neotropical distribution. Larval specimens, which were reared to adults, were collected in evergreen tropical forest and coffee plantations in February and July (in both seasons). Larval specimens became pupae during February to April, August and November, and emerged as adults between February to May, August, September and November. Previous altitudinal distribution records are between sea level and at least 400 m [80,168]; herein, specimens were collected from 704 to 746 m, which is the highest altitudinal record for this species.

*Myrmeleon (Myrmeleon) uniformis* Naváš, 1920

*Distribution*: Costa Rica, Honduras, and Mexico (Chiapas, Jalisco, Nayarit, Oaxaca, Sonora, Veracruz) [4,11,80,101,256].

*Remarks*: *Myrmeleon (M.) uniformis* is known from Mexico and Central America (Nearctic and Neotropical). Specimens, some reared from larval stage to adult, were collected in cloud forest and oak forest in February (in the dry season), and other were collected in the adult stage from May to July (in the rainy season). Larval specimens became pupae during March, and emerged as adults in April. Previous altitudinal distribution records are from sea level to 1700 m [41,80]; herein, specimens were collected from 1514 to 2173 m, which is the highest altitudinal record for this species.

Family Rhachiberothidae Tjeder, 1959

Subfamily Symphrasinae Naváš, 1909

Genus *Trichoscelia* Westwood, 1852

*Trichoscelia santareni* (Naváš, 1914)

*Distribution*: Mexico (Chiapas (new record), Quintana Roo, Tabasco) [4,11,42,279].

*Remarks*: *Trichoscelia santareni* is known only from Mexico (Neotropical). Specimens were collected in evergreen tropical forest, coffee plantations, and cloud forest, with some specimens found on *Coffea* spp. Flight period was from August to December (mainly in the rainy season). No previous altitudinal distribution records were available; herein, specimens were collected from 661 to 1487 m.

3.2. Keys to Families and Genera of Neuroptera from Volcán Tacaná, Chiapas, Mexico

See Appendix B for the Spanish version of the keys.

Key 1: Families of Neuroptera (adult males and females)

(after [8,80,105,146]).

1a. Forewing length ≥4 mm; body and wings not covered with a whitish powder  
2  
1b. Forewing length ≤3 mm; body and wings covered with a whitish powder

Coniopterygidae (Key 2)

2a. Antennae filiform, moniliform, but not clubbed; habitus not similar to Odonata  
3  
2b. Antennae clubbed; habitus similar to Odonata

Myrmeleontidae (Key 3)

3a. Forelegs raptorial  
4  
3b. Forelegs not raptorial

Rhachiberothidae (Symphrasinae, *Trichoscelia*)

4a. Pronotum shield-shaped; coxae inserted at caudal apex or approximately at the middle of the prothorax  
5  
4b. Pronotum tubular; coxae inserted at cephalic apex of the prothorax

Mantispidae (Key 4)

5a. Body generally brown; forewing length 3–18 mm, with two or more main branches of RP arising from R  
6  
5b. Body generally green; forewing length of 6.5–35 mm, with one RF main branch arising from R

Hemerobiidae (Key 5)

Chrysopidae (Key 6)
Key 2: Genera of Coniopterygidae (adult males and females)

(after [8, 146]).
1a. Absence of plicatures (structures similar to pits) in some abdominal sternites (Coniopteryginae) Ρ
1b. Presence of plicatures (structures similar to pits) in some abdominal sternites (Aleuropteryginae) Neoconis
2a. Hindwings with median vein forked Coniopteryx
2b. Hindwings with median vein simple Semidalis
3a. Fore and hindwing with medio-cubital crossvein oblique, in contact with MP or bifurcation of M Conwentzia
3b. Fore and hindwing with medio-cubital crossvein not oblique, in contact with M

Key 3: Genera of Myrmeleontidae (adult males and females)

(after [80])
1a. Antennae apically knobbed, usually as long as entire body, but sometimes as short as head and thorax combined; fore and hindwing with no elongated cell behind fusion point of Sc and RA (Ascalaphinae) Myrmeleon
1b. Antennae apically not knobbed, and not longer than the head and thorax combined; fore and hindwing with elongated cell present behind fusion point of Sc and RA (Myrmeleontinae) Ululodes
2a. Eyes divided by a transverse sulcus (Ululodini) Haploglenius
2b. Eyes entire not divided by a transverse sulcus (Haplogleniini)

Key 4: Genera of Mantispidae (adult males and females)

(after [80])
1a. Head with dome-shaped vertex in frontal view; forelegs with two pretarsal claws, arolium present (Calomantispinae) Nolima
1b. Head with a concave vertex in frontal view; forelegs with one pretarsal claw, arolium absent (Mantispinae) 2
2a. Pronotum, in lateral view, with prominent setae over entire length Dicromantispa
2b. Pronotum, in lateral view, with scattered fine setae, especially in the anterior and posterior parts Zeugomantispa
3a. Habitus with green color pattern; pronotum with most setae arising from distinct bumps Leptomantispa
3b. Habitus with yellow and brown pattern; pronotum with most setae flush arising
Key 5: Genera of Hemerobiidae (adult males and females)

(after [80,105])

