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**SINOPSIS DE LA TRIBU GNORIMOSCHEMINI
(LEPIDOPTERA: GELECHIIDAE), CON ESPECIAL
ENFOQUE A LA FAUNA DE AMÉRICA CENTRAL Y
REGIÓN NORTE DE SUDAMÉRICA**

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Tesis como requisito en la obtención del título de Doctor en Ciencias con
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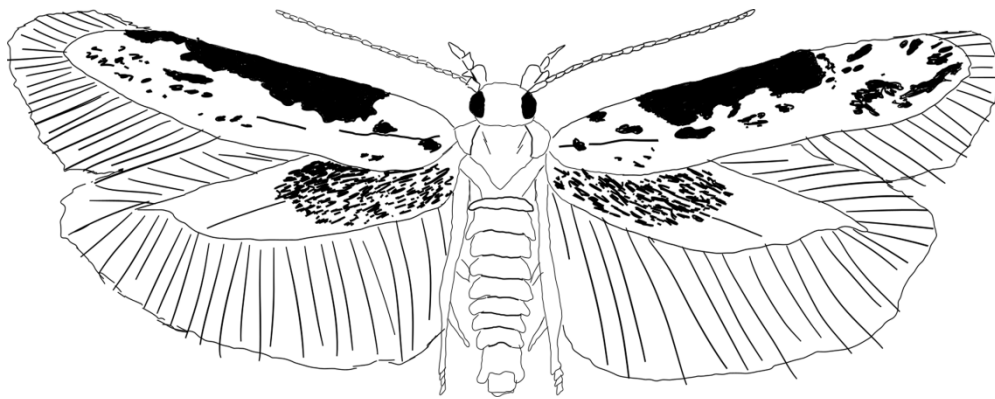
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2021

In Memoriam

Prof. Ing. Cheslavo Korytkowski

Este trabajo es dedicado en honor al mentor y estimado amigo...

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Índice

Resumen	6
Abstract	7
Prólogo	8-10
Objetivos y estructura de la tesis doctoral	11-12
Productos y difusión científica de la tesis	13-15
Capítulo I	
Sinopsis de la tribu Gnorimoschemini, un enfoque global	16-116
<i>Introducción</i>	17-19
<i>Materiales y métodos</i>	19-25
<i>Morfología general</i>	25-38
<i>Resultados</i>	38-88
Géneros de la tribu Gnorimoschemini y sus etimologías	38-42
Lista sinóptica para los Gnorimoschemini Neotropicales	42-54
Selección de plantas huésped para los Gnorimoschemini	55-59
Lista de caracteres morfológicos	59-75
Filogenia preliminar para la tribu Gnorimoschemini	75-88
<i>Conclusiones</i>	89-92
<i>Referencias</i>	93-116
Capítulo II	
Clasificación del taxon <i>Tuta absoluta</i> (Lepidoptera: Gelechiidae: Gnorimoschemini) basado en el análisis cladístico de su morfología	117-141
Capítulo III	
Revisión del género <i>Pavolechia</i> , descripción de una nueva especie y su posición sistemática dentro de la subfamilia Anacampsinæ	142-151
Capítulo IV	
Descripción de una nueva especie para el género <i>Colonanthus</i> y su posición sistemática dentro de la tribu Litini	152-162
Capítulo V	
Descripción de tres nuevas especies de Gelechiidae para Panamá	163-179
Capítulo VI	
Listado sinóptico actualizado para los Gelechiidae de Panamá	180-215
Capítulo VII	
Lepidópteros que afectan los principales cultivos anuales de Panamá	216-297
Conclusiones generales	298-301
Appendix	302-322
Glossary	323-324
Curriculum vitae	325

Resumen

El presente trabajo busca definir a través de elementos morfológicos la tribu Gnorimoschemini. Para ello se revisó el material tipo en búsqueda de aquellas sinapomorfias relevantes en la definición de la tribu. En adición, se logró clarificar aquellos caracteres de utilidad en el estudio de la familia Gelechiidae. En cuanto a la metodología utilizada, la misma incluye desde la búsqueda activa de las formas inmaduras y cría en condiciones de laboratorio, búsqueda pasiva con trampas de luz, su debido procesamiento y disecciones para la correcta determinación a través del estudio de los genitalia. En adición, a la exploración de los nuevos caracteres se realizaron micro preparaciones de cuerpo completo de los ejemplares. Se visitaron colecciones en Norte América en dónde se pudieron estudiar los tipos de Gnorimoschemini y luego los tipos de Gelechiidae de Panamá descritos por August Busck. Los análisis filogenéticos fueron realizados a través de múltiples paquetes informáticos. Entre los productos alcanzados durante los cuatro años de investigación doctoral destaco: el estudio de las relaciones filogenéticas basadas en elementos morfológicos, principalmente. También se pudo trabajar en la posición sistemática del taxon “*Tuta absoluta*”, logrando ubicarlo dentro del género *Phthorimaea*. Con el uso de nuevos caracteres se logran describir nuevos taxones para la familia Gelechiidae en el Neotrópico. Otra contribución importante lograda a través de esta investigación fue listar aquellas especies de lepidópteros que representan un riesgo para los principales cultivos de Panamá. Se reportan un total de 12 nuevos registros para Panamá y 5 nuevas especies para la familia Gelechiidae, se confirma la presencia de 5 especies de Gnorimoschemini en Panamá, mientras que para la región Neotropical se lista un total de 199 especies, predominando un mayor conocimiento de la fauna presente en América del Sur. En el futuro, la tribu Gnorimoschemini sufrirá importantes cambios en su sistemática. Varios géneros deberán ser sinonimizados y otros deberán ser transferidos a otras tribus de Gelechiidae. Se recomienda ampliar los esfuerzos de muestreo para poder realizar asociaciones de machos y hembras en los casos en que sólo son conocidos individuos de un sexo.

Palabras clave: Lepidoptera, sistemática, Gelechiidae, Gnorimoschemini, listado sinóptico, nuevas especies, Neotrópico.

Abstract

The present work seeks to define the tribe Gnorimoschemini through morphological characters; the type material was reviewed in search of those relevant synapomorphies that define the tribe. In addition, it was possible to clarify which characters are useful in the study of the family Gelechiidae. Regarding the methodology applied in this study, it includes the active search for immature forms and rearing under laboratory conditions; passive search with light trapping, sample processing and genitalic dissections for the correct determination of the species. In addition, to explore the new characters, full-body mounts of the specimens were made. Several collections in North America were visited in order to study the types of Gnorimoschemini, including the types of the Panamanian Gelechiidae described by August Busck. The phylogenetic analyzes were carried out with multiple computer packages. Among the products achieved during the four years of doctoral research, the following stand out: the study of phylogenetic relationships based on morphological elements. Mainly, it was possible to determine that the correct systematic position of the taxon "*Tuta absoluta*", is within the genus *Phthorimaea*; while with the new characters it was possible to describe new taxa for the family Gelechiidae in the Neotropics. Another important component achieved through this research was the listing of those Lepidopteran species affecting major crops in Panama. It is reported a total of 12 new records of Gelechiidae for Panama, 5 new species of Gelechiidae, and confirmed the presence of 5 species of Gnorimoschemini in Panama. A total of 199 species are known for the Neotropics, representing greater knowledge of the fauna present in South America. In the future, the tribe Gnorimoschemini will undergo important changes in its systematics, several genera may be synonymized and others must be transferred to other tribes of the family Gelechiidae. Sampling efforts should be expanded to make male-female associations in cases where only individuals of a single sex are known.

Key words: Lepidoptera, systematics, Gelechiidae, Gnorimoschemini, checklist, new species, Neotropics.

Prólogo: Una introducción al mundo de las mariposas nocturnas de Panamá

Durante décadas, el estudio de las polillas panameñas ha sido de interés para el mundo taxonómico. La posición geográfica de este país lo hizo particularmente interesante para estudios biogeográficos y de sistemática a diferentes niveles. Los primeros lepidopterólogos y recolectores que llegaron a Panamá hicieron valiosos aportes al conocimiento de las especies. Entre estos entomólogos se encuentran Lord Walsingham, Edward Meyrick, August Busck y Joseff Uljheli. Este último hizo colecciones de material valioso de la provincia de Colón, previo a la construcción del Canal, y su material está depositado en varias de las colecciones europeas.

Las polillas de Panamá son particularmente llamativas. Sus hábitos dorsales característicos y coloración cautivan la mirada de coleccionistas, artistas y fotógrafos de todo el mundo. Además, estas polillas se pueden encontrar en una amplia variedad de ecosistemas y experimentan un comportamiento complejo. Como ejemplo de este hecho, tenemos una lista preliminar de las mariposas y polillas del Museo de la Biodiversidad de Gehry. Un total de 60 especies fueron encontradas inicialmente en el jardín botánico, ubicado en el ecosistema costero de la Calzada de Amador. Se registró la presencia de *Acrolophus panamae* (Lepidoptera: Acrolophidae) como especie común que visita los alrededores. Se discutieron notas adicionales sobre el comportamiento y las paredes coloridas del edificio como un posible atrayente para las especies (Corro Chang, 2017a). Ahora, con la segunda parte del jardín ya establecido y actualizaciones de dicha lista de mariposas y polillas de Amador, se han incrementado los registros. Según nuestros datos actualizados, se ha logrado superar ya las 200 especies.

En contraste, otras especies de polillas podrían representar serios problemas para la agricultura. Por esta razón se emitió una breve comunicación explicando la importancia del grupo, posibles aplicaciones y el riesgo que algunas especies podrían representar para la agricultura y para el sector de la salud en Panamá (Corro Chang, 2017b; Corro Chang, 2018a,b; Corro Chang, 2019a). En esta breve comunicación también se habló de la presencia de especies en el país capaces de causar hasta el 100% de la pérdida de cultivos

(Corro Chang, 2020), como *Phthorimaea absoluta* (Lepidoptera: Gelechiidae: Gnorimoschemini), y se destacó la importancia del grupo como elemento inspirador para las artes.

Se llevaron a cabo dos años de estudios en las principales áreas agrícolas de Panamá. Como resultado, surge la guía de campo: “Guía de Campo, Principales Especies de Lepidoptera (Heterocera) asociadas a cultivos anuales de Panamá” (Corro Chang y Tarakanov, 2017), trabajo que fue publicado a nivel nacional. En esta guía se discutieron los principales problemas que representan un total de 69 especies, 57 géneros y 13 familias de polillas, asociadas a la agricultura en Panamá. Se discutieron detalles de su impacto, tipos de daños, plantas hospedantes, distribución mundial y estrategias de control que se aplican actualmente en América Latina. Se realizó una edición actualizada de la guía de campo, que incluyó disecciones de los genitales y registros detallados de las plagas (Corro Chang, 2021).

Muchas otras especies podrían estar modificando su hábitat y extendiéndose a diferentes niveles altitudinales. Ese es el caso de la especie *Gonodonta incurva* (Lepidoptera: Erebiidae: Calpinae), cuya presencia se registró en Panamá entre 400 a 1000 m.s.n.m. (Corro Chang, 2018c). En adición, se han aportado nuevos conocimientos sobre las polillas panameñas ampliando los inventarios sistemáticos en nuevas regiones de Panamá, y como resultado puedo mencionar la descripción de nuevos taxones para la familia Gelechiidae. Las especies *Pavolechia mimetica* Heppner y Corro Chang, 2017, *Colonanthes korytkowskii* Corro Chang, 2020, *Aristotelia barriosi* Corro Chang y Bidzilya, 2020, *Chionodes sariguaensis* Corro Chang y Bidzilya, 2020 y *Agnippe tarakanovi* Corro Chang y Bidzilya, 2020 representan ejemplos de nuevos taxones descritos de Panamá. La inclusión de diferentes sistemas de captura y la ampliación de los inventarios sistemáticos para el país ha propiciado no solo la descripción de nuevos taxones, sino también el conocimiento de las hembras del género *Colonanthes*.

Finalmente, es pertinente destacar que queda mucho por hacer para aumentar los conocimientos valiosos sobre los lepidópteros neotropicales y, en particular, la familia

Gelechiidae. Este trabajo representa solo el comienzo de un largo camino de descubrimientos. Los siguientes capítulos presentarán los principales problemas encontrados en el estudio de la sistemática de la tribu Gnorimoschemini, un grupo de taxones poco conocido en el Neotrópico y con importantes lagunas de información y muchos sinónimos, lo que convierte al grupo en un objetivo interesante para los estudios de sistemática (Corro Chang, 2019b). Además, se revisa la posición sistemática del taxón *Tuta absoluta*, cuya posición taxonómica tradicional por años resultó un gran problema taxonómico (Corro Chang y Metz, 2021a; b); además se incluye una lista de 82 especies de la familia Gelechiidae presentes en Panamá (Corro Chang et al., 2021), con la posibilidad de agregar nuevos taxones en el futuro.

Objetivos y estructura de la tesis doctoral

La organización del trabajo final corresponde a una estructura capitular, en dónde, cada capítulo corresponde con un artículo científico. A inicio de cada capítulo, se destacan los detalles de la publicación y su estatus. En adición, la sección de anexos incluye dos artículos publicados sobre el orden Lepidoptera de manera colateral, durante los cuatro años de estudios doctorales.

Objetivo general

- Estudiar la fauna de Gelechiidae comprendida entre América Central y la región norte de América del Sur, particularmente las especies pertenecientes a la tribu Gnorimoschemini.

Capítulo I

- Definir aquellas sinapomorfias encontradas entre los miembros de la tribu Gnorimoschemini, basadas en elementos morfológicos.
- Establecer posibles relaciones filogenéticas dentro de la tribu Gnorimoschemini.
- Clarificar y validar el estado de los actuales taxones.

Capítulo II

- Estudiar la clasificación del taxón *Tuta absoluta* (Lepidoptera, Gelechiidae, Gnorimoschemini) basado en el análisis cladístico de la morfología.
- Discutir la posición sistemática del taxón *Tuta absoluta* dentro del género *Phthorimaea* basándonos en la evidencia morfológica disponible.

Capítulo III

- Revisar el género Neotropical *Pavolechia* (Lepidoptera, Gelechiidae).
- Describir una nueva especie para el género Neotropical *Pavolechia*.
- Discutir la posición sistemática del género *Pavolechia* dentro de la subfamilia Anacampsinae.

Capítulo IV

- Describir una nueva especie para el género *Colonanthes*, incluyendo los genitalia de las hembras nunca antes conocidas.

- Discutir la posición sistemática del género *Colonanthes* dentro de la tribu Litini.

Capítulo V

- Describir tres nuevas especies de Gelechiidae para Panamá asociadas a ambientes frágiles y xéricos del país.

Capítulo VI

- Actualizar el listado de los Gelechiidae de Panamá incluyendo nuevos registros para el país y las especies de la tribu Gnorimoschemini conocidas.
- Mapear las zonas inventareadas históricamente dentro del país.

Capítulo VII

- Estudiar las especies de lepidópteros heteróceros asociados a la agricultura de Panamá, incluyendo algunos aspectos de las historias de vida de las especies de la tribu Gnorimoschemini.

