UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO

POSGRADO EN CIENCIAS BIOLÓGICAS

INSTITUTO DE BIOLOGÍA
SISTEMÁTICA

DIVERSIDAD DEL ORDEN NEUROPTERA EN UN GRADIENTE ALTITUDINAL EN EL VOLCÁN TACANÁ, CHIAPAS.

TESIS

QUE PARA OPTAR POR EL GRADO DE:

DOCTOR EN CIENCIAS

PRESENTA:

M. en C. Rodolfo Jonathan Cancino López

TUTOR PRINCIPAL DE TESIS: DR. ATILANO CONTRERAS RAMOS
INSTITUTO DE BIOLOGÍA, UNAM
COMITÉ TUTOR: DR. SANTIAGO ZARAGOZA CABALLERO
INSTITUTO DE BIOLOGÍA, UNAM
COMITÉ TUTOR: DRA. CLAUDIA E. MORENO ORTEGA
CENTRO DE INVESTIGACIONES BIOLÓGICAS, UAEH

CIUDAD UNIVERSITARIA, CD. MX., SEPTIEMBRE, 2022

UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO
POSGRADO EN CIENCIAS BIOLÓGICAS
INSTITUTO DE BIOLOGÍA
SISTEMÁTICA

DIVERSIDAD DEL ORDEN NEUROPTERA EN UN GRADIENTE ALTITUDINAL EN EL VOLCÁN TACANÁ, CHIAPAS.

TESIS

QUE PARA OPTAR POR EL GRADO DE:

DOCTOR EN CIENCIAS

PRESENTA:

M. en C. Rodolfo Jonathan Cancino López

TUTOR PRINCIPAL DE TESIS: DR. ATILANO CONTRERAS RAMOS
INSTITUTO DE BIOLOGÍA, UNAM
COMITÉ TUTOR: DR. SANTIAGO ZARAGOZA CABALLERO
INSTITUTO DE BIOLOGÍA, UNAM
COMITÉ TUTOR: DRA. CLAUDIA E. MORENO ORTEGA
CENTRO DE INVESTIGACIONES BIOLÓGICAS, UAEH

CIUDAD UNIVERSITARIA, CD. MX. 2022

COORDINACIÓN DEL POSGRADO EN CIENCIAS BIOLÓGICAS

INSTITUTO DE BIOLOGÍA

OFICIO CPCB/764/2022

ASUNTO: Oficio de Jurado

M. en C. Ivonne Ramírez Wence
Directora General de Administración Escolar, UNAM
Presente

Me permito informar a usted que en la reunión ordinaria del Comité Académico del Posgrado en Ciencias Biológicas, celebrada el día **6 de junio de 2022** se aprobó el siguiente jurado para el examen de grado de **DOCTOR EN CIENCIAS** del estudiante **CANCINO LÓPEZ RODOLFO JONATHAN** con número de cuenta **515015421** con la tesis titulada **"DIVERSIDAD DEL ORDEN NEUROPTERA EN UN GRADIENTE ALTITUDINAL EN EL VOLCÁN TACANÁ, CHIAPAS",** realizada bajo la dirección del **DR. ATILANO CONTRERAS RAMOS,** quedando integrado de la siguiente manera:

Presidente: DR. HARRY URAD BRAILOVSKY Y ALPEROWITZ
Vocal: DRA. ROSA GABRIELA CASTAÑO MENESES
Vocal: DR. FRANCISCO ARMENDÁRIZ TOLEDANO
Vocal: DRA. NANCY CALDERÓN CORTÉS
Secretario: DRA. CLAUDIA ELIZABETH MORENO ORTEGA

Sin otro particular, me es grato enviarle un cordial saludo.

ATENTAMENTE
"POR MI RAZA HABLARÁ EL ESPÍRITU"
Ciudad Universitaria, Cd. Mx., a 24 de agosto de 2022

COORDINADOR DEL PROGRAMA

DR. ADOLFO GERARDO NAVARRO SIGÜENZA

AGRADECIMIENTOS

Al posgrado en Ciencias biológicas de la UNAM y al Instituto de Biología, por las facilitaciones académicas y administrativas para mi formación académica.

Al Consejo Nacional de Ciencia y Tecnología, CONACYT por la beca de manutención otorgada durante mis estudios de doctorado y por el apoyo recibido a través del proyecto “Biodiversidad de Neuroptera en México: un enfoque taxonómico integrativo” (CONACYT CB2017-2018, A1-S-32693).

A la Universidad Nacional Autónoma de México, por el apoyo recibido a través del Programa de Apoyo a Proyectos de Investigación e Innovación Tecnológica (PAPIIT-UNAM) a través del proyecto IN207517 “Aportaciones a la taxonomía y filogenia del orden Neuroptera (Insecta) en México” y del proyecto IN209721 “Biodiversidad de grupos selectos de Neuropteroidea de la Península de Baja California.”

A mi tutor principal Dr. Atilano Contreras Ramos por el apoyo y guía durante el desarrollo del proyecto de doctorado.

A los miembros de mi comité tutor: A los Dres. Santiago Zaragoza Caballero y Claudia E. Moreno Ortega por su asesoría semestral para el buen desarrollo de este proyecto.

AGRADECIMIENTOS A TÍTULO PERSONAL

A la Universidad Nacional Autónoma de México, por permitirme desarrollar mis estudios de posgrado y crecer como profesional.

Al Dr. Atilano Contreras Ramos, por todo el apoyo brindado durante todo el proceso y desarrollo de este proyecto de investigación, por cada una de sus palabras y consejos para formarme como un investigador de alta calidad.

A los miembros del Jurado: Dr. Harry Urad Brailovsky Alperowitz, Dra. Rosa Gabriela Castaño Meneses, Dr. Francisco Armendáriz Toledano y Dra. Nancy Calderón Cortés por cada uno de sus atinados comentarios para mejorar y enriquecer el contenido del escrito de la tesis.

A las colecciones científicas: Colección de Insectos asociados a plantas cultivadas en la Frontera Sur (ECO-TAP-E), Florida State Collection of Arthropods, Gainesville (FSCA), y el National Museum of Natural History, Smithsonian Institution (USNM), por permitirme estudiar los especímenes de sus respectivas colecciones.

Agradecimientos al Dr. John D. Oswald, Texas A & M University, por la Lacewing Digital Library, que fue un recurso importante e invaluable en la obtención de bibliografía para este proyecto de investigación.

Especial agradecimiento a Dr. Lionel Stange (FSCA), Dr. Felipe Soto-Adames(FSCA), M. en C. Julieta Brambila (FSCA), Dr. Torsten Dikow (USNM) y M. en C. Eduardo R. Chamé V. (ECO-TAP-E) por el apoyo brindado y facilitación de material para la identificación durante las estancias en dichas colecciones.

También un especial agradecimiento a Benigno Gómez (ECOSUR-San Cristóbal), a la Reserva de la Biósfera Volcán Tacaná (Francisco J. Jiménez González, director), así como a la gente de la Finca Alianza, Finca Monte perla, Ejido El Águila, Ejido Benito Juárez El Plan, y Cantón Chiquihuites y de los Paradores Papales y La Cabaña, por la autorización del trabajo de campo.

A los Dres. Fernando Acevedo Ramos, Andrés Ramírez Ponce, David Bowles por sus valiosos comentarios y apoyo para el desarrollo de diferentes aspectos del proyecto.

A la M. en C. Cristina Mayorga por todo el apoyo otorgado durante mi estancia en la Colección Nacional de Insectos, su ayuda fue de vital importancia.

A la Biol. Susana Guzmán Gómez, responsable del Laboratorio de Microscopía y Fotografía de la Biodiversidad (II) por su asesoría y apoyo en la obtención de las fotografías del material biológico.

Al posgrado de Ciencias Biológicas de la UNAM, y particularmente a Rocío González, auxiliar de posgrado en el Instituto de Biología y al Dr. Armando Rodríguez, por su apoyo donde diferentes procesos y trámites.

Al Biol. Manuel Martínez Meléndez por el apoyo de la determinación genérica de algunos especímenes de plantas muestreados en este proyecto.

A la M. en C. Hellen Martínez Roldán por el apoyo brindado en trabajo de campo y el diseño de los mapas del sitio de muestreo utilizados en este proyecto.

Muchas gracias a la M. en C. Magali Luna, M. en C. Yesenia Marquez, Dra. Viridiana Vega, Dr. Caleb C. Martins, Dra. Dulce Hernández, Lic. Antonio López Digueros y Pasante de Biólogo Johar Almaraz por todo el apoyo brindado durante el desarrollo de mi proyecto de investigación, como al brindarme su amistad incondicional.

A mis compañeros del Instituto de Biología que de una u otra forma me han brindado su apoyo y amistad en el transcurso de este proyecto: Biol. Adrian Jacome, M. en C. Edwin Domínguez, M. en C. Uriel Garduño, Biol. Mireya González, Biol. Celeste Martínez y Pasante de Biólogo Mariana de la Cruz

A toda mi familia. A mis padres, Rosario y Pedro, por todo su amor y apoyo incondicional, a quienes les debo la persona que soy hoy. A mis hermanos, Jonas, Ivan y Nayeli, porque siempre me han demostrado su apoyo y siempre están animándome a dar lo mejor de mí. Y a mi abuela Socorro, que es mi corazón y siempre a creído en mí.

DEDICATORIA

A mi tía Gladis Esperanza López Trujillo, que a pesar de ya no estar con nosotros, siempre estará en mi mente y corazón brindándome su apoyo incondicional. Gracias por siempre creer en mí y brindarme tu amor.

"No es prudente estar demasiado seguro de la propia sabiduría. Es saludable recordar que el más fuerte puede debilitarse y el sabio, equivocarse"
Gandhi

ÍNDICE

RESUMEN

Neuroptera es un grupo de insectos holometábolos relativamente primitivos y con baja diversidad en comparación con otros grupos. A pesar de esto, presentan una amplia variación en historias de vida y morfología, incluyendo algunas familias con alto potencial en el control biológico de plagas. Aunque existen estudios enfocados en sistemática del grupo y en aspectos relacionados con el control biológico de plagas, aún faltan trabajos sobre los patrones de distribución y diversidad de los neurópteros. Este proyecto analizó los diferentes patrones de diversidad en un gradiente altitudinal; así como explorar los posibles efectos de la altitud sobre la distribución de la fauna de neurópteros del Volcán Tacaná, Chiapas, México. Para lo cual se realizó primero una recopilación e interpretación de la información previa enfocada en el estudio de la diversidad de neurópteros y los factores que pueden estar afectando su presencia y diversidad, así como los diferentes métodos de muestreo y análisis utilizados. También se proporcionó una lista actualizada y clave de identificación genérica de la fauna de Neuroptera del volcán Tacaná y se exploraron los posibles patrones de distribución altitudinal y biogeográficos de las especies, incrementando el rango de distribución de las especies de Neuroptera. Para finalmente, estimar el número potencial de especies a nivel local y regional, analizar la diversidad alfa a lo largo del gradiente altitudinal, así como evaluar la diversidad beta y sus componentes (recambio y anidamiento) tanto de especies como de taxones superiores. Como resultados, se registró un escaso número de investigaciones enfocadas al estudio de patrones de diversidad y cambios en la composición de las comunidades. Además, se concluye que es requerido planificar el diseño experimental enfocado en las preguntas de investigación y el grupo de estudio, lo que generaría un análisis e interpretación preciso de la diversidad. Entre los posibles factores que pueden influir en la diversidad se encuentran la fisonomía y estructura vegetal de los sitios y el tipo de vegetación, aunque no se descartó el estudio de factores ambientales que puedan afectar la presencia de las especies. Por tanto, un factor interesante a estudiar es la altitud, que puede funcionar como modelo para analizar cómo cambian los factores ambientales que afectan la diversidad de Neuroptera. Los resultados sobre la diversidad de Neuroptera en el volcán Tacaná, a lo largo de un gradiente altitudinal, aumentó la fauna conocida de este orden para México, con 31 registros nuevos de especies y dos géneros: *Biramus* Oswald, 1993 (Hemerobiidae) y *Titanochrysa* Sosa & Freitas, 2012 (Chrysopidae), con la extensión del rango de distribución para 25 especies pertenecientes a cinco familias. La mayoría de los nuevos registros para el país provienen de especies previamente citadas en Centro y Sudamérica. La fauna de Neuroptera de Chiapas se actualiza de 91 a 147 especies. Los neurópteros del volcán Tacaná son principalmente neotropicales, con algunos taxones de afinidad neártica restringidos a elevaciones medias y altas. Más del 80% de las especies de neurópteros del volcán se distribuyen en la subregión Brasileña, especialmente en los dominios Mesoamericano y Pacífico. Se registraron especies de neurópteros desde los 650 hasta más de 3500 m s.n.m. Con la mayor riqueza de especies entre 600 y 1700 m. La diversidad alfa se analizó con un enfoque en la diversidad taxonómica y la diversidad filogenética, así como el análisis de la diversidad beta a través de sus dos componentes: recambio de especies y anidamiento. La riqueza de especies declinó con la altitud; la abundancia y la diversidad no tuvieron un patrón claro, aunque la diversidad disminuyó en altitudes superiores a los 3.000 msnm. Los cambios en la composición de especies y taxones supraespecíficos a lo largo del gradiente altitudinal se explicaron por el recambio de especies, aumentando la disimilitud a medida que aumenta la altitud. En conclusión, las tendencias de riqueza, abundancia y diversidad de las comunidades de neurópteros en un gradiente de altitud fueron heterogéneas. Estos resultados brindan una idea general de cómo la altitud puede ser relevante para los cambios en la composición, diversidad y distribución de estos insectos a nivel espacial. Debido a que la diversidad y distribución de los neurópteros están fuertemente influenciadas por los cambios en los factores ambientales (posiblemente la temperatura y composición vegetal), relaciones bióticas (relación con otros neurópteros/insectos y sus presas), la historia de vida de los linajes (adaptaciones y mecanismos de supervivencia) y sus afinidades biogeográficas (Neotropicales o Neárticas), lo que representa una oportunidad para realizar estudios específicos enfocados en análisis biogeográficos, evolutivos y ecológicos.

ABSTRACT

Neuroptera is a group of relatively primitive holometabolous insects with low diversity compared to other groups. Despite this, they present a wide variation in life histories and morphology, including some families with high potential for biological pest control. Although there are studies focused on the systematics of the group and on aspects related to the biological control of pests, there is still a lack of knowledge on the distribution and diversity patterns of Neuroptera. This project analyzed the different tendencies of diversity in an altitude gradient and explored the possible effects of altitude on the distribution of the Neuroptera fauna of the Tacaná Volcano, Chiapas, Mexico. A compilation and interpretation of the previous information focused on the study of the diversity of Neuroptera and the factors that may be affecting their presence and diversity, as well as the different sampling and analysis methods used, were first carried out. An updated checklist and identification key of the Neuroptera fauna of the Tacaná volcano were also provided. The possible altitude and biogeographic distribution patterns of the species were explored, increasing the distribution range of the Neuroptera species. Finally, the potential number of species at the local and regional level were estimated, the alpha diversity along the altitudinal gradient was analyzed, and the beta diversity and its components (replacement and nesting) of both species and higher taxa were evaluated. As a result, a small number of investigations focused on diversity patterns and changes in the composition of the communities were registered. In addition, it is concluded that it is necessary to plan the experimental design focused on the research questions and the study group, which would generate an accurate analysis and interpretation of diversity. Among the possible factors that can influence diversity are the physiognomy and vegetal structure of the sites and the type of vegetation. Although, the study of environmental factors that could affect the presence of the species was not ruled out. Therefore, an interesting factor to study is altitude, which can work as a model to analyze how environmental factors that affect the diversity of Neuroptera change. The results on Neuroptera diversity in the Tacaná volcano, along an altitudinal gradient, increased the known fauna of this order for Mexico in 31 species and two genera: *Biramus* Oswald, 1993 (Hemerobiidae) and *Titanochrysa* Sosa

& Freitas, 2012. (Chrysopidae), with an extension of the known distribution range of 25 species in five families. Many new records for the country come from species previously reported in Central and South America. The Neuroptera fauna of Chiapas is updated from 91 to 147 species. Neuroptera from the Tacaná volcano is mainly Neotropical, with some taxa of Nearctic affinity restricted to middle and high elevations. More than 80% of the species of the volcano are distributed in the Brazilian subregion, especially in the Mesoamerican and Pacific domains. Neuropterans species were recorded from 650 to more than 3500 m a.s.l., with the highest species richness between 600 and 1700 m. Alpha diversity was analyzed with a focus on taxonomic diversity and phylogenetic diversity, as well as an analysis of beta diversity through its two components: species turnover and nesting. Species richness declined with altitude; abundance and diversity did not have a clear pattern, although diversity decreased at altitudes above 3,000 m a.s.l. Changes in the composition of species and supraspecific taxa along the altitudinal gradient were explained by species turnover, with dissimilarity increasing as altitude increases. Finally, trends of richness, abundance, and diversity of Neuropteran communities in an altitude gradient were heterogeneous. These results provide a general idea of how altitude may be relevant to changes in the composition, diversity, and distribution of these insects at a spatial level. In conclusion, the diversity and distribution of Neuroptera are strongly influenced by changes in environmental factors (possibly temperature and plant composition), biotic relationships (relationship with other Neuroptera/insects and their prey), life history of lineages (adaptations and survival mechanisms), and their biogeographical affinities (Neotropical or Nearctic), which represents an opportunity to carry out specific studies focused on biogeographical, evolutionary and ecological analyses.

1.- INTRODUCCIÓN GENERAL

Los estudios enfocados en inventarios taxonómicos en diferentes grupos de insectos han sido frecuentes en México, pero generalmente centrados en ciertos órdenes o familias y no siempre al nivel de especie. Todo esto lleva a tratar de entender las causas de la alta diversidad en regiones heterogéneas con amplia historia en sus biotas, variedad de ecosistemas y alta proporción en endemismos, como es el caso particular de México. Estos dos componentes de la biodiversidad (alfa y beta) se han estudiado en México, enfocándose en diferentes grupos biológicos (plantas, animales, entre otros), principalmente a nivel espacial (latitudinal/altitudinal), tanto en ambientes naturales como en agroecosistemas (Martínez-Sánchez *et al*., 2009; Cutz-Pool *et al*., 2010; Gillete *et al*., 2015; Pérez-Domínguez *et al*., 2015; Sánchez-Reyes *et al*., 2016). En este sentido, son relativamente escasos los estudios sobre diversidad beta, los cuales se han realizado generalmente en grupos mejor conocidos, como Lepidoptera y Coleoptera (Chamé-Vazquez *et al*., 2007; Monteagudo-Sabaté y Luis-Martinez, 2013; Pérez-Hernández y Zaragoza-Caballero, 2015). Igualmente, en trabajos sobre diversidad en un gradiente altitudinal, es aparente el desarrollo de enfoques desde descriptivos (Sánchez-Ramos *et al*., 1993) a analíticos (García-Gómez *et al*., 2011; Pérez-Domínguez *et al*., 2015; Perillo *et al*., 2017), con varios trabajos de tesis sin publicar.

El conocimiento actual del orden Neuroptera en México es fragmentado; existen pocos trabajos sobre taxonomía, sistemática, diversidad, distribución y aspectos ecológicos de las diferentes familias. Además, los trabajos están enfocados en pocas familias como Chrysopidae, Hemerobiidae y Mantispidae (Valencia-Luna *et al*., 2006; Pacheco-Rueda *et al*., 2011; Reynoso-Velasco y Contreras-Ramos, 2009, Cancino *et al*., 2015, entre otros), con trabajos realizados por investigadores extranjeros enfocados en la taxonomía de las diferentes familias (Henry *et al*., 1992; Stange, 1994; Penny, 2002; Oswald *et al*., 2002).

Los trabajos enfocados en Neuroptera en México, no se han desarrollado con análisis sobre la diversidad alfa y beta y mucho menos en estudios en un gradiente altitudinal; existen algunos trabajos en Europa, los cuales son generales y sin análisis de diversidad alfa y beta (Marín y Monserrat, 1987; Marín, 1994; Duelli *et al*., 2002), y recientemente se han comenzado a analizar la diversidad y los posibles factores que la modifican en diferentes estudios en Asia (Bozdogan, 2020a; 2020b; Lai *et al*., 2021). Por tanto, este estudio enfocado en el estudio de la diversidad del orden Neuroptera en un gradiente altitudinal, el cual representa el primer trabajo de este tipo para el grupo en México y en la región neotropical.

Al ser México un país megadiverso (Mittermeier y Goettsch, 1992), ofrece múltiples oportunidades para describir y tratar de entender cómo se organiza la diversidad biológica espacial y temporalmente. Debido a esto, la relevancia de conocer la diversidad de neurópteros en México, así como entender la sistemática y taxonomía del grupo y explorar los patrones de distribución y de diversidad alfa y beta, a nivel altitudinal. Todo esto para entender a nivel específico que efectos tiene la altitud y otros factores en su presencia, por lo que este trabajo pretende ser una investigación integral que involucre de manera profunda la taxonomía de las especies del orden Neuroptera pero también conocer aspectos ecológicos y posibles patrones de distribución y diversidad.

Con este estudio se pretende aportar a la taxonomía del grupo, así como realizar un primer acercamiento a su diversidad y distribución a lo largo de un gradiente altitudinal en la Reserva de la Biosfera Volcán Tacaná. Este es un sitio que forma parte del área montañosa denominada Núcleo Centroamericano, que conforma parte del Corredor Biológico Mesoamericano, confiriéndole una alta riqueza biológica, consecuencia del ensamblaje de biotas de origen neártico y neotropical (CONANP, 2013). Lo anterior genera un alto potencial de endemismos y posibles especies nuevas para la ciencia. Además, esta reserva de la biosfera es considerada una región prioritaria terrestre para la conservación, la cual es un sitio donde se permite la apertura a estudios relacionados con la biodiversidad, y que brinda un amplio espectro de ambientes y características que son potenciales para utilizar esta zona como modelo para dicho estudio. Esto genera la necesidad de entender su diversidad y llenar los vacíos en su estado de conservación. Por tanto, la pregunta de investigación general de este proyecto es: ¿Qué cambios existen en la diversidad y distribución de las comunidades de neurópteros a lo largo de un gradiente altitudinal en el Volcán Tacaná, Chiapas, México?. La importancia del proyecto radica en la generación de información nueva mediante el registro de especies, la descripción de nuevos taxa, la interpretación de posibles patrones de distribución altitudinal (diversidad alfa y beta), y otros aspectos ecológicos de las diferentes familias del orden Neuroptera.

Este proyecto de investigación se dividió en tres aristas principales (capítulos), la primera enfocada en conocer los antecedentes y estudios previos enfocados en el análisis de la diversidad alfa y beta de los neurópteros a nivel mundial, para entender los enfoques que se han implementado y los factores que afectan a los posibles patrones de distribución y diversidad. El segundo capítulo se centra en conocer la composición de especies del Volcán Tacaná y cómo se distribuyen a lo largo del gradiente altitudinal, caracterizando la fauna en cada una de los niveles de elevación y conociendo sus posibles afinidades altitudinales y biogeográficas. Finalmente, el capítulo 3 tiene como objetivo entender el patrón de diversidad de las comunidades de Neuroptera a lo largo de un gradiente altitudinal, evaluando tanto el componente de diversidad alfa como diversidad beta, utilizando diferentes enfoques como son la diversidad taxonómica y la diversidad filogenética, además de conocer y determinar los componentes de la diversidad beta (recambio y anidamiento) que mejor explican los valores de disimilitud en las comunidades a lo largo del gradiente altitudinal. Todo esto conllevando a entender de manera global los posibles patrones de distribución y diversidad en un gradiente de elevación en las comunidades de neurópteros en una montaña del sureste de México en la región Neotropical.

2.- MARCO TEÓRICO GENERAL

2.1. Neuroptera

Es un orden primitivo de insectos holometábolos con relativamente pocas especies; pertenece al Superorden Neuropterida, un taxón monofilético que comprende además a los órdenes Raphidioptera y Megaloptera (Kristensen, 1991; Winterton *et al*., 2010). Es uno de los grupos de insectos con metamorfosis completa (Endopterygota) más antiguos, su origen data del Pérmico (hace 276 millones de años aproximadamente; Grimaldi y Engel, 2005; Misof *et al*., 2014).

Estos insectos se caracterizan por poseer dos pares de amplias alas membranosas, con una compleja venación reticulada (Fig. 1) y sus larvas presentan como sinapomorfía la modificación de las mandíbulas y maxilas en una estructura succionadora (Winterton y Makarkin, 2010; Winterton *et al*., 2010). Debido a la radiación que experimentaron, presentan una amplia heterogeneidad morfológica y variedad de modos de vida, especialmente en el estado larval.

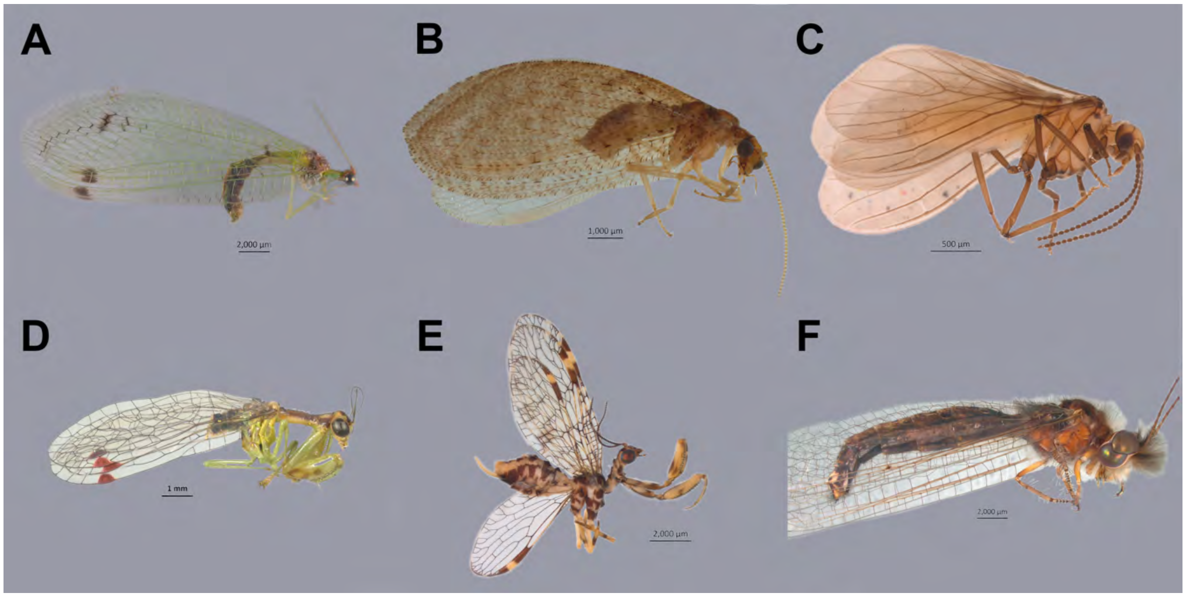


Figura 1. Ejemplos de diferentes familias de Neuroptera, donde se muestra la venación y heterogeneidad morfológica en adultos. A) *Leucochrysa pretiosa* (Chrysopidae), B) *Hemerobius discretus* (Hemerobiidae), C) *Coniopteryx latipalpis* (Coniopterigydae), D) *Nolima infensa* (Mantispidae), E) *Trichoscelia santareni* (Rachiberothidae), F) *Ameropterus trivialis* (Myrmeleontidae). Fotos: Rodolfo J. Cancino López.

Son insectos cosmopolitas, que ocupan una amplia variedad de hábitats, tanto tropicales como templados. Algunos adultos pueden alimentarse de estructuras vegetales, pero la mayoría de ellos, y todas las larvas, son depredadores; estos hábitos hacen que varias familias, como Chrysopidae, Hemerobiidae y Coniopterygidae, sean potenciales controladores biológicos de plagas (Tauber *et al*., 2009; Monserrat, 2016).

El orden está representado mundialmente por 6,000 especies distribuidas en 15 familias, y en México se encuentran registradas aproximadamente 392 especies pertenecientes a 10 familias (Contreras-Ramos y Rosas, 2014, Oswald, 2018, Oswald y Machado, 2018; Cancino *et al*., 2021), lo que representa el 6.6 % de la fauna mundial. Este orden está representado por las familias: Myrmeleontidae (135 spp.), Chrysopidae (117 spp.), Hemerobiidae (56 spp.), Coniopterygidae (47 spp.), Rachiberothidae (15 spp.), Mantispidae (12 spp.), Sisyridae (4 spp.), Berothidae (3 spp.), Ithonidae (2 spp.) y Dilaridae (1 sp.) (Oswald *et al.*, 2002; Penny, 2002; Reynoso-Velasco y Contreras-Ramos, 2009; Oswald, 2018, Oswald y Machado, 2018; Marquez-López y Contreras-Ramos, 2019; Ardila-Camacho *et al*. 2019; Cancino-López y Contreras-Ramos, 2019; Sarmiento-Cordero y Contreras-Ramos, 2019; Cancino *et al*., 2021).

2.2. Taxonomía de Neuroptera de México

En cuanto al conocimiento taxonómico, se han realizado revisiones taxonómicas, monografías y descripciones de especies desde la época de Linneo hasta la actualidad. Esto ha llevado a una constante actualización de la posición taxonómica de varias familias, aumentando o disminuyendo el número de especies presentes en cada una de ellas. La sistemática del orden también ha cambiado a lo largo de los años, desde la inclusión y exclusión de Ephemeroptera y Odonata dentro del orden, hasta los estudios de sistemática molecular más recientes que trabajan sobre las relaciones filogenéticas entre las diferentes familias (Linnaeus, 1758; Adams, 1958; New, 1991; Aspöck, 1992; Aspöck, 1999; Aspöck *et al*., 2001; Garzón-Orduña *et al*., 2016; Oswald y Machado, 2018; Machado *et al*., 2018; Winterton *et al*., 2018).

Dentro de las familias que conforman al orden, solo 10 se encuentra registradas actualmente en México. Estas presentan características morfológicas que las distinguen, principalmente, respecto a características de venación alar y la forma del cuerpo.

La familia Myrmeleontidae, es la familia más diversas en México hasta el momento, que se caracteriza por contar con individuos de tamaño mediano a grande (longitud ala anterior de 10 a >70 mm), la forma del cuerpo del adulto presenta abdomen y alas alargadas, con algunas especies generalmente robustas, presentan antenas que pueden ser largas o relativamente cortas (con forma clavada) (Oswald y Machado, 2018). Esta familia asemeja su forma a la de odonatos, a diferencia del resto de familias presentes en México. En términos generales, la estructura terminal y genital de los machos de esta familia presenta: Tergito IX cercanamente asociado con el ectoprocto o puede ser pequeño; ectoprocto simple o con diversas ornamentaciones, algunas veces fuertemente extendido ventralmente; espiráculo VIII en membrana pleural, esternito IX pequeño y simple, usualmente redondeado o raramente alargado y bifurcado; gonarco arqueado o alargado; mediuncus presente, usualmente corto; par de fuertes parameros o pequeños y laterales enganchados al ápice del gonarco; en algunos casos con presencia de pelta medial ventral, con lóbulos membranosos setosos laterales basales (pulvini), hipandrio interno pequeño, usualmente indistinguible (New, 1989). La identificación precisa de las especies en esta familia se complica por la armadura genital masculina relativamente uniforme, el frecuente dimorfismo sexual y la considerable variación intraespecífica en el patrón de las alas (Penny, 2002). Para México se registra, actualmente, un total de 135 especies, 29 géneros, 7 tribus y 4 subfamilias (Ascalaphinae, Dendroleontinae, Myrmeleontinae, Nemoleontinae). En México, el mayor número de taxa se encuentra en los géneros *Scotoleon* (18), *Eremoleon* (17), *Brachynemurus* (13), *Purenleon* (12), *Myrmeleon* (11) y *Ululodes* (8). Para la identificación taxonómica de la fauna de México pueden utilizarse la siguiente literatura: Miller y Stange, 1989; 2009; 2014; 2016; Penny, 1981; Stange, 1963; 1970; 1999; 2008; Van der Weele, 1909.

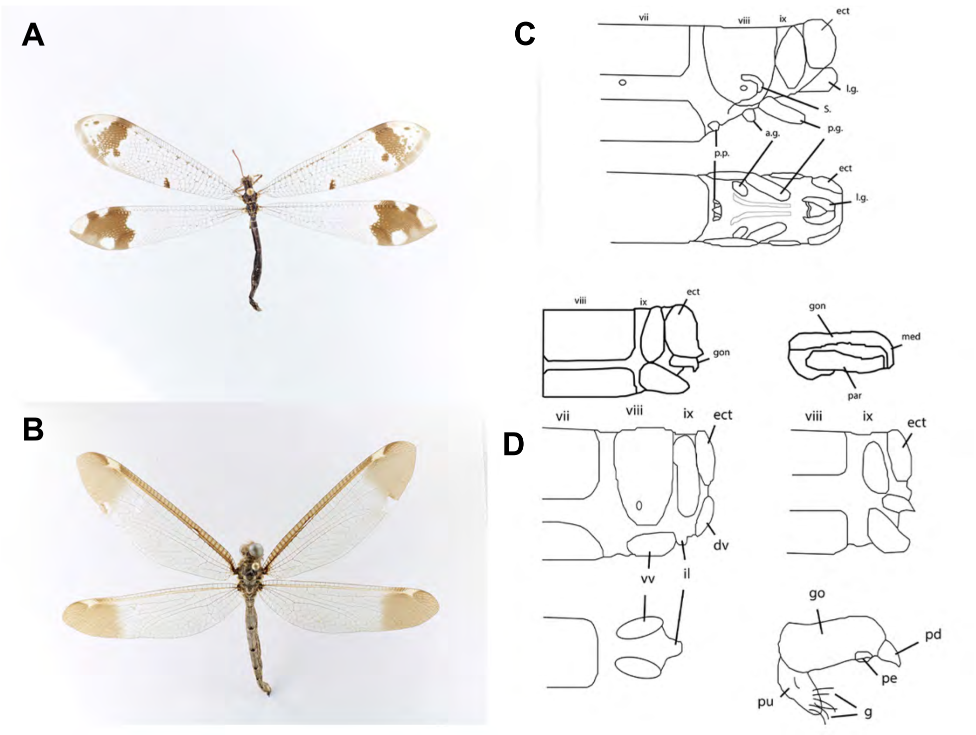


Figura 2. Representantes de la familia Myrmeleontidae y esquemas generales de la terminalia del abdomen y estructura genital redibujados de New, 1984; 1985. Fotos: Yesenia Marquez López. A) *Glenurus proi* Navás, B) *Ascalobyas microcerus* Rambur, C) Dibujos de la parte apical del abdomen y la estructura genital de la subfamilia Myrmeleontinae (ect: ectoprocto, I.g.: gonapófisis lateral, p.g.: gonapófisis posterior, a.g.: gonapófisis anterior, p.p.: placa pregenital, S: espermateca, gon: gonarco, med: mediunco, par: parameros), D) Dibujos de la parte apical del abdomen y la estructura genital de la subfamilia Ascalaphinae (ect: ectoprocto, dv: distivalva, vv: ventrovalva, li: linguella, go: gonarco, pa: paramero, pe: pelta, pv: pulvinus, g: gonosedas).

La familia Chrysopidae es la segunda familia más diversa en México, los individuos adultos de esta familia son de tamaño pequeño a mediano (longitud ala anterior de 6 a 35 mm), con ojos grandes, iridiscentes, con antenas largas y filiformes, a veces mucho más largas que el cuerpo, con el cuerpo alargado, con dos pares de alas membranosas lanceoladas, en algunos casos con marcas evidentes sobre estas, de coloración general predominantemente verde, pero en ocasiones con coloraciones marrones o rojizas (Albuquerque *et al*., 2012). En términos generales, la estructura terminal y genital de los machos de esta familia presenta: Tergito IX diferentes (en algunos casos) o fusionado con el ectoprocto, comúnmente con un marcado apodema y/o angosto antero-ventralmente; espiráculo VIII en membrana pleural; esternito VIII sin modificación o en algunos casos fusionado con el esternito IX para formar un esternito compuesto VIII+IX, frecuentemente con apodema lateral; genitalia compleja y variable; gonarco arqueado o transverso; con subrectal transverso o tignum arqueado algunas veces por arriba del gonarco; entoprocesos ausentes o presentes, arcesus ausente o presente; pseudopene ausente o presente; algunas veces con un par de alargados parameros; tignum, gonarco y pseudopene en un saco eversible (gonosaco), el cual a veces es setoso; gonapsis ausente o presente, en una membrana dorsal de esternito VIII+IX; hipandrio interno pequeño, triangular y usualmente quillado (New, 1989). La identificación precisa de las especies en esta familia, se relaciona con un estudio exhaustivo de la genitalia de los machos, principalmente, tanto a nivel genérico como específico (Brooks y Barnard, 1990), aunque en muchos casos se tiene aún desconocimiento de la genitalia de las hembras para la determinación específica. Para México se reporta, actualmente, un total de 117 especies, 18 géneros, 4 tribus y 3 subfamilias (Apochrysinae, Chrysopinae, Nothochrysinae). En México, con el mayor número de taxa en los géneros *Leucochrysa* (33), *Ceraeochrysa* (19), *Meleoma* (19), *Chrysopa* (11), *Chrysoperla* (8) y *Eremochrysa* (7). Para la identificación taxonómica de la fauna de México pueden revisarse la siguiente literatura: Alayo, 1968; Brooks y Barnard, 1990; Brooks, 1994; de Freitas y Penny, 2001; de Freitas *et al*., 2009; Penny, 2002; Sosa y Tauber, 2021; Tauber, 1969; 2010; Tauber *et al*., 2008; 2012a; 2012b; 2013; 2017; 2018.

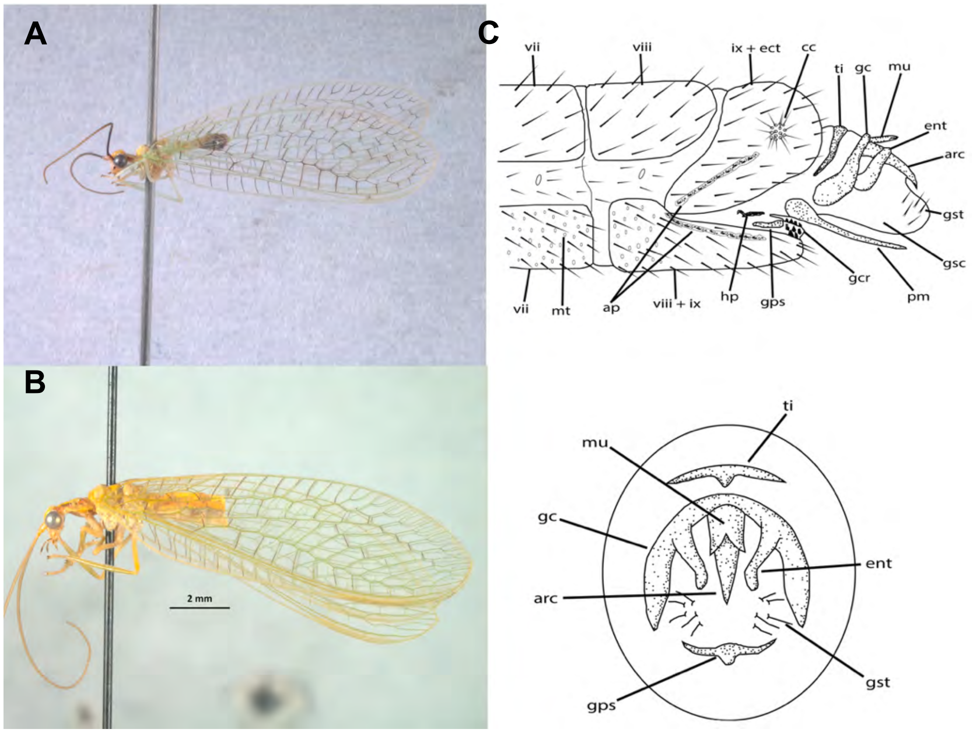


Figura 3. Representantes de la familia Chrysopidae y esquemas generales de la estructura genital redibujados de Brooks y Barnard, 1990. Fotos: Rodolfo J. Cancino López. A) *Ceraeochrysa effusa* Navás, B) *Plesiochrysa brasiliensis* Schneider, C) Dibujos de la parte apical del abdomen y la estructura genital de Chrysopidae (ap: apodemas, arc: arceso, cc: callo cercal, ect: ectoprocto, ent: entoprocesos, gc: gonarco, gcr: gonocristales, gps: gonapsis, gsc: gonosaco, gst: gonosedas, hp: hipandrio interno, mt: microtoli, mu: placa medial, pm: parameros, ti: tignum).

La familia Hemerobiidae se caracteriza por presentar individuos de tamaño pequeño a mediano (longitud del ala anterior de 3 a 18 mm), con ojos grandes, negros o cobrizos, con antenas delgadas y moniliformes, con dos pares de alas membranosas usualmente más redondeadas y cubiertas de tricosoros, presencia de múltiples sectores de la vena radial, de coloración general predominantemente marrón pero en ocasiones de colores pálidos o verdes (Monserrat, 2015). En términos generales, la estructura terminal y genital de los machos de esta familia presenta: tergitos y esternitos usualmente definidos, callo cercal y tricobotria presente. Tergitos posteriores, ocasionalmente con lóbulos posteriores dorsales; espiráculo VIII en membrana pleural (con algunas excepciones en los tergitos); tergito IX algunas veces fusionados con el ectoprocto, ocasionalmente con procesos laterales largos; esternito IX corto y simple; ectoprocto, frecuentemente alargado distalmente, algunas veces con procesos ventrales largos (frecuentemente con espinas o sedas adelgazadas); gonarco transverso, arcesus distintivo; entoprocesos algunas veces presentes; parameros simples, libres o fusionados; superprocesos presentes o ausentes; hipandrio interno pequeño (New, 1989). La identificación precisa de las especies en esta familia, se relaciona con un estudio exhaustivo de la venación alar y de la genitalia de los machos, principalmente, tanto a nivel genérico como específico (Oswald, 1993); al igual que en Chrysopidae existen casos de un desconocimiento de la genitalia de las hembras para la determinación específica. Existe un conocimiento fragmentado de la taxonomía y distribución de las especies, con muchos géneros con carencia de revisiones taxonómicas, esto muchas ocasiones puede llevar a errores en la determinación a especie (Monserrat, 2015). Para México se registran, actualmente, un total de 56 especies, 9 géneros y 5 subfamilias (Hemerobiinae, Megalominae, Microminae, Notiobiellinae y Sympherobiinae). En México, con el mayor número de taxa está en los géneros *Hemerobius* (19) y *Sympherobius* (15). Para la identificación taxonómica de la fauna de México puede revisarse la siguiente literatura: Klimaszewski y Kevan, 1988; Marquez-López y Contreras-Ramos, 2019; Monserrat, 1984; 1996; 1997; 2000; Monserrat y Penny, 1983; Oswald, 1988; 2004; Sosa *et al*., 2015.

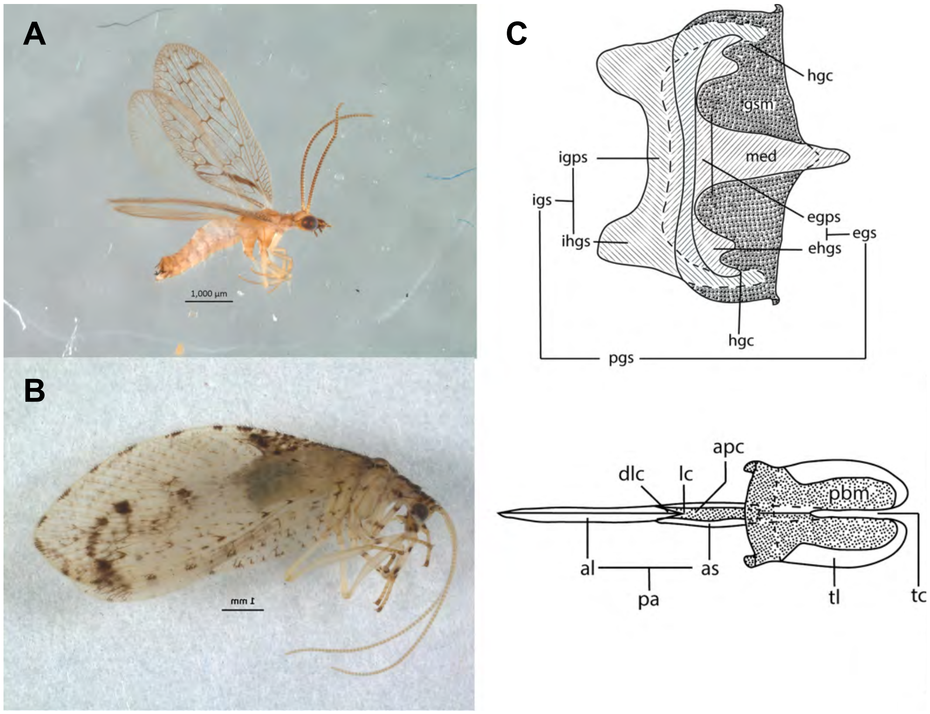


Figura 4. Representantes de la familia Hemerobiidae y esquemas generales de la estructura genital redibujados de Oswald, 1993. Fotos: Rodolfo J. Cancino López. A) *Sympherobius similis* Carpenter, B) *Nusalala championi* Kimmins, C) Dibujos de la estructura genital de Hemerobiidae (al: lámina apofisaria, apc: cavidad apofisaria, as: eje apofisario, dlc: cúspide dorsolamelar, egps: extragonopons, egs: extragonarco, ehgs: extrahemigonarco, gsm: membrana gonosacal, hgc: conjunción hemigonarcal, igps: intragonopons, igs: intragonarco, ihgs: intrahemigonarco, lc: conjución lamelar, med: mediunco, pa: apófisis parabacular, pbm: membrana parabacular, pgs: paleogonarco, tc: cúspide terminal, tl: lóbulo terminal).

La familia Coniopterygidae se caracteriza por presentar individuos pequeños (longitud del ala anterior raramente mayor de 5 mm), con venación reducida; cuerpo, alas y patas frecuentemente cubiertos con un polvo blanquecino/grisáceo que es secretado por glándulas de cera hipodérmicas en los esternitos y tergitos del abdomen y se distribuyen por todo el cuerpo a través de las patas traseras (New, 1989; Tauber *et al*., 2009). En términos generales, la estructura terminal y genital de los machos de esta familia presenta: Tergito IX y esternito IX fusionado en un anillo bien esclerotizado; hipandrio usualmente incorporado (fusión de coxopoditos IX); estilo casi siempre presente; gonarco usualmente no distintivo; esternito X usualmente presente (como simple placa o más complejo); parámeros alargados; pene verdadero presente, formado por mesómeros y parámeros (en algunos casos); segmento XI poco evidente; sin tricobotria o callo cercal (New, 1989). La identificación de las diferentes especies de esta familia en general requiere la revisión de los genitalia masculinos. En hembras, la determinación es mucho más difícil para muchas especies debido a la débil esclerotización de las estructuras de los genitales femeninos en muchas especies (Meinander, 2002). En México se conocen, actualmente, un total de 47 especies, 7 géneros, y 2 subfamilias (Aleuropteryginae y Coniopteryginae). El mayor número de taxones se encuentra en dos géneros *Coniopteryx* (18) y *Semidalis* (15). Para la identificación taxonómica de la fauna de México puede ser revisada la siguiente literatura: Meinander, 1972; 1974; 1975; 1995; Meinander y Penny, 1982; Sarmiento-Cordero y Contreras-Ramos, 2019; Sziráki, 2011.

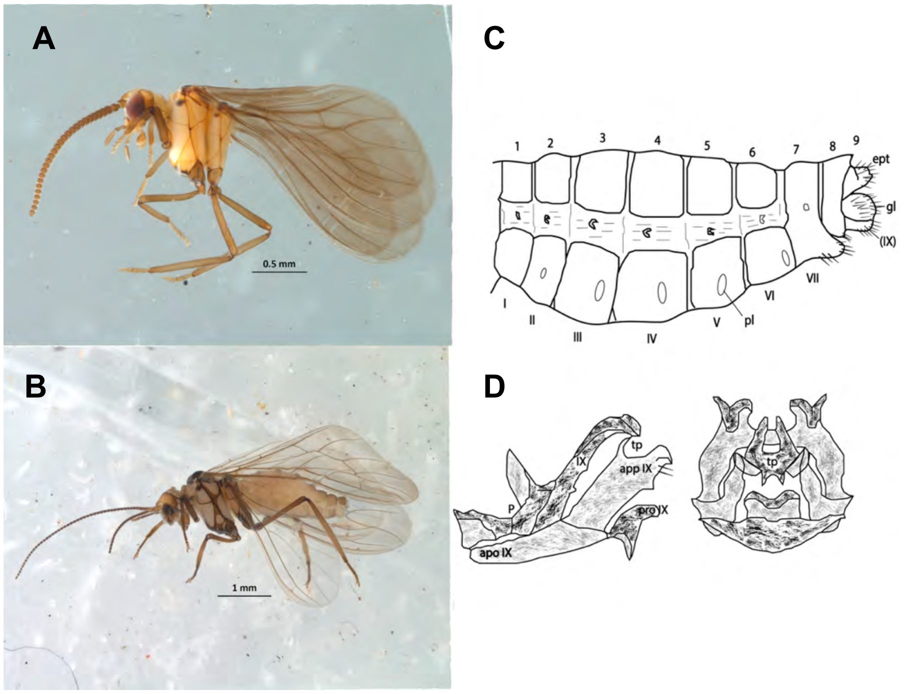


Figura 5. Representantes de la familia Coniopterygidae y esquemas del abdomen y la estructura genital de la familia redibujados de Tjeder, 1957 y Meinander, 1972. Fotos: Rodolfo J. Cancino López. A) *Coniopteryx simplicior* Meinander, B) *Conwentzia barretti* Banks, C) *Helicoconis capensis* Enderlein (ept: ectoprocto, gl: gonapófisis laterales, pl: plicaduras, 1-9: 1ro-9no. Tergitos, I-VII: 1ro-7mo. esternitos, (IX): 9no. esternito secundario), D) *Aleuropteryx juniperi* Ohm (app IX: apéndice del esternito IX, apo IX: apófisis del esternito IX, P: penis, pro IX: procesos del esternito IX, tp: placa transversa).

La familia Rachiberothidae fue recientemente propuesta, al incluir dentro a la subfamilia Symphrasinae (Rhachiberothinae + (Paraberothinae + Symphrasinae)) y separándola de las familias Berothidae y Mantispidae, siendo grupo hermano de esta última (Ardila-Camacho *et al*., 2021). Sus miembros son de tamaño pequeño a mediano (longitud del ala anterior de 5.5 a 16.7 mm); con frente pentagonal, estrecha o amplia; mandíbulas asimétricas, ligeramente curvadas ventralmente; presentan el primer par de patas raptoriales, articuladas en la zona media o extremo posterior, con la región de inserción de las patas sin expandirse; alas generalmente amplias ovoides y en ocasiones estrechas; además de presentar en las patas anteriores el órgano anterotarsal de Stitz en las patas anteriores, un noveno esternito poligonal en los machos, así como una reversión de la vena 1r-m sigmoidal en las alas anteriores (Ardila-Camacho *et al*., 2021). En términos generales, la estructura terminal y genital de los machos de esta familia presenta: esclerito estrecho o amplio, con apodema contiguo al margen anterior o aparentemente carente de apodemas; ectoprocto sin apodema, los gonocoxitos IX se fusionan con los gonocoxitos XI, formando un esclerito subrectangular en forma de bote o semiarqueado o gonocoxitos IX en forma de barra, alargados, engrosados y rectos a notablemente sinuosos, con el ápice sobresaliendo del abdomen equipado generalmente con procesos digitiformes apicales; gonocoxitos IX articulados al margen posteroventral del tergito IX+ ectoprocto (Ardila-Camacho *et al*., 2021). Para la identificación de las especies de esta familia se requiere la revisión de las estructuras genitales, con la reciente reorganización de la familia, aún se requiere un estudio exhaustivo de las características diagnósticas de las especies debido a las descripciones poco contundentes que se tiene de estas, y carencia de descripciones taxonómicas de hembras. Para México se registran, actualmente, un total de 15 especies, 2 géneros, y 1 subfamilias (Symphrasinae). En México, con el mayor número de taxa dentro del género *Plega* (12). Para la identificación taxonómica de la fauna de México puede revisarse los siguientes estudios: Ardila-Camacho *et al*., 2019; Enderlein, 1910; Navás, 1914; Penny, 1982.

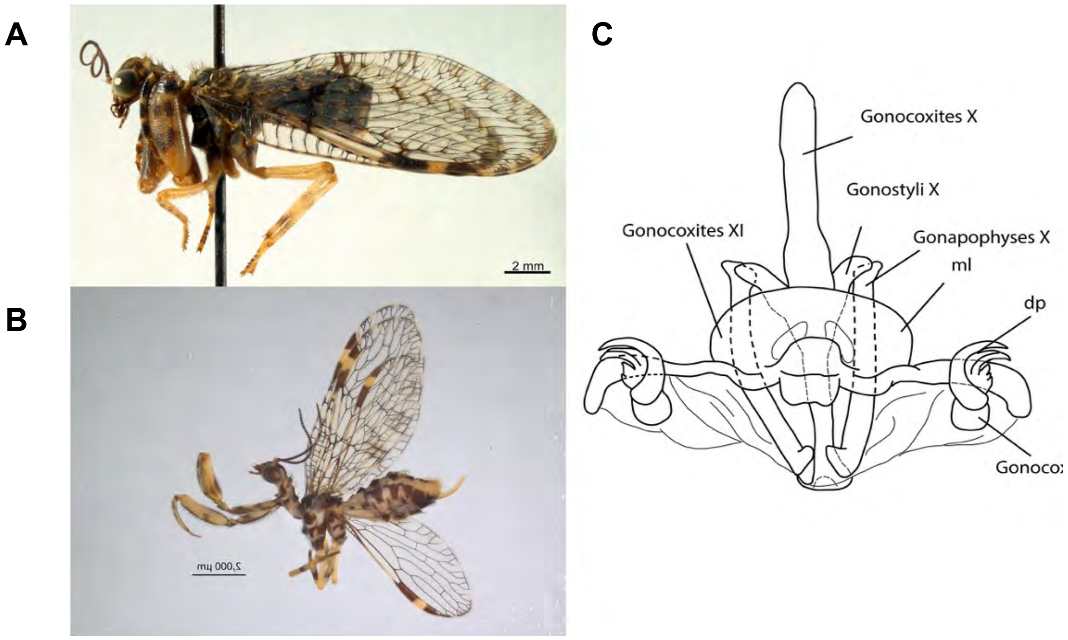


Figura 6. Representantes de la familia Rachiberothidae y esquema de la estructura genital de la familia redibujados de Ardila-Camacho *et al*., 2021. A) *Plega mixteca* Ardila-Camacho *et al.*, tomada de Ardila-Camacho *et al*., 2019, B) *Trichoscelia santareni* Navás, Foto: Rodolfo J. Cancino López, C) *Plega dactylota* Rehn (dp: procesos digitiformes, ml: lóbulo medial de gonocoxitos XI).

La familia Mantispidae se caracteriza por presentar individuos pequeños a medianos (longitud del ala anterior de 5 a 30 mm), con presencia de patas anteriores raptoriales; presentan frente rectangular a cuadrangular; mandíbulas rectas; protórax alargado, cilíndrico generalmente, con la zona posterior alargada a la región de inserción de las patas anteriores, insertándose a al extremo posterior expandido; alas típicamente alargadas y estrechas, con márgenes anteriores y posteriores subparalelos, con algunos géneros con alas ovoides (Ardila-Camacho *et al*., 2021; New, 1989). En términos generales, la estructura terminal y genital de los machos de esta familia presenta: esclerito con forma variable, con un apodema cerca del margen anterior; ectoprocto con apodema presente en el margen anterior; tergito IX no está fusionado con el ectoprocto, con forma de medio anillo, aunque más largo y estrecho que el tergito VIII; gonocoxitos IX se articulan con los brazos laterales de los gonocoxitos XI (Ardila-Camacho *et al*., 2021). Para la identificación de las especies de esta familia se requiere la revisión de las estructuras genitales; aunque existe un entendimiento amplio de la taxonomía de las especies tanto de hembras como machos, aún existe mucho trabajo taxonómico por realizar en los diferentes grupos de esta familia. En México se conocen, actualmente, un total de 12 especies, 7 géneros y 2 subfamilias (Calomantispinae y Mantispinae). El mayor número de taxa se encuentra dentro del género *Zeugomantispa* (3). Para la identificación taxonómica de la fauna de México puede revisarse la siguiente literatura: Hoffman, 1992; Reynoso-Velasco y Contreras-Ramos, 2019.

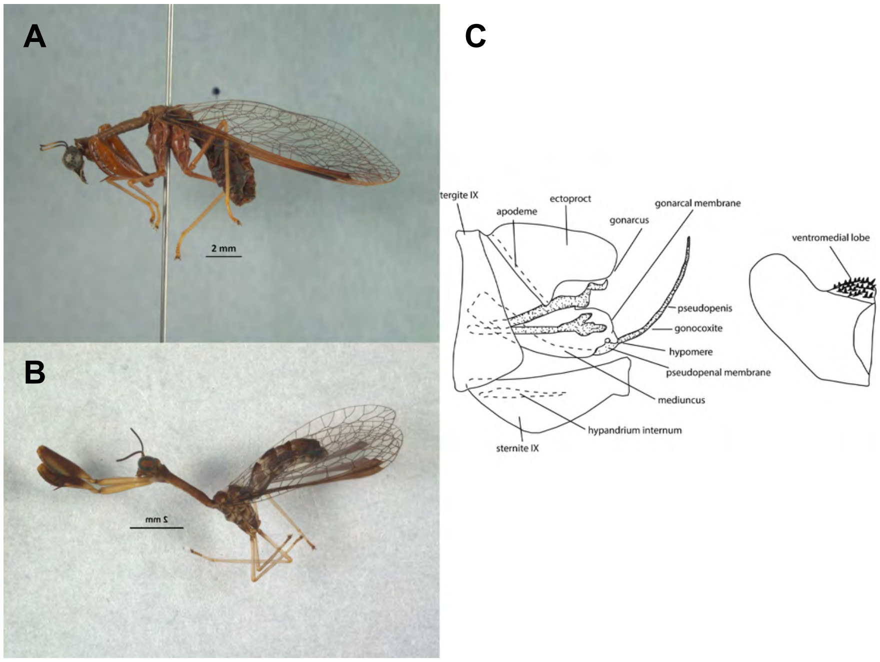


Figura 7. Representantes de la familia Mantispidae y esquemas generales de la estructura genital redibujados de Hoffman, 1992. Fotos: Rodolfo J. Cancino López. A) *Dicromantispa sayi* Banks, B) *Leptomantispa pulchella* Banks, C) *Climaciella brunnea* Say (ejemplo de estructura genital).

La familia Sisyridae se caracteriza por presentar individuos pequeños (longitud del ala anterior de 4 a 10 mm), con cabeza corta y redondeada, antenas moniliformes a filiformes, alas subiguales ovaladas, de coloración gris pálido o marrones, ocasionalmente levemente moteadas, de apariencia similar a Hemerobiidae, aunque se distinguen fácilmente debido a la presencia de venas transversales costales no bifurcadas y una sola vena Rs que surge de R1 (New, 1989). En términos generales, la estructura terminal y genital de los machos de esta familia presenta: un abdomen débil, con tergitos y esternitos pequeños y regiones pleurales muy grandes; con un par de complejos apéndices; ectoproctos muy pequeños;

gonarco, parámeros e hipandrio interno distintivos (New, 1989). Para la identificación de las especies de esta familia se requiere la revisión de las estructuras genitales; existe un entendimiento amplio de la taxonomía de las especies tanto de hembras como machos, pero aún existe mucho trabajo faunístico y taxonómico por realizar. Para México se conocen, actualmente, un total de 4 especies, 2 géneros y 1 subfamilias (Sisyrinae). El mayor número de taxa pertenecen al género *Climacia* (3). Para la identificación taxonómica de la fauna de México puede revisarse la siguiente literatura: Bowles, 2006.

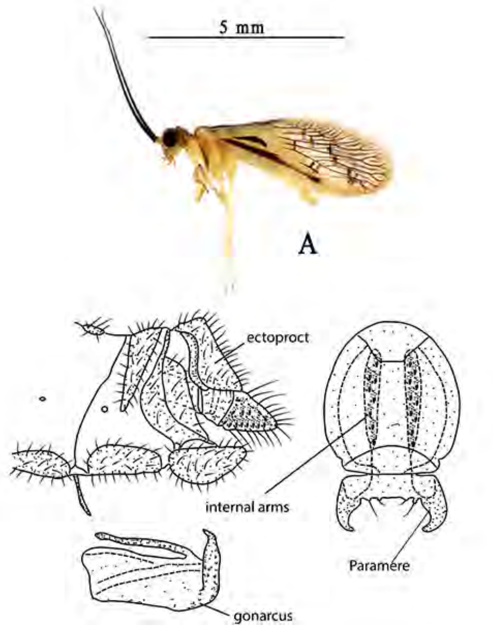


Figura 8. Representante de la familia Sisyridae y esquemas generales de la estructura genital redibujados de Parfin y Gurney, 1956. A) *Climacia basalis* Banks tomado de De Menezes *et al*., 2018, B) *Climacia chapini* Parfin y Gurney.

La familia Berothidae se caracteriza por presentar individuos pequeños a medianos (longitud del ala anterior de 6 a 15 mm), presentan escapos antenales más largos que el pedicelo; un protórax alargado en la mayoría de los géneros; alas falcadas o redondeadas con una compleja venación, abundante pilosidad y tricosoros a lo largo de los márgenes de estas, en algunas especies se puede apreciar sedas en forma de escamas sobre alas y tórax (Penny *et al*., 2007; Ardila-Camacho, 2013). En términos generales, la estructura terminal y genital de los machos de esta familia presenta: Abdomen con tergitos y esternitos bien definidos; ectoprocto y tergito IX asociados cercanamente; gonarco completo, gonocoxitos fusionados al gonarco en toda su longitud o separados distalmente; mediuncus presente, algunas veces largo; algunas veces con pseudopene en el ápice (New, 1989). Para la identificación de las especies de esta familia se requiere la revisión de las estructuras genitales; el conocimiento de la taxonomía de las especies tanto de hembras como machos aún es fragmentado, con mucho trabajo faunístico y taxonómico por realizar. Para México se registran, actualmente, un total de 3 especies, 1 géneros y 1 subfamilias (Berothinae). En México, se ha registrado hasta el momento un solo género *Lomamyia* (3). Para la identificación taxonómica de la fauna de México puede revisarse la siguiente literatura: Faulkner, 1992.

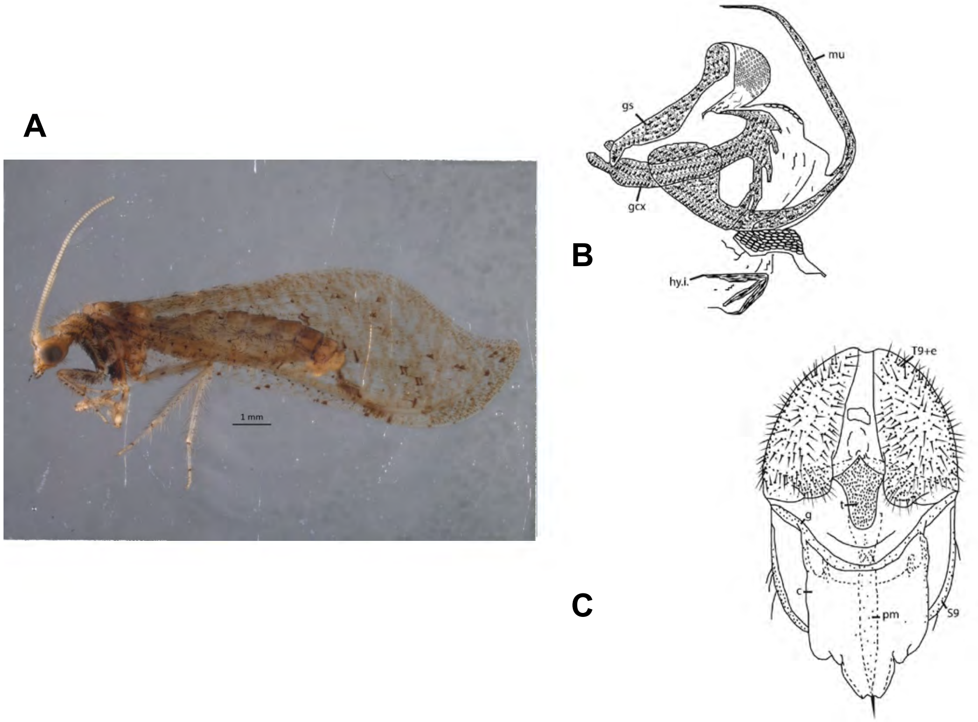


Figura 9. Representante de la familia Berothidae y esquemas generales de la estructura genital redibujados de MacLeod y Adams, 1967 (B) y Aspöck y Aspöck, 1985 (C). A) *Lomamya squamosa* Carpenter, Foto: Rodolfo J. Cancino López, B) *Cyrenoberotha penai* MacLeod y Adams (gs: gonarco, gcx: gonocoxito, hy.i.: hipandrio interno, mu: mediunco), C) *Trichoma gracilipenne* Tillyard (T9+e: tergito9 + ectoprocto, t: torulus, g: gonarco, c: 9no. Coxopodito, pm: complejo paramero-mediunco, S9: esternito9).

La familia Ithonidae se caracteriza por presentar individuos de tamaño mediano a grande (longitud del ala anterior de 15 a 40 mm), generalmente con apariencia de polilla, frecuentemente con sedas en el cuerpo. Presentan una cabeza retraída bajo el pronoto, el tórax es robusto, y las alas son largas y tienen una compleja venación alar con una vena humeral recurrente ramificada (New, 1989; Oswald y Machado, 2018). En términos generales, la estructura terminal y genital de los machos de esta familia presenta: Abdomen bien esclerosado, muchas veces robusto, cilíndrico más corto que las alas; ectoproctos algunas veces alargados y en algunos casos tan largos como para formar "claspers"; tergito VIII y IX delgados, ventralmente prolongados; esternito IX frecuentemente sustancialmente modificado con lóbulos apicales/laterales, usualmente con un fuerte apodema lateral; gonarco como un fuerte arco transversal o incompleto con placas pareadas o triangulares presentes; arcesus largo, simple o apicalmente bífido; entoprocesos presentes o ausentes; gonocoxitos adjuntos a cada lado del gonarco, algunas veces bilobulado y algunas ocasiones con lóbulos con espinas o rugosos; mediuncus algunas veces con lóbulos prominentes fusionados; hipandrio interno pequeño (New, 1989). Para la identificación de las especies de esta familia se requiere la revisión de las estructuras genitales; el conocimiento de la taxonomía de las especies tanto de hembras como machos aún es fragmentado, con mucho trabajo faunístico y taxonómico por realizar. En México se conocen, actualmente, un total de 2 especies y 2 géneros. Para la identificación taxonómica de la fauna de México puede revisarse la siguiente literatura: Carpenter, 1940; Navás, 1929.

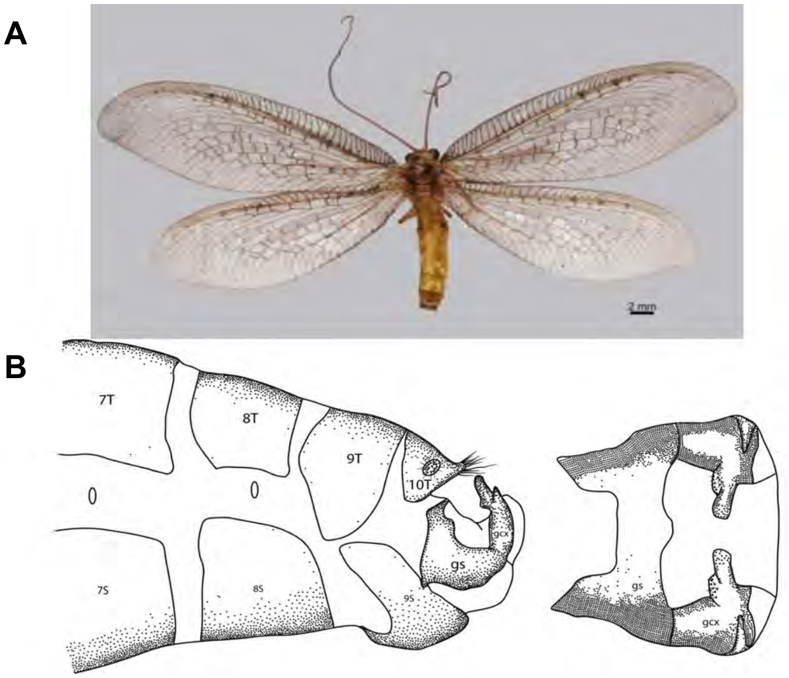


Figura 10. Representante de la familia Ithonidae y esquemas generales de la estructura genital redibujados de Penny, 1996. A) *Adamsiana alux* Ardila-Camacho *et al*., tomada de Ardila-Camacho *et al*., 2020. B) *Adamsiana curoei* Penny (7s: 7mo. esternito, 7T: 7mo. tergito, 8s: 8vo. esternito, 8T: 8vo. tergito, 9s: 9no. esternito, 9T: 9no. tergito, 10T: 10mo. tergito, gcx: gonocoxito, gs: gonarco).

La familia Dilaridae se caracteriza por presentar individuos de tamaño pequeño (longitud del ala anterior de 4 a 12 mm), que presentan ocelos en forma de tubérculos en la cabeza; partes bucales fuertemente reducidas, algunas veces apenas sobresalientes; alas subiguales con muchas sedas, membrana algunas veces moteada; caracterizándose por presentar antenas pectinadas los machos y filiformes las hembras; las hembras con un prominente ovipositor (gonocoxito 9) que se recurva sobre el abdomen (New, 1989, Bowles *et al*., 2015; Martins y de Araujo, 2016). En términos generales, la estructura terminal y genital de los machos de esta familia presenta: Abdomen corto, moderadamente robusto; ectoprocto transverso, frecuentemente con lóbulos en forma de gancho posterior y dorsal o reducidos, con alargamiento del tergito IX; tergito IX profundo; gonarco arqueado; parameros largos y delgados; hipandrio interno pequeño (New, 1989). Para la identificación de las especies de esta familia se requiere revisión de las estructuras genitales; el conocimiento de la taxonomía de las especies tanto de hembras como machos aún es fragmentado, con mucho trabajo faunístico y taxonómico por realizar para esta familia. En México se registra, actualmente, un total de una especies y un género. Para la identificación taxonómica de la fauna de México puede revisarse la siguiente literatura: Carpenter, 1940; Monserrat, 2005.

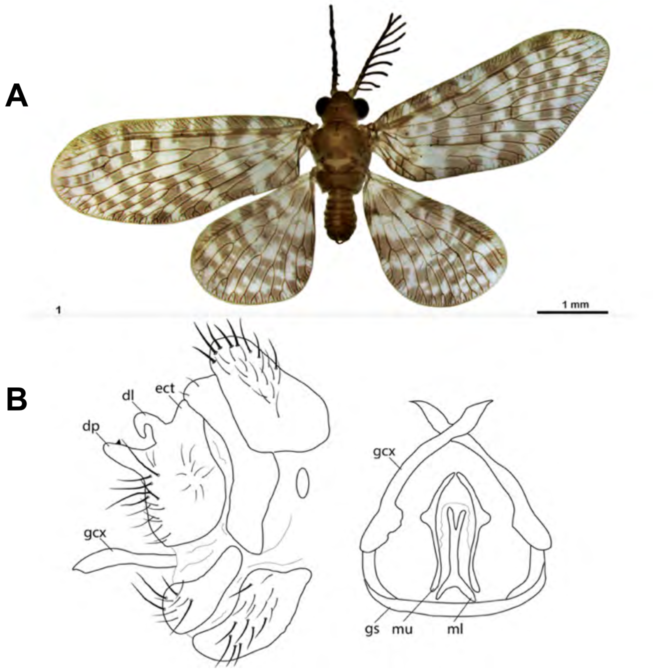


Figura 11. Representante de la familia Dilaridae y esquemas generales de la estructura genital redibujados de Machado y Rafael, 2010. A) *Nallachius dicolor* Adams tomado de Martins y de Araujo (2016), B) *Nallachius furcatus* Machado y Rafael (dl: lóbulo dorsal, dp: proceso digitiforme, ect: ectoprocto, gcx: gonocoxito, gs: gonarco, ml: lóbulo medial, mu: mediunco).

2.3. Diversidad alfa y beta

Para entender cómo se distribuyen las especies de este orden, es de suma importancia analizar la diversidad biológica en cada uno de sus componentes, diversidad alfa y beta (Jost, 2007), así como los factores que puedan influir en estas. La biodiversidad desde hace mucho ha sido objeto de estudio en diferentes partes del mundo y con diferentes grupos biológicos, esta se caracteriza por distribuirse de manera heterogénea (Koleff *et al*., 2008) tanto a nivel espacial (latitudinal/altitudinal) como temporal. Esta diversidad biológica, por lo tanto, es el resultado de una amplia variedad de factores como pueden ser los procesos biogeográficos y/o la heterogeneidad ambiental (Rosenzweig, 1995; Calderón-Patrón *et al*., 2016).

Tanto la diversidad alfa como beta, se ha analizado e interpretado de diversas formas tanto a nivel taxonómico como filogenético (en sus diferentes aproximaciones) (García-de Jesus *et al*., 2016; Cultid-Medina y Escobar, 2019). La diversidad alfa puede definirse como la medida del número de especies en una cierta área de extensión variable, pero también puede suponer un concepto temporal, debido a que muchas de las especies puedan registrarse en periodos de tiempo específicos o relativamente cortos (Loreau, 2000; Koleff *et al*., 2008).

Para el análisis de la diversidad alfa se han desarrollado diferentes aproximaciones, como son el uso de una gran variedad de índices, entre los más usados están el índice de Shannon, Simpson, Pielou, números efectivos de especies según Jost. (2006). Actualmente, con base a diferentes estudios, se cuenta con un marco conceptual y matemático unificado para la estimación y comparación de la diversidad con unidades con un sentido ecológico, tomando en cuenta los números efectivos de especies (Diversidad de orden q) (Cultid-Medina y Escobar, 2019). Los órdenes más utilizados para la estimación y análisis de la diversidad son los órdenes 0, 1 y 2; cuando $q = 0$, se obtiene un valor equivalente a la riqueza, pero si $q = 1$, se obtiene un valor de diversidad típico, equivalente al exponencial del índice de Shannon (donde no existe sesgo por la presencia de especies raras o abundantes), finalmente cuando $q = 2$, estima un valor de diversidad que representa el número efectivo de especies dominantes (más abundantes), que equivale al inverso del índice de Simpson (Moreno *et al*., 2011).

Por otro lado, la diversidad beta se entiende como el reemplazo espacial de las diferentes especies entre dos o más sitios (es decir, medir la similitud o disimilitud de especies); considerando que entre mayor sea esta, los sitios presentan una composición de especies diferente (Whittaker, 1960; Koleff, 2005). Particularmente, para el estudio de la diversidad beta (disimilitud total), esta se puede dividir en sus dos componentes: el recambio (reemplazo de especies entre sitios) y el anidamiento (pérdida o ganancia de especies entre sitios) (Baselga, 2010).