1a. Forewing with two main branches of RP
1b. Forewing with ≥ three main branches of RP
2a. Forewing with two series of gradate veins (crossoveins)
2b. Forewing with one series of gradate veins (crossoveins)
3a. Forewing with two basal crossoveins in the subcostal space
3b. Forewing with only one crossovein in the subcostal space
4a. Forewing with two crossoveins between RA and the last apical main branch of RP
4b. Forewing with only one crossovein between RA and the last apical main branch of R
5a. Forewing with narrow costal space, absence of 2r-m
5b. Forewing with broad costal area, presence of 2r-m
6a. Forewing with three series of gradate veins; MP and CuA fused basally for a short distance
6b. Forewing with two series of gradate veins; MP and CuA attached by a crossovein
7a. Forewing with first fork of the first main branch of RP more distal than the first fork of the second main branch of RP
7b. Forewing with first fork of the first main branch of RP at the same level of the first fork of the second main branch of RP

Key 6: Genera of Chrysopidae (adult males)

(after [80])

1a. Antennae shorter than 1.3 times length of the forewing; forewing with no dark spot at the pterostigma base (Chrysopini)
1b. Antennae longer than 1.3 times length of the forewing; forewing with a dark spot at the pterostigma base (Leucochrysini)
2a. Genitalia with tignum present
2b. Genitalia with tignum absent
3a. Genitalia with pseudopenis present
3b. Genitalia with pseudopenis absent
4a. Apex of abdomen with base of ectoproct extended basally to articulate with base of sternite 8 + 9; ectoproct not fused dorso-medially
4b. Apex of abdomen with base of ectoproct not extended basally to articulate with base of sternite 8 + 9; ectoproct fused dorso-medially at base
5a. Genitalia with gonapsis present; gonarcus and arcesus with horn-like structures
5b. Genitalia with gonapsis absent (rarely with gonapsis); gonarcus and arcesus with no horn-like structures
6a. Abdomen with sternite 8 + 9 short and not fused; genitalia with gonarcal bridge wide, and gonapsis long (in relation to S8 + 9) with variable shape
6b. Abdomen with sternite 8 + 9 elongate and fused; genitalia with gonarcal bridge narrow, and gonapsis short (in relation to S8 + 9), spoon-shaped
7a. Head with scapes elongated or modified and/or with horns or cavities on the frons; genitalia with pseudopenis present
7b. Head with scapes not elongated, and with no modifications, horns or cavities on the frons; genitalia with pseudopenis absent

3.3. Altitudinal Distribution of the Neuropteran Fauna from Volcán Tacaná, Chiapas, Mexico

The fauna of Neuroptera has a wide distribution along the sampled altitudinal gradient (650–3360 m), and this general fauna was not divided in distinct groups across the altitudinal gradient; nevertheless, there is a tendency for the lower altitudes to share the same species (Figure 4a, with the largest number of lacewing species occurring at low and medium altitudes in the volcano. It is evident that two lower levels have a similar fauna of lacewings, sharing the presence of Ceraeochrysa achillea, C. sanchezi, C. squama, Leucochrysa
Several species presented a wide distribution in the altitudinal gradient, two of them are present in all sampling altitudes—Hemerobius jucundus and Neoconis dentata—while Ceraeochrysa arioles, C. berlandi, Chrysopodes (C.) varicosus, Plesiychrysa brasiliensis, Semidalis problematica, Hemerobius hernandezi, and Nusalala championi are present in the altitudes between 600 and 2000 m. In addition, Coniopteryx (C.) simplicior and Hemerobius bolivari are distributed between 1000 to 3000 m, with no occurrence at lower altitudes.

A large number of species had a restricted distribution (Figure 4a). At the lowest altitude (ca. 600 m), Chrysoperla externa, Leucochrysa (L.) pretiosa, Leucochrysa (N.) azevedoi, Leucochrysa (N.) lateralis, Leucochrysa (N.) squamisetosa, Leucochrysa (N.) sp. 3, Coniopteryx (S.) josephus, Semidalis boliviensis, Semidalis soleri, Hemerobius withycombei, Notiobiella mexicana, Nusalala tessellata, Nusalala unguicaudata, Sympherobius subcostalis, Dicromantispa sayi, Leptomantispa pulchella, Myrmeleon (M.) timidus, Ululodes bicolor, and Ululodes spp. were recorded. At the second level (ca. 1000 m), we collected specimens from Chrysopodes (C.) sp. 1, Leucochrysa (N.) digitiformis, Leucochrysa (L.) varia, Leucochrysa (N.) sp. 4, Leucochrysa (N.) sp. 5, and Coniopteryx (S.) fumata. For the third altitudinal level (ca. 1400 m), Ceracochrysa defrainsi, Chrysopodes (C.) sp. 2, Leucochrysa (L.) lestagei, Leucochrysa (N.) caucella, Leucochrysa (N.) sp. 6, Titanochrysa simpliciala, Biramus aggregatus, Hemerobiiia sinuata, Hemerobius nigridorsus, Micromus subanticus, and Nolima victor were recorded. At the fourth level (ca. 2000 m), we reported Leucochrysa (N.) sp. 2, Plesiychrysa sp. 1, Ungla sp. 2, Semidalis manausensis, Notiobiella cixiformis, and Sympherobius distinctus. Finally, at the highest level (ca. 3000 m), the species Ungla sp. 1, Hemerobius alpestris, Megalomus sp., and Sympherobius sp. were reported.