Productos y difusión científica de la tesis

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Capítulo I

SINOPSIS DE LA TRIBU GNORIMOSCHEMINI, UN ENFOQUE GLOBAL

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CORRO CHANG, P. 2019. Synopsis of the tribe Gnorimoschemini (Lepidoptera: Gelechiidae), with a special approach to the Central America and northern South America fauna. *En: XXI European Congress of Lepidopterology. Book of Abstracts. Campobasso, Italy.* p. 49.

CORRO CHANG, P.; M. METZ y J.-F. LANDRY. Synopsis of the tribe Gnorimoschemini (Lepidoptera: Gelechiidae), with a special approach to the Central America and northern South America fauna. *In Preparation.*

Abstract

The tribe Gnorimoschemini includes a relevant group of micro moths, which stand out by their tiny size (around 10 mm) and their importance for different ecosystems. Larvae of species such as *Keiferia lycopersicella*, *Phthorimaea operculella*, *Tecia solanivora*, *Phthorimaea absoluta* and the complex *Symmetrischema tangolias* are responsible for large losses in Solanaceae crops worldwide; while other species could function as bioindicators in fragile ecosystems. With important gaps in the knowledge of their life histories, few larvae described specially from the Neotropics, few specialists in the world, and around 4,700 species described for the whole family with thousands of underscribed, the lack of concise literature that allows the specific diagnosis makes the group attractive for systematics studies, including functional morphology, phylogenetics and the application of molecular markers to entangle cryptic complexes within the group. The present work aims to show advances in studies based on the type material deposited in collections worldwide, and illustrate morphological aspects that allow the association at the generic and specific level of these insects. It highlights a total of 17 genera and at least 199 species with new records in the Neotropics. The greater knowledge and reference collections for the group are concentrated in North America and Europe. The occasion is used to promote the development of collections in the Neotropics that allows advances in the knowledge of the group.

Key words: tuber moth, systematics, phylogenetics, functional morphology, homology, checklist, Gnorimoschemini, Neotropics.

Introducción

Povolný (2002a,b) reconoció un grupo de polillas de especies relacionadas durante algunos años, y en 1964 las segregó como la tribu Gnorimoschemini de la familia Gelechiidae (Povolný, 1964). Pero la monofilia de la tribu aún no cuenta con el soporte suficiente (Huemer y Karsholt, 2010; Karsholt et al., 2013; Corro Chang, 2019) pese a los esfuerzos realizados por Ponomarenko con la inclusión de la morfología funcional (Ponomarenko,

2005; 2008). La utilización sólo del habitus externo no es suficiente lo que hace difícil separar a los taxones. Povolný menciona en sus artículos ciertas tendencias en el patrón del ala anterior que es muy característico en grupos con amplio número de especies y géneros, pero nunca definió los caracteres de la nueva tribu de Gelechiidae en un sentido filogenético (Povolný y Sustek, 1988; Povolný, 2002b). De esta forma, Gnorimoschemini presenta importantes lagunas en conocimiento. Por otro lado, muchas especies son completamente desconocidas en cuanto a sus historias de vida y solo se han descrito unas pocas larvas, especialmente para el Neotrópico. Hay pocos microlepidopterólogos en el mundo, sin embargo, en cuanto a riqueza se han descrito más de 4700 especies para toda la familia y miles siguen aún sin describir. La falta de literatura concisa para su identificación, hace de este grupo un objetivo interesante para estudios sistemáticos, incluida la morfología y el uso de herramientas moleculares para aclarar la diversidad críptica.

Pese a las limitantes expuestas, existen trabajos focalizados en inventarios de regiones particulares del mundo (Mann, 1857; Staudinger, 1859; 1880a,b; Rebel, 1899; Lvovskij y Piskunov, 1989; Piskunov, 1990; Karsholt y Razowski, 1996; Lastuka, 1998; Weiser, 2005; Sinev, 2008; Bidzilya y Budashkin, 2009; Lee et al., 2009; Junnilainen y Nupponen, 2010; Bidzilya y Karsholt, 2018; Bidzilya y Nupponen, 2018). En adición, dada la complejidad que presentan algunas formas, se han presentado revisiones genéricas en las cuales se abordan la complejidad morfológica de las especies, entre ellas la braquiptería (Sattler, 1988; Pitkin y Sattler, 1991; Karsholt y Sattler, 1998), condición que a su vez puede estar presente en especies del género *Gnorimoschema*, entre otros aspectos, en la literatura se incluyen las ilustraciones de los genitalia, se realizan aportes sistemáticos y biológicos (Li y Bidzilya, 2008; Bidzilya y Li, 2010; 2016; Landry et al., 2017; Nazari, 2017; Bidzilya y Mey, 2018; Bidzilya et al., 2019).

Actualmente, la tribu Gnorimoschemini incluye especies de gran importancia económica, principalmente asociadas a cultivos de solanáceas. Estimaciones realizadas en el pasado por Dálíbor Povolný sugieren que la pérdida económica de los tubérculos de papa en Costa Rica alcanza los 900.000 USD por año (Povolný, 1973d). Mundialmente se le ha dado un especial enfoque a la situación fitosanitaria de este rubro (CIP, 1991). Además de los

mayores esfuerzos realizados por Povolný para comprender al grupo, aún quedan lagunas de información: caracteres ambiguos, largas listas de sinonimias, material mal identificado, descripciones deficientes de trabajos anteriores. Todo esto complicando la definición de la tribu, géneros e identificación a nivel taxonómico de especies. Con una mejor comprensión del grupo a partir de estudios fundamentales, tales como la sistemática, académicos, investigadores y profesionales de las ciencias aplicadas, pudiesen ser beneficiarios directos de este proyecto, haciendo que las decisiones de conservación sean más eficaces y respetuosas con el medio ambiente; en adición, se prevé una mejora en la implementación de nuevos métodos de manejo integrado de aquellas especies consideradas plagas.

Materiales y métodos

A. Tratamiento sistemático de las especies

El material de Gnorimoschemini se identificó y separó en morfoespecies según los caracteres externos y las similitudes entre los especímenes. Para efecto de este trabajo, se utilizaron los criterios de clasificación establecidos por Karsholt et al. (2013) y Heikkilä et al. (2014) para el caso de las subfamilias. Para confirmar que los ejemplares eran pertenecientes a la familia Gelechiidae, se corroboraron las identificaciones utilizando las claves para Gelechiidae de Europa (Huemer y Karsholt, 1999), y para la asignación genérica dentro de la tribu Gnorimoschemini así como la terminología utilizada en las descripciones se consultaron los trabajos de Clarke, Povolný, Hodges, Ponomarenko Huemer y Karsholt (Clarke, 1969a,b; 1970; Povolný, 1985; 1986; 1987; 1989; 1990a,b,c; 1994a,b; Hodges, 1966; Ponomarenko, 2005; 2008; Huemer y Karsholt, 2010). Adicionalmente, con el fin de profundizar los conocimientos sobre las especies de Gnorimoschemini conocidas en el mundo y elaborar un listado sinóptico de las especies Neotropicales se consultaron los aportes de Povolný enfocados en la sistemática activa de la tribu, definiciones genéricas y descripciones de nuevos taxones para las diversas regiones geográficas (Povolný, 1964-2004; Powell y Povolný, 2001).

Los cambios de nomenclatura y la revisión de los nombres científicos, incluidos los sinónimos y su validez, siguieron a Meyrick (1908; 1913; 1917; 1925-1927; 1931),

Fletcher (1929), Sattler (1973), Hodges (1983) y Becker (1984). Para el caso particular de las ortografías posteriores incorrectas (*incorrect subsequent spellings*), las mismas fueron citadas de manera conveniente.

El estudio de las etimologías Latinas y Griegas utilizadas por Povolný en la formulación de sus géneros fue realizado consultando a Brown (1956).

Los cambios de nomenclatura y las decisiones de sinónimos se realizaron siguiendo las reglas del Código Internacional de Nomenclatura Zoológica (ICZN, 1985; 2000).

El patrón de distribución de las especies se complementó con datos de la literatura y la inclusión de los registros del material de las colecciones y la colección personal de la autora. Para ello, se realizaron cinco años de muestreos intensivos (2015-2019) a lo largo de Panamá, particularmente, en las provincias de Chiriquí, Coclé, Colón, Herrera, Los Santos, Veraguas y Panamá.

Los procedimientos para el montaje y micropreparaciones de microlepidópteros siguen a Landry y Landry (1994) y Heppner (2017). Las disecciones genitales (Tabla 1) se realizaron siguiendo los procedimientos de la Oficina Estadounidense de Entomología y Cuarentena Vegetal, con modificaciones particulares realizadas por Clarke (1941). También se aplicaron los procedimientos para disecciones genitales de microlepidópteros, conocidos como técnica de desenrollado o “unrolling”, y los procedimientos del Museo Británico de Historia Natural para estudiar los tipos de genitales (Robinson, 1976; Pitkin, 1986; Huemer, 1988). El uso de tinciones básicas, como Clorazol Black, Safranin O, Mercurocromo y Rose Bengal, proporciona mejores resultados en los tejidos membranosos, como los genitales femeninos (Jaeger, 2016). Para poder continuar con la exploración de caracteres morfológicos, almacenamos el material disectado en micro-viales con glicerina.

Tabla 1. Resumen metodológico para la realización de los micropreparados de los genitalia:

I	• Separación del abdomen. Remoción de escamas en alcohol 20%.
II	• Maceración del abdomen en KOH 10% por 13 minutos en calor.
III	• Lavado de la muestra en ácido acético diluido o ácido láctico.
IV	• Tinción al 1% en orange G, y chlorazol black (para reconocimiento de estructuras membranosas).
V	• Disección en celosolve.
VI	• Deshidratación de la muestra en alcohol absoluto.
VII	• Preservación de la muestra en viales con glicerina o montaje en porta objetos con bálsamo y esencia de Euparal.

Las descripciones y bases de datos se procesaron en una computadora provista de un procesador de alto rendimiento y una tarjeta gráfica. Los requisitos mínimos eran el procesador Intel Core i7 y la tarjeta de alto rendimiento, como NVidia Maximus, para admitir gráficos HD, incluida la compatibilidad con varios monitores. El estudio morfológico de los caracteres se complementó con el uso del escáner ct-nano proporcionado por el USNM, con el fin de visualizar mejor algunas estructuras, entre ellas, la culcitula.

Las fotografías de los especímenes y las disecciones genitales se realizaron con un microscopio marca LEICA modelo M205A y un microscopio de contraste de fases LEICA modelo DM3000 LED. Las imágenes fueron editadas en Adobe Photoshop versión 6.0.

Las ilustraciones científicas y esquemas complementarios se realizaron con una tableta digitalizadora profesional modelo Huion 10.

Se revisó el estado del material tipo, las plantas hospedantes, los registros de distribución y diversos depositarios, accediendo a colecciones de museo y bases de datos en línea. Adicionalmente, se consultó el catálogo de material tipo depositado en el NHMUK de Walker (1864); y el catálogo de material tipo depositado en USNM de Brown et al. (2004).

B. Abreviaciones de las instituciones consultadas

- ANIC**= Australian National Insect Collection, CSIRO, Canberra, Australia. (A. Zwick).
- NHMUK**= British Museum Natural History, London, United Kingdom. (K. Sattler y D. Lees).
- CNC**= Canadian Collection of Insects, Arachnids and Nematodes, Agriculture, Ottawa, Canada. (J-F. Landry).
- EMEC**= Essig Museum of Entomology, University of California, Berkeley, United States. (J. Powell).
- LNK**= Landessammlung für Naturkunde Karlsruhe, Karlsruhe, Germany. (R. Trusch).
- MGCL**= McGuire Center for Lepidoptera & Biodiversity, University of Florida, Gainesville, Florida, United States. (J. Heppner).
- MWM**= Museum Witt München, Munich, Germany. (T. Witt).
- MWLR**= Manaaki Whenua Landcare Research Center, Auckland, New Zealand. (R. Hoare).
- NHM**= Naturhistorisches Museum Wien, Vienna, Austria. (S. Gaal-Haszler).
- PCORRO**= Patricia Esther Corro Chang (personal collection), Panamá city, República de Panamá. (P. Corro Chang).
- PCMENT**= Programa Centroamericano de Entomología, Universidad de Panamá, Panamá, República de Panamá. (H. Barrios).
- SMD**= Naturmuseum Senckenberg Dresden, Germany. (F. Vegliante).
- TSNM**= Taras Shevchenko National Museum, Kiev, Ukraine. (O. Bidzilya).
- TLMF**= Tiroler Landesmuseum Ferdinandeum, Innsbruck, Austria. (P. Huemer).
- TMSA**= Ditsong Museum of Natural History (Transvaal Museum), Pretoria, South Africa. (M. Krüger hasta 2019).
- USNM**= National Museum of Natural History, Smithsonian Institution, Washington DC, United States. (M. Metz).
- ZMB**= Museum für Naturkunde Berlin, Humboldt University, Berlin, Germany. (W. Mey).
- ZMUC**= Zoological Museum, University of Copenhagen, Copenhagen, Denmark. (O. Karsholt).

C. Análisis filogenético y construcción de la matriz de caracteres

La construcción de la matriz (Figs. 1-3) se realizó con el software Mesquite versión 2.1 (Maddison y Maddison, 2019; 2020). Se realizó un análisis de parsimonia en Mesquite junto a una búsqueda rápida aplicando el complemento de TNT 1.5 (Goloboff y Catalano, 2016) a través del paquete Zephyr, lo que posibilitó la construcción de los árboles de consenso. Para el caso particular de los árboles generados para este apartado se utilizaron los siguientes parámetros: mxram 1000; report+0/1/0; log log.out; p data.ss; vversion; tsave *TNT_Trees.txt; rseed[; hold 10000; xinact; xmult: rss css fuse 6 drift 6 ratchet 20 replic 100; sec: slack 20; bbreak: tbr safe fillonly; xmult; bbreak; nelsen *; save; log/; tsave/; quit; y para un total de 468 árboles retenidos en memoria.

Para la realización de la matriz morfológica de caracteres se procedió a la examinación de ejemplares depositados en las colecciones del USNM y CNC, incluyendo material en préstamo de museos de diferentes partes del mundo. Adicionalmente, se solicitó el préstamo de ejemplares de la especie *Kiwaia jeanae* al MWLR, de los cuales se procedió a la extracción de los genitalia para poder así codificar los caracteres.

El estudio y exploración de caracteres fue complementado mediante la interpretación de los esquemas elaborados por Povolný en la descripción de los taxones de Gnorimoschemini; para ello fue esencial la consulta de todos los trabajos realizados por dicho autor. La lista detallada de taxones explorados se muestra en la Tabla 6. Con el fin de tener representatividad de las otras subfamilias y tribus de Gelechiidae se incluyeron representantes de cada tribu en los análisis. Para la realización de los árboles de evidencia total y a partir de secuencias, se procedió a descargar el material disponible y de acceso público en el sitio web de BOLD Systems. Es pertinente mencionar en este punto, que al menos un total de 27 especies tipo de Gnorimoschemini han sido secuenciadas y compartidas publicamente en esta base de datos en línea. Un total de 39 tipos, no disponen de secuencias en BOLD y es por esta razón que sus secuencias no pudieron ser incluidas en los análisis filogenéticos.