Para la evaluación de la estructura taxonómica de las comunidades (diversidad filogenética), existen medidas que toman en cuenta la clasificación jerárquica linneana por arriba de la categoría de especie (Pielou, 1975; Warwick y Clarke, 1995), por lo tanto, el valor taxonómico de las comunidades está en función de la estructura taxonómica que poseen cada una de las especies; incorporando con esto no solo datos numéricos, sino también información sobre sus características genéticas, funcionales y estructurales, directa o indirectamente (Bacaro *et al*., 2007; García-de Jesús *et al*., 2016; Özkan, 2018). Esta aproximación es la distintividad taxonómica, la cual se puede medir mediante diferentes métricas como son: Índice de diversidad taxonómica (Δ), que mide las distancias de la ruta taxonómica entre cualesquiera dos individuos en un ensamblaje elegidos al azar (toma en cuenta abundancias, y que exista un esfuerzo de muestreo similar); Índice de distintividad taxonómica (Δ*), que es el promedio de las distancias de las rutas taxonómicas existentes entre todos los individuos de un ensamblaje, pero descartando todas las rutas entre individuos de la misma especie (representa el caso en el que los individuos que se eligieran, pertenecieran siempre a una especie distinta); Distintividad taxonómica promedio (Δ+), que es el promedio de la distancia de la ruta taxonómica entre cualesquiera dos especies elegidas al azar, dividido entre el número total de rutas del ensamblaje (toma en cuenta solo incidencia de especies, independiente del esfuerzo de muestreo); finalmente, la variación de la distintividad taxonómica (Λ+), que sería la varianza del promedio de las distancias taxonómicas entre especies y expresa la variación de las distancias que conectan a cada par de especies en una jerarquía linneana (detecta inequidad en el árbol taxonómico, independiente del tamaño de la muestra) (Pérez Hernández, 2019).

2.4. Patrones de diversidad y distribución a través de la elevación

La distribución y diversidad de las especies en gradientes altitudinales, se pueden explicar mediante dos patrones: la disminución de la riqueza de especies conforme aumenta la altitud o los mayores picos de esta en las altitudes intermedias (Almeida-Neto *et al*., 2006; Guerrero y Sarmiento, 2010; Perillo *et al*., 2017). Para el primer caso, se propuso que los climas en altitudes elevadas son extremos y pocas especies son capaces de tolerar dichas condiciones; mientras que en altitudes bajas la estabilidad de las condiciones climáticas es mayor por lo que encuentran una mayor cantidad de especie. Este patrón se explica por la regla de Rapoport según Stevens (1989), que se extendió para explicar patrones de distribución de especies en gradientes de elevación y batimétricos (Stevens, 1992; 1996). El segundo caso, se explica por el efecto de dominio medio; el cual consiste en un traslape creciente de especies hacia el centro de dominio espacial, debido a la presencia de fuertes límites espaciales en los bordes superiores e inferiores, independientemente de la influencia de las relaciones entre especies y medio ambiente (Colwell *et al*., 2004; de Mendoza *et al*., 2017).

Particularmente para la diversidad beta en los gradientes altitudinales, se ha reportado en términos generales que esta aumenta con el incremento de la altitud (es decir, mayor disimilitud) (Castro *et al*., 2019; Willig y Presley, 2019; Fontana *et al*., 2020), con algunas excepciones, donde se registraron una disminución con respecto a la altitud (Tello *et al*., 2015; Liu *et al*., 2018). Con el recambio de especies como el componente que mejor explica la disimilitud total en comparación con el anidamiento (Perillo *et al*., 2017; Castro *et al*., 2019; Pérez-Toledo *et al*., 2021), con algunos casos reportando mayores valores de anidamiento en altitudes elevadas y con ciertos taxones mejor explicados mediante anidamiento (Noriega y Realpe, 2018; Fontana *et al*., 2020).

En términos generales, para la diversidad filogenética (en sus diferentes aproximaciones) en un gradiente altitudinal se han citado diferentes tendencias, como son su disminución con el aumento de la elevación (Leingärtner *et al*., 2014; Chun y Lee, 2018; Worthy *et al*., 2019), o, por el contrario un aumento de esta con el aumento de la altitud (principalmente en árboles) (Qin *et al*., 2019; Mariano *et al*., 2020), también se ha registrado un incremento de la diversidad filogenética en las altitudes medias, con una tendencia de joroba (Gómez-Hernández *et al*., 2016; Zhang *et al*., 2016; Manish y Maharaj, 2018). Aunque existen algunos trabajos donde no se menciona una tendencia clara para ciertos grupos (Kluge y Kessler, 2011; Chun y Lee, 2018). Y particularmente para la diversidad filogenética beta se ha reportado un aumento de esta conforme aumenta la altitud (Gómez-Hernández *et al*., 2016; Zhang *et al*., 2016; Qin *et al*., 2019). Observando con esto una clara heterogeneidad en las tendencias de diversidad y distribución de las especies, en cada uno de los diferentes enfoques analizados.

3.- OBJETIVOS

Objetivo general

Analizar los patrones de diversidad en un gradiente altitudinal; así como explorar los posibles efectos de la altitud sobre la distribución de la fauna de neurópteros del Volcán Tacaná, Chiapas, México.

Objetivos particulares

- Recopilar e interpretar la información de estudios previos centrados en el estudio de la diversidad de neurópteros y los factores que pueden estar afectando su presencia y diversidad, así como los diferentes métodos de muestreo y análisis utilizados (Capítulo I).
- Proporcionar una lista de verificación actualizada y clave de identificación de la fauna de Neuroptera del Volcán Tacaná, y explorar sus patrones de distribución latitudinal y altitudinal, contribuyendo a expandir el rango de distribución de diferentes especies de Neuroptera (Capítulo II).
- Estimar el número potencial de especies a nivel local y regional (Volcán Tacaná) para evaluar la completitud de los inventarios (Capítulo III)
- Analizar la diversidad alfa de especies y de taxones (distintividad taxonómica) a lo largo del gradiente altitudinal (Capítulo III)
- Evaluar la diversidad beta (disimilitud) y sus componentes de recambio y anidamiento por diferencias en la riqueza de especies, tanto de especies como de taxones superiores a través del gradiente altitudinal (Capítulo III)

4.- MÉTODO GENERAL

El método general para la realización del estudio de diversidad del orden Neuroptera en un gradiente altitudinal en el Volcán Tacaná, Chiapas, México se dividió en tres ejes principales: 1) Revisión Bibliográfica de los antecedentes del estudio de la diversidad del orden Neuroptera a nivel mundial, 2) Estudio cualitativo de la diversidad de los neurópteros del Volcán Tacana con énfasis en su composición de especies y patrones altitudinales y biogeográficos, 3) Análisis de la diversidad alfa y beta a lo largo del gradiente altitudinal (mediante un enfoque taxonómico y filogenético).

1) Revisión Bibliográfica de los antecedentes del estudio de la diversidad del orden Neuroptera a nivel mundial.

Para poder entender las tendencias que se han utilizado a nivel global en el estudio de la diversidad alfa y beta, particularmente para los neurópteros, se procedió a evaluar y explorar los diferentes enfoques y estudios que se han abordado en relación con el análisis de la diversidad de comunidades de Neuroptera a nivel global, se buscó en primer lugar publicaciones generadas a nivel mundial. Para ello, se emplearon buscadores académicos (Google Scholar, SciElO, Academia. edu, Redalyc) y las bases de datos de artículos científicos Lacewing Digital Library (https://lacewing. tamu. edu); consultado el 16 de junio de 2021, y The Biodiversity Heritage Library (https://www. biodiversitylibrary. org/); consultado el 10 de enero de 2021. Para las búsquedas se utilizaron palabras clave como diversidad, distribución, Neuroptera, altitudinal, gradientes, beta, alfa, composición, riqueza y los nombres de las diferentes familias del orden (Berothidae, Chrysopidae, Coniopterygidae, Dilaridae, Hemerobiidae, Ithonidae, Mantispidae, Myrmeleontidae, Nemopteridae, Nevrorthidae, Nymphidae, Osmylidae, Psychopsidae, Rachiberothidae y Sisyridae)

La literatura se ordenó con base en dos temas principales: estudios formales de diversidad y estudios de distribución de fauna y especies. Posteriormente, se extrajo la información necesaria y se organizó en una tabla, con información como País, Región biogeográfica, Riqueza estimada, Familias estudiadas, Hábitat estudiado, Tipo de muestreo, Periodo de muestreo, Tipo de análisis de diversidad y Factores que afectan la diversidad y distribución de Neuroptera. Finalmente, estos datos nos ayudaron a comprender y analizar cómo se evaluó la diversidad de neurópteros en diferentes partes del mundo y cuáles son las diferentes aproximaciones analíticas.

2) Estudio cualitativo de la diversidad de los neurópteros del Volcán Tacana con énfasis en su composición de especies y patrones altitudinales y biogeográficos.

Para dicho análisis, se obtuvo el material biológico mediante trabajo de campo y revisión de ejemplares de la Colección de Insectos Asociados a Plantas Cultivadas en la Frontera Sur, Chiapas, México (ECO-TAP-E). Los especímenes se obtuvieron del volcán Tacaná, mediante un año de muestreo sistemático en cinco puntos de muestreo a diferentes niveles altitudinales, además de muestreos esporádicos en otras localidades del volcán para obtener una muestra más representativa de las especies de Neuroptera.

Se examinaron e identificaron un total de 2534 especímenes adultos de Neuroptera. Para su identificación, se estudiaron las estructuras genitales de los especímenes utilizando el siguiente método: Se cortó el abdomen entre los segmentos VI y VII y se limpió en una solución de hidróxido de potasio (KOH) al 5% (para Hemerobiidae, Coniopterygidae, Myrmeleontidae, Mantispidae y Rhachiberothidae) a temperatura ambiente, o KOH al 10% durante 15 min a 80 ° C en un baño de agua (para Chrysopidae); la parte terminal de los abdómenes aclarados se pigmentaron usando Chlorazol Black E; y fueron observadas y estudiadas bajo un microscopio Discovery V8 Zeiss. Posteriormente, las estructuras genitales se almacenaron en microviales con glicerina asociada a su respectivo espécimen.

La identificación taxonómica se llevó a cabo utilizando literatura especializada para las diferentes familias presentes en el Volcán y en la colección científica. Todo el material biológico recolectado y la mayoría de los especímenes fueron depositados en la Colección Nacional de Insectos, Instituto de Biología, UNAM, Ciudad de México, México (CNIN) (con excepción del material de la colección de ECO-TAP-E).

El muestreo se realizó mensualmente entre febrero de 2018 y enero de 2019, en diferentes sitios y niveles altitudinales con diferentes tipos de vegetación (Selva mediana, cafetal, bosque mesófilo de montaña, bosque de pino-encino). Las muestras se obtuvieron mediante diferentes métodos de muestreo como fueron trampa de luz de vapor de mercurio y negra (pantalla y cubeta), dos trampas Malaise, cinco trampas de interceptación a nivel del suelo, cinco trampas de plato amarillo en el dosel de los árboles y red entomológica. También se aplicó un muestreo esporádico mediante trampas de luz y redes entomológicas. Las muestras se mantuvieron vivas en viales de plástico con tapón de rosca, se transportaron al laboratorio y luego se fijaron con alfileres o se conservaron en alcohol etílico al 80%.

Se establecieron cinco áreas de muestreo a diferentes altitudes: (1) Municipio de Cacahoatán, Finca Alianza (650-810 m); (2) Municipio de Cacahoatán, Ejido El Águila (1050-1390 m); (3) Municipio de Cacahoatán, Ejido Benito Juárez El Plan (1400-1770 m); (4) Municipio de Unión Juárez, Cantón Chiquihuites (2000-2470 m); y (5) Municipio de Unión Juárez, Mirador Papales (2870-3360 m). Otros sitios pertenecientes al municipio de Unión Juárez fueron muestreados esporádicamente para incrementar los registros de especies de Neuroptera: Finca San Jerónimo (720 m); Finca Monte Perla (926-988 m); Mirador Pico del Loro (1221 m); Parador Cueva del Oso (3526-3683 m); y Laguna (3651-3789 m).

Para ayudar a comprender mejor la distribución altitudinal de las especies de Neuroptera del volcán Tacaná, se realizaron diferentes análisis PAE. El “PAE” construye cladogramas basándose en el análisis cladístico de las matrices de datos de presencia-ausencia de especies y taxones supraespecíficos. En este análisis se construyó una matriz con las unidades de distribución utilizadas como “terminales” y los taxones (especie, género, familia, etc.) utilizados como “caracteres”, por lo que se lleva a cabo un análisis de parsimonia, resultando en los cladogramas más parsimoniosos. Esto para describir un patrón potencial de relación de las unidades de distribución (por ejemplo, áreas de endemismo, niveles altitudinales, etc.). Inicialmente, llevamos a cabo un PAE empleando los sitios en los cinco niveles principales de muestreo como terminales y las especies de Neuroptera presentes como caracteres. Se hicieron PAE adicionales para cada familia de Neuroptera con el fin de desentrañar posibles influencias altitudinales de cada grupo; la excepción fue Rhachiberothidae, que solo tiene una especie representativa en este estudio.

Las especies ("caracteres") se codificaron como presentes (1) o ausentes (0) para cada una de las unidades de distribución ("terminales"). Se utilizó una unidad de distribución hipotética con ausencia de todas las especies para enraizar el árbol. Las matrices se construyeron con Win-Clada, y luego se exportaron como un archivo Nexus para realizar análisis filogenéticos bajo el principio de parsimonia en TNT (Tree Analysis using New Technology, versión 1.5). El cladograma más parsimonioso se obtuvo mediante algoritmos heurísticos empleando el método de bisección y reconexión de árboles (TBR), utilizando como parámetros los siguientes: semilla aleatoria = 0, retención = 3000 y retención / = 50 de 60 repeticiones. La topología más parsimoniosa (o el consenso estricto de las topologías más parsimoniosas) se exportó al software Illustrator CS6 para su edición.

3) Análisis de la diversidad alfa y beta a lo largo del gradiente altitudinal (mediante un enfoque taxonómico y filogenético).

Para este capítulo se realizó la misma metodología utilizada en el capítulo 2, donde se excluyeron los ejemplares obtenidos de la colección de ECO-TAP-E y los muestreos esporádicos. Por lo que los análisis de diversidad se llevaron a cabo con los muestreos sistemáticos de un año (febrero 2018 a enero 2019). Todos los individuos recolectados en las diferentes trampas se consideraron como una sola muestra para cada sitio. Las diferentes trampas se colocaron a una distancia mínima de 200 m entre ellas. Los especímenes fueron identificados y depositados en la Colección Nacional de Insectos del Instituto de Biología de la Universidad Nacional Autónoma de México (CNIN-UNAM), México.

Los análisis de los datos fueron los siguientes:

- Estructura y cambios en las comunidades de neurópteros en el gradiente altitudinal

La distribución de Neuroptera a lo largo del gradiente altitudinal fue descrito por la frecuencia (F) de una especie dada, basada en el número de sitios en los que se registró contra el número total de sitios estudiados. Se obtuvo la abundancia para las comunidades de neurópteros en cada sitio. Se realizó una comparación gráfica de los patrones de abundancia de las especies en cada uno de los sitios y el nivel regional utilizando curvas de Whittaker o rango-abundancia.

- Estimación de la completitud del inventario.

La eficiencia del esfuerzo de muestreo y la estimación del número potencial de especies para cada nivel altitudinal y regionalmente se calcularon utilizando curvas de acumulación de especies con el programa EstimateS. v.9. 1. (Colwell, 2013). Esta estimación se realizó empleando el estimador Jackknife1, que es una función del número de especies presentes en una sola unidad de muestra; lo que nos da una mayor precisión global de la riqueza de los sitios. Estos datos se aleatorizaron al azar 100 veces y se compararon con los datos observados.

- Diversidad alfa: de especies y taxones

Para el análisis de la diversidad de especies se utilizaron los números de Hill, o diversidad de orden 0 (riqueza de especies), 1 (diversidad de especies raras y comunes) y 2 (diversidad de especies dominantes) según Jost (2006). Estas estimaciones se realizaron usando el programa iNEXT versión 1.3, disponible en línea https://chao.shinyapps.io/iNEXT (Hsieh *et al*., 2013). Los análisis se hicieron con 100 aleatorizaciones y se extrapolaron al doble de muestras (Chao y Jost, 2012), con un intervalo de confianza del 95%. Para comparar los diferentes valores de diversidad entre sitios, los resultados se estandarizaron a la misma cobertura de muestra (Cm), que indica la proporción de la comunidad total representada por las especies muestreadas (Chao y Jost, 2012) en el programa iNEXT. Las diversidades calculadas se compararon utilizando intervalos de confianza del 95%. Se realizó una comparación visual a partir de la superposición de los intervalos superior e inferior. Para establecer si existen diferencias significativas entre los valores de cada uno de los sitios.

Para el análisis de la diversidad filogenética alfa, se tomó en cuenta la propuesta de Clarke y Warwick (1998, 2001) que se basa en las distancias taxonómicas promedio (longitud de las rutas taxonómicas) entre dos especies seleccionadas al azar en la jerarquía linneana, que incluye a todas las especies en un conjunto. Para ello se utilizó una matriz de abundancia y una segunda matriz con la clasificación jerárquica de todas las especies. Se obtuvieron tres índices de diversidad alfa filogenética: 1) distintividad taxonómica (DivT: Δ^*), que expresa la distancia taxonómica total entre dos especies elegidas al azar (con reemplazo), 2) distintividad taxonómica promedio (DisT: Δ^+), que representa el promedio de distancias taxonómicas entre especies, y 3) la variación taxonómica (VarT: Λ^+), que mide la varianza de las distancias taxonómicas entre especies (Clarke y Warwick, 1998). Estos índices se compararon con un modelo nulo construido a partir de 1000 aleatorizaciones del conjunto de especies de cada comunidad en el programa PRIMER v7 (Clarke y Gorley, 2006) para evaluar si los valores obtenidos son estadísticamente diferentes a los esperados por azar.

- Diversidad beta: de especies y taxones

La diversidad beta total en el volcán se evaluó con el índice de Sorensen (βSOR), y se analizó con sus dos componentes: la disimilitud por recambio (βSIM) y la disimilitud por diferencias en riqueza (anidamiento) (βNES) bajo el enfoque de sitios múltiples (Baselga, 2010). Además, bajo el enfoque por pares, se midió la diversidad beta entre sitios consecutivos a través del gradiente de elevación ($\beta sor = \beta sim + \beta nes$), calculando la contribución relativa de cada componente (en porcentajes) con base en la incidencia de las especies (Carvalho *et al*., 2012).

La diversidad beta filogenética (disimilitud total de taxones) se analizó utilizando la incidencia (presencia-ausencia) de los taxones presentes en los diferentes sitios. Análogamente, a la diversidad beta de especies, la disimilitud total entre las estructuras taxonómicas de las comunidades se midió empleando el índice de Sorensen. La aproximación de Bacaro *et al*. (2007) y Baselga (2010) es un método de disimilitud taxonómica que toma en cuenta el enfoque de distintividad taxonómica de Clarke y Warwick (1998), este enfoque compara la riqueza de especies y la variación en la estructura taxonómica entre conjuntos, donde todos los taxones tienen el mismo nivel de importancia, independientemente de sus niveles jerárquicos. La diversidad beta de los taxones y sus componentes de recambio y anidamiento de taxones se calculó utilizando el enfoque de sitios múltiples y pares de sitios consecutivos (Baselga, 2010). Todos los análisis de diversidad beta se realizaron con el paquete betapart v.13 en el programa R (Baselga y Orme, 2012).

5.- CAPÍTULO I:

Changes in the diversity of Neuroptera: Study and Factors that influence their patterns

Rodolfo J. Cancino López, Santiago Zaragoza-Caballero y Atilano Contreras Ramos

Preparado para Annals of the Entomological Society of America

Changes in the diversity of Neuroptera: Study and factors that influence their patterns

Rodolfo J. Cancino López[1], Santiago Zaragoza Caballero[2], Atilano Contreras Ramos[3]
1 Posgrado en Ciencias Biológicas, UNAM, Instituto de Biología, Cd. Universitaria, México, D.F. e-mail: cancinorodolfoj@gmail.com.
2 Instituto de Biología-UNAM, Departamento de Zoología, Cd. Universitaria, 04510 Ciudad de Mexico, Mexico. Email: zaragoza@ib.unam.mx.
3 Instituto de Biología-UNAM, Departamento de Zoología, Cd. Universitaria, 04510 Ciudad de Mexico, Mexico. Email: acontreras@ib.unam.mx.

Abstract

Neuroptera is a group of primitive holometabolous insects, with low diversity compared to other groups of holometabolous insects such as Coleoptera. They present a broad variety of life histories and morphology. Some families have a high potential for biological pest control. Although considerable work on Neuroptera has been devoted to topics of systematics and taxonomy, checklists, and biological control agents. There is still a lack of studies on the distribution patterns and diversity of the group. In this work, we attempt to synthesize knowledge on alpha and beta diversity of Neuroptera, considering disciplinary trends and approaches that have been applied. In addition, we attempted to detect proposed factors that may be responsible for the patterns of diversity and distribution of these insects. The plant physiognomy and vegetation type can play a fundamental role in increasing the diversity of Neuroptera communities, although environmental factors (such as temperature and precipitation) are not ruled out. A little-studied factor is altitude, which can work as a model to analyze the effect of environmental factors in these communities. The temperature that changes along an altitude gradient can work as an environmental filter reducing the distribution ranges of species and their diversity. There is still much work to be done regarding the study of diversity patterns and changes in the composition of communities, as well as defining a good experimental design for a better analysis of diversity.

Key words: Neuroptera, Distribution, Alpha diversity, Beta diversity, Review, Methods

Introduction

Neuroptera is a group of primitive holometabolous insects with relatively low diversity compared to other orders such as Coleoptera or Hymenoptera; Neuroptera is part of the Superorder Neuropterida (Grimaldi and Engel 2005, Winterton et al. 2010). They are characterized by two pairs of broad membranous wings with a compound reticulated vein. The larvae have the synapomorphy of having modified mandibles and maxillae in a suction structure (Winterton and Makarkin 2010, Winterton et al. 2010).

Due to the radiation Neuroptera have experienced, they exhibit a vast morphological heterogeneity and variety of life history, especially during the larval stage (Aspöck et al. 2001a). As clear examples, they present the psamophilic habits of some larvae of Myrmeleontidae (Monserrat and Acevedo 2013), the parasitoid habits of Mantispidae larvae (Ardila-Camacho and García 2015), aquatic habits of larvae of Sisyridae and Nevrorthidae (Ábrahám 1998), as well as the diversity of forms that adults present. Lacewings can occur in a variety of habitats, from tropical to temperate. Some adults can feed on plant structures, but mainly larvae are predators; these habits make several families, such as Chrysopidae, Hemerobiidae, and Coniopterygidae, potential biological pest controllers (New 1991 Tauber et al. 2009, Monserrat 2016a, 2016b).

Neuroptera is considered a group of primitive insects (with its oldest record from the Late Permian of Eurasia) (Grimaldi and Engel 2005); the fossil record information has been sufficient to have a dating of the order. It is essential to mention that the vast majority of fossil records belong to the Palearctic and Neotropical regions, with approximately 65. 4% and 19. 4% of fossil records, respectively (Oswald 2020).

Regarding taxonomic knowledge, taxonomic reviews, monographs, and descriptions of species have been carried out from the time of Linnaeus to the present. This has led to a constant update of the taxonomic position of several families, increasing or decreasing the number of species present in each of them. The systematics of the order has also changed over the years, from the inclusion and exclusion of Ephemeroptera and Odonata within the order to the more recent molecular systematic studies that work on the phylogenetic relationships between the different families. (Linnaeus 1758, Adams 1958, New 1991, Aspöck 1992, Aspöck 1999, Aspöck et al. 2001b, Garzón-Orduña et al. 2016, Oswald and Machado 2018, Winterton et al. 2018, Machado et al. 2019).

Knowledge of biology and ecological aspects of some Neuroptera families is still fragmented; despite this, there is extensive and specific information on some species. In general, lacewings have a great morphological variety. In addition to irregular and slow flights (except Ascalaphinae), for some species, their flight patterns and the factors affecting them are known, besides showing sexual dimorphism in some cases (Duelli 1980, 1986, Halstead 1989, New 1991, Penny and de Freitas 2001, Tauber et al. 2009).

Due to their complex morphological habits vary, there are different studies on the knowledge of immature stages of the order, which mainly address aspects such as the taxonomy and biology of particular species and in some families with information on agroecological aspects. As an example of such studies, we can mention some more recent ones by family in Table 1.

Regarding the biological data of the families, a good compilation of these is available at a general level in New (1986). Generally, adults have different habits, such as Sisyridae and some Osmylidae associated with or near rivers. Psychopsidae mainly in humid forests and coastal areas. Berothidae is more abundant in dry regions. Chrysopidae, Hemerobiidae, and Coniopterygidae with the more general distribution. Ithonidae and some Myrmeleontidae are mainly in sandy areas or friable soil, and Nemopteridae is limited to arid regions. There is general knowledge of the different Neuroptera's habits, e.g., subterranean, parasitoids, aquatic, riparian, arboreal, psamophilic, or xylophagous. Also, in the larval stage, they are voracious predators, while in the adult stage, they may be omnivorous or phytophagous.

Over the years, different species of Neuroptera have been studied. Most of the studies before the 20th century were developed for the Palearctic and Nearctic regions, focusing mainly on taxonomic and systematic studies of the different families. These have allowed us to have a broad knowledge of the fauna of these regions in contrast with other less studied regions. These have led to studies focused on the diversity of Neuroptera in different ecosystems, both natural and agroecosystems (Canard et al. 1979, Alrouechdi et al. 1980a, 1980b, Pantaleoni and Lepera 1985, Czechowska 1990, Bozsik 1994). Based on this, the study aims to search for scientific literature focused on the study of the diversity of neuropterans and realize a synthesis to identify and discuss the factors that affect the presence and abundance of Neuroptera, as well as the different sampling and analysis methods used.

Methodology

To evaluate and explore the different approaches and studies that have been addressed regarding the diversity of Neuroptera communities at a global level, we first searched for publications generated at a general level. For this purpose, academic search engines (Google Scholar, SciELO, Academia.edu, Redalyc) and the databases of scientific articles of the Lacewing Digital Library (https://lacewing.tamu.edu, consulted June 16, 2021), and The Biodiversity Heritage Library (https://www. biodiversitylibrary. org/, consulted January 10, 2021).

Keywords such as diversity, distribution, Neuroptera, altitudinal, gradients, beta, alpha, composition, richness, and the names of the different families of the order were used for the searches. The literature was ordered based on two main topics: formal diversity studies and faunal and species distribution studies. Subsequently, the necessary information was extracted and organized into a table. Reference terms such as country, biogeographic region, richness estimations, families studied, habitat studied, sampling type, sampling period, diversity analysis method, and factors affecting the diversity and distribution of the species were utilized. Finally, these data helped us understand and elucidate how Neuroptera diversity was assessed and what analytical approaches have been used. All this is by means of the qualitative comparison of the data of the different studies and later carrying out a census to know what factors can influence the diversity and distribution of the Neuroptera.

Diversity and Distribution of Neuroptera

This order currently consists of 15 families: Berothidae, Chrysopidae, Coniopterygidae, Dilaridae, Hemerobiidae, Ithonidae, Mantispidae, Myrmeleontidae, Nemopteridae, Nevrorthidae, Nymphidae, Osmylidae, Psychopsidae, Rachiberothidae, and Sisyridae. The literature recorded a total of 603 genera and 5829 species approximately (Oswald and Machado 2018, Machado et al. 2019, Ardila-Camacho et al. 2019, Cancino-López and Contreras-Ramos 2019, Marquez-López and Contreras-Ramos 2019, Sarmiento-Cordero and Contreras-Ramos 2019, Michel 2019, Canard and Thierry 2020, Ábrahám and Monnerat 2021; Zhao et al. 2022). Although the distribution of Neuroptera is cosmopolitan, we can find them in different environments; some families and subfamilies are well distributed in a particular region, an example, Nemopteridae is restricted to arid parts of Africa, Australia, western South America, and the Mediterranean to Oriental area (Portugal to India) and Apochrysinae subfamily (Chrysopidae) are restricted to tropical zones in Africa, Asia, Australia, and the Americas (Machado and Oswald 2018).

Particularly for the New World, knowledge of species diversity and distribution is still fragmented; most studies have focused on North and South America; with a void in the entomofauna of Central America. On the other hand, the Palearctic region has a better-studied fauna inventory and distribution ranges, mainly with a spatial (latitudinal) diversity approach. Despite this, distribution data for many families are still scarce at the regional level, mainly for the Neotropical region (Monserrat 1990). Despite this, some studies have reported that some species with different biogeographic affinities may be separated altitudinally in the same area (Marquez-López et al. 2020, Cancino-López et al. 2021), although the composition of the species will always be linked to the biogeographic distribution of the region.

At the global level, Oswald and Machado (2018) described the distribution of Neuropterida. They also indicated that most families are widely distributed in tropical and subtropical regions.

Providing information of species richness in the different biogeographical regions, with the highest number of species so far in the Palearctic and Afrotropical regions (2837 spp.) and with the lowest number of species in the Nearctic and Oceania region (612 spp.) (Fig. 1a). This diversity and distribution may change over time due to increased studies in tropical regions that have yet to be explored and the need for extensive faunistic studies to help better understand the richness and distribution of species in these regions.

Regarding the biogeographic regions, the region where most diversity studies have been carried out for the order Neuroptera has been the Palearctic region (Fig. 1b). This region has a wide range of studies, from faunistic studies to recent studies of alpha and beta diversity of lacewings. These showed the need for more work in the rest of the regions to compare and elucidate possible general distribution patterns and diversity for this group of insects.

Alpha and beta diversity studies of Neuroptera

Studies focusing on the alpha and beta diversity of the world's neuropteran communities are fragmented and focused on certain types of ecosystems or particular regions. Most studies to date have been conducted focusing on different hierarchical levels such as Neuropterida, Neuroptera, and selected families (Fig. 2a). Despite this, the work that has been done in recent years continues to register new species for science and increase the ranges of several species (Martins et al. 2019, Marquez et al. 2020).

Many of the studies have been carried out in natural environments, but agroecosystems have stood out as suitable models for diversity studies (Fig. 2b); for their richness and heterogeneity (Szentkirályi 1989, Mendes 2011, Thierry et al. 2005). Therefore, agroecosystems have been a highly studied kind of ecosystem, where the richness, abundance, and frequency of lacewings have been analyzed. Understanding the diversity of Neuroptera in different types of environments seems essential, even more so because of their remarkable efficiency as pest predators in agroecosystems, as they are usual inhabitants of such landscapes (Simanton 1976, Da Chagas et al. 1982, González Olazo et al. 2012). In some studies focused on lacewings, diversity appears to be low in the agroecosystems (González Olazo et al. 2012, Martins et al. 2019, Serée et al. 2020). Even if this may often be due to the methods used in the studies, other studies have focused on evaluating the effect of chemical treatments used in different crops on the composition of the species, with greater diversity in organic cultivation (De Melo et al. 2020).

Something remarkable in the vast majority of the studies is the variety of sampling periods used, conducting diversity studies over a time range of seven to 12 months mainly (Oliveira et al. 2013, Ribeiro et al. 2013, Martins et al. 2019, Bakoidi et al. 2020, Bozdogan 2020a, De Melo et al. 2020). Few studies analyzed the diversity for more than a year but sometimes focused on only one time of year (Thierry and Canard 2005, Gruppe et al. 2004). All this could cause a bias in the understanding of the temporal diversity patterns of lacewings. Consequently, the results will be influenced by the periods studied. In some cases, low richness and abundance of the Chrysopidae and Hemerobiidae families were reported (Da Chagas et al. 1982, Ábrahám 2009), which showed their highest peaks of richness and abundance in specific months. This emphasizes the importance of evaluating changes in the diversity of Neuroptera over time, that is, the temporal variation of diversity. It is remarkable that in environments with marked seasonality, there is an evident activity during the spring season (for the Palearctic region; Bozdogan and Toroglu 2016), which in tropical areas could be influenced by rainy or dry seasons.

Various studies reported Chrysopidae and Hemerobiidae as the most conspicuous families, with richness and abundance specific to the sites where it was founded and a high affinity to environments with a broad vegetal cover. On the other hand, families such as Osmylidae, Mantispidae, Myrmeleontidae, Dilaridae, Sisyridae, Berothidae, and Ithonidae to others, are poorly represented in the sampling (Bhattacharya and Dey 2001, Ábrahám 2009, Bozdogan and Toroglu 2016, Makarkin and Ruchin 2019, Makarkin and Egorov 2020, Sarmiento-Cordero et al. 2021). All this is due to their low abundance and representativeness, which implies extensive sampling effort and emphasis on specific sampling methods for these groups.

Patterns of richness, abundance, and diversity show different trends in the studies. These different values may often be influenced by sampling *per se*, which frequently increases or decreases the values reported in diverse types of habitats, so comparing values of diversity, richness, and abundance between studies may be unclear to elucidate general patterns. Therefore, the type of sampling could influence the sample obtained as has been observed in different studies (Makarkin and Ruchin 2019, Martins et al. 2019, Podlesnik et al. 2019). In addition, the sampling period is influenced because many species have different habits, as diurnal, crepuscular, or nocturnal (Oswald and Machado 2018). Among the traps most used in studies on Neuroptera diversity are entomological nets, light traps, Moericke traps, Malaise traps, and McPhail traps among others (Fig. 3), each with different capture ranges, influencing the richness and diversity obtained in the samples. Vas et al. (2001) and Ábrahám et al. (2003) mention that the choice of sampling methods has an evident influence on the characteristics of the samples obtained. It is reflected in the different studies, where more than two types of complementary methods were used to have representativeness of the species in the evaluated sites.

The study of alpha diversity and community structure in Neuroptera has been studied from different approaches, and its study has increased in recent years. Among the characteristics most evaluated; were richness, abundance, diversity, and similarity (using distinct indices). Diverse approaches have focused on understanding differences in site diversity (whether vegetation types, crops, localities, biotopes, or regions), the local diversity of a site, or the diversity of communities over time (temporal).

In alpha diversity analyses, different indices have been used to express the Neuroptera diversity. The classic Shannon and Simpson indices were the most used (Fig. 4), which show the degree of heterogeneity and dominance. Other studies apply different indexes, so it is problematic to compare these values between studies. On the other hand, the biases generated by the different methodological designs of each study. Generally, the diversity in the neuropteran communities at the family level may be low to medium, with or without the presence of dominant species, often with a high level of equity in the communities, with some families presenting higher values of diversity as is the case of Chrysopidae (Bakoidi et al. 2020, Bozdogan 2020a).

Regarding beta diversity (similarity or dissimilarity), studies have focused mainly on the similarity between areas, types of ecosystems, and families with variable similarity values, reporting significant differences between communities at different sites (Duelli et al. 2002, Bozdogan 2020a). Often, although the similarity between the habitats is high, at the family level, these may show marked differences (Bakoidi et al. 2020). In addition to the vegetation structure, another relevant factor when comparing neuropteran communities is the distance between sites, in some studies on this factor have shown a high similarity between sites with more than 80% and very similar values of richness (Marquez-López et al. 2020). Other studies have reported marked differences in neuropteran communities between areas of the same forest (interior, middle, and edges), where the different characteristics of the communities vary depending on each family present at these sites (Bozdogan 2020b).

In recent decades the study of beta diversity and its components (turnover and nestedness) has been increasing. In addition to trying to understand how these components explain the changes in the composition of the species. For Neuroptera, these components have been little studied, although, in some studies, it is mentioned that in Neuroptera communities, there may be a high turnover of species. Particularly, for Chrysopidae communities, there is a high turnover value, although with high nestedness values in sites with high altitudes and low temperatures (Marquez-López et al. 2020, Lai et al. 2021). Among the most widely used analyses to know the similarity or dissimilarity of the Neuroptera communities, there are mainly the Sorensen, Jaccard, and Morisita indices. In these studies, it has been observed that neuropteran communities present a broad similarity when they present similar conditions such as the same type of vegetation or they appear at smaller geographical distances. It is important to note that the similarity between families may be greater or lesser, possibly to the habits that the species present, as there are groups adapted to more specific conditions.

What factors may influence the diversity of Neuroptera?

A wide variety of factors may affect the presence of insects, such as temperature, precipitation, humidity, inter-and intra-specific interactions, and food resources; these have a direct impact on the abundance and richness of species in a region. In the case of the Neuroptera, these factors seem to be neither precise nor well documented.

There are several studies that report different factors that may be influencing the diversity and abundance of Neuroptera, e. g., Czechowska (1985, 1994) reports that the type of vegetation and the age of the communities may influence the abundances of different species of Neuroptera. This is observed in agroecosystems where the presence of trees around crops provides shade and environmental heterogeneity, acting as refuges and increasing biodiversity (Ricci et al. 2006, Santos and Pérez-Maluf 2012). In some species of Hemerobiidae, there is a strong association with vegetation types such as coniferous or broadleaf forests (Monserrat and Marin 1996). In addition, in some agroecosystems such as *Citrus* sp. crops, maximum values of diversity and abundance of neuropterans were observed during the crop sprouting periods (Sarmiento-Cordero et al. 2021).

Another study reveals that a correlation between species and the habitat (particularly in the case of the Chrysopidae family) (Thierry and Canard 2005). This makes evident the importance of vegetation structural diversity for the diversification and abundance of Neuroptera in different natural environments or agroecosystems. In the specific case of agroecosystems, it was considered that the greater the plant structural diversity nearby crops, this will significantly increase their richness and diversity of both Chrysopidae and Hemerobiidae; this is related to a greater quantity of food resources and niches to inhabit (Szentkirályi 1989, Bozdongan 2020a). This may be supported by the enemy hypothesis, which states that more stable populations of predatory arthropods persist in environments with more diverse plant structures, allowing them to have more suitable sites for shelter, oviposition, hibernation, and essential food (Root 1973). In general, it seems that the species of the Neuroptera prefer the presence of shelters and food resources that allow them to inhabit different environments, for which a diverse plant physiognomy was required that provides them with diversified niches for their survival (Duelli et al. 2002, Costa et al. 2010, Bozdogan and Toroglu 2016, Agustinur et al. 2020, Paiva et al. 2020). Because many species of lacewings can distribute to different plant strata in the same habitat, there are species with affinity to the treetops (Chrysopidae, Hemerobiidae, among others) and others to the shrub areas (Myrmeleontidae, Coniopterygidae among others) (Gruppe and Schubert 2001).

Another important factor to consider is seasonality, ecosystems with marked seasonality seem that Neuroptera is more active during the spring season (Bozdogan and Toroglu 2016), although in temperate zones Neuroptera is exposed to extreme seasonal changes, to which they must adapt (Canard 2005). For example, some species of Chrysopidae survive extreme changes because of their life histories (voltinism or diapause) that allow them to escape these adversities, so that species often have distributions in northern latitudes or cold climate zones (Tauber et al. 1993, Canard 2005). Another study mentions that seasonal changes in the diversity and abundance of neuropteran communities correlated with the rainy and dry seasons (Neotropical Region), finding families with peak abundance in rainfall (Sziráki 2011, Marquez-López et al. 2020).

Different studies mention the effect of some environmental factors, such as wind speed and temperature on neuropteran populations, which could be good predictors of species richness and abundance (mainly for Chrysopidae, Hemerobiidae, and Ascalaphinae) (Chen et al. 2017, Stelzl and Devetak 1999, Yayla and Satar 2012, Bozdogan 2020b). Studies in agroecosystems indicate the relevant role of ambient temperature in the occurrence of Chrysopidae, and often the presence of vegetation cover influences the increase or decrease of the optimal temperature of these insects (Albuquerque et al. 1994, Figueira et al. 2000, Pessoa et al. 2004, Pappas et al. 2008, Martins et al. 2019). In the case of the Hemerobiidae family, these have very low-temperature thresholds, which may give them an advantage during cold periods in temperate climates (Neuenschwander 1975, 1976, New 1975). On the other hand, the family Myrmeleontidae showed greater diversity and activity in dry seasons and arid and dry conditions, with a strong influence on the type of environment, the vegetation, and the period of the year (Bakoidi et al. 2020). It showed that certain groups seem to adapt to different temperature ranges, while other species appear to have a low relationship with factors such as precipitation. humidity and humidity (Bozdogan 2020a).

Based on the different studies carried out with Neuroptera, it can be said that factors such as the vegetative structure and physiognomy, the type of vegetation, and the availability of food could influence the diversity and the changes in the composition of the species (Fig. 5). Even so, it is important to continue studying geographic and/or environmental factors that may be working as filters that allow or reduce the distribution and diversification of this group of insects.

Altitude *versus* diversity

Different studies evaluate possible factors that influence the presence and diversity of the families of the order Neuroptera, mainly those that focus on agroecosystems and their use as biological controllers of pests. One of the factors that few studies have explored is the effect of altitude on the diversity of this order.

Some studies have been carried out focused on the composition and diversity of the different families. It has been observed that certain groups seem to be restricted to particular areas in habitat, from zones with cold temperatures (alpine areas) to zones with warmer temperatures (New 1997). In recent works, different factors associated with the abundance and diversity of neuropterans have been analyzed, where it was reported that in families such as Myrmeleontidae (without Ascalaphinae) and Nemopteridae, abundance increased with altitude. Other families such as Chrysopidae, Coniopterygidae, and Ascalaphinae were affected by increasing elevation (Bozdogan 2020a). Despite this, elevation does not seem to influence families in the same way and in many cases, changes trends depending on the geographical location. Some research in the Neotropics where in temperate zones a high diversity of Hemerobiidae and Coniopterygidae is reported, while in other sites with the same conditions, but the Palearctic region they reported less diversity (Monserrat 2016a, Marquez et al. 2020). Also, in a recent study, it was shown that the alpha diversity of Chrysopidae decreased with increasing elevation, as well as a replacement of the component that best explains the dissimilarity along the altitude gradient. They reported that nestedness replaces species turnover with increasing altitude (Lai et al. 2021).

For this reason, the different species of Neuroptera can be distributed at various altitudinal ranges, with wide ranges or restricted to certain altitudinal strata. All this will depend on their biology and ecological requirements and factors such as temperature and seasonality (Bhattacharya and Dey 2001). Despite this, it is important to continue carrying out studies on how the communities of the neuropterans change along with the altitude because different environmental factors change along with the elevation that can function as environmental filters that affect the diversity or the species distribution.

Perspectives on the study of diversity of Neuroptera

Based on the previous outline, we can note that the diversity patterns for the Neuroptera are still unclear. Due to the lack of more studies focused on alpha and beta diversity both at a spatial level (latitudinal and altitudinal) and temporary. Faunistic, taxonomic, and systematic studies are of great importance for the knowledge and understanding of the fauna present in the different regions and thus able to make a better evaluation of the possible patterns of the already known species.

In addition, to highlight the importance of carrying out an adequate experimental design when working with these groups of insects, and to carry out the analyzes with more recent approaches that can be comparative. Therefore, it is essential to design specific protocols for the sampling of Neuroptera, for which several important points were taken to carry out a more complete and standardized sampling. The first point would be to adequately understand the biology and characteristics of families. These may have different adaptations or habits that can make sampling difficult. These can be their daily habits, types of food, ability to fly, habitats, or possible attractants. All this information will allow us to establish the most appropriate experimental design for the needs of the study and the selection of the type of sampling method. This selection of the sampling method directly affects the sample obtained in the field since each collection method has a certain degree of efficiency in certain groups in particular (Vas et al. 2001; Ábrahám et al. 2003).

Another point is to make a prior review of the distribution of the interest groups. This would guarantee that when selecting the study site we can have a certain probability of finding the groups of interest both spatially and temporally since there are groups that can be distributed in certain specific regions or particular times of the year. And finally, carry out a strict and intense systematic and standardized sampling, for the analysis of diversity patterns it is considered that a minimum sampling time can be one year to have both temporal and spatial data, to later carry out the most appropriate statistical analyzes to the objective of the research. The use of new approaches in the analysis of diversity is raised, so that they can be compared with other studies, as well as evaluate diversity taking into account different levels as approaches (taxonomic, phylogenetic, and functional). All this, is due to the importance of Neuroptera not only in the field of biological pest control but also as potential indicators of the quality of the environment and its conservation, due to its high affinity with habitats. Finally, Neuroptera is a group with high potential as a model group to be able to understand the patterns of distribution and diversity of species, generating more research questions about changes in species composition and the factors that can affect it.

Acknowledgments

R.J.C.-L. thanks, Consejo Nacional de Ciencia y Tecnología for a doctoral scholarship and the Posgrado en Ciencias Biológicas-UNAM, sede Instituto de Biología, for the general support through its doctoral program. This study was supported by the Projects: "Biodiversidad de grupos selectos de Neuropteroidea de la Peninsula de Baja California" (PAPIIT-UNAM, IN209721) and "Biodiversidad de Neuroptera en México: un enfoque taxonómico integrativo" (CONACYT CB2017- 2018, A1-S-32 693) under the responsibility of ACR.

References Cited

Ábrahám, L. 1998. A study on the Hungarian freshwater osmylid and sponge-flies fauna (Neuroptera: Osmylidae, Sisyridae). Somogyi Múzeumok Közleményei. 13: 263–273.

Ábrahám, L. 2009. Adatok a Biodiverzitás Napokon Gyűrűfűn előkerült recésszárnyú fajokról (Neuroptera). Natura Somogyiensis. 13: 147–150.

Ábrahám, L. and C. Monnerat. 2021. A new owlfly species of *Iranoidricerus* (Neuroptera: Myrmeleontidae) from Jordan. Zoology in the Middle East. 67: 57–64.

Ábrahám, L., V. Markó and J. Vas. 2003. Investigations on a neuropteroid community by using different methods. Acta Phytopathologica et Entomologica Hungarica. 38: 199–207. DOI: 10.1556/APhyt.38.2003.1-2.21

Acevedo, F., D. Badano and V. J. Monserrat. 2014. The larva of *Tricholeon relictus* Hölzel & Monserrat, 2002 a synanthropic antlion (Neuroptera, Myrmeleontidae). Zootaxa. 3835: 364–370.

Acevedo, F., V. J. Monserrat and D. Badano. 2013. Comparative description of larvae of the European species of *Distoleon* Banks: *D. annulatus* (Klug, 1834) and *D. tetragrammicus* (Fabricius, 1798) (Neuroptera, Myrmeleontidae). Zootaxa, 3721: 488–494.

Acevedo Ramos, F., V. J. Monserrat, A. Contreras Ramos and S. Pérez González. 2020. Comparative study of sensilla and other tegumentary structures of Myrmeleontidae larvae (Insecta, Neuroptera). Journal of Morphology. 281: 1191–1209.

Adams, P. A. 1958. Studies in the Neuroptera, with special reference to wing structure and evolution in the Osmyloidea. Ph.D. dissertation. Harvard University, Cambridge, Massachusetts, USA. 120 pp.

Agustinur, S., F. Lizmah and M. Sarong. 2020. Diversity of Insect Pest in Monoculture and Polyculture Nutmeg (Myristica fragrans Houtt.) Plantation in South Aceh District. Environ. Earth Sci. 515: 012006. DOI: https://doi.org/10.1088/17551315/515/1/012006.

Albuquerque, G. S., C. A. Tauber and M. J. Tauber. 1994. *Chrysoperla externa* (Neuroptera: Chrysopidae): life history and potencial for biological control in Central and South America. Biological Control. 4: 7–13.

Alrouechdi, K., M. Canard, R. Pralavorio and Y. Arambourg. 1980a. Repartition des adultes et des pontes de chrysopides (Neuroptera) recoltes dans une oliveraie de Provence. Neuroptera International 1: 65–74.

Alrouechdi, K., J.-P. Lyon, M. Canard and D. Fournier. 1980b. Les Chrysopides (Neuroptera) récoltés dans une oliveraie du Sud-Est de la France. Acta Oecologica/Oecologia Applicata. 1: 173–180.

Antoł, A., W. Rojek, K. Miler, K. and M. Czarnoleski. 2018. Thermal dependence of trap building in predatory antlion larvae (Neuroptera: Myrmeleontidae). Journal of Ethology. 36: 199–203

Ardila-Camacho, A. and A. García. 2015. Mantidflies of Colombia (Neuroptera, Mantispidae). Zootaxa. 3937: 401–455.

Ardila-Camacho, A., R. J. Cancino-López, F. Acevedo and A. Contreras-Ramos. 2019. Four new species of Plega Navás, 1928 (Neuroptera: Mantispidae) from Mexico. Zootaxa. 4612: 351–372.

Ardila-Camacho, A., R. J. Pires Machado and A. Contreras Ramos. 2021. A review of the biology of Symphrasinae (Neuroptera: Rhachiberothidae), with the description of the egg and primary larva of Plega Navás, 1928. Zoologischer Anzeiger. 294: 165–185.

Aspöck, H. (ed.). 1999. Neuropterida: Raphidioptera, Megaloptera, Neuroptera. Kamelhälse, Schlammfliegen, Ameisenlöwen. Stapfia 60: i-x, 1-244.

Aspöck, U. 1992. Crucial points in the phylogeny of the Neuroptera (Insecta). Pp. 63-73. In: Canard, M.; Aspöck, H.; Mansell, M. W. (eds.). *Current Research in Neuropterology. Proceedings of the Fourth International Symposium on Neuropterology*. Privately printed, Toulouse, France. 414 pp.

Aspöck, H., H. Hölzel and U. Aspöck. 2001a. Kommentierter Katalog der Neuropterida (Insecta: Raphidioptera, Megaloptera, Neuroptera) der Westpaläarktis. Denesia. 2 :1–606.

Aspöck, U., J. D. Plant and H. L. Nemeschkal. 2001b. Cladistic analysis of Neuroptera and their systematic position within Neuropterida (Insecta: Holometabola: Neuropterida: Neuroptera). Systematic Entomology. 26: 73–86.

Aves de Oliveira, S., B. Souza, A. Machado Auad and C. Antunes Carvalho. 2010. Can larval lacewings *Chrysoperla externa* (Hagen) (Neuroptera, Chrysopidae) be reared on pollen? Revista Brasileira de Entomologia, 54: 697–700.

Badano, D. 2020. Larval morphology of three Afrotropical pit-building antlions of the genus Myrmeleon Linnaeus (Neuroptera, Myrmeleontidae). Israel Journal of Ecology and Evolution. 2020: 63–72.

Badano, D. and R. A. Pantaleoni. 2014. The larvae of European Ascalaphidae (Neuroptera). Zootaxa. 3796: 287–319.

Badano, D., A. Di Giulio, H. Aspöck, U. Aspöck and P. Cerretti. 2021. Burrowing specializations in a lacewing larva (Neuroptera: Dilaridae). Zoologischer Anzeiger. 293: 247–256

Badano, D., F. Acevedo, R. A. Pantaleoni and V. J. Monserrat. 2016. *Myrmeleon almohadarum* sp. nov., from Spain and North Africa, with description of the larva (Neuroptera Myrmeleontidae). Zootaxa. 4196: 210–220.

Bakkes, D. K., C. L. Sole and M. W. Mansell. 2017. Revision of Afrotropical silky lacewings (Neuroptera: Psychopsidae). Zootaxa. 4362: 151–212.

Bakoidi, A., F. Dobo, I. Djibo, J. Maoge, H. Bozdogan and L. S. Tinkeu Ngamo. 2020. Diversity and distribution of antlions (Neuroptera: Myrmeleontidae) in the Northern region of Cameroon (Afrotropical region). Journal of Biodiversity and Environmental Sciences. 16: 61–71.

Baliteau, L. 2016. Eléments sur la biologie des larves de Mantispa styriaca Poda, 1761 (Neuroptera, Mantispidae). Revue de l'Association Roussillonnaise d'Entomologie. 25: 41–46.

Beutel, R. G., F. Friedrich and U. Aspöck. 2010. The larval head of Nevrorthidae and the phylogeny of Neuroptera (Insecta). Zoological Journal of the Linnean Society. 158: 533–562.

Bhattacharya, D. K. and S. R. Dey. 2001. Biodiversity of Neuroptera associated with aphids of Western Himalaya. Entomon. 26: 320–325.

Bozdogan, H. 2020a Diversity of lacewing assemblages (Neuropterida: Neuroptera) in different forest habitats and agricultural areas in the East Mediterranean area of Turkey. Entomological Research. 50: 163–173. DOI: https://doi.org/10.1111/1748-5967.12426.

Bozdogan, H. 2020b. Species richness and composition of Neuroptera in the forests fragments of the Taurus Mountains Range, Turkey. Saudi Journal of Biological Sciences. 27: 1201–1207. doi: https://doi.org/10.1016/j.sjbs.2020.02.018.

Bozdogan, H. and E. Toroglu. 2016. Lacewing (Insecta: Neuroptera) fauna of Başkonuş Mountain National Park (Kahramanmaraş Province-Turkey). Balıkesir Üniversitesi Fen Bilimleri Enstitüsü Dergisi, Cilt. 18: 89–103.

Bowles, D. E. 2006. Spongillaflies (Neuroptera: Sisyridae) of North America with a key to the larvae and adults. Zootaxa. 1357: 1–19.

Bozsik, A. 1994. Impact of vegetational diversity on structure parameters of chrysopid assemblages. Redia. 77: 69–77.

Buys, S. C. 2008. Observations on the biology of *Anchieta fumosella* (Westwood 1867) (Neuroptera Mantispidae) from Brazil. Tropical Zoology. 21: 91–95.

Canard, M. 2005. Seasonal adaptations of green lacewing (Neuroptera: Chrysopidae). European Journal of Entomology. 102: 317–324.

Canard, M. and Thierry, D. 2020. Description of a new species of *Chrysoperla* Steinmann, 1964 of the *Ch. mediterranea* Hölzel, 1972 group from Europe (Neuropterida, Neuroptera, Chrysopidae). Linzer Biologische Beiträge. 52: 141–149.

Canard, M., P. Neuenschwander and S. Michelakis. 1979. Les Névroptères capturés au piège de McPhail dans les oliviers in Grèce. 3: La Crète occidentale. Annales de la Société Entomologique de France. 15: 607–615.

Cancino-López, R. J. and A. Contreras-Ramos. 2019. A new species of *Ceraeochrysa* Adams (Neuroptera, Chrysopidae), with a key to the species from Mexico. ZooKeys, 888: 95–104.

Cancino-López, R. J.; C. C. Martins and A. Contreras-Ramos. 2021. Neuroptera Diversity from Tacaná Volcano, Mexico: Species Composition, Altitudinal and Biogeographic Pattern of the Fauna. Diversity. 13: 537. https://doi.org/10.3390/d13110537

Candan, S., Z. Suludere, F. Açikgöz and A. Hasbenli. 2005. Ultrastructure of the egg chorion of Nemoptera sinuata Olivier 1811 (Neuroptera: Nemopteridae) from Turkey. Entomological News, Philadelphia. 116: 1–10.

Cannings, R. A. and S. G. Cannings. 2006. The Mantispidae (Insecta: Neuroptera) of Canada, with notes on morphology, ecology, and distribution. Canadian Entomologist. 138: 531–544.

Chen, Z. Z., L. Y. Liu and S. Y. Liu et al. 2017. Response of *Chrysoperla nipponensis* (Okamoto) (Neuroptera: Chrysopidae) under long and short photoperiods. Journal of Insect Science. 17: 35. https://doi.org/10.1093/jisesa/iex005.

Costa, R. I. F., B. Souza and S. de Freitas. 2010. Spatiotemporal dynamic of green lacewings (Neuroptera Chrysopidae) taxocenosis on natural ecossystems. Neotrop. Entomol. 4: 470–475. DOI: https://doi.org/ 10.1590/S1519566X2010000400003.

Czechowska, W. 1985. Neuropteran (Planipennia and Raphidioptera; Neuropteroidea) communities of coniferous forest in the Kampinoska Forest and in Bialoleka Dworska near Warsaw. Fragmenta Faunistica. 29: 391–404.

Czechowska, W. 1990. Neuropterans (Neuropteroidea) of linden-oak-hornbeam and thermophilous oak forests of the Mazovian Lowland. Fragmenta Faunistica, 34: 95–119.

Czechowska, W. 1994. Neuropterans (Neuropteroidea: Rhaphidioptera, Planipennia) of the canopy layer in pine forests. Fragmenta Faunistica. 36: 459–467.

Da Chagas, E. F., S. S. Neto, A. J. B. P. Braz, C. P. B. Mateus and I. P. Coelho. 1982. Flutuação populacional de pragas e predadores em citros. Pesq. agropec. bras*.,* Brasilia. 17: 817–824.

De Jong, G. D. 2011. Observations on the biology of *Polystoechotes punctatus* (Fabricius) (Neuroptera: Ithonidae): adult trophic status, description of the male reproductive system, and associations with mites. Proceedings of the Entomological Society of Washington*.* 113: 291–298.

De Lira-Ramos, K. V., A. Ardila-Camacho, E. González-Gaona, N. García-González and A. Contreras-Ramos. 2022. The first record of the genus *Plega* Navás, 1928 (Neuroptera: Rhachiberothidae: Symphrasinae) as a parasitoid of the sawfly genus *Monoctenus* Dahlbom, 1835 (Hymenoptera: Symphyta: Diprionidae). Papéis Avulsos De Zoologia. 62: e202262022. DOI: https://doi.org/10.11606/1807-0205/2022.62.022

De Melo, M. A., M. L. N. M. Araujo and C. C. Martins. 2020. Entomofauna de Hemerobiidae (Neuroptera) em sistema de cultivo orgânico e convencional de frutíferas no município de Avaré, SP, Brasil. Revista de Biologia Neotropical. 17: 121–129.

Devetak, D., S. Lipovšek and M. A. Pabst. 2010. Larval morphology of the antlion *Neuroleon microstenus* (McLachlan, 1898) (Neuroptera, Myrmeleontidae), with notes on larval biology. Zootaxa. 2428: 55–63.

Dorey, J. B. and D. J. Merritt. 2017. First observations on the life cycle and mass eclosion events in a mantis fly (Family Mantispidae) in the subfamily Drepanicinae. Biodiversity Data Journal*,* 5: 2–12.

Duelli, P. 1980. Adaptive dispersal and appetitive flight in the green lacewing, Chrysopa carnea. Ecological Entomology. 5: 213–220.

Duelli, P. 1986. Flight activity patterns in lacewings (Planipennia, Chrysopidae). Pp. 165-170 in Gepp, J., H. Aspöck, H. Hölzel. (eds.). Recent Research in Neuropterology. Proceedings of the 2nd International Symposium on Neuropterology. Privately printed, Graz, Austria. 176 pp.

Duelli, P., M. K. Obrist and P. F. Fluckiger. 2002. Forest edges are biodiversity hotspots–also for Neuroptera. Acta Zoologica Academiae Scientiarum Hungaricae. 48: 75–87.

Figueira, L. K., C. F. Carvalho and B. Souza. 2000. Biologia e exigências termicas de *Chrysoperla externa* (Hagen, 1861) (Neuroptera: Chrysopidae) alimentada com ovos de *Alabama argillacea* (Hübner, 1818) (Lepidoptera: Noctuidae). Ciência e Agrotecnologia. 24: 319–326.

Fisher, M. L., R. C. Mower and C. R. Nelson. 2019. *Climacia californica* Chandler, 1953 (Neuroptera: Sisyridae) in Utah: taxonomic identity, host association and seasonal occurrence. Aquatic Insects. 40: 317–327.

Gavira, O., S. Sánchez, P. Carrasco, J. Ripoll and S. Solís. 2012. Presence of the family Nevrorthidae (Neuroptera) in the Iberian Peninsula. Boletín de la Sociedad Entomológica Aragonesa. 51: 217–220.

Garzón-Orduña, I. J., I. Menchaca-Armenta, A. Contreras-Ramos, X.-y Liu and S. L. Winterton. 2016. The phylogeny of brown lacewings (Neuroptera: Hemerobiidae) reveals multiple reductions in wing venation. BMC Evolutionary Biology, 16: 1–19.

González-Olazo, E. V. and J. F. Heredia. 2010. Morfología de los estadios larvales y datos biológicos de *Chrysopodes* (*Chrysopodes*) *spinellus* (Neuroptera: Chrysopidae), nueva cita para la Argentina. Acta Zoológica Lilloana. 54: 87–92.

González-Olazo, E. V., I. Redolfi, G. Patt and M. Campos. 2012. Diversidad específica de controladores biológicos crisópidos (Neuroptera: Chrysopidae) en el germoplasma olivícola en la Plaza Solar, La Rioja, Argentina. UNLaR Ciencia. 1: 31–35.

Grebennikov, V. V. 2004. Grub-like larvae of Neuroptera (Insecta): a morphological review of the families Ithonidae and Polystoechotidae and a description of *Oliarces clara*. European Journal of Entomology. 101: 409–417.

Grimaldi, D. and M. S. Engel. 2005. *Evolution of the insects*. Cambridge University Press. Cambridge. pp. 755.

Gruppe, A. V. and H. Schubert. 2001. The spatial distribution and plant specificity of Neuropterida in different forest sites in southern Germany. Beiträge zur Entomologie. 51: 517–527.

Gruppe, A., M. Gossner and U. Simon. 2004. Neuropteren in Wäldern Schwabens und Oberbayerns (Insecta: Neuropterida). Beiträge zur Bayerischen Entomofaunistik. 6: 243–254.

Halstead, J. A. 1989. On the biology and rarity of the owlfly *Ululodes arizonensis* in California (Neuroptera: Ascalaphidae). Pan-Pacific Entomologist. 65: 418–419.

Haug, J. T., V. Baranov, M. Schädel, P. Müller, C. Gröhn and C. Haug. 2020. Challenges for understanding lacewings: how to deal with the incomplete data from extant and fossil larvae of Nevrorthidae (Neuroptera)?. Fragmenta Entomologica, Roma. 52: 137–167.

Hayashi, M. and M. Nomura. 2011. Larvae of the green lacewing *Mallada desjardinsi* (Neuroptera: Chrysopidae) protect themselves against aphid-tending ants by carrying dead aphids on their backs. Applied Entomology and Zoology. 46: 407–413.

Hernández-Juárez, A., L. A. Aguirre-Uribe, A. González-Ruíz, J. C. Chacón-Hernández, J. Landeros-Flores, E. Cema-Chávez, M. Flores-Dávila and M. K. Harris. 2016. Impact of endosulfan on the predatory efficiency of larval *Chrysoperla carnea* (Neuroptera: Chrysopidae) on the eggs of *Heliothis virescens* and *Spodoptera frugiperda* (Lepidoptera: Noctuidae). Canadian Entomologist. 148: 112–117.

Herrera-Flórez, A. F., C. Haug, E.-G. Burmeister and J. T. Haug. 2020. A neuropteran insect with the relatively longest prothorax: the "giraffe" among insects is the larva of a Necrophylus species from Libya (Neuroptera, Nemopteridae). Spixiana. 43: 305–314.

Jandausch, K., H. Pohl, U. Aspöck, S. L. Winterton and R. G. Beutel. 2018. Morphology of the primary larva of *Mantispa aphavexelte* Aspöck & Aspöck, 1994 (Neuroptera: Mantispidae) and phylogenetic implications to the order of Neuroptera. Arthropod systematics & phylogeny. 76: 529–560.

Jandausch, K., R. G. Beutel and R. Bellstedt. 2019. The larval morphology of the spongefly Sisyra nigra (Retzius, 1783) (Neuroptera: Sisyridae). Journal of Morphology. 280: 1742–1758.

Komatsu, T. 2014. Larvae of the Japanese termitophilous predator *Isoscelipteron okamotonis* (Neuroptera, Berothidae) use their mandibles and silk web to prey on termites. Insectes Sociaux. 61: 203–205.

Lai, Y., Y. Liu y X. Liu. 2021. Elevational diversity patterns of green lacewings (Neuroptera: Chrysopidae) uncovered with DNA barcoding in a biodiversity hotspot of Southwest China. Front. Ecol. Evol. 9: 778–686. DOI: 10.3389/fevo.2021.778686.

Lin, Y.-h., J.-r. Liao and C.-c Ko. 2021. Larval morphology of pit-building antlions of the tribe Myrmeleontini (Neuroptera, Myrmeleontidae) from Taiwan. Zoological Studies. 60: 1–24.

Linnaeus, C. 1758. Systema natura per regna tria naturae secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. 10th Edition. Vol. 1. Salvii, Holmiae. 824 pp.

Machado, R. J. P., J. P. Gillung, S. L. Winterton, I. J. Garzón-Orduña, A. R. Lemmon, E. M. Lemmon and J. D. Oswald. 2019. Owlflies are derived antlions: anchored phylogenomics supports a new phylogeny and classification of Myrmeleontidae (Neuroptera). Systematic Entomology. 44: 418–450. DOI: 10.1111/syen.12334.

Maia-Silva, C., M. Hrncir, D. Koedam, R. J. P. Pires Machado and V. L. I. Imperatriz Fonseca. 2013. Out with the garbage: the parastic strategy of the mantisfly Plega hagenella mass-infesting colonies of the eusocial bee Melipona subnitida in northeastern Brazil. Naturwissenschaften, Berlin. 100: 101–105.

Makarkin, V. N. and A. Ruchin. 2019. New data on Neuroptera and Raphidioptera of Mordovia (Rusia). Caucasian Entomological Bulletin. 15: 147–157.

Makarkin, V. N. and L. V. Egorov. 2020. New data on Neuroptera and Raphidioptera of the Chuvash Republic. Eversmannia. 64: 47–51.

Makarkin, V. N., S. Wedmann and T. Weiterschan. 2012. First record of a fossil larva of Hemerobiidae (Neuroptera) from Baltic amber. Zootaxa. 3417: 53–63.

Mantoanelli, E., G. S. Albuquerque, C. A. Tauber and M. J. Tauber. 2006. *Leucochrysa* (*Leucochrysa*) *varia* (Neuroptera: Chrysopidae): larval descriptions, developmental rates, and adult color variation. Annals of the Entomological Society of America. 99: 7–18.

Mantoanelli, E., C. A. Tauber, G. S. Albuquerque and M. J. Tauber. 2011. Larvae of four *Leucochrysa* (*Nodita*) species (Neuroptera: Chrysopidae: Leucochrysini) from Brazil's Atlantic coast. Annals of the Entomological Society of America, 104: 1233–1259.

Marquez-López, Y. and A. Contreras-Ramos. 2018. Description of the pupa of *Climaciella brunnea* (Say) (Mantispidae, Mantispinae) and a key to known pupae of mantispids from North America. Zootaxa. 4444: 66–72.

Marquez-López, Y. and A. Contreras-Ramos. 2019. A new species of *Wesmaelius* Krüger from Mexico, with a key to the New World species of the subgenus *Kimminsia* Killington (Neuroptera, Hemerobiidae). ZooKeys. 841: 61-70.

Marquez-López, Y., M. D. C. Herrera Fuentes and A. Contreras-Ramos. 2020. Alpha and beta diversity of dustwings and brown lacewings (Neuroptera: Coniopterygidae, Hemerobiidae) in a temperate forest of Tlaxcala, Mexico. Proceedings of the Entomological Society of Washington, 122: 869–889.

Martins, C. C., A. Ardila Camacho and G. W. Courtney. 2018. Neotropical Osmylidae larvae (Insecta, Neuroptera): description of habitats and morphology. Aquatic Insects. 32: 1–27. DOI: 10.1080/01650424.2018.1436181.

Martins, C. C., R. S. Santos, W. P. Sutil and J. F. A. de Oliveira. 2019. Diversity and abundance of green lacewings (Neuroptera: Chrysopidae) in a Conilon coffee plantation in Acre, Brazil. Acta Amazonica. 49: 173–178.

Matsuno, S. and H. Yoshitomi. 2016. Descriptions of three larvae of *Osmylus* species from Japan (Neuroptera: Osmylidae), with a proposed naming system for the larval sclerites. Zootaxa. 4189: 348–366.

Mendes, R. 2011. Neuroptera communities of the Azores: influence of the habitat and seasonality in the distribution, abundance and dominance. Master's thesis. Universidade dos Açores, Ponta Delgada, Portugal. ii + 56 pp.

Miguélez, D. and L. F. Valladares. 2008. Contribución al conocimiento de *Osmylus fulvicephalus* (Scopoli, 1763) en el área cantábrica: distribución y características del hábitat de su larva (Planipennia, Osmylidae). Graellsia. 64: 345–348.

Michel, B. 2019. Revision of the genus *Disparomitus* van der Weele, 1909 with descriptions of four new species (Neuroptera, Ascalaphidae). Zootaxa. 4551: 1–39. http://dx.doi.org/10.11646/zootaxa.4551.1.1

Möller, A., L. R. Minter and P. A. S. Olivier. 2006. Larval morphology of *Podallea vasseana* Navás and *Podallea manselli* Aspöck & Aspöck from South Africa (Neuroptera: Berothidae). African Entomology. 14: 1–12.

Monserrat, V. J. 1990. A systematic checklist of the Hemerobiidae of the world (Insecta: Neuroptera), pp. 215-262. In: Mansell, M.W. y H. Aspöck (Eds.). *Advances in Neuropterology, Proceedings of the Third International Symposium on Neuropterology*. Pretoria.

Monserrat, V. J. 2005. Nuevos datos sobre algunas pequeñas familias de neurópteros (Insecta: Neuroptera: Nevrorthidae, Osmylidae, Sisyridae, Dilaridae). Heteropterus: Revista de Entomología. 5: 1–26.

Monserrat, V. J. 2006. Nuevos datos sobre algunas especies de la familia Berothidae (Insecta: Neuroptera). Heteropterus: Revista de Entomología. 6: 173–207.

Monserrat, V. J. 2008. Sobre la morfología y la ultraestructura del huevo en algunas especies de Hemerobiidae (Insecta, Neuroptera). Graellsia. 64: 265–273.

Monserrat, V. J. 2014a. Los dilaridos de la península Ibérica (Insecta, Neuropterida, Neuroptera, Dilaridae). Heteropterus: Revista de Entomología. 14: 187–214.

Monserrat, V. J. 2014b. Los sisiridos de la península Ibérica (Insecta, Neuropterida, Neuroptera, Sisyridae). Heteropterus: Revista de Entomología. 14: 215–239.

Monserrat, V. J. 2014c. Los berótidos de la Península Ibérica (Insecta: Neuropterida: Neuroptera: Berothidae). Heteropterus: Revista de Entomología. 14: 31–54.

Monserrat, V. J. 2014d. Los osmílidos de la Península Ibérica (Insecta: Neuropterida: Neuroptera: Osmylidae). Heteropterus: Revista de Entomología. 14: 55–72.

Monserrat, V. J. 2014e. Los mantíspidos de la Península Ibérica y Baleares (Insecta, Neuropterida, Neuroptera, Mantispidae). Graellsia. 70(e012): 1–52.

Monserrat, V. J. 2015. Los hemeróbidos de la Península Ibérica y Baleares (Insecta, Neuropterida, Neuroptera: Hemerobiidae). Graellsia. 71(e026): 1–71.

Monserrat, V. J. 2016a. Los coniopterígidos de la Península Ibérica e Islas Baleares (Insecta, Neuropterida, Neuroptera: Coniopterigydae). Graellsia. 72(e047): 1–115.

Monserrat, V. J. 2016b. Los crisopidos de la península ibérica y baleares (Insecta, Neuropterida, Neuroptera: Chrysopidae). Graellsia. 72: 1–123.

Monserrat, V. J. and F. Acevedo. 2013. Los mirmeleónidos (Hormigas-León) de la peninsula ibérica e islas Baleares (Insecta, Neuropterida, Neuroptera, Myrmeleontidae). Graellsia. 69: 283–321.

Monserrat, V. J. and F. Marín. 1996. Plant substract specificity of Iberian Hemerobiidae (Insecta: Neuroptera). Journal of Natural History. 30: 775–787.

Monserrat, V. J. and L. M. Díaz-Aranda. 2012. Los estadios larvarios de los crisópidos Ibéricos (Insecta, Neuroptera, Chrysopidae), nuevos elementos sobre la morfología larvaria aplicables a la sistemática de la familia. Graellsia. 68: 31–158.

Monserrat, V. J., V. Triviño and F. Acevedo. 2012. Los nemoptéridos y crócidos de la Península Ibérica (Insecta: Neuroptera: Nemopteridae, Crocidae). Heteropterus: Revista de Entomología. 12: 231–255.

Morales, J. 2020. Notas ecológicas de esponjas dulceacuícolas parasitadas por larvas de *Sisyra iridipennis* Costa, 1884 (Neuroptera: Sisyridae) en el río Águeda (Salamanca, España). Nova Acta Científica Compostelana (Bioloxía). 27: 29–34.

Neuenschwander, P. 1975. Influence of temperature and humidity on the immature stages of *Hemerobius pacificus*. Environmental Entomology. 4: 215–220.

Neuenschwander, P. 1976. Biology of the adult Hemerobius pacificus. Environmental Entomology. 5: 96–100.

New, T. R. 1975. The biology of Chrysopidae and Hemerobiidae (Neuroptera), with reference to their usage as biocontrol agents: a review. Ecological Entomology. 127: 115–140.

New, T. R. 1982. The larva of *Nymphes* Leach (Neuroptera, Nymphidae). Neuroptera International. 2: 79–84.

New, T. R. 1986. A review of the biology of Neuroptera Planipennia. Neuroptera International. 1: 1–57.

New, T. R. 1991. Neuroptera (lacewings). Pp. 525-542 in Naumann, I. D. (chief ed.). The Insects of Australia. 2nd Edition. Vol. 1. Melbourne University Press, Melbourne.

New, T. R. 1997. Neuroptera of Australia: faunal elements, diversity and relationships. Deutsche Entomologische Zeitschrift. 44: 259–265.

New, T. R. and K. J. Lambkin. 1989. The larva of *Norfolius* (Neuroptera: Nymphidae). Systematic Entomology, 14: 93–98.

Oliveira, R. C., R. I. R. Lara, A. R. Fonseca and N. W. Perioto. 2013. Hemerobiidae (Neuroptera) in the midwestern region of Minas Gerais State, Brazil. Revista Colombiana de Entomología. 39: 256–259.

Oswald, J. D. 2020. Lacewing digital library. Neuropterida species of the World. http://lacewing.tamu. edu/Species-Catalogue/index.html.

Oswald, J. D. and R. J. P. Machado. 2018. Biodiversity of the Neuropterida (Insecta: Neuroptera: Megaloptera, and Raphidioptera). Pp. 627-671. In: Foottit, R. G.; Adler, P. H. (eds.). Insect Biodiversity: science and society. Vol. II. First Edition. John Wiley & Sons, New York.

Pacheco-Rueda, I., J. R. Lomelí-Flores, E. Rodríguez-Leyva and M. Ramírez-Delgado. 2011. Ciclo de vida y parámetros poblacionales de Sympherobius barberi Banks (Neuroptera: Hemerobiidae) criado con Dactylopius opuntiae Cockerell (Hemiptera: Dactylopiidae). Acta Zoológica Mexicana. 27: 325–340.

Paiva, I. G., A. M. Auad, B. A. Verssimo and L. C. P. Silveira. 2020. Differences in the insect fauna associated to a monocultural pasture and a silvopasture in Southeastern Brazil. Sci. Rep. 10: 12112. DOI: https://doi.org/10.1038/s41598020689735.

Pantaleoni, R. A. and D. Lepera. 1985. I Neurotteri delle colture agrarie: indagine sui crisopidi in agrumeti della Calabria. Pp. 451-457. In: *Atti XIV Congresso Nazionale Italiano di Entomologia* (held in Palermo-Erice-Bagheria 28 May - 1 June 1985).

Pantaleoni, R. A. 1990. I Neurotteri (Neuropteroidea) della Valle del Bidente-Ronco (Appennino Romagnolo). Bollettino dell'Istituto di Entomologia “guido Grandi” della Università degli studi di Bologna. 44: 89–142.

Pappas, M. L., G. D. Broufas and D. S. Koveos. 2008. Effect of temperature on survival, development and reproduction of the predatory lacewing *Dichochrysa prasine* (Neuroptera: Chrysopidae) reared on *Ephestia Kuehniella* eggs (Lepidoptera: Pyralidae). Biological Control. 45: 396–403.

Penny, N. D. and S. de Freitas. 2001. Sexual dimorphism in Ceraeochrysa cubana (Neuroptera: Chrysopidae). Journal of the Kansas Entomological Society. 74: 57–58.

Penny, N. D., J. R. Arias and J. S. Armistead. 2007. Seasonal emergence of Neuroptera in Fairfax County, Virginia. Proceedings of the California Academy of Sciences. 58: 7–19.