At the family level, different results were obtained on the relationship of the different altitudinal ranges. Chrysopidae, the family with the largest number of species in the
Tacaná volcano, presents a similar distribution pattern to that observed for Neuroptera in general (Figure 4b); nevertheless, for the whole order, the two lowest levels (ca. 600 and 1000 m, respectively) are closer to each other in species composition than either is to the medium level (ca. 1400 m), while the composition of chrysopid species is similar between the three lower levels. Eight genera of green lacewings were recorded from the volcano, of which *Ceraeochrysa*, *Chrysoperla*, *Chrysopodes*, *Leucochrysa*, and *Plesiochrysa* occurred in a wide range between 600 m to 2000 m, with *Ceraeochrysa* reaching higher altitudes. The three remaining genera were distributed between the middle and high altitudes, with *Titanochrysa* exclusively in the middle altitudes (between 1200 to 1600 m), *Meleoma* present between the middle and high altitudes (1200 to 3000 m), and finally *Ungla* restricted to high altitudes (between 2000 to 3000 m).

Hemerobiidae presented an inverse pattern to that observed for Neuroptera in general, i.e., most species were shared between the highest altitudinal ranges (Figure 4c). Eight genera of brown lacewings were reported for the Tacaná volcano, of which *Hemerobius*, *Megalomus*, *Notiobiella*, *Nusalala*, and *Sympherobius* have a wide range of altitudinal distribution (between 600 to 3000 m), with *Hemerobius*, *Megalomus*, and *Sympherobius* present at the highest altitudinal levels, contrary to other genera—*Biramus*, *Hemerobiella*, and *Micromus*—restricted exclusively to medium altitudes (1400 to 1700 m).

Myrmeleontidae have no species recorded at the highest level of the volcano (ca. 3000 m); however, when the other four sampled levels are compared, there is a tendency for the highest levels to share the same species (Figure 4d). Such family presented the lowest number of genera of all families, with a total of three genera, of which *Ullulodes* and *Haploglenius* were restricted to low altitudes (600 to 900 m). On the contrary, *Myrmeleon* presented a wider altitudinal distribution, present from low to high altitudes (700 to 2000 m).

Mantispidae also had no species recorded at the highest level of the volcano (ca. 3000 m), and the species composition fluctuated along the altitudinal gradient, with most species occurring at the median altitudes (Figure 4e). Four genera of mantidflies were recorded. *Zeugomantispa* occurred mainly at high and medium elevations, with the highest distribution at 2000 m. In contrast, some genera were recorded at low altitudes (*Dicromantispida* and *Leptomantispa*) or medium altitudes (*Nolima*).

Coniopterygidae was present in all sampled levels; however, its species composition also fluctuated along the altitudinal gradient, without a definite tendency, similar to Mantispidae (Figure 4f). Only four genera of dustywings were recorded, of which *Coniopteryx*, *Neoconis*, and *Semidalis* presented a wide range in altitude (between 600 to 3000 m), with *Coniopteryx* and *Neoconis* present at the highest altitudinal levels. The genus *Conwentzia* was present from medium to high altitudes (1700 to 3000 m).

Rhachiberothidae was represented only by one species, *Trichoscelia santareni*, which is endemic to Mexico and was restricted to low and medium altitudes [85].

3.4. Biogeographic Composition of the Neuropteran Fauna from Volcán Tacaná, Chiapas, Mexico

Despite a fragmented knowledge about neuropteran distribution, herein, we attempt a characterization of the fauna from Tacaná volcano following the criteria of Morrone [280,281]. The fauna of lacewings had only 9% of the species of Nearctic affinity, with 16% of the species occurring at the median altitudes (Figure 4e). Four genera of mantidflies were recorded. *Zeugomantispa* occurred mainly at high and medium elevations, with the highest distribution at 2000 m. In contrast, some genera were recorded at low altitudes (*Dicromantispida* and *Leptomantispa*) or medium altitudes (*Nolima*).

Coniopterygidae was present in all sampled levels; however, its species composition also fluctuated along the altitudinal gradient, without a definite tendency, similar to Mantispidae (Figure 4f). Only four genera of dustywings were recorded, of which *Coniopteryx*, *Neoconis*, and *Semidalis* presented a wide range in altitude (between 600 to 3000 m), with *Coniopteryx* and *Neoconis* present at the highest altitudinal levels. The genus *Conwentzia* was present from medium to high altitudes (1700 to 3000 m).

Rhachiberothidae was represented only by one species, *Trichoscelia santareni*, which is endemic to Mexico and was restricted to low and medium altitudes [85].
The Tacaná volcano is part of the Central American mountain range and its fauna has great affinity to the Neotropical region. More than 80% of the Tacaná volcano lacewing species occur in the Brazilian subregion, especially the Mesoamerican and Pacific domains, with approximately 50% and 71% of the species, respectively. Several neuropteran species (61%) are present only in the Mexican Transition Zone. Some species are also present in the Antilles and some subregions of South America. Most of the species with a Neotropical affinity are reported from the provinces of Puntarenas-Chiriquí and Guatuso-Talamanca (both Pacific)—which include around 50% of the species present in the Volcano—as well as from the Veracruzan, Pacific Lowlands, and Balsas Basin (all Mesoamerican), and the Transmexican Volcanic Belt and Chiapas Highlands (both from the Mexican transition zone). This last province received 52 new records of Neuroptera, of which 21 belong to the family Chrysopidae.