This figure displays a comprehensive matrix of morphological characters for a wide range of taxa. The taxa listed on the left include various species of the genus *Scrobipalpa* (e.g., *Scrobipalpa atiplicella*, *Scrobipalpa petasata*, *Scrobipalpa psiliella*) and other related species like *Exoceptia neopetrella* and *Neopalpa neonata*. The matrix columns represent numerous morphological traits, such as body shape, head features, and leg characteristics. Each cell in the matrix is color-coded to indicate the specific state of a character for a given taxon, with colors ranging from blue to red.

Figura 1. Vista de la matriz de caracteres morfológicos.

This figure shows a screenshot of a software interface for viewing a molecular character matrix. The interface includes a menu bar at the top with options like "ees Analysis View", "Matrix Alter Select Display Analysis.Matrix", and "Window". Below the menu bar, there are several checkboxes and labels for different analysis methods, such as "Trees from Mesquite's heuristic search" and "Consensus Tree". The main area of the interface is a grid where the rows represent taxa and the columns represent molecular characters (likely nucleotide positions). Each cell in the grid is color-coded to represent a specific nucleotide state (A, C, G, T) for a given taxon.

Figura 2. Vista de la matriz de caracteres moleculares.

Character	Morphological & ecological data				Molecular data COI																		
	Diet	Larvae feeding habit	Larvae gregarious	Larvae with shelter	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
Group Gelechia rhombella	Strict monophagous, one family of plants	Roller	Unknown	Present	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
gnorimoschema gallaeosolidaginis	Strict monophagous, one family of plants	Gall maker	Absent	Present	0	0	1	3	3	3	0	?	?	0	3	3	3	3	0	3	3	3	3
chysteris chersaea	Strict monophagous, one family of plants	Miner	Unknown	Present	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
rysacca melanocampa	Polyphagous, many families of plants	Unknown	Unknown	Present	0	0	1	3	3	3	0	?	?	0	3	3	3	3	0	3	3	3	3
rysaccoides gallaespinosae	Polyphagous, many families of plants	Gall maker	Absent	Present	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
chinoglossa trinota	Strict monophagous, one family of plants	Miner	Unknown	Present	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ceptia neopetrella	Unknown	Unknown	Unknown	Unknown	0	0	1	3	3	3	0	?	?	0	3	3	3	3	0	3	3	3	3
umenta nundinella	Strict monophagous, one family of plants	Roller	Absent	Present	0	0	1	3	3	3	0	?	?	0	3	3	3	3	0	3	3	3	3
siferia lycopersicella	Strict monophagous, one family of plants	Miner	Absent	Unknown	0	0	1	3	3	3	0	?	?	0	3	3	3	3	0	3	3	3	3
waia cheradias	Polyphagous, many families of plants	Unknown	Absent	Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
agnifacia aulomha	Unknown	Unknown	Unknown	Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
popalpa neonata	Strict monophagous, one family of plants	Unknown	Unknown	Unknown	3	0	1	3	1	3	0	?	?	0	3	3	3	3	0	3	3	3	3
svadopalpa striata	Unknown	Unknown	Unknown	Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pacopsis inustella	Strict monophagous, one family of plants	Miner	Absent	Present	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
araschema detectendrum	Strict monophagous, one family of plants	Unknown	Unknown	Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
thorimaea operculella	Polyphagous, many families of plants	Miner	Present	Present	0	0	1	3	3	3	0	?	?	0	3	3	3	3	0	3	3	3	3
chmidtmielsenia nielseni	Unknown	Unknown	Unknown	Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
robipalpa atriplicella	Polyphagous, many families of plants	Miner	Absent	Present	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ta zebrella	Polyphagous, many families of plants	Roller	Unknown	Present	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
robipalpa aptatella	Polyphagous, many families of plants	Miner	Unknown	Present	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
robipalpoidea obscurus	Unknown	Unknown	Unknown	Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
robipalpomima neuquenensis	Unknown	Unknown	Unknown	Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Figura 3. Vista de la matriz de caracteres concatenada en Mesquite, en la misma se incluyen caracteres morfológicos, ecológicos y moleculares.

Morfología general

A. Morfología externa

El estudio de los caracteres externos entre Gnorimoschemini resultó una tarea poco productiva, ya que la mayoría de las especies carecen de estructuras externas distintivas (Fig. 4). La identificación a primera vista es algo prácticamente imposible. Para atender esta condición, podemos sugerir el estudio de estructuras particulares que se encuentran en la cabeza (Fig. 6). La presencia de un pecten podría ser relevante para distinguir algunos géneros, por ejemplo, en *Megacraspedus* y *Bryotropha*. La probóscide escamada (Fig. 5) es una característica relevante en la definición de Gelechiidae y Gelechioidea, probablemente más relevante que la venación de las alas posteriores. Con el fin de ilustrar elementos externos e internos de la morfología en Gelechiidae, se utilizó como modelo la especie *Colonanthes korytkowskii* (Corro Chang y Metz, 2020).

Existen importantes diferencias en la orientación de los palpos labiales (Fig. 7), en particular, el segundo segmento puede estar ornamentado, puede cubrirse con escamas engrosadas o con una brocha reducida de escamas. El palpo puede ser prorecto o invertido.

Otro carácter significativo se encuentra en el ala posterior: el ápice de las alas es sinuoso y ésta es una característica importante en Gelechiidae (pero en aquellas especies con una condición braquíptera el carácter está ausente). Sin embargo, pudiesen existir excepciones como en los géneros *Dactylotula* y *Nealyda* en los cuales el ala posterior presenta una sinuación característica, más que nada, dando el aspecto de una bifurcación en su ápice.

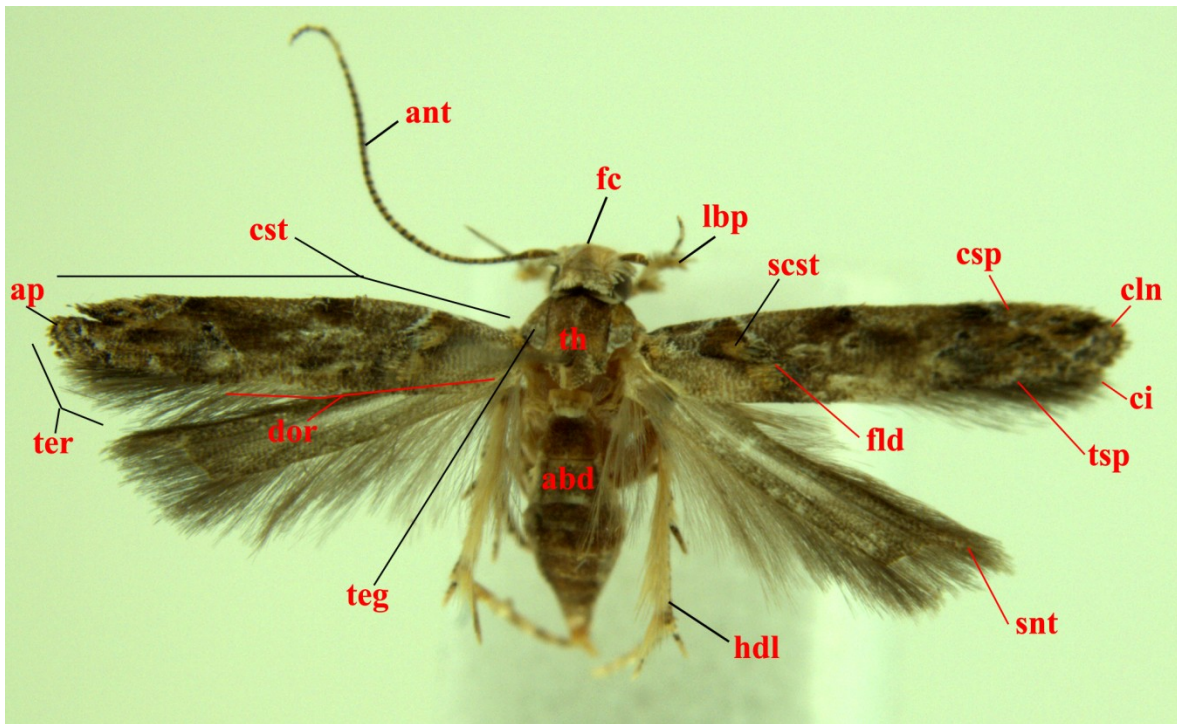


Figura 4. Habitus dorsal de la especie *Colonanthes korytkowskii* mostrando las principales regiones corporales y código de maculaciones en un ejemplar de Gelechiidae. Abreviaciones: abd=abdomen, ant=antena, ap=ápice, cst=costa, ci=cilia, cln=línea de cilia, csp=mancha costal, dor=dorso, fc=cabeza, fld=doblez, hdl=pata posterior, lbp=palpo labial, scst=línea subcostal, snt=sinuación del ala posterior, teg=tegula, ter=termen, th=torax, tsp=mancha tornal.

El patrón de las alas (Fig. 4) es otra característica a destacar: la presencia de bandas, puntuaciones, manchas y escamas levantadas son algunos caracteres valiosos para tener una idea al menos de un género. La principal variedad de caracteres útiles para la determinación a nivel de especie ocurre en la morfología de los genitales. Los complejos genitales en Gelechiidae *sensu lato* hacen que el grupo sea interesante para los estudios morfológicos y la transformación de estas características.

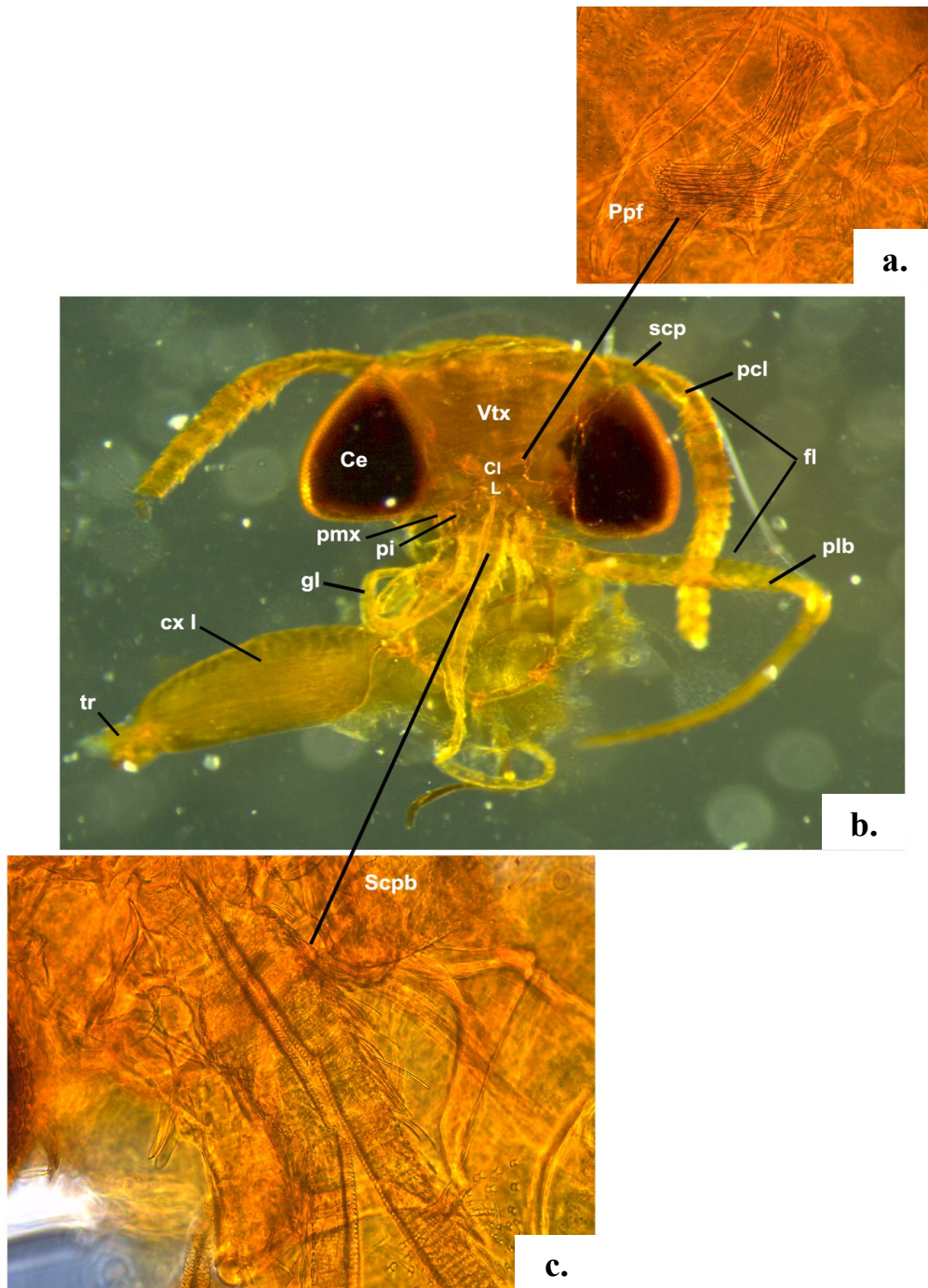


Figura 5. Detalle de cabeza en *Colonantes korytkowskii* (Gelechiidae) incluyendo proboscis escamosa, caracter relevante en la determinación de la familia Gelechiidae. a.) Detalle de palpifer; b.) Vista generalizada de cabeza, Ce=ojo compuesto, Cl=clypeus, cxI=coxa I, fl=flagelómero, gl=galea, L=labium, pi=pilífero, pmx=palpo maxilar, plb=palpo labial, Ppf=palpifer; scp=scapo, Scpb=proboscis escamosa, tr=trocánter, Vtx=vertex; c.) Detalle de escamas en la proboscis.