Pessoa, L. G. A., M. V. Leite, S. de Freitas and G. C. Garbin. 2004. Efeito da variação da temperatura sobre o desenvolvimento embrionário e pós-embrionário de *Ceraeochrysa paraguaria* (Navás) (Neuroptera: Chrysopidae). Arquivos do Instituto Biológico. 71: 473–476.

Podlesnik, J., P. Jakšić, A. Nahirnić, F. Janžekovič, T. Klenovšek, V. Klokočovnik and D. Devetak. 2019. Fauna of the brown lacewings of Serbia (Insecta: Neuroptera: Hemerobiidae). Acta Entomologica Slovenica. 27: 17–29.

Reguilón, C. and S. R. Nuñez Campero. 2005. Morfología de los estadios larvales de *Sympherobius marmoratipennis* (Neuroptera: Hemerobiidae). Revista de la Sociedad Entomológica Argentina. 64: 81–85.

Ribeiro, A. E. L., M. A. Castellani, A. A. Moreira, R. P. Maluf, C. G. V. Silvaand and A. S. Santos. 2013. Diversidade e sazonalidade de crisopídeos (Neuroptera: Chrysopidae) em plantas de urucum. Horticultura Brasileira. 31: 636–641.

Ricci, M. dos S. F., J. R. Costa, A. N. Pinto and V. L. S Santos. 2006. Cultivo orgânico de cultivares de café a pleno sol e sombreado. Pesquisa Agropecuária Brasileira. 41: 569–575.

Root, R. B. 1973. Organization of a plant-arthropod association in simple and diverse habitats: the fauna of collards (*Brassica oleracem*). Ecological Monographs. 43: 94–125.

Santos, P. S. and R. Pérez-Maluf. 2012. Diversidade de himenópteros parasitoides em áreas de mata de cipó e cafezais em Vitória da Conquista-Bahia. Magistra. 24: 84–90.

Sarmiento-Cordero, M. A and A. Contreras-Ramos. 2019. Two new species and a key to the dustywings of Mexico (Neuroptera, Coniopterygidae). Zootaxa. 554: 551–563.

Sarmiento-Cordero, M. A., B. Rodríguez-Vélez, F. M. Huerta-Martínez, C. A. Uribe-Mú and A. Contreras-Ramos. 2021. Estructura de la comunidad de Neuroptera (Insecta) en un cultivo de limón mexicano en Colima, México. Revista Mexicana de Biodiversidad. 92: e923399.

Satar, A. and C. Özbay. 2004. Eggs, first instar larvae and distribution of the neuropterids Lertha extensa and L. sheppardi (Neuroptera: Nemopteridae) in south-eastern Turkey. Zoology in the Middle East. 32: 91–96.

Serée, L., R. Rouzes, D. Thiéry and A. Rusch. 2020. Temporal variation of the effects of landscape composition on lacewings (Chrysopidae: Neuroptera) in vineyards. Agricultural and Forest Entomology. 22: 274–283.

Silva, P. S., C. A. Tauber, G. S. Albuquerque and M. J. Tauber. 2013. Larvae of five horticulturally important species of *Chrysopodes* (Neuroptera, Chrysopidae): shared generic features, descriptions and keys. ZooKeys, 262: 39–92.

Simanton, W. A. 1976. Occurrence of insect and mite pests of citrus, their predators and parasitism in relation to spraying operations. J. Series FL Agric. Exp. St. 51349: 135–63.

Stelzl, M. and D. Devetak. 1999. Neuroptera in agricultural ecosystems. Agriculture, Ecosystems & Environment. 74: 305–321.

Suludere, Z., A. Satar, S. Candan and S. Canbulat. 2006. Morphology and surface structure of eggs and first instar larvae of Dielocroce baudii (Neuroptera: Nemopteridae) from Turkey. Entomological News, Philadelphia. 117: 521–530.

Szentkirályi, F. 1989. Aphidophagus chrysopid and hemerobiid (Neuropteroidea) subguilds in different maize fields: Influence of vegetational diversity on subguild structure. Acta Phytopathologica et Entomologica Hungarica. 24: 207–211.

Sziráki, G. 2011. Coniopterygidae of the world. Annotated check-list and identification keys for living species, species groups and supraspecific taxa of the family. Lambert Academic Publishing, Saarbrücken. 249 pp.

Sziráki, G. and O. S. Jr Flint. 2005. Larva of *Brucheiser penai* Riek, 1975 (Neuroptera Coniopterygidae). Annali del Museo Civico di Storia Naturale di Ferrara. 8: 45–48.

Tauber, M. J., C. A. Tauber and S. Gardescu. 1993. Prolonged storage of *Chrysoperla carnea* (Neuroptera: Chrysopidae). Environmental Entomology. 22: 843–848.

Tauber, C. A 2014. Nothochrysinae (Neuroptera: Chrysopidae): new larval description and generic synonymy, with a consideration of generic relationships. Psyche. (ID839261): 1–10.

Tauber, C. A. and D. K. Faulkner. 2015. *Pimachrysa* (Neuroptera: Chrysopidae: Nothochrysinae): larval description and support for generic relationships. Psyche. (ID875738): 1–19.

Tauber, C. A., M. J. Tauber and G. S. Albuquerque. 2009. Neuroptera (Lacewings, Antlions). *Encyclopedia of insects.* Academic Press, London. pp. 785-798.

Tauber, C. A., M. J. Tauber and G. S. Albuquerque. 2014. Debris-carrying in larval Chrysopidae: unraveling its evolutionary history. Annals of the Entomological Society of America. 107: 295–314.

Thierry, D. and M. Canard. 2005. The biodiversity of green lacewings (Neuroptera Chrysopidae) in a mosaic ecosystem in southern France. In: Pantaleoni, R.A., A. Letardi, C. Corazza. (eds.). Proceedings of the Ninth International Symposium on Neuropterology (20-23 June 2005, Ferrara, Italy). *Annali del Museo Civico di Storia Naturale di Ferrara*, 8:131-138.

Thierry, D., B. Deutsch, M. Paulian, J. Villenave and M. Canard. 2005. Typifying ecosystems by using green lacewing assemblages. Agronomy for Sustainable Development. 25: 473–479.

Trillo, M. C., J. A. Ardila and M. J. Albo. 2015. Ocurrencia de mantíspidos (Neuroptera, Mantispidae) eclosionados de ootecas en tres especies de araña (Araneae: Trechaleidae) de Uruguay. Boletín de la Sociedad Zoológica del Uruguay. 24: 198–205.

Vas, J., L. Ábrahám and V. Markó. 2001. Methodological investigations on a Neuropteroidea community. Acta Phytopathologica et Entomologica Hungarica. 36: 101–113. DOI: 10.1556/APhyt.36.2001.1-2.14

Wedmann, S., V. N. Makarkin, T. Weiterschan, and T. Hörnschemeyer. 2013. First fossil larvae of Berothidae (Neuroptera) from Baltic amber, with notes on the biology and termitophily of the family. Zootaxa. 3716: 236–258.

Weissmair, W. 2005. Schwammhafte (Insekta: Neuroptera: Sisyridae) -- Parasiten der Moostiere (Bryozoa). Denisia. 16: 299–304.

Winterton, S. L., N. B. Hardy and B. M. Wiegmann. 2010. On wings of lace: phylogeny and bayesian divergence time stimates of Neuropterida (Insecta) based on morphological and molecular data. Systematic Entomology, 35: 349–378.

Winterton, S. L. and V. N. Makarkin. 2010. Phylogeny of moth lacewings and giant lacewings (Neuroptera: Ithonidae, Polystoechotidae) using DNA sequence data, morphology and fossils. Annals of the Entomological Society of America. 103: 511–522.

Winterton, S. L., A. R. Lemmon, J. P. Gillung, I. J. Garzón, D. Badano, D. K. Bakkes, L. C. V. Breitkreuz, M. S. Engel, E. M. Lemmon, X. Liu, R. J. P Machado, J. H. Skevington and J. D. Oswald. 2018. Evolution of lacewings and allied orders using anchored phylogenomics (Neuroptera, Megaloptera, Raphidioptera). Systematic Entomology. 43: 330–354. DOI: https://doi.org/10.1111/syen.12278.

Yayla, M. and S. Satar. 2012. Temperature influence on development of *Sympherobius pygmaeus* (Rambur) (Neuroptera: Hemerobiidae) reared on *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae). Türkiye Entomoloji Dergisi. 36: 11–22.

Zhao, Y., G. Sziráki and Z. Liu. 2022. Two new species of *Heteroconis* Enderlein, 1905 from China (Neuroptera, Coniopterygidae). ZooKeys 1081: 89–98. DOI: https://doi.org/10.3897/zookeys.1081.72606

Table 1. Some recent studies on information about immature stages of the different families of Neuroptera

Family	Immature stage studies	References
Berothidae	Taxonomic-Biology/extant	Möller et al. 2006
	Taxonomic-Biology/extant	Monserrat 2006
	Taxonomic-Biology/extinct	Wedmann et al. 2013
	Biology/extant	Komatsu 2014
	Taxonomic-Biology/extant	Monserrat 2014c
Chrysopidae	Taxonomic-Biology/extant	Mantoanelli et al. 2006
	Biology/extant	Aves de Oliveira et al. 2010
	Taxonomic-Biology/extant	González-Olazo and Heredia 2010
	Biology-Biologic control/extant	Hayashi and Nomura 2011
	Taxonomic/extant	Mantoanelli et al. 2011

	Faunistic-Taxonomic-Biology/extant	Monserrat and Díaz-Aranda 2012
	Taxonomic-Biology/extant	Silva et al. 2013
	Taxonomic-Systematic/extant	Tauber 2014
	Taxonomic-Systematic-Biology/extant	Tauber et al. 2014
	Taxonomic-Systematic-Biology/extant	Tauber and Faulkner 2015
	Taxonomic-Biology/extant	Monserrat 2016b
	Biology- Biologic control/extant	Hernández-Juárez et al. 2016
Coniopterygidae	Taxonomic/extant	Sziráki and Flint 2005
	Taxonomic-Biology/extant	Monserrat 2016a
Dilaridae	Biology/extant	Monserrat 2005
	Taxonomic-Biology/extant	Monserrat 2014a
	Taxonomic-Systematic/extant	Badano et al. 2021
Hemerobiidae	Taxonomic/extant	Reguilón and Nuñez-Campo 2005
	Taxonomic/extant	Monserrat 2008
	Biology/extant	Pacheco-Rueda et al. 2011
	Taxonomic/extinct	Makarkin et al. 2012
	Taxonomic-Biology/extant	Monserrat 2015
Ithonidae	Taxonomic-Systematic/extant	Grebennikov 2004
	Biology/extant	De Jong 2011
Mantispidae	Biology/extant	Cannings and Cannings 2006
	Taxonomy-Biology/extant	Monserrat 2014e
	Biology/extant	Trillo et al. 2015
	Biology/extant	Baliteau 2016
	Biology/extant	Dorey and Merritt 2017
	Taxonomic-Systematic/extant	Jandausch et al. 2018
	Taxonomic/extant	Marquez-López and Contreras-Ramos 2018
Myrmeleontidae	Taxonomic-Biology/extant	Devetak et al. 2010
	Biology/extant	Monserrat and Acevedo 2013
	Taxonomic/extant	Acevedo et al. 2013
	Taxonomic-Biology/extant	Badano and Pantaleoni 2014
	Taxonomic-Ecology/extant	Acevedo et al. 2014
	Taxonomic-Systematic-Ecology/extant	Badano et al. 2016
	Ecology/extant	Antoł et al. 2018
	Taxonomic/extant	Acevedo et al. 2020
	Taxonomic/extant	Badano 2020
	Taxonomic-Ecology/extant	Lin et al. 2021
Nemopteridae	Taxonomic/extant	Satar and Özbay, 2004
	Taxonomic/extant	Candan et al. 2005
	Taxonomic/extant	Suludere et al. 2006
	Biology/extant	Monserrat et al.2012
	Taxonomic/extant	Herrera-Flórez et al. 2020
Nevrorthidae	Taxonomic-Systematic/extant	Beutel et al. 2010

	Biology-Ecology/extant	Gavira et al. 2012
	Taxonomic-Systematic-Biology/extinct-extant	Haug et al. 2020
Nymphidae	Taxonomic/extant	New 1982
	Taxonomic/extant	New and Lambkin 1989
Osmylidae	Distribution-Biology/extant	Miguélez and Valladares, 2008
	Biology/extant	Monserrat 2014d
	Taxonomic/extant	Matsuno and Yoshitomi 2016
	Taxonomic-Biology/extant	Martins et al. 2018
Psychopsidae	Taxonomic/extant	Bakkes et al. 2017
Rachiberothidae	Biology/extant	Buys 2008
	Biology/extant	Maia-Silva 2013
	Taxonomic-Biology/extant	Ardila-Camacho et al. 2021
	Biology/extant	De Lira-Ramos et al. 2022
Sisyridae	Biology/extant	Weissmair 2005
	Taxonomic/extant	Bowles 2006
	Taxonomic-Biology/extant	Monserrat, 2014b
	Taxonomic-Biology/extant	Fisher et al. 2019
	Taxonomic-Systematic/extant	Jandausch et al. 2019
	Biology-Ecology/extant	Morales 2020

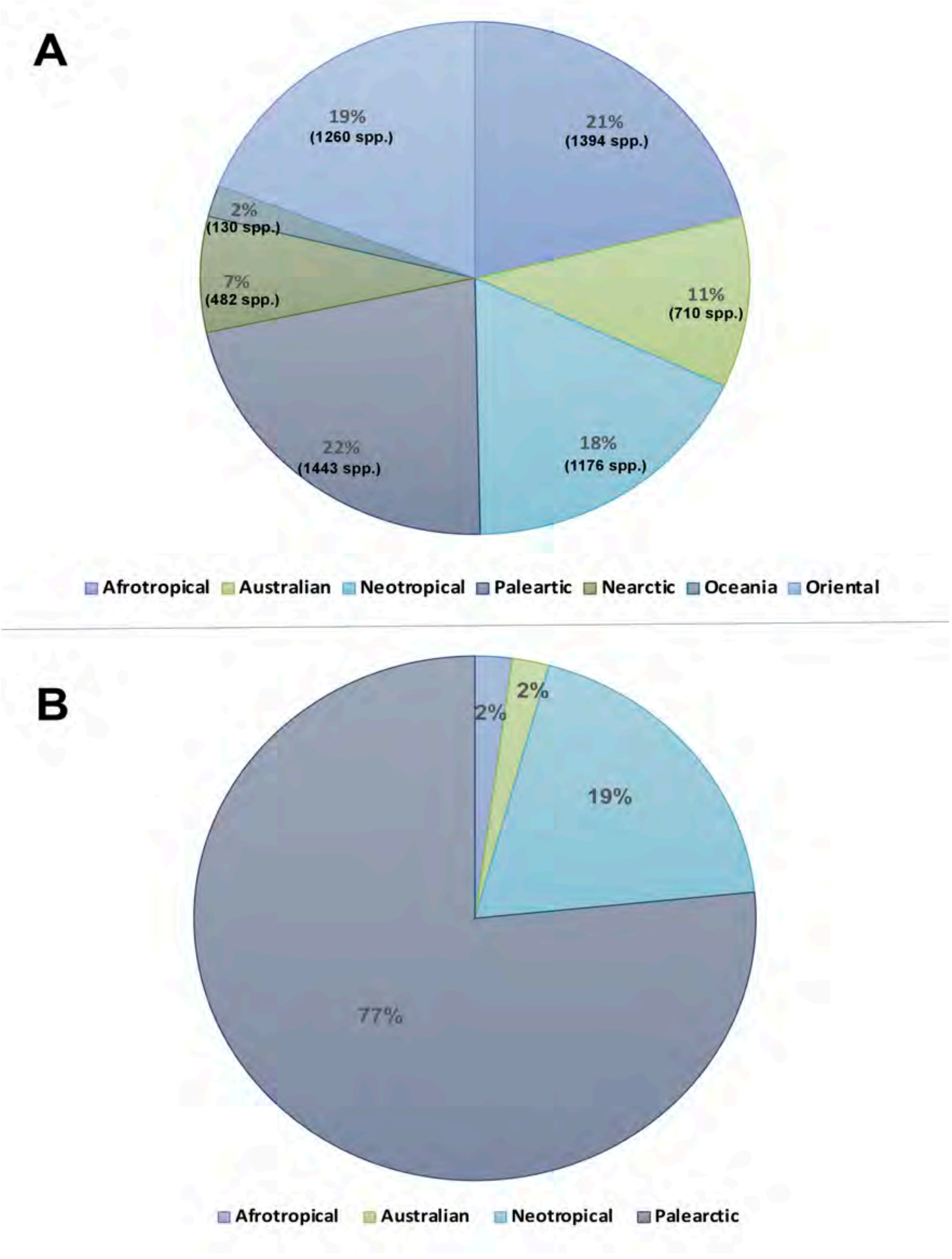


Fig. 1 A) Percentage of all Neuropterid species present in each biogeographical region (Oswald and Machado, 2018). B) Percentage of the total number of scientific articles (emphasis on the study of the diversity of Neuroptera) produced in the different biogeographical regions (n=50).

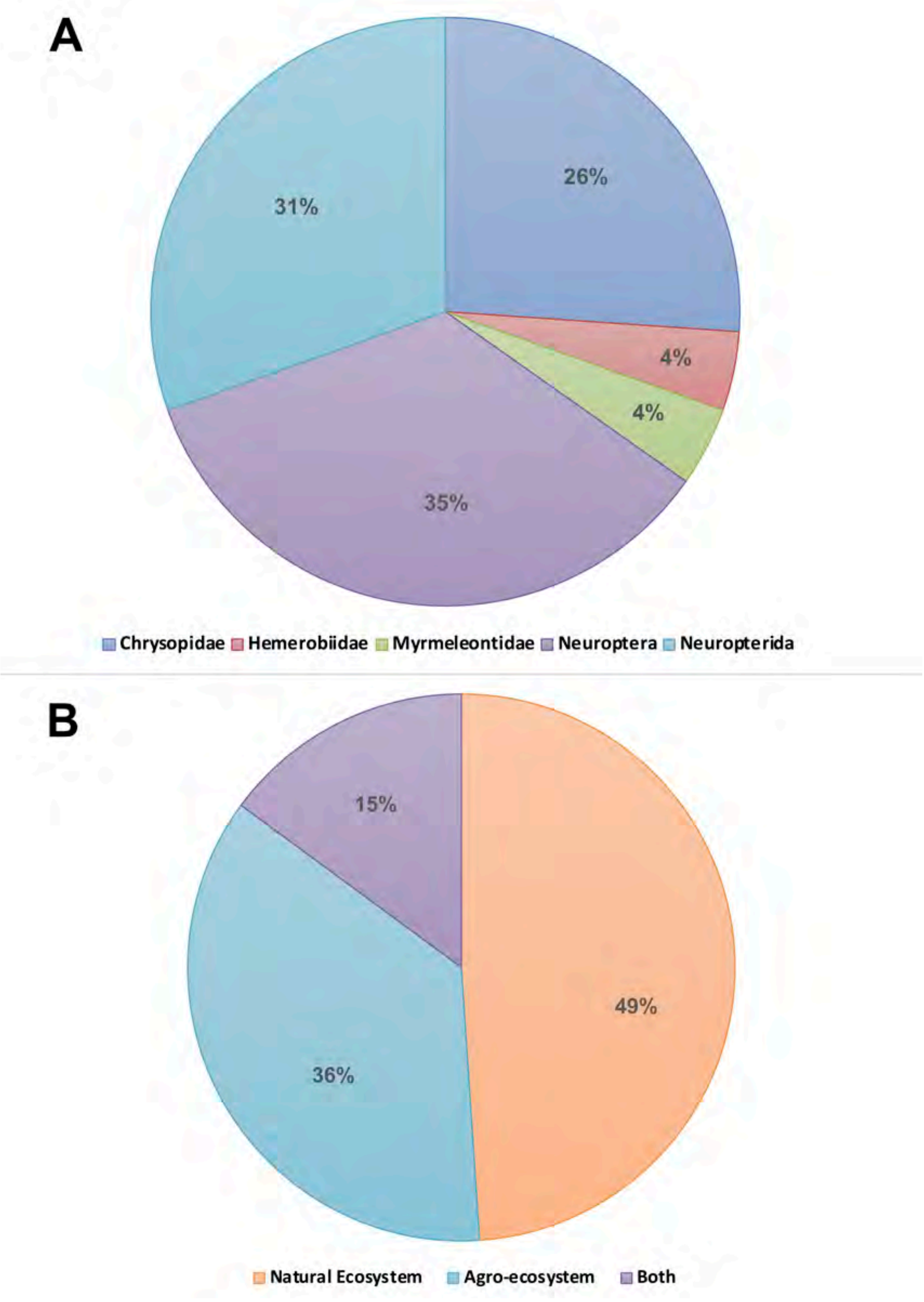


Fig. 2 A) Percentage of study groups most used in scientific articles on diversity. B) Percentage of studies on the diversity of Neuroptera carried out in the main habitats (n=50).

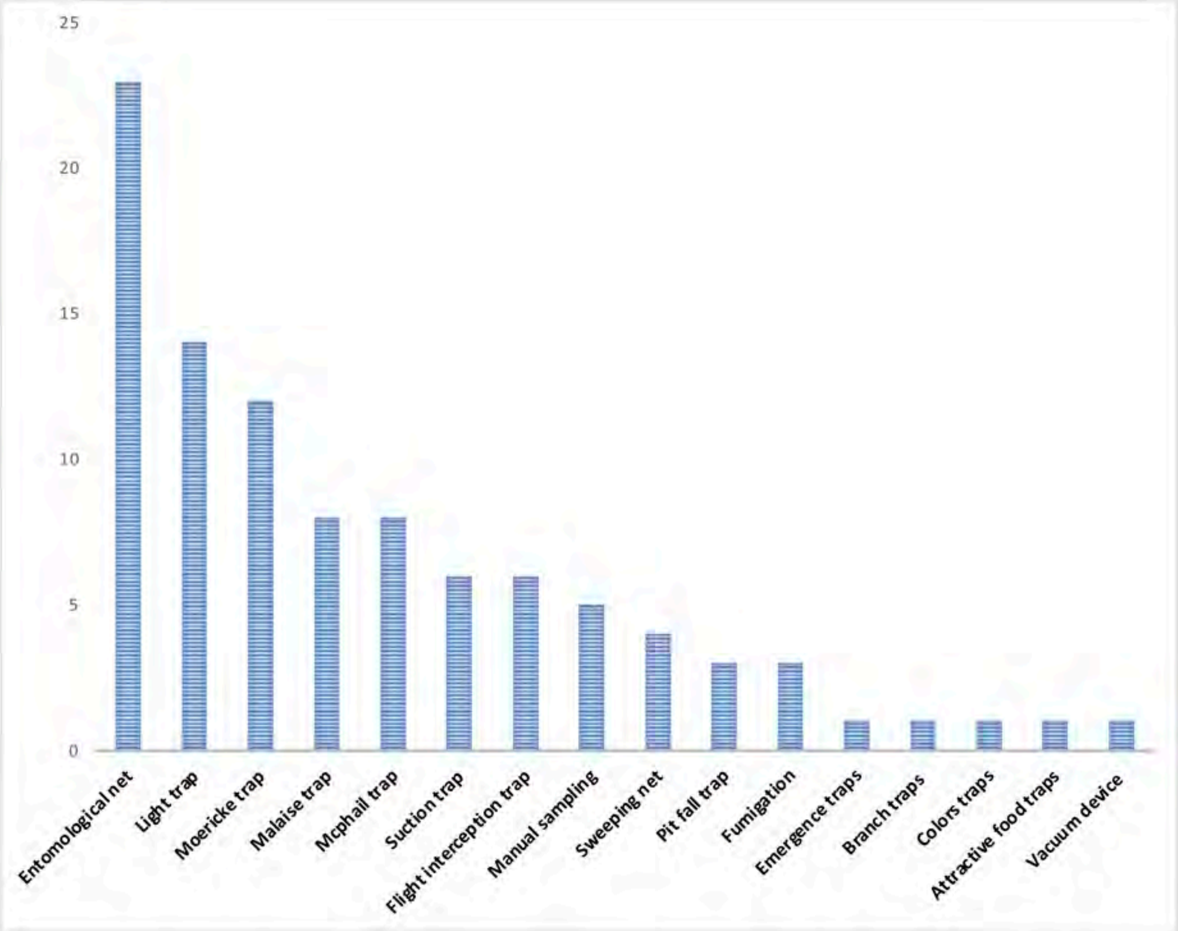


Fig. 3 Frequency of use of different sampling methods for diversity studies of Neuroptera (n = 50).

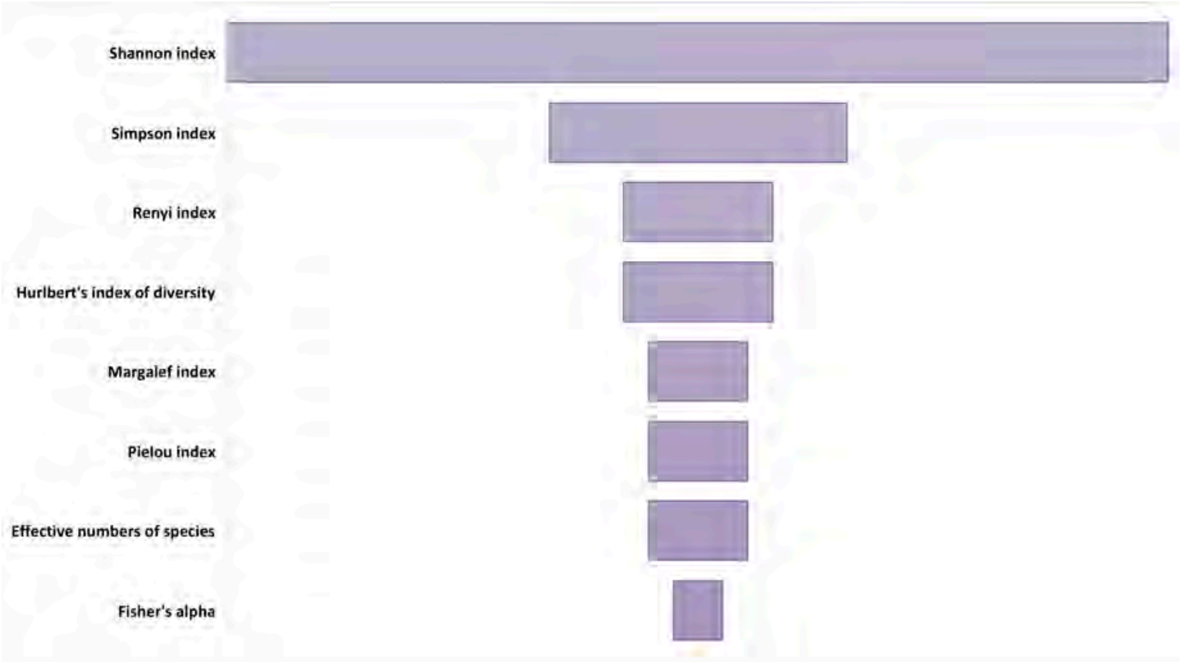


Fig. 4 Frequency of use of different diversity index used in scientific articles of the order Neuroptera (n=50)

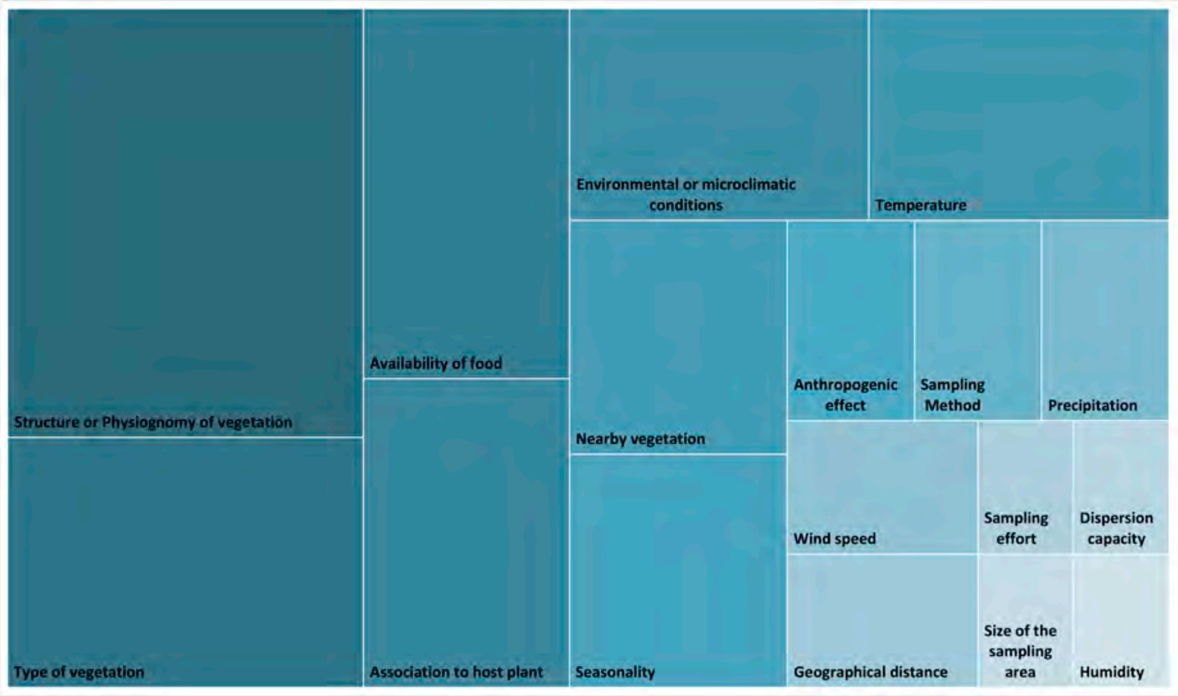


Fig. 5 Reported factors that may influence the diversity of neuropterans in the diversity studies reviewed (Hierarchical chart, with the big and most intense color frames as the most frequently mentioned factors) (n = 50).

Supplementary material. Table of previous studies on Neuroptera diversity worldwide.

Biogeographical region	Richness	# of families	Study group	Altitudinal range (m.a.s.l.)	Habitat	Diversity Analysis	Factors Influencing Diversity	Sampling method	Sampling time (Months)	References
Palearctic	50	7	Neuroptera	550-1300	Natural ecosystem	Without diversity analysis	Vegetation structure	Entomological net, Manual collection, Beating net	16	Marín, F. 1994. Las comunidades de neuropterós de la provincia de Albacete (Insecta: Neuropteroidea). Al-Basit, Estudios Albacetenses, 34:247-304.
Afrotropical	12	1	Myrmeleontidae	No data	Natural ecosystem	Shannon index, Simpson index, Pielou index, Sorensen index, Jaccard index	Environmental conditions and habitat type	Entomological net, Manual collection	12	Bakoidi, A., F. Dobo, I. Djibo, J. Maoge, Hakan Bozdogan and L. S. Tinkeu Ngamo. 2020. Diversity and distribution of antlions (Neuroptera: Myrmeleontidae) in the Northern region of Cameroon (Afrotropical region). Journal of Biodiversity and Environmental Sciences, 16:61-71.
Palearctic	10	1	Chrysopidae	No data	Natural ecosystem/ Agroecosystem	Shannon Index, Ronkoren Index, Eveness Index	Vegetation structure and size of the sampling area	Entomological net	14	Bozsik, A. 1994. Impact of vegetational diversity on structure parameters of chrysopid assemblages. Redia, 77:69-77.
Palearctic	2	1	Myrmeleontidae	No data	Natural ecosystem	Without diversity analysis	Precipitation and Temperature	Manual collection	18	Bozdoğan, H., y A. Satar. 2017. Seasonal abundance and diversity of some pit building antlions larvae (Neuroptera: Myrmeleontidae). Journal of Natural and Applied Sciences, 33:121-126.
Australian	41	7	Neuroptera	1100-1400	Natural ecosystem/ Agroecosystem	Without diversity analysis	Type of vegetation	Entomological net, Light trap, Fumigation	5	New, T. R. 1989. Preliminary appraisal of a tropical lacewing fauna: local diversity of Neuroptera around Wau, Papua New Guinea. Neuroptera International, 5:211-218
Palearctic	37	6	Neuropterida	ca. 100	Agroecosystem	Renyi diversity formula, Similarity (Horn Index)	The type of trap used affects the sample obtained from the Neuropteroid communities	Light trap, Malaisetrap, Suction trap	8	Ábrahám, L., V. Markó and J. Vas. 2003. Investigations on a neuropteroid community by using different methods. Acta Phytopathologica et Entomologica Hungarica, 38:199-207.
Palearctic	43	5	Neuropteroidea	470	Agroecosystem	Renyi diversity formula, Similarity (Horn Index)	Type of sampling method and morphological and behavioral characteristics of the species	Light Trap, Malaise Trap, Suction Trap, Yellow Plate Trap	18	Vas, J., L. Ábrahám and V. Markó. 2001. Methodological investigations on a Neuropteroidea community. Acta Phytopathologica et Entomologica Hungarica, 36:101-113
Palearctic	11	1	Chrysopidae	No data	Agroecosystem	Without diversity analysis	Possibly the seasonality	Mcphail Trap	12	Campos, M. and P. Ramos. 1983. Chrisopidos (Neuroptera) capturados en un olivar del sur de Espana. Neuroptera International, 2:219-227.
Palearctic	31	5	Neuroptera	400-1400	Natural ecosystem/ Agroecosystem	Shannon and Simpson index, Bray Curtis analysis (dissimilarity)	Type of vegetation and environmental factors (Precipitation, Temperature, Wind speed, Humidity)	Entomological net, Light trap	12	Bozdogan, H. 2020a. Diversity of lacewing assemblages (Neuropterida: Neuroptera) in different forest habitats and agricultural areas in the East Mediterranean area of Turkey. Entomological Research, 50, 163–173.

Palearctic	26	5	Neuroptera	622-2050	Natural ecosystem	Dominance Index, Simpson Index, Shannon Index	Wind speed, temperature, distance between forest areas	Entomological net, Light trap	17	Bozdogan, H. 2020b. Species richness and composition of Neuroptera in the forests fragments of the Taurus Mountains Range, Turkey. Saudi Journal of Biological Sciences, 27:1201-1207.
Neotropical	30	1	Chrysopidae	950-1200	Natural ecosystem	Shannon Index, Jaccard Index	Plant physiognomy and temperature	Entomological net	16	Costa, R. I .F., B. Souza and S. de Freitas. 2010. Spatiotemporal dynamic of green lacewings (Neuroptera Chrysopidae) taxocenosis on natural ecossystems. Neotropical Entomology 4:470–475.
Palearctic	12	5	Neuroptera	950-1500	Natural ecosystem	Without diversity analysis	Possibly the food resource influences the presence of the species	Entomological net, Light trap	10	Bozdogan, H. and E. Toroglu. 2016. Lacewing (Insecta: Neuroptera) fauna of Başkonuş Mountain National Park (Kahramanmaraş Province-Turkey). BAUN Fen Bil. Enst. Dergisi, Cilt, 18:89-103
Palearctic	62	4	Neuropterida	100-960	Natural ecosystem	Alpha diversity (Fisher's alpha), Eveness (Shannon's J)	Association with host plant, microclimatic conditions, flight behavior and nutritional requirements	Flight intercept trap	8 to 24	Gruppe, A. 2008. Diversity and host tree preference of Neuropterida (Insecta) in mixed forest stands in Germany. Pp. 145–156. In: Floren, A.; Schmidl, J. (editors). Canopy Arthropod Research in Europe: basic and applied studies from the high frontier. Bioform, Nürnberg. 576 pp.
Palearctic	58	4	Neuroptera	No data	Natural ecosystem/ Agroecosystem	Without diversity analysis	Plant physiognomy	Yellow plate trap, Intercept traps, Pitfall traps	20	Duelli, P., M. K. Obrist and P. F. FlÜckiger. 2002. Forest edges are biodiversity hotspots– also for neuroptera. Acta Zoologica Academiae Scientiarum Hungaricae, 48:75–87
Palearctic	44	4	Neuropterida	410-465	Natural ecosystem	Without diversity analysis	Plant physiognomy and tree host species	Flight intercept trap, Emergency trap, Branch trap	21	Gruppe, A. and H. Schubert. 2001. The spatial distribution and plant specificity of Neuropterida in different forest sites in southern Germany. Beiträge zur Entomologie, 51:517-527
Palearctic	31	4	Neuropterida	364	Natural ecosystem	Without diversity analysis	Plant physiognomy	Flight intercept trap	7	Gruppe, A. and J. Müller. 2005. Distribution of Neuropterida in beech dominated forests in southern Germany. In: Pantaleoni, R. A.; Letardi, A.; Corazza, C. (editors). Proceedings of the Ninth International Symposium on Neuropterology. Meeting: 20-23 June 2005, Ferrara, Italy. Annali del Museo Civico di Storia Naturale di Ferrara, 8:145-152.
Palearctic	23	4	Neuropteroidea	900-1060	Natural ecosystem	Without diversity analysis	Plant physiognomy and type of vegetation	Entomological net, Beating net	9	Marín, F. and V. J. Monserrat. 1987. Los neurópteros del encinar ibérico (Insecta, Neuropteroidea). Boletín de Sanidad Vegetal, Plagas, 13:347-359.
Palearctic	15	1	Chrysopidae	91	Agroecosystem	Shannon Index, Margalef Index, Hurlbert Index	There are no specific factors	Light trap	ca. 63	Deutsch, B., M. Paulian, D. Thierry and M. Canard. 2005. Quantifying biodiversity in ecosystems with green lacewing assemblages. Agronomy for Sustainable Development, 25:337-343.
Palearctic	39	3	Neuropterida	No data	Natural ecosystem	Shannon and Pielou Diversity Index, Similarity (Sorensen and Morisita Index)	Vegetation structure and food availability	Yellow plate trap.	7	Czechowska, W. 1997. A comparative analysis of the structure of Neuropteroidea communities of tree canopies in linden-oak-hornbeam forests, light oak forests, mixed coniferous forests and pine forests. Fragmenta Faunistica, 40:127-168
Neotropical	6	1	Chrysopidae	478	Agroecosystem	Without diversity analysis	There are no specific factors	Entomological net, Plastic bottle trap	6	González Olazo, E. V., I. Redolfi, G. Patt and M. Campos. 2012. Diversidad específica de controladores biológicos crisópidos (Neuroptera: Chrysopidae) en el germoplasma olivícola en la Plaza Solar, La Rioja, Argentina. UNLaR Ciencia, 1:31-35.
Palearctic	38	3	Neuroptera	100-800	Natural ecosystem	Similarity (Sorensen and Morisita index)	Climatic and habitat conditions	Yellow plate trap.	6	Czechowska, W. 2002. Raphidioptera and Neuroptera (Neuropterida) of the canopy in montane, upland and lowland fir forests of Abies alba Mill. In Poland. Fragmenta Faunistica, 45:31-56.
Palearctic	30	3	Neuropterida	No data	Natural ecosystem	Similarity (Sorensen Index)	Type of vegetation and food availability	Moericke's trap	16	Czechowska, W. 1985. Neuropteran (Planipennia and Raphidioptera; Neuropteroidea) communities of coniferous forest in the Kampinoska Forest and in Bialoleka Dworska near Warsaw. Fragmenta Faunistica, 29:391-404.

Palearctic	30	3	Neuropterida	No data	Natural ecosystem	Similarity (Sorensen and Morisita Index)	There are no specific factors	Entomological net, Moericke trap	7	Czechowska, W. 1990. Neuropterans (Neuropteroidea) of linden-oak-hornbeam and thermophilous oak forests of the Mazovian Lowland. Fragmenta Faunistica, 34:95-119.
Palearctic	27	3	Neuropterida	500-960	Natural ecosystem	Without diversity analysis	Association with host plant	Flight intercept trap	8	Gruppe, A. 2006. Vergleich der Neuropteren-Zönosen auf Tanne und Fichte in Bayern (Neuropterida: Raphidioptera, Neuroptera). Beiträge zur Bayerischen Entomofaunistik, 8:1-11.
Palearctic	27	3	Neuroptera	No data	Natural ecosystem	Without diversity analysis	Association to vegetation	Color traps	7	Saure, C. and K. H. Kielhorn. 1993. Netzflügler als Bewohner der Kronenregion von Eiche und Kiefer (Neuroptera: Coniopterygidae, Hemerobiidae, Chrysopidae). Faunistisch-Ökologische Mitteilungen, 6:391-402.
Palearctic	25	3	Neuropteroidea	300-400	Natural ecosystem/ Agroecosystem	Renyi diversity formula, Horn and Jaccard index (Similarity)	Habitat preference, diversity of habitats	Malaise trap	14	Vas, J., V. Markó, L. Ábrahám and Z. Mészáros. 2001. Study of Neuropteroidea (Raphidioptera, Neuroptera) communities by using Malaise traps in an untreated orchard and its environment. Acta Phytopathologica et Entomologica Hungarica, 36:115-122.
Palearctic	22	3	Neurotpterida	ca. 400	Natural ecosystem	Hurlbert index, Shannon index, Diversity log series alfa	diversity of trees	Flight intercept trap	6	Gruppe, A. and S. Sobek. 2011. Effect of tree species diversity on the neuropterid community in a deciduous forest. Acta Entomologica Slovenica,, 19:17-28.
Neotropical	21	3	Neuroptera	81	Agroecosystem	Alpha diversity sensu Jost (Hill numbers 0,1 and 2)	Food availability	Entomological net, Beating net, Malaise trap, Yellow plate trap, Fumigation	13	Sarmiento-Cordero, M. A., B. Rodríguez-Vélez, F. M. Huerta-Martínez, C. A. Uribe-Mú and A. Contreras-Ramos. 2021. Estructura de la comunidad de Neuroptera (Insecta) en un cultivo de limón mexicano en Colima, México. Revista Mexicana de Biodiversidad, 92: e923399.
Palearctic	24	2	Neuroptera	No data	Agroecosystem	Shannon-Wiener index, Similarity with Whittaker and Fairbanks formula.	There are no specific factors	Entomological net, Manual collection, Beating net, Light trap, Suction trap, Yellow plate trap, Pitfall traps	ca. 28	Szabó, S.and F. Szentkirályi. 1981. Communities of Chrysopidae and Hemerobiidae (Neuroptera) in some apple-orchards. Acta Phytopathologica, Academiae Scientiarum Hungaricae, 16:157-169.
Neotropical	7	1	Chrysopidae	157	Agroecosystem	Shannon-Wiener index, Simpson index and Dominance index	Sampling effort and temperature	Entomological net	12	Martins, C. C., R. S. Santos, W. P. Sutil and J. F. A. de Oliveira. 2019. Diversity and abundance of green lacewings (Neuroptera: Chrysopidae) in a Conilon coffee plantation in Acre, Brazil. Acta Amazonica, 49:173-178
Palearctic	22	2	Neuroptera	ca. 100	Natural ecosystem	Williams diversity measure	Plant physiognomy	Malaise trap	12	Hollier, J. 2007. Body size and habitat stability -- a comparison of lacewing (Neuroptera: Chrysopidae and Hemerobiidae) assemblages from different successional habitats. British Journal of Entomology and Natural History, 21:31-35
Neotropical	5	1	Hemerobiidae	712-857	Natural ecosystem	Shannon-Wiener index and evenness (J)	There are no specific factors	Malaise trap	12	Oliveira, R. C., I. R. Rogéria Lara, A. R. Fonseca and N. W. Perioto. 2013. Hemerobiidae (Neuroptera) in the midwestern region of Minas Gerais State, Brazil. Revista Colombiana de Entomología, 39: 256-259.
Palearctic	20	1	Chrysopidae	810-930	Natural ecosystem	Shannon-Wiener index and evenness (J)	Possibly the seasonality	Light trap	6	Paulian, M., M. Canard, D. Thierry and C. Ciubuc. 2000. Survey of green lacewings in southern Transylvania, Rumania, with some ecological notes (Neuroptera: Chrysopidae). Journal of Neuropterology, 3:25-31.
Palearctic	22	2	Neuroptera	No data	Agroecosystem	Shannon-Wiener index and Similarity (Renkonen index, Jaccard index)	Diversity of surrounding vegetation	Entomological net, Manual collection, Light trap, Pitfall traps, Soil sampling.	ca. 42	Szentkirályi, F. 1989. Aphidophagous chrysopid and hemerobiid (Neuropteroidea) subguilds in different maize fields: Influence of vegetational diversity on subguild structure. Acta Phytopathologica et Entomologica Hungarica, 24:207-211.
Palearctic	8	1	Chrysopidae	700-1000	Agroecosystem	Without diversity analysis	Pesticides	Entomological net	18	Porcel, M., F. Ruano, B. Cotes, A. Peña, A. and M. Campos, M. 2013. Agricultural Management systems affect the green lacewing community (Neuroptera: Chrysopidae) in Olive Orchards in Southern spain. Environment Entomology, 42:97-106.
Neotropical	16	1	Chrysopidae	915	Agroecosystem	Shannon-Wiener index	Diversity of surrounding vegetation	Entomological net, Yellow Mcphail traps	12	Ribeiro, A. E. L., M. A. Castellani, A. A. Moreira, R. P. Maluf, C. G. V. Silva and A. S. Santos. 2013. Diversidade e sazonalidade de crisopídeos (Neuroptera: Chrysopidae) em plantas de urucum. Horticultura Brasileira, 31: 636-641.

Neotropical	7	1	Hemerobiidae	765	Agroecosystem	Without diversity analysis	Food availability	Entomological net, Light trap, Möricke trap	24	Rosa-Lara, R. I., N. W. Perioto and S. de Freitas. 2010. Diversity of hemerobiids (Neuroptera) and associations with preys in coffee plants. Pesq. agropec. bras., Brasília, 45:115-123.
Neotropical	19	2	Neuroptera	2837-2896	Natural ecosystem	Alpha diversity sensu Jost (Hill number 0 and 1) and Beta diversity sensu Jost (Sorensen Index)	Geographical distance and type of vegetation, environmental conditions	Entomological net, Light trap, Malaise trap	13	Marquez-López, Y., M. C. Herrera-Fuentes and A. Contreras-Ramos. 2020. Alpha and Beta Diversity of Dustywings and Brown Lacewings (Neuroptera: Coniopterygidae, Hemerobiidae) in a Temperate Forest of Tlaxcala, Mexico. Proceedings of the Entomological Society of Washington, 122:869-889.
Palearctic	11	2	Neuroptera	0-620	Agroecosystem	Without diversity analysis	Plant physiognomy	McPhail trap	12	Canard, M., P. Neuenschwander and S. Michelakis. 1979. Les Névroptères capturés au piège de McPhail dans les oliviers in Grèce. 3: La Crète occidentale. Annales de la Société Entomologique de France, 15: 607-615.
Palearctic	9	1	Chrysopidae	66	Agroecosystem	Shannon-Wiener index, Euclidean distance.	Plant physiognomy and seasonality	Lure bait traps	5	Serée, L., R. Rouzes, D. Thiéry, D. and A. Rusch, A. 2020. Temporal variation of the effects of landscape composition on lacewings (Chrysopidae: Neuroptera) in vineyards. Agricultural and Forest Entomology, 22: 274–283.
Palearctic	10	2	Neuroptera	No data	Agroecosystem	Shannon-Weiner index, McIntosh's diversity index, Simpson index	anthropogenic activities	Entomological net, Suction trap, Yellow trap, Mcphail traps, Vacuum	6	Trouvé, C., D.Thierry and M. Canard. 2002. Preliminary survey of the lacewings (Neuroptera: Chrysopidae, Hemerobiidae) in agroecosystems in northern France, with phenological notes. Sziráki, G. (editor). Neuropterology 2000. Proceedings of the Seventh International Symposium on Neuropterology. Meeting: 6-9 August 2000, Budapest, Hungary. Acta Zoologica Academiae Scientiarum Hungaricae, 48:359-369.
Palearctic	8	2	Neuroptera	1000	Agroecosystem	Without diversity analysis	Diversity of surrounding vegetation	Mcphail Trap	4	Canard, M. and Y. Laudého. 1980. Les Névroptères capturés au piège de McPhail dans les oliviers in Grèce. 2: La région d'Akrefnion. Biologia Gallo-Hellenica, 9:139-146
Palearctic	41	1	Chrysopidae	6-816	Natural ecosystem/ Agroecosystem	Margalef index, Shannon index, Hurlbert index	There are no specific factors	Entomological net, Light trap , Yellow traps, Suction trap, Mcphail traps, Fumigation	1 to 12	Thierry, D., B. Deutsch, M. Paulian, J. Villenave and M. Canard. 2005. Typifying ecosystems by using green lacewing assemblages. Agronomy for Sustainable Development, 25:473-479
Palearctic	12	1	Chrysopidae	200-800	Natural ecosystem	Shannon-Weiner index, Hurlbert index	Affinity of spp to certain ecological and environmental conditions	Entomological net	2	Thierry, D. and M. Canard. 2005. The biodiversity of green lacewings (Neuroptera Chrysopidae) in a mosaic ecosystem in southern France. In: Pantaleoni, R.A., A. Letardi, C. Corazza. (eds.). Proceedings of the Ninth International Symposium on Neuropterology (20-23 June 2005, Ferrara, Italy). Annali del Museo Civico di Storia Naturale di Ferrara, 8:131-138
Palearctic	8	2	Neuroptera	No data	Natural ecosystem/ Agroecosystem	Without diversity analysis	There are no specific factors	Entomological net	8	Paulian, M. and I. Andriescu. 1996.Chrysopidae and Hemerobiidae recorded from crops and adjacent natural habitats in the Danube Delta, Rumania (Insecta: Neuroptera). Pp. 203-206. In: Canard, M., H. Aspöck, and M. W.Mansell (eds.). Pure and Applied Research in Neuropterology. Proceedings of the Fifth International Symposium on Neuropterology (2-6 May 1994, Cairo, Egypt). Privately printed, Toulouse, France. 341 pp.
Palearctic	22	1	Neuropterida	No data	Natural ecosystem	Similarity (Sorensen and Morisita Index)	Vegetation Maturity	Moericke's trap	7	Czechowska, W. 1994. Neuropterans (Neuropteroidea: Rhaphidioptera, Planipennia) of the canopy layer in pine forests. Fragmenta Faunistica, 36:459-467.
Neotropical	4	1	Neuropterida	766-826	Agroecosystem	Shannon-Weiner index, Simpson index	Phytosanitary treatments, type of crop and plant structure	McPhail trap	12	De Melo, M.A., M.L.N.M. Araujo and C.C. Martins. 2020. Entomofauna de Hemerobiidae (Neuroptera) em sistema de cultivo orgânico e convencional de frutíferas no município de Avaré, SP, Brasil. Revista de Biologia Neotropical, 17:121-129
Palearctic	40	1	Chrysopidae	1338-4525	Natural ecosystem/ Agroecosystem	Shannon-Wiener diversity index, Sørensen dissimilarity index (βsor): Partitioned into Simpson	Temperature, resource and resultant interspecific competitions	Entomological net, Light trap	4	Lai, Y., Y. Liu and X. Liu. 2021. Elevational diversity patterns of green lacewings (Neuroptera: Chrysopidae) uncovered with DNA barcoding in a biodiversity hotspot of Southwest China. Frontier Ecology and Evolution, 9:778–686.

						dissimilarity index (βsim) and nestedness-resultant dissimilarity (βnes).				
Palearctic	58	6	Neuropterida	No data	Natural ecosystem	Without diversity analysis	There are no specific factors	Entomological net, Light trap	24	Ábrahám, L. 2000. Alderfly (Megaloptera) and lacewing (Neuroptera) fauna of the Villány Hills, South Hungary. Dunántúli Dolg. Term. Tud. Sorozat, 10:249-266.
Palearctic	32	6	Neuroptera	No data	Natural ecosystem	Without diversity analysis	There are no specific factors	Entomological net, Light trap	3	Ábrahám, L. 2009. Adatok a Biodiverzitás Napokon Gyűrűfűn. Natura Somogyiensis, 13:147-150.

6.- CAPÍTULO II:

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

Rodolfo J. Cancino-López, Caleb C. Martins & Atilano Contreras-Ramos

Publicado en Diversity

(Artículo de Requisito)

diversity

Article

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

Rodolfo J. Cancino-López [1,2], **Caleb C. Martins** [2] and **Atilano Contreras-Ramos** [2,*]

[1] Posgrado en Ciencias Biológicas, Unidad de Posgrado, Circuito de Posgrados, Universidad Nacional Autónoma de México, Ciudad de México 04510, Mexico; cancinorodolfoj@gmail.com
[2] Colección Nacional de Insectos, Departamento de Zoología, Instituto de Biología, Universidad Nacional Autónoma de México, Ciudad de México 04510, Mexico; calebcalifre@gmail.com
* Correspondence: acontreras@ib.unam.mx

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

Citation: Cancino-López, R.J.; Martins, C.C.; Contreras-Ramos, A. Neuroptera Diversity from Tacaná Volcano, Mexico: Species Composition, Altitudinal and Biogeographic Pattern of the Fauna. *Diversity* **2021**, *13*, 537. https://doi.org/10.3390/d13110537

Academic Editor: Luc Legal

Received: 28 September 2021
Accepted: 22 October 2021
Published: 26 October 2021

1. Introduction

Neuropterans (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 stablished (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).

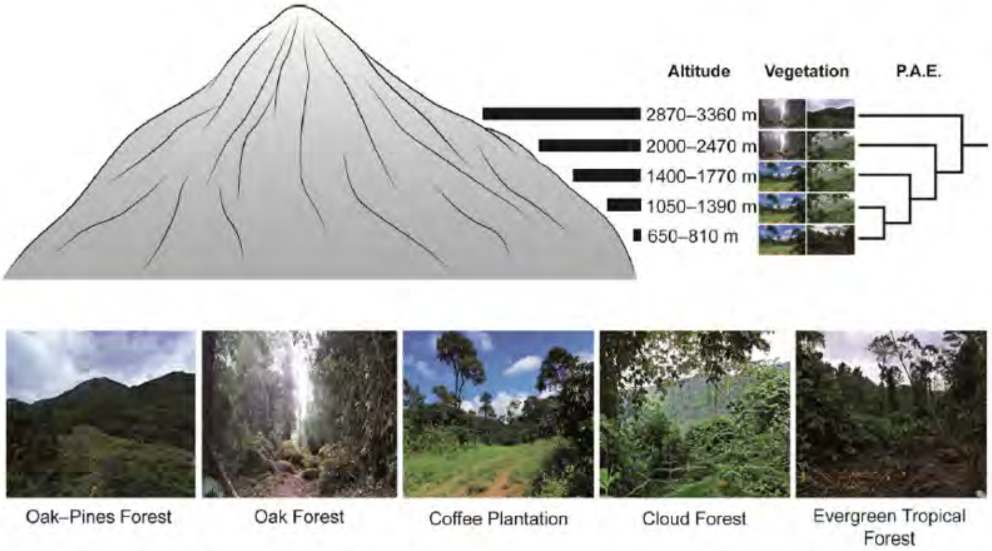


Figure 2. Different altitudinal levels sampled at the Tacaná volcano Biosphere Reserve (Chiapas, Mexico) and its vegetation characterization. PAE = Results of the Parsimony Analysis of Endemism using all Neuroptera species.

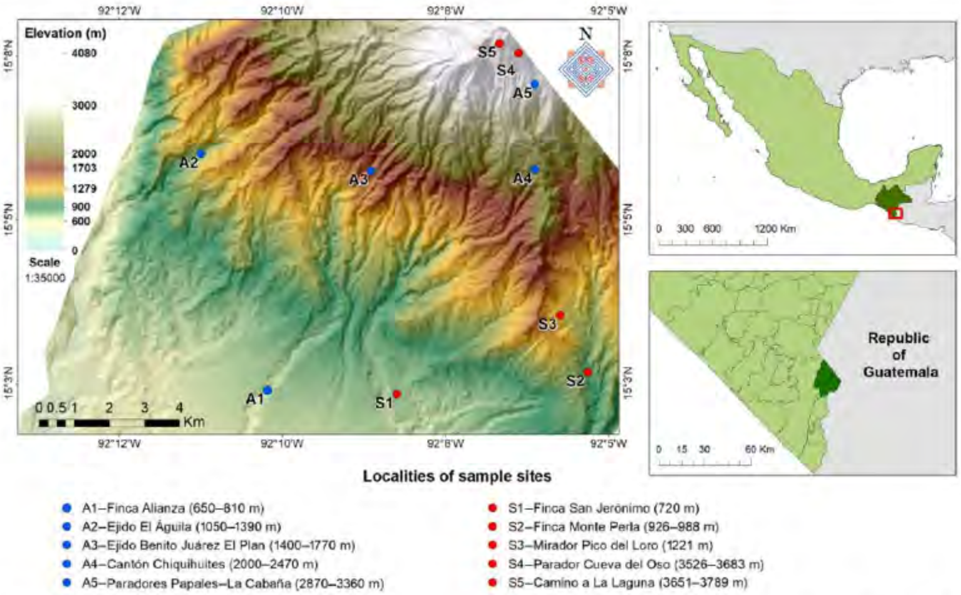


Figure 3. Map with the sampling sites at the Tacaná volcano Biosphere Reserve (Chiapas, Mexico). A1–A5: Annual systematic sampling sites; S1–S5: Sporadic sampling sites. Design of the wind rose was based on the Mayan symbol "the Four Sides of the Earth (Xocom Balumil)"; the rhombuses on the vertical 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 bisection 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 Estadistica y Geografia (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 Léon, 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 [11,13,21,24,25,80–82,104,137,158,159,169,171–176].

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* Navás, 1913
Subgenus *Chrysopodes* Navás, 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 northernmost record for the species, ca. 1064 km north from previous records (Finca Las Cruces, Puntarenas, Costa Rica). This species, together with *Chrysopodes* (*Chrysopodes*) *varicosus* (Navás, 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* (Navás, 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 northernmost 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 [4,11,21,80,82,83,137,158,160,166,167,169,175,202–207].

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. 6095 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 (Ajutchitlán, 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 Potosí), 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 *Myriocarpa* 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 *Hemerobius* 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 [4,11,18,35,83,192,223–230].

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 **Navás, 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 (Chiapas (**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 *Clibadium* 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 distribution 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. Specimens 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, Morelos, 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 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), Hondura, 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* Navás, 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 Navás, 1909
Genus *Trichoscelia* Westwood, 1852
***Trichoscelia santareni* (Navás, 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	5
4a. Pronotum shield-shaped; coxae inserted at caudal apex or approximately at the middle of the prothorax	Rhachiberothidae (Symphrasinae, *Trichoscelia*)
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	Hemerobiidae (Key 5)
5b. Body generally green; forewing length of 6.5–35 mm, with one RP main branch arising from R	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)	2
1b. Presence of plicatures (structures similar to pits) in some abdominal sternites (Aleuropteryginae)	*Neoconis*
2a. Hindwings with median vein forked	3
2b. Hindwings with median vein simple	*Coniopteryx*
3a. Fore and hindwing with medio-cubital crossvein oblique, in contact with MP or bifurcation of M	*Semidalis*
3b. Fore and hindwing with medio-cubital crossvein not oblique, in contact with M	*Conwentzia*

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)	2
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)	*Myrmeleon*
2a. Eyes divided by a transverse sulcus (Ululodini)	*Ululodes*
2b. Eyes entire not divided by a transverse sulcus (Haplogleniini)	*Haploglenius*

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	3
2b. Pronotum, in lateral view, with scattered fine setae, especially in the anterior and posterior parts	*Dicromantispa*
3a. Habitus with green color pattern; pronotum with most setae arising from distinct bumps	*Zeugomantispa*
3b. Habitus with yellow and brown pattern; pronotum with most setae flush arising	*Leptomantispa*

Key 5: Genera of Hemerobiidae (adult males and females)

(after [80,105])

1a. Forewing with two main branches of RP	2
1b. Forewing with ≥three main branches of RP	3
2a. Forewing with two series of gradate veins (crossveins)	*Sympherobius*
2b. Forewing with one series of gradate veins (crossveins)	7
3a. Forewing with two basal crossveins in the subcostal space	*Megalomus*
3b. Forewing with only one crossvein in the subcostal space	4
4a. Forewing with two crossveins between RA and the last apical main branch of RP	5
4b. Forewing with only one crossvein between RA and the last apical main branch of R	6
5a. Forewing with narrow costal space, absence of 2r-m	*Hemerobius*
5b. Forewing with broad costal area, presence of 2r-m	*Hemerobiella*
6a. Forewing with three series of gradate veins; MP and CuA fused basally for a short distance	*Nusalala*
6b. Forewing with two series of gradate veins; MP and CuA attached by a crossvein	*Micromus*
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	*Biramus*
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	*Notiobiella*

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

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*

(N.) askanes, L. (N.) nigrovaria, L. (N.) tarini, Plesiochrysa sp. 2, *Coniopteryx* (S.) *quadricornis, Hemerobius hirsuticornis,* and *Megalomus minor*.

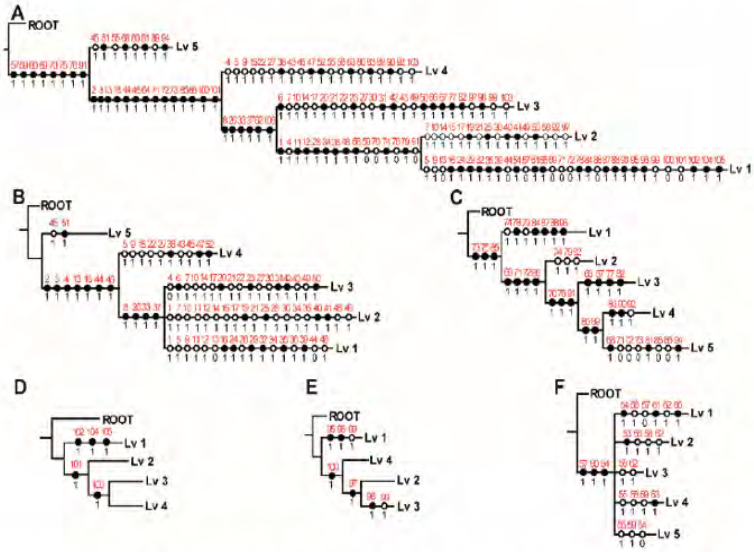


Figure 4. Parsimony Analysis of Endemism (PAE) from the five levels sampled at the Tacaná volcano Biosphere Reserve (Chiapas, Mexico). (**A**) Neuroptera fauna (one most parsimonious tree); (**B**) Chrysopidae fauna (one most parsimonious tree); (**C**) Hemerobiidae fauna (one most parsimonious tree); (**D**) Myrmeleontidae fauna (one most parsimonious tree); (**E**) Mantispidae fauna (one most parsimonious tree); (**F**) Coniopterygidae fauna (strict consensus of three most parsimonious trees). Lv1 = 650–810 m; Lv2 = 1050–1390 m; Lv3 = 1400–1770 m; Lv4 = 2000–2470 m; Lv5 = 2870–3360 m. Red numbers = Neuroptera species (see Table S1); 0 = absence; 1 = presence.

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, Plesiochrysa 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), *Ceraeochrysa defreitasi, Chrysopodes* (C.) sp. 2, *Leucochrysa* (L.) *lestagei, Leucochrysa* (N.) *caucella, Leucochrysa* (N.) sp. 6, *Titanochrysa simpliciala, Biramus aggregatus, Hemerobiella sinuata, Hemerobius nigridorsus, Micromus subanticus,* and *Nolima victor* were recorded. At the fourth level (ca. 2000 m), we reported *Leucochrysa* (N.) sp. 2, *Plesiochrysa* sp. 1, *Ungla* sp. 2, *Semidalis manausensis, Notiobiella cixiiformis,* 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 *Ululodes* 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 (*Dicromantispa* 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 having a wide distribution in the New World. The largest portion of the fauna, ca. 75%, had a Neotropical affinity, with only Rhachiberothidae, 87% of Chrysopidae, 64% of Coniopterygidae, 72% of Hemerobiidae, and 50% of Myrmeleontidae species occurring in the Neotropical region. The recorded species of Mantispidae possess a wide distribution across the New World.

The species with a Nearctic distribution belong particularly to Hemerobiidae (*Hemerobius discretus*, *Micromus subanticus*, and *Sympherobius distinctus*) and Coniopterygidae (*Coniopteryx latipalpis* and *Coniopteryx westwoodii*), while the widely distributed species belong to Chrysopidae (*Ceraeochrysa cincta*, *Ceraeochrysa cubana*, *Ceraeochrysa sanchezi*, *Chrysoperla externa* and *Plesiochrysa brasiliensis*) and Hemerobiidae (*Megalomus minor*, *Nusalala tessellata*, *Sympherobius similis*).

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 Tacaná 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 Tacaná 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 Tacaná 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 *Notiobiella*, 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), *Ululodes*, and *Haploglenius* (Myrmeleontidae) were only recorded at lower altitudes (from 600 to 900 m), while others such as *Nolima* (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 Neartic 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.;

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 Meléndez provided support in the generic identification of some plant samples. We are very much indebted to Benigno Gómez (ECOSUR-San Cristóbal), to Reserva de la Biósfera Volcán Tacaná (Francisco J. Jiménez González, director), to the people from Finca Alianza, Finca Monteperla, Ejido El Águila, 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
Chrysopidae					
1. *Ceraeochrysa achillea* de Freitas & Penny in de Freitas et al., 2009	1	1	0	0	0
2. *Ceraeochrysa arioles* (Banks, 1944)	1	1	1	1	0
3. *Ceraeochrysa sarta* (Banks, 1914)	1	1	1	1	0
4. *Ceraeochrysa cincta* (Schneider, 1851)	1	1	0	1	0
5. *Ceraeochrysa cubana* (Hagen, 1861)	1	0	0	1	0
6. *Ceraeochrysa defreitasi* Penny in Penny, 2002	0	0	1	0	0
7. *Ceraeochrysa derospogon* de Freitas & Penny in de Freitas et al., 2009	0	1	1	0	0
8. *Ceraeochrysa effusa* (Navás, 1911)	1	1	1	0	0
9. *Ceraeochrysa infausta* (Banks, 1945)	1	0	0	1	0
10. *Ceraeochrysa lineaticornis* (Fitch, 1855)	0	1	1	0	0
11. *Ceraeochrysa sanchezi* (Navás, 1924)	1	1	0	0	0
12. *Ceraeochrysa squama* de Freitas & Penny, 2001	1	1	0	0	0
13. *Ceraeochrysa tacanensis* Cancino-López & Contreras-Ramos, 2019	0	1	1	1	0
14. *Ceraeochrysa* sp.	0	1	1	0	0
15. *Chrysoperla asoralis* (Banks, 1915)	0	1	0	1	0
16. *Chrysoperla externa* (Hagen, 1861)	1	0	0	0	0
17. *Chrysopodes* (C.) *crassinervis* Penny, 1998	0	1	1	0	0
18. *Chrysopodes* (C.) *varicosus* (Navás, 1914)	1	1	1	1	0
19. *Chrysopodes* (C.) sp. 1	0	1	0	0	0
20. *Chrysopodes* (C.) sp. 2	0	0	1	0	0
21. *Leucochrysa* (L.) *clara* (McLachlan, 1867)	0	1	1	0	0
22. *Leucochrysa* (L.) *colombia* (Banks, 1910)	0	0	1	1	0
23. *Leucochrysa* (L.) *lestagei* Navás, 1922	0	0	1	0	0
24. *Leucochrysa* (L.) *pretiosa* (Banks, 1910)	1	0	0	0	0
25. *Leucochrysa* (L.) *varia* (Schneider, 1851)	0	1	0	0	0
26. *Leucochrysa* (L.) *variata* (Navás, 1913)	1	1	1	0	0
27. *Leucochrysa* (N.) *amistadensis* Penny, 2001	0	0	1	1	0
28. *Leucochrysa* (N.) *askanes* (Banks, 1945)	1	1	0	0	0
29. *Leucochrysa* (N.) *azevedoi* Navás, 1913	1	0	0	0	0
30. *Leucochrysa* (N.) *camposi* (Navás, 1933)	0	1	1	0	0
31. *Leucochrysa* (N.) *caucella* Banks, 1910	0	0	1	0	0
32. *Leucochrysa* (N.) *lateralis* Navás, 1913	1	0	0	0	0
33. *Leucochrysa* (N.) *maculosa* de Freitas & Penny, 2001	1	1	1	0	0
34. *Leucochrysa* (N.) *nigrovaria* (Walker, 1853)	1	1	0	0	0

Table A1. *Cont.*

NEUROPTERA SPECIES/FAMILIES	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
35. *Leucochrysa* (*N.*) *squamisetosa* de Freitas & Penny, 2001	1	0	0	0	0
36. *Leucochrysa* (*N.*) *tarini* (Navás, 1924)	1	1	0	0	0
37. *Leucochrysa* (*N.*) sp. 1	1	1	1	0	0
38. *Leucochrysa* (*N.*) sp. 2	0	0	0	1	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	1	0	0
43. *Meleoma macleodi* Tauber, 1969	0	0	1	1	0
44. *Meleoma titschacki* Navás, 1928	0	1	1	1	0
45. *Meleoma* sp.	0	0	0	1	1
46. *Plesiochrysa brasiliensis* (Schneider, 1851)	1	1	1	1	0
47. *Plesiochrysa* sp. 1	0	0	0	1	0
48. *Plesiochrysa* sp. 2	1	1	0	0	0
49. *Titanochrysa annotaria* (Banks, 1945)	0	1	1	0	0
50. *Titanochrysa simpliciala* Tauber *et al.*, 2012	0	0	1	0	0
51. *Ungla* sp. 1	0	0	0	0	1
52. *Ungla* sp. 2	0	0	0	1	0
Coniopterygidae					
53. *Coniopteryx* (*S.*) *fumata* Enderlein, 1907	0	1	0	0	0
54. *Coniopteryx* (*S.*) *josephus* Sarmiento-Cordero & Contreras-Ramos, 2019	1	0	0	0	0
55. *Coniopteryx* (*S.*) *latipalpis* Meinander, 1972	0	0	0	1	1
56. *Coniopteryx* (*S.*) *quadricornis* Meinander in Meinander & Penny, 1982	1	1	0	0	0
57. *Coniopteryx* (*C.*) *simplicior* Meinander, 1972	0	1	1	1	1
58. *Coniopteryx* (*C.*) *westwoodii* (Fitch, 1855)	0	1	0	1	0
59. *Conwentzia barretti* (Banks, 1899)	0	0	1	1	1
60. *Neoconis dentata* Meinander, 1972	1	1	1	1	1
61. *Semidalis boliviensis* (Enderlein, 1905)	1	0	0	0	0
62. *Semidalis hidalgoana* Meinander, 1975	1	1	1	0	0
63. *Semidalis manausensis* Meinander, 1980	0	0	0	1	0
64. *Semidalis problematica* Monserrat, 1984	1	1	1	1	0
65. *Semidalis soleri* Monserrat, 1984	1	0	0	0	0
Hemerobiidae					
66. *Biramus aggregatus* Oswald, 2004	0	0	1	0	0
67. *Hemerobiella sinuata* Kimmins, 1940	0	0	1	0	0
68. *Hemerobius alpestris* Banks, 1908	0	0	0	0	1
69. *Hemerobius bolivari* Banks, 1910	0	1	1	1	1
70. *Hemerobius discretus* Navás, 1917	0	0	1	1	1
71. *Hemerobius domingensis* Banks, 1941	0	1	1	1	0
72. *Hemerobius gaitoi* Monserrat, 1996	0	1	1	1	0
73. *Hemerobius hernandezi* Monserrat, 1996	1	1	1	1	0
74. *Hemerobius hirsuticornis* Monserrat & Deretsky, 1999	1	1	0	0	0
75. *Hemerobius jucundus* Navás, 1928	1	1	1	1	1
76. *Hemerobius martinezae* Monserrat, 1996	0	0	1	1	1
77. *Hemerobius nigridorsus* Monserrat, 1996	0	0	1	0	0
78. *Hemerobius withycombei* (Kimmins, 1928)	1	0	0	0	0
79. *Megalomus minor* Banks in Baker, 1905	1	1	0	0	0
80. *Megalomus pictus* Hagen, 1861	0	0	0	1	1
81. *Megalomus* sp.	0	0	0	0	1
82. *Micromus subanticus* (Walker, 1853)	0	0	1	0	0
83. *Notiobiella cixiiformis* Gerstaecker, 1888	0	0	0	1	0
84. *Notiobiella mexicana* Banks, 1913	1	0	0	0	0
85. *Nusalala championi* Kimmins, 1936	1	1	1	1	0
86. *Nusalala irrebita* (Navás, 1929)	0	1	1	1	0
87. *Nusalala tessellata* (Gerstaecker, 1888)	1	0	0	0	0
88. *Nusalala unguicaudata* Monserrat, 2000	1	0	0	0	0
89. *Sympherobius axillaris* Navás, 1928	0	0	0	1	1
90. *Sympherobius distinctus* Carpenter, 1940	0	0	0	1	0
91. *Sympherobius marginatus* (Kimmins, 1928)	0	0	1	1	1
92. *Sympherobius similis* Carpenter, 1940	0	1	0	1	0
93. *Sympherobius subcostalis* Monserrat, 1990	1	0	0	0	0
94. *Sympherobius* sp.	0	0	0	0	1
Mantispidae					
95. *Dicromantispa sayi* (Banks, 1897)	1	0	0	0	0
96. *Leptomantispa pulchella* (Banks, 1912)	1	0	0	0	0
97. *Nolima infensa* Navás, 1924	0	1	1	0	0
98. *Nolima victor* Navás, 1914	0	0	1	0	0
99. *Zeugomantispa compellens* (Walker, 1860)	1	0	1	0	0
100. *Zeugomantispa minuta* (Fabricius, 1775)	0	1	1	1	0
Myrmeleontidae					
101. *Myrmeleon* (*M.*) *immaculatus* De Geer, 1773	0	1	1	1	0
102. *Myrmeleon* (*M.*) *timidus* Gerstaecker, 1888	1	0	0	0	0
103. *Myrmeleon* (*M.*) *uniformis* Navás, 1920	0	0	1	1	0
104. *Ululodes bicolor* (Banks, 1895)	1	0	0	0	0
105. *Ululodes* sp.	1	0	0	0	0
Rhachiberothidae					
106. *Trichoscelia santareni* (Navás, 1914)	1	1	1	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	2
1b. Longitud de alas anteriores ≤3 mm; cuerpo y alas cubiertos con polvo blanquecino	Coniopterygidae (Clave 2)
2a. Antenas filiformes, moniliformes, pero no clavadas; hábito no similar a Odonata	3
2b. Antenas clavadas; hábito similar a Odonata	Myrmeleontidae (Clave 3)
3a. Patas anteriores raptoriales	4
3b. Patas anteriores no raptoriales	5
4a. Pronoto en forma de escudo; coxas insertadas en el ápice caudal o aproximadamente en la mitad del protórax	Rhachiberothidae (Symphrasinae, *Trichoscelia*)
4b. Pronoto tubular; coxas insertadas en el ápice cefálico del protórax	Mantispidae (Clave 4)
5a. Cuerpo generalmente de color cafe; ala anterior con una longitude de 3–18 mm, con dos o más ramas principales de RP surgiendo de R	Hemerobiidae (Clave 5)
5b. Cuerpo generalmente de color verde; ala anterior con una longitude de 6.5–35 mm, con una rama principal de RP surgiendo de R	Chrysopidae (Clave 6)

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)	2
1b. Presencia de plicaturas (estructuras similares a pozillos) en algunos esternitos abdominales (Aleuropteryginae)	*Neoconis*
2a. Alas posteriores con vena media bifurcada	3
2b. Alas posteriores con vena media simple	*Coniopteryx*
3a. Ala anterior y posterior con vena transversal medio-cubital oblicua, en contacto con MP o bifurcación de M	*Semidalis*
3b. Ala anterior y posterior con vena transversal medio-cubital no oblicua, en contacto con M	*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)	2
1b. Antenas apicalmente no clavadas, y no tan largas como la cabeza y tórax; alas ante- riores y posteriores con una celda alargada detrás del punto de fusión de Sc y RA (Myrmeleontinae)	*Myrmeleon*
2a. Ojos divididos por una sutura transversal (Ululodini)	*Ululodes*
2b. Ojos enteros no divididos por una sutura transversal (Haplogleniini)	*Haploglenius*

Clave 4: Géneros de Mantispidae (Adultos machos y hembras)

(Modificado de [80])

1a. Cabeza con vértex en forma de domo en vista frontal; patas anteriores con dos uñas pretarsales con ariola presente (Calomantispinae)	*Nolima*
1b. Cabeza con vértex concavo en vista frontal; patas anteriores con una uña tarsal, con arolia ausente (Mantispinae)	2
2a. Pronoto, en vista lateral, con prominentes sedas en toda su longitud	3
2b. Pronoto, en vista lateral, con finas sedas dispersas, especialmente en las zonas anterior y posterior	*Dicromantispa*
3a. Hábito con patrón de color verde; pronoto con sedas emergiendo de bases evidentemente elevadas	*Zeugomantispa*
3b. Hábito con patrones de colores cafe y amarillo; pronoto con sedas que emergen al nivel de la superficie	*Leptomantispa*

Clave 5: Géneros de Hemerobiidae (Adultos machos y hembras)

(Modificado de [80,105])

1a. Ala anterior con dos ramas principals de RP	2
1b. Ala anterior con ≥ tres ramas principals de RP	3
2a. Ala anterior con dos series de venas gradadas (transversales)	*Sympherobius*
2b. Ala anterior con una serie de venas gradadas (transversales)	7
3a. Ala anterior con dos venas transversales basales en el espacio subcostal	*Megalomus*
3b. Ala anterior con solo una vena transversal basal en el espacio subcostal	4
4a. Ala anterior con dos venas transversales entre RA y la última rama principal de RP	5
4b. Ala anterior con solo una vena transversal entre RA y la última rama principal de RP	6
5a. Ala anterior con espacio costal estrecho, ausencia de 2r-m	*Hemerobius*
5b. Ala anterior con espacio costal Amplio, presencia de 2r-m	*Hemerobiella*
6a. Ala anterior con tres series de venas gradadas; MP y CuA fusionada basalmente por una distancia corta	*Nusalala*
6b. Ala anterior con dos series de venas gradadas; MP y CuA unidas por una vena transversal	*Micromus*
7a. 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	*Biramus*
7b. 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	*Notiobiella*

Clave 6: Géneros de Chrysopidae (Adultos machos)

(Modificado de [80])

1a. Antenas de menos de 1.3 veces la longitud del ala anterior; alas sin mancha oscura en la base del pterostigma (Chrysopini)	2
1b. Antenas de más de 1.3 veces la longitud del ala anterior; alas con una mancha oscura en la base del pterostigma (Leucochrysini)	*Leucochrysa*
2a. Genitalia con tignum presente	3
2b. Genitalia con tignum ausente	4
3a. Genitalia con pseudopene presente	*Plesiochrysa*
3b. Genitalia con pseudopene ausente	*Chrysoperla*
4a. Ápice del abdomen con la base del ectoprocto extendido basalmente para articular con base de esternito 8 + 9; ectoprocto no fusionado dorso-medialmente	5
4b. Ápice del abdomen con base de ectoprocto no extendido basalmente para articular con base de esternito 8 + 9; ectoprocto fusionado dorso-medialmente en base	*Ungla*
5a. Genitalia con presencia de gonapsis; gonarcus y arcesus con estructuras en forma de cuernos	6
5b. Genitalia con gonapsis ausente (raramente con gonapsis); gonarcus y arcesus sin estructuras en forma de cuernos	7
6a. Abdomen con esternito 8 + 9 corto y no fusionado; genitales con puente gonarcal ancho, y gonapsis larga (en relación a esternito 8 + 9) de forma variable	*Ceraeochrysa*
6b. Abdomen con esternito 8 + 9 alargado y fusionado; genitales con puente gonarcal estrecho, y gonapsis corta (en relación con esternito 8 + 9), con forma de cuchara	*Titanochrysa*
7a. Cabeza con escapos alargados o modificados y / o con cuernos o cavidades en la frente; genitalia con pseudopene presente	*Meleoma*
7b. Cabeza con escapos no alargados y sin modificaciones, cuernos o cavidades en la frente; genitalia con ausencia de pseudopene	*Chrysopodes*

References

1. Tauber, C.A.; Tauber, M.J.; Albuquerque, G.S. Neuroptera (Lacewings, Antlions). In *Encyclopedia of Insects*, 2nd ed.; Resh, V.H., Cardé, R.T., Eds.; Elsevier: Amsterdam, The Netherlands; Academic Press: London, UK, 2009; pp. 695–707.
2. Monserrat, V.J. Los crisópidos de la Península Ibérica y Baleares (Insecta, Neuropterida, Neuroptera: Chrysopidae). *Graellsia* **2016**, *72*, e037. [CrossRef]
3. Oswald, J.D.; Machado, R.J.P. Biodiversity of the Neuropterida (Insecta: Neuroptera: Megaloptera, and Raphidioptera). In *Insect Biodiversity: Science and Society*, 1st ed.; Foottit, R.G., Adler, P.H., Eds.; John Wiley and Sons: New York, NY, USA, 2018; Volume 2, pp. 627–671.