The Neuroptera fauna of the different altitudinal levels possess different biogeographic affinities, with lower elevational levels (650 m to 810 m) having a greater Neotropical affinity (79% of the species) and a smaller number of species of Nearctic affinity (5%). Nearctic affinity therefore increases with altitude, i.e., at the highest altitudes (2870–3360 m), 50% of the species have Neotropical affinity and 45% of them have Nearctic affinity.

4. Discussion

The number of studies about Neuroptera diversity is still low when compared with that about other insect orders; such studies are mainly focused on faunal lists of a particular country or region. Despite the Neotropical region being fourth in number of Neuropterida species [3], these Neuroptera species are still poorly known, which demonstrates a need for more studies in this area. The Nearctic region is sixth in the number of lacewing species [3]; however, this is the region with the largest number of studies about Neuroptera diversity in the Americas.

Several studies have recorded that neuropterans have a wide altitudinal distribution, from sea level to mountainous areas of more than 4000 m [2,80,282,283], which is supported in the present study, with neuropteran species recorded from 650 to more than 3500 m. Herein, we observed that neuropterans presented a higher species richness between 600 and 1700 m, with a few number of species occurring at altitudes above 3000 m, agreeing with the general information on the vertical distribution of the order; i.e., lacewings, although a cosmopolitan group, will individually present an affinity to tropical, subtropical, xeric and warm environments, or high mountain areas [3,284,285].

Some species, especially those from Chrysopidae, Hemerobiidae, and Coniopterygidae, were restricted to a single altitudinal range. It is noteworthy that the level with the highest number of species with restricted distribution was the lowest one (ca. 600 m), with a total of 19 species, while the highest level (ca. 3000 m) had the lowest number (4 spp.). Most of these restricted species represented new records for the state, the country, or potentially new species for science. This may be indicative of a possible high degree of endemism in the study site, and possible adaptations, in addition to the influence of biogeographical history, so it would be important to conduct studies focused on the ecological and biogeographical aspects that would explain these trends in the distribution of Neuroptera.

The Neuroptera fauna was biogeographically characterized, especially regarding possible biogeographical affinity (cf., [286]). The largest similarity of the neuropteran fauna at the Tacaná volcano occurred between levels 1 and 2 (between 600 and 1200 m); these levels were characterized by considerable anthropogenic impact as there were coffee plantations mixed with native vegetation (evergreen tropical forest or cloud forest). These areas also presented more Neotropical and cosmopolitan species, and as altitude increased, this composition was lost with the inclusion of taxa of Nearctic affinity. Overall, there is a strong affinity to the Pacific and Mesoamerican domains, supporting an evident Central and South American relationship of the fauna. This agrees with Halffter et al. [287], in that lineages of modern distribution constitute the typical Neotropical pattern, integrated after
the consolidation of the Panamanian bridge with species close to those of northern South America, now distributed in the tropical lowlands of Mexico, or some representing the Mesoamerican mountain pattern, composed by taxa that evolved in the Central American Nucleus, often presenting expansions towards the north, and whose most important affinity is ancient South America.

Volcán Tacá may be assumed to have a high potential for endemism, being part of the Central American Core Mountain system (within the Mexican Transition Zone subregion and the Chiapas Highlands province). Its neuropteran fauna is predominantly Neotropical with some species of Nearctic affinity and others of a wide distribution in the Americas; this conforms with Halffter et al. [288], in that mountains of the Mexican transition zone present a fauna with strong Nearctic affinity at their high altitudes (above 2400 m), while the fauna is related to the Neotropical region in the lowlands and plains (below 1200 m). The Nearctic affinity of the studied fauna is low when compared to other studies within the Mexican Transition Zone, such as Marquez-López et al. [9], who recorded the diversity of Hemerobiidae and Coniopterygidae in the Trans-Mexican Volcanic Belt, at ca. 2800 m, and obtained a higher Nearctic affinity. Based on this, the biogeographic affinities of Neuroptera may change notoriously, even between sites of the same subregion. Probably, the Neuroptera fauna is different in southern portions of the Mexican Transition Zone, due to a decrease in the number of species and lineages of northern origin, and the effect of the Isthmus of Tehuantepec that functions as a barrier, as was mentioned by Halffter [289], for entomofauna in general.

Altitudinal distribution patterns were different at the family level, which may be due to environmental conditions or habits that may sort the species out on the different levels. For instance, Chrysopidae and Hemerobiidae, despite presenting similar life histories [290], the former had a more diverse and shared species composition at low altitudes, while the latter displayed a similar pattern at medium and high altitudes.

The higher chrysopid species richness seen at low and medium altitudes was drastically lower at elevations above 3000 m; such diversity may be related to the presence of coffee plantations between 650 and 1770 m. This family is often present in agroecosystems, where they feed on various soft-bodied prey that are considered pests of different crops [137,291]. Most of the Chrysopidae species of the Tacá volcano have a Neotropical affinity, which agrees with the literature [2,292–295] about their large abundance and the diversification of green lacewings in tropical, subtropical, and temperate zones, and its lesser frequency in high and cold zones, with some species adapted to extreme temperature conditions.