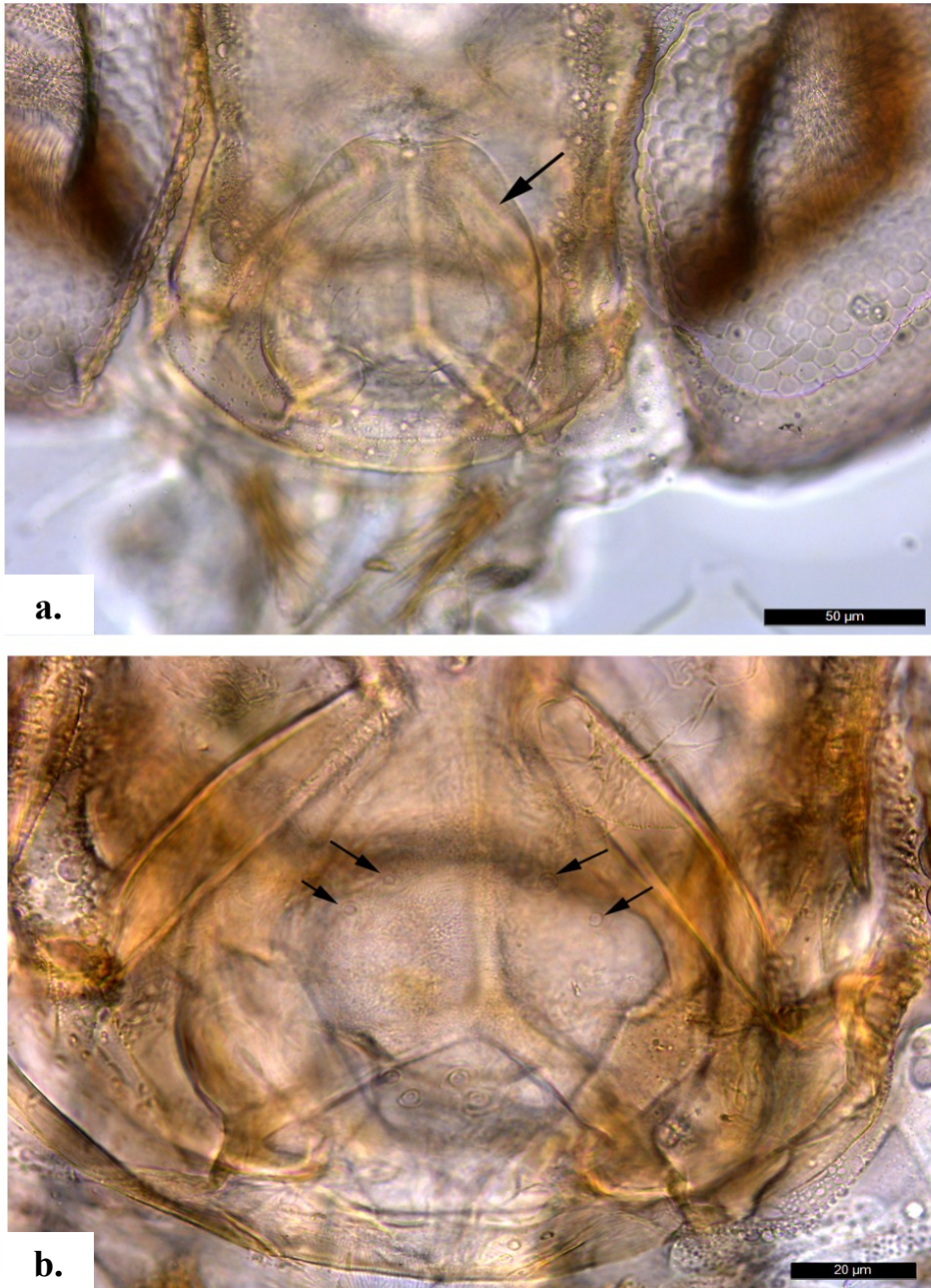


Figura 6. Cabeza de *Colonantes korytkowskii* (Gelechiidae). a.) Aumento de cabeza mostrando el sitoporo; b.) Sitoporo provisto de 4 sensila campaniformes.

Los miembros de la tribu Gnorimoschemini *sensu lato* tienen una amplia variedad de formas de vida. Este hecho incentiva la formulación de esta investigación. La revisión exhaustiva de la literatura mundial ayuda a comprender las necesidades reales de conocimiento sobre la sistemática del grupo y nos hizo pensar que el grupo parece estar formado por una mezcla de representantes de otras tribus de la familia Gelechiidae. Este

estudio sugiere un total de 13 plantas nutricias, la mayoría de ellas asociadas con miembros de la tribu Gnorimoschemini. Existe una tendencia al hábito polífago entre los miembros del grupo, y un número considerable de especies con formas de vida desconocidas. Esta tendencia a la polifagia hace que el autor confirme la hipótesis de que la tribu Gnorimoschemini es una mezcla de taxones de varias tribus y subfamilias de Gelechiidae.

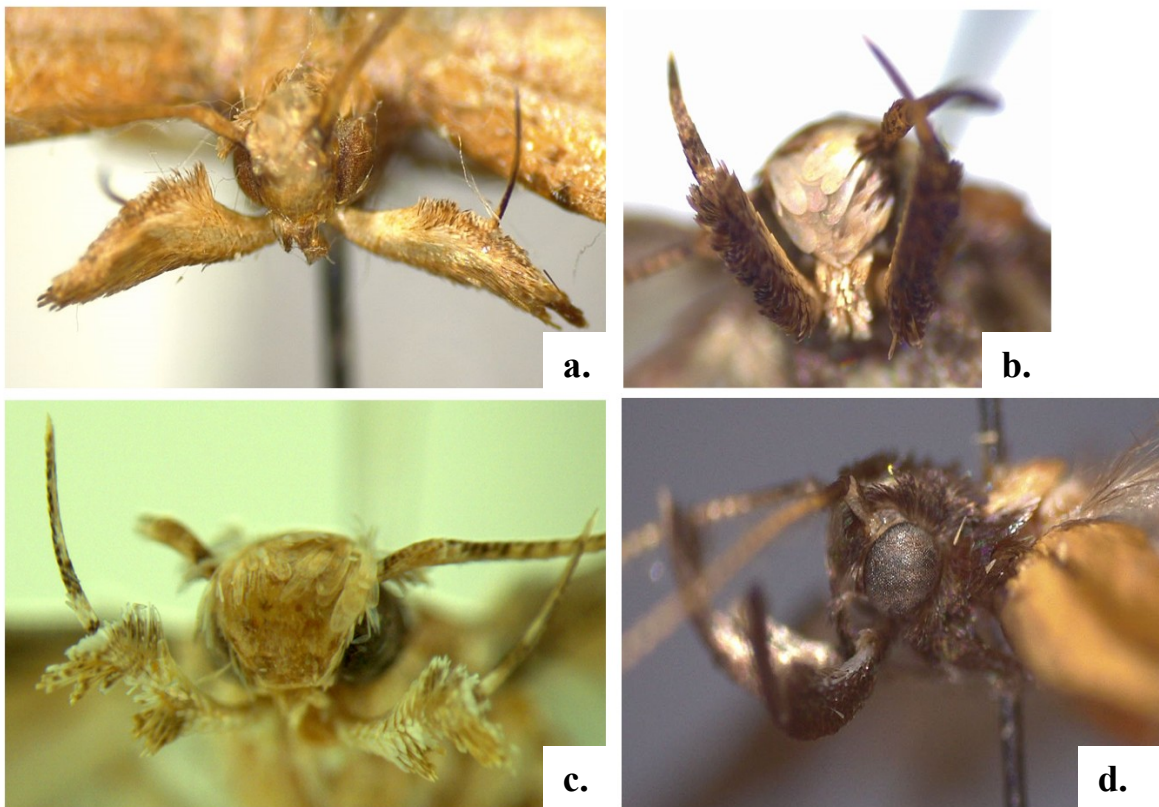


Figura 7. Variabilidad en palpos labiales dentro de la familia Gelechiidae. a.) *Dichomeris ligulella*. b.) *Tecia solanivora*. c.) *Colanthes korytkowskii*. d.) *Dichomeris cornuta*.

B. La morfología larval

Durante décadas, el estudio de las formas inmaduras ha proporcionado información importante. Trabajos clásicos a nivel mundial han sido cruciales en el conocimiento de las historias biológicas de los Gelechioidea, entre ellos, es pertinente destacar las descripciones realizadas por Amsel para los microlepidopteros del Medio Oriente (Amsel y Hering, 1931), las descripciones realizadas por Kieffer y Jörgensen (1910), los trabajos en la fauna Europea de Turati y las descripciones de especies minadoras por parte de Hering (Turati, 1924; Hering, 1927; 1936) y las crías y ciclos biológicos desarrollados por Kieffer (Kieffer,

1936a,b,c); a nivel de la región Holártica destaca el trabajo de Powell y Povolný para los Gnorimoschemini asociados a ambientes litorales y algunas revisiones de la fauna de microlepidopteros para ciertos estados en EE.UU. (Riley, 1869; Powell y Povolný, 2001); los ciclos de vida de especies de importancia económica, como es el caso de *Symmetrischema tangolias* (Castillo-Yepez, 2005), y las descripciones hechas por King y Viejo Montesinos (2011) y Baran (2013). Más recientemente, es pertinente mencionar las importantes contribuciones realizadas en el conocimiento de las larvas del género *Scrobipalpula* y aquellas del género *Scrobipalpomima* destacando la relevancia de la quetotaxia y descripciones de las pupas (Adamski et al., 2018; Vargas, 2020).

Durante la presente investigación, la autora ha confirmado que sólo unas pocas larvas son bien conocidas dentro de la tribu Gnorimoschemini. Una de las principales limitaciones en el estudio de la morfología larval es el tamaño mínimo de las larvas, lo que dificulta su percepción a simple vista. Además, el estudio de los minadores de hojas tiene algunas limitaciones en los ambientes tropicales. Por ejemplo, los problemas de humedad y de condensación, lo que provoca el crecimiento de moho en los contenedores. Algunas especies son bien conocidas porque son plagas en algunos cultivos, y mantener las colonias en condiciones de laboratorio es algo más fácil, pero las plantas silvestres son más difíciles.

Mención especial requieren las especies alpinas, las cuales sólo se encuentran por encima de los 2.000 msnm. Esta particularidad se da entre los géneros *Klimeschiopsis*, *Sattleria*, *Tila* y *Vladimirea* (Povolný, 1965; 1967b,c; Pitkin y Sattler, 1991; Huemer y Karsholt, 2010; Huemer y Hebert, 2011). Son raros e incluso los coleccionistas más experimentados en algunos casos conocen estas especies por un solo ejemplar. Cualquier esfuerzo para criar estas orugas es valioso, considerando las lagunas en el conocimiento sobre su biología. Otros géneros revisados y con presencia en el Ártico son *Lutilabria*, *Pogochaetia* y *Cosmardia*. Entre las particularidades de los ejemplares de estos géneros destacan su amplia envergadura y sus alas anchas. En dónde el ala posterior es más oscura que las alas anteriores y de coloración completamente críptica (Huemer, 1993; Huemer y Erlebach, 2003; Rodeland, 2016).

Afortunadamente, en este apartado introductorio al estudio de la morfología larvaria, se incluyen algunas de las principales características disponibles en el diagnóstico de *Phthorimaea absoluta*, un conocido Gnorimoschemini considerado una plaga en cultivos de solanáceas (Fig. 8).

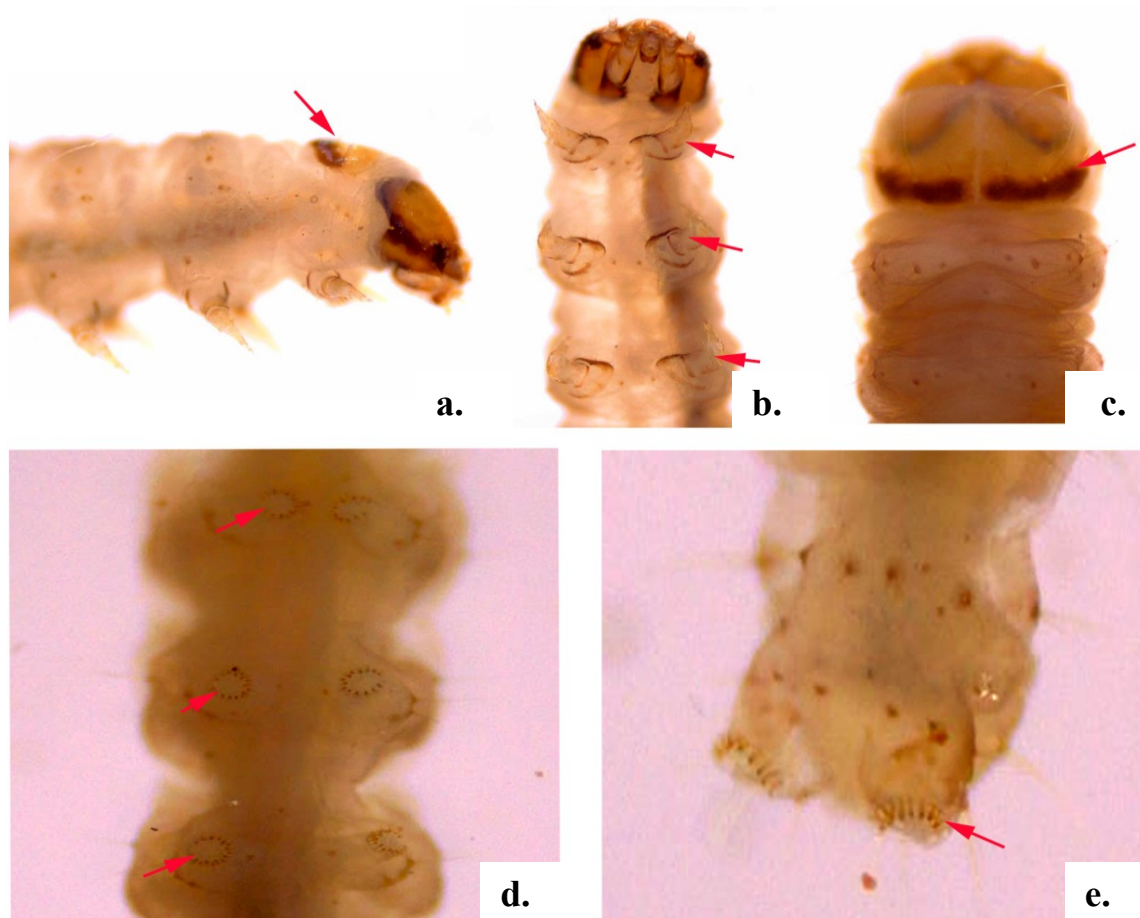


Figura 8. La larva de *Phthorimaea absoluta* (Gelechiidae: Gnorimoschemini) mostrando algunos caracteres relevantes. a,c.) Escudo protorácico parcialmente melanizado en su margen externo; b.) Patas torácicas bien desarrolladas; d.) Ganchos uniordinales en círculo; e.) Ganchos en propatas en segmento A9 uniordinales y en semicírculo.

C. Micropreparaciones de cuerpo completo y morfología interna de los adultos

El estudio de la morfología interna (Figs. 9-15) en Lepidoptera ha revelado caracteres útiles en la definición de géneros. En algunos estudios los autores han diseñado protocolos de micropreparaciones para la exploración de nuevas funcionalidades. Estas preparaciones se han probado en diferentes familias de lepidópteros. Por ejemplo: Gelechiidae y Scythriididae (Landry, 1991; Lee y Brown, 2006).