4. Oswald, J.D.; Contreras-Ramos, A.; Penny, N.D. Neuroptera (Neuropterida). In *Biodiversidad, Taxonomía y Biogeografía de Artrópodos de México: Hacia una Síntesis de su Conocimiento*; Llorente-Bousquets, J., Morrone, J.J., Eds.; Universidad Nacional Autónoma de México: Ciudad de México, México, 2002; Volume 3, pp. 559–581.
5. Contreras-Ramos, A.; Rosas, M.V. Biodiversidad de Neuroptera en México. *Rev. Mex. Biodivers.* **2014**, *85*, 5264–5270. [CrossRef]
6. Cancino-López, R.J.; Contreras-Ramos, A. A new species of *Ceraeochrysa* Adams (Neuroptera, Chrysopidae), with a key to the species from Mexico. *ZooKeys* **2019**, *888*, 95–104. [CrossRef]
7. Marquez-López, Y.; Contreras-Ramos, A. A new species of *Wesmaelius* Krüger from Mexico, with a key to the New World species of the subgenus *Kimminsia* Killington (Neuroptera, Hemerobiidae). *ZooKeys* **2019**, *841*, 61–70. [CrossRef] [PubMed]
8. Sarmiento-Cordero, M.A.; Contreras-Ramos, A. Two new species and a key to the dustywings of Mexico (Neuroptera, Coniopterygidae). *Zootaxa* **2019**, *554*, 551–563. [CrossRef] [PubMed]
9. Marquez-López, Y.; Herrera-Fuentes, M.d.C.; Contreras Ramos, A. Alpha and beta diversity of dustywings and brown lacewings (Neuroptera: Coniopterygidae, Hemerobiidae) in a temperate forest of Tlaxcala, Mexico. *Proc. Entomol. Soc. Wash.* **2020**, *122*, 869–889. [CrossRef]
10. Ardila-Camacho, A.; Martins, C.C.; Aspöck, U.; Contreras-Ramos, A. Comparative morphology of extant raptorial Mantispoidea (Neuroptera: Mantispidae, Rhachiberothidae) suggests a non-monophyletic Mantispidae and a single origin of the raptorial condition within the superfamily. *Zootaxa* **2021**, *4992*, 001–089. [CrossRef]
11. Lacewing Digital Library. Neuropterida Species of the World. Available online: http://lacewing.tamu.edu/Species-Catalogue/index.html (accessed on 21 May 2021).
12. Brooks, S.J. A taxonomic review of the common green lacewing genus *Chrysoperla* (Neuroptera: Chrysopidae). *Bull. Br. Mus. Nat Hist. Entomol.* **1994**, *63*, 137–210.
13. De Freitas, S.; Penny, N.D.; Adams, P.A. A revision of the New world genus *Ceraeochrysa* (Neuroptera: Chrysopidae). *Proc. Calif. Acad. Sci.* **2009**, *60*, 503–610.
14. Tauber, C.A. Taxonomy and biology of the lacewing genus *Meleoma* (Neuroptera: Chrysopidae). *Univ. Calif. Publ. Entomol.* **1969**, *58*, 211.
15. Tauber, C.A.; Sosa, F.; Albuquerque, G.S.; Tauber, M.J. Revision of the Neotropical green lacewings genus *Ungla* (Neuroptera, Chrysopidae). *ZooKeys* **2017**, *674*, 1–188. [CrossRef]
16. Meinander, M. A revision of the family Coniopterygidae (Planipennia). *Acta Zool. Fenn.* **1972**, *136*, 1–357.
17. Meinander, M. Coniopterygidae from North America (Neuroptera). *Not. Entomol.* **1975**, *55*, 28–32.
18. Monserrat, V.J. Revisión del género *Hemerobius* de Latinoamérica (Neuroptera, Hemerobiidae). *Fragm. Ent.* **1996**, *27*, 399–523.
19. Ardila-Camacho, A.; Cancino-López, R.J.; Acevedo, F.; Contreras-Ramos, A. Four new species of *Plega* Navás, 1928 (Neuroptera: Mantispidae) from Mexico. *Zootaxa* **2019**, *4612*, 351–372. [CrossRef] [PubMed]
20. Van der Weele, H.W. Ascalaphiden. Collections Zoologiques du Baron Edm. de Selys Longchamps. *Catalogue Systématique et Descriptif* **1909**, *8*, 1–326.
21. Banks, N. Neuroptera of northern South America. Part III. Chrysopidae. *Bol. Entomol. Venez.* **1944**, *3*, 1–34.
22. Navás, L. Insectos del Museo de Hamburgo. Primera [I] serie. *Soc. Ent. De España Bol.* **1928**, *11*, 59–67, 90–100, 121–138.
23. Banks, N. New American Chrysopidae. *Can. Entomol.* **1914**, *46*, 24–27. [CrossRef]
24. Banks, N. Chrysopidae (Nothochrysidae) collected in Mexico by Dr. A. Dampf (Neuroptera). *Psyche* **1948**, *55*, 151–177. [CrossRef]
25. Banks, N. A list of neuropteroid insects from Mexico. *Trans. Am. Entomol. Soc.* **1901**, *27*, 361–371.
26. Navás, L. Chrysopides nouveaux (Ins. Neur.). *Ann. Soc. Sci. Brux.* **1911**, *35 Pt 2*, 266–282.
27. Navás, L. Les chrysopides (Ins. Névr.) du Musée de Londres. *Ann. Soc. Sci. Brux.* **1913**, *37*, 292–330.
28. Adams, P.A. A new species of *Leucochrysa* from Mexico (Neuroptera, Chrysopidae). *Folia Entomol. Mex.* **1979**, *4*, 95–101.
29. Tauber, C.A.; Albuquerque, G.S.; Tauber, M.J. Nomenclatorial changes and redescriptions of three of Navás' *Leucochrysa* (*Nodita*) species (Neuroptera, Chrysopidae). *ZooKeys* **2011**, *92*, 9–33. [CrossRef]
30. Walker, F. *List of the Specimens of Neuropterous Insects in the Collection of the British Museum. Part II.—(Sialidae–Nemopterides)*; British Museum: London, UK, 1853; pp. 501–529.
31. Navás, L. Insectos neotrópicos. 3.a serie. *Rev. Chil. De Hist. Nat.* **1928**, *31*, 316–328.
32. Meinander, M. The Coniopterygidae (Neuroptera, Planipennia). A check-list of the species of the world, descriptions of new species and other new data. *Acta Zool. Fenn.* **1990**, *189*, 1–95.
33. Banks, N. Descriptions of new North American neuropteroid insects. *Trans. Am. Entomol. Soc.* **1899**, *25*, 199–218.
34. Monserrat, V.J. Contribución al conocimiento de los coniopterígidos de México (Neuroptera, Planipennia, Coniopterygidae). *EOS Rev. Española De Entomol.* **1984**, *60*, 211–222.
35. Monserrat, V.J. A systematic checklist of the Hemerobiidae of the world (Insecta: Neuroptera). In *Advances in Neuropterology, Proceedings of the Third International Symposium on Neuropterology*; 3–4 February 1988, Berg en Dal, Kruger National Park, South Africa; Mansell, M.W., Aspöck, H., Eds.; South African Department of Agricultural Development: Pretoria, South Africa, 1990; pp. 215–262.
36. Kimmins, D.E. New and little known Neuroptera of Central America. *EOS Rev. Española De Entomol.* **1928**, *4*, 363–370.
37. Nakahara, W. Contributions to the knowledge of the Hemerobiidae of western North America (Neuroptera). *Proc. U. S. Natl. Mus.* **1966**, *116*, 205–222. [CrossRef]
38. Navás, L. Mantíspidos nuevos (Segunda serie). *Mem. R. Acad. Cienc. Artes Barc.* **1914**, *11*, 83–103.

39. McLachlan, R. An attempt towards a systematic classification of the family Ascalaphidae. *Zool. J. Linn. Soc.* **1873**, *11*, 219–276. [CrossRef]
40. Banks, N. Some Mexican Neuroptera. *Proc. Calif. Acad. Sci.* **1895**, *5*, 515–522.
41. Navás, L. Sur des Névroptères nouveaux ou critiques. Deuxième [II] série. *Ann. Soc. Sci. Brux.* **1920**, *39*, 189–203.
42. Navás, L. Névroptères nouveaux de l'Amerique du Nord. IIème série. *Entomol. Z. Frankf. Am Main* **1914**, *28*, 18–20, 25, 26.
43. Meinander, M. Coniopterygidae from western North America (Neuroptera). *Entomol. Scand.* **1974**, *5*, 217–232. [CrossRef]
44. Guérin-Méneville, F.É. *Iconographie du Règne Animal de G. Cuvier, ou Représentation d'après Nature de l'une des Espèces les Plus Remarquables, et Souvent non Encore Figurées, de Chaque Genre d'animaux, Insectes*; J. B. Baillière: London, UK; Paris, France, 1838. [CrossRef]
45. Hagen, H.A. Synopsis of the Neuroptera of North America, with a list of the South American species. *Smithson. Misc. Collect.* **1861**, *4*, 1–347. [CrossRef]
46. Hagen, H.A. Stray notes on Myrmeleonidae, Part 4. *Can. Entomol.* **1888**, *20*, 34–38, 57–60, 72–74, 93–97. [CrossRef]
47. Banks, N. New genera and species of Nearctic neuropteroid insects. *Trans. Am. Entomol. Soc.* **1899**, *26*, 239–259.
48. Banks, N. Some new neuropteroid insects. *J. N. Y. Ent. Soc.* **1903**, *11*, 236–243.
49. Banks, N. Notes on Brachynemuri of the *B. ferox* group. *Proc. Entomol. Soc. Wash* **1903**, *5*, 173–177.
50. Banks, N. Descriptions of new Nearctic neuropteroid insects. *Trans. Am. Entomol. Soc.* **1905**, *32*, 1–20.
51. Banks, N. New tropical American Neuroptera. *Proc. Entomol. Soc. Wash* **1907**, *9*, 30–34.
52. Banks, N. Synopses and descriptions of exotic Neuroptera. *Trans. Am. Entomol. Soc.* **1913**, *39*, 201–242.
53. Banks, N. A new myrmeleonid from Yucatan. In *Fauna of the Caves of Yucatan*; Pearse, A.S., Ed.; Publications of the Carnegie Institution of Washington: Washington, DC, USA, 1839; pp. 1–235.
54. Banks, N. Contributions toward a knowledge of the insect fauna of Lower California. No. 4. Neuroptera: Myrmeleonidae. *Proc. Calif. Acad. Sci.* **1942**, *24*, 133–151.
55. Enderlein, G. Klassifikation der Mantispiden nach dem material des Stettiner Zoologischen Museums. *Stett. Ent. Zeit.* **1910**, *71*, 341–379.
56. Navás, L. Neurópteros nuevos o poco conocidos (Cuarta [IV] serie). *Mem. R. Acad. Cienc. Artes Barc.* **1915**, *11*, 373–398.
57. Navás, L. Comunicaciones entomológicas. 4. Insectos exóticos nuevos, críticos o poco conocidos. *Rev. R. Acad. Cienc. Exactas Fís. Quím. Nat. Zaragoza* **1919**, *6*, 61–81.
58. Navás, L. Insectos nuevos o poco conocidos [I]. *Mem. R. Acad. Cienc. Artes Barc.* **1922**, *17*, 383–400.
59. Navás, L. Algunos insectos del Museo de París. 2.a serie [IIa]. *Brotéria* **1924**, *21*, 99–114.
60. Navás, L. Comunicaciones entomológicas. 10 [sic; =9]. Mis excursiones científicas en 1927. *Rev. R. Acad. Cienc. Exactas Fís. Quím. Nat. Zaragoza* **1927**, *11*, 79–137.
61. Navás, L. Insectos neotrópicos. 5.a serie. *Rev. Chil. De Hist. Nat.* **1929**, *33*, 17–24.
62. Navás, L. Insectos de Méjico. *Soc. Ent. De España Bol.* **1933**, *16*, 68–75.
63. Linsley, E.G.; MacSwain, J.W. Two new species of *Plega* from Mexico (Neuroptera, Mantispidae). *Pan-Pac. Entomol.* **1955**, *31*, 15–19.
64. Adams, P.A. New ant-lions from the southwestern United States (Neuroptera: Myrmeleontidae). *Psyche* **1956**, *63*, 82–108. [CrossRef]
65. Adams, P.A. A review of the Mesochrysinae and Nothochrysinae (Neuroptera: Chrysopidae). *Bull. Mus. Comp. Zool.* **1967**, *135*, 215–238.
66. Adams, P.A. New species and synonymy in the genus *Meleoma* (Neuroptera, Chrysopidae), with a discussion of genitalic homologies. *Postilla* **1969**, *136*, 1–18. [CrossRef]
67. Adams, P.A. A new species of *Hypochrysa* and a new subgenus and species of *Mallada* (Neuroptera: Chrysopidae). *Pan-Pac. Entomol.* **1978**, *54*, 292–296.
68. Stange, L.A. The Dimarellini of Mexico (Neuroptera: Myrmeleontidae) with the descriptions of two new species of *Dimarella*. *Ann. Entomol. Soc. Am.* **1963**, *56*, 810–816. [CrossRef]
69. Stange, L.A. *Revision of the Ant-Lion Tribe Brachynemurini of North America (Neuroptera: Myrmeleontidae)*; University of California Publications in Entomology: Oakland, CA, USA, 1970; pp. 1–192.
70. Stange, L.A. A new species of the genus *Dendroleon* Brauer from Mexico (Neuroptera: Myrmeleontidae). *Insecta Mundi* **2008**, *54*, 1–9.
71. Parker, F.D.; Stange, L.A. Systematic and biological notes on the tribe Platymantispini (Neuroptera: Mantispidae) and the description of a new species of *Plega* from Mexico. *Can. Entomol.* **1965**, *97*, 604–612. [CrossRef]
72. Johnson, V. New species of Coniopterygidae (Neuroptera) from North America. *Psyche* **1980**, *87*, 181–192. [CrossRef]
73. Monserrat, V.J.; Penny, N.D. Sobre las especies americanas del género *Notiobiella* Banks, 1909, II (Neuroptera, Planipennia, Hemerobiidae). *Nouv. Rev. Entomol.* **1983**, *13*, 125–132.
74. Miller, R.B.; Stange, L.A. Revision of the genus *Dimarella* Banks (Neuroptera: Myrmeleontidae). *Insecta Mundi* **1989**, *3*, 11–40.
75. Miller, R.B.; Stange, L.A. A revision of the genus *Maracandula* Currie (Neuroptera: Myrmeleontidae). *Insecta Mundi* **2009**, *101*, 1–10.
76. Miller, R.B.; Stange, L.A. A revision of the genus *Purenleon* Stange (Neuroptera: Myrmeleontidae: Nemoleontini). *Insecta Mundi* **2014**, *384*, 1–67.

77. Miller, R.B.; Stange, L.A. A revision of the genus *Eremoleon* Banks (Neuroptera: Myrmeleontidae: Nemoleontini). *Insecta Mundi* **2016**, *495*, 1–111.
78. Penny, N.D. Two new species of *Meleoma* (Neuroptera: Chrysopidae) from western North America, with a revised key to species. *Ann. Entomol. Soc. Am.* **2006**, *99*, 58–63. [CrossRef]
79. Ohl, M.; Oswald, J.D. Annotated catalog of the Mantispidae of the World (Neuroptera). *Contrib. Entomol. Internat.* **2004**, *5*, 131–262.
80. Penny, N.D. A Guide to the lacewings (Neuroptera) of Costa Rica. *Proc. Calif. Acad. Sci.* **2002**, *53*, 161–457.
81. Valencia-Luna, L.; Romero-Nápoles, J.; Valdez-Carrasco, J.; Carrillo-Sánchez, J.L.; López-Martínez, V. Taxonomía y registros de Chrysopidae (Insecta: Neuroptera) en el estado de Morelos, México. *Acta Zool. Mex.* **2006**, *22*, 17–61.
82. Penny, N.D.; Adams, P.A.; Stange, L.A. Species catalog of the Neuroptera, Megaloptera, and Raphidioptera of America north of Mexico. *Proc. Calif. Acad. Sci.* **1997**, *50*, 39–114.
83. Penny, N.D. Lista de Megaloptera, Neuroptera e Raphidioptera do México, América Central, ilhas Caraíbas e América do Sul. *Acta Amazon.* **1977**, *7*, 1–61. [CrossRef]
84. Monserrat, V.J.; Bayo, J. Nuevos datos sobre los coniopterígidos de Méjico central (Neuroptera: Coniopterygidae). *Bol. Asoc. Esp. Entomol.* **1995**, *19*, 125–130.
85. Reynoso-Velasco, D.; Contreras-Ramos, A. Mantispidae (Neuroptera) of Mexico: Distribution and key to genera. *Ann. Entomol. Soc. Am.* **2008**, *101*, 703–712. [CrossRef]
86. Reynoso-Velasco, D.; Contreras-Ramos, A. Mantispidae (Neuroptera) of México's National University biological stations Chamela and Los Tuxtlas. *Proc. Entomol. Soc. Wash.* **2009**, *111*, 708–713. [CrossRef]
87. Cancino-López, R.J.; Marquez-López, Y.; Contreras-Ramos, A. Mantispidos (Neuroptera) del estado de Morelos, México: Diversidad y distribución. *Dugesiana* **2015**, *22*, 201–208. [CrossRef]
88. Bowles, D.E. Spongillaflies (Neuroptera: Sisyridae) of North America with a key to the larvae and adults. *Zootaxa* **2006**, *1357*, 1–19. [CrossRef]
89. Bowles, D.E. New distributional records for Neotropical spongillaflies (Neuroptera: Sisyridae). *Insect Mundi* **2015**, *400*, 1–7.
90. Bowles, D.E.; Contreras Ramos, A.; Sarmiento-Cordero, M.A.; Ferro, M.L. New distributional records for pleasing lacewings (Neuroptera: Dilaridae, *Nallachius* spp.) in the Americas. *Insecta Mundi* **2015**, *406*, 1–10.
91. Marquez-López, Y.; Cancino López, R.J.; López-García, R.; Sarmiento-Cordero, M.A.; Contreras-Ramos, A. Crisopas, moscas serpiente y moscas escorpión (Neuroptera, Raphidioptera y Mecoptera). In *La Biodiversidad en Morelos. Estudio de Estado 2*; Conabio: Tlalpan, Mexico, 2020; Volume 2, pp. 153–161.
92. Sarmiento-Cordero, M.A.; Rodriguez-Velez, B.; Huerta-Martinez, F.M.; Uribe-Mú, C.A.; Contreras Ramos, A. Community structure of Neuroptera (Insecta) in a Mexican lime orchard in Colima, Mexico. *Rev. Mex. Biodivers.* **2021**, *92*, 1–10. [CrossRef]
93. Brooks, S.J.; Barnard, P.C. The green lacewings of the world: A generic review (Neuroptera: Chrysopidae). *Bull. Br. Mus. Nat. Hist. Entomol.* **1990**, *59*, 117–286.
94. Tauber, C.A. A systematic review of the genus *Leucochrysa* (Neuroptera: Chrysopidae) in the United States. *Ann. Entomol. Soc. Am.* **2004**, *97*, 1129–1158. [CrossRef]
95. Monserrat, V.J. Revisión del género *Megalomus* de Latinoamérica (Neuroptera, Hemerobiidae). *Fragm. Ent.* **1997**, *29*, 123–206.
96. Monserrat, V.J. Revisión del género *Nusalala* (Neuroptera, Hemerobiidae). *Fragm. Ent.* **2000**, *32*, 83–162.
97. Oswald, J.D. A revision of the genus *Sympherobius* Banks (Neuroptera: Hemerobiidae) of America north of Mexico with a synonymical list of the world species. *J. N. Y. Entomol. Soc.* **1988**, *96*, 390–451.
98. Hoffman, K.M. Systematics of the Mantispinae (Neuroptera: Mantispidae) of North, Central and South America. Ph.D. Thesis, Clemson University, Clemson, SC, USA, 1992.
99. Reynoso-Velasco, D.; Contreras-Ramos, A. Taxonomic review of the mantidfly genus *Nolima* Navás (Neuroptera, Mantispidae, Calomantispinae). *ZooKeys* **2019**, *853*, 131–158. [CrossRef]
100. Penny, N.D. Review of the generic level classification of the new world Ascalaphidae (Neuroptera). *Acta Amazon.* **1981**, *11*, 391–406. [CrossRef]
101. Stange, L.A. A systematic catalog, bibliography and classification of the world antlions (Insecta: Neuroptera: Myrmeleontidae). *Mem. Amer. Ent. Inst.* **2004**, *74*, 1–565.
102. Adams, P.A. *Ceraeochrysa*, a new genus of Chrysopinae (Neuroptera) (Studies in New World Chrysopidae, Part II). *Neuroptera Int.* **1982**, *2*, 69–75.
103. Sosa, F.; Tauber, C.A. The neotropical green lacewing genus *Ceraeochrysa* Adams (Neuroptera: Chrysopidae)—New synonymies and combinations, a new species, and an updated key to species. *Zootaxa* **2021**, *4970*, 1–52. [CrossRef] [PubMed]
104. Tauber, C.A.; de León, T.; Penny, N.D.; Tauber, M.J. The genus *Ceraeochrysa* (Neuroptera: Chrysopidae) of America north of México: Larvae, adults and comparative biology. *Ann. Entomol. Soc. Am.* **2000**, *93*, 1195–1221. [CrossRef]
105. Oswald, J.D. Revision and cladistic analysis of the world genera of the family Hemerobiidae (Insecta: Neuroptera). *J. N. Y. Entomol. Soc.* **1993**, *101*, 143–299.
106. Tauber, C.A. Revision of *Neosuarius*, a subgenus of *Chrysopodes* (Neuroptera, Chrysopidae). *ZooKeys* **2010**, *44*, 1–104. [CrossRef]
107. Adams, P.A. *Plesiochrysa*, a new subgenus of *Chrysopa* (Neuroptera) (Studies in New World Chrysopidae, Part I). *Neuroptera Int.* **1982**, *2*, 27–32.

108. Tauber, C.A.; de León, T. Systematics of green lacewings (Neuroptera: Chrysopidae): Larvae of *Ceraeochrysa* from Mexico. *Ann. Entomol. Soc. Am.* **2001**, *94*, 197–209. [CrossRef]
109. Garzón-Orduña, I.J.; Menchaca-Armenta, I.; Contreras-Ramos, A.; Liu, X.; Winterton, S.L. The phylogeny of brown lacewings (Neuroptera: Hemerobiidae) reveals multiple reductions in wing venation. *BMC Evol. Biol.* **2016**, *16*, 1–92. [CrossRef]
110. Breitkreuz, L.C.V.; Duelli, P.; Oswald, J.D. *Apertochrysa* Tjeder, 1966, a new senior synonym of *Pseudomallada* Tsukaguchi, 1995 (Neuroptera: Chrysopidae: Chrysopinae). *Zootaxa* **2021**, *4966*, 215–225. [CrossRef]
111. Núñez, E.Z. Ciclo biológico y crianza de *Chrysoperla externa* y *Ceraeochrysa cincta* (Neuroptera, Chrysopidae). *Rev. Per.* **1989**, *31*, 76–82.
112. Henry, C.S.; Penny, N.D.; Adams, P.A. The neuropteroid orders of Central America (Neuroptera and Megaloptera). In *Insects of Panama and Mesoamerica: Selected Studies*; Quintero, D., Aiello, A., Eds.; Oxford University Press: Oxford, UK, 1992; pp. 432–458.
113. López-Arroyo, J.I.; Tauber, C.A.; Tauber, M.J. Comparative life histories of the predators *Ceraeochrysa cincta, C. cubana,* and *C. smithi* (Neuroptera: Chrysopidae). *Ann. Entomol. Soc. Am.* **1999**, *92*, 208–217. [CrossRef]
114. Limburg, D.D.; Rosenheim, J.A. Extrafloral nectar consumption and its influence on survival and development of an omnivorous predator, larval *Chrysoperla plorabunda* (Neuroptera: Chrysopidae). *Environ. Entomol.* **2001**, *30*, 595–604. [CrossRef]
115. Liu, T.; Chen, T. Effects of the insect growth regulator fenoxycarb on immature *Chrysoperla rufilabris* (Neuroptera: Chrysopidae). *Fla. Entomol.* **2001**, *84*, 628–633. [CrossRef]
116. Machado Auad, A.; Toscano, L.C.; Boica, A.L., Jr.; de Freitas, S. Aspectos biológicos dos estádios imaturos de *Chrysoperla externa* (Hagen) e *Ceraeochrysa cincta* (Schneider) (Neuroptera: Chrysopidae) alimentados com ovos e ninfas de *Bemisia tabaci* (Gennadius) biótipo B (Hemiptera: Aleyrodidae). *Neotrop. Entomol.* **2001**, *30*, 429–432. [CrossRef]
117. Arredondo, H.C. Manejo y producción de *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae). In *Cría de Insectos Plaga y Organismos Benéficos*; Bautista, N., Bravo, H., Chavarin, C., Eds.; CONABIO, Instituto de Fitosanidad y Colegio de Postgraduados: Tlalpan, Mexico, 2004; pp. 177–195.
118. Pantaleoni, R.A. Perspectivas del uso de Raphidioptera y Neuroptera Coniopterygidae como agentes de control biológico. In *Teoría y Aplicación del Control Biológico*; Rodríguez del Bosque, L.A., Arredondo Bernal, H.C., Eds.; Sociedad Mexicana de Control Biológico: Ciudad de México, México, 2007; pp. 106–126.
119. Ramírez-Delgado, M.; López Arroyo, J.I.; González-Hernández, A.; Badii Zabeh, M.H. Rasgos biológicos y poblacionales del depredador *Ceraeochrysa* sp. nr. *cincta* (Neuroptera: Chrysopidae). *Acta Zool. Mex.* **2007**, *23*, 79–95.
120. Cortez-Mondaca, E.; Orduño-Cota, F.J.; López-Buitimea, M. Species of Chrysopidae associated with whiteflies in soybean in northern Sinaloa, Mexico. *Southwest. Entomol.* **2008**, *33*, 153–155. [CrossRef]
121. Cortez-Mondaca, E.; López-Buitimea, M.; López-Arroyo, J.I.; Orduño-Cota, F.J.; Herrera-Rodríguez, G. Especies de Chrysopidae asociadas al pulgón del sorgo en el norte de Sinaloa, México. *Southwest. Entomol.* **2016**, *41*, 541–545. [CrossRef]
122. Reynoso-Velasco, D.; Contreras-Ramos, A. Overview of the taxonomic and biological knowledge of Mexican Mantispidae (Insecta: Neuroptera). In Proceedings of the 10th International Symposium on Neuropterology, Piran, Slovenia, 22–25 June 2008; Devetak, D., Lipovšek, S., Arnett, A.E., Eds.; University of Maribor: Maribor, Slovenia, 2010; pp. 269–276.
123. Pacheco-Rueda, I.; Lomelí-Flores, J.R.; Rodríguez-Leyva, E.; Ramírez-Delgado, M. Ciclo de vida y parámetros poblacionales de *Sympherobius barberi* Banks (Neuroptera: Hemerobiidae) criado con *Dactylopius opuntiae* Cockerell (Hemiptera: Dactylopiidae). *Acta Zool. Mex.* **2011**, *27*, 325–340. [CrossRef]
124. Ail-Catzim, C.; Cerna-Chávez, E.; Landeros-Flores, J.; Aguirre-Uribe, L.; Flores-Dávila, M.; Badii-Zabeh, M.; Ochoa-Fuentes, Y. Respuesta funcional de diferentes instares larvales de *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) sobre ninfas de *Bactericera cockerelli* (Sulc) (Homoptera: Psyllidae). *Rev. Fac. Cienc. Agrar. Univ. Nac. Cuyo* **2012**, *44*, 279–288.
125. Ail-Catzim, C.E.; Cerna-Chávez, E.; Landeros-Flores, J.; Ochoa-Fuentes, Y.; García-López, A.M.; Rodríguez-González, R.E. Efecto de insecticidas sobre la mortalidad y depredación de *Chrysoperla carnea* (Neuroptera: Chrysopidae). *Southwest. Entomol.* **2015**, *40*, 565–573. [CrossRef]
126. Palomares-Peréz, M.; Ayala-Zermeño, M.A.; Rodríguez-Vélez, B.; de la Cruz-Llanas, J.; Sánchez-González, J.A.; Arredondo-Bernal, H.C.; Córdoba-Urtiz, E.G. Abundancia y depredación de *Ceraeochrysa valida* (Neuroptera: Chrysopidae) sobre *Diaphorina citri* (Hemiptera: Liviidae) en Colima, México. *Chil. J. Agric. Anim. Sci.* **2016**, *32*, 234–243. [CrossRef]
127. Palomares-Pérez, M.; Molina-Ruelas, T.J.; Bravo-Núñez, M.; Arredondo-Bernal, C.H. Life table of *Chrysoperla externa* (Neuroptera: Chrysopidae) reared on *Melanaphis sacchari* (Hemiptera: Aphididae). *Rev. Colomb. Entomol.* **2020**, *46*, 1–5. [CrossRef]
128. Pérez-González, O.; Rodríguez-Guerra, R.; López-Arroyo, J.I.; Sandoval-Coronado, C.F.; Maldonado-Blanco, M.G. Effect of Mexican *Hirsutella citriformis* (Hypocreales: Ophiocordycipitaceae) strains on *Diaphorina citri* (Hemiptera: Liviidae) and the predators *Chrysoperla rufilabris* (Neuroptera: Chrysopidae) and *Hippodamia convergens* (Coleoptera: Coccinellidae). *Fla. Entomol.* **2016**, *99*, 509–515. [CrossRef]
129. Morrone, J.J. Biogeographic regionalization and biotic evolution of Mexico: Biodiversity's crossroads of the New World. *Rev. Mex. Biodivers.* **2019**, *90*, 902–980. [CrossRef]
130. Macías, J.L.; Arce, J.L.; Layer, P.W.; Saucedo, R.; Mora, J.C. Eruptive History of the Tacaná Volcanic Complex. In *Active Volcanoes of Chiapas (Mexico) El Chichón and Tacaná, Active Volcanoes of the World*; Scholamacchia, T., Macías, J.L., Eds.; Springer: Berlin/Heidelberg, Germany, 2015; pp. 38–115.
131. Köppen, W. Das geographische System der Klimate. In *Handbuch der Klimatologie*; Köppen, W., Geiger, R., Eds.; Verlag von Gebrüder Borntraeger: Berlin, Germany, 1936; pp. 1–44.

132. García, E. *Modificaciones al Sistema de Clasificacion Climática de Koppen para Adaptarlo a las Condiciones de la República Mexicana*; Universidad Nacional Autónoma de México, Instituto de Geografía: Ciudad de México, Mexico, 1964.
133. CONANP. *Programa de Manejo Reserva de la Biosfera Volcán Tacaná*, 1st ed.; SEMARNAT: Ciudad de México, Mexico, 2013; pp. 1–199.
134. Veloso, A.; Nuñez, H. Inventario de fauna de la Región de Antofagasta: Recursos metodológicos e información. *Rev. Chil. De Hist. Nat.* **1998**, *71*, 571–591.
135. Jerez, V. Diversidad y patrones de distribución geográfica de insectos coleópteros en ecosistemas desérticos de la región de Antofagasta, Chile. *Rev. Chil. De Hist. Nat.* **2000**, *73*, 79–92. [CrossRef]
136. Alayo, D.P. Los Neurópteros de Cuba. *Poeyana* **1968**, *2*, 1–127.
137. De Freitas, S.; Penny, N.D. The green lacewings (Neuroptera: Chrysopidae) of Brazilian agro-ecosystems. *Proc. Calif. Acad. Sci.* **2001**, *52*, 245–395.
138. Tauber, C.A.; Albuquerque, G.S.; Tauber, M.J. A new species of *Leucochrysa* and a redescription of *Leucochrysa* (*Nodita*) *clepsydra* Banks (Neuroptera: Chrysopidae). *Zootaxa* **2008**, *1781*, 1–19. [CrossRef]
139. Tauber, C.A.; Albuquerque, G.S.; Tauber, M.J. The Neotropical genus *Titanochrysa* (Neuroptera, Chrysopidae): Larval descriptions, biological notes, a new species, and taxonomic changes. *Zootaxa* **2012**, *3514*, 1–26. [CrossRef]
140. Tauber, C.A.; Albuquerque, G.S.; Tauber, M.J. Three new Brazilian species of *Chrysopodes* (Neuroptera: Chrysopidae). *Ann. Entomol. Soc. Am.* **2012**, *105*, 638–663. [CrossRef]
141. Tauber, C.A.; Sosa, F.; Albuquerque, G.S. Two common and problematic leucochrysine species—*Leucochrysa* (*Leucochrysa*) *varia* (Schneider) and *L.* (*L.*) *pretiosa* (Banks) (Neuroptera, Chrysopidae): Redescriptions and synonymies. *ZooKeys* **2013**, *310*, 57–101. [CrossRef] [PubMed]
142. Tauber, C.A.; Sosa, F.; Contreras-Ramos, A. *Cryptochrysa* Freitas and Penny, a generic homonym, replaced by *Titanochrysa* Sosa and Freitas (Neuroptera: Chrysopidae). *Zootaxa* **2018**, *4375*, 287–295. [CrossRef]
143. Meinander, M. Coniopterygidae from South and Central America (Neuroptera). *Not. Entomol.* **1974**, *54*, 97–106.
144. Meinander, M. Coniopterygidae (Neuroptera, Planipennia) from Costa Rica and Nicaragua. *Brenesia* **1995**, *43*, 61–70.
145. Meinander, M.; Penny, N.D. Neuroptera of the Amazon Basin. Part 5. Coniopterygidae. *Acta Amazon.* **1982**, *12*, 185–208. [CrossRef]
146. Sziráki, G. *Coniopterygidae of the World: Annotated Check-List and Identification Keys for Living Species, Species Groups and Supra Specific Taxa of the Family*; Lambert Academic Publishing: Saarbrucken, Germany, 2011; pp. 1–264.
147. Kevan, D.K.; Klimaszewski, J. The Hemerobiidae of Canada and Alaska. Genus *Hemerobius* L. *Giorn. Ital. Entomol.* **1987**, *16*, 305–369.
148. Klimaszewski, J.; Kevan, D.K. The brown lacewing flies of Canada and Alaska (Neuroptera: Hemerobiidae). Part III. The genus *Micromus* Rambur. *Giorn. Ital. Entomol.* **1988**, *19*, 31–76.
149. Monserrat, V.J. Sobre las especies americanas del género Notiobiella Banks, 1909, I. (Neuroptera, Planipennia, Hemerobiidae). In Progress in World's Neuropterology. In Proceedings of the 1st International Symposium on Neuropterology, Graz, Austria, 22–26 September 1980; Gepp, J., Aspöck, H., Hölzel, H., Eds.; Privately Printed: Graz, Austria, 1984; pp. 85–97.
150. Oswald, J.D. Review of the brown lacewing genus *Biramus* (Neuroptera: Hemerobiidae: Hemerobiinae), with the description of a new species from Costa Rica and Panama. *Tijdschr. Entomol.* **2004**, *147*, 41–47. [CrossRef]
151. Sosa, F.; Lara, R.I.R.; Martins, C.C. A new species of *Hemerobiella* Kimmins (Neuroptera, Hemerobiidae) from Venezuela with notes on the genus. *Zootaxa* **2015**, *4028*, 421–429. [CrossRef] [PubMed]
152. Morris, W.S.; Oliva, O.; Carrasco, S. *Diseño e Iconografia Chiapas: Geometrías de la Imaginación*, 1st ed.; CONACULTA: Tuxtla Gutiérrez, Mexico, 2006.
153. Morrone, J.J. *Evolutionary Biogeography: An Integrative Approach with Case Studies*; Columbia University Press: New York, NY, USA, 2009; pp. 1–304.
154. WinClada Ver. 1.00.08. Available online: http://taxonomy.zoology.gla.ac.uk/rod (accessed on 15 September 2020).
155. Goloboff, P.A.; Catalano, S.A. TNT version 1.5, including full implementation of phylogenetic morphometrics. *Cladistics* **2016**, *32*, 221–238. [CrossRef]
156. Breitkreuz, L.C.V.; Winterton, S.L.; Engel, M.S. Wing tracheation in Chrysopidae and other Neuropterida (Insecta): A resolution of the confusion about vein fusion. *Am. Mus. Novit.* **2017**, *3890*, 1–44. [CrossRef]
157. Instituto Nacional de Estadística y Geografía (INEGI). Available online: https://www.inegi.org.mx/app/geo2/elevacionesmex/ (accessed on 20 March 2021).
158. Banks, N. A review of the Chrysopidae (Nothochrysidae) of Central America. *Psyche* **1945**, *52*, 139–174. [CrossRef]
159. Penny, N.D. New species of Chrysopinae (Neuroptera: Chrysopidae) from Costa Rica, with selected taxonomic notes and a neotype designation. *Entomol. News* **2001**, *112*, 1–14.
160. Navás, L. Crisópidos (Ins. Neur.) neotrópicos [I]. *Rev. Chil. De Hist. Nat.* **1924**, *27*, 110–116.
161. Schneider, W.G. Die in Schlesien einheimischen Arten der Gattung *Chrysopa*. *Z. Für Entomol. Breslau* **1851**, *5*, 1–16.
162. Navás, L. Neue Neuropteren. Zweite [II] serie. *Ent. Mitt.* **1915**, *4*, 194–202.
163. Navás, L. Sur des Névroptères nouveaux ou critiques. Sixième [VI] série. *Ann. Soc. Sci. Brux.* **1922**, *42*, 166–173.
164. Navás, L. Insectos de la Argentina y Chile. *Estudios* **1924**, *22*, 358–368.
165. Navás, L. Insectos suramericanos. Séptima [VII] serie. *Rev. R. Acad. Cienc. Exactas Fís. Nat. Madr.* **1933**, *30*, 303–314.
166. Lacroix, J.L. Quelques insectes Névroptères exotiques. *Ann. Soc. Linn. Lyon* **1925**, *72*, 67–72.

167. González-Olazo, E.V. Los neurópteros asociados con los cultivos cítricos de la Provincia de Tucumán y descripción de una nueva especie de *Nomerobius* (Hemerobiidae). *Cirpon* **1987**, *5*, 37–54.
168. Klimaszewski, J.; Kevan, D.K.; Peck, S.B. A review of the Neuroptera of the Galápagos Islands with a new record for *Sympherobius barberi* (Banks) (Hemerobiidae). *Can. J. Zool.* **1987**, *65*, 3032–3040. [CrossRef]
169. Pérez-Gelabert, D.E.; Flint, O.S., Jr. Annotated list of the Neuroptera of Hispaniola, with new faunistic records of some species. *J. Neuropterol.* **2000**, *3*, 9–23.
170. Monserrat, V.J. Nuevos datos sobre algunas especies de crisópidos (Insecta: Neuroptera: Chrysopidae). *Heteropterus* **2008**, *8*, 171–196.
171. Banks, N. New exotic neuropteroid insects. *Proc. Entomol. Soc. Wash.* **1913**, *15*, 137–143.
172. Navás, L. Les Chrysopides (Ins. Névr.) du Musée de Londres. *Ann. Soc. Sci. Brux.* **1914**, *38*, 73–114.
173. Banks, N. New neuropteroid insects from the Antilles. *Mem. Soc. Cuba. Hist. Nat. Felipe Poey* **1941**, *15*, 385–402.
174. Navás, L. Algunos insectos de Cuba [I], recogidos por don Fermín Z. Cervera. *Rev. R. Acad. Cienc. Exactas Fís. Nat. Madr.* **1924**, *21*, 323–332.
175. Adams, P.A.; Penny, N.D. Neuroptera of the Amazon Basin. Part 11a. Introduction and Chrysopini. *Acta Amazon.* **1985**, *15*, 413–479. [CrossRef]
176. Stange, L.A. Green lacewings (of Florida) (Insecta: Neuroptera: Chrysopidae). *IFAS Extension Entomol. Nematol. Publ. Ser.* **2012**, *534*, 1–4.
177. Navás, L. Névroptères nouveaux de l'Amérique du Nord [I]. *Entomol. Z.* **1913**, *27*, 19–20.
178. Fitch, A. Report upon the noxious and other insects of the state of New York. *Trans. N. Y. State Agr. Soc.* **1855**, *14*, 705–880.
179. Banks, N. A revision of the Nearctic Chrysopidae. *Trans. Am. Entomol. Soc.* **1903**, *29*, 137–162.
180. Navás, L. Some Neuroptera from the United States. *Bull. Brooklyn Entomol. Soc.* **1914**, *9*, 60–62.
181. Smith, R.C. The Chrysopidae (Neuroptera) of Canada. *Ann. Entomol. Soc. Am.* **1932**, *25*, 579–601. [CrossRef]
182. Throne, A.L. The Neuropterai—Suborder Planipennia of Wisconsin. Part I. Introduction and Chrysopidae. *Mich. Entomol.* **1971**, *4*, 65–78.
183. Penny, N.D.; Arias, J.R.; Armistead, J.S. Seasonal emergence of Neuroptera in Fairfax County, Virginia. *Proc. Calif. Acad. Sci.* **2007**, *58*, 7–19.
184. Garland, J.A.; Kevan, D.K. Chrysopidae of Canada and Alaska (Insecta, Neuroptera): Revised checklist, new and noteworthy records, and geo-referenced localities. *Zootaxa* **2007**, *1486*, 1–84. [CrossRef]
185. Scudder, G.G.E.; Cannings, R.A. A checklist of the neuropterid insects of British Columbia (Insecta: Megaloptera, Neuroptera and Raphidioptera) with a summary of their geographic distribution. *J. Ent. Soc. Br. Columb.* **2009**, *106*, 17–23.
186. Navás, L. Crisópidos (Neur.) de Cuba. *Soc. Ent. De España Bol.* **1924**, *7*, 51–53.
187. Navás, L. Insecta nova. Series XIII. *Mem. Dell'Accad. Pontif. Nuovi Lincei* **1929**, *12*, 15–23.
188. Banks, N. New neuropteroid insects, native and exotic. *Proc. Acad. Nat. Sci. Phila.* **1914**, *66*, 608–632.
189. Navás, L. Insectos sudamericanos. Cuarta [IV] serie. *Rev. R. Acad. Cienc. Exactas Fís. Nat. Madr.* **1921**, *19*, 255–267.
190. Banks, N. New South American neuropteroid insects. *Proc. Entomol. Soc. Wash* **1910**, *12*, 146–160.
191. Navás, L. Neurópteros nuevos o poco conocidos (Sexta [VI] serie). *Mem. R. Acad. Cienc. Artes Barc.* **1915**, *12*, 119–136.
192. Navás, L. Algunos insectos de la República Argentina. *Rev. R. Acad. Cienc. Exactas Fís. Nat. Madr.* **1918**, *16*, 491–504.
193. Navás, L. Algunos insectos neurópteros de la República Argentina. Serie tercera [III]. *Rev. R. Acad. Cienc. Exactas Fís. Nat. Madr.* **1919**, *17*, 287–305.
194. Navás, L. Insectos de la Argentina y Chile. 3.a serie. *Rev. Soc. Entomol. Argent.* **1933**, *5*, 79–86.
195. Adams, P.A. A new subspecies of *Chrysoperla externa* (Hagen) from Cocos Island, Costa Rica (Neuroptera: Chrysopidae). *Bull. -South. Calif. Acad. Sci.* **1983**, *82*, 42–45.
196. Banks, N. New Chrysopidae and species new to the United States. *Can. Entomol.* **1938**, *70*, 118–122. [CrossRef]
197. Zimmerman, E.C. Studies of Hawaiian Neuroptera. *Proc. Hawaii. Entomol. Soc.* **1939**, *10*, 487–510.
198. Zimmerman, E.C. *Insects of Hawaii: A Manual of the Insects of the Hawaiian Islands, including an Enumeration of the Species and Notes on Their Origin, Distribution, Hosts, Parasites, etc. Volume 6 (Ephemeroptera-Neuroptera-Trichoptera and Supplement to Volumes 1 to 5)*; University of Hawaii Press: Honolulu, HI, USA, 1957; pp. 7–11.
199. Monserrat, V.J.; de Freitas, S. Contribución al conocimiento de los crisópidos de Coquimbo, Patagonia y Tierra del Fuego (Argentina, Chile) (Insecta, Neuroptera, Chrysopidae). *Graellsia* **2005**, *61*, 163–179. [CrossRef]
200. Ivie, M.A.; Marske, K.A.; Foley, I.A.; Guerrero, K.A.; Ivie, L.L. Appendix 2. Species lists of the beetles, non-beetle hexapods and non-hexapod invertebrates of Montserrat. In *A Biodiversity Assessment of the Centre Hills, Montserrat. Durrell Conservation Monograph No. 1*; Young, R.P., Ed.; Durrell Wildlife Conservation Trust: Jersey, Channel Islands, 2008; pp. 237–311.
201. Penny, N.D. New Chrysopinae from Costa Rica (Neuroptera: Chrysopidae). *J. Neuropterol.* **1998**, *1*, 55–78.
202. Schneider, W.G. *Symbolae ad Monographiam Generis Chrysopae, Leach. Sexaginta Picturarum Tabulis, in Lapide acu delineatis, Quarum Quinquaginta Quatuor Coloribus Impressae Sunt*; Illustratae. Editio Major. Ferdinandum Hirt: Vratislaviae, Poland, 1851; pp. 9–13. [CrossRef]
203. Navás, L. Insecta nova. Series XIV. *Mem. Dell'Accad. Pontif. Nuovi Lincei* **1929**, *12*, 24–32.
204. Navás, L. Insectos neotrópicos. 7.a serie. *Rev. Chil. De Hist. Nat.* **1930**, *34*, 299–307.
205. Navás, L. Décadas de insectos nuevos. Década 3. *Rev. R. Acad. Cienc. Exactas Fís. Nat. Madr.* **1931**, *26*, 79–86.

206. Navás, L. Insecta nova. Series XII. *Mem. Dell'Accad. Pontif. Nuovi Lincei* **1927**, *10*, 1–10.
207. Smith, R.C. The Neuroptera of Haiti, West Indies. *Ann. Entomol. Soc. Am.* **1931**, *24*, 798–823. [CrossRef]
208. Sosa, F.J. Espécies de Crisopídeos (Neuroptera: Chrysopidae) da Venezuela. Ph.D. Thesis, Faculdade de Ciencias Agrárias e Veterinárias-UNESP, Sao Paulo, Brasil, November 2011.
209. McLachlan, R. New genera and species, &c., of neuropterous insects; and a revision of Mr. F. Walker's British Museum Catalogue of Neuroptera, part ii. (1853), as far as the end of the genus *Myrmeleon*. *Biol. J. Linn. Soc. Lond.* **1867**, *9*, 230–281.
210. Navás, L. Sur des Névroptères nouveaux ou critiques. Cinquième [V] série. *Ann. Soc. Sci. Brux.* **1922**, *41*, 250–256.
211. Navás, L. Insectos exóticos nuevos o poco conocidos. Segunda [II] serie. *Mem. R. Acad. Cienc. Artes Barc.* **1925**, *19*, 181–200.
212. Navás, L. Neue Neuropteren. Dritte [III] serie. *Ent. Mitt.* **1917**, *6*, 274–282.
213. Kimmins, D.E. Notes on some types of Chrysopidae (Neuroptera) in the British Museum Collections. *Ann. Mag. Nat. Hist.* **1940**, *5*, 442–449. [CrossRef]
214. Navás, L. Insectos suramericanos. Sexta [VI] serie. *Rev. R. Acad. Cienc. Exactas Fís. Nat. Madr.* **1933**, *29*, 191–198.
215. Meinander, M. A review of the genus *Coniopteryx* (Neuroptera, Coniopterygidae). *Suom. Hyönteistieteellinen Aikakauskirja* **1981**, *47*, 97–110.
216. Meinander, M. Coniopterygidae from South and Central America II (Neuroptera). *Neuroptera Int.* **1983**, *2*, 179–198.
217. Martins, C.C.; Amorim, D.S. Brazilian dustywings (Neuroptera: Coniopterygidae): New species of *Incasemidalis* Meinander, 1972 and *Coniopteryx* Curtis, 1834, checklist and key for the Brazilian species. *Zootaxa* **2016**, *4083*, 257–289. [CrossRef]
218. Ferro, M.L. New state records for Coniopterygidae (Neuroptera) with an updated list of species in North America north of Mexico. *Insecta Mundi* **2018**, *668*, 1–20.
219. Parfin, S.I. The Megaloptera and Neuroptera of Minnesota. *Am. Midl. Nat.* **1952**, *47*, 421–434. [CrossRef]
220. Johnson, V. New Coniopterygidae from Central America. *Ann. Entomol. Soc. Am.* **1978**, *71*, 163–164. [CrossRef]
221. Meinander, M. Coniopterygidae from Brazil (Neuroptera). *Entomol. Scand.* **1980**, *11*, 129–144. [CrossRef]
222. Monserrat, V.J. Nuevos datos sobre los hemeróbidos de América (Neuroptera: Hemerobiidae). *J. Neuropterol.* **1998**, *1*, 109–153.
223. Navás, L. Neurópteros críticos. *Butll. Inst. Catalana Hist. Nat.* **1929**, *9*, 113–115.
224. Nakahara, W. Systematic studies on the Hemerobiidae (Neuroptera). *Mushi* **1960**, *34*, 1–69.
225. Navás, L. Insectos de la Argentina. *Rev. R. Acad. Cienc. Exactas Fís. Quím. Nat. Zaragoza* **1933**, *16*, 87–120.
226. Nakahara, W. Neotropical Hemerobiidae in the United States National Museum. *Proc. U. S. Natl. Mus.* **1965**, *117*, 107–122. [CrossRef]
227. Monserrat, V.J. Nuevos datos sobre algunas especies del género *Hemerobius* L., 1758 (Insecta, Neuroptera: Hemerobiidae). *Graellsia* **1991**, *47*, 61–70. [CrossRef]
228. Monserrat, V.J. Nuevos datos sobre algunas especies de hemeróbidos (Insecta: Neuroptera: Hemerobiidae). *Heteropterus* **2004**, *4*, 1–26. [CrossRef]
229. Lara, R.I.R.; de Freitas, S. Caracterização morfológica de espécies de *Hemerobius* Linnaeus, 1758 (Neuroptera, Hemerobiidae) associadas a cultivos de café (*Coffea arabica* L.), milho (*Zea mays* L.) e erva-mate (*Ilex paraguariensis* St. Hill.). *Rev. Bras. Entomol.* **2003**, *47*, 427–434. [CrossRef]
230. García, A.; Figueiredo, E.; Valente, C.; Monserrat, V.J.; Branco, M. First record of *Thaumastocoris peregrinus* in Portugal and of the neotropical predador *Hemerobius bolivari* in Europe. *Bull. Insectol.* **2013**, *66*, 251–256.
231. Navás, L. Insecta nova. I Series. *Mem. Dell'Accad. Pontif. Nuovi Lincei* **1917**, *3*, 1–11.
232. Gurney, A.B. Notes on Nearctic Hemerobiidae, with descriptions of two new species (Neuroptera). *Ann. Entomol. Soc. Am.* **1948**, *41*, 213–222. [CrossRef]
233. Navás, L. Insectos americanos nuevos o críticos. *Brotéria* **1921**, *19*, 113–124.
234. Monserrat, V.J.; Deretsky, Z. New faunistical, taxonomic and systematic data on brown lacewings (Neuroptera: Hemerobiidae). *J. Neuropterol.* **1999**, *2*, 45–66.
235. Baker, C.F. Notes on neuropteroid insects of the Pacific Coast of North America with descriptions of new species by Nathan Banks. *Invertebr. Pac.* **1905**, *1*, 85–91.
236. Navás, L. Insectos del Museo de París. 4.a serie. *Brotéria* **1927**, *24*, 5–33.
237. Banks, N. Some new neotropical neuropteroid insects. *Psyche* **1930**, *37*, 183–191. [CrossRef]
238. Navás, L. Alcuni insetti del Museo di Zoologia della R. Universita di Torino. *Boll. Mus. Zool. Anat. Comp. Univ. Torino* **1932**, *42*, 1–38.
239. Kimmins, D.E. Notes on the genera *Megalomus* Rambur and *Nesobiella*, gen. nov. (Neuroptera), with descriptions of new species. *Ann. Mag. Nat. Hist.* **1935**, *16*, 602–619. [CrossRef]
240. Hagen, H.A. Monograph of the Hemerobiidae. Part. II [*Micromus*]. *Proc. Boston Soc. Nat. Hist.* **1886**, *23*, 276–292.
241. Navás, L. New Neuroptera from the United States. *Bull. Brooklyn Entomol. Soc.* **1914**, *9*, 13–20.
242. MacLeod, E.G.; Stange, L.A. Brown lacewings (of Florida) (Insecta: Neuroptera: Hemerobiidae). *IFAS Ext. Entomol. Nematol. Publ. Series* **2005**, *225*, 1–6.
243. Monserrat, V.J. Nuevos datos sobre algunas especies de hemeróbidos (Insecta, Neuroptera, Hemerobiidae). *Graellsia* **2008**, *64*, 233–253. [CrossRef]
244. Flint, O.S., Jr. Annotated checklist of the Neuroptera of Virginia (Arthropoda: Insecta). *Banisteria* **2015**, *45*, 3–47.

245. Almaraz Valle, V.M.; Lomeli Flores, J.R.; Rodríguez Leyva, E.; Vázquez Navaro, J.M.; Vanegas Rico, J.M. Two new species of brown lacewings as predators of *Melanaphis sacchari* in central Mexico. *J. Agric. Urban Entomol.* **2020**, *36*, 64–69. [CrossRef]
246. Kimmins, D.E. New species of *Nusalala* (Neuroptera, Hemerobiidae). *Ann. Mag. Nat. Hist.* **1936**, *17*, 568–576. [CrossRef]
247. Navás, L. Insectos neurópteros del Museo de Hamburgo. *Mem. Real Soc. Esp. Hist. Nat.* **1929**, *15*, 315–322.
248. Gerstaecker, C.E.A. Weitere Beiträge zur artenkenntniss der Neuroptera Megaloptera. *Mitt. D. Nat. V. F. Neuvorp U. Rügen* **1888**, *19*, 89–130.
249. Navás, L. Hemeróbidos (Ins. Neur.) nuevos con la clave de las tribus y géneros de la familia. *Brotéria* **1910**, *9*, 69–90.
250. Navás, L. Neurópteros sudamericanos. Primera [I] serie. *Brotéria* **1914**, *12*, 45–56, 215–234.
251. Navás, L. Estudis sobre Neuròpters (Insectes). *Arxius de l'Institut de Ciències, IEC, Secció de Ciències.* **1919**, *7*, 179–203.
252. Navás, L. Neuropteren aus Brasilien. *Mitt. Münch. Entomol. Ges.* **1925**, *15*, 64–68.
253. Navás, L. Algunos insectos del Brasil (3.a serie) [IIIb]. *Brotéria* **1926**, *23*, 5–15.
254. Penny, N.D.; Monserrat, V.J. Neuroptera of the Amazon Basin. Part 10. Hemerobiidae. *Acta Amazon.* **1983**, *13*, 879–909. [CrossRef]
255. Carpenter, F.M. A revision of the Nearctic Hemerobiidae, Berothidae, Sisyridae, Polystoechotidae and Dilaridae (Neuroptera). *Proc. Am. Acad. Arts Sci.* **1940**, *74*, 193–280. [CrossRef]
256. Navás, L. Insectos de la América Central. *Brotéria* **1924**, *21*, 55–86.
257. Banks, N. New Neuroptera and Trichoptera from the United States. *Psyche* **1943**, *50*, 74–81. [CrossRef]
258. Lawson, H.R.; McCafferty, W.P. A checklist of Megaloptera and Neuroptera (Planipennia) of Indiana. *Gt. Lakes Entomol.* **1984**, *17*, 129–131.
259. Cannings, R.A.; Cannings, S.G. The Mantispidae (Insecta: Neuroptera) of Canada, with notes on morphology, ecology, and distribution. *Can. Entomol.* **2006**, *138*, 531–544. [CrossRef]
260. Faúndez, E.I. The family Mantispidae (Insecta: Neuroptera) in North Dakota. *Gt. Lakes Entomol.* **2016**, *49*, 55–58.
261. Hoffman, K.M.; Flint, O.S., Jr.; Pérez-Gelabert, D.E. The Mantispidae of the West Indies with special reference to the Dominican Republic (Neuroptera: Mantispidae). *Insecta Mundi* **2017**, *559*, 1–15.
262. Navás, L. Veinticinco formas nuevas de insectos. *Bol. Soc. Ib. Ci. Nat.* **1927**, *26*, 48–75.
263. Penny, N.D. Neuroptera of the Amazon Basin. Part. 6. Mantispidae. *Acta Amazon.* **1982**, *12*, 415–463. [CrossRef]
264. Machado, R.J.P.; Rafael, J.A. Taxonomy of the Brazilian species previously placed in *Mantispa* Illiger, 1798 (Neuroptera: Mantispidae), with the description of three new species. *Zootaxa* **2010**, *2454*, 1–61. [CrossRef]
265. Ardila-Camacho, A.; García, A. Mantidflies of Colombia (Neuroptera, Mantispidae). *Zootaxa* **2015**, *3937*, 401–455. [CrossRef]
266. Ardila-Camacho, A.; Calle-Tobón, A.; Wolff, M.; Stange, L.A. New species and new distributional records of Neotropical Mantispidae (Insecta: Neuroptera). *Zootaxa* **2018**, *4413*, 295–324. [CrossRef]
267. Alvim, B.G.C.; Machado, R.J.P.; Krolow, T.K. Mantidflies (Neuroptera, Mantispidae) from Tocantins state (Brazil): Distribution and identification key. *Check List* **2019**, *15*, 275–285. [CrossRef]
268. Olivier, G.A. *Encyclopedie méthodique. Histoire naturelle. Volume 7 (Insectes)*; Chez Panckoucke, Imprimeur: Paris, France, 1797. [CrossRef]
269. Fischer von Waldheim, J.G.F. Notice sur quelques Orthoptères et Nevroptères du Brésil. *Bull. Soc. Nat. Moscou* **1834**, *7*, 322–330.
270. Navás, L. Algunos insectos de Santa Fe (Repúplica Argentina). *Estudios* **1921**, *21*, 49–53.
271. Davidson, J.A. Rearing *Mantispa viridis* Walker in the laboratory (Neuroptera, Mantispidae). *Entomol. News* **1969**, *80*, 29–31.
272. Brûlé, S.; Touroult, J.; Dalens, P.H. *Réserve Nationale Naturelle des Nouragues, Site de Saut Pararé. Inventaire Entomologique 2009–2010*; Rapport Final; Société Entomologique Antilles-Guyane: Rémire-Montjoly, Guyane, 2011.
273. Olivier, G.A. Encyclopedie méthodique. In *Histoire Naturelle. Volume 8 (Insectes)*; Chez Panckoucke: Paris, France, 1811.
274. Packard, A.S., Jr. Occurrence of *Myrmeleon immaculatum* DeGeer in Maine. *Psyche* **1900**, *9*, 95. [CrossRef]
275. Lucas, J.R.; Stange, L.A. Key and descriptions to the *Myrmeleon* larvae of Florida (Neuroptera: Myrmeleontidae). *Fla. Entomol.* **1981**, *64*, 207–216. [CrossRef]
276. Arnett, A.E.; Gotelli, N.J. Pit-building decisions of larval ant lions: Effects of larval age, temperature, food, and population source. *J. Insect Behav.* **2001**, *14*, 89–97. [CrossRef]
277. Banks, N. New neuropteroid insects. *Bull. Mus. Comp. Zool.* **1920**, *64*, 297–362.
278. Navás, L. Insectos suramericanos. Décima serie. *Rev. R. Acad. Cienc. Exactas Fís. Nat. Madr.* **1935**, *32*, 360–375.
279. Penny, N.D. Review of the generic level classification of the New World Mantispidae (Neuroptera). *Acta Amazon.* **1982**, *12*, 209–223. [CrossRef]
280. Morrone, J.J. Biogeographic areas and transition zones of Latin America and the Caribbean Islands based on panbiogeographic and cladistic analyses of the entomofauna. *Annu. Rev. Entomol.* **2006**, *51*, 467–494. [CrossRef] [PubMed]
281. Morrone, J.J. Biogeographical regionalization of the Neotropical region. *Zootaxa* **2014**, *3782*, 1–110. [CrossRef]
282. Monserrat, V.J. Los hemeróbidos de la Península Ibérica y Baleares (Insecta, Neuropterida, Neuroptera: Hemerobiidae). *Graellsia* **2015**, *71*, 1–71. [CrossRef]
283. Monserrat, V.J. Los coniopterígidos de la Península Ibérica e Islas Baleares (Insecta, Neuropterida, Neuroptera: Coniopterigydae). *Graellsia* **2016**, *72*, 1–115. [CrossRef]
284. Monserrat, V.J.; Acevedo, F.; Triviño, V. Los ascaláfidos de la Península Ibérica y Baleares (Insecta: Neuroptera: Ascalaphidae). *Heteropterus* **2012**, *12*, 33–58.

285. Monserrat, V.J.; Acevedo, F. Los mirmeleónidos (hormigas-león) de la Península Ibérica e Islas Baleares (Insecta, Neuropterida, Neuroptera, Myrmeleontidae). *Graellsia* **2013**, *69*, 283–321. [CrossRef]
286. Contreras-Medina, R.; Luna-Vega, I.; Morrone, J.J. Application of parsimony analysis of endemicity to Mexican gymnosperm distributions: Grid-cells, biogeographical provinces and track analysis. *Biol. J. Linn. Soc.* **2007**, *92*, 405–417. [CrossRef]
287. Halffter, G.; Verdú, J.R.; Márquez, J.; Moreno, C.E. Biogeographical analysis of Scarabaeinae and Geotrupinae along a transect in Central Mexico (Coleoptera, Scarabaeoidae). *Fragm. Entomol.* **2008**, *40*, 273–322. [CrossRef]
288. Halffter, G.; Llorente-Bousquets, J.; Morrone, J.J. La perspectiva biogeográfica histórica. In *Capital Natural de México, Volume I: Conocimiento Actual de la Biodiversidad*; Soberón, J., Halffter, G., Llorente, J., Eds.; Conabio: Tlalpan, Mexico, 2009; pp. 67–86.
289. Halffter, G. Biogeography of the montane entomofauna of Mexico and Central America. *Annu. Rev. Entomol.* **1987**, *32*, 95–114. [CrossRef]
290. Stelzl, M.; Devetak, D. Neuroptera in agricultural ecosystems. *Agric. Ecosyst. Environ.* **1999**, *74*, 305–321. [CrossRef]
291. De Freitas, S.; Penny, N.D. Neuroptera. In *Insetos do Brasil: Diversidades e Taxonomia*; Rafael, J.A., Melo, G.A.R., Carvalho, C.J.B., Casari, S.A., Constantino, R., Eds.; Holos Editora: Ribeirão Preto, Brazil, 2012; pp. 537–546.
292. New, T.R. A review of the biology of Neuroptera Planipennia. *Neuroptera Int.* **1986**, *1*, 1–57.
293. New, T.R. *Planipennia, Lacewings. Handbuch der Zoologie*; Walter de Gruyter: Berlin, Germany, 1989; Volume 4, pp. 1–132.
294. New, T.R. *The Neuroptera of Malesia. Fauna Malesiana*; Brill: Leiden, The Netherlands, 2003; Volume 4, pp. 1–204.
295. Popov, A. Neuropterida of northern Europe. *Acta Zool. Acad. Sci. Hung.* **2002**, *48*, 281–291.
296. Sosa, F.; de Freitas, S. New Neotropical species of *Ceraeochrysa* Adams (Neuroptera: Chrysopidae). *Zootaxa* **2010**, *2562*, 57–65. [CrossRef]
297. Martins, C.C.; Santos, R.S.; Sutil, W.P.; de Oliveira, J.F.A. Diversity and abundance of green lacewings (Neuroptera: Chrysopidae) in a Conilon coffee plantation in Acre, Brazil. *Acta Amaz.* **2019**, *49*, 173–178. [CrossRef]
298. Marín, F.; Monserrat, V.J. Los neuróperos del encinar ibérico (Insecta, Neuropteroidea). *Bol. San. Veg. Plagas* **1987**, *13*, 347–359.
299. Saure, C.; Kielhom, K.H. Netzflügler als Bewohner der Kronenregion von Eiche und Kiefer (Neuroptera: Coniopterygidae, Hemerobiidae, Chrysopidae). *Faun. Ökol. Mitt.* **1993**, *6*, 391–402.
300. González-Olazo, E.V. El genero *Megalomus* Rambur (Neurop.-Planipennia-Hemerobiidae) en Argentina y Chile. *Acta Zool. Lilloana* **1981**, *36*, 97–113.
301. Klimaszewski, J.; Kevan, D.K. Review of Canadian and Alaskan brown lacewing flies (Neuroptera: Hemerobiidae) with a key to the genera. Part IV: The genera *Megalomus* Rambur, *Boriomyia* Banks, *Psectra* Hagen and *Sympherobius* Banks. *Ann. Transvaal Mus.* **1992**, *35*, 435–457.
302. Shetlar, D.J. The Biosystematics of the Nearctic Ascalaphidae (Insecta: Neuropteroidea: Planipennia), with Notes on Biology and Morphology. Ph.D. Thesis, Pennsylvania State University, University Park, PA, USA, 1977.
303. Machado, R.J.P. A new species of *Trichoscelia* Westwood (*Neuroptera: Mantispidae*) from northern South America. *Zootaxa* **2018**, *4425*, 185–192. [CrossRef]
304. Monserrat, V.J. Los mantíspidos de la Península Ibérica y Baleares (Insecta, Neuropterida, Neuroptera, Mantispidae). *Graellsia* **2014**, *70*, 1–52. [CrossRef]
305. Duelli, P. Neuroptera from the Mediterranean Island of Malta (Neuroptera). *Entomofauna* **1994**, *15*, 125–127.
306. Gruppe, A.; Schubert, H. The spatial distribution and plant specificity of Neuropterida in different forest sites in southern Germany. *Beitr. Entomol.* **2001**, *51*, 517–527. [CrossRef]
307. Ábraham, L. A Látrányi Puszta Természetvédelmi Terület recésszárnyu-alkatú (Megaloptera, Raphidioptera, Neuroptera) faunája. *Nat. Somogy.* **2003**, *5*, 193–200. [CrossRef]
308. Sziráki, G. Coniopterygidae (Neuroptera) from southwestern parts of Asia. *Folia Ent. Hung.* **1999**, *60*, 179–186.

Supplementary Materials

Table S1. Material examined.

Chrysopidae.

- *Ceraeochrysa achillea* de Freitas and Penny in de Freitas *et al*., 2009

  Material examined (7♂, 1♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′24.72″N, 92º10′20.46″W, 687 m, 10-II-2018, 1♂, entomological net [pinned]; Finca Alianza, 15º02′27.54″N, 92º10′12.72″W, 689 m, 10-III-2018, 1♀, entomological net [pinned]; Finca Alianza, 15º02′23.34″N, 92º10′22.32″W, 690 m, 8-V-2018, 1♂, entomological net [pinned]; Finca Alianza, 15º03′43.44″N, 92º10′35.1″W, 775 m, 8-VIII-2018, 1♂, entomological net [pinned]; Finca Alianza, 15º02′22.56″N, 92º10′21.78″W, 723 m, 2-XI-2018, 1♂, entomological net [pinned]; Finca Alianza, 15º02′24″N, 92º10′21.84″W, 690 m, 2-XI-2018, 1♂, entomological net [pinned]; Finca Alianza, 15º03′44.94″N, 92º10′32.88″W, 728 m, 3-I-2019, 1♂, entomological net [pinned]; Ejido El Águila, 15º06′10.5″N, 92º10′55.68″W, 1191 m, 7-I-2019, 1♂, entomological net [pinned].

- *Ceraeochrysa arioles* (Banks, 1944)

  Material examined (7♂, 8♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′48.06″N, 92º09′54.48″W, 678 m, 8-VI-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′57.42″N, 92º11′16.98″W, 1069 m, 11-V-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′39.42″N, 92º11′21.72″W, 1161 m, 12-VI-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′41.7″N, 92º11′21.84″W, 12-VI-2018, 1151 m, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′38.52″N, 92º11′23.16″W, 1173 m, 11-VII-2018, 1♂, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′49.68″N, 92º11′19.98″W, 1112 m, 11-VII-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′49.86″N, 92º11′19.8″W, 1105 m, 10-VIII-2018, 1♀, entomological net [pinned]; Ejido El Águila, 15º05′48.42″N, 92º11′20.82″W, 1125 m, 7-IX-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′39.36″N, 92º11′23.76″W, 1228 m, 5-X-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′41.46″N, 92º11′21.9″W, 1161 m, 5-X-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′46.14″N, 92º11′20.88″W, 1131 m, 6-XII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′44.88″N, 92º08′38.76″W, 1530 m, 8-XI-2018, 1♂, entomological net, [pinned]; **Union Juárez**, Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 14-V-2018, 2♀, light trap [pinned].