Among the eight green lacewing genera recorded at the Tacá volcano, five have a general distribution between 600 and 2000 m, with *Ceraeochrysa* and *Leucochrysa* showing a wider distribution compared to the other three (*Chrysoperla*, *Chrysopodes*, and *Plesiochrysa*). This broad altitudinal distribution has been previously recorded for these genera, with species recorded from sea level to more than 2000 m [12,13,80,106,137,138,140,296]. Both *Ceraeochrysa* and *Leucochrysa*, which presented the highest altitudinal range, displayed a high species diversity when compared to other genera, with two or three species reported to the region. Other genera were restricted to medium and high altitudes (*Meleoma*, *Titanochrysa*, and *Ungla*), which could be explained because these genera are associated with better-preserved environments, as opposed to low altitude sites with greater anthropogenic disturbance, such as coffee plantations where the other five genera, especially *Ceraeochrysa*, are often present [297].

Hemerobiidae displayed a higher number of species, most of them of Nearctic affinity, at middle altitudes between 1200 and 1700 m, decreasing at lower (ca. 600 m) and high altitudes (above 3000 m). Brown lacewings have a considerable affinity for oak and pine forests, as known from studies where Neuroptera present a strong affinity to the vegetation cover where they live [298,299]. Similar to Chrysopidae, this family presents substantial diversification in tropical, subtropical, and temperate environments, avoiding extreme environments such as deserts or high mountains [282]. Although both families have similar
habits and distribution patterns, it is likely that ecological factors are influencing their distribution, perhaps with specific colonization mechanisms of brown lacewings at certain altitudinal levels to avoid possible competition for resources with Chrysopidae.

Eight genera of Hemerobiidae were recorded, five of them along the altitudinal gradient, from lowland areas characterized by evergreen tropical forest and coffee crops to high altitudes predominantly with pine forest. Species of Hemerobius, Megalomus, and Sympherobius have been previously reported with a broad altitudinal distribution, from sea level to over 3000 m [18,95,97,147,300,301]. Species of Nusalala and Notobiella, known to have a wide altitudinal range, were not recorded above 2500 m, which could be due to the ecological requirements of these species, which have not been reported at altitudes above 1900 m [80,96,149], probably incapable of colonizing the highest peaks of the volcano.

Myrmeleontidae and Mantispidae had the smallest number of genera and species; despite previous records from a wide altitudinal range (sea level to ca. 3000 m) [80,85,99,265,266,302,303]; herein, both families had most species at low and medium altitudes (between 600 and 1500 m), with a decrease in the number of species up to 2000 m, and absence at altitudes higher than 3000 m. These families have been reported with higher species richness in tropical and warm environments, occurring less frequently or being absent in cold climates and high mountain areas [19,284,285], yet with few species reported between 2000 and 4000 m in Europe [304]. At the volcano, the maximum altitudinal record for these families was above 2000 m, with Myrmeleon (M.) uniformis and Zeugomantispa minuta. Genera such as Dicromantispa, Leptomantispa (Mantispidae), Uluodes, and Haploglenius (Myrmeleontidae) were only recorded at lower altitudes (from 600 to 900 m), while others such as Nolina (Mantispidae) remained at medium altitudes (1200 to 1500 m), which probably reflects that some genera are related to warmer environments with heterogeneous vegetation (as the low altitude sites studied here). Previous studies support that these families are typically present at low altitudes [244,298,305–307].

Species of Coniopterygidae at the volcano were generally of Nearctic affinity. This family did not have a particular trend in its distribution, although in the highest areas above 3500 m its presence decreased considerably. This probably reflects that this family is mostly distributed in tropical and warm environments, and to a lesser extent in temperate zones or is absent in very cold climates [16,283,308]. Only four genera of dustywings were reported from the Tacaná volcano; three of them had a wide altitudinal distribution (Coniopteryx, Neoconis, and Semidalis), with Coniopteryx and Semidalis having previous records of a wide altitudinal distribution, while Neoconis has been reported at ca. 1600 m [16,43,143]. Conwentzia was present between 1700 and 3000 m, without occurring at low altitudes, and represented by a single species that has previous records between 400 and 2800 m [16].

Concerning the Rhachiberothidae, the only species collected in the volcano—Trichoscelia santareni—is endemic to Mexico, and has a Neotropical affinity, with records in the states of Tabasco and Quintana Roo [85].

This study highlights the importance of recording the distribution pattern of Neuroptera species for a better understanding and potential management of insect communities in protected areas, such as the Tacaná volcano. Noteworthy is the large number of new records of Neuroptera species for Mexico, which increases the known distribution range of such species and genera. Despite the Neuroptera fauna of the Tacaná volcano is most similar in lower altitudes, each studied family possessed a particular distribution and affinity along the altitudinal levels. The biogeographic affinity of the Neuroptera fauna from Tacaná volcano is variable between the altitudinal levels, with the lowest altitudes presenting species with Neotropical affinity, whereas higher levels have an increase in the number of species with Nearctic affinity.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/d13110537/s1, Table S1: material examined.

Author Contributions: Conceptualization, R.J.C.-L. and A.C.-R.; methodology, R.J.C.-L. and C.C.M.; formal analysis, R.J.C.-L. and C.C.M.; writing—original draft preparation, R.J.C.-L. and C.C.M.;
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writing—review and editing, C.C.M. and A.C.-R.; supervision and funding acquisition, A.C.-R. All authors have read and agreed to the published version of the manuscript.