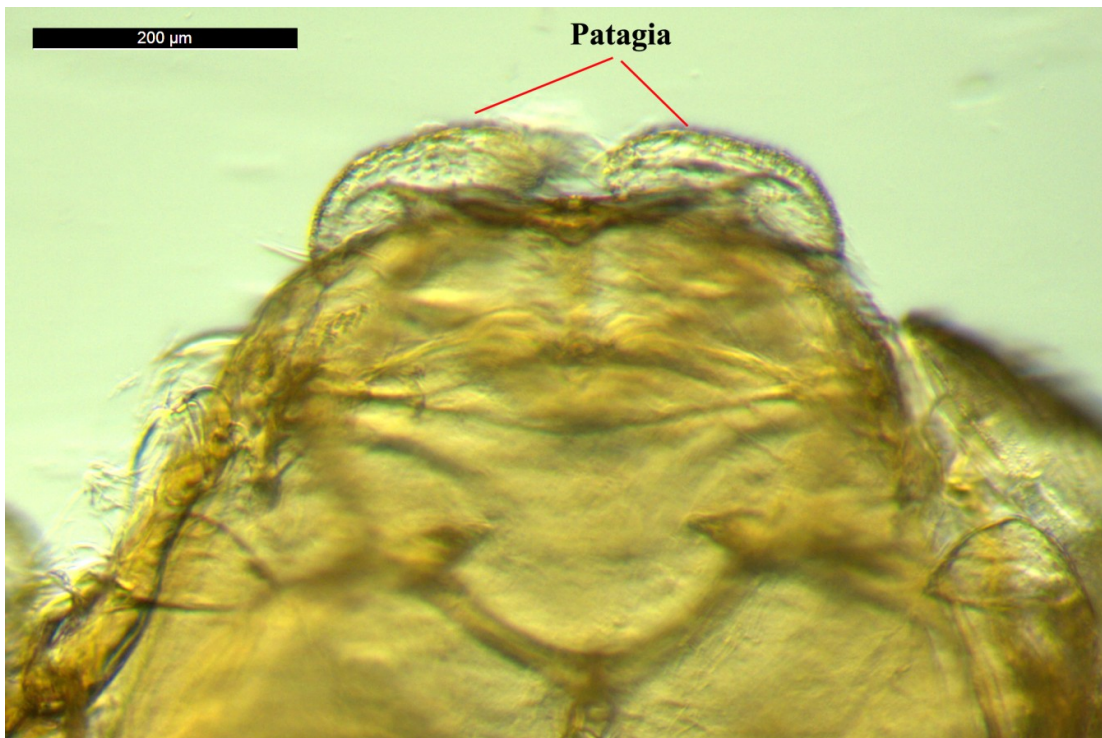


Figura 9. Habitus dorsal de *Colonanthes korytkowskii* (Gelechiidae) mostrando detalle de patagia.

Pese a los esfuerzos realizados en algunas investigaciones, una minoría de los trabajos incluyen las preparaciones de cuerpo completo en las descripciones de nuevos taxones. Es muy probable que esto se deba a lo laboriosas que resultan ser este tipo de preparaciones o porque se posee un mínimo de ejemplares disponibles para las preparaciones, siendo este el caso particular de los microlepidópteros.

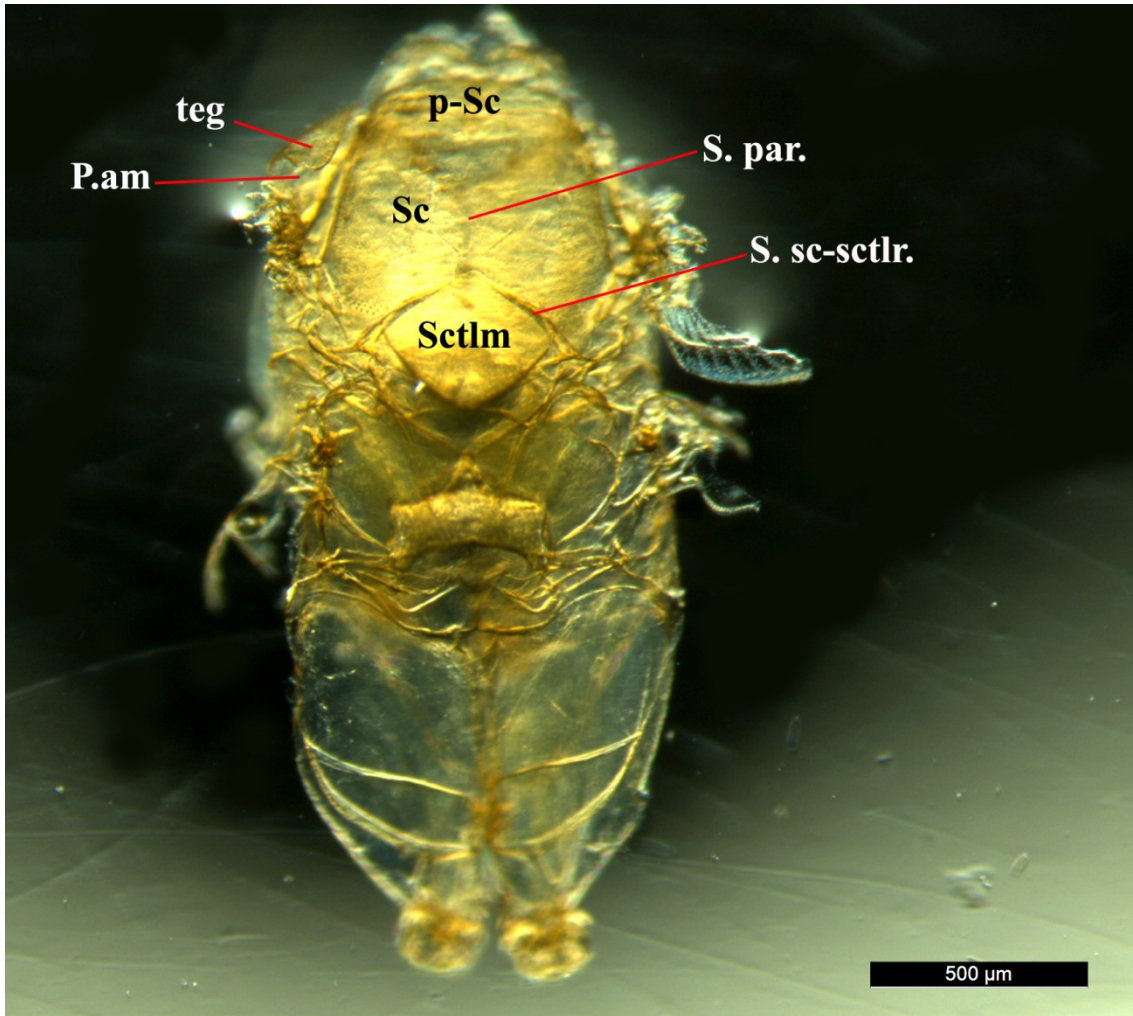


Figura 10. Habitus dorsal de tórax en *Colonanthes korytkowskii*. Abreviaciones: P.am=proceso notal medial, p-Sc=prescutum, Sc=scutum, Sctlm=scutellum, S.par.=sutura parapsidial, S.sc-sctlr.=sutura scuto-scutelar, teg=tégula.

En la especie *C. korytkowskii* (Gelechiidae: Litini), los patagia están desarrollados a manera de lóbulos subcirculares, de textura membranosa y superficie completamente rugosa. De acuerdo con Kellogg (1895), esta estructura funciona a manera de escudo protector de las inserciones del ala anterior, protegiendo los delgados lóbulos que rodean al ala anterior, siendo éstas regiones extremadamente frágiles en el cuerpo de las polillas. En otros grupos, dentro de Lepidoptera éstas estructuras pudiesen estar muy reducidas e inconspicuas, sin embargo, cabe resaltar que la estructura es compartida con el orden Trichoptera, su grupo hermano.

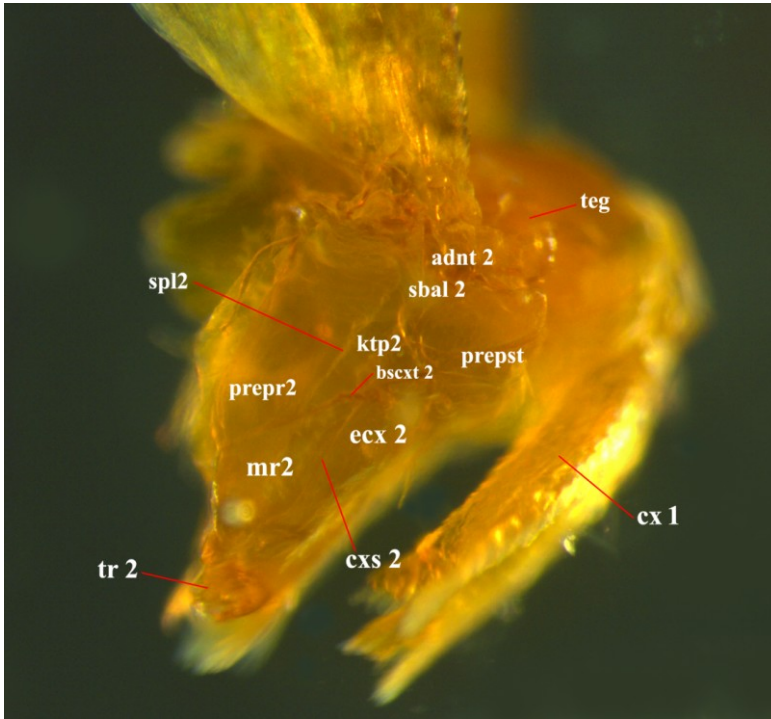


Figura 11. Vista lateral de protórax y mesotórax en *Colonanthes korytkowskii* (Gelechiidae). Abreviaciones: adnt2=adnotal 2, bscxt2=basicoxito2, cx1=coxa 1, cxs2=sutura coxal 2, ecx2=esclerito coxal 2, ktp2=katepisternum 2, mr2=merón 2, prepr2=pre-epimerón 2, prepst=pre-episternum, sbal2=subalar 2, spl2=sutura pleural 2, teg=tégula, tr2=trocánter 2.

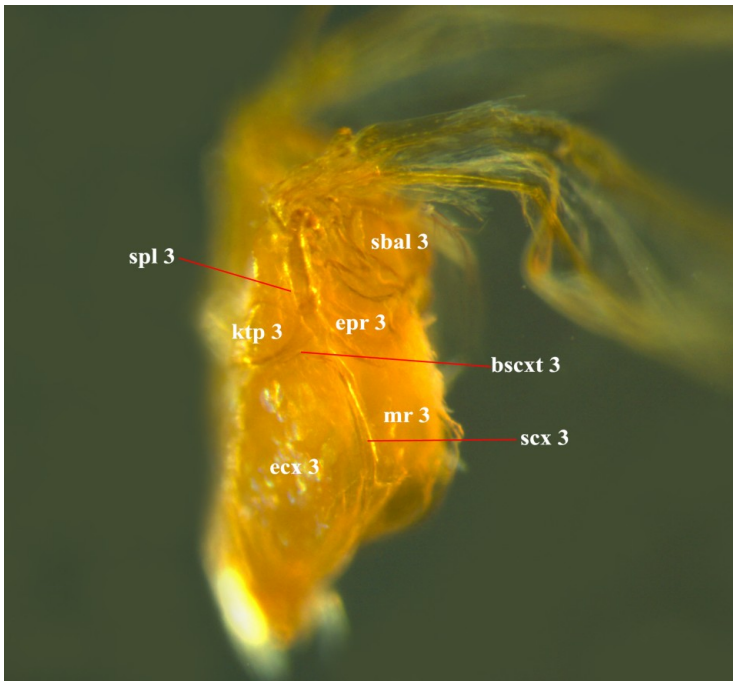


Figura 12. Vista lateral del metatórax de *Colonanthes korytkowskii* (Gelechiidae). Abreviaciones: bscxt3=basicoxito 3, ecx3=esclerito coxal 3, epr3=epimerón 3, ktp3=katepisternum 3, mr3=merón 3, sbal3=sub-alar 3, scx3=sutura coxal 3, spl3=sutura pleural 3.

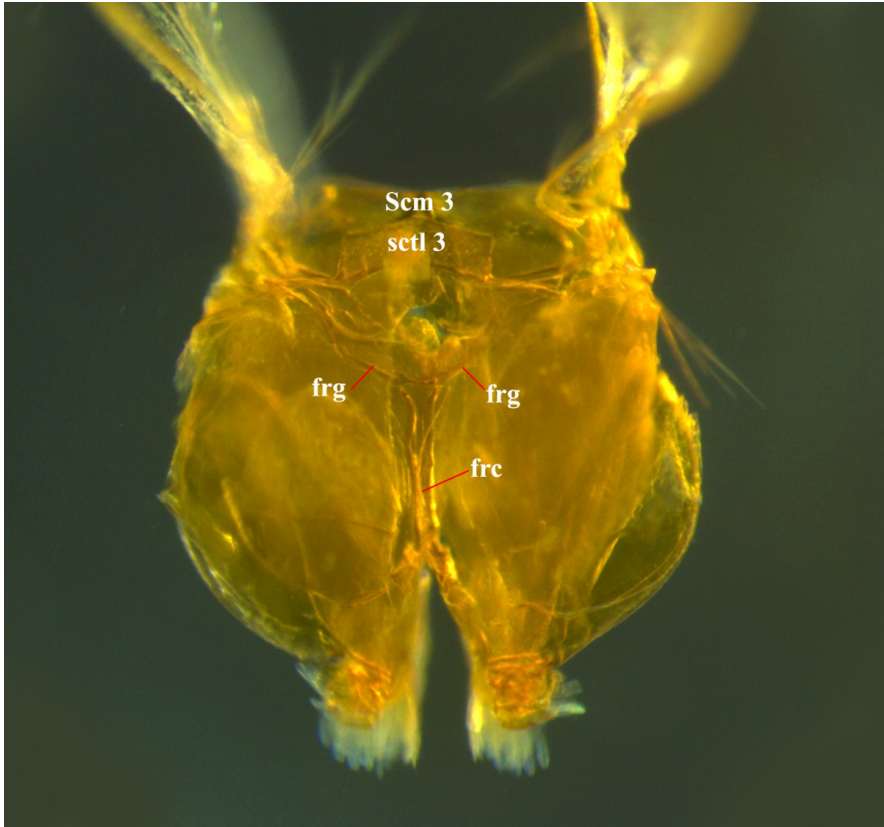


Figura 13. Vista ventral en metatorax en *Colonanthes korytkowskii* (Gelechiidae). Abreviaciones: frc=furca, frg=fragma, Scm3=scutum 3, sctl3=scutellum 3.

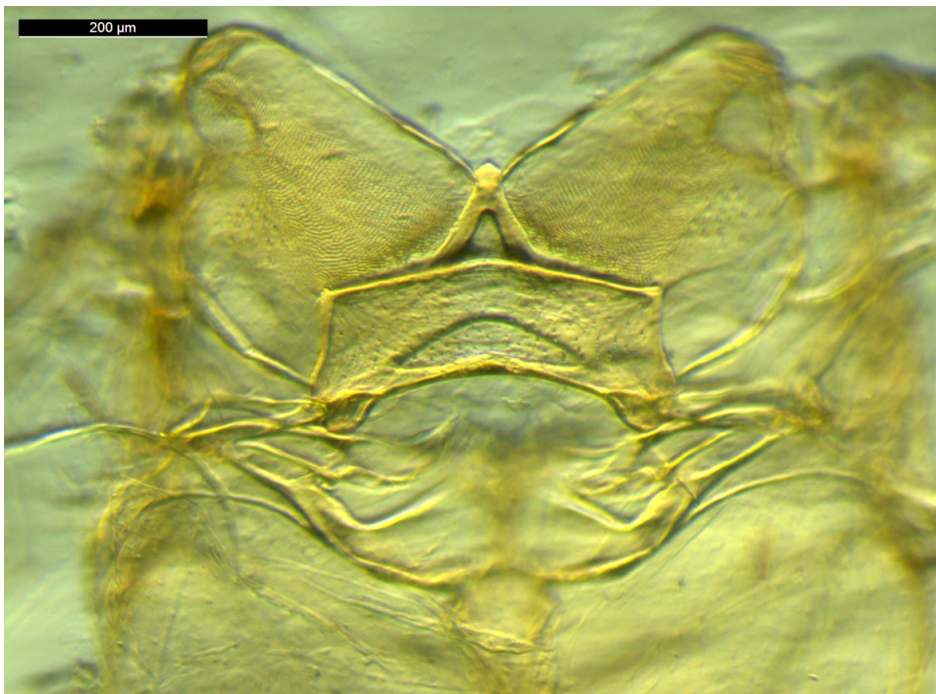


Figura 14. Vista dorsal en *Colonanthes korytkowskii* (Gelechiidae). Detalle de rugosidad sobre fragma y área del scutellum.