- *Ceraeochrysa sarta* (Banks, 1914**)**

  Material examined (27♂, 74♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′27.06″N, 92º10′12.54″W, 673 m, 10-II-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′42.3″N, 92º10′34.5″W, 748 m, 1-X-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′34.5″N, 92º10′33.72″W, 732 m, 1-XI-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′40.02″N, 92º10′35.94″W, 700 m, 3-I-2019, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′45.52″N, 92º10′32.94″W, 774 m, 5-I-2019, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′34.5″N, 92º10′50.16″W, 1217 m, 13-III-2018, 1♀, light trap, [pinned]; Ejido El Águila, 15º05′54.78″N, 92º11′19.26″W, 1073 m, 13-III-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′49.5″N, 92º11′4.86″W, 1333 m, 12-IV-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′58.26″N, 92º10′56.7″W, 1324 m, 12-IV-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′45.42″N, 92º11′20.76″W, 1131 m, 12-VI-2018, 2♀, entomological net, [pinned]; Ejido El Águila, 15º05′33.24″N,92º10′50.64″W, 1194 m, 12-VI-2018, 1♀, light trap [pinned];

Ejido El Águila, 15º05′38.82″N, 92º11′21.84″W, 1209 m, 11-VII-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′38.52″N, 92º11′23.16″W, 1173 m, 11-VII-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′52.98″N, 92º11′18.84″W, 1120 m, 11-VII-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′55.56″N, 92º11′18.36″W, 1112 m, 11-VII-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′40.56″N, 92º11′22.26″W, 1148 m, 11-VII-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′36.36″N, 92º10′37.56″W, 1288 m, 9-VIII-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′40.2″N, 92º11′22.44″W, 1153 m, 10-VIII-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′54.96″N, 92º11′19.2″W, 1110 m, 7-IX-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′50.52″N, 92º11′19.32″W, 1097 m, 7-IX-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′41.46″N, 92º11′21.9″W, 1161 m, 5-X-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′55.02″N, 92º11′19.44″W, 1102 m, 5-X-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′43.74″N, 92º11′17.52″W, 1251 m, 5-XI-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′43.02″N, 92º11′16.98″W, 1248 m, 5-XI-2018, 2♂, entomological net, [pinned]; Ejido El Águila, 15º05′41.1″N, 92º11′16.86″W, 1250 m, 5-XI-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′54.18″N, 92º11′16.68″W, 1122 m, 5-XI-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′53.4″N, 92º11′15.72″W, 1136 m, 5-XI-2018, 1♂, 2♀, entomological net, [pinned]; Ejido El Águila, 15º05′51.18″N, 92º11′14.7″W, 1188 m, 5-XI-2018, 2♂, entomological net, [pinned]; Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 5-XI-2018, 1♀, light trap, [pinned]; Ejido El Águila, 15º05′48.18″N, 92º11′20.52″W, 1115 m, 6-XII-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′47.46″N, 92º11′20.28″W, 1127 m, 6-XII-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 6-I-2019, 1♀, light trap, [pinned]; Ejido El Águila, 15º06′0.6″N, 92º11′15.12″W, 1056 m, 7-I-2019, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′36.3″N, 92º10′49.2″W, 1223 m, 8-I-2019, 2♀, entomological net, [pinned]; Ejido El Águila, 15º05′34.2″N, 92º10′48.24″W, 1206 m, 8-I-2019, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 17-II-2018, 1♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05′41.7″N, 92º08′41.1″W, 1586 m, 16-II-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′42.78″N, 92º08′40.32″W, 1534 m, 18-II-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′44.52″N, 92º08′36.72″W, 1605 m, 16-III-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.98″N, 92º08′40.86″W, 1590 m, 15-III-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′42.9″N, 92º08′40.08″W, 1583 m, 15-III-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′41.82″N, 92º08′41.22″W, 1575 m, 14-IV-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.2″N, 92º08′41.94″W, 1587 m, 19-V-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.5″N, 92º08′41.82″W, 1568 m, 21-V-2018, 2♂, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′13.02″N, 92º08′55.2″W, 1430 m, 14-VI-2018, 1♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05′42.54″N, 92º08′41.7″W, 1675 m, 15-VI-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.76″N, 92º08′44.64″W, 1537 m, 15-VI-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.28″N, 92º08′45.06″W, 1535 m, 15-VI-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′42.06″N, 92º08′40.32″W, 1555 m, 12-VII-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.24″N, 92º08′44.16″W, 1560 m, 13-VII-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.64″N, 92º08′44.64″W, 1548 m, 13-VII-2018, 1♀, entomological net, [inned]; Ejido Benito Juárez El Plan, 15º05′36″N, 92º08′44.16″W, 1538 m, 13-VII-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.28″N, 92º08′44.88″W, 1534 m, 13-VII-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 13-VII-2018, 1♂, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.48″N, 92º08′43.92″W, 1553 m, 12-VIII-2018, 2♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.88″N, 92º08′44.52″W, 1537 m, 12-VIII-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′34.38″N, 92º08′45.54″W, 1511 m, 12-VIII-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.16″N, 92º08′45″W, 1536 m, 20-IX-2018, 2♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 20-IX-2018, 1♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05′42.24″N, 92º08′40.32″W, 1587 m, 21-IX-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.98″N, 92º08′41.7″W, 1581 m, 21-IX-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.86″N, 92º08′41.22″W, 1587 m, 21-IX-2018, 1♂, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.88″N, 92º08′44.46″W, 1550 m, 7-X-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 7-X-2018, 1♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º06′40.68″N, 92º08′41.82″W, 1577 m, 8-XI-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′42.3″N, 92º08′40.38″W, 1565 m, 8-XI-2018, 2♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′43.5″N, 92º08′37.2″W, 1619 m, 6-XII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′38.52″N, 92º08′42.84″W, 1568 m, 8-XII-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′59.82″N, 92º08′41.28″W, 1753 m, 9-I-2019, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′49.5″N, 92º08′48.54″W, 1697 m, 9-I-2019, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′44.04″N, 92º08′36.72″W, 1622 m, 9-I-2019, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.68″N, 92º08′41.58″W, 1577 m, 9-I-2019, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′38.58″N, 92º08′42.84″W, 1565 m, 9-I-2019, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′37.44″N, 92º08′43.68″W, 1564 m, 9-I-2019, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′34.32″N, 92º08′45″W, 1515 m, 9-I-2019, 2♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′45.66″N, 92º08′40.5″W, 1582 m, 10-I-2019, 1♂, entomological net, [pinned]; **Unión Juárez**, Finca Monte Perla, 15º02′45.36″N, 92º05′16.26″W, 973 m, 11-III-2018, 1♀, entomological net, [pinned]; Cantón Chiquihuites, 15º05′43.74″N, 92º05′57.6″W, 2081 m, 14-V-2018, 1♂, 4♀, light trap, [pinned]; same data but 19-VI-2018, 1♀, [pinned]; same data but 16-VII-2018, 1♀, [pinned]; same data but 8-X-2018, 2♀, [pinned]; Cantón Chiquihuites, 15º05′58.56″N, 92º05′55.74″W, 2168 m, 20-XI-2018, 1♀, entomological net, [pinned]; Cantón Chiquihuites, 15º05′43.74″N, 92º05′57.6″W, 2081 m, 14-I-2019, 1♀, light trap, [pinned].

- *Ceraeochrysa cincta* (Schneider, 1851)

  Material examined (1♂, 4♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′28.74″N, 92º10′9.48″W, 661 m, 5-I-2019, 1♀, light trap [pinned]; Ejido El Águila, 15º05′36.96″N, 92º10′48.36″W, 1230 m, 12-II–12-III-2018, 1♀, Malaise trap [alcohol]; Ejido El Águila, 15º05′38.82″N, 92º11′23.7″W, 1141 m, 12-VI-2018, 1♀, entomological net [pinned]; Ejido El Águila, 15º05′37.62″N, 92º11′21.96″W, 1050 m, 7-I-2019, 1♀, entomological net [pinned]; **Unión Juárez**, Cantón Chiquihuites, 15º05′45.84″N, 92º05′57″W, 2110 m, 18-VI-2018, 1♂, entomological net [alcohol].

- *Ceraeochrysa cubana* (Hagen, 1861)

  Material examined (1♂, 2♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′26.34″N, 92º10′13.56″W, 684 m, 10-II-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º02′27.48″N, 92º10′12.48″W, 680 m, 10-III-2018, 1♂, entomological net, [pinned]; **Unión Juárez**, Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 14-V-2018, 1♀, light trap, [pinned].

- *Ceraeochrysa defreitasi* Penny in Penny, 2002

  Material examined (1♂): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, 15º05′27.90″N, 92º08′41.94″W, 1590 m, 11-VIII-2018, 1♂, entomological net [pinned].

- *Ceraeochrysa derospogon* de Freitas and Penny in de Freitas *et al*., 2009

  Material examined (3♂): **Mexico: Chiapas, Cacahoatán**, Ejido El Aguila, 15º05′38.94″N, 92º11′24.12″W, 1185 m, 6-XII-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′41.76″N, 92º11′22.26″W, 1204 m, 6-XII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.16″N,92º08′45″W, 1544 m, 8-XII-2018, 1♂, entomological net, [pinned].

- *Ceraeochrysa effusa* (Navás, 1911)

  Material examined (14♂, 5♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º03′38.88″N, 92º10′36.66″W, 746 m, 9-VII-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′44.16″N, 92º10′33.42″W, 768 m, 1-X-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′34.5″N, 92º10′50.16″W, 1217 m, 11-V-2018, 1♂, light trap, [pinned]; Ejido El Águila, 15º05′36.42″N, 92º11′20.76″W, 1111 m, 12-VI-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′39.36″N, 92º11′23.76″W, 1228 m, 5-X-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′13.98″N, 92º08′55.14″W, 1424 m, 16-III-2018, 1♀, black light trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′41.34″N, 92º08′41.1″W, 1584 m, 14-VI-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′30″N, 92º08′45″W, 1530 m, 15-VI-2018, 2♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.04″N, 92º08′45.6″W, 1529 m, 15-VI-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.76″N, 92º08′44.64″W, 1537 m, 15-VI-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36″N, 92º08′44.16″W, 1538 m, 13-VII-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.44″N, 92º08′42.84″W, 1583 m, 13-VII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.18″N, 92º08′44.22″W, 1548 m, 13-VII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.64″N, 92º08′44.64″W, 1548 m, 13-VII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 7-X-2018, 1♂, light trap, [pinned]; same data but 7-XI-2018, 1♂, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.68″N, 92º08′41.58″W, 1577 m, 9-I-2019, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.06″N, 92º08′44.52″W, 1552 m, 9-I-2019, 1♂, entomological net, [pinned].

- *Ceraeochrysa infausta* (Banks, 1945)

  Material examined (2♂, 1♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′48.06″N, 92º09′54.48″W, 678 m, 8-VI-2018, 1♂, entomological net, [pinned];

Finca Alianza, 15º03′40.32″N, 92º10′35.64″W, 664 m, 5-IX-2018, 1♂, entomological net, [pinned]; **Unión Juárez**, Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 14-V-2018, 1♀, light trap, [Pinned].

- *Ceraeochrysa lineaticornis* (Fitch, 1855)

Material examined (1♂, 6♀): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º05′58.26″N, 92º10′16.98″W, 1075 m, 13-III-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′40.08″N, 92º11′22.62″W, 1153 m, 12-VI-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′41.7″N, 92º11′21.84″W, 1151 m, 12-VI-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′41.46″N, 92º11′21.84″W, 1137 m, 7-IX-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′48.36″N, 92º11′20.7″W, 1110 m, 5-X-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′47.46″N, 92º11′20.4″W, 1131 m, 5-X-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.12″N, 92º08′44.28″W, 1548 m, 12-VIII-2018, 1♂, entomological net, [pinned].

- *Ceraeochrysa sanchezi* (Navás, 1924)

Material examined (1♂, 2♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′31.2″ N, 92º10′13.5″ W, 713 m, 7-VI-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′39.3″N, 92º11′23.58″W, 1150 m, 10-VIII-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′38.94″N, 92º11′24.12″W, 1185 m, 6-XII-2018, 1♀, entomological net, [pinned].

- *Ceraeochrysa squama* de Freitas and Penny, 2001

Material examined (2♂): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′46.44″N, 92º09′58.8″W, 680 m, 7-VIII-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′37.62″N, 92º11′21.96″W, 1050 m, 7-I-2019, 1♂, entomological net, [pinned].

- *Ceraeochrysa tacanensis* Cancino and Contreras, 2019

Material examined (23♂, 9♀): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 11-V-2018, 1♂, light trap, [pinned]; Ejido El Águila, 15º05′34.92″N, 92º10′48.72″W, 1286 m, 9-VIII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan 15º05′27.66″N, 92º08′50.5″W, 1487 m, 20-V-2018, 1♂, black light trap (bucket), [pinned]; Ejido Benito Juárez El Plan 15º05′27.18″N, 92º08′51.06″W, 1479 m, 13-VII-2018, 1♂, 1♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05′32.46″N, 92º08′45.6″W, 1561 m, 13-VII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 13-VII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.24″N, 92º08′44.16″W, 1560 m, 13-VII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.88″N, 92º08′44.52″W, 1537 m, 12-VIII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.74″N, 92º08′41.04″W, 1578 m, 7-X-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′38.04″N, 92º08′43.26″W, 1570 m, 7-X-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 7-X-2018, 2♂, 2♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.48″N, 92º08′30.12″W, 1482 m, 7-XI-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.16″N, 92º08′44.88″W, 1546 m, 9-I-2019, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.24″N, 92º08′43.86″W, 1550 m, 9-I-2019, 1♂, entomological net, [pinned]; **Unión Juárez**, Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 14-V-2018, 7♂, 1♀, light trap, [pinned]; same data but 19-VI-2018, 1♂, 1♀, [pinned]; Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 17-VII-2018, 1♂, entomological net, [pinned]; Cantón Chiquihuites, 15º05′47.1″N, 92º05′57.42″W, 2061 m, 9-X-2018, 1♂, entomological net, [pinned]; Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 8-X-2018, 1♂, 1♀, light trap, [pinned].

- *Ceraeochrysa* sp.

  Material examined (2♂): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º05′56.64″N, 92º11′17.64″W, 1092 m, 11-VII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1462 m, 12-VIII-2018, 1♂, light trap, [pinned].

- *Chrysoperla asoralis* (Banks, 1915)

  Material examined (2♂, 1♀): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º05′34.5″N, 92º10′50.16″W, 1217 m, 13-III-2018, 1♂, light trap, [pinned]; Ejido El Águila, 15º05′36.42″N, 92º11′20.76″W, 1111 m, 12-VI-2018, 1♂, entomological net, [pinned]; **Unión Juárez**, Cantón Chiquihuites, 15º05′43.74″N, 92º05′57.6″W, 2081 m, 14-V-2018, 1♀, light trap, [pinned].

- *Chrysoperla externa* (Hagen, 1861)

  Material examined (1♂): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′46.01″ N, 92º09′57.12″ W, 694 m, 9-III-2018, 1♂, entomological net, [pinned].

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

  Material examined (24♂, 18♀, 2?): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 13-II-2018, 1?, light trap, [pinned]; Ejido El Águila, 15º05′34.5″N, 92º10′50.16″W, 1217 m, 13-III-2018, 1♂, 1♀, light trap, [pinned]; same data but 11-V-2018, 4♂, 2♀, 1?, [pinned]; Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 12-VI-2018, 3♂, light trap [pinned]; same data but 11-VII-2018, 7♂, 4♀, [pinned]; same data but 10-VIII-2018, 4♂, 4♀, [pinned]; Ejido El Águila, 15º05′57.96″N, 92º11′17.46″W, 1062 m, 7-IX-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 7-IX-2018, 2♂, 2♀, light trap, [pinned]; same data but 5-X-2018, 1♂, [pinned]; Ejido El Águila, 15º05′33.78″N, 92º10′52.02″W, 1209 m, 5-X-2018, 1♀, black light trap, [pinned]; Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 6-XII-2018, 1♀, light trap, [pinned]; same data but 6-I-2019, 1♀, [pinned]; Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 6-XII-2018, 1♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 7-X-2018, 2♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1462 m, 7-XI-2018, 1♂, light trap, [pinned].

- *Chrysopodes* (*Chrysopodes*) *varicosus* (Navás, 1914)

  Material examined (22♂, 30♀, 1?): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′28.74″N, 92º10′9.66″W, 704 m, 7-VIII-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′29.52″N, 92º10′54.96″W, 1193 m, 11-IV-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′33.12″N, 92º10′54.54″W, 1270 m, 10-V-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 12-VI-2018, 2♀, light trap, [pinned]; Ejido El Águila, 15º05′33.78″N, 92º10′52.02″W, 1209 m, 7-IX-2018, 1♂, black light trap, [pinned]; Ejido El Águila, 15º05′57.18″N, 92º11′17.58″W, 1080 m, 5-X-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′33.78″N, 92º10′52.02″W, 1209 m, 5-X-2018, 1♀, black light trap, [pinned]; Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 6-I-2019, 1♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 17-II-2018, 1♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.68″N, 92º08′41.52″W, 1574 m, 17-II-2018, 2♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.74″N, 92º08′41.7″W, 1569 m, 15-III-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.44″N, 92º08′41.76″W, 1596 m, 19-V-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.5″N, 92º08′41.82″W, 1568 m, 21-V-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.08″N, 92º08′41.94″W, 1614 m, 14-VI-2018, 2♂, 2♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.68″N, 92º08′40.92″W, 1581 m, 14-VI-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.62″N, 92º08′41.76″W, 1591 m, 15-VI-2018, 1♂, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.76″N, 92º08′44.64″W, 1537 m, 15-VI-2018, 2♂, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.28″N, 92º08′45.06″W, 1535 m, 15-VI-2018, 2♂, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′39.42″N, 92º11′21.72″W, 1650 m, 15-VI-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36″N, 92º08′44.16″W, 1538 m, 13-VII-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′49.26″N, 92º08′31.8″W, 1668 m, 13-VII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.78″N, 92º08′43.8″W, 1553 m, 13-VII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.54″N, 92º08′43.92″W, 1554 m, 13-VII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.18″N, 92º08′44.22″W, 1548 m, 13-VII-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 13-VII-2018, 1♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.92″N, 92º08′41.94″W, 1590 m, 11-VIII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′34.38″N, 92º08′45.54″W, 1511 m, 12-VIII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.58″ N, 92º08′45″W, 1521 m, 12-VIII-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.12″N, 92º08′44.28″W, 1548 m, 12-VIII-2018, 1♂, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 12-VIII-2018, 1♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.16″N, 92º08′45″W, 1536 m, 20-IX-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.44″N, 92º08′41.58″W, 1582 m, 20-IX-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.98″ N, 92º08′41.7″W, 1581 m, 21-IX-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.8″N, 92º08′41.58″W, 1596 m, 21-IX-2018, 1♂, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.54″N, 92º08′44.16″W, 1537 m, 7-X-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′50.82″ N, 92º08′30.78″W, 1705 m, 7-XI-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 7-XI-2018, 1♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05′44.88″N, 92º08′38.76″W, 1530 m, 8-XI-2018, 1♀, entomological net, [pinned]; **Unión Juárez**, Cantón Chiquihuites, 15º05′54.42″N, 92º05′57.96″W, 2157 m, 19-II-2018, 1?, light trap, [pinned]; Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 14-V-2018, 1♀, light trap, [pinned].

- *Chrysopodes* sp. 1

Material examined (1♀): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º05′33.24″N,92º10′50.64″W, 1194 m, 11-VII-2018, 1♀, light trap, [pinned].

- *Chrysopodes* sp. 2

Material examined (1♀): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, 15º05′27.66″N, 92º08′50.52″W, 1487 m, 17-II-2018, 1♀, black light trap (bucket), [pinned].

- *Meleoma macleodi* Tauber, 1969

Material examined (1♂, 3♀): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, 15º05′40.68″N, 92º08′41.1″W, 1582 m, 16-II-2018, 1♂, entomological net, [pinned]; **Unión Juárez,** Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 14-V-2018, 3♀, light trap, [pinned].

- *Meleoma titschacki* Navás, 1928

Material examined (48♂, 47♀): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º05′51.42″N, 92º11′1.32″W, 1342 m, 12-IV-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′36.3″N, 92º10′49.2″W, 1222 m, 8-I-2019, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.68″N, 92º08′41.1″W, 1582 m, 16-II-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 17-II-2018, 2♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.8″N, 92º08′40.98″W, 1569 m, 14-IV-2018, 1♂, 7♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.62″N, 92º08′38.04″W, 1596 m, 19-V-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.62″N, 92º08′41.1″W, 1586 m, 20-V-2018, 2♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.08″N, 92º08′41.94″W, 1614 m, 14-VI-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.66″N, 92º08′43.86″W, 1554 m, 15-VI-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 13-VII-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.24″N, 92º08′44.16″W, 1560 m, 13-VII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.44″N, 92º08′42.84″W, 1583 m, 13-VII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′38.58″N, 92º08′42.84″W, 1568 m, 13-VII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 12-VIII-2018, 2♂, 1♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.58″N, 92º08′45″W, 1521 m, 12-VIII-2018, 2♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.12″N, 92º08′44.28″W, 1548 m, 12-VIII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′37.74″N, 92º08′43.26″W, 1572 m, 12-VIII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.16″N, 92º08′45″W, 1536 m, 20-IX-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 20-IX-2018, 1♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.74″N, 92º08′41.04″W, 1578 m, 7-X-2018, 1♂, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.54″N, 92º08′44.16″W, 1537 m, 7-X-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′38.04″N, 92º08′43.26″W, 1570 m, 7-X-2018, 1♂, 3♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 7-X-2018, 3♀, light trap, [pinned]; Ejido Benito Juárez El

Plan, 15º05′34.8″N, 92º08′46.2″W, 1548 m, 7-XI-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.1″N, 92º08′45.3″W, 1556 m, 7-XI-2018, 2♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′37.56″N, 92º08′43.98″W, 1552 m, 7-XI-2018, 1♂, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′38.28″N, 92º08′42.9″W, 1573 m, 7-XI-2018, 1♂, 2♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.86″N, 92º08′41.52″W, 1585 m, 7-XI-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 7-XI-2018, 1♂, 2♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.3″N, 92º08′44.04″W, 1550 m, 8-XII-2018, 2♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.72″N, 92º08′43.92″W, 1554 m, 8-XII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′37.26″N, 92º08′43.8″W, 1569 m, 8-XII-2018, 4♂, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′38.52″N, 92º08′42.84″W, 1568 m, 8-XII-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.98″N, 92º08′40.8″W, 1567 m, 8-XII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′34.44″N, 92º08′45.18″W, 1538 m, 8-XII-2018, 1♂, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.1″N, 92º08′45″W, 1544 m, 8-XII-2018, 3♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.46″N, 92º08′44.58″W, 1530 m, 8-XII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.06″N, 92º08′44.28″W, 1548 m, 8-XII-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′34.32″N, 92º08′45″W, 1515 m, 9-I-2019, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′35.16″N, 92º08′44.88″W, 1546 m, 9-I-2019, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.24″N, 92º08′43.86″W, 1550 m, 9-I-2019, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′36.66″N, 92º08′43.68″W, 1556 m, 9-I-2019, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′38.58″N, 92º08′42.84″W, 1565 m, 9-I-2019, 1♂, 2♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.68″N, 92º08′41.58″W, 1577 m, 9-I-2019, 1♂, entomological net, [pinned]; **Unión Juárez**, Cantón Chiquihuites, 15º05′46.26″N, 92º05′56.46″W, 2072 m, 18-III-2018, 2♂, 1♀, light trap, [pinned]; Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 8-X-2018, 1♂, light trap, [pinned]; Cantón Chiquihuites, 15º05′51.3″N, 92º05′58.86″W, 2142 m, 20-XI-2018, 1♀, entomological net, [pinned].

- *Meleoma* sp.

  Material examined (3♀): **Mexico: Chiapas, Unión Juárez**, Cantón Chiquihuites, 15º06′9.48″N, 92º06′20.64″W, 2453 m, 19-XI-2018, 1♀ entomological net, [pinned]; Cantón Chiquihuites, 15º06′12.6″N, 92º06′18.96″W, 2459 m, 19-XI-2018, 1♀ entomological net, [pinned]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 13-IX-2018, 1♀, light trap, [pinned].

- *Plesiochrysa brasiliensis* (Schneider, 1851)

  Material examined (7♂, 10♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′28.74″N, 92º10′9.48″W, 661 m, 5-I-2019, 1♀, light trap, [pinned]; Ejido El Águila, 15º05′34.5″N, 92º10′50.16″W, 1217 m, 13-III-2018, 2♂, 4♀, light trap, [pinned]; Ejido El Águila, 15º05′48.36″N, 92º11′20.7″W, 1110 m, 5-X-2018, 1♂ entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.08″N, 92º08′38.76″W, 1650 m, 15-VI-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.44″N, 92º08′42.84″W, 1583 m, 13-VII-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′27.48″N, 92º08′50.64″W, 1482 m, 7-XI-2018, 1♂ entomological net, [pinned]; Ejido Benito

Material examined (1♀): **Mexico: Chiapas, Unión Juárez**, Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 16-V-2018, 1♀, light trap, [pinned].

- *Ungla* sp.2

Material examined (1♂): **Mexico: Chiapas, Unión Juárez**, Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 14-V-2018, 1♂, light trap, [pinned].

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

Material examined (4♂, 3♀, 1?): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º06′9.24″N, 92º10′58.68″W, 1173 m, 13-II-2018, 1?, entomological net, [pinned]; Ejido El Águila, 15º06′10.62″N, 92º10′54.42″W, 1165 m, 11-V-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º06′10.5″N, 92º10′54.48″W, 1080 m, 7-IX-2018, 1♂, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′32.22″N, 92º10′35.52″W, 1227 m, 4-X-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º06′9.9″N, 92º10′56.7″W, 1290 m, 7-I-2019, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′55.2″N, 92º08′31.26″W, 1665 m, 20-V-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º06′2.64″N, 92º08′38.1″W, 1705 m, 12-VIII–20-IX-2018, 1♀, Malaise trap, [alcohol].

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

Material examined (2♀): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, 15º06′2.64″N, 92º08′38.1″W, 1705 m, 15-IV–20-V-2018, 1♀, Malaise trap, [alcohol]; **Unión Juárez**, Cantón Chiquihuites, 15º05′44.7″N, 92º05′58.56″W, 2079 m, 17-IV-2018, 1♀, entomological net, [pinned].

- *Leucochrysa (Leucochrysa) lestagei* Navás, 1922

Material examined (1♂): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, 15º05′14.51″N, 92º08′52.89″W, 1440 m, 27-V–01-VI-2018, Chame, E., 1♂, entomological net, [pinned] (ECO-TAP-E).

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

Material examined (22♂, 14♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º03′36.78″N, 92º10′35.4″W, 754 m, 7-VII-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º02′22.98″N, 92º10′22.68″W, 691 m, 8-VII-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º03′43.86″N, 92º10′33.42″W, 780 m, 9-VII-2018, 2♂, entomological net, [pinned]; Finca Alianza, 15º02′35.4″N, 92º10′4.8″W, 681 m, 7-VIII-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º02′46.44″N, 92º09′58.8″W, 680 m, 7-VIII-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º03′43.02″N, 92º10′34.2″W, 780 m, 8-VIII-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º03′40.44″N, 92º10′35.58″W, 747 m, 3-IX-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º02′23.58″N, 92º10′22.02″W, 690 m, 4-IX-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′35.76″N, 92º10′34.26″W, 752 m, 5-IX-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′42.96″N, 92º10′34.74″W, 763 m, 1-X-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º02′42.78″N, 92º09′59.1″W, 809 m, 2-X-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′37.56″N,92º10′35.22″W, 769 m, 3-X-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º03′33.84″N, 92º10′33.12″W, 746 m, 3-X-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º03′34.92″N, 92º10′33.72″W, 741 m, 1-XI-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′40.26″N, 92º10′35.52″W, 740 m, 1-XI-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º03′43.14″N, 92º10′34.08″W, 766 m, 1-XI-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º02′22.56″N, 92º10′21.78″W, 723 m, 2-XI-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º03′43.26″N, 92º10′34.2″W, 772 m, 2-XI-2018, 1♂, 1♀, entomological net, [pinned]; Finca Alianza, 15º02′40.44″N, 92º09′34.98″W, 767 m, 2-XI-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º02′40.02″N, 92º09′36.3″W, 774 m, 2-XI-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′37.56″N, 92º10′36.18″W, 726 m, 2-XI-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º02′36.36″N, 92º09′35.88″W, 758 m, 2-XI-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º03′35.7″N, 92º10′34.5″W, 763 m, 2-XI-2018, 3♀, entomological net, [pinned]; Finca Alianza, 15º02′28.74″N, 92º10′9.48″W, 661 m, 2-XI-2018, 2♂, light trap, [pinned]; Finca Alianza, 15º03′40.5″N, 92º10′36.12″W, 798 m, 4-XII-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º02′35.82″N, 92º09′34.68″W, 749 m, 4-XII-2018, 1♂, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′44.94″N, 92º10′32.88″W, 728 m, 3-I-2019, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′43.26″N, 92º10′34.62″W, 763 m, 3-I-2019, 1♂, entomological net, [pinned]; Finca Alianza, 15º03′38.7″N, 92º10′35.64″W, 752 m, 3-I-2019, entomological net, 1♀, entomological net, [pinned].

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

  Material examined (1♂): **Mexico, Chiapas, Cacahoatán**, Ejido El Águila, 15º05′35.76″N, 92º10′40.5″W, 1254 m, 12-VII-2018, 1♂, entomological net, [pinned].

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

  Material examined (3♂, 1♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º03′44.7″N, 92º10′33.18″W, 789 m, 3-X-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′41.1″N, 92º11′16.86″W, 1250 m, 5-XI-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º06′10.5″N, 92º10′54.72″W, 1154 m, 7-I-2019, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′40.86″N, 92º08′41.52″W, 1585 m, 7-XI-2018, 1♂, entomological net, [pinned].

- *Leucochrysa* (*Nodita*) *amistadensis* Penny, 2001

  Material examined (2♂, 2♀): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, 15º05′14.51″N, 92º08′52.89″W, 1440 m, 27-V–01-VI-2015, E. Chame, 1♂, direct sampling, [alcohol] (ECO-TAP-E); Ejido Benito Juárez El Plan, 15º05′55.32″N, 92º08′30.06″W, 1721 m, 20-V-2018, 1♀, entomological net, [pinned]; **Unión Juárez**, Cantón Chiquihuites, 15º05′56.82″N, 92º05′56.22″W, 2120 m, 11-IX-2018, 1♀, entomological net, [pinned]; Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 10-IX-2018, 1♂, light trap, [pinned].

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

  Material examined (13♂, 11♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′27″N, 92º10′12.96″W, 689 m, 8-IV-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º02′22.8″N, 92º10′21.96″W, 683 m, 8-V-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º02′32.34″N, 92º10′5.22″W, 690 m, 8-VI-2018, 2♀, entomological net, [pinned]; Finca Alianza, 15º02′22.08″N, 92º10′22.38″W, 680 m, 9-VI-2018, 2♀, entomological net, [pinned]; Finca Alianza, 15º02′23.64″N, 92º10’22.2”W, 685 m, 8-VII-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º02’23.82”N, 92º10’22.02”W, 683 m, 8-VII-2018, 1♂, 1♀, entomological net, [pinned]; Finca Alianza, 15º02’32.34”N, 92º10’5.52 “W, 687 m, 8-VII-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º03’36.18”N, 92º10’34.2”W, 746 m, 9-VII-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º03’34.38”N, 92º10’35.28”W, 744 m, 6-VIII-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º02’45.96”N, 92º09’56.46”W, 747 m, 4-IX-2018, entomological net, 1♂, [pinned]; Finca Alianza, 15º03’40.2”N,92º10’35.88”W, 759 m, 5-IX-2018, 2♂, entomological net, [pinned]; Finca Alianza, 15º02’42.78”N, 92º09’59.1”W, 809 m, 2-X-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º02’22.2”N, 92º10’22.92”W, 697 m, 2-X-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º03’37.56”N, 92º10’35.22”W, 769 m, 3-X-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º02’22.56”N, 92º10’21.78”W, 723 m, 2-XI-2018, 1♂, 1♀, entomological net, [pinned]; Finca Alianza, 15º02’35.7”N, 92º09’34.5”W, 763 m, 2-XII-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º03’35.82”N, 92º10’34.68”W, 749 m, 4-XII-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º03’35.7”N, 92º10’34.38”W, 748 m, 3-I-2019, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05’58.32”N, 92º11’16.68”W, 1085 m, 5-X-2018, 1♂, entomological net, [pinned].

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

  Material examined (1♂): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º03’38.58”N, 92º10’35.94”W, 743 m, 5-I-2019, 1♂, entomological net, [pinned].

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

  Material examined (2♂, 1♀): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º05’32.7”N, 92º10’51.24”W, 1231 m, 25-VI-2019, Marquez-López, Y., 1♀, light trap, [pinned]; Ejido Benito Juárez El Plan, 15º05’44.1”N, 92º08’36.9”W, 1620 m, 8-XII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05’36.72”N, 92º08’43.92”W, 1554 m, 8-XII-2018, 1♂, entomological net, [pinned].

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

  Material examined (2♀): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, 15º05’40.68”N, 92º08’41.1”W, 1582 m, 16-II-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05’35.46”N, 92º08’44.64”W, 1557 m, 7-X-2018, 1♀, entomological net, [pinned].

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

  Material examined (2♂): **Mexico: Chiapas, Unión Juárez**, San Jeronimo, recorrido 1, 15º02’19.6”N, 92º08’14.55”W, 720 m, 11-VII-2017, C. Sánchez B., 2♂, Ceratrap, [alcohol] (ECO-TAP-E).

- *Leucochrysa* (*Nodita*) *lateralis* Navás, 1913

  Material examined (8♂, 9♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º03’41.34”N, 92º10’35.46”W, 746 m, 9-VII-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º03’42.96”N, 92º10’34.74”W, 763 m, 1-X-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º02’37.56”N, 92º09’35.22”W, 769 m, 3-X-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º03’40.26”N, 92º10’35.52”W, 740 m, 1-XI-2018, 2♂, entomological net, [pinned]; Finca Alianza, 15º03’36”N, 92º10′34.38″W, 755 m, 1-XI-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º03′34.92″N, 92º10′33.72″W, 741 m, 1-XI-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º02′46.32″N, 92º09′57.3″W, 713 m, 2-XI-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º02′22.56″N, 92º10′21.78″W, 723 m, 2-XI-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º03′35.7″N, 92º10′34.5″W, 763 m, 2-XII-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′44.82″N, 92º10′32.46″W, 780 m, 4-XII-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′35.7″N, 92º10′34.38″W, 748 m, 3-I-2019, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′43.26″N, 92º10′34.62″W, 763 m, 3-I-2019, 1♂, entomological net, [pinned]; Finca Alianza, 15º03′43.02″N, 92º10′34.5″W, 777 m, 5-I-2019, 1♂, 2♀, entomological net, [pinned]; Finca Alianza, 15º03′40.62″N,92º10′35.52″W, 765 m, 5-I-2019, 1♂, entomological net, [pinned].

- *Leucochrysa* (*Nodita*) *maculosa* de Freitas and Penny, 2001

Material examined (11♂, 10♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º03′36.84″N, 92º10′35.22″W, 753 m, 9-VII-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º06′10.62″N, 92º10′56.58″W, 1151 m, 12-IV-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º06′10.2″N, 92º10′55.32″W, 1155 m, 11-V-2018, 3♂, 1♀, entomological net, [pinned]; Ejido El Águila, 15º06′09″N, 92º10′59.82″W, 1111 m, 12-VI-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º06′11.04″N, 92º10′54.24″W, 1160 m, 12-VI-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º06′8.52″N, 92º11′1.2″W, 1117 m, 12-VI-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º06′11.1″N, 92º10′53.52″W, 1163 m, 12-VI-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′35.28″N, 92º10′38.88″W, 1264 m, 12-VII-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º06′9.96″N, 92º10′55.74″W, 1070 m, 7-IX-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º06′10.68″N, 92º10′53.94″W, 1097 m, 7-IX-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º06′10.5″N, 92º10′54.48″W, 1080 m, 7-IX-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′55.26″N, 92º08′30.42″W, 1736 m, 20-V-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′53.58″N, 92º08′38.94″W, 1668 m, 21-V-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′55.32″N, 92º08′30.12″W, 1675 m, 14-VI-2018, 1♀, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′55.14″N, 92º08′30.66″W, 1688 m, 13-VII-2018, 2♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′46.8″N, 92º08′33.72″W, 1652 m, 13-VII-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º05′48.3″N, 92º08′37.08″W, 1436 m, 9-XII-2018, 1♀, entomological net, [pinned].

- *Leucochrysa* (*Nodita*) *nigrovaria* (Walker, 1853)

Material examined (5♂, 5♀, 1?): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′26.4″N, 92º10′14.64″W, 678 m, 9-IV-2018, 1?, entomological net, [pinned]; Ejido El Águila, 15º05′40.56″N, 92º11′22.26″W, 1148 m, 11-VII-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′49.2″N, 92º11′20.34″W, 1120 m, 7-IX-2018, 1♂, 1♀, entomological net, [pinned]; Ejido El Águila, 15º06′10.5″N, 92º10′54.06″W, 1085 m, 7-IX-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 7-IX-2018, 1♀, light trap, [pinned]; Ejido El Águila, 15º05′40.62″N, 92º11′17.22″W, 1247 m, 5-XI-2018, 1♂, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′41.1″N, 92º11′16.86″W, 1250 m, 5-XI-2018, 1♀, entomological net, [pinned]; Ejido El Águila, 15º05′43.02″N, 92º11′16.98″W, 1248 m, 5-XI-2018, 1♂, entomological net, [pinned]; Ejido El Águila, 15º06′10.5″N, 92º10′54.72″W, 1154 m, 7-I-2019, 1♀, entomological net, [pinned].

- *Leucochrysa* (*Nodita*) *squamisetosa* de Freitas and Penny, 2001

  Material examined (1♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′34.14″N, 92º10′4.2″W, 659 m, 8-VI-2018, 1♀, light trap, [pinned].

- *Leucochrysa* (*Nodita*) *tarini* (Navás, 1924)

  Material examined (6♂, 8♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′20.64″N, 92º10′14.4″W, 661 m, 9-II-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º02′21.18″N, 92º10′20.88″W, 665 m, 9-III-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º02′21.78″N, 92º10′22.44″W, 678 m, 8-V-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º02′36.3″N, 92º10′5.52″W, 704 m, 7-VI-2018, 1♂, entomological net, [pinned]; Finca Alianza, 15º02′23.7″N, 92º10′21.9″W, 677 m, 8-VII-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′35.1″N, 92º10′34.02″W, 734 m, 1-X-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′44.7″ N, 92º10′33.18″W, 789 m, 3-X-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′35.7″N, 92º10′34.38″W, 748 m, 3-I-2019, 2♂, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′40.62″N, 92º10′35.52″W, 765 m, 5-I-2019, 1♂, entomological net, [pinned]; Finca Alianza, 15º03′38.58″N, 92º10′35.94″W, 743 m, 5-I-2019, 1♂, entomological net, [pinned]; Finca Alianza, 15º03′23.7″N, 92º10′34.56″W, 748 m, 5-I-2019, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′36.72″N, 92º10′48.66″W, 1223 m, 8-I-2019, 1♀, entomological net, [pinned].

- *Leucochrysa* sp. 1

  Material examined (3♂, 2♀, 1?): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º03′35.46″N, 92º10′33.72″W, 741 m, 7-VII-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′45″N, 92º10′33.24″W, 775 m, 5-IX-2018, 1♂, 1♀, entomological net, [pinned]; Finca Alianza, 15º03′45.42″N, 92º10′32.94″W, 774 m, 5-I-2019, 1♂, entomological net, [pinned]; Ejido El Águila, 15º05′47.46″N, 92º11′20.4″W, 1131 m, 5-X-2018, 1♂, entomological net, [pinned]; Ejido Benito Juárez El Plan, 15º06′1.44″N, 92º08′46.32″W, 1483 m, 14-IV-2018, 1?, entomological net, [pinned].

- *Leucochrysa* sp. 2

  Material examined (1♀): **Mexico: Chiapas, Unión Juárez**, Cantón Chiquihuites, 15º05′54.42″N, 92º05′55.86″W, 2149 m, 11-IX-2018, 1♀, entomological net, [pinned].

- *Leucochrysa* sp. 3

  Material examined (1♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′46.32″N, 92º09′57.3″W, 713 m, 2-XI-2018, 1♀, entomological net, [pinned].

- *Leucochrysa* sp. 4

  Material examined (1♂): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º05′35.28″N, 92º10′50.22″W, 1195 m, 12-II-2018, 1♂, entomological net, [pinned].

- *Leucochrysa* sp. 5

Material examined (1♂): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º06′7.08″N, 92º10′53.16″W, 1192 m, 12-IV-2018, 1♂, entomological net, [pinned].

- *Leucochrysa* sp. 6

Material examined (1♂, 1♀): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 20-IX-2018, 1♂, light trap, [pinned]; same data but 7-X-2018, 1♀, [pinned].

Coniopterygidae.

- *Neoconis dentata* Meinander, 1972

Material examined (18♂, 17♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′23.94″N, 92º10′22.02″W, 693 m, 8-V-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º03′44.22″N, 92º10′10.26″W, 727 m, 8-VI-2018, 1♀, entomological net, [alcohol]; Finca Alianza, 15º02′22.2″N, 92º10′23.22″W, 711 m, 7-VIII-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′46.62″N, 92º11′6.72″W, 1336 m, 12-IV-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′51.18″N, 92º11′14.7″W, 1188 m, 5-XI-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′41.22″N, 92º11′16.86″W, 1235 m, 5-XI-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′48.96″N, 92º08′36.84″W, 1534 m, 15-III-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.48″N, 92º08′33.78″W, 1506 m, 16-III-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′58.02″N, 92º08′33.42″W, 1632 m, 16-III-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′42.18″N, 92º08′40.5″W, 1590 m, 14-IV-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′55.32″N, 92º08′30.06″W, 1721 m, 20-V-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′53.58″N, 92º08′29.64″W, 1703 m, 20-V-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′54.54″N, 92º08′29.94″W, 1715 m, 20-V-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′41.46″N, 92º08′41.04″W, 1574 m, 21-V-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′13.02″N, 92º08′55.2″W, 1430 m, 14-VI-2018, 1♀, light trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′34.56″N, 92º08′45.3″W, 1521 m, 15-VI-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′48.6″N, 92º08′36.36″W, 1529 m, 15-VI-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′42.24″N, 92º08′40.32″W, 1587 m, 21-IX-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′43.86″N, 92º08′39.18″W, 1570 m, 21-IX-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′41.94″N, 92º08′41.52″W, 1577 m, 6-X-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′41.64″N, 92º08′39.18″W, 1586 m, 6-X-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′43.5″N, 92º08′37.2″W, 1619 m, 8-XII-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′45.66″N,92º08′40.5″W, 1582 m, 10-I-2019, 1♂, entomological net, [alcohol]; **Unión Juárez,** Cantón Chiquihuites, 15º05′58.68″N, 92º05′56.7″W, 2125 m, 17-IV-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′43.74″N, 92º05′57.6″W, 2060 m, 14-V-2018, 1♀, light trap, [alcohol]; Cantón Chiquihuites, 15º06′8.88″N, 92º06′8.52″W, 2345 m, 18-VI-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′3.18″N, 92º05′57.06″W, 2206 m, 17-VII-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′55.32″N, 92º05′54.72″W, 2255 m, 17-VII-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′56.88″N, 92º05′54.3″W, 2264 m, 14-VIII-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′2.28″N, 92º05′51.6″W, 2066 m, 11-IX-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′58.56″N, 92º05′55.74″W, 2168 m, 20-XI-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′3.42″N, 92º05′46.08″W, 2377 m, 11-XII-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′51.48″N, 92º05′59.22″W, 2142 m, 14-I-2019, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3089 m, 16-V-2018, 1♂, light trap, [alcohol].

- *Coniopteryx* (*Coniopteryx*) *latipalpis* Meinander, 1972

Material examined (14♂, 6♀): **Mexico: Chiapas, Unión Juárez**, Cantón Chiquihuites, 15º05′46.26″N, 92º05′56.46″W, 2079 m, 16-IV-2018, 1♂, light trap, [alcohol]; Cantón Chiquihuites, 15º06′15.6″N, 92º06′8.76″W, 2430 m, 14-V-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-Parador La Cabaña, 15º07′4.56″N, 92º06′11.7″W, 3095 m, 22-II-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-Parador La Cabaña, 15º06′49.56″N, 92º05′52.38″W, 2884 m, 16-V-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-Parador La Cabaña, 15º07′17.34″N, 92º06′14.88″W, 3277 m, 21-VI-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-Parador La Cabaña, 15º07′12.78″N, 92º06′8.82″W, 3190 m, 19-VII-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-Parador La Cabaña, 15º06′54.54″N, 92º05′54.3″W, 2951 m, 12-X-2018, 8♂, 4♀, entomological net, [alcohol].

- *Coniopteryx simplicior* Meinander, 1972

Material examined (109♂, 45♀): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º05′34.5″N, 92º10′50.16″W, 1194 m, 13-III-1998, 2♂, light trap, [alcohol]; Ejido El Águila, 15º05′39.24″N, 92º11′23.34″W, 1160 m, 13-III-1998, 1♂, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º06′0.9″N, 92º11′14.7″W, 1079 m, 10-VIII-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′2.64″N, 92º08′38.1″W, 1705 m, 17-II–15-III-2018, 1♂, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′13.02″N, 92º08′55.2″W, 1430 m, 16-III-2018, 1♂, light trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 15-IV-2018, 1♂, light trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′40.5″N, 92º08′41.82″W, 1568 m, 21-V-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 20-V–14-VI-2018, 1♂, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′35.28″N, 92º08′44.88″W, 1534 m, 13-VII-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 13-VII-2018, 1♂, 1♀, light trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′35.88″N, 92º08′44.52″W, 1537 m, 12-VIII-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 12-VIII-2018, 1♂, light trap, [alcohol]; same data but 7-XI-2018, 1♂, 2♀, [alcohol]; Ejido Benito Juárez El Plan, 15º05′46.08″N, 92º08′35.04″W, 1649 m, 8-XII-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 8-XII-2018, 1♂, light trap, [alcohol]; Ejido Benito Juárez El Plan, 15º06′2.64″N, 92º08′38.1″W, 1705 m, 9-I–6-II-2019, 1♂, Malaise trap, [alcohol]; **Unión Juárez**, Finca Monte Perla, 15º02′48.96″N, 92º05′19.68″W, 961 m, 11-III-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′1.38″N, 92º06′6.6″W, 2270 m, 19-II-2018, 2♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′8.7″N, 92º06′8.28″W, 2357 m, 19-II-2018, 2♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′7.62″N, 92º06′7.98″W, 2363 m, 19-II-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′51.24″N, 92º06′28.92″W, 2163 m, 20-II-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′51.36″N, 92º06′36.9″W, 2196 m, 20-II-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′51.48″N, 92º06′31.02″W, 2179 m, 19-III-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′52.8″N, 92º06′24.12″W, 2116 m, 19-III-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′53.64″N, 92º06′39.9″W, 2198 m, 19-III-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′51″N, 92º06′33.72″W, 2197 m, 19-III-2018, 1♂, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′46.26″N, 92º05′56.46″W, 2079 m, 16-IV-2018, 14♂, light trap, [alcohol]; Cantón Chiquihuites, 15º05′46.5″N, 92º05′55.98″W, 2075 m, 17-IV-2018, 1♂, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′52.38″N, 92º05′58.62″W, 2146 m, 17-IV-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′50.64″N, 92º05′58.86″W, 2138 m, 17-IV-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′54″N, 92º05′56.22″W, 2141 m, 17-IV-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′8.82″N, 92º06′8.16″W, 2351 m, 14-V-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′43.74″N, 92º05′57.6″W, 2060 m, 14-V-2018, 1♂, light trap, [alcohol]; Cantón Chiquihuites, 15º06′10.8″N, 92º06′8.22″W, 2371 m, 20-VI-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º07′10.92″N, 92º06′8.22″W, 2380 m, 16-VII-2018, 1♂, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′17.16″N, 92º06′8.76″W, 2200 m, 15-VIII-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′9.06″N, 92º06′18.42″W, 2430 m, 19-XI-2018, 2♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′8.76″N, 92º06′17.82″W, 2406 m, 10-XII-2018, 3♂, 2♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′20.52″N, 92º06′14.64″W, 2452 m, 10-XII-2018, 1♂, 3♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′19.86″ N, 92º06′14.94″ W, 2452 m, 10-XII-2018, 4♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′19.38″ N, 92º06′15.12″ W, 2459 m, 10-XII-2018, 4♂, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′12.96″N, 92º06′18.48″W, 2453 m, 10-XII-2018, 2♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′12″N, 92º06′20.46″W, 2464 m, 10-XII-2018, 2♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′13.98″N, 92º06′16.08″W, 2464 m, 15-I-2019, 3♂, 5♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′12.54″N, 92º06′19.02″W, 2460 m, 15-I-2019, 2♂, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′12.24″N, 92º06′20.4″W, 2457 m, 15-I-2019, 3♂, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′11.16″N, 92º06′21.36″W, 2458 m, 15-I-2019, 1♂, 2♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′9.42″N, 92º06′20.22″W, 2440 m, 15-I-2019, 4♂, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′9.18″N, 92º06′19.44″W, 2430 m, 15-I-2019, 5♂, 5♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′19.74″N, 92º06′13.2″W, 2079 m, 15-I-2019, 2♂, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′20.58″N, 92º06′14.64″W, 2443 m, 15-I-2019, 4♂, 5♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′20.1″N, 92º06′14.7″W, 2454 m, 15-I-2019, 1♂, 3♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′19.92″ N, 92º06′14.88″ W, 2451 m, 15-I-2019, 3♂, 4♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′19.68″N, 92º06′14.94″W, 2459 m, 15-I-2019, 6♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-Parador La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 19-IV-2018, 3♂, 2♀, light trap, [alcohol].

- *Coniopteryx westwoodii* (Fitch, 1855)

3042 m, 21-III-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-Parador La Cabaña, 15º07′1.74″N, 92º06′5.7″W, 3027 m, 21-III–20-IV-2018, 1♂, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-Parador La Cabaña, 15º07′6.96″N, 92º06′7.56″W, 3104 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-Parador La Cabaña, 15º07′9.9″N, 92º06′7.86″W, 3143 m, 17-V-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-Parador La Cabaña, 15º07′4.5″N, 92º06′4.32″W, 3064 m, 17-V-2018, 1♂, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-Parador La Cabaña, 15º07′7.2″N, 92º06′7.14″W, 3106 m, 17-V-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-Parador La Cabaña, 15º07′17.34″N, 92º06′14.88″W, 3277 m, 21-VI-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-Parador La Cabaña, 15º07′3.12″N, 92º06′3.66″W, 3035 m, 19-VII-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-Parador La Cabaña, 15º07′2.52″N, 92º06′3.72″W, 3043 m, 16-VIII-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-Parador La Cabaña, 15º07′12.78″N, 92º06′7.08″W, 3219 m, 22-XI-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-Parador La Cabaña, 15º07′2.04″N, 92º05′59.94″W, 3035 m, 14-XII-2018, 1♂, entomological net, [alcohol].

- *Semidalis boliviensis* (Enderlein, 1905)

Material examined (9♂): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′22.74″N, 92º10′22.98″W, 683 m, 8-IV-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′22.08″N, 92º10′22.38″W, 680 m, 9-VI-2018, 2♂, entomological net, [alcohol]; Finca Alianza, 15º02′23.16″N, 92º10′22.26″W, 692 m, 7-VIII-2018, 2♂, entomological net, [alcohol]; Finca Alianza, 15º02′32.46″N, 92º10′4.38″W, 682 m, 7-VIII-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′33.72″N, 92º10′13.56″W, 698 m, 2-X-2018, 2♂, entomological net, [alcohol]; Finca Alianza, 15º02′35.82″N, 92º09′34.68″W, 749 m, 4-XII-2018, 1♂, entomological net, [alcohol].

- *Semidalis hidalgoana* Meinander, 1975

Material examined (22♂, 10♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′35.58″N, 92º10′12.36″W, 704 m, 7-V-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′22.8″N, 92º10′21.96″W, 683 m, 8-V-2018, 1♂, 2♀, entomological net, [alcohol]; Finca Alianza, 15º02′23.4″N, 92º10′22.02″W, 689 m, 8-V-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′23.64″N, 92º10′22.14″W, 692 m, 8-V-2018, 1♂, 1♀, entomological net, [alcohol]; Finca Alianza, 15º02′23.7″N, 92º10′21.9″W, 677 m, 8-VII-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′40.44″N, 92º09′34.98″W, 767 m, 2-XII-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′39.12″N, 92º11′23.52″W, 1161 m, 13-III-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′38.82″N, 92º11′23.7″W, 1141 m, 12-VI-2018, 2♂, 2♀, entomological net, [alcohol]; Ejido El Águila, 15º05′41.88″N, 92º11′21.66″W, 1142 m, 11-VII-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′38.52″N, 92º11′23.16″W, 1173 m, 11-VII-2018, 5♂, entomological net, [alcohol]; Ejido El Águila, 15º05′39.3″N, 92º11′23.58″W, 1150 m, 10-VIII-2018, 2♂, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′39.12″N, 92º11′23.7″W, 1160 m, 7-IX-2018, 1♂, 2♀, entomological net, [alcohol]; Ejido El Águila, 15º05′38.94″N, 92º11′24.12″W, 1185 m, 6-XII-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′40.5″N, 92º08′41.82″W, 1612 m, 21-V-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′35.28″N, 92º08′44.88″W, 1534 m, 13-VII-2018, 1♂, entomological net, [alcohol]; **Unión Juárez**, Finca Monte Perla, 15º02′40.08″N, 92º05′18.84″W, 958 m, 12-II-2018, 1♂, entomological net, [alcohol].

- *Semidalis manausensis* Meinander, 1980

Material examined (15♂, 3♀): **Mexico: Chiapas, Unión Juárez**, Cantón Chiquihuites, 15º06′0.6″N, 92º05′56.16″W, 2206 m, 17-VII-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′59.4″N, 92º05′57″W, 2129 m, 17-VII-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′3.18″N, 92º05′57.06″W, 2206 m, 17-VII-2018, 2♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′17.16″N, 92º06′8.76″W, 2200 m, 17-VIII-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′15.24″N, 92º06′8.4″W, 2417 m, 10-IX-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′0.6″N, 92º05′56.76″W, 2140 m, 11-IX-2018, 2♂, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′3.06″N, 92º05′54.54″W, 2317 m, 11-IX-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′2.46″N, 92º05′53.64″W, 2270 m, 11-IX-2018, 2♂, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′23.28″N, 92º05′15.3″W, 2444 m, 12-IX–10-X-2018, 1♂, Malaise trap, [alcohol]; Cantón Chiquihuites, 15º05′51.42″N, 92º05′58.02″W, 2076 m, 11-XII-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′1.68″N, 92º05′58.74″W, 2381 m, 11-XII-2018, 2♂, 1♀, entomological net, [alcohol].

- *Semidalis problematica* Monserrat, 1984

Material examined (213♂, 91♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′23.16″N, 92º10′13.8″W, 667 m, 7-V-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′59.94″N, 92º11′16.86″W, 1171 m, 13-II-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′36.96″N, 92º10′48.36″W, 1230 m, 12-II–12-III-2018, 13♂, 1♀, Malaise trap, [alcohol]; Ejido El Águila, 15º06′8.88″N, 92º10′55.08″W, 1303 m, 13-III-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º06′10.56″N, 92º10′56.04″W, 1170 m, 13-III-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º06′9.78″N, 92º10′55.26″W, 1296 m, 13-III-2018, 2♂, 2♀, entomological net, [alcohol]; Ejido El Águila, 15º05′35.58″N, 92º10′46.98″W, 1236 m, 14-III-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′36.96″N, 92º10′48.36″W, 1230 m, 12-III–11-IV-2018, 21♂, 12♀, Malaise trap, [alcohol]; Ejido El Águila, 15º05′36.42″N, 92º10′49.02″W, 1249 m, 11-IV-2018, 2♂, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º06′2.94″N, 92º10′52.08″W, 1232 m, 12-IV-2018, 2♂, entomological net, [alcohol]; Ejido El Águila, 15º06′2.16″N, 92º10′53.1″W, 1242 m, 12-IV-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º06′.06″N, 92º10′55.5″W, 1279 m, 12-IV-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º06′4.02″N, 92º10′52.44″W, 1244 m, 12-IV-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′36.96″N, 92º10′48.36″W, 1230 m, 11-IV–10-V-2018, 1♂, Malaise trap, [alcohol]; Ejido El Águila, 15º06′6.54″N, 92º11′7.2″W, 1109 m, 11-V-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′36.96″N, 92º10′48.36″W, 1230 m, 10-V–11-VI-2018, 1♂, Malaise trap, [alcohol]; Ejido El Águila, 15º06′8.52″N, 92º11′1.2″W, 1117 m, 12-VI-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′35.82″N, 92º10′40.92″W, 1274 m, 12-VII-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′34.92″N, 92º10′48.72″W, 1286 m, 9-VIII-2018, 4♂, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′36.96″N, 92º10′48.36″W, 1230 m, 9-VIII-2018, 6♂, 3♀, entomological net, [alcohol]; Ejido El Águila, 15º05′35.76″N, 92º10′35.52″W, 1302 m, 9-VIII-2018, 1♂, 2♀, entomological net, [alcohol]; Ejido El Águila, 15º05′36.6″N, 92º10′36.96″W, 1288 m, 9-VIII-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º06′9.96″N, 92º10′55.74″W, 1070 m, 7-IX-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′39.36″N, 92º11′23.76″W, 1228 m, 7-IX-2018, 1♂, 2♀, entomological net, [alcohol]; Ejido El Águila, 15º05′34.5″N, 92º10′48.18″W, 1240 m, 4-XI-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′48″N, 92º11′16.5″W, 1309 m, 5-XI-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′50.7″N, 92º11′16.5″W, 1317 m, 5-XI-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′42.06″N, 92º11′16.79″W, 1230 m, 5-XI-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º06′10.44″N, 92º10′54.84″W, 1160 m, 6-XII-2018, 2♂, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º06′10.92″N, 92º10′53.7″W, 1163 m, 7-XII-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º06′10.5″N, 92º10′55.68″W, 1191 m, 7-I-2019, 2♂, entomological net, [alcohol]; Ejido El Águila, 15º06′9.9″N, 92º10′56.7″W, 1290 m, 7-I-2019, 2♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′45.12″N, 92º08′38.58″W, 1547 m, 16-II-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′52.5″N, 92º08′34.92″W, 1682 m, 16-II-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′41.7″N, 92º08′40.62″W, 1572 m, 17-II-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′50.22″N, 92º08′35.64″W, 1521 m, 17-II-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′49.2″N, 92º08′36.72″W, 1565 m, 17-II-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′48.12″N, 92º08′32.46″W, 1606 m, 15-III-2018, 2♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′44.82″N, 92º08′38.58″W, 1550 m, 15-III-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′43.86″N, 92º08′39.54″W, 1570 m, 15-III-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′52.14″N, 92º08′33.42″W, 1645 m, 15-III-2018, 2♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′48.96″N, 92º08′36.84″W, 1534 m, 15-III-2018, 8♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′50.64″N, 92º08′35.22″W, 1564 m, 15-III-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′48.96″ N, 92º08′36.36″W, 1555 m, 15-III-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′47.76″N, 92º08′36.54″W, 1539 m, 15-III-2018, 3♂, 2♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.48″N, 92º08′33.78″W, 1506 m, 16-III-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′58.02″N, 92º08′33.42″W, 1632 m, 16-III-2018, 1♂, 2♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′46.5″N, 92º08′35.1″W, 1654 m, 16-III-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′54.9″N, 92º08′30″W, 1641 m, 16-III-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′55.14″N, 92º08′31.02″W, 1645 m, 16-III-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 15-III–15-IV-2018, 2♂, 1♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′46.68″N, 92º08′39.96″W, 1478 m, 14-IV-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′40.92″N, 92º08′41.64″W, 1584 m, 14-IV-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′53.16″N, 92º08′36.78″W, 1627 m, 14-IV-2018, 2♂, 4♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′50.04″N, 92º08′36.78″W, 1645 m, 14-IV-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′43.86″N, 92º08′34.08″W, 1592 m, 15-IV-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′50.46″N, 92º08′30.48″W, 1690 m, 15-IV-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′55.26″N, 92º08′30.12″W, 1685 m, 15-IV-2018, 3♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′48″N, 92º08′35.58″W, 1655 m, 15-IV-2018, 1♂, entomological net, [alcohol]; Ejido Benito

Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 15-IV–20-V-2018, 3♂, 4♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′48.78″N, 92º08′43.32″W, 1606 m, 19-V-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′54.42″N, 92º08′32.58″W, 1703 m, 20-V-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′49.38″N, 92º08′31.8″W, 1667 m, 20-V-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′59.16″N, 92º08′32.82″W, 1747 m, 20-V-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′57.6″N, 92º08′33.36″W, 1729 m, 20-V-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′57.06″N, 92º08′30.42″W, 1736 m, 20-V-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′52.98″N, 92º08′29.52″W, 1698 m, 20-V-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′48.78″N, 92º08′36.24″W, 1637 m, 21-V-2018, 5♂, 3♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′47.58″N, 92º08′37.8″W, 1621 m, 21-V-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′41.46″N, 92º08′41.04″W, 1574 m, 21-V-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′52.56″N, 92º08′38.82″W, 1659 m, 21-V-2018, 4♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′53.58″N, 92º08′38.94″W, 1668 m, 21-V-2018, 4♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′48.12″N, 92º08′36.78″W, 1630 m, 21-V-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′41.46″N, 92º08′41.04″W, 1574 m, 21-V-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′45.12″N, 92º08′38.7″W, 1601 m, 21-V-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′46.2″N, 92º08′38.1″W, 1539 m, 21-V-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′54.72″N, 92º08′29.88″W, 1716 m, 14-VI-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′45.9″N, 92º08′38.34″W, 1607 m, 14-VI-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′46.98″N, 92º08′36.84″W, 1479 m, 14-VI-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′40.68″N, 92º08′40.92″W, 1581 m, 14-VI-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′45.3″N, 92º08′39″W, 1554 m, 15-VI-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′47.58″N, 92º08′37.8″W, 1528 m, 15-VI-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′44.04″N, 92º08′39.54″W, 1709 m, 15-VI-2018, 4♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′48.6″N, 92º08′36.36″W, 1529 m, 15-VI-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′45.78″N, 92º08′37.8″W, 1546 m, 15-VI-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′45.9″N, 92º08′38.94″W, 1562 m, 12-VII-2018, 3♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′49.26″N, 92º08′31.8″W, 1668 m, 13-VII-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 13-VII–12-VIII-2018, 1♂, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′54.84″N, 92º08′30.24″W, 1634 m, 12-VIII-2018, 4♂, 2♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 12-VIII–20-IX-2018, 1♂, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 20-IX-2018, 1♂, light trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′53.04″N, 92º08′29.46″W, 1688 m, 20-IX-2018, 2♂, 3♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′49.92″N, 92º08′36″W, 1545 m, 21-IX-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 7-X–7-XI-2018, 1♂, 1♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′52.92″N, 92º08′30.12″W, 1729 m, 7-XI-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido

Benito Juárez El Plan, 15º05′46.08″N, 92º08′35.08″W, 1643 m, 7-XI-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′50.4″N, 92º08′38.34″W, 1406 m, 8-XI-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′49.2″N, 92º08′36.78″W, 1600 m, 7-XII-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′47.52″N, 92º08′35.64″W, 1478 m, 9-XII-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 8-XII-2018–9-I-2019, 1♂, 1♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º06′1.92″N, 92º08′39.66″W, 1732 m, 9-I-2019, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′50.58″N, 92º08′30.42″W, 1690 m, 9-I-2019, 1♂, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′47.64″N, 92º08′36.96″W, 1587 m, 10-I-2019, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′47.94″N, 92º08′39.06″W, 1584 m, 10-I-2019, 1♂, 2♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′45.66″N, 92º08′40.5″W, 1582 m, 10-I-2019, 1♂, 5♀, entomological net, [alcohol]; **Unión Juárez**, Cantón Chiquihuites, 15º05′58.68″N, 92º05′56.7″W, 2125 m, 17-IV-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′46.08″N, 92º05′54.6″W, 2057 m, 17-IV-2018, 1♂, 3♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′14.58″N, 92º06′9.9″W, 2436 m, 14-V-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′0.06″N, 92º05′59.88″W, 2223 m, 15-V-2018, 2♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′54.54″N, 92º05′55.92″W, 2130 m, 15-V-2018, 1♂, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′57.96″N, 92º05′56.1″W, 2279 m, 14-VIII-2018, 1♂, 3♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′58.56″N, 92º05′57.72″W, 2184 m, 14-VIII-2018, 1♂, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′17.16″N, 92º06′8.76″W, 2200 m, 15-VIII-2018, 2♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′15.24″N, 92º06′8.4″W, 2417 m, 10-IX-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′0.6″N, 92º05′57.9″W, 2122 m, 20-XI-2018, 2♂, entomological net, [alcohol].

- *Semidalis soleri* Monserrat, 1984

Material examined (78♂, 23♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′27.06″N, 92º10′11.82″W, 676 m, 10-II-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′23.52″N, 92º10′16.68″W, 673 m, 8-IV-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′22.68″N, 92º10′22.44″W, 692 m, 8-IV-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′21.96″N, 92º10′23.46″W, 683 m, 8-IV-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′32.04″N, 92º10′13.2″W, 699 m, 7-V-2018, 1♂, 1♀, entomological net, [alcohol]; Finca Alianza, 15º02′37.44″N, 92º10′6.06″W, 698 m, 7-V-2018, 1♂, 1♀, entomological net, [alcohol]; Finca Alianza, 15º02′23.34″N, 92º10′22.32″W, 690 m, 8-V-2018, 2♂, entomological net, [alcohol]; Finca Alianza, 15º02′23.76″N, 92º10′21.9″W, 691 m, 8-V-2018, 1♂, 1♀, entomological net, [alcohol]; Finca Alianza, 15º02′23.76″N, 92º10′22.2″W, 693 m, 8-V-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′23.94″N, 92º10′22.02″W, 693 m, 8-V-2018, 1♂, 1♀, entomological net, [alcohol]; Finca Alianza, 15º02′33.84″N, 92º10′13.44″W, 730 m, 7-VI-2018, 2♂, entomological net, [alcohol]; Finca Alianza, 15º02′22.08″N, 92º10′22.38″W, 680 m, 9-VI-2018, 10♂, 1♀, entomological net, [alcohol]; Finca Alianza, 15º03′38.82″N, 92º10′36.06″W, 755 m, 7-VII-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′32.1″N, 92º10′5.22″W, 684 m, 8-VII-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′23.7″N, 92º10′21.9″W, 677 m, 8-VII-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′46.74″N, 92º09′55.86″W, 718 m, 8-VII-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º03′9.06″N, 92º10′33.12″W, 758 m, 6-VIII-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′23.16″N, 92º10′22.26″W, 692 m, 7-VIII-2018, 3♂, entomological net, [alcohol]; Finca Alianza, 15º02′32.46″N, 92º10′4.38″W, 682 m, 7-VIII-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′22.32″N, 92º10′23.4″W, 697 m, 4-IX-2018, 3♂, 1♀, entomological net, [alcohol]; Finca Alianza, 15º02′23.22″N, 92º10′22.68″W, 686 m, 4-IX-2018, 2♂, 2♀, entomological net, [alcohol]; Finca Alianza, 15º03′40.2″N, 92º10′35.88″W, 759 m, 5-IX-2018, 2♂, 1♀, entomological net, [alcohol]; Finca Alianza, 15º03′35.76″N, 92º10′34.26″W, 752 m, 5-IX-2018, 4♂, 2♀, entomological net, [alcohol]; Finca Alianza, 15º03′35.1″N, 92º10′34.02″W, 734 m, 1-X-2018, 2♂, 1♀, entomological net, [alcohol]; Finca Alianza, 15º03′40.62″N, 92º10′35.58″W, 794 m, 1-X-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′22.2″N, 92º10′22.92″W, 697 m, 2-X-2018, 2♂, 4♀, entomological net, [alcohol]; Finca Alianza, 15º02′33.72″N, 92º10′13.56″W, 698 m, 2-X-2018, 2♂, entomological net, [alcohol]; Finca Alianza, 15º03′33.84″N, 92º10′33.12″W, 746 m, 3-X-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º03′40.38″N, 92º10′35.34″W, 770 m, 3-X-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′22.56″N, 92º10′21.78″W, 723 m, 2-XI-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º03′35.7″N, 92º10′34.5″W, 763 m, 2-XII-2018, 2♂, entomological net, [alcohol]; Finca Alianza, 15º03′40.44″N, 92º10′35.1″W, 767 m, 2-XII-2018, 2♂, entomological net, [alcohol]; Finca Alianza, 15º03′39.06″N, 92º10′36.84″W, 799 m, 2-XII-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′35.82″N, 92º09′34.68″W, 749 m, 4-XII-2018, 2♂, entomological net, [alcohol]; Finca Alianza, 15º03′40.5″N, 92º10′36.12″W, 798 m, 4-XII-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º03′43.26″N, 92º10′34.62″W, 763 m, 3-I-2019, 1♂, 1♀, entomological net, [alcohol]; Finca Alianza, 15º03′35.7″N, 92º10′34.38″W, 748 m, 3-I-2019, 3♂, 2♀, entomological net, [alcohol]; Finca Alianza, 15º03′40.02″N, 92º10′35.94″W, 700 m, 3-I-2019, 4♂, entomological net, [alcohol]; Finca Alianza, 15º03′38.7″N, 92º10′35.64″W, 752 m, 3-I-2019, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′40.62″N, 92º09′35.52″W, 765 m, 5-I-2019, 1♂, 1♀, entomological net, [alcohol]; Finca Alianza, 15º03′38.58″N, 92º10′35.94″W, 743 m, 5-I-2019, 1♂, 1♀, entomological net, [alcohol]; Finca Alianza, 15º03′45.42″N, 92º10′32.94″W, 774 m, 5-I-2019, 1♂, entomological net, [alcohol]; Finca Alianza, 15º03′23.7″N, 92º10′34.56″W, 748 m, 5-I-2019, 2♂, 2♀, entomological net, [alcohol].

Hemerobiidae.

- *Biramus aggregatus* Oswald, 2004

Material examined (9♂, 9♀): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, 15º06′9.84″N, 92º08′36.08″W, 1712 m, 17-II–16-III-2018, 3♂, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 15-III–15-IV-2018, 2♂, 3♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′47.4″N, 92º08′32.82″W, 1657 m, 15-IV-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′49.74″N, 92º08′31.8″W, 1671 m, 15-IV-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 15-IV–20-V-2018, 2♂, 4♀, Malaise trap, [alcohol]; same data but 20-V–14-VI-2018, 1♂, [alcohol]; Ejido Benito Juárez El Plan, 15º05′46.62″N, 92º08′33.18″W, 1705 m, 9-I-2019, 1♀, entomological net, [alcohol].

- *Hemerobiella sinuata* Kimmins, 1940

Material examined (1♂): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, 15º05′41.64″N, 92º08′39.18″W, 1586 m, 6-X-2018, 1♂, entomological net, [alcohol].

- *Hemerobius alpestris* Banks, 1908

Material examined (14♂, 13♀, 1?): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, Volcán Tacaná-Rumbo a la laguna, 15º07′35.34″N, 92º06′37.56″W, 3651 m, 17-I-2019, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, Volcán Tacaná-Rumbo a la laguna,15º07′42.06″N, 92º06′40.14″W, 3789 m, 17-I-2019, 2♀, entomological net, [alcohol]; **Unión Juárez**, Volcán Tacaná, Paradores Papales-La Cabaña, 15º07′3.06″N, 92º06′2.28″W, 3030 m, 20-III-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Paradores Papales-La Cabaña, 15º07′12.78″N, 92º06′8.76″W, 3184 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Paradores Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 16-V-2018, 1♂, light trap, [alcohol]; Volcán Tacaná, Paradores Papales-La Cabaña, 15º07′9.9″N, 92º06′7.86″W, 3143 m, 17-V-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Paradores Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 20-VI-2018, 1♂, 1♀, light trap, [alcohol]; same data but 15-VIII-2018, 1♂, 1♀, [alcohol]; same data but 13-IX-2018, 1♂, 1♀, [alcohol]; same data but 12-X-2018, 1♂, [alcohol]; same data but 22-XI-2018, 1♀, [alcohol]; Volcán Tacaná, Paradores Papales-La Cabaña, 15º07′12.06″N, 92º06′7.74″W, 3156 m, 22-XI-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Paradores Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 12-XII-2018, 1♂, light trap, [alcohol]; Volcán Tacaná, Paradores Papales-La Cabaña, 15º07′10.62″N, 92º06′7.14″W, 3165 m, 13-XII-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Falta poco, 15º07′28.74″N, 92º06′20.04″W, 3496 m, 17-I-2019, 2♂, 2♀, 1?, entomological net, [alcohol]; Volcán Tacaná, Parador Cueva del Oso, 15º07′29.64″N, 92º06′21.36″W, 3526 m, 16-VIII-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Cueva del Oso, 15º07′38.28″N, 92º06′22.74″W, 3683 m, 16-VIII-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Cueva del Oso, 15º07′33.78″N, 92º06′21.36″W, 3599 m, 16-VIII-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Cueva del Oso, 15º07′33.78″N, 92º06′22.62″W, 3599 m, 13-XII-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Cueva del Oso, 15º07′38.16″N, 92º06′22.74″W, 3681 m, 13-XII-2018, 1♂, entomological net, [alcohol].

- *Hemerobius bolivari* Banks, 1910

Material examined (7♂, 21♀): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º05′48.36″N, 92º11′5.58″W, 1346 m, 12-IV-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º06′1.44″N, 92º10′53.1″W, 1270 m, 12-IV-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º06′8.76″N, 92º10′59.58″W, 1123 m, 12-VI-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 12-VI-2018, 1♀, light trap, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 15-III–15-IV-2019, 2♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º06′2.64″N, 92º08′34.68″W, 1680 m, 14-VI-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′40.62″N, 92º08′41.76″W, 1591 m, 15-VI-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′35.76″N, 92º08′44.64″W, 1537 m, 15-VI-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′43.44″N, 92º08′37.2″W, 1604 m, 13-VII-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 13-VII–12-VIII-2018, 1♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′35.46″N, 92º08′44.64″W, 1557 m, 7-X-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′52.92″N, 92º08′30.12″W, 1729 m, 7-XI-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′36.54″N, 92º08′44.16″W, 1539 m, 7-XI-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′49.2″N, 92º08′36.78″W, 1600 m, 7-XII-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′46.92″N, 92º08′33.96″W, 1677 m, 8-XII-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 8-XII-2018–9-I-2019, 2♀, Malaise trap, [alcohol]; **Unión Juárez**, Cantón Chiquihuites, 15º05′25.02″N, 92º05′14.52″W, 2450 m, 19-VI–17-VII-2018, 1♀, Malaise trap, [alcohol]; Cantón Chiquihuites, 15º05′50.76″N, 92º05′58.62″W, 2141 m, 14-VIII-2018, 2♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′53.94″N, 92º05′58.32″W, 2150 m, 9-X-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′52.74″N, 92º05′57.54″W, 2132 m, 11-XII-2018, 2♂, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′9.06″N, 92º06′17.82″W, 2400 m, 15-I-2019, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.68″N, 92º06′8.04″W, 3166 m, 22-XI-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 1♀, light trap, [alcohol].