Funding: This study was supported by the Projects: “Aportaciones a la taxonomía y filogenia del orden Neuroptera (Insecta) en México” (PAPIIT-UNAM, IN207517) and “Biodiversidad de Neuroptera en México: un enfoque taxonómico integrativo” (CONACYT CB2017–2018, A1-S-32693).

Institutional Review Board Statement: Not applicable. Specimens were collected under scientific collecting license FAUT-0218 granted to A.C.-R. by Mexico’s government (SEMARNAT, Dirección General de Vida Silvestre, official letter SGPA/DGVS/000109/18).

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available in Tables A1 and S1.

Acknowledgments: Our appreciation goes to “Colección de Insectos asociados a plantas cultivadas en la Frontera Sur (ECO-TAP-E)”, the Florida State Collection of Arthropods, Gainesville (FSCA), and the National Museum of Natural History, Smithsonian Institution (USNM), for allowing R.J.C.-L. to study the specimens of the respective collections. Magali Luna-Luna and Johar Almaraz-Hernández provided support during fieldwork. Hellen Martínez Roldán provided support in the design of the map of the sampling points. Manuel Martínez Melendez provided support in the generic identification of some plant samples. We are very much indebted to Benigno Gómez (ECOSUR-San Cristobal), to Reserva de la Biosfera Volcán Tacaná (Francisco J. Jiménez González, director), to the people from Finca Alianza, Finca Monteperla, Ejido El Águla, Ejido Benito Juárez El Plan, and Cantón Chiquihuites, for authorization for fieldwork and hospitality. This paper is in partial fulfillment for the requirements of the Posgrado en Ciencias Biológicas, UNAM, by R.J.C.-L. for obtaining the degree of Doctor in Biological Sciences. R.J.C.-L. thanks Consejo Nacional de Ciencia y Tecnología for a doctoral scholarship and Posgrado en Ciencias Biológicas-UNAM, sede Instituto de Biología, for general support through his doctoral program. CCM thanks Programa de Becas Posdoctorales DGAPA-UNAM 2019–2021 for a postdoctoral fellowship at Instituto de Biología-UNAM (IBUNAM). 

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Species of Neuroptera from Tacaná volcano, Chiapas, Mexico, distributed by the sampled altitudinal levels.

| Neuroptera Species/Families | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 |
|----------------------------|---------|---------|---------|---------|---------|
| Ceraeochrysa achillas de Freitas & Penny in de Freitas et al., 2009 | 1       | 1       | 0       | 0       | 0       |
| Ceraeochrysa ariole (Banks, 1944) | 1       | 1       | 1       | 1       | 0       |
| Ceraeochrysa sarta (Banks, 1914) | 1       | 1       | 1       | 1       | 0       |
| Ceraeochrysa cubana (Hagen, 1861) | 1       | 0       | 0       | 1       | 0       |
| Ceraeochrysa defreitasi Penny in Penny, 2002 | 0       | 0       | 0       | 1       | 0       |
| Ceraeochrysa sarta (Banks, 1914) | 0       | 1       | 0       | 0       | 1       |
| Ceraeochrysa squama de Freitas & Penny in de Freitas et al., 2009 | 1       | 1       | 1       | 0       | 0       |
| Ceraeochrysa squama (Navás, 1911) | 1       | 1       | 1       | 0       | 0       |
| Ceraeochrysa clara (Navás, 1913) | 0       | 1       | 0       | 0       | 1       |
| Ceraeochrysa varia (Navás, 1933) | 0       | 1       | 0       | 0       | 1       |
| Ceraeochrysa nigrovaria (Banks, 1910) | 0       | 0       | 1       | 0       | 0       |
| Chrysopodes (C.) cana (Hagen, 1867) | 1       | 1       | 1       | 1       | 0       |
| Chrysopides (C.) varius (Navás, 1914) | 1       | 1       | 1       | 0       | 0       |
| Chrysopides (C.) varius (Navás, 1914) | 0       | 1       | 0       | 0       | 1       |
| Chrysopides (C.) varius (Navás, 1914) | 0       | 0       | 1       | 0       | 0       |
| Leucochrysa (L.) clara (McLachlan, 1867) | 0       | 1       | 0       | 0       | 1       |
| Leucochrysa (L.) pretiosa (Banks, 1910) | 1       | 0       | 0       | 1       | 0       |
| Leucochrysa (L.) sarta (Schneidr, 1851) | 0       | 1       | 0       | 0       | 1       |
| Leucochrysa (L.) varians (Navás, 1913) | 1       | 1       | 0       | 0       | 1       |
| Leucochrysa (L.) nigrovaria (Walker, 1853) | 1       | 1       | 0       | 0       | 1       |
### Table A1. Cont.