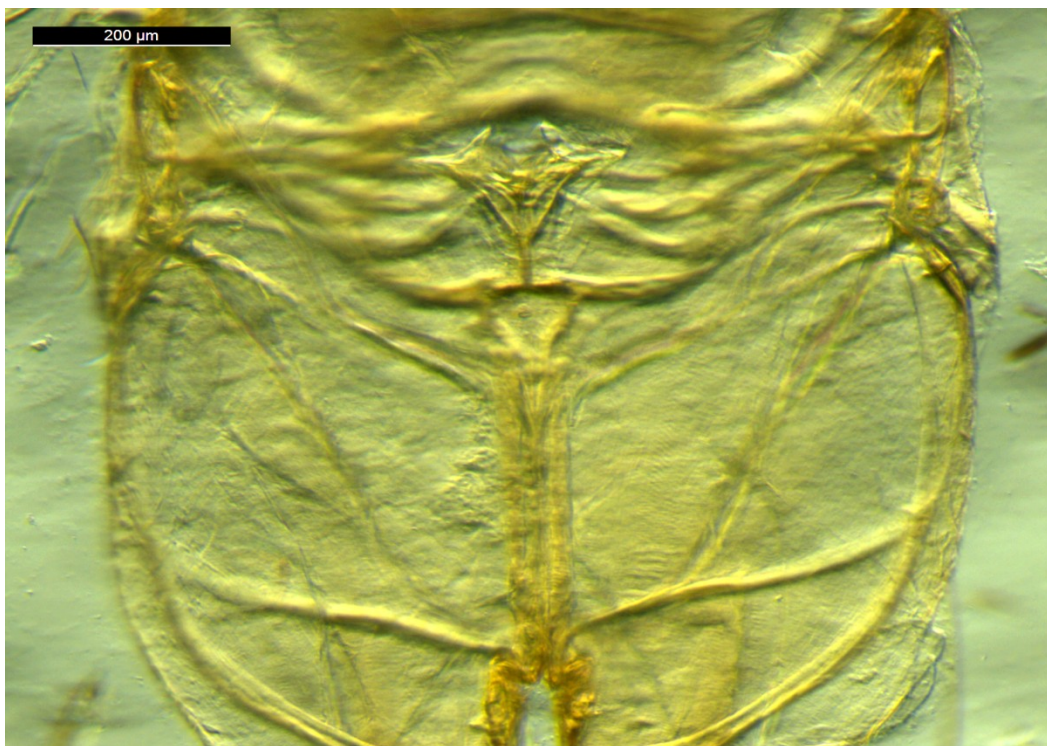


Figura 15. Metafurca en *Colanthes korytkowskii* (Gelechiidae).

D. La morfología en los genitalia

Los genitales masculinos constituyen uno de los caracteres más complejos de este estudio. Presentan una amplia variedad de formas y estructuras relevantes para los estudios taxonómicos. Hemos examinado un total de 27 caracteres relacionados con los genitales masculinos en Gnorimoschemini y representantes de otras tribus de Gelechiidae (Fig. 16). Algunos de estos caracteres fueron utilizados en el estudio de la posición sistemática de “*Tuta absoluta*”, logrando así poder ubicarlo en el género *Phthorimaea* (Corro Chang y Metz, 2021).

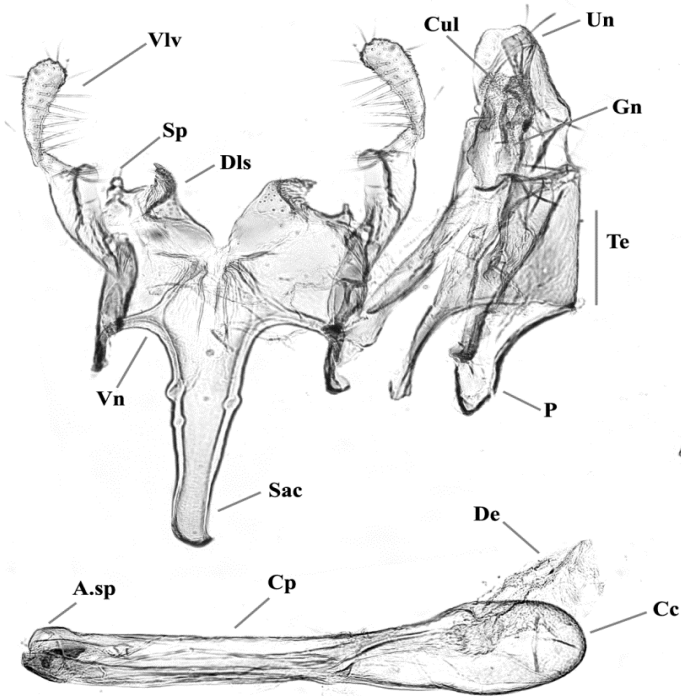
El estudio de la compleja morfología en los genitalia de los machos ha provisto de nuevos elementos que son relevantes en la definición de la tribu Gnorimoschemini. Probablemente, es en los genitalia masculinos es donde se han encontrado los elementos morfológicos más llamativos, desde la asimetría hasta la prolongación de ciertas estructuras. Los genitalia masculinos en esta tribu se caracterizan por un cucullus simple, en algunos casos provisto

de setas marginales. Existe un par de líneas fusionadas en la base del saccus, de aspecto diamantado. El saccus es ancho, aplastado. La unión vincular presenta una longitud similar a la longitud saccular. El uncus es dentado. La culcitula esta bien desarrollada. La articulación del esclerito medio del gnathos no suele solaparse con los brazos del tegumen; esta es una característica detectada en la mayoría de los ejemplares de la tribu. El esclerito medio del gnathos presenta forma de cuchara. El tegumen es moderadamente convexo y presenta una fisura amplia. El phallus es recto, generalmente carece de lamina ducti ejaculatorii y su ápice es simple, desprovisto de espina apical.

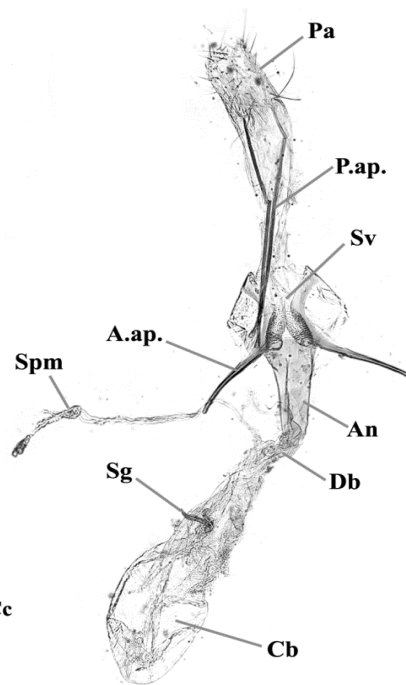
El género *Scrobipalpula* (Povolný, 1964a), representa un ejemplo de género bien definido cuyas características morfológicas encontradas en el material tipo son consistentes entre los taxones posteriormente descritos. Es quizá uno de los elementos más notables en su morfología, la forma del esclerito medio del gnathos, que es ancho y comúnmente se considera en forma de ancla.

Con respecto a la morfología de los genitalia de las hembras (Fig. 17), existen tres caracteres diagnósticos en la definición de Gelechiidae y aún de mayor relevancia en la tribu Gnorimoschemini. El primero es la forma del corpus bursae y la ornamentación de su superficie, que puede ser lisa, arrugada, parcialmente cubierta de microtrichia o acanthae. La segunda característica incluye el signum, que en Gnorimoschemini es único y cuya disposición a lo largo del corpus bursae es variable. La tercera característica, es la espermateca, que puede ser simple o bifurcada en el utrículo o en algunos casos helicoidal.

Las hembras del género *Gnorimoschema* (Busck, 1900) presentan un corpus bursae elongado, cuya superficie es lisa y con algunas porciones arrugadas. El signum es acrinioideo, protuberante, localizado al inicio del corpus bursae y su margen externo es dentado. El sinus vaginalis es estrecho. La lamella post-vaginalis posee ciertos bolsillos en posición lateral. La apófisis posteriores son de aproximadamente la misma longitud que el ductus bursae.



16.



17.

Figuras 16-17. Morfología general de los genitalia en macho y hembra de *Phthorimaea absoluta*. 16. Macho (gen. slide GL2000, P. Corro). Fig. 16. Macho. Vlv=valva; Sp=proceso saccular; Dls=lóbulo distal de sacculus; Vn=vinculum; Sac=sacculus; Un=uncus; Cul=culcitula; Gn=gnathos; Te=tegumen; P=pedunculus; A.sp=espina apical del phallus; Cp=corpus phallus; De=ductus ejaculatorius; Cc=caecum. 17. Hembra (gen. slide GL2022, P. Corro). Cb=corpus bursa; Sg=signum; Db=ductus bursa; An=antrum; Spm=espermateca; A.ap.=apófisis anterioris; Sv=sinus vaginalis; P.ap.=apófisis posterioris; Pa=papilla anales. Corro Chang y Metz, 2021.

Resultados

Géneros de la tribu Gnorimoschemini y sus etimologías

La tribu Gnorimoschemini a nivel mundial está compuesta por un total de 68 géneros (Tabla 2), de los cuales 33 géneros son actualmente aceptados, y 35 de ellos representan sinonimias. El estudio detallado de los trabajos realizados por Povolný y seguidamente el estudio de sus etimologías sugieren significativos cambios a futuro para los miembros de esta tribu.

Tabla 2. Géneros a nivel mundial de la tribu Gnorimoschemini y sus estatus actuales.

Género de Gnorimoschemini	Etimología	Estatus actual
1. <i>Agonochaetia</i> Povolný, 1965	Griego. <i>Agonos</i> “búsqueda” y <i>chaite</i> “pelo largo”	válido
2. <i>Australiopalpa</i> Povolný, 1974	Localidad Australia y <i>palpa</i> (palpos)	sinonimia de <i>Scrobipalpa</i>
3. <i>Australiopalpula</i> Povolný, 1974	Localidad Australia y <i>palpula</i> (palpos pequeños)	sinonimia de <i>Scrobipalpa</i>
4. <i>Barticeja</i> Povolný, 1967	Localidad Bartica	válido
5. <i>Brachypsaltis</i> Meyrick, 1931	Griego. <i>Brachyp</i> “reducido” y <i>saltis</i> “sal”	sinonimia de <i>Tecia</i>
6. <i>Canarischema</i> Karsholt, 2017	Localidad Islas Canarias y <i>schema</i> “forma”	válido
7. <i>Caryocolum</i> Gregor and Povolný, 1954	Desconocida	válido
8. <i>Chaetopogon</i> Rye, 1881	Desconocida	sinonimia de <i>Pogochaetia</i>
9. <i>Cosmardia</i> Povolný, 1965	Desconocida	válido
10. <i>Distinxia</i> Povolný, 1967	Desconocida	sinonimia de <i>Vladimirea</i>
11. <i>Echinoglossa</i> Clarke, 1965	Desconocida	sinonimia de <i>Ephysteris</i>
12. <i>Empista</i> Povolný, 1968	Desconocida	sinonimia de <i>Kiwaia</i>
13. <i>Ephysteris</i> Meyrick, 1908	Griego. <i>Ephestris</i> “ornamento externo”	válido
14. <i>Ergasiola</i> Povolný, 1967	Griego. <i>Erga</i> “contra” y <i>siola</i> “vestidura”	sinonimia de <i>Scrobipalpa</i>
15. <i>Eurysacca</i> Povolný, 1967	Griego. <i>Eury</i> “amplio” y <i>saccus</i> “bolsa”	válido
16. <i>Eurysaccoides</i> Povolný, 1998	Griego. <i>Eury</i> “amplio” y <i>saccus</i> “bolsa” referencia a forma del <i>saccus</i>	válido
17. <i>Euscrobiopalpa</i> Povolný, 1967	<i>Euscrobis</i> “amplio” y <i>palpa</i> “palpos”	sinonimia de <i>Scrobipalpa</i>
18. <i>Exceptia</i> Povolný, 1967	Desconocida	válido
19. <i>Fapua</i> Kieffer and Jörgensen, 1910	Desconocida	sinonimia de <i>Tecia</i>
20. <i>Frumenta</i> Busck, 1939	Desconocida	válido
21. <i>Gnorimoschema</i> Busck, 1900	Griego. <i>Gnorimos</i> “conocida” y <i>schema</i> “forma”	válido
22. <i>Gobipalpa</i> Povolný, 1973	Localidad Gobi y <i>palpa</i> (palpos)	sinonimia de <i>Scrobipalpa</i>
23. <i>Hedma</i> Dumont, 1932	Desconocida	sinonimia de <i>Microlechia</i>

Tabla 2. Continuación.

Género de Gnorimoschemini	Etimología	Estatus actual
24. <i>Iseopsis</i> Povolný, 1965	Dedicada a Ilse y Günter Petersen	sinonimia de <i>Scrobipalpa</i>
25. <i>Insuloschema</i> Povolný, 2004	Griego. <i>Insulos</i> “hábito insular” y <i>schema</i> “forma”	válido
26. <i>Keiferia</i> Busck, 1939	Dedicada al Dr. H.H. Kiefer lepidopterólogo y acarólogo que trabajó para el Departamento de Agricultura de California y describió varias especies de microlepidópteros y ácaros asociados a plantas.	válido
27. <i>Kiwaia</i> Philpott, 1930	Desconocida	sinonimia dentro de <i>Litini</i>
28. <i>Klimeschiopsis</i> Povolný, 1967	Dedicada al entomólogo y lepidopterólogo austriaco Josef Wilhelm Klimesch.	válido
29. <i>Lata</i> Kieffer and Jörgensen, 1910	Desconocida	sinonimia de <i>Tecia</i>
30. <i>Lerupsia</i> Riedl, 1965	Desconocida	sinonimia de <i>Gnorimoschema</i>
31. <i>Lutilabria</i> Povolný, 1965	Desconocida	válido
32. <i>Magnifacia</i> Povolný, 1967	Griego. <i>Magnus</i> “grande” y <i>facia</i> “banda ó cinturón”	sinonimia de <i>Scrobipalpa</i>
33. <i>Megalocypha</i> Janse, 1960	Desconocida	sinonimia de <i>Microlechia</i>
34. <i>Microcraspedus</i> Janse, 1958	Desconocida	sinonimia de <i>Ephysteris</i>
35. <i>Microlechia</i> Turati, 1924	Desconocida	válido
36. <i>Neopalpa</i> Povolný, 1998	Griego. <i>Neo</i> “nuevo” y <i>palpa</i> “palpos”	válido
37. <i>Neoschema</i> Povolný, 1967	Griego. <i>Neo</i> “nuevo” y <i>schema</i> “forma”	sinonimia de <i>Gnorimoschema</i>
38. <i>Nevadopalpa</i> Povolný, 1998	Localidad Nevada (EEUU).	sinonimia de <i>Scrobipalpa</i>
39. <i>Ochrodia</i> Povolný, 1966	Desconocida	válido
40. <i>Opacopsis</i> Povolný, 1964	Desconocida	válido
41. <i>Paraschema</i> Povolný, 1990	Griego. <i>Para</i> “cerca” y <i>schema</i> “forma”	válido
42. <i>Phthorimaea</i> Meyrick, 1902	Griego. <i>Phthorimos</i> “destructor”	válido
43. <i>Phloeocecis</i> Chrétien, 1908	Desconocida	sinonimia de <i>Ephysteris</i>
44. <i>Pogochaetia</i> Staudinger, 1879	Desconocida	válido

Tabla 2. Continuación.