- *Hemerobius discretus* Navás, 1917

Material examined (156♂, 163♀, 1?): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, 15º06′1.44″N, 92º08′40.98″W, 1742 m, 9-I-2019, 1♀, entomological net, [alcohol]; **Unión Juárez**, Cantón Chiquihuites, 15º05′53.16″N, 92º06′39.72″W, 2183 m, 20-II-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′35.16″N, 92º05′37.92″W, 1732 m, 23-II-2018, 1♂, 1♀, black light trap, [alcohol]; Cantón Chiquihuites, 15º05′46.26″N, 92º05′56.46″W, 2079 m, 18-III-2018, 2♀, light trap, [alcohol]; Cantón Chiquihuites, 15º06′16.08″N, 92º06′12.9″W, 2300 m, 16-IV-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′46.26″N, 92º05′56.46″W, 2079 m, 16-IV-2018, 1♂, light trap, [alcohol]; Cantón Chiquihuites, 15º06′1.8″N, 92º05′56.16″W, 2253 m, 17-IV-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′10.5″N, 92º06′8.04″W, 2376 m, 14-V-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′43.74″N, 92º05′57.6″W, 2060 m, 14-V-2018, 1♂, light trap, [alcohol]; Cantón Chiquihuites, 15º05′54″N, 92º05′56.22″W, 2130 m, 15-V-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′54.6″N, 92º05′55.56″W, 2173 m, 17-VII-2018, 2♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 10-IX-2018, 1♂, 1♀, light trap, [alcohol]; same data but 8-X-2018, 1♂, 2♀, [alcohol]; same data but 20-XI-2018, 3♂, 3♀, [alcohol]; Cantón Chiquihuites, 15º05′51.3″N, 92º05′58.86″W, 2142 m, 20-XI-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′19.38″N, 92º06′15.12″W, 2459 m, 10-XII-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′20.22″N, 92º06′14.64″W, 2454 m, 10-XII-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 10-XII-2018, 1♂, light trap, [alcohol]; same data but 14-I-2019, 1♂, [alcohol]; Cantón Chiquihuites-Parador Las Flores, 15º06′37.2″N, 92º05′54.9″W, 2779 m, 16-V-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites-Parador Las Flores, 15º06′35.4″N, 92º05′55.26″W, 2748 m, 16-V-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′6.54″N, 92º05′58.62″W, 3077 m, 21-II-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.26″N, 92º05′56.94″W, 3046 m, 21-II-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.68″N, 92º06′9.18″W, 3100 m, 22-II-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.78″N, 92º06′0.9″W, 3113 m, 22-II-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.58″N, 92º06′59.94″W, 3114 m, 22-II-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.54″N, 92º06′50.46″W, 3032 m, 22-II-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′48″N, 92º06′9.18″W, 3099 m, 22-II-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′1.98″N, 92º05′54.9″W, 3010 m, 23-II-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′1.74″N, 92º06′5.7″W, 3027 m, 22-II–20-III-2018, 2♂, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.54″N, 92º06′7.44″W, 3059 m, 22-II–20-III-2018, 8♂, 4♀, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.06″N, 92º06′5.04″W, 3071 m, 20-III-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.5″N, 92º06′6.3″W, 3095 m, 20-III-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′5.58″N, 92º06′9″W, 3110 m, 20-III-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.7″N, 92º06′6.9″W, 3155 m, 21-III-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.08″N, 92º06′9.6″W, 3185 m, 21-III-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.84″N, 92º06′8.94″W, 3192 m, 21-III-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.88″N, 92º06′7.8″W, 3128 m, 21-III-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′7.68″N, 92º06′8.1″W, 3133 m, 21-III-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.72″N, 92º06′2.64″W, 3136 m, 21-III-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.84″N, 92º06′8.46″W, 3213 m, 21-III-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′5.88″N, 92º06′7.92″W, 3109 m, 21-III-2018, 2♂, 1♀, light trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.9″N, 92º06′6.3″W, 3078 m, 22-III-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′1.74″N, 92º06′5.7″W, 3027 m, 21-III–20-IV-2018, 6♂, 3♀, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.3″N, 92º06′7.62″W, 3070 m, 21-III–20-IV-2018, 4♂, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.24″N, 92º06′8.52″W, 3176 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.26″N, 92º06′9.78″W, 3199 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.52″N, 92º06′8.04″W, 3138 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.38″N, 92º06′9.42″W, 3197 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.78″N, 92º06′8.76″W, 3184 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.24″N, 92º06′7.56″W, 3174 m, 19-IV-2018, 2♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.08″N, 92º06′9.36″W, 3196 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.8″N, 92º06′10.08″W, 3201 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.88″N, 92º06′7.32″W, 3134 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.48″N, 92º06′7.8″W, 3139 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.32″N, 92º06′10.74″W, 3199 m, 19-IV-2018, 2♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′2.52″N, 92º06′3.48″W, 3039 m, 19-IV-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.32″N, 92º06′9.42″W, 3198 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.92″N, 92º06′10.14″W, 3202 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.48″N, 92º06′8.7″W, 3180 m, 19-IV-2018, 2♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.3″N, 92º06′8.22″W, 3176 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.92″N, 92º06′8.28″W, 3163 m, 19-IV-2018, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′11.16″N,92º06′8.1″W, 3163 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′11.22″N, 92º06′8.1″W, 3173 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′7.08″N, 92º06′6.48″W, 3103 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.86″N, 92º06′8.1″W, 3156 m, 19-IV-2018, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.86″N, 92º06′7.08″W, 3145 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′5.88″N, 92º06′5.7″W, 3086 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′5.64″ N, 92º06′5.64″W, 3079 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′5.28″N, 92º06′5.34″W, 3079 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′5.22″N, 92º06′6.84″W, 3085 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′5.58″N, 92º06′5.88″W, 3084 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′5.7″N, 92º06′6.42″W, 3087 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 19-IV-2018, 3♂, 3♀, light trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′7.44″N, 92º06′6.42″W, 3104 m, 20-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′1.74″N, 92º06′5.7″W, 3027 m, 20-IV–18-V-2018, 2♂, 1♀, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.3″N, 92º06′7.62″W, 3070 m, 20-IV–18-V-2018, 5♂, 1♀, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 16-V-2018, 18♂, 32♀, light trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.44″N, 92º06′5.76″W, 3071 m, 16-V-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.12″N, 92º06′7.02″W, 3129 m, 17-V-2018, 1♂, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.94″N, 92º06′7.86″W, 3132 m, 17-V-2018, 3♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′7.8″N, 92º06′8.04″W, 3120 m, 17-V-2018, 2♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′7.74″N, 92º06′6.78″W, 3111 m, 17-V-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′6.36″N, 92º06′4.86″W, 3088 m, 17-V-2018, 4♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.5″N, 92º06′4.32″W, 3064 m, 17-V-2018, 8♂, 8♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′15.3″N, 92º06′10.86″W, 3231 m, 17-V-2018, 4♂, 4♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′14.22″N, 92º06′10.68″W, 3218 m, 17-V-2018, 2♂, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.98″N, 92º06′9.84″W, 3205 m, 17-V-2018, 2♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.14″N, 92º06′10.26″W, 3201 m, 17-V-2018, 1♂, 4♀, entomological net, [alcohol]; Volcán

Tacaná, Parador Papales-La Cabaña, 15º07′14.1″N, 92º06′9.9″W, 3207 m, 17-V-2018, 1♂, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.84″N, 92º06′9.06″W, 3184 m, 17-V-2018, 2♂, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.66″N, 92º06′8.94″W, 3181 m, 17-V-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′15.6″N, 92º06′8.4″W, 3210 m, 17-V-2018, 2♂, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′11.34″N, 92º06′8.58″W, 3164 m, 17-V-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′11.58″N, 92º06′7.2″W, 3159 m, 17-V-2018, 3♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.9″N, 92º06′7.86″W, 3143 m, 17-V-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 20-VI-2018, 1♂, 4♀, light trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12″N, 92º06′8.16″W, 3167 m, 21-VI-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.66″N, 92º06′8.4″W, 3180 m, 21-VI-2018, 2♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.32″N, 92º06′10.38″W, 3224 m, 21-VI-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′14.7″N, 92º06′10.92″W, 3218 m, 21-VI-2018, 1♂, 3♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′16.38″N, 92º06′14.58″W, 3256 m, 21-VI-2018, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′17.34″N, 92º06′14.88″W, 3277 m, 21-VI-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′19.5″N, 92º06′15.18″W, 3309 m, 21-VI-2018, 3♂, 5♀, 1?, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′6.42″N, 92º06′6.06″W, 3100 m, 21-VI-2018, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′20.58″N, 92º06′15.24″W, 3358 m, 21-VI-2018, 3♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′7.68″N, 92º06′8.64″W, 3125 m, 21-VI-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.34″N, 92º06′8.1″W, 3132 m, 21-VI-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.18″N, 92º06′7.08″W, 3182 m, 21-VI-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 18-VII-2018, 2♀, light trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.02″N, 92º06′8.1″W, 3139 m, 19-VII-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.12″N, 92º06′7.5″W, 3123 m, 19-VII-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′5.82″N, 92º06′4.56″W, 3124 m, 19-VII-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.34″N, 92º06′8.34″W, 3117 m, 19-VII-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9″N, 92º06′7.02″W, 3146 m, 16-VIII-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′5.64″N, 92º06′5.58″W, 3082 m, 16-VIII-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.92″N, 92º06′11.04″W, 3195 m, 13-IX-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.96″N, 92º06′9.42″W, 3188 m, 13-IX-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′7.26″N, 92º06′7.32″W, 3084 m, 13-IX-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.44″N, 92º06′8.82″W, 3235 m, 13-IX-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.5″N, 92º06′9.48″W, 3210 m, 13-IX-2018, 2♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La

Cabaña, 15º07′3.3″N, 92º06′7.62″W, 3070 m, 13-IX–13-X-2018, 1♀, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.44″N, 92º06′9.6″W, 3207 m, 11-X-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.78″N, 92º06′10.38″W, 3234 m, 11-X-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.3″N, 92º06′7.62″W, 3070 m, 11-X–21-XI-2018, 1♂, 1♀, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′09″N, 92º06′7.44″W, 3093 m, 22-XI-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′6.3″N, 92º06′7.14″W, 3115 m, 22-XI-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 22-XI-2018, 1♂, light trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′1′.2″N, 92º06′7.98″W, 3143 m, 13-XII-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.88″N, 92º06′8.16″W, 3109 m, 13-XII-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′1.74″N, 92º06′5.7″W, 3027 m, 18-I–8-II-2019, 1♀, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.3″N, 92º06′7.62″W, 3070 m, 18-I–8-II-2019, 1♀, Malaise trap, [alcohol]; Volcán Tacaná, Parador Falta poco, 15º07′28.74″N, 92º06′20.04″W, 3496 m, 17-I-2019, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Cueva del oso, 15º07′33″N, 92º06′22.68″W, 3580 m, 13-XII-2018, 1♀, entomological net, [alcohol].

- *Hemerobius domingensis* Banks, 1941

Material examined (8♂, 7♀): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 11-VII-2018, 1♀, light trap, [alcohol]; Ejido Benito Juárez El Plan, 15º06′2.64″N, 92º08′38.1″W, 1705 m, 15-III–15-IV-2018, 1♂, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′46.92″N, 92º08′33.18″W, 1637 m, 20-V-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′45.54″N, 92º08′35.46″W, 1637 m, 13-VII-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′35.28″N, 92º08′44.88″W, 1534 m, 13-VII-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 13-VII-2018, 1♂, light trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′49.92″N, 92º08′31.02″W, 1695 m, 20-IX-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′50.58″N, 92º08′30.42″W, 1690 m, 9-I-2018, 1♂, entomological net, [alcohol]; **Unión Juárez**, Cantón Chiquihuites, 15º05′56.7″N, 92º06′43.14″W, 2165 m, 19-III-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′51.18″N, 92º06′33.06″W, 2191 m, 19-III-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′55.68″N, 92º06′42.36″W, 2205 m, 19-III-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′51.54″N, 92º06′31.32″W, 2171 m, 19-III-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′50.1″N, 92º05′59.04″W, 2137 m 17-IV-2018, 2♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′50.04″N, 92º05′59.28″W, 2140 m, 19-VI-2018, 1♀, entomological net, [alcohol].

- *Hemerobius gaitoi* Monserrat, 1996

Material examined (25♂, 9♀): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º06′10.56″N, 92º10′56.04″W, 1170 m, 13-III-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º06′.72″N, 92º10′54.18″W, 1264 m, 12-IV-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º06′10.62″N, 92º10′54.42″W, 1165 m, 11-V-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º06′10.56″N, 92º10′54.54″W, 1160 m, 12-VI-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º06′10.38″N, 92º10′55.44″W, 1155 m, 12-VI-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′36.96″N, 92º10′48.36″W, 1230 m, 13-VI–12-VII-2018, 1♂, Malaise trap, [alcohol]; Ejido El Águila, 15º05′36.36″N, 92º10′37.56″W, 1288 m, 9-VIII-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′36.96″N, 92º10′48.36″W, 1230 m, 9-VIII-2018, 2♂, entomological net, [alcohol]; Ejido El Águila, 15º05′35.76″N, 92º10′35.52″W, 1302 m, 9-VIII-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′9.84″N, 92º08′36.08″W, 1712 m, 17-II–16-III-2018, 1♂, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º06′2.64″N, 92º08′38.1″W, 1705 m, 15-III–15-IV-2018, 1♂, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º06′2.76″N, 92º08′36.84″W, 1767 m, 15-IV-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 15-IV–20-V-2018, 1♂, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′47.88″N, 92º08′32.58″W, 1646 m, 20-V-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′49.38″N, 92º08′31.8″W, 1667 m, 20-V-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′52.98″N, 92º08′29.52″W, 1698 m, 20-V-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′45.12″N, 92º08′38.7″W, 1601 m, 21-V-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 14-VI–13-VII-2018, 1♂, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′55.26″N, 92º08′30.36″W, 1660 m, 13-VII-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′0.18″N, 92º08′33.06″W, 1645 m, 12-VIII-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′53.04″N, 92º08′29.46″W, 1688 m, 20-IX-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 7-XI-2018, 1♀, light trap, [alcohol]; **Unión Juárez**, Cantón Chiquihuites, 15º06′1.2″N, 92º05′58.14″W, 2216 m, 17-IV-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′43.74″N, 92º05′57.6″W, 2060 m, 14-V-2018, 2♂, 1♀, light trap, [alcohol]; Cantón Chiquihuites, 15º05′53.4″N, 92º05′58.26″W, 2146 m, 15-V-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′51.6″N, 92º05′59.16″W, 2138 m, 15-V-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′56.88″N, 92º05′54.3″W, 2264 m, 14-VIII-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′3.42″N, 92º05′46.08″W, 2377 m, 11-XII-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 14-I-2019, 1♂, light trap, [alcohol].

- *Hemerobius hernandezi* Monserrat, 1996

Material examined (76♂, 97♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′46.44″N, 92º09′55.86″W, 722 m, 8-VI-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′22.08″N, 92º10′22.38″W, 680 m, 9-VI-2018, 1♀, entomological net, [alcohol]; Finca Alianza, 15º02′28.74″N, 92º10′9.48″W, 661 m, 3-XII-2018, 1♂, light trap, [alcohol]; Ejido El Águila, 15º05′41.64″N, 92º11′22.8″W, 1257 m, 13-II-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′34.5″N, 92º10′50.16″W, 1194 m, 13-III-2018, 1♀, light trap, [alcohol]; Ejido El Águila, 15º05′35.22″N, 92º10′48.18″W, 1205 m, 11-IV-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′59.1″N, 92º10′55.8″W, 1319 m, 12-IV-2018, 1♂, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′51.42″N, 92º11′1.32″W, 1338 m, 12-IV-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º06′10.62″N, 92º10′54.42″W, 1165 m, 11-V-2018, 1♂, 2♀, entomological net, [alcohol]; Ejido El Águila, 15º05′40.08″N, 92º11′22.62″W, 1153 m, 12-VI-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′38.82″N, 92º11′23.7″W, 1141 m, 12-VI-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º06′0.06″N, 92º11′15.84″W, 1055 m, 12-VI-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′34.32″N, 92º10′47.88″W, 1213 m, 10-VII-2018, 1♀, entomological net, [alcohol]; Ejido El

Águila, 15º05′43.98″N, 92º11′21″W, 1143 m, 11-VII-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′35.46″N, 92º10′38.76″W, 1262 m, 12-VII-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′33.42″N, 92º10′49.14″W, 1243 m, 4-X-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′42.06″N, 92º11′16.74″W, 1230 m, 5-XI-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′54.18″N, 92º11′16.68″W, 1122 m, 5-XI-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′33.78″N, 92º10′52.02″W, 1209 m, 6-XII-2018, 1♀, black light trap, [alcohol]; Ejido El Águila, 15º05′35.04″N, 92º10′39.9″W, 1240 m, 8-I-2019, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′45.36″N, 92º08′38.58″W, 1549 m, 16-II-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′34.98″N, 92º08′38.52″W, 1487 m, 17-II-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′27.66″N, 92º08′50.52″W, 1487 m, 17-II-2018, 1♀, black light trap, [alcohol]; Ejido Benito Juárez El Plan, 15º06′9.84″N, 92º08′36.08″W, 1712 m, 17-II–16-III-2018, 7♂, 15♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º06′2.64″N, 92º08′38.1″W, 1705 m, 17-II–16-III-2018, 1♂, 2♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′48.96″N, 92º08′36.84″W, 1534 m, 15-III-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′40.5″N, 92º08′41.7″W, 1588 m, 15-III-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′2.64″N, 92º08′38.1″W, 1705 m, 15-III–15-IV-2018, 2♂, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 15-III–15-IV-2018, 10♂, 11♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º06′2.76″N, 92º08′36.84″W, 1767 m, 15-IV-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 15-IV–20-V-2018, 18♂, 14♀, Malaise trap, [alcohol]; same data but 20-V–14-VI-2018, 1♂, 3♀, [alcohol]; same data but 14-VI–13-VII-2018, 1♂, 2♀, [alcohol]; Ejido Benito Juárez El Plan, 15º05′40.92″N, 92º08′41.4″W, 1595 m, 12-VII-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 13-VII-2018, 1♂, 2♀, light trap, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 13-VII–12-VIII-2018, 2♂, 3♀, Malaise trap, [alcohol]; same data but 12-VIII–20-IX-2018, 1♂, 1♀, [alcohol]; Ejido Benito Juárez El Plan, 15º05′35.16″N, 92º08′45″W, 1536 m, 20-IX-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′36.48″N, 92º08′44.16″W, 1531 m, 20-IX-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′35.88″N, 92º08′44.46″W, 1550 m, 7-X-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′2.64″N, 92º08′38.1″W, 1705 m, 7-X–7-XI-2018, 1♂, 3♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 7-XI-2018, 1♀, light trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′46.62″N, 92º08′39.66″W, 1467 m, 8-XI-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 7-XI–8-XII-2018, 3♂, 5♀, Malaise trap, [alcohol]; same data but 8-XII-2018–9-I-2019, 6♂, 6♀, [alcohol]; Ejido Benito Juárez El Plan, 15º05′42.36″N, 92º08′38.58″W, 1595 m, 9-I-2019, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′2.64″N, 92º08′38.1″W, 1705 m, 9-I–6-II-2019, 1♀, Malaise trap, [alcohol]; **Unión Juárez**, Cantón Chiquihuites, 15º05′34.86″N, 92º05′55.08″W, 2011 m, 31-I-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′51.84″N, 92º06′36.42″W, 2205 m, 19-III-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′43.74″N, 92º05′57.6″W, 2060 m, 14-V-2018, 1♂, 2♀, light trap, [alcohol]; Cantón Chiquihuites, 15º05′53.4″N, 92º05′58.26″W, 2146 m, 15-V-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 19-VI-2018, 1♂, light trap, [alcohol]; Cantón Chiquihuites, 15º05′56.46″N, 92º05′29.22″W, 2117 m, 17-VII-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′51.3″N, 92º05′58.74″W, 2153 m, 9-X-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′46.08″N, 92º05′58.08″W, 2080 m, 9-X-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′50.1″N, 92º05′59.82″W, 2133 m, 20-XI-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′58.14″N, 92º05′57.12″W, 2156 m, 20-XI-2018, 1♂, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′54.84″N, 92º05′55.74″W, 2131 m, 11-XII-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′53.4″N, 92º05′57.72″W, 2157 m, 11-XII-2018, 1♂, entomological net, [alcohol].

- *Hemerobius hirsuticornis* Monserrat and Deretsky, 1999

Material examined (5♂,1♀): **Mexico: Chiapas, Cacahoatán,** Finca Alianza, 15º03′35.7″N, 92º10′34.38″W, 748 m, 3-I-2019, 1♂, 1♀, entomological net, [alcohol]; Finca Alianza, 15º03′38.7″N, 92º10′35.64″W, 752 m, 3-I-2019, 2♂, entomological net, [alcohol]; Finca Alianza, 15º03′38.58″N, 92º10′35.94″W, 743 m, 5-I-2019, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′34.5″N, 92º10′50.16″W, 1194 m, 13-III-2018, 1♂, light trap, [alcohol].

- *Hemerobius jucundus* Navás, 1928

Material examined (180♂, 178♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º03′15.84″N, 92º10′34.2″W, 736 m, 7-VII-2018, 1♀, entomological net, [alcohol]; Finca Alianza, 15º03′23.7″N, 92º10′34.56″W, 748 m, 5-I-2019, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′35.46″N, 92º10′50.16″W, 1204 m, 4-XI-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′53.4″N, 92º11′15.72″W, 1136 m, 5-XI-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º06′10.92″N, 92º10′53.82″W, 1162 m, 6-XII-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′9.84″N, 92º08′36.08″W, 1712 m, 17-II–16-III-2018, 1♂, 2♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 15-III–15-IV-2018, 1♂, 3♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′49.74″N, 92º08′31.8″W, 1671 m, 15-IV-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′2.76″N, 92º08′36.84″W, 1767 m, 15-IV-2018, 2♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 15-IV–20-V-2018, 1♂, 1♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′40.5″N, 92º08′41.82″W, 1612 m, 21-V-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′54.84″N, 92º08′30.24″W, 1634 m, 12-VIII-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′0.18″N, 92º08′33.06″W, 1645 m, 12-VIII-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 7-XI–8-XII-2018, 1♂, Malaise trap, [alcohol]; **Unión Juárez**, Cantón Chiquihuites, 15º06′24.9″N, 92º06′12.54″W, 2381 m, 19-II-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′51.24″N, 92º06′35.7″W, 2203 m, 19-III-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′51.24″N, 92º06′31.5″W, 2181 m, 19-III-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′13.02″N, 92º06′7.56″W, 2402 m, 16-IV-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′21.54″N, 92º06′10.8″W, 2422 m, 16-IV-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′53.58″N, 92º05′57.54″W, 2142 m, 17-IV-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′54″N, 92º05′56.22″W, 2141 m, 17-IV-2018, 1♂, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′58.68″N, 92º05′56.7″W, 2125 m, 17-IV-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′54.18″N, 92º05′58.32″W, 2125 m, 17-IV-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′49.5″N, 92º05′59.04″W, 2121 m, 17-IV-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′18.84″N, 92º06′10.74″W, 2428 m, 14-V-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′15.6″N, 92º06′8.76″W, 2430 m, 14-V-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′8.1″N, 92º06′7.86″ W, 2340 m, 14-V-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′7.8″N, 92º06′8.1″W, 2334 m, 14-V-2018, 2♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′7.32″N, 92º06′8.64″W, 2334 m, 14-V-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′43.74″N, 92º05′57.6″W, 2060 m, 14-V-2018, 1♀, light trap, [alcohol]; Cantón Chiquihuites, 15º05′48.06″N, 92º05′59.94″W, 2113 m, 15-V-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′49.14″N, 92º05′59.64″W, 2121 m, 15-V-2018, 1♂, 2♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′49.86″N, 92º05′59.22″W, 2124 m, 15-V-2018, 2♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′50.52″N, 92º05′58.74″W, 2126 m, 15-V-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′51.6″N, 92º05′59.16″W, 2138 m, 15-V-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′53.4″N, 92º05′58.26″W, 2146 m, 15-V-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′53.4″N, 92º05′57.42″W, 2155 m, 15-V-2018, 2♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′1.74″N, 92º05′57.12″W, 2184 m, 15-V-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′23.28″N, 92º05′15.3″W, 2444 m, 16-V–19-VI-2018, 1♂, 1♀, Malaise trap, [alcohol]; Cantón Chiquihuites, 15º06′13.32″N, 92º06′8.1″W, 2330 m, 18-VI-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′12.3″N, 92º06′10.32″W, 2255 m, 18-VI-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′7.5″N, 92º06′8.34″W, 2341 m, 18-VI-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′55.62″N, 92º05′55.62″W, 2153 m, 19-VI-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′53.46″N, 92º05′57″W, 2153 m, 19-VI-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′53.58″N, 92º05′58.02″W, 2162 m, 19-VI-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 19-VI-2018, 1♀, light trap, [alcohol]; Cantón Chiquihuites, 15º05′23.28″N, 92º05′15.3″W, 2444 m, 20-VI–18-VII-2018, 1♀, Malaise trap, [alcohol]; Cantón Chiquihuites, 15º05′25.02″N, 92º05′14.52″W, 2450 m, 17-VII–15-VIII-2018, 1♀, Malaise trap, [alcohol]; Cantón Chiquihuites, 15º05′53.58″N, 92º05′57.42″W, 2159 m, 14-VIII-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′56.88″N, 92º05′54.3″W, 2264 m, 14-VIII-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′17.16″N, 92º06′8.76″W, 2200 m, 15-VIII-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′10.74″N,92º06′8.04″W, 2376 m, 10-IX-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′13.98″N, 92º06′7.8″W, 2422 m, 10-IX-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′53.58″N, 92º05′58.26″W, 2159 m, 11-IX-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′48.18″N, 92º06′0.24″W, 2119 m, 9-X-2018, 1♂, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′46.08″N, 92º05′58.08″W, 2080 m, 9-X-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′46.32″N, 92º05′57.06″W, 2077 m, 9-X-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′25.02″N, 92º05′14.52″W, 2450 m, 10-X–21-XI-2018, 1♂, Malaise trap, [alcohol]; Cantón Chiquihuites, 15º05′31.14″N, 92º05′35.7″W, 2430 m, 20-XI-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′53.52″N, 92º05′57.72″W, 2173 m, 20-XI-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′52.86″N, 92º05′58.02″W, 2166 m, 20-XI-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′22.8″N, 92º06′11.64″W, 2370 m, 10-XII-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′9.18″N, 92º06′19.5″W, 2427 m, 10-XII-2018, 1♂, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′51.42″N, 92º05′58.02″W, 2076 m, 11-XII-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′51.66″N, 92º05′57.48″W, 2129 m, 11-XII-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′53.4″N, 92º05′57.72″W, 2157 m, 11-XII-2018, 2♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′23.28″N, 92º05′15.3″W, 2444 m, 12-XII-2018–16-I-2019, 1♀, Malaise trap, [alcohol]; Cantón Chiquihuites, 15º05′45.6″N, 92º05′57.06″W, 2000 m, 14-I-2019, 1♂, 2♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′13.98″N, 92º06′16.08″W, 2464 m, 15-I-2019, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′23.28″N, 92º05′15.3″W, 2444 m, 15-I–11-II-2019, 1♂, 1♀, Malaise trap, [alcohol];Volcán Tacaná, Parador Lindavista, 15º06′45.96″N, 92º05′53.1″W, 2902 m, 16-V-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Lindavista, 15º06′44.34″N, 92º05′53.1″W, 2876 m, 20-VI-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.4″N, 92º05′59.94″W, 3119 m, 21-II-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′1.74″N, 92º06′5.7″W, 3027 m, 22-II-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.66″N, 92º06′0.6″W, 3122 m, 22-II-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º06′56.46″N, 92º05′54.72″W, 2963 m, 22-II-2018, 1♀, black light trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.54″N, 92º06′7.44″W, 3059 m, 21-II–20-III-2018, 2♀, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′1.74″N, 92º06′5.7″W, 3027 m, 21-II–20-III-2018, 1♀, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′2.04″N, 92º06′3.18″W, 3038 m, 20-III-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.7″N, 92º06′6.9″W, 3155 m, 21-III-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.08″N, 92º06′9.54″W, 3214 m, 21-III-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.72″N, 92º06′2.64″W, 3136 m, 21-III-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.06″N, 92º06′7.32″W, 3135 m, 21-III-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.56″N, 92º06′9.54″W, 3214 m, 21-III-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.06″N, 92º06′8.04″W, 3187 m, 21-III-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′5.88″N, 92º06′7.92″W, 3109 m, 21-III-2018, 1♂, light trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.62″N, 92º06′3.36″W, 3060 m, 22-III-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.3″N, 92º06′7.62″W, 3070 m, 21-III–20-IV-2018, 1♂, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′1.74″N, 92º06′5.7″W, 3027 m, 21-III–20-IV-2018, 2♂, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.42″N, 92º06′1.98″W, 3037 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.14″N, 92º06′7.08″W, 3143 m, 19-IV-2018, 2♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.86″N, 92º06′7.08″W, 3145 m, 19-IV-2018, 3♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.92″N, 92º06′8.28″W, 3163 m, 19-IV-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.8″N, 92º06′8.34″W, 3171 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.78″N, 92º06′8.76″W, 3184 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.72″N, 92º06′8.88″W, 3191 m, 19-IV-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.08″N, 92º06′27″W, 3193 m, 19-IV-2018, 2♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.08″N, 92º06′9.36″W, 3196 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.26″N, 92º06′9.78″W, 3199 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.32″N, 92º06′10.74″W, 3199 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.8″N, 92º06′10.08″W, 3201 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.92″N, 92º06′10.14″W, 3202 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′5.64″N, 92º06′6.9″W, 3098 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.46″N, 92º06′8.34″W, 3116 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9″N, 92º06′7.5″W, 3124 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.88″N, 92º06′7.32″W, 3134 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.48″N, 92º06′7.8″W, 3139 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 19-IV-2018, 1♂, 1♀, light trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′1.74″N, 92º06′5.7″W, 3027 m, 20-IV–18-V-2018, 1♀, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.3″N, 92º06′7.62″W, 3070 m, 20-IV–18-V-2018, 1♀, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.14″N, 92º06′7.86″W, 3091 m, 16-V-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 16-V-2018, 5♂, light trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.9″N, 92º06′7.86″W, 3143 m, 17-V-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′11.58″N, 92º06′7.2″W, 3159 m, 17-V-2018, 4♂, 4♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′11.34″N, 92º06′8.58″W, 3164 m, 17-V-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′15.6″N, 92º06′8.4″W, 3210 m, 17-V-2018, 4♂, 4♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.66″N, 92º06′8.94″W, 3181 m, 17-V-2018, 4♂, 3♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.84″N, 92º06′9.06″W, 3184 m, 17-V-2018, 4♂, 4♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′14.1″N, 92º06′9.9″W, 3207 m, 17-V-2018, 4♂, 4♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.14″N, 92º06′10.26″W, 3201 m, 17-V-2018, 3♂, 3♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.98″N, 92º06′9.84″W, 3205 m, 17-V-2018, 1♂, 6♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′14.22″N, 92º06′10.68″W, 3218 m, 17-V-2018, 3♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′15.3″N, 92º06′10.86″W, 3231 m, 17-V-2018, 5♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′15.18″N, 92º06′12.84″W, 3246 m, 17-V-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.5″N, 92º06′4.32″W, 3064 m, 17-V-2018, 7♂, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′6.36″N, 92º06′4.86″W, 3088 m, 17-V-2018, 1♂, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′7.2″N, 92º06′7.14″W, 3106 m, 17-V-2018, 3♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′7.74″N, 92º06′6.78″W, 3111 m, 17-V-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′7.8″N, 92º06′8.04″W, 3120 m, 17-V-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.94″N, 92º06′7.86″W, 3132 m, 17-V-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.12″N, 92º06′7.02″W, 3129 m, 17-V-2018, 1♂, 3♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 20-VI-2018, 2♂, light trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′48.66″N, 92º06′3.06″W, 3040 m, 21-VI-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12″N, 92º06′8.16″W, 3167 m, 21-VI-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.66″N, 92º06′8.4″W, 3180 m, 21-VI-2018, 3♂, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.44″N, 92º06′9.54″W, 3209 m, 21-VI-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.32″N, 92º06′10.38″W, 3224 m, 21-VI-2018, 2♂, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.98″N, 92º06′10.62″W, 3219 m, 21-VI-2018, 3♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′14.7″N, 92º06′10.92″W, 3218 m, 21-VI-2018, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′19.38″N, 92º06′15.54″W, 3310 m, 21-VI-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′19.5″N, 92º06′15.18″W, 3309 m, 21-VI-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′6.42″N, 92º06′6.06″W, 3100 m, 21-VI-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′20.58″N, 92º06′15.24″W, 3358 m, 21-VI-2018, 2♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′7.68″N, 92º06′8.64″W, 3125 m, 21-VI-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.34″N, 92º06′8.1″W, 3132 m, 21-VI-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.76″N, 92º06′7.68″W, 3134 m, 21-VI-2018, 1♂, 3♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′11.04″N, 92º06′8.1″W, 3157 m, 21-VI-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.18″N, 92º06′7.08″W, 3182 m, 21-VI-2018, 4♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′1.74″N, 92º06′5.7″W, 3027 m, 21-VI–19-VII-2018, 3♀, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.3″N, 92º06′7.62″W, 3070 m, 21-VI–19-VII-2018, 1♀, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′7.44″N, 92º06′6.42″W, 3102 m, 17-VII-2018, 1♀, Ground-level interception trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 18-VII-2018, 1♀, light trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.56″N, 92º06′8.16″W, 3158 m, 19-VII-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.56″N, 92º06′8.58″W, 3198 m, 19-VII-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.98″N, 92º06′8.1″W, 3191 m, 19-VII-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.12″N, 92º06′7.08″W, 3159 m, 19-VII-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′11.7″N, 92º06′8.34″W, 3204 m, 19-VII-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.78″N, 92º06′8.82″W, 3190 m, 19-VII-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.56″N, 92º06′10.14″W, 3202 m, 19-VII-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′14.46″N, 92º06′10.02″W, 3220 m, 19-VII-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′5.64″N, 92º06′5.58″W, 3084 m, 19-VII-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′7.08″N, 92º06′7.14″W, 3095 m, 19-VII-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′7.86″N, 92º06′7.98″W, 3152 m, 19-VII-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.28″N, 92º06′8.22″W, 3113 m, 19-VII-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.34″N, 92º06′8.34″W, 3117 m, 19-VII-2018, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.42″N, 92º06′7.62″W, 3139 m, 19-VII-2018, 1♂, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.3″N, 92º06′7.62″W, 3070 m, 19-VII–16-VIII-2018, 1♂, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 15-VIII-2018, 2♂, light trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.36″N, 92º06′2.04″W, 3043 m, 16-VIII-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.76″N, 92º06′7.98″W, 3127 m, 16-VIII-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9″N, 92º06′7.74″W, 3146 m, 16-VIII-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.08″N, 92º06′7.74″W, 3156 m, 16-VIII-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.08″N, 92º06′10.38″W, 3193 m, 16-VIII-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.3″N, 92º06′7.62″W, 3070 m, 18-VIII–14-IX-2018, 1♂, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.04″N, 92º06′6.3″W, 3093 m, 13-IX-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.54″N, 92º06′8.7″W, 3205 m, 13-IX-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.96″N, 92º06′9.42″W, 3188 m, 13-IX-2018, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.44″N, 92º06′8.82″W, 3235 m, 13-IX-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.5″N, 92º06′9.48″W, 3210 m, 13-IX-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.92″N, 92º06′11.04″W, 3195 m, 13-IX-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′7.8″N, 92º06′7.62″W, 3120 m, 13-IX-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′7.26″N, 92º06′7.32″W, 3084 m, 13-IX-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.06″N, 92º06′7.56″W, 3138 m, 13-IX-2018, 3♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.36″N, 92º06′7.5″W, 3173 m, 13-IX-2018, 2♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.32″N, 92º06′7.38″W, 3165 m, 13-IX-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.26″N, 92º06′8.52″W, 3169 m, 13-IX-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′11.88″N, 92º06′7.08″W, 3162 m, 13-IX-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.14″N, 92º06′7.26″W, 3187 m, 13-IX-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 13-IX-2018, 1♂, 1♀, light trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.3″N, 92º06′7.62″W, 3070 m, 13-IX–13-X-2018, 2♂, Malaise trap, [alcohol];Volcán Tacaná, Parador Papales-La Cabaña, 15º07′7.98″N, 92º06′7.74″W, 3085 m, 11-X-2018, 2♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.42″N, 92º06′8.46″W, 3185 m, 11-X-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.78″N, 92º06′8.4″W, 3182 m, 11-X-2018, 2♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.62″N, 92º06′9.6″W, 3207 m, 11-X-2018, 1♂, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.78″N, 92º06′10.38″W, 3234 m, 11-X-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.52″N, 92º06′8.88″W, 3124 m, 11-X-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.94″N, 92º06′7.08″W, 3136 m, 11-X-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.6″N, 92º06′7.5″W, 3141 m, 11-X-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.6″N, 92º06′7.5″W, 3158 m, 11-X-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.5″N, 92º06′7.08″W, 3176 m, 11-X-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.74″N, 92º06′7.08″W, 3190 m, 11-X-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.92″N, 92º06′8.7″W, 3168 m, 11-X-2018, 2♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.6″N, 92º06′7.08″W, 3184 m, 11-X-2018, 1♂, 2♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.3″N, 92º06′7.62″W, 3070 m, 11-X–21-XI-2018, 1♀, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′09″N, 92º06′7.44″W, 3093 m, 22-XI-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′10.68″N, 92º06′8.04″W, 3166 m, 22-XI-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.06″N, 92º06′8.46″W, 3174 m, 13-XII-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′9.3″N, 92º06′7.5″W, 3190 m, 17-I-2019, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′3.36″N, 92º06′4.5″W, 3073 m, 18-I-2019, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′1.74″N, 92º06′5.7″W, 3027 m, 18-I–8-II-2019, 1♂, Malaise trap, [alcohol].

- *Hemerobius martinezae* Monserrat, 1996

Material examined (13♂, 16♀): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, 15º06′9.84″N, 92º08′36.08″W, 1712 m, 17-II–16-III-2018, 2♂, 1♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 15-III–15-IV-2018, 2♂, 1♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′40.5″N, 92º08′41.82″W, 1568 m, 21-V-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′40.68″N, 92º08′40.92″W, 1581 m, 14-VI-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′34.74″N, 92º08′45.12″W, 1526 m, 14-VI-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′40.44″N, 92º08′41.58″W, 1582 m, 20-IX-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′50.58″N, 92º08′36″W, 1470 m, 9-XII-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 8-XII-2018–9-I-2019, 1♂, Malaise trap, [alcohol]; **Unión Juárez**, Cantón Chiquihuites, 15º05′57.72″N, 92º06′44.76″W, 2213 m, 20-II-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′51.24″N, 92º06′28.92″W, 2163 m, 20-II-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′13.98″N, 92º06′7.86″W, 2417 m, 18-III-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′16.5″N, 92º06′9″W, 2419 m, 16-IV-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′53.7″N, 92º05′57.96″W, 2150 m, 17-IV-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′8.1″N, 92º06′7.86″W, 2340 m, 14-V-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′7.2″N, 92º06′8.7″W, 2336 m, 18-VI-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 19-VI-2018, 1♀, light trap, [alcohol]; same data but 8-X-2018, 1♂, [alcohol]; Cantón Chiquihuites, 15º05′46.32″N, 92º05′57.06″W, 2077 m, 9-X-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′15.84″N, 92º06′8.4″W, 2440 m, 19-XI-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′31.14″N, 92º05′35.7″W, 2430 m, 20-XI-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′8.76″N, 92º06′17.82″W, 2406 m, 10-XII-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′12.24″N, 92º06′20.4″W, 2457 m, 15-I-2019, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.88″N, 92º06′7.8″W, 3128 m, 21-III-2018, 1♂, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′8.88″N, 92º05′59.64″W, 3093 m, 22-III-2018, 1♂, entomological net, [alcohol].

- *Hemerobius nigridorsus* Monserrat, 1996

Material examined (2♂): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 1712 m, 15-IV–20-V-2018, 1♂, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º06′2.64″N, 92º08′38.1″W, 1705 m, 7-X–7-XI-2018, 1♂, Malaise trap, [alcohol].

- *Hemerobius withycombei* (Kimmins, 1928)

Material examined (2♂, 2♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′20.46″N, 92º10′18.42″W, 663 m, 11-III-2018, 1♀, entomological net, [alcohol]; Finca Alianza, 15º02′34.14″N, 92º10′4.26″W, 683 m, 8-VII-2018, 1♀, entomological net, [alcohol]; Finca Alianza, 15º03′35.46″N, 92º10′34.14″W, 717 m, 7-VII-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′35.4″N, 92º10′4.8″W, 681 m, 7-VIII-2018, 1♂, entomological net, [alcohol].

- *Megalomus minor* Banks in Baker, 1905

Material examined (18♂, 12♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′20.64″N, 92º10′14.4″W, 661 m, 9-II-2018, 1♀, entomological net, [alcohol]; Finca Alianza, 15º02′27.42″N, 92º10′13.02″W, 683 m, 10-II-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′27.96″N, 92º10′13.08″W, 680 m, 9-II–9-III-2018, 1♀, Malaise trap, [alcohol]; Finca Alianza, 15º02′27.48″N, 92º10′12.24″W, 717 m, 10-III-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′37.14″N, 92º10′7.2″W, 713 m, 10-III-2018, 1♂, light trap, [alcohol]; Finca Alianza, 15º02′26.88″N, 92º10′13.26″W, 691 m, 11-III-2018, 1♀, entomological net, [alcohol]; Finca Alianza, 15º02′22.14″N, 92º10′23.16″W, 684 m, 8-IV-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′27.6″N, 92º10′12″W, 687 m, 9-IV-2018, 2♀, light trap, [alcohol]; Finca Alianza, 15º02′35.04″N, 92º10′12.9″W, 713 m, 10-IV-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′31.5″N, 92º10′13.62″W, 705 m, 10-IV-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′23.64″N, 92º10′16.62″W, 669 m, 10-IV-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′23.16″N, 92º10′13.8″W, 667 m, 7-V-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′34.86″N, 92º10′13.08″W, 705 m, 7-V-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′22.8″N, 92º10′21.96″W, 683 m, 8-V-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′21.78″N, 92º10′22.44″W, 678 m, 8-V-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′30.66″N, 92º10′13.74″W, 709 m, 8-VI-2018, 1♀, entomological net, [alcohol]; Finca Alianza, 15º02′34.14″N, 92º10′4.2″W, 696 m, 8-VI-2018, 1♀, light trap, [alcohol]; Finca Alianza, 15º02′31.38″N, 92º10′13.38″W, 707 m, 9-VI-2018, 1♀, entomological net, [alcohol]; Finca Alianza, 15º02′22.26″N, 92º10′14.1″W, 657 m, 7–9-VI-2018, 1♂, yellow plate trap, [alcohol]; Finca Alianza, 15º03′40.02″N, 92º10′35.94″W, 700 m, 3-I-2019, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′47.64″N, 92º11′20.94″W, 1179 m, 13-II-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′39″N, 92º11′24.06″W, 1130 m, 11-V-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′59.7″N, 92º11′15.96″W, 1060 m, 11-V-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′33.78″N, 92º10′52.02″W, 1209 m, 11-V-2018, 1♂, light trap, [alcohol]; Ejido El Águila, 15º06′0.06″N, 92º11′15.84″W, 1055 m, 12-VI-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′55.56″N, 92º11′18.36″W, 1112 m, 11-VII-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′46.36″N, 92º11′20.34″W, 1130 m, 10-VIII-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′49.2″N, 92º11′20.34″W, 1120 m, 7-IX-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 6-I-2019, 1♀, light trap, [alcohol].

- *Megalomus pictus* Hagen, 1861

Material examined (1♂, 2♀): **Mexico: Chiapas, Unión Juárez**, Cantón Chiquihuites, 15º05′58.32″N, 92º05′56.46″W, 2139 m, 15-V-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 19-VI-2018, 1♂, light trap, [alcohol]; Cantón Chiquihuites, 15º07′13.14″N, 92º06′7.26″W, 3187 m, 13-IX-2018, 1♀, entomological net, [alcohol].

- *Megalomus* sp.

Material examined (2♂): **Mexico: Chiapas, Unión Juárez**, Volcán Tacaná, Parador Papales-La Cabaña, 15º07′13.98″N, 92º06′10.62″W, 3219 m, 21-VI-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.9″N, 92º06′9.36″W, 3235 m, 22-XI-2018, 1♂, entomological net, [alcohol].

- *Micromus subanticus* (Walker, 1853)

Material examined (1♀): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 15-IV-2018, 1♀, light trap, [alcohol].

- *Nusalala championi* Kimmins, 1936

Material examined (8♂, 13♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º03′43.44″N, 92º10′35.1″W, 775 m, 8-VIII-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º06′11.16″N, 92º10′54.24″W, 1160 m, 12-VI-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′41.7″N, 92º11′21.84″W, 1151 m, 12-VI-2018, 1♂, entomological net, [alcohol]; Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 12-VI-2018, 1♀, light trap, [alcohol]; Ejido El Águila, 15º05′34.92″N, 92º10′40.2″W, 1256 m, 4–6-XI-2018, 1♀, Ground-level interception trap, [alcohol]; Ejido El Águila, 15º05′33.78″N, 92º10′52.02″W, 1209 m, 6-XII-2018, 1♀, black light trap, [alcohol]; Ejido El Águila, 15º05′35.58″N, 92º10′42.36″W, 1255 m, 8-I-2019, 1♀, entomological net, [alcohol]; Ejido El Águila-Recorrido 2, 15º05′29.09″N, 92º11′22.29″W, 1001 m, 5-VII-2017, C. Sanchéz B., 2♂, ceratrap, [alcohol] (ECO-TAP-E); Ejido Benito Juárez El Plan, 15º06′9.84″N, 92º08′36.08″W, 1712 m, 17-II–16-III-2018, 1♂, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′13.5″N, 92º08′54.78″W, 1430 m, 15-III-2018, 1♀, entomological net, [alcohol];

Ejido Benito Juárez El Plan, 15º06′2.64″N, 92º08′38.1″W, 1705 m, 15-III–15-IV-2018, 1♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′40.92″N, 92º08′41.64″W, 1584 m, 14-IV-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º06′2.64″N, 92º08′38.1″W, 1705 m, 15-IV–20-V-2018, 1♀, Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′40.62″N, 92º08′41.76″W, 1591 m, 15-VI-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′43.44″N, 92º08′40.26″W, 1531 m, 12-VII-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′48.24″N, 92º08′38.64″W, 1604 m, 11–13-VIII-2018, 1♂, yellow plate trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′35.46″N, 92º08′44.64″W, 1557 m, 7-X-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′49.02″N, 92º08′31.74″W, 1678 m, 9-I-2019, 1♀, entomological net, [alcohol]; **Unión Juárez**, Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 8-X-2018, 1♀, light trap, [alcohol]; Cantón Chiquihuites, 15º05′51.6″N, 92º05′58.32″W, 2174 m, 9-X-2018, 1♀, entomological net, [alcohol].

- *Nusalala irrebita* (Navás, 1929)

Material examined (1♂, 6♀): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 11-VII-2018, 1♀, light trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′13.02″N, 92º08′55.2″W, 1430 m, 16-III-2018, 1♀, light trap, [alcohol]; **Unión Juárez**, Cantón Chiquihuites, 15º06′12.84″N, 92º06′8.04″W, 2405 m, 14-V-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′52.32″N, 92º05′58.56″W, 2139 m, 15-V-2018, 1♂, entomological net, [alcohol]; Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 8-X-2018, 1♀, light trap, [alcohol]; Cantón Chiquihuites, 15º05′51.3″N, 92º05′58.74″W, 2153 m, 9-X-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites, 15º06′20.52″N, 92º06′14.64″W, 2452 m, 10-12-2018, 1♀, entomological net, [alcohol].

- *Nusalala tessellata* (Gerstaecker, 1888)

Material examined (1♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′46.44″N, 92º09′55.86″W, 722 m, 8-VI-2018, 1♀, entomological net, [alcohol].

- *Nusalala unguicaudata* Monserrat, 2000

Material examined (4♂, 1♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′27.42″N, 92º10′13.02″W, 683 m, 10-II-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′27.06″N, 92º10′12.48″W, 678 m, 8-IV-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º03′35.82″N, 92º10′34.68″W, 749 m, 4-XII-2018, 1♀, entomological net, [alcohol]; Finca Alianza, 15º02′38.58″N, 92º09′35.94″W, 743 m, 5-I-2019, 1♂, entomological net, [alcohol]; Finca Alianza, 15º03′45.42″N, 92º10′32.94″W, 774 m, 5-I-2019, 1♂, entomological net, [alcohol].

- *Notiobiella cixiiformis* (Gerstaecker, 1888)

Material examined (1♀): **Mexico: Chiapas, Unión Juárez**, Cantón Chiquihuites, 15º05′43.74″N, 92º05′57.6″W, 2060 m, 14-V-2018, 1♀, light trap, [alcohol].

- *Notiobiella mexicana* Banks, 1913

Material examined (1♂, 1♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′22.2″N, 92º10′22.92″W, 670 m, 8-IV-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′23.76″N, 92º10′22.2″W, 693 m, 8-V-2018, 1♀, entomological net, [alcohol].

- *Sympherobius axillaris* Navás, 1928

Material examined (6♂, 4♀): **Mexico: Chiapas, Unión Juárez**, Cantón Chiquihuites, 15º06′14.94″N, 92º06′8.52″W, 2406 m, 16-IV-2018, 1♀, entomological net, [alcohol]; Cantón Chiquihuites-Parador Las Flores, 15º06′29.52″ N, 92º05′56.88″ W, 2668 m, 16-V-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales- Parador La cabaña, 15º07′3.3″N, 92º06′7.62″W, 3070 m, 21-III–20-IV-2018, 1♂, Malaise trap, [alcohol]; Volcán Tacaná, Parador Papales- Parador La cabaña, 15º07′5.4″N, 92º06′6.78″W, 3101 m, 19-IV-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales- Parador La cabaña, 15º07′12.78″N, 92º06′8.76″W, 3184 m, 19-IV-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales- Parador La cabaña, 15º07′13.98″N, 92º06′9.84″W, 3205 m, 17-V-2018, 1♀, entomological net, [alcohol]; Volcán Tacaná, Parador Papales- Parador La cabaña, 15º07′4.5″N, 92º06′4.32″W, 3064 m, 17-V-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales- Parador La cabaña, 15º07′4.44″N, 92º06′7.92″W, 3088 m, 15-VIII-2018, 1♀, light trap, [alcohol]; same data but 13-IX-2018, 1♂, [alcohol]; Volcán Tacaná, Parador Papales- Parador La cabaña, 15º07′7.62″N, 92º06′06″W, 3134 m, 22-XI-2018, 1♂, entomological net, [alcohol].

- *Sympherobius distinctus* Carpenter, 1940

Material examined (1♂): **Mexico: Chiapas, Unión Juárez**, Cantón Chiquihuites, 15º05′43.74″N, 92º05′57.6″W, 2060 m, 14-V-2018, 1♂, light trap, [alcohol].

- *Sympherobius marginatus* (Kimmins, 1928)

Material examined (1♂, 5♀): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, 15º06′9.84″N, 92º08′36.08″W, 1712 m, 17-II–16-III-2018, 2♀ Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.24″N, 92º08′36.48″W, 15-IV–20-V-2018, 1♀ Malaise trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′40.92″N, 92º08′41.52″W, 1588 m, 14-IV-2018, 1♀, entomological net, [alcohol]; **Unión Juárez**, Cantón Chiquihuites, 15º05′52.8″N, 92º05′58.62″W, 2156 m, 19-VI-2018, 1♂, entomological net, [alcohol]; Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.24″N, 92º06′8.52″W, 3176 m, 19-IV-2018, 1♀, entomological net, [alcohol].

- *Sympherobius similis* Carpenter, 1940

Material examined (1♂, 1♀): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º05′40.02″N, 92º11′22.44″W, 1168 m, 13-III-2018, 1♂, entomological net, [alcohol]; **Unión Juárez**, Cantón Chiquihuites, 15º05′46.26″N, 92º05′56.46″W, 2079 m, 16-IV-2018, 1♀, light trap, [alcohol].

- *Sympherobius subcostalis* Monserrat, 1990

Material examined (1♂, 1♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′23.16″N, 92º10′22.32″W, 700 m, 4-IX-2018, 1♀, entomological net [alcohol]; Finca Alianza, 15º03′35.7″N, 92º10′34.38″W, 748 m, 3-I-2019, 1♂, entomological net [alcohol].

- *Sympherobius* sp.

Material examined (1♂): **Mexico: Chiapas, Unión Juárez**, Volcán Tacaná, Parador Papales-La Cabaña, 15º07′12.66″N, 92º06′8.94″W, 3181 m, 17-V-2018, 1♂, entomological net, [alcohol].

Mantispidae.

- *Nolima infensa* Navás, 1924

Material examined (1♂, 2♀): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º05′47.04″N, 92º11′22.5″W, 1250 m, 13-II-2018, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 7-X-2018, 2♀, light trap, [alcohol].

- *Nolima victor* Navás, 1914

Material examined (2♂, 1♀): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1479 m, 7-X-2018, 1♂, 1♀, light trap [alcohol]; same data but 7-XI-2018, 1♂, light trap [alcohol].

- *Dicromantispa sayi* (Banks, 1897)

Material examined (4♂, 2♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′43.44″N, 92º09′35.1″W, 775 m, 8-VIII-2018, 1♀, entomological net, [pinned]; Finca Alianza, 15º02′3414″N, 92º10′4.2″W, 659 m, 4-IX-2018, 1♀, light trap, [alcohol]; Finca Alianza, 15º03′42.96″N, 92º10′34.74″W, 763 m, 1-X-2018, 1♂, entomological net, [alcohol]; Finca Alianza, 15º02′28.74″N, 92º10′9.48″W, 661 m, 1-XI-2018, 2♂, light trap, [alcohol]; Finca Alianza, 15º03′38.7″N, 92º10′35.64″W, 752 m, 3-I-2019, 1♂, entomological net, [alcohol].

- *Leptomantispa pulchella* (Banks, 1912)

Material examined (1♂): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′29.22″N, 92º10′13.14″W, 694 m, 10-II-2018, 1♂, light trap, [alcohol].

- *Zeugomantispa compellens* (Walker, 1860)

Material examined (4♂, 1♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º03′44.82″N, 92º10′33.36″W, 772 m, 1-XI-2018, 1♀, entomological net, [alcohol]; Finca Alianza, 15º03′35.7″N, 92º10′34.38″W, 748 m, 3-I-2019, 2♂, entomological net, [alcohol]; Finca Alianza, 15º03′45.42″N, 92º10′32.94″W, 774 m, 5-I-2019, 1♂, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1462 m, 15-IV-2018, 1♂, light trap, [alcohol].

- *Zeugomantispa minuta* (Fabricius, 1775)

Material examined (3♂, 5♀): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 6-I-2019, 1♂, 1♀, light trap, [alcohol]; Ejido Benito Juárez El Plan, 15º05′27.18″N, 92º08′51.06″W, 1462 m, 15-IV-2018, 1♀, light trap, [alcohol]; same data but 13-VII-2018, 1♂, [alcohol]; **Unión Juárez**, Cantón Chiquihuites, 15º05′46.26″N, 92º05′56.46″W, 2072 m, 16-IV-2018, 2♀, light trap, [alcohol]; Cantón Chiquihuites, 15º05′43.79″N, 92º05′57.6″W, 2081 m, 19-VI-2018, 1♀, light trap, [alcohol]; same data but 16-VII-2018, 1♂, [alcohol].

Mymeleontidae.

- *Haploglenius flavicornis* McLachlan, 1873

  Material examined (1♀): **Mexico: Chiapas, Unión Juárez**, Finca Monte Perla, 15º02′40.8″N 92º05′17.4″ W, 926 m, 5-IX-2018, 1♀, black light trap, [alcohol].

- *Ululodes bicolor* (Banks, 1895)

  Material examined (1♂): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′34.14″N, 92º10′4.2″W, 696 m, 8-VII-2018, 1♂, light trap, [alcohol].

- *Ululodes* sp.

  Material examined (1♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′28.74″N, 92º10′9.48″W, 661 m, 1-XI-2018, 1♀, light trap, [alcohol].

- *Myrmeleon immaculatus* De Geer, 1773

  Material examined (16♂, 20♀): **Mexico: Chiapas, Cacahoatán**, Ejido El Águila, 15º05′09″N, 92º10′58.6″W, 1130 m, 27-XII-2017(larvae), 14-III-2018(Emerged) 1♂, manual collection, [alcohol]; Ejido El Águila, 15º05′35.88″N, 92º10′45.36″W, 1264 m, 12-II-2018(larvae), 30-IV–13-V-2018 (Emerged), 4♂, 1♀, manual collection, [alcohol]; Ejido El Águila, 15º05′34.44″N, 92º10′50.46″W, 1217 m, 14-II-2018(larvae), 5–7-IV-2018 (Emerged) 2♀, manual collection, [alcohol]; Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 10-VIII-2018, 1♀, entomological net, [alcohol]; Ejido Benito Juárez El Plan, 15º05′13.26″N, 92º08′54.72″W, 1433 m, 16-II-2018(larvae), 16-IV–17-V-2018(Emerged) 1♂, 5♀, manual collection, [alcohol]; Ejido Benito Juárez El Plan, 15º05′33.72″N, 92º08′45.66″W, 1514 m, 16-II-2018(larvae), 13-V-2018(Emerged), 1♀, manual collection, [alcohol]; Ejido Benito Juárez El Plan, 15º05′35.1″N, 92º08′45″W, 1535 m, 16-II-2018(larvae), 11–17-V-2018(Emerged), 1♂, 2♀, manual collection, [alcohol]; Ejido Benito Juárez El Plan, 15º05′40.68″N, 92º08′41.1″W, 1582 m, 16-II-2018(larvae), 12-IV–3-V-2018(Emerged) 2♂, 1♀, manual collection, [alcohol]; Ejido Benito Juárez El Plan, 15º06′2.58″N, 92º08′37.98″W, 1692 m, 17-II-2018(larvae), 28-IV–13-V-2018(Emerged), 1♂, 1♀, manual collection, [alcohol]; Ejido Benito Juárez El Plan, 15º06′3.12″N, 92º08′38.4″W, 1612 m, 20-V-2018(larvae), 22-VI-2018(Emerged) 1♂, manual collection, [alcohol]; **Unión Juárez**, Finca Monte Perla, 15º02′49.3″N, 92º05′18.4″W, 960 m, 13-III-2017(larvae), 18-IV–28-V-2017(Emerged), 2♂, 3♀, manual collection, [alcohol]; Finca Monte Perla, 15º02′55.44″N, 92º05′19.26″W, 988 m, 11-II-2018(larvae), 15-V-2018(Emerged) 1♀, manual collection, [alcohol]; Finca Monte Perla, 15º02′43.68″N, 92º05′16.08″W, 955 m, 11-II-2018(larvae), 5-VI-2018(Emerged) 1♂, manual collection, [alcohol]; Mirador Pico del Loro, 15º03′32.4″N, 92º05′44.4″W, 1221 m, 13-III-2017(larvae), 18-IV–5-VI-2017(Emerged) 1♂, 1♀, manual collection, [alcohol]; Cantón Chiquihuites-San Isidro, 15º05′35.4″N, 92º05′37.86″W, 1749 m, 19-II-2018(larvae), 24-IV–30-V-2018(Emerged), 1♂, 1♀, manual collection, [alcohol].

- *Myrmeleon timidus* Gerstaecker, 1888

  Material examined (8♂, 6♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′32.52″N, 92º10′13.98″W, 706 m, 10-II-2018(larvae), 8-II–1-V-2018(Emerged) 2♂, 3♀, manual collection, [alcohol]; Finca Alianza, 15º03′36.18″N, 92º10′34.2″W, 746 m, 9-VII-2018(larvae), 5-VIII–28-XI-2018(Emerged) 6♂, 3♀, manual collection, [alcohol].

- *Myrmeleon uniformis* Navás, 1920

Material examined (4♂, 2♀): **Mexico: Chiapas, Cacahoatán**, Ejido Benito Juárez El Plan, 15º05′33.72″N, 92º08′45.66″W, 1514 m, 16-II-2018(larvae), 20-IV-2018(Emerged), 2♀, manual collection, [alcohol]; **Unión Juárez**, Cantón Chiquihuites, 15º05′43.74″N, 92º05′57.6″W, 2060 m, 14-V-2018, 2♂, light trap, [alcohol]; same data but 19-VI-2018, 1♂, [alcohol]; Cantón Chiquihuites, 15º05′54.6″N, 92º05′55.56″W, 2173 m, 17-VII-2018, 1♂, entomological net, [alcohol].

Rachiberothidae.

- *Trichoscelia santareni* (Navás, 1914)

Material examined (4♂, 5♀): **Mexico: Chiapas, Cacahoatán**, Finca Alianza, 15º02′28.74″N, 92º10′9.48″W, 661 m, 1-XI-2018, 1♂, light trap, [alcohol]; Finca Alianza, 15º02′35.82″N, 92º09′34.68″W, 749 m, 2-XII-2018, 1♀, entomological net, [alcohol]; Ejido El Águila, 15º05′33.24″N, 92º10′50.64″W, 1194 m, 10-VIII-2018, 1♂, 1♀, light trap, [alcohol]; same data but 7-IX-2018, 1♀, [alcohol]; same data but 5-X-2018, 1♂, 1♀, [alcohol]; Ejido Benito Juárez El Plan, 15º05′27.66″N, 92º08′50.5″W, 1487 m, 7-XI-2018, 1♀, black light trap, [alcohol]; **Unión Juárez**, Finca Monte Perla, 15º02′40.8″N, 92º05′17.4″W, 926 m, 8-VIII-2018, 1♂, black light trap, [alcohol].

7.- CAPÍTULO III:

Diversity of Lacewings (Neuroptera) in an Altitudinal Gradient of the Tacaná Volcano, Southern Mexico

Rodolfo J. Cancino-López, Claudia E. Moreno, Atilano Contreras-Ramos

Publicado en Insects

insects

MDPI

Article

Diversity of Lacewings (Neuroptera) in an Altitudinal Gradient of the Tacaná Volcano, Southern Mexico

Rodolfo J. Cancino-López [1,2], Claudia E. Moreno [3] and Atilano Contreras-Ramos [2,*]

[1] Posgrado en Ciencias Biológicas, Unidad de Posgrado, Circuito de Posgrados, Universidad Nacional Autónoma de México, Mexico City 04510, Mexico; cancinorodolfoj@gmail.com
[2] Colección Nacional de Insectos, Departamento de Zoología, Instituto de Biología, Universidad Nacional Autónoma de México, Mexico City 04510, Mexico
[3] Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo, Mineral de la Reforma, Hidalgo 42184, Mexico; cmoreno@uaeh.edu.mx
* Correspondence: acontreras@ib.unam.mx

Simple Summary: Lacewings are insects with a great diversity of morphology and habits and are potentially important as bioindicators and biological control agents. However, there is little worldwide information on their patterns of distribution and diversity. Therefore, it is essential to understand what changes occur in their diversity through spatial changes such as elevation. We analyzed Neuroptera diversity locally and between sites through an elevation gradient, finding two marked trends: (1) a decrease in richness with increasing altitude and, (2) greater diversity and potential richness at an intermediate elevation. In addition, a high degree of species turnover means that there is an evident transition between the lowland communities and the forest in the upper parts of the volcano, reflecting an altitudinal replacement of species and exclusivity for certain altitudes. These patterns will help us understand the distribution diversity of lacewings for better management and conservation of insects and the ecosystems with which they are associated.

Abstract: Neuroptera is an order of insects with a moderate diversity of species numbers yet a high between-family morphological diversity, which has a significant ecological role as a predator. However, there are few studies focused on describing changes in species diversity along environmental gradients. We evaluated changes in the alpha and beta diversity of species and the higher taxa in Neuroptera communities in the Tacaná Volcano in southern Mexico. Five sites each at different altitudes were studied through systematic annual sampling. The taxonomic and phylogenetic alpha diversity were analyzed, as well as the beta diversity and its components, species turnover and nestedness. The alpha diversity had two trends: (1) decreased standardized richness and taxonomic distinctness with increasing altitude, and (2) increased estimated richness and species diversity at intermediate altitudes. The highest turnover values for species, as well as for supra-specific taxa, were recorded at sites with lower altitudes. The highest total beta diversity value was recorded at elevations above 3000 m, whereas the highest number of species and supra-specific taxa were observed at sites between 600 and 2000 m, with an evident decrease above 3000 m. The type of vegetation and environmental conditions may be influencing the decrease in diversity toward higher elevations, which could explain the niche specialization of Neuroptera species to particular sites within the gradient. These results highlight the need to study the environmental factors and their effects on species composition along an elevation gradient.

Keywords: taxonomic diversity; taxonomic distinctness; species composition; beta diversity; species turnover; nestedness; elevational gradient

check for updates

Citation: Cancino-López, R.J.; Moreno, C.E.; Contreras-Ramos, A. Diversity of Lacewings (Neuroptera) in an Altitudinal Gradient of the Tacaná Volcano, Southern Mexico. *Insects* **2022**, *13*, 652. https://doi.org/10.3390/insects13070652

Academic Editor: Giuliana Allegrucci

Received: 7 June 2022
Accepted: 13 July 2022
Published: 19 July 2022

1. Introduction

Biodiversity patterns across spatial gradients have long been a topic of great interest for understanding evolutionary processes that shape biological communities [1,2]. In particular, altitude gradients allow us to analyze changes in species richness and community composition in response to environmental variations such as precipitation, temperature, vegetation structure, and humidity, among others [3,4]. For this reason, mountain systems have been considered natural laboratories for the analysis of different patterns, which can explain the distinct ecological processes that shape the attributes of biodiversity, since environmental conditions change with an increasing elevation over short spatial distances, which influences the distribution of species [5,6].

In general, species richness along elevational gradients follows two main patterns: decreasing richness at higher altitudes, or greater richness at intermediate elevations [7,8]. In the first case, extreme climates at high altitudes harbor few species capable of tolerating such conditions, and at low altitudes, a greater number of species are concentrated due to the stability of climatic conditions [9]. On the other hand, the pattern of higher richness at intermediate altitudes is related to the mid-domain effect, which consists of an increasing overlap of species toward the center of a spatial domain due to the presence of strong spatial boundaries at the upper and lower edges, regardless of the influence of the relationship between species and the environment [1,10].

Beta diversity (dissimilarity in species composition) increases with increasing altitude, i.e., there is higher dissimilarity at mountain tops [5,6,8,11], with some exceptions of an opposite pattern [12,13]. When total dissimilarity is partitioned into dissimilarity due to turnover (species replacement between sites) and dissimilarity due to nestedness (species loss or gain between sites) [14], species turnover is often the main component that explains total dissimilarity [5,8,15]. However, there are cases in which high nestedness values have been recorded at high elevations [2].

Neuropteran communities can be excellent models for investigating the effects of environmental and spatial changes on species diversity and habitat composition [16] because differences in habitat types and shapes can determine and influence the diversity, abundance, and distribution of Neuroptera in different ecosystems [17]. Neuroptera is a group of mainly terrestrial insects with approximately 6000 species, 603 genera, and 15 families [18], with a worldwide distribution. Neuroptera species occupy a wide variety of habitats, from tropical to temperate. They present a morphological diversity and variety of specializations in their life histories, mainly during their larval stage [19]. Some adults may feed on plant structures (such as honeydew and nectar from flowers), but most, and primarily the larvae, are predators of many soft-bodied arthropods including aphids, whiteflies, small lepidopteran caterpillars, and eggs, or as parasitoids of some spiders, bees, and wasps, with some families associated with termites or river sponges [17]. Neuropterans may serve as indicator groups for habitat transformation [20] as they present a high specificity to particular habitats and biomes, making them sensitive to ecological alterations [21,22]. Many species depend on external thermal conditions, such as wind speed and ambient temperature, to maintain viable populations, using these variables as predictors of species richness and abundance [17,23].

In many cases, the composition and characteristics of neuropteran communities are determined by the species of prey and their abundance, the microclimates present, and the plant structure of the habitat [17,24]. In some families, such as Chrysopidae and Hemerobiidae, their high capacity to colonize and adapt to new environmental conditions is evident [25], which allows them to adjust their feeding areas based on their habits, cost-benefits, and abilities to locate their food resource [26]. Despite this, Neuroptera are generally insects with a weak ability to fly (except for Ascalaphinae), which means that their dispersal ability often depends on air currents [27]. In general, Neuroptera species seem to prefer the presence of shelters and food resources that allow them to inhabit different environments, with the need for a complex plant physiognomy that provides them with diversified niches for their survival [28].

Studies on the alpha diversity and community structure of Neuroptera have been carried out using different approaches, and their study has increased in recent years. Some aim to understand the differences in diversity between sites, the local diversity of a site, or the diversity of communities over time (temporal). Regarding beta diversity, studies have focused mainly on the similarity between areas, types of ecosystems, and families, reporting significant differences between communities at different sites [26,29]. For Neuroptera, beta diversity components have been little studied, although it has been noted that in communities of lacewings, there might be a high species turnover.

One of the factors that few studies have explored is the effects of altitude on the diversity of Neuroptera, whereas some studies have focused on the composition and diversity of the different families. It has been observed that certain groups seem to be restricted to particular areas, from zones with cold temperatures (alpine areas) to zones with warmer temperatures [30]. In recent works, the different factors associated with the abundance and diversity of neuropterans have been analyzed. It has been reported in families such as Myrmeleontidae (without Ascalaphinae) and Nemopteridae, that the abundance increased with altitude, whereas other families such as Chrysopidae, Coniopterygidae, and Ascalaphinae decreased with elevation [29]. Despite this, elevation does not seem to influence families in the same way and, in many cases, trends change depending on the geographical location. Also, a recent study showed that the alpha diversity of Chrysopidae decreased with increasing elevation, as well as the component that best explains the dissimilarity changes along the altitudinal gradient. They reported that nestedness replaces species turnover with increasing altitude [31]. These patterns depend on the biological/ecological requirements of Neuroptera species and factors such as temperature and seasonality [32]. It is crucial to continue carrying out studies on how the communities of neuropterans change with altitude, as different environmental factors change with elevation and may function as environmental filters that affect the diversity or the species distribution.

In the present study, we analyze the diversity of Neuroptera (lacewings and allies) along an altitudinal gradient of the Tacaná Volcano Biosphere Reserve, which lies at the northernmost limit of the mountainous area called the Central American Nucleus, which is part of the Mesoamerican Biological Corridor in southern Mexico. This region presents a high biological richness, endemism, and a great variety of vegetation types, resulting from the assemblage of biotas of Nearctic and Neotropical origin [33]. This study aimed to analyze the changes in the Neuroptera communities along an altitudinal gradient of the Tacaná Volcano. Therefore, the following specific objectives were proposed: (1) estimate the potential number of species at the local and regional levels (Tacaná Volcano) to assess the completeness of the inventory; (2) analyze the alpha diversity of species and taxa (taxonomic distinctness) along the altitudinal gradient; and (3) evaluate the beta diversity (dissimilarity) and its turnover and nestedness components due to differences in species richness, both for species and for higher taxa through the altitudinal gradient. Higher values of species richness and diversity were expected to be found at mid-elevations according to the mid-domain effect, due in part to spatial limitations at high altitudes (reduction in area) and low altitudes (reduction of conserved zones because of anthropogenic activities). Regarding beta diversity, a higher dissimilarity in species composition is expected between sites with high and low altitudes compared to the intermediate elevation sites; areas at medium elevation present similar environmental conditions (same type of vegetation), which may lead to the recording of similar faunas. However, the phylogenetic alpha and beta diversities could decrease with altitude, with a higher number of lineages at low altitudes better adapted to stable environmental conditions, and fewer lineages adapted to the extreme conditions at the upper parts of the volcano, which suggests an environmental filter that may influence the dispersal or colonization of lineages along the gradient.

2. Materials and Methods

2.1. Study Area

The Tacaná Volcano Biosphere Reserve is located in the state of Chiapas, Mexico, and in the department of San Marcos, Guatemala. The volcano reaches an altitude of 4092 m and has an area of approximately 300 square kilometers, of which three-quarters correspond to Mexico, and contains a wide variety of types of vegetation (predominantly cloud forest). The volcano is part of the Central American Volcanoes and Chiapas Coastal Plain Subprovince [34], a unit extended along the Pacific between the Isthmus of Tehuantepec and Guatemala. In addition, it belongs to the Mexican Transition Zone within the Altiplano de Chiapas biogeographic province [35]. The environmental heterogeneity of the volcano offers a wide spectrum of habitats and conditions, making it an ideal study area to understand patterns of diversity across an elevational gradient in the Neotropics.

The reserve presents an average annual rainfall of 4438 mm with a relative humidity of 90% during the rainy season, autumn, and part of the winter, whereas during the dry season, it remains above 50%. Taking into account the Köppen climate classification modified by García [36], the climates that predominate in the reserve are the following: temperate humid (average annual temperature of 15.3 °C), semi-warm humid (average annual temperature of 20.7 °C), and warm humid (average annual temperature of 24.3 °C) with abundant rains in summer.

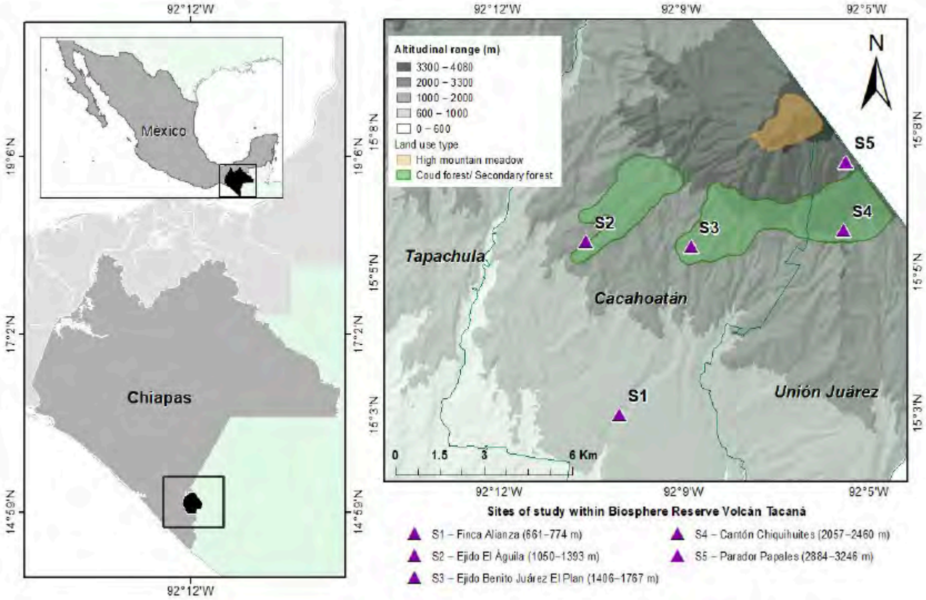
2.2. Sampling Design and Method

Five sampling sites were located each at a different altitude within the part of the volcano belonging to Mexico from 661 to 3246 m above sea level (Figure 1) in the municipalities of Cacahoatán and Unión Juárez in Chiapas state (Supplementary Materials Table S1). Systematic monthly samplings were carried out for a year (February 2018 to January 2019) at the five sampling sites. The collection period in each site was two and a half days each month during days with less moonlight. However, Malaise traps were working permanently throughout the year (with samples picked up monthly). Each month, seven sampling points separated by 500 m were established at the sampling sites where different sampling techniques were placed: a black light trap (bucket) and a black and white light trap (screen) (sampling point 1), two Malaise traps (sampling point 2), one ground-level intercept trap, and one yellow plate trap hung on the tree canopy (both placed at each of the remaining five sampling points) [37–39]. All points were randomly placed in a sampling area of approximately 2 km^2. In addition, sweeping was applied to the surroundings of the seven sampling points on the canopy and the herbaceous stratum of the vegetation of each sampling site with the use of an entomological net for four hours (10:00–14:00) per person (2 people) [39] (Figure 2). All the specimens collected through the different techniques during the twelve months of fieldwork were considered as a single annual sample unit for each site; in this regard, the temporal variation of diversity was not analyzed in this work. The different traps were placed at a minimum distance of 200 m between them. Specimens were identified and deposited in the Colección Nacional de Insectos of the Instituto de Biología of the Universidad Nacional Autónoma de México (CNIN-UNAM), Mexico. It is necessary to mention that this article stems from a global project on the Tacaná Volcano Neuroptera. The data used in this investigation were exclusively those obtained from the collection methods with annual systematic sampling carried out by Cancino et al. [39], without taking into account material from museum collections or other sites within the volcano, as mentioned in the previous publication.

2.3. Data Analysis

2.3.1. Inventory Completeness Estimation

The estimations of the completeness of the inventory and the potential number of species for each altitude level were calculated using the sample coverage (Sc) estimator [40]. These estimates were carried out using the iNEXT version 1.3 program [41]. These data were randomized 100 times and compared with the observations [40] with a confidence interval of 95%.



(**A**) (**B**)

Figure 1. Map of the distribution of sampling sites in the Tacaná Volcano Reserve, Chiapas, Mexico. (A) Geographical Location, (B) Sites of study.

Figure 2. 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**) Black and white light trap; (**F**) Entomological net (Reprinted with permission from Cancino et al. [39]. Copyright 2021, by the authors).

2.3.2. Alpha Diversity: Species and Taxa

Hill's numbers were used for the analysis of species diversity, either of order 0 (richness of species), order 1 (diversity of rare and common species), or order 2 (diversity of dominant species) according to Jost [42]. These estimates were carried out using the iNEXT version 1.3 program [41]. The analyses were carried out with 100 randomizations and were extrapolated to twice the number of samples [40] with a confidence interval of 95%. To compare the different diversity values between sites, the results were standardized to the same sample coverage (Sc), which indicates the proportion of the total community represented by the sampled species [40] using the iNEXT program. The calculated diversities were compared using 95% confidence intervals [43]. A visual comparison was made based on the superposition of the upper and lower intervals in order to establish whether significant differences between the values of each of the sites exist [44].