| NEUROPTERA SPECIES/FAMILIES | LEVEL 1 | LEVEL 2 | LEVEL 3 | LEVEL 4 | LEVEL 5 |
|-----------------------------|---------|---------|---------|---------|---------|
| 35. Leucochrysa (N.) squamitetsosa de Freitas & Penny, 2001 | 1 | 0 | 0 | 0 | 0 |
| 36. Leucochrysa (N.) tarinii (Navás, 1924) | 1 | 1 | 0 | 0 | 0 |
| 37. Leucochrysa (N.) sp. 1 | 1 | 1 | 1 | 0 | 0 |
| 38. Leucochrysa (N.) sp. 2 | 0 | 0 | 1 | 0 | 0 |
| 39. Leucochrysa (N.) sp. 3 | 1 | 0 | 0 | 0 | 0 |
| 40. Leucochrysa (N.) sp. 4 | 0 | 1 | 0 | 0 | 0 |
| 41. Leucochrysa (N.) sp. 5 | 0 | 1 | 0 | 0 | 0 |
| 42. Leucochrysa (N.) sp. 6 | 0 | 0 | 0 | 0 | 0 |
| 43. Meloea macleodi Tauber, 1969 | 0 | 0 | 0 | 0 | 0 |
| 44. Meloea tiltschaki Navás, 1928 | 0 | 1 | 1 | 0 | 0 |
| 45. Meloea sp. | 0 | 0 | 0 | 0 | 0 |
| 46. Plesiochrysa brasiliensis (Schneider, 1851) | 1 | 1 | 0 | 0 | 0 |
| 47. Plesiochrysa sp. 1 | 0 | 0 | 0 | 0 | 0 |
| 48. Plesiochrysa sp. 2 | 1 | 1 | 0 | 0 | 0 |
| 49. Titanochrysa annularia (Banks, 1945) | 0 | 0 | 1 | 0 | 0 |
| 50. Titanochrysa simpliciata Tauber et al., 2012 | 0 | 0 | 1 | 0 | 0 |
| 51. Ungle sp. 1 | 0 | 0 | 0 | 0 | 0 |
| 52. Ungle sp. 2 | 0 | 0 | 0 | 0 | 0 |

#### Coniopterygidae

| Coniopteryx (S.) fumata Enderlein, 1907 | 1 | 0 | 0 | 0 | 0 |
| Coniopteryx (S.) josephus Sarmiento-Cordero & Contreras-Ramos, 2019 | 0 | 0 | 0 | 0 | 0 |
| Coniopteryx (S.) latipalpis Meinder, 1972 | 0 | 0 | 0 | 0 | 0 |
| Coniopteryx (S.) quadricornis in Meinder & Penny, 1982 | 1 | 0 | 0 | 0 | 0 |

#### Hemerobiidae

| Hemerobius domingensis Banks in Baker, 1905 | 1 | 0 | 0 | 0 | 0 |
| Hemerobius jucundus Meinander, 1996 | 1 | 0 | 0 | 0 | 0 |
| Hemerobius quadridentatus Meinander, 1996 | 0 | 0 | 0 | 0 | 0 |
| Hemerobius hirsuticornis Monserrat & Deretsky, 1999 | 1 | 0 | 0 | 0 | 0 |
| Hemerobius bicostalis Meinander, 1972 | 0 | 0 | 0 | 0 | 0 |
| Hemerobius martini Navás, 1924 | 0 | 0 | 0 | 0 | 0 |
| Hemerobius nigromarginatus Navás, 1917 | 0 | 0 | 0 | 0 | 0 |
| Hemerobius dominicensis Banks, 1941 | 0 | 0 | 0 | 0 | 0 |
| Hemerobius jucundus Meinander, 1972 | 1 | 0 | 0 | 0 | 0 |
| Hemerobius quadridentatus Meinander, 1972 | 0 | 0 | 0 | 0 | 0 |
| Hemerobius hirsuticornis Monserrat & Deretsky, 1999 | 0 | 0 | 0 | 0 | 0 |
| Hemerobius bicostalis Meinander, 1972 | 0 | 0 | 0 | 0 | 0 |
| Hemerobius martini Navás, 1924 | 0 | 0 | 0 | 0 | 0 |
| Hemerobius nigromarginatus Navás, 1917 | 0 | 0 | 0 | 0 | 0 |

#### Mantispidae

| Dictromantispa sayi (Banks, 1897) | 1 | 0 | 0 | 0 | 0 |
| Leptomantispa palpella (Banks, 1912) | 0 | 0 | 0 | 0 | 0 |
| Nolina infensa Navás, 1924 | 0 | 0 | 0 | 0 | 0 |
| Nolina victr Navás, 1914 | 0 | 0 | 0 | 0 | 0 |
| Zeugomantispa complenis (Walker, 1860) | 1 | 0 | 0 | 0 | 0 |
| Zeugomantispa minuta (Fabricius, 1775) | 0 | 0 | 0 | 0 | 0 |

#### Myrmeleontidae

| Myrmelonus (M.) immaculatus De Geer, 1773 | 0 | 0 | 0 | 0 | 0 |
| Myrmelonus (M.) timitius Gerstaecker, 1888 | 0 | 0 | 0 | 0 | 0 |
| Myrmelonus (M.) uniformis Navás, 1920 | 0 | 0 | 0 | 0 | 0 |
| Utlodes bicolor (Banks, 1895) | 1 | 0 | 0 | 0 | 0 |

#### Rhachiberothidae

| Trichoscirta santarensis (Navás, 1914) | 1 | 0 | 0 | 0 | 0 |
Appendix B

Clave en español de familias y géneros de Neuroptera del Volcán Tacaná, Chiapas, México.

Clave 1: Familias de Neuroptera (adultos machos y hembras)
(Modificada de [8,80,105,146]).