Género de Gnorimoschemini	Etimología	Estatus actual
45. <i>Primischema</i> Povolný, 1989	Griego. <i>Primis</i> “primitivo” y <i>schema</i> “forma”	sinonimia de <i>Symmetrischema</i>
46. <i>Sattleria</i> Povolný, 1965	Dedicada al Dr. Klaus Sattler, entomólogo alemán, curador de microlepidópteros en el Museo Británico y que ha contribuido en el conocimiento de la familia Gelechiidae.	válido
47. <i>Sautereopsis</i> Povolný, 1965	Desconocida. Pero se presume fue dedicado al lepidopterólogo alemán, Sauter.	sinonimia de <i>Agonochaetia</i>
48. <i>Schmidtnielsenia</i> Povolný, 1987	Dedicada al Dr. Ebber Schmidt-Nielsen, lepidopterólogo danés.	válido
49. <i>Scrobischema</i> Povolný, 1980	Latín. <i>Scrobis</i> “hendidura” y <i>schema</i> “forma”	sinonimia de <i>Tecia</i>
50. <i>Scrobipalpa</i> Janse, 1951	Desconocida	válido
51. <i>Scrobipalpoides</i> Povolný, 1985	Latín. <i>Scrobis</i> “hendidura” y <i>palpoides</i> “palpos”	sinonimia de <i>Scrobipalpa</i>
52. <i>Scrobipalpomima</i> Povolný, 1985	Latín. <i>Scrobis</i> “hendidura” y <i>mimus</i> “imitador”	válido
53. <i>Scrobipalpopsis</i> Povolný, 1967	Latín. <i>Scrobis</i> “hendidura” y <i>apopsis</i> “eminente”	sinonimia de <i>Scrobipalpa</i>
54. <i>Scrobipalpula</i> Povolný, 1964	Latín. <i>Scrobis</i> “hendidura” y <i>palpula</i> “palpos pequeños”	válido
55. <i>Scrobipalpuloides</i> Povolný, 1987	Latín. Derivación de <i>Scrobipalpula</i>	válido
56. <i>Scrobipalpulopsis</i> Povolný, 1987	Latín. Derivación de <i>Scrobipalpula</i>	sinonimia de <i>Scrobipalpula</i>
57. <i>Scrobitasta</i> Povolný, 1985	Latín. <i>Scrobis</i> “hendidura” y <i>tasta</i> “toque”	válido
58. <i>Symmetrischema</i> Povolný, 1967	Griego. <i>Symmetros</i> “simétrico” y <i>schema</i> “forma”	válido

Tabla 2. Continuación.

Género de Gnorimoschemini	Etimología	Estatus actual
59. <i>Symmetrischemulum</i> Povolný, 1989	Griego. Pequeña forma simétrica.	sinonimia de <i>Symmetrischema</i>
60. <i>Synthesiopalpa</i> Povolný, 1966	De la composición <i>synthesis</i> “composición” y <i>palpus</i> “palpos”.	sinonimia de <i>Tricerophora</i>
61. <i>Tecia</i> Kieffer and Jörgensen, 1910	Desconocida	válido
62. <i>Tila</i> Povolný, 1965	Desconocida	sinonimia de <i>Pogochaetia</i>
63. <i>Tildenia</i> Povolný, 1967	Desconocida	sinonimia de <i>Keiferia</i>
64. <i>Trychnopalpa</i> Janse, 1958	Desconocida	sinonimia de <i>Tricerophora</i>
65. <i>Turcopalpa</i> Povolný, 1973	Localidad Turquía y <i>palpus</i> “palpos”	sinonimia de <i>Scrobipalpa</i>
66. <i>Tuta</i> Kieffer and Jörgensen, 1910	Latín. <i>Tutus</i> “guardian o defensor”	válido
67. <i>Vladimirea</i> Povolný, 1967	Dedicada al Dr. Vladimir Kuznetsov, entomólogo, lepidopterólogo ruso y gran amigo de Povolný	válido
68. <i>Zeempista</i> Povolný, 1974	Desconocida	sinonimia de <i>Kiwaia</i>

Lista sinóptica de los Gnorimoschemini Neotropicales

Como parte de la contribución al conocimiento de los Gelechiidae Neotropicales, se han logrado listar recientemente un total de 82 especies de Gelechiidae para Panamá; de estas 5 representan nuevos taxones y 12 representan nuevos registros para el país (Heppner y Corro Chang, 2017; Corro Chang y Tarakanov, 2017; Corro Chang y Bidzilya, 2020; Corro Chang y Metz, 2020; Corro Chang et al., 2021; Corro Chang, 2021).

El presente listado comprende un total de 17 géneros y 199 especies de la tribu Gnorimoschemini presentes en el Neotrópico. El registro de la especie *Symmetrischema striatellum* (Murtfeldt, 1900) continúa siendo polémico, pese a los esfuerzos de muestreo en Panamá éste registro no ha podido ser confirmado, aún así Povolný lista la especie previamente para Panamá (Povolný, 1994a). Mientras que Centroamérica continua teniendo grandes vacíos en el conocimiento de los Gnorimoschemini.

BARTICEJA Povolný, 1967:104

Barticeja Povolný, 1967:104. Type-species: *Phthorimaea epitricha* Meyrick, 1917

epitricha (Meyrick, 1917)

Phthorimaea epitricha Meyrick, 1917 (1):47

Telphusa ochrotoma Meyrick, 1923 (3):17

Distribution. Guyana, Brazil.

EPHYSTERIS Meyrick, 1908:724

Ephysteris Meyrick, 1908:724. Type-species: *Ephysteris chersaea* Meyrick, 1908

Microcraspedus Janse, 1958:6(1):137. Type-species: *Megacraspedus brachypogon* Meyrick, 1937

Ephystereris Janse, 1960:6, Incorrect subsequent spelling.

Opacopsis Povolný, 1964:64:344. Type-species: *Gelechia inustella* Zeller, 1839

Echinoglossa Clarke, 1965:117(3508):85. Type-species: *Echinoglossa trinota* (Clarke, 1965)

Ochrodia Povolný, 1966:63:142. Type-species: *Gelechia subdiminutella* Stainton, 1867

Epenteris Clarke, 1969:117:85, Incorrect subsequent spelling.

scimitarella Landry, 2010:714

Distribution. Ecuador (Galapagos).

sporobolella Landry, 2010:710

Distribution. Ecuador (Galapagos).

subdiminutella (Stainton, 1867:45)

Distribution. Ecuador (Galapagos), Jamaica, Mexico.

trinota Clarke, 1965:85

Distribution. Chile (Juan Fernandez), Ecuador (Galapagos).

EURYSACCA Povolný, 1967

Eurysacca Povolný, 1967:37:97; Type-species: *Phthorimaea melanocampta* Meyrick, 1917

acutivalva Povolný, 1986:31

Distribution. Argentina.

albonigra Povolný, 1986:24

Distribution. Argentina.

annulata Povolný, 1986:11

Distribution. Argentina.

atrata Povolný, 1986:5

Distribution. Argentina.

boertmanni Povolný, 1990:195

Distribution. Peru.

chili (Povolný, 1967:119)

Distribution. Argentina, Chile, Peru.
danorum Povolný, 1986:4
Distribution. Argentina.
eurysaccomima Povolný, 1987:42
Distribution. Argentina.
excisa Povolný, 1986:32
Distribution. Argentina.
gnorimina Povolný, 1986:25
Distribution. Argentina.
media Povolný, 1986:22
Distribution. Chile, Ecuador.
melanocampta (Meyrick, 1917:44)
Distribution. Colombia, Ecuador, Peru.
melanopicta Povolný, 1986:37
Distribution. Argentina.
minima Povolný, 1986:29
Distribution. Argentina, Peru.
novalis Povolný, 1989:152
Distribution. Argentina.
paleana Povolný, 1986:34
Distribution. Argentina.
parvula Povolný, 1986:27
Distribution. Argentina, Peru.
quinoae Povolný, 1997:41-43
Distribution. Bolivia.
conifer Povolný, 1986:18
Distribution. Argentina.
subatrata Povolný, 1986:9
Distribution. Argentina.
subsplendida Povolný, 1986:19
Distribution. Argentina.
tenebrosa Povolný, 1986:16
Distribution. Peru.
vera Povolný, 1990:196
Distribution. Peru.

EXCEPTIA Povolný, 1967

Exceptia Povolný, 1967:37:114; Type-species: *Gnorimoschema neopetrella* Keifer, 1936

hospita Povolný, 1989:155
Distribution. Argentina.

GNORIMOSCHEMA Busck, 1900

Gnorimoschema Busck, 1900:23(1208); Type-species: *Gelechia gallaesolidaginis* Riley

Gnorimochema Dyar, [1903]:25:405, Incorrect subsequent misspelling.
Gonorimoschema Deurs, 1954:27:51, Incorrect subsequent misspelling.
Gnorrimomoschema Hartig, 1964:41:36, Incorrect subsequent misspelling.
Larupsia Soffner, 1967:57:117, Incorrect subsequent misspelling.
Neoschema Povolný, 1967:37:81; Type-species: *Gnorimoschema (Neoschema) klotsi* Povolný

ilyella Zeller, 1877:337

Distribution. Colombia, Peru.

motasi Povolný, 1976:22

Distribution. Colombia.

saphirinella (Chambers, 1875:250)

Distribution. Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama.

KEIFERIA Busck, 1939

Keiferia Busck, 1939:568. Type-species: *Phthorimaea lycopersicella* Busck

Eucatoptus Walsingham, 1897:71. Type-species: *Eucatoptus lycopersicella* Walsingham, 1897.

Tildenia Povolný, 1967:37:101; Type-species: *Gelechia glochinella* Zeller

brunnea Povolný, 1973:610

Distribution. West Indies, Virgin Island (St. Thomas).

chloroneura (Meyrick, 1923:6)

Distribution. Brazil.

colombiana Povolný, 1975:109

Distribution. Colombia, Ecuador.

dalibori King and Viejo Montesinos, 2012:61

Distribution. Chile.

funebrella Povolný, 1984:302

Distribution. Venezuela.

griseofusca Povolný, 1984:304

Distribution. Venezuela.

gudmanella (Walsingham, 1897:77)

Distribution. West Indies.

keiferioides (Povolný, 1987:41)

Distribution. Argentina.

lobata Povolný, 1990:205

Distribution. Bolivia.

lycopersicella (Walsingham, 1897:71)

Phthorimaea lenta Meyrick, 1917

Distribution. Bermuda, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Guyana, Hispaniola, Honduras, Jamaica, Mexico, Nicaragua, Panama, Peru, Trinidad and Tobago, Venezuela, Virgin Islands, West Indies (St. Croix).

propria Povolný, 1990:205

Distribution. Peru.
rusposoria Povolný, 1970:6
Distribution. Grenada.
subtilis Povolný, 1984:307
Distribution. Venezuela.
vitalis Povolný, 1990:206
Distribution. Peru.
vorax (Meyrick, 1939:53)
Distribution. Argentina.

PARASCHEMA Povolný, 1990

Paraschema Povolný, 1990:16:211; Type-species: *Paraschema detectendrum* Povolný, 1990

detectendrum Povolný, 1990:215
Distribution. Bolivia.

PHTHORIMAEA Meyrick, 1902

Phthorimaea Meyrick, 1902:38:103; Type-species: *Gelechia (Bryotropha) operculella* Zeller

Phthyorimaea Turner, 1910

Phthyorimaea Turner, 1919:31:125, Incorrect subsequent misspelling.

Phthorimaea Turner, 1919:31:125, Incorrect subsequent misspelling.

Phthorimoea Forbes, 1923:68:276, Incorrect subsequent misspelling.

Phthorimoea Povolný and Zakopal, 1951:14:97, Incorrect subsequent misspelling.

Phthorimaea Issiki, 1957:1:45, Incorrect subsequent misspelling.

Phthorimea Diakonoff, [1968]

Phthorimea Oei-Dharma, 1969

absoluta (Meyrick, 1917:45)

Distribution. Argentina, Brazil, Bolivia, Chile, Costa Rica, Colombia, Ecuador, Haiti, Panama, Paraguay, Perú, Uruguay, Venezuela.

argentinae Povolný, 1989:95

Distribution. Argentina, Chile.

euchthonia (Meyrick, 1939:53)

Distribution. Argentina, Venezuela.

exacta Meyrick, 1917:46

Distribution. Guyana.

ferella (Berg, 1875:241)

Distribution. Argentina.

impudica Walsingham, 1911:51

Distribution. Panama (Panama Canal: Tabernilla).

interjuncta Meyrick, 1931:62

Distribution. Brazil.

involuta Meyrick, 1917:47

Distribution. Guyana.

operculella (Zeller, 1873:262)

Distribution. Antigua and Barbuda, Argentina, Bermuda, Brazil, Bolivia, Chile, Costa Rica, Colombia, Cuba, Ecuador, Honduras, Hispaniola, Jamaica, Mexico, Panama, Paraguay, Peru, Puerto Rico, Saint Vincent and Grenadines, Venezuela, Virgin islands, Uruguay.

perfidiosa Meyrick, 1917:41

Distribution. Colombia, Ecuador (Galapagos).

pherometopa Povolný, 1967:107

Distribution. Mexico.

robusta Povolný, 1989:93

Distribution. Argentina.

sphenophora (Walsingham, 1897:73)

Distribution. West Indies, Grenada.

urosema (Meyrick, 1917:43)

Distribution. Peru.

SCHMIDTNIELSENIA Povolný, 1987

Schmidtnielsenia Povolný, 1987:13(1):79; Type-species: *Schmidtnielsenia nielseni* Povolný, 1987

nielseni Povolný, 1987:81

Distribution. Argentina.

SCROBIPALPA Janse, 1951

Scrobipalpa Janse, 1951:5(3):199; Type-species: *Gelechia heliopa* Lower
Ilseopsis Povolný, 1965:62:481; Type-species *Ilseopsis peterseni* Povolný
Magnifacia Povolný, 1967:37:97; Type-species: *Phthorimaea aulorrhoea* Meyrick
Ergasiola Povolný, 1967:1:232; Type-species: *Phthorimaea ergasima* Meyrick
Euscrobipalpa Povolný, 1967:1:212; Type-species: *Scrobipalpa grossa* Povolný
Scrobipalpoides Povolný, 1985:11(1):28; Type-species: *Scrobipalpoides obscurus* Povolný

aulorrhoea (Meyrick, 1935:560)

Distribution. Argentina.

ignorans Povolný, 1987:79

Distribution. Argentina.

trifida Povolný, 1987:77

Distribution. Argentina.

uncispina Povolný, 1987:75

Distribution. Argentina.

obscurus Povolný, 1985:30

Distribution. Argentina.

fallax Povolný, 1987:53

Distribution. Argentina, Peru.

hemilitha (Clarke, 1965:81)
Distribution. Chile (Juan Fernandez Is.).
simulatrix Povolný, 1987:57
Distribution. Argentina.