For the analysis of alpha phylogenetic diversity, the proposal of Clarke and Warwick [45] was used, which is based on the average taxonomic distances (length of the taxonomic routes) between two randomly selected species in the Linnaean hierarchy, which includes all species in an assemblage. For this, an abundance matrix was used as well as a second matrix with the hierarchical classification of all the species. Three indices of phylogenetic alpha diversity were obtained: (1) taxonomic distinctness (DivT: Δ^*), which expresses the total taxonomic distance between two randomly chosen species (with replacement), (2) average taxonomic distinctness (DisT: $\Delta+$), which represents the average of taxonomic distances between species, and (3) the taxonomic variation (VarT: $\not\subset+$), which measures the variance of the taxonomic distances between species [45]. These indices were compared with a null model built from 1000 randomizations of the set of species of each community in the PRIMER v7 Trial version [46], in order to assess whether the values obtained are statistically different from those expected at random.

2.3.3. Beta Diversity: Species and Taxa

The total taxonomic beta diversity on the volcano was evaluated with the Sorensen index (βSOR) and was analyzed with its two components: the dissimilarity due to turnover (βSIM) and the dissimilarity due to differences in richness (nestedness) (βNES) under the multiple-site approach [14]. In addition, under the pair-wise approach, the beta diversity between consecutive sites was measured through the elevation gradient (βsor = βsim + βnes), calculating the relative contribution of each component (in percentages) based on the incidence of the species [2,8].

Phylogenetic beta diversity (total dissimilarity of taxa) was analyzed using the incidence (presence–absence) of the taxa present at the different sites. Analogous to the beta diversity of species, the total dissimilarity between the taxonomic structures of the communities was measured using the Sorensen index. The approximation of Bacaro et al. [47] and Baselga [14] is a taxonomic dissimilarity method from the taxonomic distinctness approach of Clarke and Warwick [45]. This approach compares species richness and variations in taxonomic structures between assemblages, where all taxa have the same level of importance, regardless of their hierarchical levels. The beta diversity of taxa and its taxa turnover and nestedness components was calculated using the multiple-site approach and consecutive pairs of sites [14]. All beta diversity analyses were performed with the Betapart v.13 package in the R program [48].

3. Results

A total of 2527 individuals corresponding to 105 species, 28 genera, seven tribes (Chrysopini, Leucochrysini, Coniopterygini, Conwentzini, Fontenelleini, Myrmeleontini, and Ululodini), 13 subfamilies (Chrysopinae, Coniopteryginae, Aleuropteryginae, Hemerobiinae, Megalominae, Microminae, Notiobiellinae, Sympherobiinae, Mantispinae, Calomantispinae, Myrmeleontinae, Ascalaphinae, and Symphrasinae), and six families of Neuroptera were collected. The highest number of species was represented by Chrysopidae (51 species) and Hemerobiidae (29 species), and the greatest abundance by Hemerobiidae

(709 individuals) and Coniopterygidae (1094 individuals) (Table 1). Forty-four species occurred at only one site, and only two species were found at all five sampling sites; On average, Neuroptera species were recorded at two sampling sites (Table 1). At each site, most species were in low abundance and very few species were dominant (Figure 3).

Table 1. List of species of Neuroptera, number of sampling sites where the species was found, and abundance at each sample site along the altitudinal gradient at the Tacaná Volcano, Mexico. S1–S5: Site 1 to Site 5, where S1 has the lowest and S5 the highest altitude. * Species previously identified as *Ululodes* sp.1 (Adapted with permission from Cancino et al. [39]. Copyright 2021, by the authors.

Family	Scientific Name	Number of Sites Occupied	S1	S2	S3	S4	S5	TOTAL
	Genus *Ceraeochrysa*		661–774 m	1050–1393 m	1406–1767 m	2057–2460 m	2884–3246 m	
Chrysopidae	*C. achillea* de Freitas & Penny, 2009	2	7	1	0	0	0	8
	C. arioles (Banks, 1944)	4	1	11	1	2	0	15
	C. cincta (Schneider, 1851)	3	1	3	0	1	0	5
	C. cubana (Hagen, 1861)	2	2	0	0	1	0	3
	C. defreitasi Penny, 2002	1	0	0	1	0	0	1
	C. derospogon de Freitas & Penny, 2009	2	0	2	1	0	0	3
	C. effusa (Navás, 1911)	3	2	3	14	0	0	19
	C. infausta (Banks, 1945)	2	2	0	0	1	0	3
	C. lineaticornis (Fitch, 1855)	2	0	6	1	0	0	7
	C. sanchezi (Navás, 1924)	2	1	2	0	0	0	3
	C. sarta (Banks, 1914)	4	5	37	48	11	0	101
	C. squama de Freitas & Penny, 2001	2	1	1	0	0	0	2
	C. tacanensis Cancino & Contreras, 2019	3	0	2	35	26	0	63
	Ceraeochrysa sp. 1	2	0	1	1	0	0	2
	Genus *Chrysoperla*							
	C. asoralis (Banks, 1915)	2	0	2	0	1	0	3
	C. externa (Hagen, 1861)	1	1	0	0	0	0	1
	Genus *Chrysopodes* Subgenus *Chrysopodes*							
	C. crassinervis Penny, 1998	2	0	41	3	0	0	44
	C. varicosus (Navás, 1914)	4	1	8	42	2	0	53
	Chrysopodes sp.1	1	0	1	0	0	0	1
	Chrysopodes sp.2	1	0	0	1	0	0	1
	Genus *Leucochrysa* Subgenus *Leucochrysa*							
	L. clara (McLachlan, 1867)	2	0	6	2	0	0	8
	L. colombia (Banks, 1910)	2	0	0	1	1	0	2
	L. pretiosa (Banks, 1910)	1	36	0	0	0	0	36
	L. varia (Schneider, 1851)	1	0	1	0	0	0	1
	L. variata (Navás, 1913	3	1	2	1	0	0	4
	Subgenus *Nodita*							
	L. amistadensis Penny, 2001	2	0	0	1	2	0	3
	L. askanes (Banks, 1945)	2	23	1	0	0	0	24
	L. azevedoi Navás, 1913	1	1	0	0	0	0	1
	L. camposi (Navás, 1933)	2	0	1	2	0	0	3
	L. caucella Banks, 1910	1	0	0	2	0	0	2
	L. lateralis Navás, 1913	1	17	0	0	0	0	17

Table 1. *Cont.*

	Scientific Name							
Family		**Number of Sites Occupied**	**S1**	**S2**	**S3**	**S4**	**S5**	**TOTAL**
	L. maculosa de Freitas & Penny, 2001	3	1	13	7	0	0	21
	L. nigrovaria (Walker, 1853)	2	1	10	0	0	0	11
	L. squamisetosa de Freitas & Penny, 2001	1	1	0	0	0	0	1
	L. tarini (Navás, 1924)	2	13	1	0	0	0	14
	Leucochrysa sp.1	3	4	1	1	0	0	6
	Leucochrysa sp.2	1	0	0	0	1	0	1
	Leucochrysa sp.3	1	1	0	0	0	0	1
	Leucochrysa sp.4	1	0	1	0	0	0	1
	Leucochrysa sp.5	1	0	1	0	0	0	1
	Leucochrysa sp.6	1	0	0	2	0	0	2
	Genus *Meleoma*							
	M. macleodi Tauber, 1969	2	0	0	1	3	0	4
	M. titschacki Navás, 1928	3	0	2	76	17	0	95
	Meleoma sp. 1	2	0	0	0	2	1	3
	Genus *Plesiochrysa*							
	P. brasiliensis (Schneider, 1851)	4	1	7	4	4	0	16
	Plesiochrysa sp.1	1	0	0	0	5	0	5
	Plesiochrysa sp.2	2	1	3	0	0	0	4
	Genus *Titanochrysa*							
	T. annotaria (Banks, 1945)	2	0	2	10	0	0	12
	T. simpliciala Tauber et al., 2012	1	0	0	2	0	0	2
	Genus *Ungla*							
	Ungla sp.1	1	0	0	0	0	1	1
	Ungla sp. 2	1	0	0	0	1	0	1
Coniopterygidae	Genus *Coniopteryx* Species group *Scotoconioptery*							
	C. fumata Enderlein, 1907	1	0	1	0	0	0	1
	C. josephus Sarmiento & Contreras, 2019	1	1	0	0	0	0	1
	C. latipalpis Meinander, 1972	2	0	0	0	2	18	20
	C. quadricornis Meinander, 1982	2	3	8	0	0	0	11
	Species group *Coniopteryx*							
	C. simplicior Meinander, 1972	4	0	6	18	124	5	153
	C. westwoodii (Fitch, 1855)	2	0	3	0	2	0	5
	Genus *Conwentzia*							
	C. barretti (Banks, 1899)	3	0	0	1	2	17	20
	Genus *Neoconis*							
	N. dentata Meinander, 1972	5	3	3	18	10	1	35
	Genus *Semidalis*							
	S. boliviensis (Enderlein, 1905)	1	9	0	0	0	0	9
	S. hidalgoana Meinander, 1975	3	10	19	2	0	0	31
	S. manausensis Meinander, 1980	1	0	0	0	18	0	18
	S. problematica Monserrat, 1984	4	2	107	174	21	0	304
	S. soleri Monserrat, 1984	1	101	0	0	0	0	101
	Genus *Biramus*							
Hemerobiidae	*B. aggregatus* Oswald, 2004	1	0	0	18	0	0	18
	Genus *Hemerobiella*							

Table 1. *Cont.*

Family	Scientific Name	Number of Sites Occupied	S1	S2	S3	S4	S5	TOTAL
	H. sinuata Kimmins, 1940	1	0	0	1	0	0	1
	Genus *Hemerobius*							
	H. alpestris Banks, 1908	1	0	0	0	0	15	15
	H. bolivari Banks, 1910	4	0	4	14	8	2	28
	H. discretus Navás, 1917	3	0	0	1	31	286	318
	H. domingensis Banks, 1941	3	0	1	7	7	0	15
	H. gaitoi Monserrat, 1996	3	0	10	15	9	0	34
	H. hernandezi Monserrat, 1996	4	3	20	135	15	0	173
	H. hirsuticornis Monserrat & Deretsky, 1999	2	5	1	0	0	0	6
	H. jucundus Navás, 1928	5	2	3	16	69	268	358
	H. martinezae Monserrat, 1996	3	0	0	12	14	3	29
	H. nigridorsus Monserrat, 1996	1	0	0	2	0	0	2
	H. withycombei (Kimmins, 1928)	1	4	0	0	0	0	4
	Genus *Megalomus*							
	M. minor Banks, 1905	2	21	9	0	0	0	30
	M. pictus Hagen, 1861	2	0	0	0	2	1	3
	Megalomus sp. 1	1	0	0	0	0	2	2
	Genus Micromus							
	M. subanticus (Walker, 1853)	1	0	0	1	0	0	1
	Genus *Notiobiella*							
	N. cixiiformis Gerstaecker, 1888	1	0	0	0	1	0	1
	N. mexicana Banks, 1913	1	2	0	0	0	0	2
	Genus *Nusalala*							
	N. championi Kimmins, 1936	4	1	6	10	2	0	19
	N. irrebita (Navás, 1929d)	3	0	1	1	5	0	7
	N. tessellata (Gerstaecker, 1888)	1	1	0	0	0	0	1
	N. unguicaudata Monserrat, 2000	1	5	0	0	0	0	5
	Genus *Sympherobius*							
	S. axillaris Navás, 1928	2	0	0	0	2	8	10
	S. distinctus Carpenter, 1940	1	0	0	0	1	0	1
	S. marginatus (Kimmins, 1928)	3	0	0	4	1	1	6
	S. similis Carpenter, 1940	2	0	1	0	1	0	2
	S. subcostalis Monserrat, 1990	1	2	0	0	0	0	2
	Sympherobius sp. 1	1	0	0	0	0	1	1
Mantispidae	Genus *Dicromantispa*							
	D. sayi (Banks, 1897)	1	6	0	0	0	0	6
	Genus *Leptomantispa*							
	L. pulchella (Banks, 1912)	1	1	0	0	0	0	1
	Genus *Nolima*							
	N. infensa Navás, 1924	2	0	1	2	0	0	3
	N. victor Navás, 1914	1	0	0	3	0	0	3
	Genus *Zeugomantispa*							
	Z. compellens (Walker, 1860)	2	4	0	1	0	0	5
	Z. minuta (Fabricius, 1775)	3	0	2	2	4	0	8
Myrmeleontidae	Genus *Myrmeleon*							
	M. immaculatus De Geer, 1773	3	0	9	16	2	0	27

Table 1. *Cont.*

Family	Scientific Name	Number of Sites Occupied	S1	S2	S3	S4	S5	TOTAL
	M. timidus Gerstaecker, 1888	1	14	0	0	0	0	14
	M. uniformis Navás, 1920	2	0	0	2	4	0	6
	Genus *Ululodes*							
	U. bicolor (Banks, 1895)	1	1	0	0	0	0	1
	Genus *Ameropterus*							
	A. trivialis (Gerstaecker, 1888) *	1	1	0	0	0	0	1
Rhachiberothidae	Genus *Trichoscelia*							
	T. santareni (Navás, 1914)	3	2	5	1	0	0	8
	Total		329	393	737	438	630	2527
	Number of observed species Number of genera	- -	48 20	51 18	51 20	42 18	16 8	105 28
	Sample completeness (%)	-	66%	74%	75%	88%	62%	73%

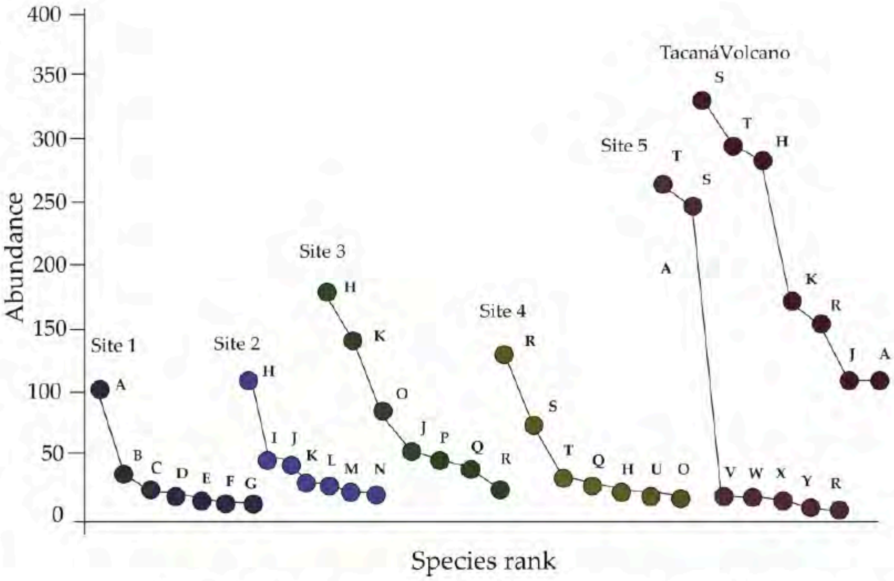


Figure 3. Rank-abundance curves of Neuroptera species for the different sampling sites and at the regional level of the Tacaná Volcano, Mexico. Species: A. *Semidalis soleri*, B. *Leucochrysa pretiosa*, C. *Leucochrysa askanes*, D. *Megalomus minor*, E. *Leucochrysa lateralis*, F. *Myrmeleon timidus*, G. *Leucochrysa tarini*, H. *Semidalis problematica*, I. *Chrysopodes crassinervis*, J. *Ceraeochrysa sarta*, K. *Hemerobius hernandezi*, L. *Semidalis hidalgoana*, M. *Leucochrysa maculosa*, N. *Ceraeochrysa arioles*, O. *Meleoma titschacki*, P. *Chrysopodes varicosus*, Q. *Ceraeochrysa tacanensis*, R. *Coniopteryx simplicior*, S. *Hemerobius jucundus*, T. *Hemerobius discretus*, U. *Semidalis manausensis*, V. *Coniopteryx latipalpis*, W. *Conwentzia barretti*, X. *Hemerobius alpestris*, Y. *Sympherobius axillaris*.

3.1. Inventory Completeness

The mid-elevation sites (between 1200 and 2000 m) recorded more than 70% of the estimated species, whereas the lower and higher elevations recorded less than 70% of the estimated species (Table 1). At the regional level, 140 species were estimated for the Tacaná Volcano, so the 105 recorded species represent 73% completeness of the inventory. Therefore, based on the sample coverage estimator, 35 species of Neuroptera could still be recorded on the volcano with the same collection techniques. A low number of rare species was found at the regional level; 24 species had only one individual (22.8% of the total) and 11 species had two individuals (10.5% of the total).

3.2. Alpha Diversity: Species and Taxa

The sample coverage of each site was high, with values above 90%. When standardizing species richness to the same estimated sample coverage (Sc = 0.970), only the last elevation at the highest altitude had lower richness and diversity than the lower sites according to the confidence intervals. Standardized richness decreased with increasing altitude (Figure 4A). On the other hand, the observed and estimated richnesses and order 1 and 2 diversities had higher values at intermediate altitudes (Figure 4B,C). The taxonomic distinctness (DivT) in the first four sites presented similar values. The highest value is observed at site three and the lowest value at site five. The average taxonomic distinctness (DisT) values showed a similar trend, with the highest value at site three and the lowest value at site five. Finally, the taxonomic variation (VarT) is lower in sites four and five, whereas the highest value was found for site two (Figure 4D). Therefore, the taxonomic structure remains relatively constant at low and medium altitudes, with a drastic decrease at altitude ranges above 3000 m a.s.l.

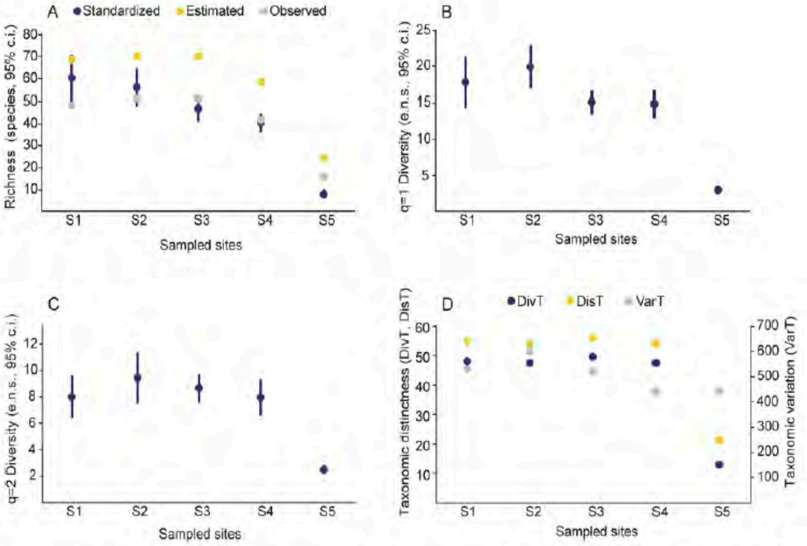


Figure 4. Species richness and diversity of orders 1 and 2 and taxonomic distinctness indices for each of the sampled sites. (**A**) Species richness, (**B**) Order q = 1 diversity, (**C**) Order q = 2 diversity, (**D**) Taxonomic distinctness (DivT), average taxonomic distinctness (DistT), and taxonomic variation (VarT). For standardized diversity values, error bars are 95% confidence intervals (c.i.), and for q = 1 and q = 2 diversities, the units are the effective number of species (e.n.s.).

3.3. Beta Diversity: Species and Taxa

The taxonomic beta diversity (total dissimilarity) among the five sampling sites is high (βSOR = 71.4%) and is mainly due to species turnover (βSIM = 63.3%) with a low nestedness contribution (βNES = 8.1%). When comparing the species composition between consecutive sites in altitude along the gradient, it was found that among the first four sites of the altitude gradient (between 600 and 2000 m), the beta diversity is mainly due to the turnover of species, and the highest turnover occurs between 600 and 1000 m a.s.l. (Table 2). However, the highest total beta diversity occurred between sites four and five (from 2000 to 3000 m), mainly due to nestedness (Figure 5A). Thus, sample site five has a neuropteran fauna that is mostly a subset of the fauna found at site four; of the 16 species recorded at site five, only 4 were found exclusively at this elevation (*Ungla* sp.1, *Megalomus* sp.1, *Sympherobius* sp.1, and *Hemerobius alpestris* Banks, 1908), whereas the remaining 12 species were also found at site four.

Table 2. Total taxonomic and phylogenetic beta diversity (total dissimilarity [βsor]) as the sum of its components (turnover [βsim] and nestedness [βnes]) for the Neuropteran community along an elevational gradient of the Tacaná Volcano.

	Taxonomic Beta Diversity			Phylogenetic Beta Diversity		
Pair Sites	**βsim**	**+βnes=**	**βsor**	**βsim**	**+βnes**	**=βsor**
1 vs. 2	0.468	0.0217	0.489	0.333	0.007	0.34
1 vs. 3	0.659	0.0138	0.673	0.476	0.009	0.485
1 vs. 4	0.714	0.016	0.73	0.434	0.028	0.462
1 vs. 5	0.875	0.0615	0.936	0.5	0.211	0.711
2 vs. 3	0.372	0	0.372	0.255	0.004	0.259
2 vs. 4	0.476	0.0506	0.526	0.315	0.042	0.357
2 vs. 5	0.75	0.13	0.88	0.411	0.259	0.67
3 vs. 4	0.38	0.0599	0.44	0.289	0.047	0.336
3 vs. 5	0.5	0.261	0.761	0.323	0.296	0.619
4 vs. 5	0.25	0.336	0.582	0.117	0.336	0.453

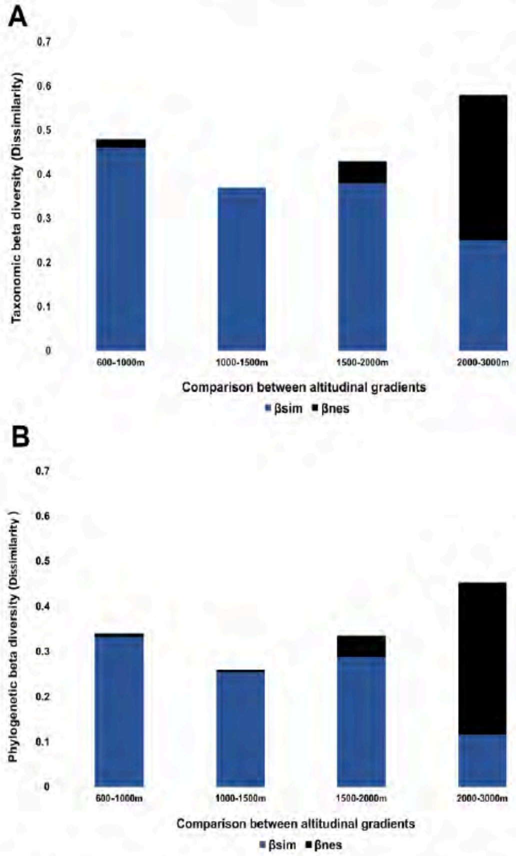


Figure 5. Taxonomic and phylogenetic beta diversity (Dissimilarity [βsor]) of the Neuroptera community of the Tacaná Volcano with the criterion of pairs of sites, with each of its components, turnover (βsim), and nestedness (βnes). (**A**) Taxonomic beta diversity across the altitude gradient of the Tacaná Volcano obtained using species incidence. (**B**) Phylogenetic beta diversity through the altitudinal gradient of the Tacaná Volcano using taxa incidence.

Phylogenetic beta diversity, which took into account the supra-specific taxonomic levels between the five sites of the altitudinal gradient (βSOR = 60.4%), was explained by a high turnover (βSIM = 49.8%) and a low nestedness (βNES = 10.6%). When evaluating the taxonomic dissimilarity between pairs of sites, a very similar trend was found for the beta diversity of species, although with lower values for including supra-specific taxa (Figure 5B).

4. Discussion

Neuroptera communities have been reported with low abundances compared to other insect orders [38,49]; however, a high number of individuals and species were reported in this study. The presence and representativeness of families such as Chrysopidae, Hemerobiidae, and Coniopterygidae is not a different trend from that previously recorded in other studies where they appear as the most abundant or richest families of Neuroptera [26,29,49,50].

Abundance presented the highest values at medium and high altitudes, possibly related to the restricted distribution of some families along the gradient. As Bozdogan [51] points out, the abundance of certain families increases with altitude and decreases for others. For example, Hemerobiidae has higher abundance values at high altitudes (with evident adaptations to extreme environmental conditions), whereas Chrysopidae has higher abundance values at low and medium elevations (with a preference for more tropical or warmer areas) [30,32]. In this work, a decrease in the abundance of Chrysopidae, Mantispidae, Myrmeleontidae, and Rhachiberothidae was observed with increasing altitude, in contrast to families such as Hemerobiidae and Coniopterygidae. Therefore, we believe that the abundance of species may be influenced by factors such as their biology, vegetation, climatic conditions, and anthropogenic activity. This agrees with what was observed in a study on the elevation diversity patterns of Chrysopidae, suggesting that temperature had a significant effect on the abundance of these green lacewings [31], reducing their abundance in areas with lower temperatures.

A particular dominant species was reported per site (*Semidalis soleri* (site 1), *Coniopteryx simplicior* (site 4), *Hemerobius discretus* (Site 5)), in some cases shared between nearby sites (*Semidalis problematica* (sites 2 and 3) (Figure 3). This has been observed in lacewing communities where the species are correlated to different habitats (mainly the dominant ones), characterizing the habitats by the occupancy of dominant species or exclusivity [21]. Also, Coniopterygidae seems to select their habitat depending on specific plant substrates, which are sometimes local and rare and sometimes extremely abundant [52]. Based on previous studies, the specificity of a plant substrate could explain the presence of dominant species at specific sites so that sites at different levels that shared dominant species also had the same type of vegetation. On the volcano, the dominant species belonged to the families Hemerobiidae and Coniopterygidae, which have been previously recorded in other studies as abundant [49,50].

4.1. Inventory Completeness

The lack of species to be recorded to complete the faunal inventory of the volcano is possibly influenced by the extension of the volcano (by only recording species present in the Mexican section), the high degree of specificity at certain altitudes, and the need for intense efforts for sampling. Several authors discuss the difficulties of sampling and that some require greater efforts both in the time needed and the methods used [49,53]. Due to the fact that the populations present relatively low abundances, the choice of methods also has a clear influence on the characteristics of the samples obtained [37,38].

4.2. Alpha Diversity: Species and Taxa

Studies on the diversity of the Neuroptera have focused on agroecosystems and differences between different types of habitats [50,54] but few have evaluated changes in species composition along an elevational gradient [17,31,51].

The values of the estimated diversities did not show significant differences, except for sites four and five (sites above 2000 m). The values of diversity q0 (species richness) and q1 (diversity of common and rare species) decreased with increasing altitude (Figure 4A,B). This was also observed in a study by Lai et al. [31] where the alpha diversity of Chrysopidae decreased with increasing elevation. In the cases of diversity q2 (diversity of dominant species), the number of dominant species was similar at the first four sites in contrast to site five, which had the lowest value (Figure 4C). Both the composition and characteristics of Neuropteran communities are often determined by prey species and abundance, microclimate, and plant structure [17,26,51]. These changes in the values of the diversities in the study sites could be due to the heterogeneity in the plant structures, where the lowest altitude site presented a disturbed plant physiognomy and patches of agroecosystems, whereas medium altitudes were characterized by the presence of cloud forests and coffee plantations. On the other hand, the highest altitudes above 3000 m, had extreme environmental conditions with a loss of vegetation cover and the presence of pine forests and oak patches.

This means that at high altitudes, the richness and diversity of Neuroptera are exclusive to those species that adapted to the extreme conditions. Therefore, the increase in elevation can affect the distribution of Neuroptera species [55]. Therefore, the dispersal capacity of the species and their local abiotic conditions, such as temperature, precipitation, and wind speed, among others, can behave as filters, which generates differences in the composition of species in different areas [56]. This pattern of higher richness at low and medium altitudes has been observed in other groups of insects such as aquatic invertebrates, ants, wasps, and bees, among others [5,8,57].

The values of the alpha diversity based on the degree of species relatedness were the highest at the sites between 600 and 1700 m (Figure 4D). This suggests that these areas had greater diversity in their taxonomic structure as a reflection of greater phylogenetic separation between the species that make up these communities. The high values of taxonomic variation show that most species are concentrated in a few supra-specific taxa [45,58]. Sites with ranges above 2000 m had lower values of taxonomic distinctness, showing low diversity and taxonomic difference, which indicated that the species of Neuroptera are better distributed in the different hierarchical levels present in these communities. Although there is no decrease in the diversity of higher taxa with increasing altitude, there is a decrease in diversity at high altitudes, as has been observed in other studies where phylogenetic diversity decreases with increasing elevation [59–61].

Both the number and abundance of each species and the variety of taxa present in the community seem to decrease at high altitudes, although the distribution of species is better represented than at sites at low or medium altitudes. This diversity of taxa in Neuroptera is represented at the family level where families such as Myrmeleontidae and Mantispidae diversify better at low or medium altitudes but their presence and diversification decrease as the altitude increases. On the other hand, families such as Hemerobiidae seem to increase their numbers and diversify with increasing elevation.

Finally, the changes in the variety of taxa between communities could be influenced by the adaptations and life histories of the different lineages that comprise them. As an example of this, the family Chrysopidae has greater diversity at low and medium altitudes but has little representation at altitudes above 3000 m; although together with Hemerobiidae, they are known for their great capacity for colonization and adaptation to new conditions [62]. In the case of Chrysopidae, some genera are frequently reported in agroecosystems, which, together with the native vegetation, provide high availability of food, niches to occupy, and adequate climatic conditions. On the other hand, Hemerobiidae species seem to diversify better at high elevations because their adaptations and life histories allow them to colonize habitats with more extreme conditions [63] and possibly avoid competition with Chrysopidae lineages. This showed possible distinct tendencies for the different families, although at a global level, the diversity tendencies are the same at the species and higher taxa levels.

4.3. Beta Diversity: Species and Taxa

At the regional level, the beta diversity (the change in species diversity from one site to another) showed a strong turnover pattern as the component that had the greatest contribution along the gradient. For Neuroptera, there is one study that uses this approach to investigate its influence on changes in species composition. On the other hand, in other groups of arthropods, these components have been evaluated where the turnover of species is presented as the most important component [2,8].

When we compared diversity between sites, almost all comparisons were explained by species turnover (Table 2), except for the two sites above 2000 m, which can be explained mainly by nestedness (Figure 5). Previously, this has been recorded in Chrysopidae in an altitudinal study, where nestedness replaced turnover as the main component of dissimilarity as the elevation increased (mainly in sites with low temperatures) [31]. Also, nestedness values at high altitudes have been reported in beetle communities in a mountainous system of Colombia, where high turnover values were reported at a general level but at sites above 2000 m, the beta diversity was better explained by nestedness [2]. This is probably because the conditions that exist at these altitudes function as environmental filters that do not allow the colonization of other species. In addition, in other studies, a latitudinal pattern has been recorded where above the 37th parallel, the beta diversity is due to a nestedness pattern, and to the south, the turnover is more important [64], which suggests that this tendency could be repeated for certain groups of insects in an altitudinal gradient.

The fact that the changes in the composition of Neuroptera in this study were mainly due to turnover leads us to hypothesize that this turnover is due to the selection of species in a certain environment or due to dispersal processes [65]. In addition, it is known that the structure, vegetation cover, and climatic conditions (such as temperature and wind speed) are important factors for the presence of certain species [17,21,23,66]. The first sites in this study (high turnover values) also have large extensions of conserved forests and patches of agroecosystems that could be functioning as a means of safeguarding biodiversity. This could allow them to have more specific niches for their diversification and generate the stratification of species along the altitudinal gradient.

The dissimilarity of Neuroptera on the volcano between the different sites was high as previously reported, with high dissimilarities between sites within a wide distance or with different environmental characteristics [30,51]. Moreover, in other cases where the sites presented the same environmental or vegetation conditions and were close to each other, they had a low dissimilarity [50,67].

The difference in taxa compositions between communities was better explained by the turnover of supra-specific taxa since particular genera were substituted at the sites. Furthermore, nestedness seems to have a strong effect at sites above 2000 m. Both total and turnover dissimilarity values were low compared to species-level values due to the low supra-generic diversity compared to the high number of species present on the volcano. Therefore, it seems that the differences in the taxonomic structures between communities in the altitudinal gradient are more diversified at altitudes below 1800 m, whereas above this range, the diversification begins to decrease.

Finally, the variety of taxa of the Neuroptera community along the Tacaná Volcano shows a strong pattern of species turnover. This means that there is a strong transition between the lowland communities and the forest in the upper area of the volcano that generates an evident altitudinal replacement of species and a clear exclusivity for certain altitudes.

5. Conclusions

Neuroptera species presented an evident restriction to particular sites, with few families distributed throughout the altitudinal gradient (Chrysopidae, Coniopterygidae, and Hemerobiidae). Generally, these insects presented low abundance on the volcano. The highest abundance peaks were observed at medium and high altitudes. The particular dominant species for each site are possibly associated with the environmental conditions and vegetation types. The need to increase the sampling effort at the local level was also observed, mainly focused on groups less represented in the study and with specific requirements at the time of collection. The highest estimated species richness value was recorded at low altitudes, decreasing with increasing elevation. The values of diversities q1 and q2 have similar trends, showing a decrease with increasing altitude, with the highest value at the site above 1000 m; the lower diversity value at low altitudes (>1000 m) is possibly due to the anthropogenic effect. The alpha diversity based on the degree of species relatedness showed that the diversity in the taxonomic structure seems to remain constant at low and medium altitudes, with a drastic decrease in altitude ranges above 3000 m. The high altitudes had better species distribution in the different hierarchical levels. Total species dissimilarity values at the local and regional levels show strong species turnover along the altitudinal gradient, except for sites above 2000 m, which were better explained by nestedness. The most evident turnover was between high and low altitudes. The difference in the taxa composition between communities recorded a global value of 71%. On the other hand, the beta taxonomic distinctness recorded a similar trend to that calculated for species but with much lower turnover values for the supra-specific taxa both regionally and between sites. These results support the influence of changes in elevation on the diversity and composition of Neuroptera species, which may be influenced by mechanisms such as environmental factors or species dispersal limitations (reflected by high turnover rates).

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/insects13070652/s1, Table S1: Characteristics of the sampling sites along the altitudinal gradient of the Tacaná Volcano, Chiapas, Mexico.

Author Contributions: Conceptualization, R.J.C.-L. and A.C.-R.; methodology, R.J.C.-L. and C.E.M.; formal analysis, R.J.C.-L.; writing—original draft preparation, R.J.C.-L.; writing—review and editing, C.E.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: The present research is funded by "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-32 693).

Institutional Review Board Statement: Specimens were collected under the 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).

Data Availability Statement: Not applicable.

Acknowledgments: Our appreciation goes to 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. R.J.C.-L. would like to thank Lionel Stange (†), Julieta Brambila, Felipe Soto (FSCA), and Torsten Dikow (USNM) for their support and provision of identification materials during his stays. 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 sites. Caleb Martins, Adrian Ardila-Camacho, and Yesenia Marquez provided support during the identification of the specimens studied. Cristina Mayorga provided material and support in the handling of the specimens. We are very much indebted to Benigno Gómez (ECOSUR-San Cristóbal); the Reserva de la Biósfera Volcán Tacaná (Francisco J. Jiménez González, director); and the people from Finca Alianza, Ejido El Águila, Ejido Benito Juárez El Plan, and Cantón Chiquihuites, and from Los Paradores Papales and La Cabaña for the authorization for the fieldwork and their hospitality. RJC-L thanks Consejo Nacional de Ciencia y Tecnología-Mexico for a doctoral scholarship and Posgrado en Ciencias Biológicas-UNAM, sede Instituto de Biología, for general support through his doctoral program.

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

References

1. De Mendoza, G.; Traunspurger, W.; Palomo, A.; Catalan, J. Nematode distributions as spatial null models for macroinvertebrate species richness across environmental gradients: A case from mountain lakes. *Ecol. Evol.* **2017**, *7*, 3016–3028. [CrossRef] [PubMed]
2. Noriega, J.A.; Realpe, E. Altitudinal turnover of species in a Neotropical peripheral mountain system: A case study with dung beetles (Coleoptera: Aphodiinae and Scarabaeinae). *Environ. Entomol.* **2018**, *47*, 1376–1387. [CrossRef] [PubMed]
3. Escobar, F.; Lobo, J.M.; Halffter, G. Altitudinal variation of dung beetle (Scarabaeidae: Scarabaeinae) assemblages in the Colombian Andes. *Glob. Ecol. Biogeogr.* **2005**, *14*, 327–337. [CrossRef]
4. Girardin, C.A.J.; Farfan-Rios, W.; Garcia, K.; Feeley, K.J.; Jørgensen, P.M.; Araujo Murakami, A.; Cayola Pérez, L.; Seidel, R.; Paniagua, N.; Fuentes Claros, A.F.; et al. Spatial patterns of above-ground structure, biomass and composition in a network of six Andean elevation transects. *Plant. Ecol. Divers.* **2014**, *7*, 161–171. [CrossRef]
5. Castro, D.M.P.; Callisto, M.; Solar, R.R.C.; Macedo, D.R.; Fernandes, G.W. Beta diversity of aquatic invertebrates increases along an altitudinal gradient in a Neotropical mountain. *Biotropica* **2019**, *5*, 399–411. [CrossRef]
6. Willig, M.R.; Presley, S.J. The spatial configuration of taxonomic biodiversity along a tropical elevational gradient: α-, β-, and γ-partitions. *Biotropica* **2019**, *51*, 104–116. [CrossRef]
7. Guerrero, R.J.; Sarmiento, C.E. Distribución altitudinal de hormigas (Hymenoptera, Formicidae) en la vertiente Noroccidental de la sierra nevada de santa Marta (Colombia). *Acta Zool. Mex.* **2010**, *26*, 279–302. [CrossRef]
8. Perillo, L.N.; Neves, F.d.S.; Antonini, Y.; Martins, R.P. Compositional changes in bee and wasp communities along Neotropical mountain altitudinal gradient. *PLoS ONE* **2017**, *12*, e0182054. [CrossRef]
9. Stevens, G.C. The elevational gradient in altitudinal range: An extension of Rapoport's latitudinal rule to altitude. *Amer. Nat.* **1992**, *140*, 893–911. [CrossRef]
10. Colwell, R.K.; Rahbek, C.; Gotelli, N.J. The mid-domain effect and species richness patterns: What have we learned so far? *Am. Nat.* **2004**, *163*, E1–E23. [CrossRef]
11. Fontana, V.; Guariento, E.; Hilpold, A.; Niedrist, G.; Steinwandter, M.; Spitale, D.; Nascimbene, J.; Tappeiner, U.; Seeber, J. Species richness and beta diversity patterns of multiple taxa along an elevational gradient in pastured grasslands in the European Alps. *Sci. Rep.* **2020**, *10*, 12516. [CrossRef] [PubMed]
12. Wang, J.; Soininen, J.; Zhang, Y.; Wang, B.; Yang, X.; Shen, J. Patterns of elevational beta diversity in micro and macroorganisms. *Glob. Ecol. Biogeogr.* **2012**, *21*, 743–750. [CrossRef]
13. Tello, J.S.; Myers, J.A.; Macía, M.J.; Fuentes, A.F.; Cayola, L.; Arellano, G.; Loza, M.I.; Torrez, V.; Cornejo, M.; Miranda, T.B.; et al. Elevational gradients in β-diversity reflect variation in the strength of local community assembly mechanisms across spatial scales. *PLoS ONE* **2015**, *10*, e0121458. [CrossRef] [PubMed]
14. Baselga, A. Partitioning the turnover and nestedness components of beta diversity. *Glob. Ecol. Biogeogr.* **2010**, *19*, 134–143. [CrossRef]
15. Pérez-Toledo, G.R.; Valenzuela-González, J.E.; Moreno, C.E.; Villalobos, F.; Silva, R.R. Patterns and drivers of leaf-litter ant diversity along a tropical elevational gradient in Mexico. *J. Biogeogr.* **2021**, *48*, 2512–2523. [CrossRef]
16. Stelzl, M.; Devetak, D. Neuroptera in agricultural ecosystems. *Agric. Ecosyst. Environ.* **1999**, *74*, 305–321. [CrossRef]
17. Bozdogan, H. Species richness and composition of Neuroptera in the forests fragments of the Taurus Mountains Range, Turkey. *Saudi J. Biol. Sci.* **2020**, *27*, 1201–1207. [CrossRef]
18. Oswald, J.D.; Machado, R.J.P. Biodiversity of the Neuropterida (Insecta: Neuroptera: Megaloptera, and Raphidioptera). In *Insect Biodiversity: Science and Society*, 1st ed.; Foottit, R.G., Adler, P.H., Eds.; John Wiley and Sons: New York, NY, USA, 2018; Volume 2, pp. 627–671.
19. Winterton, S.L.; Hardy, N.B.; Wiegmann, B.M. On wings of lace: Phylogeny and bayesian divergence time stimates of Neuropterida (Insecta) based on morphological and molecular data. *Syst. Entomol.* **2010**, *35*, 349–378. [CrossRef]
20. Thierry, D.; Deutsch, B.; Paulian, M.; Villenave, J.; Canard, M. Typifying ecosystems by using green lacewing assemblages. *Agron. Sustain. Dev.* **2005**, *25*, 473–479. [CrossRef]
21. Thierry, D.; Canard, M. The biodiversity of green lacewings (Neuroptera Chrysopidae) in a mosaic ecosystem in southern France. In Proceedings of the Ninth International Symposium on Neuropterology, Ferrara, Italy, 20–23 June 2005; Volume 8, pp. 131–138.
22. Monserrat, V.J. Los berótidos de la Península Ibérica (Insecta: Neuropterida: Neuroptera: Berothidae). *Heteropterus Rev. Entomol.* **2014**, *14*, 31–54.
23. Chen, Z.Z.; Liu, L.Y.; Liu, S.Y.; Cheng, L.Y.; Wang, X.H.; Xu, Y.Y. Response of *Chrysoperla nipponensis* (Okamoto) (Neuroptera: Chrysopidae) under long and short photoperiods. *J. Insect Sci.* **2017**, *17*, 1–9. [CrossRef] [PubMed]
24. Gruppe, A.; Sobek, S. Effect of tree species diversity on the neuropterid community in a deciduous forest. *Acta Entomol. Slov.* **2011**, *19*, 17–28.
25. Badano, D.; Makris, C.; John, E.; Hadjiconstantis, M.; Sparrow, D.; Sparrow, R.; Thomas, B.; Devetak, D. The antlions of Cyprus: Review and new reports (Neuroptera: Myrmeleontidae). *Frag. Entomol.* **2018**, *50*, 95–102. [CrossRef]
26. Duelli, P.; Obrist, M.K.; Fluckiger, P.F. Forest edges are biodiversity hotspots–also for Neuroptera. *Acta Zool. Acad. Sci. Hung.* **2002**, *48*, 75–87.
27. Monserrat, V.J. Los hemeróbidos de la Península Ibérica y Baleares (Insecta, Neuropterida, Neuroptera: Hemerobiidae). *Graellsia* **2015**, *71*, 1–71. [CrossRef]

28. Agustinur, S.; Lizmah, F.; Sarong, M. Diversity of Insect Pest in Monoculture and Polyculture Nutmeg (Myristica fragrans Houtt.) Plantation in South Aceh District. *Environ. Earth Sci.* **2020**, *515*, 012006. [CrossRef]
29. Bozdogan, H.; Toroglu, E. Lacewing (Insecta: Neuroptera) fauna of Başkonuş Mountain National Park (Kahramanmaraş Province-Turkey). *BAUN Fen. Bil. Enst. Dergisi.* **2016**, *18*, 89–103.
30. New, T.R. Neuroptera of Australia: Faunal elements, diversity and relationships. *Dtsch. Entomol. Z.* **1997**, *44*, 259–265. [CrossRef]
31. Lai, Y.; Liu, Y.; Liu, X. Elevational diversity patterns of green lacewings (Neuroptera: Chrysopidae) uncovered with DNA barcoding in a biodiversity hotspot of Southwest China. *Front. Ecol. Evol.* **2021**, *9*, 778686. [CrossRef]
32. Bhattacharya, D.K.; Dey, S.R. Biodiversity of Neuroptera associated with aphids of Western Himalaya. *Entomon* **2001**, *26*, 320–325.
33. CONANP. *Programa de Manejo Reserva de la Biosfera Volcán Tacaná*, 1st ed.; SEMARNAT: Mexico City, Mexico, 2013; p. 204.
34. Lugo Hubp, J.; Córdova, C. Regionalización geomorfológica de la república mexicana. *Investig. Geogr.* **1992**, *25*, 25–63. [CrossRef]
35. Morrone, J.J. Biogeographical regionalization of the Neotropical region. *Zootaxa* **2014**, *3782*, 1–110. [CrossRef] [PubMed]
36. García, E. *Modificaciones al Sistema de Clasificación Climática de Köppen*; Instituto de Geografía Unam: Mexico City, Mexico, 2008; pp. 1–71.
37. Vas, J.; Ábrahám, L.; Markó, V. Methodological investigations on a Neuropteroidea community. *Acta Phytopathol. Entomol. Hung.* **2001**, *36*, 101–113. [CrossRef]
38. Ábrahám, L.; Markó, V.; Vas, J. Investigations on a neuropteroid community by using different methods. *Acta Phytopathol. Entomol. Hung.* **2003**, *38*, 199–207. [CrossRef]
39. Cancino-López, R.J.; Martins, C.C.; Contreras-Ramos, A. Neuroptera Diversity from Tacaná Volcano, Mexico: Species Composition, Altitudinal and Biogeographic Pattern of the Fauna. *Diversity* **2021**, *13*, 537. [CrossRef]
40. Chao, A.; Jost, L. Coverage-based rarefaction and extrapolation: Standardizing samples by completeness rather than size. *Ecology* **2012**, *93*, 2533–2547. [CrossRef]
41. Hsieh, T.C.; Ma, K.H.; Chao, A. iNEXT Online: Interpolationand Extrapolation (Version 1.2.0). 2013. Available online: http://chao.stat.nthu.edu.tw/inext/ (accessed on 28 April 2021).
42. Jost, L. Entropy and diversity. *Oikos* **2006**, *113*, 363–375. [CrossRef]
43. Chao, A.; Gotelli, N.J.; Hsieh, T.C.; Sander, E.L.; Ma, K.H.; Colwell, R.K.; Ellison, A.M. Rarefaction and extrapolation with Hill numbers: A framework for sampling and estimation in species diversity studies. *Ecol. Monogr.* **2014**, *84*, 45–67. [CrossRef]
44. Cultid-Medina, C.; Escobar, F. Pautas para la estimación y comparación estadística de la diversidad biológica (qD). In *La Biodiversidad en un Mundo Cambiante: Fundamentos Teóricos y Metodológicos Para su Estudio*; Moreno, C.E., Ed.; Universidad Autónoma del Estado de Hidalgo/Libermex: Mexico City, Mexico, 2019; pp. 175–202.
45. Clarke, K.R.; Warwick, R.M. A further biodiversity index applicable to species lists: Variation in taxonomic distinctness. *Mar. Ecol. Prog. Ser.* **2001**, *216*, 265–278. [CrossRef]
46. Clarke, K.R.; Gorley, R.N. *PRIMER: User Manual/Tutorial (Plymouth Routines in Multivariate Ecological Research)*; Version 6; PRIMER-E Ltd.: Plymouth, UK, 2006.
47. Bacaro, G.; Ricotta, C.; Mazzoleni, S. Measuring beta-diversity from taxonomic similarity. *J. Veg. Sci.* **2007**, *18*, 793–798. [CrossRef]
48. Baselga, A.; Orme, L.A. Betapart: An R package for the study beta diversity. *Methods Ecol. Evol.* **2012**, *3*, 808–812. [CrossRef]
49. Sarmiento-Cordero, M.A.; Rodríguez-Vélez, B.; Huerta-Martínez, F.M.; Uribe-Mú, C.A.; Contreras-Ramos, A. Community structure of Neuroptera (Insecta) in a Mexican lime orchard in Colima, Mexico. *Rev. Mex. Biodivers.* **2021**, *92*, e923399. [CrossRef]
50. Marquez-López, Y.; Herrera Fuentes, M.D.C.; Contreras-Ramos, A. Alpha and beta diversity of dustwings and brown lacewings (Neuroptera: Coniopterygidae, Hemerobiidae) in a temperate forest of Tlaxcala, Mexico. *Proc. Entomol. Soc. Wash.* **2020**, *122*, 869–889. [CrossRef]
51. Bozdogan, H. Diversity of lacewing assemblages (Neuropterida: Neuroptera) in different forest habitats and agricultural areas in the East Mediterranean area of Turkey. *Entomol. Res.* **2020**, *50*, 163–173. [CrossRef]
52. Monserrat, V.J. Los coniopterígidos de la Península Ibérica e Islas Baleares (Insecta, Neuropterida, Neuroptera: Coniopterigydae). *Graellsia* **2016**, *72*, 1–115. [CrossRef]
53. Martins, C.C.; Santos, R.S.; Sutil, W.P.; de Oliveira, J.F.A. Diversity and abundance of green lacewings (Neuroptera: Chrysopidae) in a Conilon coffee plantation in Acre, Brazil. *Acta Amaz.* **2019**, *49*, 173–178. [CrossRef]
54. De Melo, M.A.; Araujo, M.L.N.M.; Martins, C.C. Entomofauna de Hemerobiidae (Neuroptera) em sistema de cultivo orgânico e convencional de frutíferas no município de Avaré, SP, Brasil. *Rev. Biol. Neotrop.* **2020**, *17*, 121–129. [CrossRef]
55. Kovanci, B.; Canbulat, S.; Kovanci, B. The brown lacewings (Neuroptera, Hemerobiidae) of northwestern Turkey with new records, their spatio-temporal distribution and harbouring plants. *Rev. Bras. Entomol.* **2014**, *58*, 147–156. [CrossRef]
56. da Luz, G.R.; da Mota, G.S.; Spadeto, C.; Tolentino, G.S.; Fernandes, G.W.; Nunes, Y.R.F. Regenerative potential of the soil seed bank along an elevation gradient of rupestrian grassland in southeastern Brazil. *Botany* **2018**, *96*, 281–298. [CrossRef]
57. Castro-Delgado, S.; Vergara-Cobian, C.; Arellano-Ugarte, C. Distribucíon de la riqueza, composición taxonómica y grupo funcionales de hormigas del suelo a lo largo de un gradiente altitudinal en el refugio de vida silvestre Laquipampa, Lambayeque-Perú. *Ecol. Apl.* **2008**, *7*, 89–103. [CrossRef]
58. Pérez-Hernández, C.X. Distintividad taxonómica: Evaluación de la diversidad en la estructura taxonómica en los ensambles. In *La Biodiversidad en un Mundo Cambiante: Fundamentos Teóricos y Metodológicos para su Estudio*; Moreno, C.E., Ed.; Universidad Autónoma del Estado de Hidalgo/Libermex: Mexico City, Mexico, 2019; pp. 285–306.

59. Leingärtner, A.; Krauss, J.; Steffan-Dewenter, I. Species richness and trait composition of butterfly assemblages change along an altitudinal gradient. *Oecologia* **2014**, *175*, 613–623. [CrossRef] [PubMed]
60. Chun, J.H.; Lee, C.B. Diversity patterns and phylogenetic structure of vascular plants along elevational gradients in a mountain ecosystem, South Korea. *J. Mt. Sci.* **2018**, *15*, 280–295. [CrossRef]
61. Worthy, S.J.; Jiménez Paz, R.A.; Pérez, A.J.; Reynolds, A.; Cruse-Sanders, J.; Valencia, R.; Barone, J.A.; Burgess, K.S. Distribution and community assembly of trees along an andean elevational gradient. *Plants* **2019**, *8*, 326. [CrossRef] [PubMed]
62. McEwen, P.K.; New, T.R.; Whittington, A.E. *Lacewings in the Crop Environment*; Cambridge University Press: Cambridge, MA, USA, 2001; 564p.
63. Podlesnik, J.; Jakšić, P.; Nahirnić, A.; Janžekovič, F.; Klenovšek, T.; Klokočovnik, V.; Devetak, D. Fauna of the brown lacewings of Serbia (Insecta: Neuroptera: Hemerobiidae). *Acta Entomol. Slov.* **2019**, *27*, 17–29.
64. Baselga, A.; Gómez-Rodríguez, C.; Lobo, J.M. Historical legacies in world amphibian diversity revealed by the turnover and nestedness components of beta diversity. *PLoS ONE* **2012**, *7*, e32341. [CrossRef]
65. Baselga, A. The relationship between species replacement, dissimilarity derived from nestedness, and nestedness. *Glob. Ecol. Biogeogr.* **2012**, *21*, 1223–1232. [CrossRef]
66. Bakoidi, A.; Dobo, F.; Djibo, I.; Maoge, J.; Bozdogan, H.; Tinkeu Ngamo, L.S. Diversity and distribution of antlions (Neuroptera: Myrmeleontidae) in the Northern region of Cameroon (Afrotropical region). *J. Biodivers. Environ. Sci.* **2020**, *16*, 61–71.
67. Czechowska, W. Raphidioptera and Neuroptera (Neuropterida) of the canopy in montane, upland and lowland fir forests of Abies alba Mill. in Poland. *Fragm. Faun.* **2002**, *45*, 31–56. [CrossRef]

8.- DISCUSIÓN GENERAL

Este estudio aporta al conocimiento de los patrones de distribución y diversidad del orden Neuroptera a través de un gradiente altitudinal, siendo el primer estudio en su tipo para México y para la región Neotropical. Este trabajo aborda tres ejes principales: el primero enfocado en conocer los antecedentes y estudios previos sobre el análisis de la diversidad de los neurópteros a nivel mundial, para entender que enfoques se han implementado y que posibles factores la afectan. El segundo, dirigido a evaluar la composición de especies del Volcán Tacaná y sus patrones de distribución altitudinal y afinidades biogeográficas a lo largo del gradiente de altitud. Finalmente, se analizó los posibles patrones de diversidad alfa y beta de los neurópteros en el gradiente altitudinal utilizando un enfoque taxonómico y filogenético.

En el primer capítulo se concluye que los patrones de diversidad de orden Neuroptera aún son poco contundentes, debido a la falta de estudios con este grupo. Se recalca la importancia de los estudios previos (faunísticos, taxonómicos y sistemáticos) para el entendimiento de las faunas de las distintas regiones, que sirven como base principal para futuras evaluaciones más precisas sobre patrones de distribución y diversidad de las especies. También se enfatiza en la importancia de un adecuado diseño experimental y de muestreo, mencionando como puntos principales el conocimiento de la biología y características de las familias a estudiar, la adecuada selección de métodos de muestreo, el conocimiento previo de la distribución de los taxones a estudiar (tanto espacial como temporal) y un estricto e intenso muestreo sistemático y estandarizado, para realizar posteriormente los análisis estadísticos más adecuados al objetivo de la investigación. Se alza el uso de nuevos enfoques en el análisis de la diversidad, para que puedan ser comparativos con otros estudios, así como evaluar a la diversidad tomando en cuenta diferentes niveles como enfoques (taxonómico, filogenético y funcional). También con base en un censo de los diferentes estudios se considera que entre los factores potenciales que influyen en la diversidad y composición de las especies se encuentra la estructura y fisionomía vegetal, el tipo específico de vegetación y la disponibilidad de recursos alimenticios. Así como factores geográficos y/o ambientales que pueden estar funcionando como filtros que reduzcan o permitan la distribución y diversificación de los neurópteros.

El capítulo dos se centra evaluar la composición de las comunidades de neurópteros y patrones de distribución de estos en el gradiente altitudinal del Volcán Tacaná y sus posibles afinidades biogeográficas. Este estudio corroboró la amplia distribución altitudinal del orden Neuroptera (Penny, 2002; Monserrat, 2015; 2016), registrándolos desde los 650 m hasta los 3500 m. Con los mayores picos de riqueza en las altitudes bajas y medias y con una evidente disminución en altitudes superiores a los 3000 m. También se observó que algunas especies, principalmente de las familias Chrysopidae, Hemerobiidae y Coniopterygidae presentaron rangos altitudinales restringidos a ciertos sitios (principalmente por debajo de los 1000 m). También se recalca la importancia de la zona de estudio, como una región con alto potencial de endemismo y diversidad, al reportar un alto número de nuevos registros y posibles especies nuevas para la ciencia. Esto soportado por un estudio previo de Martínez-Camilo *et al*. (2019) que señalan que el Volcán Tacaná al formar parte de una región terrestre prioritaria (Tacaná-Boquerón), presenta un alto número de endemismos respecto a su composición florística, lo que le confiere una alta biodiversidad. Respecto a la composición y distribución de los neurópteros y sus afinidades biogeográficas, la mayor similitud y afinidad de la fauna se reporta en niveles por debajo de los 1200 m. Estos niveles presentaron un mayor número de especies de afinidad neotropical y distribución cosmopolita y se observó que conforme aumentaba la altitud, la composición de las especies fue cambiando con la inclusión de taxas de afinidad neártica. Esto se ajusta a Halffter *et al*. (2009), que indica que las montañas de la zona de transición mexicana presentan una fauna con fuerte afinidad neártica en sus grandes altitudes, mientras que la fauna que está relacionada con la región neotropical se encuentra en las tierras bajas y llanuras. En general, la fauna del Volcán Tacana presentó una fuerte afinidad con los dominios del Pacífico y Mesoamericano, respaldando una evidente relación con la fauna del Centro y Sudamérica. Lo cual previamente fue mencionado por Miranda (1942) respecto a las fuertes afinidades florísticas de la región con Centro y Sudamérica. Y concuerda con Halffter *et al*. (2008), quienes mencionan que los linajes con distribución moderna presentan un patrón neotropical típico, que se integro luego de la consolidación del puente panameño, con especies cercanas a las del norte de Sudamérica y ahora distribuidas en las tierras bajas tropicales de México. Y algunas especies presentan el patrón montañoso mesoamericano, compuesto por taxones que evolucionaron en el Núcleo Centroamericano, presentando a menudo expansiones hacia el norte, y cuya afinidad más importante es la antigua Sudamérica. Todo esto permite que el Volcán Tacaná sea probablemente el límite de distribución más al norte de muchas de las especies de bosque de montaña de Centro y Sudamérica (Martínez-Camilo *et al*., 2019). Finalmente, se concluye que las afinidades biogeográficas de Neuroptera pueden cambiar notoriamente, incluso entre sitios de la misma subregión. Probablemente, la fauna de Neuroptera sea diferente en las porciones sur de la Zona de Transición Mexicana, debido a una disminución en el número de especies y linajes de origen norteño, y al efecto del Istmo de Tehuantepec, que funciona como barrera, como lo mencionó Halffter (1987). Esta tendencia no es nueva en la región, para estudios florísticos se ha considerado al Istmo de Tehuantepec como una importante barrera biogeográfica que ha interrumpido el flujo de elementos florísticos del norte hacia Chiapas y Centroamérica y viceversa (Graham, 2010).

El capítulo tres centrado en los patrones de diversidad alfa y beta en un gradiente altitudinal de las comunidades de Neuroptera, registró varios especímenes y especies con elevada abundancia y elevado número de individuos, como en el caso de Chrysopidae, Hemerobiidae y Coniopterygidae; lo cual no es una tendencia diferente a la registrada previamente en otros estudios, donde se recuperaron como los taxones más abundantes o ricas (Bozdogan y Toroglu, 2016; Marquez-López *et al*., 2020). Estas comunidades cambiaron en composición, riqueza y abundancia en cada uno de los sitios, aunque familias como Chrysopidae, Coniopterygidae y Hemerobiidae registraron especies con alta frecuencia a lo largo del gradiente altitudinal. En este estudio, la riqueza tuvo valores más altos en altitudes medias y disminuyó con la elevación, mientras que la abundancia mostró los picos más altos en elevaciones medias y altas, con un aparente aumento con la elevación. Las diferentes tendencias en riqueza y abundancia pueden explicarse por el fuerte cambio en la composición de la fauna a lo largo del gradiente, con algunas familias restringidas a diferentes altitudes. Los valores de diversidad q^0 y q^1 disminuyeron con el aumento de la altitud. Esto también se observó en un estudio previo de Lai *et al*. (2021), donde la diversidad alfa de Chrysopidae disminuyó con el aumento de la elevación. En el caso de diversidad q2, el número de especies dominantes fue similar en los primeros cuatro sitios, en contraste con el sitio cinco, que tuvo el valor más bajo. Tanto la composición como las características de las comunidades de neurópteros a menudo están determinadas por las especies de sus presas y su abundancia, el microclima y la estructura de la vegetación (Czechowska, 1985; Duelli *et al*., 2002; Bozdogan, 2020a; 2020b). Esto se observó en el volcán, donde el sitio de baja altitud presentó una fisonomía vegetal con signos de perturbación, y con parches de agroecosistemas, mientras que altitudes medias se caracterizaron por la presencia de bosque mesofilo de montaña y cafetales. Por otro lado, las altitudes por encima de los 3000 m presentaron condiciones ambientales extremas, con pérdida de cobertura vegetal y presencia de bosque de pino y encino. En las altitudes elevadas la riqueza y diversificación de los neurópteros fue exclusiva de aquellas especies adaptadas a las condiciones extremas presentes en dichas alturas. Lo que nos lleva a pensar que la capacidad de dispersión de las especies y sus condiciones abióticas locales pueden comportarse como filtros, lo que genera diferencias en la composición de especies entre áreas (da Luz *et al*., 2018.). Con respecto al enfoque utilizado para el análisis de la diversidad filogenética, los valores de distintividad taxonómica alfa mostraron que los sitios entre 600 y 1700 m presentaron los valores más altos, lo que mostró que estas áreas presentaban mayor diversidad en su estructura taxonómica, como reflejo de una mayor separación filogenética entre las especies que conforman estas comunidades. Además, fueron los sitios con altos valores de variación taxonómica, ya que la mayoría de las especies se concentran en unos pocos taxones supra-específicos (Clarke y Warwick, 2001; Moreno *et al*., 2009; Pérez Hernández, 2019). Los sitios con rangos superiores a 2000 m presentaron valores más bajos de distintividad taxonómica, mostrando baja diversidad y variación taxonómica, lo que indica que las especies de Neuroptera están mejor distribuidas en los diferentes niveles jerárquicos presentes en estas comunidades. Esta disminución en la diversidad de taxones superiores con la altitud también se ha observado en otros estudios (Leingärtner *et al*., 2014; Chun y Lee, 2018; Worthy *et al*., 2019). Esta diversificación en la estructura taxonómica en Neuroptera se representa de mejor manera a nivel de familia, donde familias como Myrmeleontidae y Mantispidae se diversifican mejor a altitudes bajas o medias, pero su presencia y diversificación disminuye a medida que aumenta la altitud. Por otro lado, familias como Hemerobiidae parecen aumentar su número y diversificarse a medida que aumenta la elevación. Finalmente, los cambios en la estructura taxonómica entre comunidades podrían estar influenciados por las adaptaciones e historias de vida de los diferentes linajes que las componen. Como ejemplo de ello, la familia Chrysopidae con mayor diversidad en altitudes bajas y medias, pero con poca representación en altitudes superiores a los 3000 m; aunque junto con Hemerobiidae, son conocidas por su gran capacidad de colonización y adaptación a nuevas condiciones (McEwen *et al*., 2001). En el caso de Chrysopidae, algunos géneros son reportados con frecuencia en los agroecosistemas, los cuales, junto con la vegetación nativa, brindan alta disponibilidad de alimento, nichos para ocupar y condiciones climáticas adecuadas. Por otro lado, las especies de Hemerobiidae parecen diversificarse mejor a grandes alturas porque sus adaptaciones e historias de vida les permiten colonizar hábitats con condiciones más extremas (Podlesnik *et al*., 2019) y posiblemente evitar la competencia con los linajes de Chrysopidae. A nivel regional, la diversidad beta mostró un patrón de recambio fuerte como el componente que tuvo la mayor contribución a lo largo del gradiente, tal como se ha reportado en otros grupos de artrópodos (González-Montaña *et al*., 2017; Perillo *et al*., 2017; Noriega y Realpe, 2018; Amell-Caez *et al*., 2019). En consecuencia, podemos hipotetizar que este recambio se debe a la selección de la especie a algún ambiente o debido a procesos de dispersión (Baselga, 2012). Además, se sabe que la cobertura vegetal y las condiciones climáticas (como la temperatura y la velocidad del viento) son factores esenciales para la presencia de ciertas especies (Chen *et al*., 2017; Bozdogan, 2020b). Los valores de distintividad beta-taxonómica se explicó por recambio de taxones, debido a que algunos géneros y familias fueron sustituidos o perdidos a lo largo del gradiente altitudinal. A nivel de familia, se observó una perdida de linajes (Mantispidae, Myrmeleontidae y Rhachiberothidae) conforme incremento la altitud; en general estas familias parecen tener mayor presencia en ambientes tropicales y cálidos, y con menor frecuencia o ausencia en climas fríos y zonas de alta montaña (Ardila-Camacho *et al*., 2019; Monserrat y Acevedo, 2013), con algunas excepciones. (Monserrat, 2014). Esto puede ser explicado por las adaptaciones que tienen ante las condiciones ambientales como son la temperatura, velocidad del viento, humedad o incluso tipo de sustrato, que cambian a lo largo del gradiente, así como requerimientos alimenticios (presas y plantas hospederas) que pueden influir en la distribución de estas familias. Respecto a los géneros presentes, las perdidas y substituciones parecen explicarse debido a una especificidad de los géneros a ciertos rangos altitudinales, lo que refleja que los requerimientos ambientales juegan un papel importante en la distribución de los géneros en el gradiente, cambiando la composición de los géneros con base en las adaptaciones que estos linajes presentan y posiblemente a las afinidades biogeográficas que estos puedan tener. Asimismo, el anidamiento parece tener un fuerte efecto en sitios por encima de los 2000 m. Lo cual refleja que las comunidades por arriba de estas altitudes son un subconjunto de los linajes previamente reportados en altitudes bajas y medias. Tanto la disimilitud total como los valores de recambio fueron bajos en comparación con los valores a nivel de especie. Esto se debe a la baja diversidad supra-genérica en comparación con el alto número de especies del volcán. Por lo tanto, parece que las diferencias en la estructura taxonómica entre las comunidades en el gradiente de elevación están más diversificadas en altitudes por debajo de los 1800 m, mientras que por encima de este rango la diversificación comienza a disminuir. Finalmente, el fuerte patrón de recambio de las especies en el Volcán Tacaná representa una fuerte transición entre las comunidades de las tierras bajas y el bosque de la parte alta que genera un claro recambio altitudinal de especies y una aparente exclusividad en determinadas altitudes.

Toda esta investigación y conocimiento obtenido no solo repercute en el campo del control biológico de plagas, sino también como potenciales indicadores de la calidad del ambiente y conservación, debido a su alta afinidad con los hábitats. Finalmente, Neuroptera es un grupo con alto potencial como modelo para poder realizar estudios enfocados en los patrones de distribución y diversidad de las especies, debido a su alta sensibilidad a los cambios en el ecosistema y su especialización en ciertos tipos de hábitats. Para lo cual se requiere efectuar más estudios con este grupo tanto taxonómicos como de diversidad para comenzar a establecer posibles patrones o tendencias que generarían más preguntas enfocadas en entender los cambios en la composición de las especies y los factores que pueden afectarla. Por lo que sería importante llevar a cabo estudios enfocados en los aspectos ecológicos y biogeográficos que explicarían estas tendencias.

9.- CONCLUSIONES GENERALES

- Los estudios enfocados en los cambios de las comunidades de neurópteros a traves de la elevación, junto a los factores ambientales pueden ayudar a explicar posibles filtros ambientales que inciden en la diversidad o distribución de las especies, asi como diseñar protocolos de muestreo adecuados para el enfoque de estudio.

- Debido a su alta afinidad a habitat o ambientes particulares, Neuroptera podria funcionar como grupo con alto potencial como modelo para comprender los patrones de distribución y diversidad de las especies, por lo cual es necesario implementar estudios que puedan corroborar dicho potencial.

- El Volcán Tacaná como región prioritaria terrestre para la biodiversidad y debido a su compleja historia biogeografica, destaco como una zona con un amplio número de nuevos registro de especies de Neuroptera, aumentando los rangos de distribución de estas y registrando posibles especies nuevas para la ciencia.

- La afinidad biogeográfica de la fauna de Neuroptera del Volcán Tacaná es variable entre los niveles altitudinales, presentando en las altitudes más bajas especies con afinidad Neotropical, mientras que a niveles más altos aumento en el número de especies con afinidad Neártica, reflejo de los diferentes procesos biogeográficos de la región.

- Solo familias como Chrysopidae, Coniopterygidae y Hemerobiidae, presentaron una mayor frecuencia a lo largo del gradiente, explicado por un alto potencial de dispersión y colonización lo que les permite explotar un mayor numero de recursos a diferencia del resto de familias que fueron restringidas a ciertos niveles altitudinales.

- A pesar de las bajas tasas de abundancia registrada para las comunidades de neurópteros, es importante señalar que en el gradiente altitudinal las altitudes medias y altas mostraron altos numero de especimenes, probablemente influenciados por una o dos familias adaptadas a dichas altitudes.

- Las comunidades de neurópteros presentaron tendencias de riqueza y diversidad similares con la disminución con el aumento de la altitud, esto puede estar influenciado por los factores ambientales y caracteristicas del habitat junto con las adaptaciones de las diferentes especies que conforman a las comunidades. A altitudes bajas es importante tomar en cuenta el factor antropogénico que puede influir en la estructura y composición de las comunidades.

- Los valores de distintividad taxonómica alfa mostraron que la diversidad en la estructura taxonómica parece permanecer constante en altitudes bajas y medias, con una disminución drástica en los rangos de altitud por encima de los 3000 m. Las altitudes más altas presentaron mejor distribución de especies en los diferentes niveles taxonómicos.

- La disimilitud total de especies a nivel local y regional estuvo fuertemente definida por el recambio de especies a lo largo de la elevación. La excepción fueron los sitios por encima de los 2000 m, que se explicaron mejor por el anidamiento. El cambio más visible se produjo entre altitudes elevadas y bajas. Para el caso de la diversidad taxonómica beta se registró una tendencia similar a la disimilitud total de las especies. Presentando valores de recambio mucho más bajos para taxones supra-específicos a nivel regional como entre sitios. Lo que nos habla de un fuerte recambio entre la fauna presente en zonas bajas con las comunidades de alta montaña.

10.- REFERENCIAS BIBLIOGRÁFICAS GENERALES

Adams, P.A. 1958. Studies in the Neuroptera, with special reference to wing structure and evolution in the Osmyloidea. Ph.D. dissertation. Harvard University, Cambridge, Massachusetts, USA. 120 pp.

Alayo, D.P. 1968. Los Neurópteros de Cuba. *Poeyana*, 2:1-127.

Albuquerque, G.S., C.A. Tauber y M.J. Tauber. 2012. Green lacewings (Neuroptera: Chrysopidae): predatory lifestyle. Pp. 593–631. En: Panizzi, A.R. y J.R.P. Parra. (Eds.), *Insect bioecology and nutrition for integrated pest management*. CRC Press, Boca Raton, Florida, USA. 732 pp.

Almeida-Neto, M., G. Machado, R. Pinto-da-Rocha y A.A. Giaretta. 2006. Harvestman (Arachnida: Opiliones) species distribution along three Neotropical elevational gradients: an alternative rescue effect to explain Rapoport's rule?. *Journal of Biogeography*, 33:361-375. DOI: 10.1111/j.1365-2699.2005.01389.x

Amell-Caez, Y., I. De Castro-Arrazola, H. García, J.D. Monroy-G y J.A. Noriega. 2019. Spatial diversity of dung beetle assemblages (Coleoptera: Scarabaeidae: Scarabaeinae) in five ecoregions from Sucre, Colombian Caribbean coast. *Revista Colombiana de Entomología*, 45:e7963. DOI: 10.25100/socolen.v45i2.7963

Ardila-Camacho, A. 2013. First record of beaded lacewings (Neuroptera, Berothidae) from Colombia. *Zootaxa,* 3669:159-164. DOI: 10.11646/Zootaxa.3669.2.7

Ardila-Camacho, A., R.J. Cancino-López, F. Acevedo y A. Contreras-Ramos. 2019. Four new species of *Plega* Navás, 1928 (Neuroptera: Mantispidae) from Mexico. *Zootaxa*, 4612:351-372. DOI: 10.11646/zootaxa.4612.3.3

Ardila-Camacho, A., R. Castillo Argaez, J.I. Martínez. 2020. A new species of moth lacewing from the mesoamerican genus *Adamsiana* Penny 1996 (Neuroptera: Ithonidae). *Neotropical Entomology*, 49:435-444. DOI: 10.1007/s13744-020-00773-y

Ardila-Camacho, A., C.C. Martins, U. Aspöck y A. Contreras Ramos, A. 2021. Comparative morphology of extant raptorial Mantispoidea (Neuroptera: Mantispidae, Rhachiberothidae) suggests a non-monophyletic Mantispidae and a single origin of the raptorial condition within the superfamily. *Zootaxa*, 4992:1-89. DOI: 10.11646/zootaxa.4992.1.1

Aspöck, H. 1999. Neuropterida: Raphidioptera, Megaloptera, Neuroptera. Kamelhälse, Schlammfliegen, Ameisenlöwen. *Stapfia*, 60:i-x, 1-244.

Aspöck, U. 1992. Crucial points in the phylogeny of the Neuroptera (Insecta). Pp. 63-73. En: Canard, M., H. Aspöck, y M.W. Mansell. (eds.), *Current Research in Neuropterology. Proceedings of the Fourth International Symposium on Neuropterology*. Privately printed, Toulouse, France. 414 pp.

Aspöck, U. y H. Aspöck. 1985. Die Berothiden Australiens (und Neuseelands) 11: Die Genera Trichoma TILLYARD, Trichoberotha HANDSCHIN, Protobiella TILLYARD und Austroberothella n. g. (Neuropteroidea: Planipennia: Berothidae). *Zeitschrift der Arbeitsgemeinschaft österreichischer Entomologen*, 36:65-85.

Aspöck, U., J.D. Plant y H.L. Nemeschkal. 2001. Cladistic analysis of Neuroptera and their systematic position within Neuropterida (Insecta: Holometabola: Neuropterida: Neuroptera). *Systematic Entomology*, 26:73-86. DOI: 10.1046/j.1365-3113.2001.00136.x

Bacaro, G., C. Ricotta y S. Mazzoleni. 2007. Measuring beta-diversity from taxonomic similarity. *Journal of Vegetation Science*, 18:793-798. DOI: 10.1111/j.1654-1103.2007.tb02595.x

Baselga, A. 2010. Partitioning the turnover and nestedness components of beta diversity. *Global Ecology and Biogeography,* 19:134-143. DOI: 10.1111/j.1466-8238.2009.00490.x

Baselga, A. 2012. The relationship between species replacement, dissimilarity derived from nestedness, and nestedness. *Global Ecology and Biogeography*, 21:1223-1232. DOI: 10.1111/j.1466-8238.2011.00756.x

Baselga, A. y L.A. Orme. 2012. Betapart: an R package for the study beta diversity. *Methods in Ecology and Evolution*, 3:808-812. DOI: 10.1111/j.2041-210X.2012.00224.x

Bowles, D.E. 2006. Spongillaflies (Neuroptera: Sisyridae) of North America with a key to the larvae and adults. *Zootaxa*, 1357:1-19. DOI: 10.5281/zenodo.174617

Bowles, D.E., A. Contreras Ramos, M.A. Sarmiento-Cordero y M.L. Ferro. 2015. New distributional records for pleasing lacewings (Neuroptera: Dilaridae, *Nallachius* spp.) in the Americas. *Insecta Mundi*, 406:1-10.