1a. Longitud de alas anteriores ≥4 mm; cuerpo y alas no cubiertos con polvo blanquecino
Coniopterygidae (Clave 2)
1b. Longitud de alas anteriores ≤3 mm; cuerpo y alas cubiertos con polvo blanquecino
2a. Antenas filiformes, moniliformes, pero no clavadas; hábito no similar a Odonata
Rhachiberothidae (Symphrasinae, Trichoscelia)
2b. Antenas clavadas; hábito similar a Odonata
Myrmeleontidae (Clave 3)
3a. Patas anteriores raptoriales
Mantispidae (Clave 4)
3b. Patas anteriores no raptoriales
Chrysopidae (Clave 5)

Clave 2: Géneros de Coniopterygidae (Adultos machos y hembras)
(Modificada de [8,146]).

1a. Ausencia de plicaturas (estructuras similares a pozillos) en algunos esternitos abdominales (Coniopteryginae)
Neocoris
1b. Presencia de plicaturas (estructuras similares a pozillos) en algunos esternitos abdominales (Aleuropteryginae)
Coniopteryx
2a. Alas posteriores con vena media bifurcada
Semitalids
2b. Alas posteriores con vena media simple
Conwentzia

Clave 3: Géneros de Myrmeleontidae (Adultos machos y hembras)
(Modificado de [80]).

1a. Antenas apicalmente clavadas, usualmente tan largas como el cuerpo, pero algunas veces tan cortas como la cabeza y tórax combinados; alas anteriores y posteriores con una celda no alargada detrás del punto de fusión de Sc y RA (Ascalaphinae)
Myrmeleon
1b. Antenas apicalmente no clavadas, y no tan largas como la cabeza y tórax; alas anteriores y posteriores con una celda alargada detrás del punto de fusión de Sc y RA (Myrmeleontinae)
Ullules
2a. Ojos divididos por una sutura transversal (Ululodini)
Haploglenius
2b. Ojos enteros no divididos por una sutura transversal (Haploglenini)

Clave 4: Géneros de Mantispidae (Adultos machos y hembras)
(Modificado de [80]).

1a. Cabeza con vertex en forma de domo en vista frontal; patas anteriores con dos uñas pretarsales con ariola presente (Calomantispinae)
Noëlima
1b. Cabeza con vertex concavo en vista frontal; patas anteriores con una uña tarsal, con ariola ausente (Mantispinae)
2a. Pronoto, en vista lateral, con prominentes sedas en toda su longitud
2b. Pronoto, en vista lateral, con finas sedas dispersas, especialmente en las zonas anterior y posterior
3a. Hábito con patrón de color verde; pronoto con sedas emergiendo de bases evidentemente elevadas
3b. Hábito con patrones de colores cafe y amarillo; pronoto con sedas que emergen al nivel de la superficie
Clave 5: Géneros de Hemerobiidae (Adultos machos y hembras)
(Modificado de [80,105])

1. Ala anterior con dos ramas principales de RP
2. Ala anterior con tres ramas principales de RP
3. Ala anterior con dos series de venas gradadas (transversales)
4. Ala anterior con una serie de venas gradadas (transversales)
5. Ala anterior con dos venas transversales basales en el espacio subcostal
6. Ala anterior con solo una vena transversal basal en el espacio subcostal
7. Ala anterior con dos venas transversales entre RA y la última rama principal de RP
8. Ala anterior con solo una vena transversal entre RA y la última rama principal de RP
9. Ala anterior con espacio costal estrecho, ausencia de 2r-m
10. Ala anterior con espacio costal Amplio, presencia de 2r-m
11. Ala anterior con tres series de venas gradadas; MP y CuA fusionadas por una distancia corta
12. Ala anterior con dos series de venas gradadas; MP y CuA unidas por una vena transversal
13. Ala anterior con la primera bifurcación de la primera rama principal de RP más distal que la primera bifurcación de la segunda rama principal de RP
14. Ala anterior con la primera bifurcación de la primera rama principal de RP al mismo nivel que la primera bifurcación de la segunda rama principal de RP

Clave 6: Géneros de Chrysopidae (Adultos machos)
(Modificado de [80])

1. Antenas de menos de 1.3 veces la longitud del ala anterior; alas sin mancha oscura en la base del pterostigma (Chrysopini)
2. Antenas de más de 1.3 veces la longitud del ala anterior; alas con una mancha oscura en la base del pterostigma (Leucochrysini)
3. Genitalia con tignum presente
4. Genitalia con tignum ausente
5. Genitalia con presencia de gonapsis; gonarcus y arcesus con estructuras en forma de cuernos
6. Genitalia con gonapsis ausente (raramente con gonapsis); gonarcus y arcesus sin estructuras en forma de cuernos
7. Genitalia con gonapsis ausente (raramente con gonapsis); gonarcus y arcesus en forma de cuchara
8. Genitalia con gonapsis ausente (raramente con gonapsis); gonarcus y arcesus con estructuras en forma de cuernos
9. Genitalia con gonapsis ausente (raramente con gonapsis); gonarcus y arcesus en forma de cuchara
10. Genitalia con presencia de gonapsis, gonarcus y arcesus con estructuras en forma de cuernos
11. Genitalia con gonapsis ausente (raramente con gonapsis); gonarcus y arcesus sin estructuras en forma de cuernos
12. Genitalia con gonapsis ausente (raramente con gonapsis); gonarcus y arcesus con estructuras en forma de cuernos
13. Genitalia con gonapsis ausente (raramente con gonapsis); gonarcus y arcesus con estructuras en forma de cuernos

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