Bozdogan, H. 2020a. Diversity of lacewing assemblages (Neuropterida: Neuroptera) in different forest habitats and agricultural areas in the East Mediterranean area of Turkey. *Entomological Research*, 50:163-173. DOI: 10.1111/1748-5967.12426

Bozdogan, H. 2020b. Species richness and composition of Neuroptera in the forests fragments of the Taurus Mountains Range, Turkey. *Saudi Journal of Biological Sciences*, 27:1201-1207. DOI: 10.1016/j.sjbs.2020.02.018

Bozdogan, H. y E. Toroglu. 2016. Lacewing (Insecta: Neuroptera) fauna of Başkonuş Mountain National Park (Kahramanmaraş Province-Turkey). *BAUN Fen Bil. Enst. Dergisi, Cilt*, 18:89-103.

Brooks, S.J. 1994. A taxonomic review of the common green lacewing genus *Chrysoperla* (Neuroptera: Chrysopidae). *Bulletin of the Natural History Museum, Entomology Series*, 63:137-210.

Brooks, S.J. y P.C. Barnard. 1990. The green lacewings of the world: a generic review (Neuroptera: Chrysopidae). *Bulletin of the British Museum (Natural History), Entomology Series,* 59:117-286.

Calderón-Patrón, J.M., I. Goyenechea, R. Ortíz-Pulido, J. Castillo-Cerón, N. Manríquez-Morán, A. Ramírez-Bautista, A. Rojas-Martínez, G. Sánchez-Rojas, I. Zuria y C. Moreno. 2016. Beta diversity in a highly heterogeneous area: disentangling species and taxonomic dissimilarity for terrestrial vertebrates. *PLoSONE*, 11:1-15. DOI: 10.1371/journal.pone.0160438

Cancino-López, R.J. y A. Contreras-Ramos. 2019. A new species of *Ceraeochrysa* Adams (Neuroptera, Chrysopidae), with a key to the species from Mexico. *ZooKeys*, 888:95-104. DOI: 10.3897/zookeys.888.39064

Cancino-López, R.J., Y. Marquez-López y A. Contreras-Ramos. 2015. Mantíspidos (Neuroptera) del estado de Morelos, México: diversidad y distribución. *Dugesiana*, 22:201-208. DOI: 10.32870/dugesiana.v22i2.4735

Cancino-López, R.J., C.C. Martins y A. Contreras-Ramos. 2021. Neuroptera Diversity from Tacaná Volcano, Mexico: Species Composition, Altitudinal and Biogeographic Pattern of the Fauna. *Diversity*, 13: 537. DOI: 10.3390/d13110537

Carpenter, F.M. 1940. A revision of the Nearctic Hemerobiidae, Berothidae, Sisyridae, Polystoechotidae and Dilaridae (Neuroptera). *Proceedings of the American Academy of Arts and Sciences*, 74:193-280. DOI: 10.2307/20023398

Carvalho J.C., P. Cardoso, P.A.V. Borges, D. Schmera y J. Podani. 2012. Measuring fractions of beta diversity and their relationships to nestedness: a theoretical and empirical comparison of novel approaches. *Oikos*, 122:825-834. DOI: 10.1111/j.1600-0706.2012.20980.x

Castro, D.M.P., M. Callisto, R.R.C. Solar, D.R. Macedo y G.W. Fernandes. 2019. Beta diversity of aquatic invertebrates increases along an altitudinal gradient in a neotropical mountain. *Biotropica*, 5:399-411. DOI: 10.1111/btp.12660

Chamé-Velázquez, E.R., P. Reyes-Castillo y B. Gómez. 2007. Fauna de passalidae (coleoptera: scarabaeoidea) en el bosque mesófilo de montaña del sureste de chiapas, México. pp. 63-68. En: Zunino, M. y A. Melic (Eds.), *Escarabajos, diversidad y conservación biológica. Ensayos en homenaje a Gonzalo Halffter*. Sociedad Entomológica Aragonesa (S.E.A.), Monografías 3ercer Milenio M3M, Zaragoza.

Chao, A. y L. Jost. 2012. Coverage-based rarefaction and extrapolation: standardizing samples by completeness rather than size. *Ecology*, 93:2533-2547. DOI: 10.1890/11-1952.1

Chen, Z.Z., L.Y. Liu, S.Y. Liu, L.Y. Cheng, X.H. Wang y Y.Y. Xu. 2017. Response of *Chrysoperla nipponensis* (Okamoto) (Neuroptera: Chrysopidae) under long and short photoperiods. *Journal of Insect Science*, 17:35;1-9. DOI: 10.1093/jisesa/iex005

Chun, J.H. y C.B. Lee. 2018. Diversity patterns and phylogenetic structure of vascular plants along elevational gradients in a mountain ecosystem, South Korea. *Journal of Mountain Science,* 15:280-295. DOI: 10.1007/s11629-017-4477-x

Clarke, K.R. y R.N. Gorley. 2006. *PRIMER: User manual/tutorial. (Versión v6) [Programa de computación]*. Plymouth, Reino Unido: PRIMER-E Ltd. 192pp.

Clarke, K.R. y R.M. Warwick. 1998. A taxonomic distinctness index and its statistical properties. *Journal of Applied Ecology*, 35:523-531. DOI: 10.1046/j.1365-2664.1998.3540523.x

Clarke K.R. y R.M. Warwick, R.M. 2001. A further biodiversity index applicable to species lists: variation in taxonomic distinctness. *Marine Ecology Progress Series*, 216:265-278. DOI: 10.3354/meps216265

Colwell, R.K. 2013. EstimateS (Version 9.1)[Software]. Storrs: University of Connecticut. Diambil dari http://viceroy.eeb.uconn.edu/estimates/index.html.

Colwell, R.K., C. Rahbek y N.J. Gotelli. 2004. The mid-domain effect and species richness patterns: What have we learned so far? *American Naturalist*, 163:E1-E23. DOI: 10.1086/382056

CONANP. 2013. Programa de Manejo Reserva de la Biosfera Volcán Tacaná. SEMARNAT, 1 Edición, México. 204pp.

Contreras-Ramos, A. y M.V. Rosas. 2014. Biodiversidad de Neuroptera en México. *Revista Mexicana de Biodiversidad*, 85:5264-5270. DOI: 1a0d.75d5e0N/rmeubr.o3p2t6e7r7a

Cultid-Medina, C. y F. Escobar. 2019. Pautas para la estimación y comparación estadística de la diversidad biológica (qD). pp. 175-202. En: Moreno, C.E. (Ed.), *La biodiversidad en un mundo cambiante: Fundamentos teóricos y metodológicos para su estudio.* Universidad Autónoma del Estado de Hidalgo/ Libermex, Ciudad de México, México.

Cutz-Pool, L.Q., A. García-Gómez, G. Castañon-Meneses y J.G. Palacios-Vargas. 2010. Diversidad de invertebrados de musgos corticícolas en la región del volcán

Iztaccíhuatl, Estado de México. *Revista Colombiana de Entomología,* 36:90-95. DOI: 10.25100/socolen.v36i1.9127

Czechowska, W. 1985. Neuropteran (Planipennia and Raphidioptera; Neuropteroidea) communities of coniferous forest in the Kampinoska Forest and in Bialoleka Dworska near Warsaw. *Fragmenta Faunistica*, 29:391-404.

da Luz, G.R., G.S. da Mota, C. Spadeto, G.S. Tolentino, G.W. Fernandes y Y.R.F. Nunes. 2018. Regenerative potential of the soil seed bank along an elevation gradient of rupestrian grassland in southeastern Brazil. *Botany-Botanique*, 96:281-298. DOI: 10.1139/cjb-2017-0162.

de Freitas, S. y N.D. Penny. 2001. The green lacewings (Neuroptera: Chrysopidae) of Brazilian agro-ecosystems. *Proceedings of the California Academy of Sciences*, 52: 245-395.

de Freitas, S., N.D. Penny y P.A. Adams. 2009. A revision of the New World genus *Ceraeochrysa* (Neuroptera: Chrysopidae). *Proceedings of the California Academy of Sciences*, 60:503-610.

de Mendoza, G., W. Traunspurger, A. Palomo, A. y J. Catalan. 2017. Nematode distributions as spatial null models for macroinvertebrate species richness across environmental gradients: A case from mountain lakes. *Ecology and Evolution*, 7:3016-3028. DOI: 10.1002/ece3.2842

de Menezes, E.T., I. Barreto de Oliveira, R. Boldrini y B.M. de Paiva Ottoni-Boldrini. 2018. Primeiros registros de *Climacia* (Neuroptera: Sisyridae) para o estado de Roraima, Brasil. *Boletim do Museu Integrado de Roraima*, 12: 11-16. DOI: 10.24979/bolmirr.v12i01.660.

Duelli, P., M.K. Obrist y P.E. Flückiger. 2002. Forest Edges are biodiversity hotspots-Also for Neuroptera. *Acta Zoologica Academiae Scientiarum Hungaricae,* 48:75-87.

Enderlein, G. 1910. Klassifikation der Mantispiden nach dem material des Stettiner Zoologischen Museums. *Stettiner Entomologische Zeitung*, 71:341-379.

Faulkner, D.K. 1992. A revision of the genus *Lomamyia* Banks (Planipennia: Berothidae) with an emphasis on the western United States species. Master's thesis. California State University. Long Beach, California, USA. xii + 119 pp.

Fontana, V., E. Guariento, A. Hilpold, G. Niedrist, M. Steinwandter, D. Spitale, J. Nascimbene, U. Tappeiner y J. Seeber. 2020. Species richness and beta diversity patterns of multiple taxa along an elevational gradient in pastured grasslands in the European Alps. *Scientific Reports*, 10:12516. DOI: 10.1038/s41598-020-69569-9.

García-de Jesús, S., C.E. Moreno, M.A. Morón, I. Castellanos, I. y N.P. Pavón. 2016. Integrando la estructura taxonómica en el análisis de la diversidad alfa y beta de los escarabajos Melolonthidae en la Faja Volcánica Transmexicana. *Revista Mexicana de Biodiversidad*, 87:1033-1044. DOI: 10.1016/j.rmb.2016.06.003

García-Gómez, A., G. Castaño-Meneses y J.G. Palacios-Vargas. 2011. Distribución y diversidad de colémbolos (Hexapoda: Collembola) en el gradiente altitudinal de un bosque templado en México. *Revista de Biología Tropical*, 59:315-327.

Garzón-Orduña, I.J., I. Menchaca-Armenta, A. Contreras-Ramos, X.-y Liu y S.L.Winterton. 2016. The phylogeny of brown lacewings (Neuroptera: Hemerobiidae) reveals multiple reductions in wing venation. *BMC Evolutionary Biology*, 16:1-19. DOI: 10.1186/s12862-016-0746-5.

Gillete, P.N., K.K. Ennis, G. Domínguez-Martínez y S.M. Philpott. 2015. Changes in species richness, abundance and composition of arboreal twig-nesting ants along an elevational gradient in coffee landscapes. *Biotropica*, 47:712-722. DOI: 10.1111/btp.12263

Gómez-Hernández, M., G. Williams-Linera, D.J. Lodge, R. Guevara, E. Ruiz-Sanchez y E. Gándara. 2016. Phylogenetic diversity of macromycetes and woody plants along an elevational gradient in Eastern Mexico. *Biotropica,* 48:577-585. DOI:10.1111/btp.12332.

González-Montaña, L.A., W. Wilches-Álvarez y C. Rocha-Caicedo. 2017. Alpha and beta diversity of epigean arthropods (Arthropoda) in three sectors on the Eastern

Cordillera of Colombia. *Revista Colombiana de Entomología*, 43:292-300. DOI: 10.25100/socolen.v43i2.5962.

Graham, A. 2010. Late Cretaceous and Cenozoic history of Latin American vegetation and terrestrial environments. *Monographs in Systematic Botany from the Missouri Botanical Garden*, 113:1-617.

Grimaldi, D. y M.S. Engel. 2005. *Evolution of the insects*. Cambridge University Press. Cambridge. 755pp.

Guerrero, R.J. y C.E. Sarmiento. 2010. Distribución altitudinal de hormigas (Hymenoptera, Formicidae) en la vertiente Noroccidental de la sierra nevada de santa Marta (Colombia). *Acta Zoológica Mexicana,* 26:279-302.

Halffter, G. 1987. Biogeography of the montane entomofauna of Mexico and Central America. *Annual Review of Entomology, 32*:95-114. DOI:10.1146/annurev.en.32.010187.000523.

Halffter, G., J.R. Verdú, J. Márquez y C.E. Moreno. 2008. Biogeographical analysis of Scarabaeinae and Geotrupinae along a transect in Central Mexico (Coleoptera, Scarabaeoidae). *Fragmenta Entomologica*, 40:273-322. DOI:10.4081/fe.2008.99.

Halffter, G., J. Llorente-Bousquets y J.J. Morrone. 2009. La perspectiva biogeográfica histórica. pp.67-86. En: Soberón, J., G. Halffter y J.Llorente (Eds.), *Capital Natural de México, Volumen I: Conocimiento Actual de la Biodiversidad*; Conabio: Tlalpan, Mexico.

Henry, C.S., N.D. Penny y P.A. Adams. 1992. The neuropteroid orders of Central America (Neuroptera y Megaloptera). pp. 432-458. En: Quintero, D. y A. Aiello (Eds.), *Insects of Panamá and Mesoamérica*, Oxford University Press, Oxford.

Hoffman, K.M. 1992. Systematics of the Mantispinae (Neuroptera: Mantispidae) of North, Central and South America. Ph.D. dissertation. Clemson University. Clemson, South Carolina, USA. xiii + 501pp.

Hsieh, T.C., K.H. Ma. y A. Chao. 2013. iNEXT online: interpolationand extrapolation (Version 1.2.0) http://chao.stat.nthu.edu.tw/inext/ (Accessed on 28 April 2021)

Jost, L. 2006. Entropy and diversity. *Oikos*, 113:363-375. DOI: 10.1111/j.2006.0030-1299.14714.x

Jost, L. 2007. Partitioning diversity into independent alpha and beta components. *Ecology*, 88:2427-2439. DOI: 10.1890/06-1736.1

Klimaszewski, J. y D.K. McE Kevan. 1988. The brown lacewing flies of Canada and Alaska (Neuroptera: Hemerobiidae). Part III. The genus *Micromus* Rambur. *Giornale Italiano di Entomologia*, 19:31-76.

Kluge, J. y M. Kessler. 2011. Phylogenetic diversity, trait diversity and niches: species assembly of ferns along a tropical elevational gradient. *Journal of Biogeography*, 38: 394-405. DOI: 10.1111/j.1365-2699.2010.02433.x

Koleff, P. 2005. Conceptos y medidas de la diversidad beta. pp.19-40. En: Halffter, G., J. Soberón, P. Koleff y A. Melic (Eds.), *Sobre Diversidad Biológica: el Significado de las Diversidades Alfa, Beta y Gamma*. S.E.A. Conabio. Conacyt. Diversitas. Vol.4 Monografia 3ercer Milenio, Mexico.

Koleff, P., J. Soberón *et al*., 2008. Patrones de diversidad espacial en grupos selectos de especies. pp. 323-364. En: Lobo, J., E. Pineda y A. Ruggiero (Eds.), *Capital natural de México, vol. I: Conocimiento actual de la biodiversidad*. Conabio, México.

Kristensen, N.P. 1991. Phylogeny of extant hexapods. pp. 126-140. En: Commonwealth Scientific y Industrial Research Organization (Eds.), *Insects of Australia*. Melbourne University Publishing.

Lai, Y., Y. Liu y X. Liu. 2021. Elevational diversity patterns of green lacewings (Neuroptera: Chrysopidae) uncovered with DNA barcoding in a biodiversity hotspot of Southwest China. *Frontiers in Ecology and Evolution*, 9:778-686. DOI: 10.3389/fevo.2021.778686.

Leingärtner, A., J. Krauss y I. Steffan-Dewenter. 2014. Species richness and trait composition of butterfly assemblages change along an altitudinal gradient. *Oecologia*, 175:613-623. DOI: 10.1007/s00442-014-2917-7.

Linnaeus, C. 1758. Systema natura per regna tria naturae secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. 10th Edition. Vol. 1. Salvii, Holmiae. 824pp.

Liu, C., K.L. Dudley, Z.H. Xu y E.P. Economo. 2018. Mountain metacommunities: Climate and spatial connectivity shape ant diversity in a complex landscape. *Ecography*, 41:101-112. DOI: 10.1111/ecog.03067

Loreau, M. 2000. Are communities saturated? On the relationship between α, β and γ diversity. *Ecology Letters*, 3:73-76. DOI: 10.1046/j.1461-0248.2000.00127.x

Machado, R.J.P. y J.A. Rafael. 2010. Two new species of Dilaridae (Insecta: Neuroptera) with additional notes on Brazilian species. *Zootaxa*, 2421:61-68. DOI: 10.11646/zootaxa.2421.1.5.

Machado, R.J.P., J.P. Gillung, S.L. Winterton, I.J. Garzón-Orduña, A.R. Lemmon, E.M. Lemmon, y J.D. Oswald. 2018. Owlflies are derived antlions: anchored phylogenomics supports a new phylogeny and classification of Myrmeleontidae (Neuroptera). *Systematic Entomology,* 44:418-450. DOI: 10.1111/syen.12334.

MacLeod, E.G. y P.A. Adams. 1967. A Review of the Taxonomy and Morphology of the Berothidae, with the Description of a New Subfamily from Chile (Neuroptera). *Psyche*, 74:237-265.

Manish, K. y K. Maharaj Pandit. 2018. Phylogenetic diversity, structure and diversification patterns of endemic plants along the elevational gradient in the Eastern Himalaya. *Plant Ecology & Diversity*, 11:501-513. DOI: 10.1080/17550874.2018.1534147

Mariano, F.R., V. Leite Rezende, C. Njaime Mendes, R. Manoel dos Santos, C. Rodrigo de Souza, A. Souza de Moura, F. Santana Machado, P. Vieira Pompeu, W.A. Caldas Carvalho y M.A. Leite Fontes. 2020. Phylogenetic beta diversity in an upper montane Atlantic Forest along an altitudinal gradient. *Plant Ecology*, 221:671-682. DOI: 10.1007/s11258-020-01041-0

Marín, F. 1994. Las comunidades de neurópteros de la provincial de Albacete (Insecta, Neuropteroidea). *Al-Basit: Revista de estudios albacetenses,* 34:247-304.

Marín, F. y V.J. Monserrat. 1987. Los Neurópteros del encinar ibérico (Insecta, Neuropteroidea). *Boletín de sanidad vegetal. Plagas,* 13:347-359.

Marquez-López, Y. y A. Contreras-Ramos. 2019. A new species of *Wesmaelius* Krüger from Mexico, with a key to the New World species of the subgenus *Kimminsia* Killington (Neuroptera, Hemerobiidae). *ZooKeys*, 841:61-70. DOI:10.3897/zookeys.841.29570

Marquez-López, Y., M.d.C. Herrera-Fuentes y A. Contreras Ramos. 2020. Alpha and beta diversity of dustywings and brown lacewings (Neuroptera: Coniopterygidae, Hemerobiidae) in a temperate forest of Tlaxcala, Mexico. *Proceedings of the Entomological Society of Washington*, 122:869-889. DOI: 10.4289/0013-8797.122.4.869.

Martínez-Camilo, R. N. Martínez-Meléndez, M. Martínez-Meléndez, M.Á. Pérez-Farrera y D.A. Jiménez-López. 2019. Why continue with floristic checklists in Mexico? The case of the Tacaná-Boquerón Priority Terrestrial Region, in the Mexican State of Chiapas. *Botanical Sciences,* 97:741-753. DOI: 10.17129/botsci.2174.

Martínez-Sánchez, I., S. Niño-Maldonado, L. Barrientos-Lozano y J.V. Horta-Vega. 2009. Dinamica poblacional de Chrysomelidae (Coleoptera) en un gradiente altitudinal en tres municipios del Estado de Hidalgo, Mexico. *TecnoIntelecto*, 6:2-4.

Martins, C.C. y P.A. de Araujo. 2016. First record of Dilaridae (Neuroptera) in the state of Pernambuco, Brazil. *Check List*, 12:1-5. DOI: 10.15560/12.3.1889

McEwen, P.K., T.R. New y A.E. Whittington. 2001. Lacewings in the crop environment. Cambridge University Press. 564pp.

Meinander, M. 1972. A revision of the family Coniopterygidae (Planipennia). *Acta Zoologica Fennica*, 136:1-357.

Meinander, M. 1974. Coniopterygidae from South and Central America (Neuroptera). *Notulae Entomologicae*, 54:97-106.

Meinander, M. 1975. Coniopterygidae from North America (Neuroptera). *Notulae Entomologicae*, 55:28-32.

Meinander, M. 1995. Coniopterygidae (Neuroptera, Planipennia) from Costa Rica and Nicaragua. *Brenesia*, 43:61-70.

Meinander, M. 2002. Family Coniopterygidae. En: Penny, N.D. (ed.). A Guide to the Lacewings (Neuroptera) of Costa Rica. *Proceedings of the California Academy of Sciences*, 53:227-236, 374-393.

Meinander, M. y N.D. Penny. 1982. Neuroptera of the Amazon Basin. Part 5. Coniopterygidae. *Acta Amazonica*, 12:185-208.

Miller, R.B. y L.A. Stange. 1989. Revision of the genus *Dimarella* Banks (Neuroptera: Myrmeleontidae). *Insecta Mundi,* 3:11-40.

Miller, R.B. y L.A. Stange. 2009. A revision of the genus *Maracandula* Currie (Neuroptera: Myrmeleontidae). *Insecta Mundi,* 101:1-10.

Miller, R.B. y L.A. Stange. 2014. A revision of the genus *Purenleon* Stange (Neuroptera: Myrmeleontidae: Nemoleontini). *Insecta Mundi,* 384:1-67.

Miller, R.B. y L.A. Stange. 2016. A revision of the genus *Eremoleon* Banks (Neuroptera: Myrmeleontidae: Nemoleontini). *Insecta Mundi,* 495:1-111.

Miranda F. 1942. Estudios sobre la vegetación de México. II. Observaciones preliminares sobre la vegetación de la región de Tapachula, Chiapas. *Anales del Instituto de Biología*. Serie Botánica 13: 53-70.

Mittermeier, R. y C. Goettsch. 1992. La importancia de la Diversidad biológica de México. México ante los Retos de la Biodiversidad. pp. 63-73. Ed. Comision Nacional para el Conocimiento y Uso de la Biodiversidad. México.

Misof, B., L. Shanlin, K. Meusemann, R.S. Peters, A. Donath, C. Mayer, *et al*., 2014. Phylogenomics resolves the timing and pattern of insect evolution. *Science*, 346:763-767. DOI: 10.1126/science.1257570

Monserrat, V.J. 1984. Sobre las especies Americanas del género *Notiobiella* Banks, 1909, I. (Neuroptera, Planipennia, Hemerobiidae). pp. 85-97. En: Gepp, J.; H. Aspöck, y H. Hölzel. (Eds.), *Progress in World's Neuropterology. Proceedings of the 1st International Symposium on Neuropterology*. Meeting: 22-26 September 1980, Graz, Austria. Privately printed, Graz, Austria. 265pp.

Monserrat, V.J. 1996. Revision del genero *Hemerobius* de latinoamerica (Neuroptera, Hemerobiidae). *Fragmenta Entomologica*, 27:399-523.

Monserrat, V.J. 1997. Revisión del género *Megalomus* de Latinoamérica (Neuroptera, Hemerobiidae). *Fragmenta Entomologica*, 29:123-206.

Monserrat, V.J. 2000. Revisión del género *Nusalala* (Neuroptera, Hemerobiidae). *Fragmenta Entomologica*, 32:83-162.

Monserrat, V.J. 2005. Nuevos datos sobre algunas pequeñas familias de neurópteros (Insecta: Neuroptera: Nevrorthidae, Osmylidae, Sisyridae, Dilaridae). *Heteropterus: Revista de Entomología*, 5:1-26.

Monserrat, V.J. 2014. Los mantíspidos de la Península Ibérica y Baleares (Insecta, Neuropterida, Neuroptera, Mantispidae). *Graellsia*, 70:1–52. DOI: https://doi.org/10.3989/graellsia.2014.v70.115.

Monserrat, V.J. 2015. Los hemeróbidos de la Península Ibérica y Baleares (Insecta, Neuropterida, Neuroptera: Hemerobiidae). *Graellsia,* 71:1-71. DOI: 10.3989/graellsia.2015.v71.129.

Monserrat, V.J. 2016. Los crisopidos de la península ibérica y baleares (Insecta, Neuropterida, Neuroptera: Chrysopidae). *Graellsia*, 72:1-123. DOI: 10.3989/graellsia.2016.v72.143

Monserrat, V.J. y F. Acevedo. 2013. Los mirmeleónidos (hormigas-león) de la Península Ibérica e Islas Baleares (Insecta, Neuropterida, Neuroptera, Myrmeleontidae). *Graellsia*, 69:283–321. DOI: https://doi.org/10.3989/graellsia.2013.v69.098.

Monserrat, V.J. y N.D. Penny. 1983. Sobre las especies Americanas del genero *Notiobiella* Banks, 1909, II (Neuroptera, Planipennia, Hemerobiidae). *Nouvelle Revue d'Entomologie*, 13:125-132.

Monteagudo-Sabaté, D. y M.A. Luis-Martinez. 2013. Patrones de riqueza altitudinal de Papilionidae, Pieridae y Nymphalidae (Lepidoptera: Rhopalocera) en áreas montañosas de México. *Revista de Biología Tropical*, 61:1509-1520.

Moreno, C.E., F. Barragán, E. Pineda y N. Pavón. 2011. Re-análisis de la diversidad alfa: alternativas para interpretar y comparar información sobre comunidades ecologicas. *Revista Mexicana de Biodiversidad*, 82:1249-1261.

Moreno, C.E., G. Castillo-Campos y J.R. Verdú. 2009. Taxonomic diversity as complementary information to assess plant species diversity in secondary vegetation and primary tropical deciduous forest. *Journal of Vegetation Science*, 20:935-943. DOI: 10.1111/j.1654-1103.2009.01094.x

Navás, L. 1914. Névroptères nouveaux de l'Amerique du Nord. IIème série. *Entomologische Zeitschrift, Frankfurt am Main*, 28:18-20, 25-26.

Navás, L. 1929. Insectos neotropicos. 5.a serie. *Revista Chilena de Historia Natural*, 33:17-24.

New, T.R. 1989. Planipennia, Lacewings. Handbuch der Zoologie. Vol. 4 (Arthropoda: Insecta), Part 30. Walter de Gruyter, Berlin. 132pp.

New, T.R. 1991. Neuroptera (lacewings). pp. 525-542. En: Naumann, I.D. (chief Ed.), *The Insects of Australia*. 2nd Edition. Vol. 1. Melbourne University Press, Melbourne.

Noriega, J.A. y E. Realpe. 2018. Altitudinal Turnover of Species in a Neotropical Peripheral Mountain System: A case study with Dung Beetles (Coleoptera: Aphodiinae and Scarabaeinae). *Environmental Entomology*, 47:1376-1387. DOI: 10.1093/ee/nvy133

Oswald, J.D. 1988. A revision of the genus *Sympherobius* Banks (Neuroptera: Hemerobiidae) of America north of Mexico with a synonymical list of the world species. *Journal of the New York Entomological Society*, 96:390-451.

Oswald, J.D. 1993. Revision and cladistic analysis of the world genera of the family Hemerobiidae (Insecta: Neuroptera). *Journal of the New York Entomological Society,* 101:143-299.

Oswald, J.D. 2004. Review of the brown lacewing genus *Biramus* (Neuroptera: Hemerobiidae: Hemerobiinae), with the description of a new species from Costa Rica and Panama. *Tijdschrift voor Entomologie*, 147:41-47. DOI: 10.1163/22119434-900000135.

Oswald, J.D. 2018. Lacewing digital library. Neuropterida species of the World. http://lacewing.tamu. edu/Species-Catalogue/index.html.

Oswald, J.D. y R.J.P. Machado. 2018. Biodiversity of the Neuropterida (Insecta: Neuroptera: Megaloptera, and Raphidioptera). pp. 627-671. En: Foottit, R.G. y P.H. Adler (Eds.), *Insect Biodiversity: science and society*. Vol. II. First Edition. John Wiley & Sons, New York.

Oswald, J.D., A. Contreras-Ramos y N.D. Penny. 2002. Neuroptera (Neuropterida). pp. 559-581. En: Llorente-Bousquets, J. y J.J. Morrone (Eds.), *Biodiversidad, taxonomía y biogeografía de artrópodos de México: hacia una síntesis de su conocimiento*, Vol. III. Universidad Nacional Autónoma de México. México, D.F.

Özkan, K. 2018. Taksonomik çeşitliliğin belirlenmesi için yeni önerilen bir eşitlik. *Turkish Journal of Forestry*, 19:336-346. DOI: 10.18182/tjf.441061

Pacheco-Rueda, I., J.R. Lomelí-Flores, E. Rodríguez-Leyva y M. Ramírez-Delgado. 2011. Ciclo de vida y parámetros poblacionales de *Sympherobius barberi* Banks (Neuroptera: Hemerobiidae) criado con *Dactylopius opuntiae* Cockerell (Hemiptera: Dactylopiidae). *Acta Zoológica Mexicana*, 27:325-340.

Parfin, S.I. y A.B. Gurney. 1958. The spongilla-flies, with special reference to those of the western hemisphere (Sisyridae, Neuroptera). *Proceedings of the United States National Museum*, 105: 421-529. DOI: 10.5479/si.00963801.105-3360.421

Penny, N.D. 1981. Review of the generic level classification of the New World Ascalaphidae (Neuroptera). *Acta Amazonica*, 11:391-406. DOI: 10.1590/1809-43921981112391

Penny, N.D. 1982. Neuroptera of the Amazon Basin. Part 6. Mantispidae. *Acta Amazonica*, 12:415-463. DOI: 10.1590/1809-43921982122415

Penny, N.D. 1996. A remarkable new genus and species of Ithonidae from Honduras (Neuroptera). *Journal of the Kansas Entomological Society,* 69:81-86.

Penny, N.D. 2002. A Guide to the lacewings (Neuroptera) of Costa Rica. *Proceedings of the California Academy of Sciences*, 53:161-457.

Penny, N.D., P.A. Adams y L.A. Stange. 1997. Species catalog of the Neuroptera, Megaloptera, and Raphidioptera of America North of Mexico. *Proceedings of the California Academy of Sciences*, 50:39-114.

Pérez-Domínguez, J.F., M. Villalvazo-Palacios y M. Vásquez-Bolaños. 2015. Distribución altitudinal de hormigas poneromorfas (Hymenoptera: Formicidae) en Sierra de Quila y Suroeste de Jalisco. *Entomología Mexicana*, 2:595-600.

Pérez Hernández, C.X. 2019. Distintividad taxonómica: Evaluación de la diversidad en la estructura taxonómica en los ensambles. pp. 285-306. En: Moreno, C.E. (Ed.), *La biodiversidad en un mundo cambiante: Fundamentos teóricos y metodológicos para su estudio*. Universidad Autónoma del Estado de Hidalgo/Libermex, Ciudad de México.

Pérez-Hernández, C.X y S. Zaragoza-Caballero. 2015. Diversidad alfa y beta de Cantharidae (Coleoptera) en el bosque tropical caducifolio de la vertiente del Pacífico mexicano. *Revista Mexicana de Biodiversidad*, 86:771-781. DOI: 10.1016/j.rmb.2015.07.001

Pérez-Toledo, G.R., J.E. Valenzuela-González, C.E. Moreno, F. Villalobos y R.R. Silva. 2021. Patterns and drivers of leaf-litter ant diversity along a tropical elevational gradient in Mexico. *Journal of Biogeography*, 48:2512-2523. DOI: 10.1111/jbi.14217.

Perillo, L.N, Fd.S. Neves, Y. Antonini y R.P. Martins. 2017. Compositional changes in bee and wasp communities along Neotropical mountain altitudinal gradient. *PLoS ONE,* 12: e0182054. DOI: 10.1371/journal.pone.0182054

Pielou, E.C. 1975. Ecological diversity. Nueva York: Wiley. viii + 165pp.

Podlesnik, J., P. Jakšić, A. Nahirnić, F. Janžekovič, T. Klenovšek, V. Klokočovnik y D. Devetak, 2019. Fauna of the brown lacewings of Serbia (Insecta: Neuroptera: Hemerobiidae). *Acta Entomologica Slovenica*, 27:17-29.

Qin, H., Y.B. Zhang, G. Dong y F. Zhang. 2019. Altitudinal patterns of taxonomic, phylogenetic and functional diversity of forest communities in Mount Guandi, Shanxi, China. *Chinese Journal of Plant Ecology*, 43:762-773. DOI: 10.17521/cjpe.2018.0088

Reynoso-Velasco, D. y A. Contreras-Ramos. 2009. Mantispidae (Neuroptera) of México's National University biological stations Chamela and Los Tuxtlas. *Proceedings of the Entomological Society of Washington*, 111:708-713. DOI: 10.4289/0013-8797-111.3.708

Reynoso Velasco, D. y A. Contreras Ramos, A. 2019. Taxonomic review of the mantidfly genus *Nolima* Navás (Neuroptera, Mantispidae, Calomantispinae). *ZooKeys*, 853:131-158. DOI: 10.3897/zookeys.853.30317

Rosenzweig, M.L. 1995. Species diversity in space and time. Cambridge University Press. United Kingdom.

Sánchez-Ramos, G., J. Lobo, M. Lara Villalón y P. Reyes-Castillo. 1993. Distribución altitudinal y estacional de la entomofauna necrófilos en la sierra norte de Hidalgo, México. *Acta Zoológica México*, 5:1-47.

Sánchez-Reyes, U.J., S. Niño-Maldonado, L. Barrientos-Lozano, S.M. Clark y R.W. Jones. 2016. Faunistic patterns of leaf beetles (Coleoptera, Chrysomelidae) within elevational and temporal gradients in Sierra de San Carlos, Mexico. *ZooKeys*, 611: 11-56. DOI: 10.3897/zookeys.611.9608

Sarmiento-Cordero, M.A y A. Contreras-Ramos. 2019. Two new species and a key to the dustywings of Mexico (Neuroptera, Coniopterygidae). *Zootaxa*, 554:551-563. DOI: 10.11646/zootaxa.4671.4.6.

Sosa, F.J. y C.A. Tauber. 2021. The Neotropical green lacewing genus *Ceraeochrysa* Adams (Neuroptera: Chrysopidae)—new synonymies and combinations, a new species, and an updated key to species. *Zootaxa*, 4970:1-52. DOI: 10.11646/zootaxa.4970.1.1

Sosa, F.; Lara, R.I.R. y C.C. Martins. 2015. A new species of *Hemerobiella* Kimmins (Neuroptera, Hemerobiidae) from Venezuela with notes on the genus. *Zootaxa*, 4028:421-429. DOI: 10.11646/zootaxa.4028.3.7

Stange, L.A. 1963. The Dimarellini of Mexico (Neuroptera: Myrmeleontidae) with the descriptions of two new species of *Dimarella*. *Annals of the Entomological Society of America*, 56:810-816.

Stange, L.A. 1970. Revision of the ant-lion tribe Brachynemurini of North America (Neuroptera: Myrmeleontidae). *University of California Publications in Entomology,* 55:vi+1-192.

Stange, L.A. 1994. Reclassification of the New World antlion genera formerly included in the tribe Brachynemurini (Neuroptera: Myrmeleontidae). *Insecta Mundi*, 8:67-119.

Stange, L.A. 1999. A new species of *Eremoleon* Banks from Costa Rica (Neuroptera: Myrmeleontidae). *Journal of Neuropterology,* 2:5-10.

Stange, L.A. 2008. A new species of the genus *Dendroleon* Brauer from Mexico (Neuroptera: Myrmeleontidae). *Insecta Mundi,* 54:1-9.

Stevens, G.C. 1989. The latitudinal gradient in geographical range: how so many species coexist in the tropics. *American Naturalist*, 133:240-256.

Stevens, G.C. 1992. The elevational gradient in altitudinal range: an extension of Rapoport's latitudinal rule to altitude. *American Naturalist*, 140:893-911.

Stevens, G.C. 1996. Extending Rapoport's rule to marine fishes. *Journal of Biogeography*, 23:149-154.

Sziráki, G. 2011. Coniopterygidae of the World: Annotated Check-List and Identification Keys for Living Species, Species Groups and Supra Specific Taxa of the Family. Lambert Academic Publishing: Saarbrucken, Germany. 264pp.

Tauber, C.A. 1969. Taxonomy and biology of the lacewing genus *Meleoma* (Neuroptera: Chrysopidae). *University of California Publications in Entomology,* 58:vi+1-94.

Tauber, C.A. 2010. Revision of *Neosuarius*, a subgenus of *Chrysopodes* (Neuroptera, Chrysopidae). *ZooKeys*, 44:1-104. DOI: 10.3897/zookeys.44.387

Tauber, C.A., G.S. Albuquerque y M.J. Tauber. 2008. A new species of *Leucochrysa* and a redescription of *Leucochrysa* (*Nodita*) *clepsydra* Banks (Neuroptera: Chrysopidae). *Zootaxa*, 1781:1-19. DOI: 10.11646/ZOOTAXA.1781.1.1.

Tauber, C.A., M.J. Tauber y G.S. Albuquerque. 2009. Neuroptera (Lacewings, Antlions). *Encyclopedia of insects.* Academic Press, London. pp. 785-798.

Tauber, C.A., G.S. Albuquerque y M.J. Tauber. 2012a. The Neotropical genus *Titanochrysa* (Neuroptera, Chrysopidae): larval descriptions, biological notes, a new species, and taxonomic changes. *Zootaxa*, 3514:1-26. DOI: 10.11646/zootaxa.3514.1.1.

Tauber, C.A., G.S. Albuquerque y M.J. Tauber. 2012b. Three new Brazilian species of *Chrysopodes* (Neuroptera: Chrysopidae). *Annals of the Entomological Society of America*, 105:638-663. DOI: 10.1603/AN12028.

Tauber, C.A., F. Sosa y G.S. Albuquerque. 2013. Two common and problematic leucochrysine species – *Leucochrysa* (*Leucochrysa*) *varia* (Schneider) and *L.* (*L.*)

pretiosa (Banks) (Neuroptera, Chrysopidae): redescriptions and synonymies. *ZooKeys*, 310:57-101. DOI: 10.3897/zookeys.310.5071.

Tauber, C.A., F. Sosa, G.S. Albuquerque y M.J. Tauber. 2017. Revision of the Neotropical green lacewings genus *Ungla* (Neuroptera, Chrysopidae). *ZooKeys*, 674:1-188. DOI: 10.3897/zookeys.674.11435.

Tauber, C.A., F. Sosa y A. Contreras-Ramos. 2018. *Cryptochrysa* Freitas and Penny, a generic homonym, replaced by *Titanochrysa* Sosa and Freitas (Neuroptera: Chrysopidae). *Zootaxa*, 4375:287-295. DOI: 10.11646/zootaxa.4375.2.9.

Tello, J.S., J.A. Myers, M.J. Macía, A.F. Fuentes, L. Cayola, G. Arellano, M.I. Loza, V. Torrez, M. Cornejo, T.B. Miranda y P.M. Jørgensen. 2015. Elevational gradients in β-diversity reflect variation in the strength of local community assembly mechanisms across spatial scales. *PloS ONE*, 10: e0121458. DOI: 10.1371/journal.pone.0121458

Tjeder, B. 1957. Neuroptera-Planipennia. The Lace-wings of Southern Africa. 1. Introduction and families Coniopterygidae, Sisyridae, and Osmylidae. *South African Animal Life*, 4:95-188.

Valencia-Luna, L., J. Romero-Nápoles, J. Valdez-Carrasco, J.L. Carrillo-Sánchez y V. López-Martínez. 2007. Taxonomía y registros de Chrysopidae (Insecta: Neuroptera) en el estado de Morelos, México. *Acta Zoológica Mexicana,* 22:17-61.

van der Weele, H.W. 1909. Catalogue des ascalaphides des collections du muséum. *Bulletin du Muséum National d'Histoire Naturelle*, Paris, 15:170-174.

Warwick, R.M. y K.R. Clarke. 1995. New ‘biodiversity’ measures reveal a decrease in taxonomic distinctness with increasing stress. *Marine Ecology Progress Series*, 129:301-305. DOI: 10.3354/meps129301

Whittaker, R.H. 1960. Vegetation of the Siskiyou Mountains, Oregon and California. *Ecological Monographs*, 30:279-338.

Winterton, S.L. y V.N. Makarkin. 2010. Phylogeny of moth lacewings and giant lacewings (Neuroptera: Ithonidae, Polystoechotidae) using DNA sequence data, morphology and fossils. *Annals of the Entomological Society of America*, 103:511-522. DOI: 10.1603/AN10026

Winterton, S.L., N.B. Hardy y B.M. Wiegmann. 2010. On wings of lace: phylogeny and bayesian divergence time stimates of Neuropterida (Insecta) based on morphological and molecular data. *Systematic Entomology*, 35:349-378. DOI: 10.1111/j.1365-3113.2010.00521.x

Winterton, S.L., A.R. Lemmon, J.P. Gillung, I.J., Garzón, D. Badano, D.K. Bakkes, L.C.V. Breitkreuz, M.S. Engel, E.M. Lemmon, X. Liu, R.J.P. Machado, J.H. Skevington y J.D. Oswald. 2018. Evolution of lacewings and allied orders using anchored phylogenomics (Neuroptera, Megaloptera, Raphidioptera). *Systematic Entomology*, 43:330-354. DOI: 10.1111/syen.12278.

Willig, M.R. y S.J. Presley. 2019. The spatial configuration of taxonomic biodiversity along a tropical elevational gradient: α-, β-, and γ-partitions. *Biotropica*, 51:104-116. DOI: 10.1111/btp.12632

Worthy, S.J., R.A. Jiménez Paz, A.J. Pérez, A. Reynolds, J. Cruse-Sanders, R. Valencia, J.A. Barone y K.S. Burgess. 2019. Distribution and community assembly of trees along an andean elevational gradient, *Plants*, 8:326. DOI:10.3390/plants8090326

Zhang, W., D. Huang, R. Wang, J. Liu y N. Du. 2016. Altitudinal Patterns of Species Diversity and Phylogenetic Diversity across Temperate Mountain Forests of Northern China. *PLoS ONE,* 11:e0159995. DOI: 10.1371/journal.pone.0159995

11.- APÉNDICE

ZooKeys 888: 95–104 (2019)
doi: 10.3897/zookeys.888.39064
http://zookeys.pensoft.net

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

A new species of *Ceraeochrysa* Adams (Neuroptera, Chrysopidae), with a key to the species from Mexico

Rodolfo J. Cancino-López[1], Atilano Contreras-Ramos[2]

1 Posgrado en Ciencias Biológicas, sede Instituto de Biología-UNAM, Cd. Universitaria, 04510 Ciudad de México, Mexico **2** *Instituto de Biología-UNAM, Departamento de Zoología, Cd. Universitaria, 04510 Ciudad de México, Mexico*

Corresponding author: *Atilano Contreras-Ramos* (acontreras@ib.unam.mx)

Academic editor: *S. Winterton* | Received 14 August 2019 | Accepted 9 October 2019 | Published 11 November 2019

http://zoobank.org/64A28110-F068-4C89-8396-0C23C6A96337

Citation: Cancino-López RJ, Contreras-Ramos A (2019) A new species of *Ceraeochrysa* Adams (Neuroptera, Chrysopidae), with a key to the species from Mexico. ZooKeys 888: 95–104. https://doi.org/10.3897/zookeys.888.39064

Abstract

The genus *Ceraeochrysa* Adams is widely distributed in the New World, from southeastern Canada to Argentina, with 15 out of 61 previously known species recorded in Mexico. In this paper, *Ceraeochrysa tacanensis* **sp. nov.** is described and illustrated from Volcán Tacaná, Chiapas, and an identification key to *Ceraeochrysa* species present in Mexico is provided. The new species is similar to others with swollen and darkened posterior branches of the cubital vein, and it can be separated from these other species by an elongate gonapsis extending from the base of the gonosaccus; the gonapsis is slightly upturned, terminating in a rounded apex with dorsal microteeth. Females of the new species have non-distinctive genitalia morphology. However, they can be associated with males of the species by body color pattern, synchrony, and sympatry.

Keywords

Central American Volcanic Arc, Green lacewings, taxonomy, Volcán Tacaná

Introduction

The Neotropical green lacewing genus *Ceraeochrysa* (Neuroptera, Chrysopidae) was separated from *Chrysopa* by Adams (1982), who based his definition of the genus on male genitalic characters and recognized 24 species. Further studies added several species to this genus (Brooks and Barnard 1990; Penny 1997, 1998, 2002; Tauber et al. 2000; Freitas and Penny 2001; Tauber and De León 2001). *Ceraeochrysa* is the second most species-rich chrysopid genus in the New World after *Leucochrysa* McLachlan, comprising 61 valid species (Sosa and Freitas 2010, 2011; Tauber and Flint 2010; Tauber and Garland 2014).

This genus is distributed from southeastern Canada to Argentina, and its greatest species richness and abundance is in the tropics (Adams 1982; Brooks and Barnard 1990; Freitas et al. 2009; Tauber et al. 2000; Sosa and Freitas 2010). Currently, countries having the highest species richness of *Ceraeochrysa* include Brazil (33 species), Costa Rica (23), Mexico (15), Panama (14), and Venezuela (12) (Freitas et al. 2009; Sosa and Freitas 2010; Oswald 2018; Martins and Machado 2019). Species of this genus have been reported from dry and open forests and various agroecosystems (Tauber et al. 2000; Freitas et al. 2009). Their larvae are trash-bearers and feed on soft-bodied arthropods such as aphids, diaspidids, thrips, aleyrodids, psyllids, and neonatal larvae of Lepidoptera, which makes them potentially useful for biological control (Tauber et al. 2000; Freitas 2001; Penny 2002; Freitas et al. 2009).

There have been few studies of the Chrysopidae of Mexico, and knowledge of this group is fragmented. The aim of this paper is to describe and illustrate a new species of the genus *Ceraeochrysa* as part of a survey of the lacewings of the Tacaná Volcano, Chiapas across an altitudinal gradient. Also, a key to males of the species of this genus known from Mexico is included, excluding *C. indicata* (Navás) and *C. lateralis* (Guérin-Méneville) for which males are unknown. Due to their potential importance in the biological control of agricultural pests, there is an established need to better describe the green lacewing fauna of Mexico.

Materials and methods

The material examined was obtained during monthly samplings (February 2018–January 2019) in the Tacaná Volcano Biosphere Reserve, Chiapas state, Mexico. Specimens were captured at lights traps and with aerial net on vegetation, kept alive in plastic screw cap vials, then they were pinned as they died, or after being killed by freezing. For dissection of genitalia, the abdomen was cut between the 6th and 7th segments and the apical segments were removed and cleared with solution of 10% potassium hydroxide (KOH) for 15 min at 80 °C in a water bath. The cleared genitalia were stained using Clorazol Black E and then placed in microvials with glycerin. Observations were done under a Discovery V8 Zeiss dissecting microscope. Serial images from different layers were taken with a Zeiss Axio Zoom V16 microscope fitted with an AxioCam MRc5 digital camera and stacked using Zen 2012 (Blue edition). Head width was measured as the distance between the outer margins of the eyes, dorsally. Wing length was measured from the joint region to the apex (Sosa and Freitas 2010). The holotype and allotype, both dissected, are deposited at the Colección Nacional de Insectos (**CNIN**) of the Instituto de Biología, UNAM, Mexico City; paratypes will be deposited at CNIN, the Colección de Insectos asociados a plantas cultivadas en la Frontera Sur (**ECO-TAP-E**) and the National Museum of Natural History, Smithsonian Institution (**NMNH**), Washington, DC. The key was constructed based on Freitas et al. (2009).

Taxonomy

***Ceraeochrysa tacanensis* Cancino-López & Contreras-Ramos, sp. nov.**
http://zoobank.org/6B20810F-BA84-4838-AF7B-9AD9837497B4
Figures 1–3

Material examined (20 males, 11 females). ***Holotype*** **(male):** MEXICO: Chiapas, Cacahoatán, Ej[ido] Benito Juárez El Plan, 15°05'27.18"N, 92°08'51.06"W, 1479 m, 17.ii.2018, Cancino-López & Luna-Luna, light trap [genitalia dissected] (CNIN). ***Allotype*****:** MEXICO: Chiapas, Unión Juárez, Cantón Chiquihuites, 15°05'46.26"N, 92°05'56.46"W, 2072 m, 16.iv.2018, Cancino-López & Luna-Luna, light trap [genitalia dissected] (CNIN). ***Paratypes*****:** MEXICO: Chiapas, Cacahoatán, Ej[ido] Benito Juárez El Plan, 15°05'27.18"N, 92°08'51.06"W, 1479 m, 17.ii.2018, Cancino-López & Luna-Luna, light trap, 1 male, 1 female [genitalia dissected] (CNIN); same data but, 15°05'13.02"N, 92°08'55.2"W, 1430 m, 16.iii.2018, 2 males [one with genitalia dissected] (CNIN); same data but, 15°05'53.28"N, 92°08'29.88"W, 1705 m, 16.iii.2018, Cancino-López, 1 female, entomological net (CNIN); same data but, 15°05'36.48"N, 92°08'43.92"W, 1553 m, 12.viii.2018, 2 males (CNIN); same data but, 15°05'37.74"N, 92°08'43.26"W, 1572 m, 1 male (CNIN); same data but, 15°05'27.18"N, 92°08'51.06"W, 1479 m, 20.ix.2018, Cancino-López & Luna-Luna, 1 female, light trap (CNIN); same data but, 15°05'41.94"N, 92°08'41.52"W, 1577 m, 06.x.2018, Cancino-López, 1 female, entomological net (NMNH); same data but, 15°05'34.98"N, 92°08'45.42"W, 1541 m, 07.xi.2018, 1 female (NMNH); same data but, 15°05'40.98"N, 92°08'40.8"W, 1567 m, 08.xii.2018, 2 males (CNIN); same data but, 15°05'36.54"N, 92°08'43.8"W, 1549 m, 1 male (CNIN); same data but, 15°05'37.44"N, 92°08'43.68"W, 1564 m, 08.i.2019, 1 male (NMNH); same data but, 15°05'35.22"N, 92°08'44.76"W, 1533 m, 1 male (NMNH); same data but, 15°05'45.66"N, 92°08'40.5"W, 1582 m, 10.i.2019, 1 male, 1 female (ECO-TAP-E). MEXICO: Chiapas, Unión Juárez, Cantón Chiquihuites, 15°05'54.42"N, 92°05'57.96"W, 2157 m, 19.ii.2018, Cancino-López & Luna-Luna, 1 male [genitalia dissected], light trap (CNIN); same data but, 15°05'46.26"N, 92°05'56.46"W, 2076 m, 16.iv.2018, 1 male (CNIN); same data but, 15°05'43.74"N, 92°05'57.6"W, 2060 m, 14.v.2018, 3 males (CNIN); same data but, 15°05'43.79"N, 92°05'57.6"W, 2081 m, 10.ix.2018, 1 male, 1 female (NMNH); same data but, 15°05'43.79"N, 92°05'57.6"W, 08.x.2018, 1 male (CNIN); same data but, 15°06'9.06"N, 92°06'18.42"W, 2430 m, 19.xi.2018, Cancino-López, 1 male, entomological net (NMNH); same data but, Almaraz-Hernández, 1 female (NMNH); same data but, 15°05'43.79"N, 92°05'57.6"W, 2081 m, 14.i.2019, Cancino-López & Luna-Luna, 1 male, light trap (CNIN).

Diagnosis. This species has marks on the pronotum (a discontinuous red lateral stripe) and on the meso- and metanota (two anterior reddish black spots on each) (Fig. 1B) and on the abdominal tergites (orange to dark-brown lateral elongate marks) (Fig. 1D); forewing has the posterior branches of the cubital vein swollen, darkened and edged with dark on the membrane; last tarsal segments are darkened (Fig. 1A). The gonosaccus basally bears gonosetae (Fig. 3A); the arcessus is very long, narrow, straight,

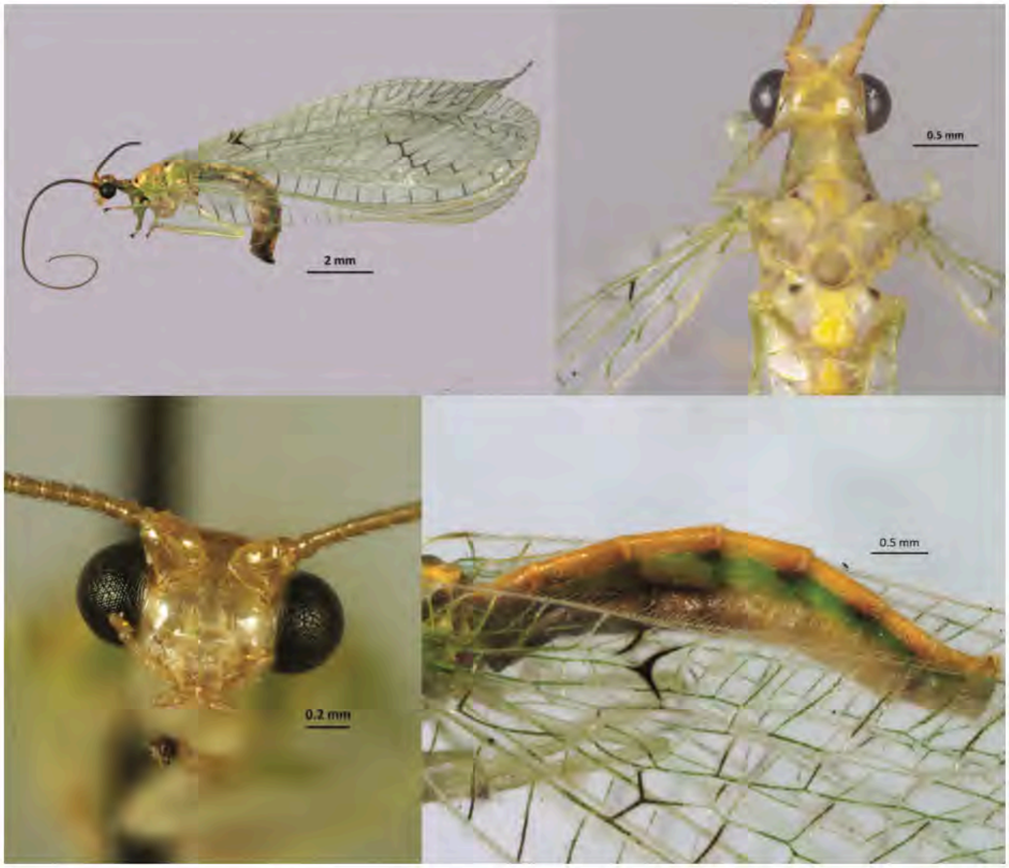


Figure 1. *Ceraeochrysa tacanensis* sp. nov. **A** habitus, lateral **B** head and thorax, dorsal **C** head, frontal **D** abdomen, lateral.

with curved apical point (Fig. 3B); the gonapsis is elongate, its basal section extends internally from the base of gonosaccus and is slightly upturned, terminating anteriorly in a smoothly rounded apex (Fig. 3E), the distal section extends externally and terminates dorsally with microteeth (Fig. 3D); a membranous sac between apices of gonapsis and sternite 9 bears a field of well-developed gonocristae (Fig. 3A).

Description. Measurements, mean (range) (*n* = 20). Male. Head: width 1.3 mm (1.2–1.4 mm). Pronotum: length 0.85 mm (0.7–1 mm), width 0.6 mm (0.4–0.8 mm). Forewing: length 11.7 mm (10–13.4 mm); 4–6 inner and 5–7 outer gradate veins. Hindwing: length 10.2 mm (8.8–11.6 mm); 3–5 inner and 4–6 outer gradate veins. **Female (*n* = 11).** Head: width 1.2 mm (1.1–1.3 mm). Pronotum: length 10 mm (0.9–1.1 mm), width 0.95 mm (0.9–1 mm). Forewing: length 12.4 mm (11.9–12.9 mm); 5–6 inner and 7 outer gradate veins. Hindwing: length 13.5 mm (10.2–11.9 mm); five or six inner and six or seven outer gradate veins.

Head. Front mainly pale (rarely with one brown, irregular transverse-stripe), vertex, clypeus, labrum, gena, maxillary, and labial palpi pale (Fig. 1C). Scape pale with

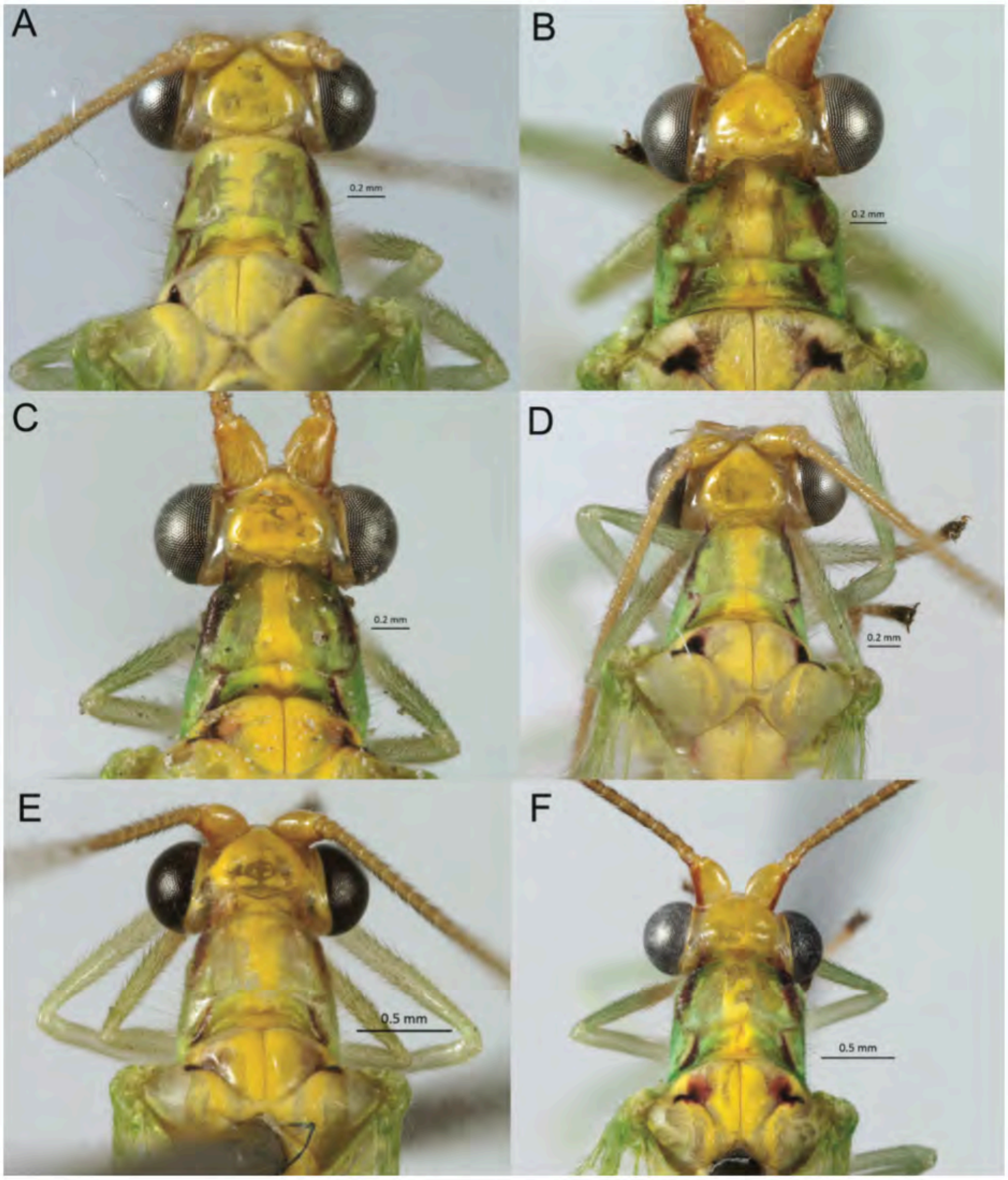


Figure 2. *Ceraeochrysa tacanensis* sp. nov., stripe variation on pronotum **A** discontinuous **B** interrupted **C** thickened **D** narrow **E** pale red **F** dark red.

lateral red stripe and pedicel pale with posterior-lateral red spot; flagellum pale, with 85–90 flagellomeres ($n = 31$).

Thorax. Pronotum greenish with a discontinuous red lateral stripe on each side and a medial, longitudinal yellow band; meso- and metanota greenish, each with a medial, longitudinal yellow band and two anterior reddish-black spots (Fig. 1A), and sometimes with two posterior red or orange spots; pleura pale green. Legs: pale green with yellow

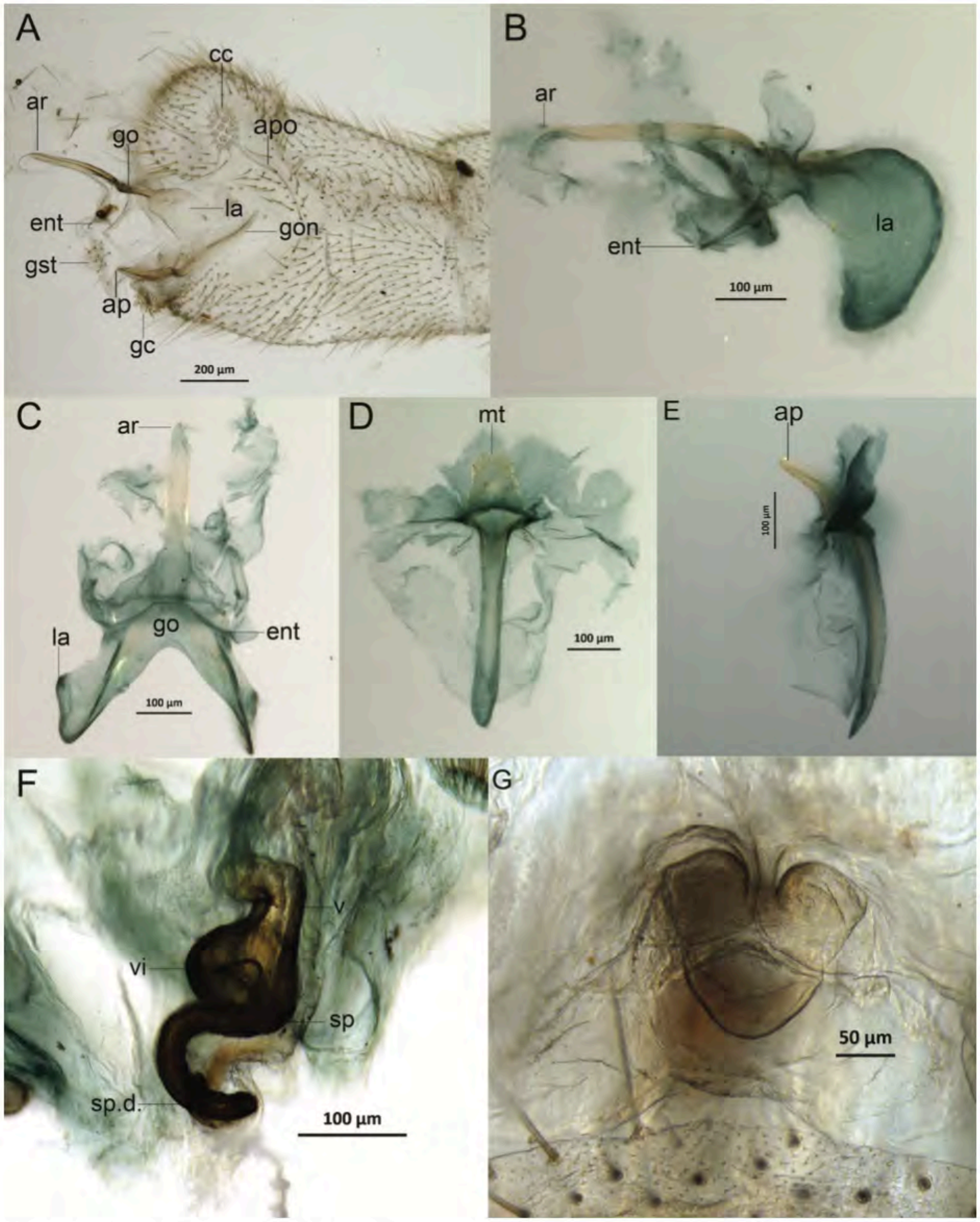


Figure 3. *Ceraeochrysa tacanensis* sp. nov. genitalia: **A** male terminalia, lateral **B** gonarcal complex, lateral **C** gonarcal complex, dorsal **D** gonapsis, dorsal **E** gonapsis, lateral **F** spermathecal complex, dorsolateral **G** female subgenitalia, frontal. Abbreviations: **ap**, apex of gonapsis; **apo**, male apodeme; **ar**, arcessus; **cc**, callus cerci; **ent**, entoprocessus; **gc**, gonocristae; **go**, gonarcus; **gon**, gonapsis; **gst**, gonosetae; **la**, lateral arms; **mt**, microteeth on gonapsis; **sp**, spermatheca; **sp.d.**, spermathecal duct; **v**, vela; **vi**, ventral impression.

tarsi, except one or two dark-brown apical tarsomeres (Fig. 1C). Forewings: venation mostly green, but some crossveins dark; dark markings at apex of 1A, posterior cubitus, and Cua-Cup crossveins form a distinct chevron-shaped mark (Fig. 1D); four to six inner and five to seven outer gradate veins. Hindwing: venation green, with apical section of radius dark; three to five inner and four to six outer gradate veins, all green.

Abdomen. Green, with dorsal, longitudinal yellow band; tergites with orange to dark-brown lateral elongate marks at posterior margin (Fig. 1D). Male apodeme slightly sclerotized and thin, without ventral lobe (Fig. 3A).

Male genitalia. Gonarcus thick with wide and elongate lateral plates (Fig. 3C); entoprocessus elongate, with evenly tapering tips (Fig. 3B); gonocornus lacking. Arcessus very long, narrow, straight, with downward curved apical point (Fig. 3B). Gonosaccus basally with gonosetae (Fig. 3A). Gonapsis elongate, extending from base of gonosaccus, slightly upturned, terminating internally in a smoothly rounded apex (Fig. 3E), with sclerotized microteeth on dorsal side (Fig. 3D); membranous sac between apices of gonapsis and sternite 9 with a field of well-developed gonocristae (Fig. 3A).

Female. Similar to holotype. *Female genitalia*. Female subgenitalia as wide as long, with rounded apex and narrow medial notch (Fig. 3G); spermatheca well sclerotized, with vela broad basally and strongly arched apically; spermathecal duct slightly sinuous before entering oviduct; ventral impression conspicuous (Fig. 3F).

Variation. Lateral stripes of pronotum are variable, for instance whether they are continuous or interrupted (Fig. 2A, B), thickened or narrow (Fig. 2C, D), pale or dark red (Fig. 2E, F); also, dorsolateral marks of the abdomen are generally orange, but may be reddish brown.

Etymology. This species is named after the Tacaná Volcano, located in the state of Chiapas, Mexico, where the specimens were collected.

Ecology. This species is presently known from cloud forest (1,430–1,705 m a.s.l.) and mixed oak-cloud forest (2,060–2,430 m a.s.l), and with similar collecting techniques and collecting effort, it was not found at lower (661–1,393 m a.s.l.) or higher (2,884–3,246 m a.s.l) elevation collecting sites. Specimens were found on *Alinus* sp., *Quercus* sp., and *Saurauia* sp., and were collected from February through May, August through December 2018, and January 2019.

Discussion

Ceraeochrysa tacanensis sp. nov. shares the posterior branches of the cubital vein swollen and dark, V-shaped marking with *C. angulata* (Navás), *C. angusta* Freitas & Penny, *C. digitata* Freitas & Penny, *C. elegans* Penny, *C. nigripedis* Penny, and *C. tauberae* Penny. Also, an elongate arcessus is shared with these species (except *C. angulata* and *C. digitata*), plus *C. bitacornua* Freitas & Penny. The new species differs from the former species because it has a discontinuos stripe on the pronotum, while the rest have spots (*C. angulata*, *C. angusta*, *C. elegans*, *C. nigripedis*, and *C. tauberae*) or a continuous stripe (*C. bitacornua* and *C. digitata*). Another species with a discontinous stripe on the pronotum is *C. pittieri* Sosa & Freitas (Sosa and Freitas 2010: figs 4, 5), however, this species does not share other traits as explained above. In addition, *C. tacanensis* sp. nov. shares marks on the abdominal tergites with *C. elegans*, although the tarsal segments are darkened apically in the new species, as in *C. nigripedis*. Regarding genitalia, the new species is most similar to *C. nigripedis*, sharing a simple dorsal apodeme, an elongate gonapsis, and the shape of the gonarcal complex. However, the new species has a gonosaccus with gonosetae and a membranous sac with gonocristae between apex of gonapsis and sternite 9, similar to *C. elegans*. The sclerotized microteeth extended on the dorsal side of the gonapsis apex may be a unique trait of the new species (also present in the unrelated *C. sanchezi*), while *C. elegans* has microteeth restricted to the apex.

Key to species of *Ceraeochrysa* of Mexico (Modified from Freitas et al. 2009)

1 Pronotum with one or more pairs of lateral spots, or thin, sub-medial stripes **2**
– Pronotum with red or brown lateral stripes or no stripes **3**
2 Last two tarsal segments of legs black; lateral surface of antennal scape red; abdominal tergites with orange spots .... ***Ceraeochrysa tacanensis* Cancino-López & Contreras, sp. nov.**
– Tarsal segments of legs pale; lateral surface of antennal scape dark; abdominal tergites with red bands .... ***C. elegans* Penny**
3 Area of vertex behind antennal bases entirely red .... ***C. smithi* (Navás)**
– Area of vertex behind antennal bases pale **4**
4 Basal flagellar segments pale **5**
– Basal flagellar segments dark **9**
5 Maxillary palpi pale, with dark marks .... ***C. cubana* (Hagen)**
– Maxillary palpi pale, without dark marks **6**
6 Antennal scape with two stripes .... ***C. arioles* (Banks)**
– Antennal scape with one stripe **7**
7 Antennal scape with lateral stripe .... ***C. valida* (Banks)**
– Antennal scape with dorsal stripe **8**
8 Mesonotum with dark marks; male dorsal apodeme with long ventral branch, basally attached; arcessus as broad as long; gonapsis thick and short .... ***C. cornuta* (Navás)**
– Mesonotum unmarked; male dorsal apodeme with recurved ventral branch basally attached; arcessus broad; gonapsis long, slender, apically upturned .... ***C. cincta* (Schneider)**
9 Antennal scape with lateral or dorsolateral stripe/spot **10**
– Antennal scape with dorsal stripe .... ***C. claveri* (Navás)**
10 Genae dark to partially dark **11**
– Genae pale yellow to pale brown **13**
11 Apex of male ectoproct rounded, with simple, thin setae .... ***C. derospogon* Freitas and Penny**
– Apex of male ectoproct pointed, with chalazae (thick-based setae) **12**
12 Male tergite 9 + ectoproct deeply divided; gonosaccus with field of gonocristae; sternite 8 + 9 quadrate with one long chalazate seta at each lateral corner;

ventral fork of dorsal apodeme not projected caudally beyond ectoproct....... .... ***C. berlandi* (Navás)**

– Male tergite 9 + ectoproct not deeply divided; gonosaccus lacking field of gonocristae; sternite 8 + 9 rounded with chalazate setae throughout; ventral fork of dorsal apodeme projected ventrocaudally well beyond ectoproct ....***C. effusa* (Navás)**

13 Arcessus membranous basally with a pair of hooks and two inflated lobes, apex with a medial hook and pair of lateral, decurved and medially curved sclerotized lobes .... ***C. everes* (Banks)**

– Arcessus not membranous basally, of triangular-shape; apex with medial decurved point .... ***C. sanchezi* (Navás)**

Acknowledgments

We thank Harry Brailovsky (Instituto de Biología-UNAM) and David Bowles (Missouri State University) for providing comments and suggestions on the manuscript. Our appreciation goes to Museo Nacional de Costa Rica, for allowing Adrian Ardila-Camacho to photograph the holotypes of *C. elegans* and *C. nigripedis*, and we also thank Adrian for taking those photos. We thank Susana Guzmán (Laboratorio de Microscopía, IBUNAM) for advice on stereomicroscope photography. Magali Luna-Luna and Johar Almaraz-Hernández provided support during fieldwork, and Yesenia Marquez-López helped with image editing. We are indebted to Beningno Gómez, Reserva de la Biosfera Volcán Tacaná (Francisco J. Jiménez González, director), Cantón Chiquihuites, and Ejido Benito Juárez El Plan, for authorization for fieldwork in the study area. RJCL 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. This study was supported by project IN207517 "Aportaciones a la taxonomía y filogenia del orden Neuroptera (Insecta) en México" funded by "Programa de Apoyo a Proyectos de Investigación e Innovación Tecnológica" (PAPIIT-UNAM).

References

Adams PA (1982) *Ceraeochrysa*, a new genus of Chrysopinae (Neuroptera) (Studies in New World Chrysopidae, Part II). Neuroptera International 2: 69–75.

Brooks SJ, Barnard PC (1990) The green lacewings of the world: a generic review (Neuroptera: Chrysopidae). Bulletin of the British Museum of Natural History Entomology 59: 117–286.

Freitas S (2001) O uso de crisópideos no controle biológico de pragas. Funep, Jaboticabal, 66 pp.

Freitas S, Penny ND (2001) The green lacewings (Neuroptera: Chrysopidae) of Brazilian agro-ecosystems. Proceedings of the California Academy of Sciences 52: 245–395.

Freitas S, Penny ND, Adams PA (2009) A revision of the New world genus *Ceraeochrysa* (Neuroptera: Chrysopidae). Proceedings of the California Academy of Sciences 60: 503–610.

Martins CC, Machado RJP (2019) Chrysopidae in Catálogo Taxonômico da Fauna do Brasil. PNUD. http://fauna.jbrj.gov.br/fauna/faunadobrasil/7242 [Accessed on: 2019–10–10]

Oswald JD (2018) Lacewing digital library. Neuropterida species of the world. http://lacewing.tamu.edu/Species-Catalogue/index.html [Accessed on: 2019–10–10]

Penny ND (1997) Four new species of Costa Rican *Ceraeochrysa* (Neuroptera: Chrysopidae). Pan-Pacific Entomologist 73: 61–69.

Penny ND (1998) New Chrysopinae from Costa Rica (Neuroptera: Chrysopidae). Journal of Neuropterology 1: 55–78.

Penny ND (2002) A Guide to the lacewings (Neuroptera) of Costa Rica. Proceedings of the California Academy of Sciences 53: 161–457.

Sosa F, Freitas S (2010) New Neotropical species of *Ceraeochrysa* Adams (Neuroptera: Chrysopidae). Zootaxa 2562: 57–65. https://doi.org/10.11646/zootaxa.2562.1.4

Sosa F, Freitas S (2011) A new synonym, a new male description and new geographical records for three *Ceraeochrysa* species (Neuroptera: Chrysopidae). Zootaxa 2913: 47–58. https://doi.org/10.11646/zootaxa.2913.1.5

Tauber CA, Garland JA (2014) *Kymachrysa*, a new genus of Nearctic green lacewings (Neuroptera, Chrysopidae, Chrysopini). ZooKeys 437: 87–108. http://doi.org/10.3897/zookeys.437.7984

Tauber CA, Flint Jr OS (2010) Resolution of some taxonomic and nomenclatural issues in a recent revision of *Ceraeochrysa* (Neuroptera: Chrysopidae). Zootaxa 2565: 55–67. https://doi.org/10.11646/zootaxa.2565.1.4

Tauber CA, De León T (2001) Systematics of green lacewings (Neuroptera: Chrysopidae): larvae of *Ceraeochrysa* from Mexico. Annals of the Entomological Society of America 94: 197–209. https://doi.org/10.1603/0013-8746(2001)094[0197:SOGLNC]2.0.CO;2

Tauber CA, De León T, Penny N,Tauber MJ (2000) The genus *Ceraeochrysa* (Neuroptera: Chrysopidae) of America north of Mexico: larvae, adults, and comparative biology. Annals of the Entomological Society of America 93: 1195–1221. https://doi.org/10.1603/0013-8746(2000)093[1195:TGCNCO]2.0.CO;2