SCROBIPALPOMIMA Povolný, 1985

Scrobipalpomima Povolný, 1985:11(1):4; Type-species: *Scrobipalpomima neuquenensis* Povolný, 1985

addenda Povolný, 1989:146
Distribution. Argentina.
agustini Vargas, 2020
Distribution. Chile.
anonyma Povolný, 1985:11
Distribution. Argentina.
concurrentis Povolný, 1989:147
Distribution. Argentina.
elongata Povolný, 1989:150
Distribution. Argentina.
excellens Povolný, 1985:8
Distribution. Argentina.
fugitiva Povolný, 1989:151
Distribution. Argentina.
grisescens Povolný, 1985:10
Distribution. Argentina.
illustris Povolný, 1989:151
Distribution. Argentina.
improbabilis Povolný, 1989:139
Distribution. Argentina.
indifferens Povolný, 1985:21
Distribution. Argentina.
karsholti Povolný, 1985:14
Distribution. Argentina.
manuscriptus Cepeda, 2019:22
Distribution. Chile.
neuquenensis Povolný, 1985:6
Distribution. Argentina.
obscuroides Povolný, 1989:144
Distribution. Argentina.
obsoleta Povolný, 1985:17
Distribution. Argentina.
obtusa Povolný, 1989:140
Distribution. Argentina.
patagoniae Povolný, 1985:23
Distribution. Argentina.
patens Povolný, 1985:16

Distribution. Argentina.
phalluspinosus Cepeda, 2019:24
Distribution. Chile.
pseudogrisescens Povolný, 1989:141
Distribution. Argentina.
questionaria Povolný, 1985:24
Distribution. Argentina.
relicta Povolný, 1985:18
Distribution. Argentina.
schematica Povolný, 1985:12
Distribution. Argentina.
septemtrionalis Povolný, 1990:180
Distribution. Argentina, Bolivia.
serena Povolný, 1989:145
Distribution. Argentina.
symmetrischemoides (Povolný, 1989:148)
Distribution. Argentina.
triangulignathos (Povolný, 1985:23)
Distribution. Argentina.

SCROBIPALPULA Povolný, 1964

Scrobipalpula Povolný, 1964:61:339; Type-species: *Gelechia psilella* Herrich-Schäffer, 1854
Scrobipalpulopsis Povolný 1987:13(1):44; Type-species: *Phthorimaea stirodes* Meyrick

acuta Povolný, 1990:188
Distribution. Peru.
albolineata Povolný, 1987:7
Distribution. Argentina.
agnathos Povolný, 1987:43
Distribution. Argentina.
atra Povolný, 1987:16
Distribution. Argentina, Chile, Peru.
caustonae Landry, 2010:728
Distribution. Ecuador (Galapagos).
crustaria (Meyrick, 1917:42)
Distribution. Peru.
daturae (Zeller, 1877:358)
Distribution. Colombia.
densata (Meyrick, 1917:42)
Scrobipalpula lacinosum Meyrick, 1931
Distribution. Argentina, Ecuador (Galapagos), Peru.
ephoria (Meyrick, 1917:36)
Distribution. Peru.
eurysacomima Povolný, 1987:42

Distribution. Argentina.
equatoriella Landry, 2010:726
Distribution. Ecuador (Galapagos).
falcata Povolný, 1987:31
Distribution. Argentina.
fallacoides Povolný, 1987:56
Distribution. Argentina.
fjeldsai Povolný, 1990:190
Distribution. Peru.
flava Povolný, 1987:28
Distribution. Argentina.
gregalis (Meyrick, 1917)
Distribution. Peru.
gregariella (Zeller, 1877:339)
Distribution. Colombia, Peru.
hastata Povolný, 1987:9
Distribution. Argentina.
incerta Povolný, 1989:154
Distribution. Argentina.
inornata Landry, 2010:723
Distribution. Ecuador (Galapagos).
isochlora (Meyrick, 1931:280)
Distribution. Brazil, Colombia, Venezuela.
latisaccula Povolný, 1987:10
Distribution. Argentina.
latiuncula Povolný, 1987:25
Distribution. Argentina.
megaloander Povolný, 1987:34
Distribution. Argentina.
melanolepis (Clarke, 1965:83)
Distribution. Chile (Juan Fernandez Is.)
motasi Povolný, 1976:21
Distribution. Colombia.
omicron Povolný, 1987:39
Distribution. Argentina.
pallens Povolný, 1987:19
Distribution. Argentina.
parachiquitella Povolný, 1968:16
Distribution. Cuba.
patagonica Povolný, 1977:141
Distribution. Argentina, Chile.
praeses Povolný, 1987:48
Distribution. Argentina, Peru.
psilella (Herrich-Schäffer, 1854:162)
Distribution. Argentina, Bolivia, Peru.
radiata Povolný, 1987:23
Distribution. Argentina.

rosariensis Povolný, 1987:40
Distribution. Argentina.
stirodes (Meyrick, 1931:385)
Distribution. Argentina.
subtenera Povolný, 1987:38
Distribution. Argentina.
tenera Povolný, 1987:37
Distribution. Argentina.
transiens Povolný, 1987:11
Distribution. Chile.
trichinaspis (Meyrick, 1917:41)
Distribution. Peru.
wilsoni Vargas, 2019:218.
Distribution. Chile.

SCROBIPALPULOIDES Povolný, 1987

Scrobipalpuloides Povolný, 1987:13(1):59; Type-species: *Scrobipalpuloides inapparens* Povolný, 1987

ascendens (Povolný, 1990)
Distribution. Peru.
congruens (Povolný, 1987)
Distribution. Argentina.
dispar Povolný, 1990:181
Distribution. Peru.
habitans (Povolný, 1987)
Distribution. Argentina.
inapparens (Povolný, 1987)
Distribution. Argentina.

SCROBITASTA Povolný, 1985

Scrobitasta Povolný, 1985:11(1):25; Type-species: *Scrobitasta varians* Povolný, 1985

varians Povolný, 1985:26
Distribution. Argentina.

SYMMETRISCHEMA Povolný, 1967

Symmetrischema Povolný, 1967:37:53; Type-species: *Phthorimaea plaesiosema* Turner, 1919
Symmetrischemulum Povolný, 1989:15:66; Type-species: *Symmetrischemulum nummulatum* Povolný
Primischema Povolný, 1989:15:59; Type-species: *Symmetrischema elementare* Povolný

alternatum Povolný, 1990:158

Distribution. Peru.
alticolum Povolný, 1990:163
 Distribution. Peru.
altisona (Meyrick, 1917:46)
 Distribution. Peru.
andinum Povolný, 1990:154
 Distribution. Peru.
anthracinum (Povolný, 1990:161)
 Distribution. Peru.
anthracoides Povolný, 1990:165
 Distribution. Peru.
arctanderi Povolný, 1990:172
 Distribution. Peru.
ardeola (Meyrick, 1931:280)
 Distribution. Argentina, Paraguay.
assimile Povolný, 1990:156
 Distribution. Peru.
atrifascis (Meyrick, 1917:45)
 Distribution. Peru.
borsaniella (Köhler, 1939:370)
 Distribution. Argentina.
capsicivorum Povolný, 1973:209
 Distribution. Peru.
capsicum (Bradley & Povolný, 1965:58)
 Distribution. West Indies, Montserrat.
cestrivorum (Clarke, 1950:288)
 Distribution. Argentina, Peru.
conifer (Meyrick, 1916:582)
 Distribution. Ecuador.
costaricanum Povolný, 1990:59
 Distribution. Costa Rica.
disciferum Povolný, 1989:74
 Distribution. Argentina.
draculinum Povolný, 1989:77
 Distribution. Argentina.
dulce Povolný, 1984:299
 Distribution. Venezuela.
elementare Povolný, 1989:60
 Distribution. Argentina.
escondidella Landry, 2010:730
 Distribution. Ecuador (Galapagos).
femininum Povolný, 1989:89
 Distribution. Argentina.
funebreale Povolný, 1990:166
 Distribution. Peru.
grandispinum Povolný, 1990:173
 Distribution. Peru.

inkorum Povolný, 1990:157
 Distribution. Peru.

insertum Povolný, 1988:77
 Distribution. Colombia.

krabbei (Povolný, 1990:171)
 Distribution. Peru.

loquax (Meyrick, 1917:45)
 Distribution. Peru.

major Povolný, 1990:160
 Distribution. Peru.

nanum Povolný, 1989:84
 Distribution. Argentina, Chile.

nummulatum Povolný, 1989:71
 Distribution. Argentina.

oblitum Povolný, 1989:82
 Distribution. Argentina.

peruanum Povolný, 1990:155
 Distribution. Peru.

piperinum Povolný, 1989:85
 Distribution. Argentina.

primigenium Povolný, 1989:62
 Distribution. Argentina.

pulchrum Povolný, 1989:64
 Distribution. Argentina.

purum Povolný, 1990:168
 Distribution. Peru.

respectabile Povolný, 1989:92
 Distribution. Argentina.

senex Povolný, 1990:164
 Distribution. Peru.

solitare Povolný, 1989:87
 Distribution. Argentina.

solum Povolný, 1989:90
 Distribution. Argentina.

striatellum (Murtfeldt, 1900:163)
Eucatoptus striatella (Murtfeldt, 1900)
 Distribution. Argentina, Bermuda, Chile, Mexico, Panama*, Venezuela.

symmetricum Povolný, 1990:169
 Distribution. Peru.

tangolias (van Gyen, 1913:338)
S. aquilinum Meyrick, 1917
 Distribution. Argentina, Chile, Colombia, Ecuador, Peru.

tuberosella Busck, 1931:59
 Distribution. Ecuador.

ventralella (Zeller, 1877:348)
 Distribution. Colombia.

TECIA Kieffer and Jörgensen, 1910

Tecia Kieffer and Jörgensen, 1910:27:375; Type-species: *Tecia mendozella* Kieffer and Jörgensen

Fapua Kieffer and Jörgensen, 1910:27:378; Type-species: *Fapua albinervella* Kieffer and Jörgensen

Lata Kieffer and Jörgensen, 1910:27:398; Type-species: *Tecia (Lata) kiefferi* Kieffer and Jörgensen

Fapua Strand, 1911:55:168; Type-species: *Fapua albinervella* Strand

Orsotricha Meyrick, 1914:1(9):269; Type-species: *Topeutis venosa* Butler

Brachypsaltis Meyrick, 1931:4(2-4):58; Type-species: *Brachypsaltis subalbata* Meyrick

Scrobischema Povolný, 1980:77(1):55; Type-species: *Scrobipalpopsis (Scrobischema) vergarai* Povolný

albinervella (Kieffer and Jörgensen, 1910:378)

Distribution. Argentina.

arnicella (Clarke, 1942:268)

Distribution. Venezuela.

confirmans (Povolný, 1990:179)

Distribution. Bolivia.

kiefferi Kieffer and Jörgensen, 1910:398

Distribution. Argentina.

solanivora Povolný, 1973:133

Distribution. Costa Rica, Colombia, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Venezuela.

subalbata (Meyrick, 1931:58)

Distribution. Argentina.

venosa (Butler, 1883:77)

Distribution. Argentina, Colombia.

TUTA Kieffer and Jörgensen, 1910

Tuta Kieffer and Jörgensen, 1910:27:363; Type-species: *Gnorimoschema atriplicella* Kieffer and Jörgensen

Tuta Strand, 1911:165:55:169; Type-species: *Gnorimoschema atriplicella* Strand

atriplicella (Kieffer and Jörgensen, 1910:363)

Distribution. Argentina.

Selección de plantas huésped para los Gnorimoschemini

La tribu Gnorimoschemini incluye un grupo de polillas de importancia económica, principalmente asociadas con cultivos de solanáceas. Sin embargo, en Panamá (Tabla 3), hay oficialmente reportadas un total de 677 plantas nutricias de Gnorimoschemini. De ellas, 164 especies son solanáceas, 303 especies de Asteraceae, 1 especie de Betulaceae, 19 Rosaceae, 35 Lamiaceae, 98 Ericaceae, 2 Chenopodiaceae y 55 especies de Scrophulariaceae (STRI, 2016).

Para comprender y aportar detalles de la biología de Gnorimoschemini, los inventarios faunísticos son esenciales. Este conocimiento es relevante para revelar asociaciones secretas entre estas polillas y sus huéspedes, como piezas importantes de la historia natural, y comprender los complejos procesos de coevolución entre las especies: proporciona pistas importantes para comprender cómo las formas inmaduras de las micropolillas secuestran compuestos secundarios y como logran tolerarlos; al igual que permite conocer como estas especies pueden mantener relaciones estrictas con sus plantas huésped. Además, en el pasado se han descrito algunas larvas. La literatura sugiere que solo 28 especies Neotropicales tienen larvas conocidas, pero con importantes lagunas sobre los hábitos de alimentación y el comportamiento de las formas inmaduras. Como ejemplo de especies bien conocidas es pertinente mencionar el caso de las especies consideradas plagas, el caso particular de *Phthorimaea operculella*, especie que ha sido objeto de estudios detallados de comportamiento y ciclos vitales, destacando la partenogénesis por deuterotoquia en las hembras (Harsimran et al., 2014; Kroschel et al., 2016; Liu et al., 2018). Algunos géneros solo son conocidos por unos pocos adultos atraídos por la luz. Para aportar conocimientos adicionales, como lo hizo August Busck en su época, es fundamental incrementar los inventarios faunísticos y las colecciones de los museos. Como prioridad en esta sinopsis incluimos datos valiosos de especies depositadas en las colecciones del mundo (Tablas 4, 5). En el caso particular de la especie *P. operculella* (Tabla 4) se alimenta de una amplia selección de plantas huésped. La especie ha sido registrada alimentándose de plantas de las familias Brassicaceae, Poaceae y Rubiaceae. Esta información obtenida de los ejemplares de museo hace pensar en una posible mala identificación de las larvas depositadas en las

colecciones de museo, por esta razón, es imperante realizar estudios biológicos detallados incluyendo las características de los ejemplares desde estadios iniciales hasta el adulto y de esta manera confirmar dichos registros.

Las plantas solanáceas han desarrollado un papel importante a lo largo de la historia, alimentando a las civilizaciones humanas, pero también son populares en las industrias farmacéuticas con los descubrimientos de nuevas drogas. Algunas de estas plantas, en particular las de los géneros *Atropa* y *Datura*, son populares por sus efectos alucinógenos o como ingrediente en rituales de magia chamánica, pero también con amplias aplicaciones en tratamientos oftalmológicos. El trabajo de cría de larvas en el extranjero ha demostrado que estas polillas pueden utilizar huéspedes alternativos (Fig. 18), especialmente plantas de la familia Asteraceae, como la absenta. La absenta ó *Artemisia absinthium* es una planta muy conocida, por su alta toxicidad y una amplia variedad de aplicaciones, pero también como parte de un patrimonio histórico en Francia y Suiza. La planta es importante en la elaboración de platos tradicionales y la famosa “hada verde” o aguardiente de absenta.

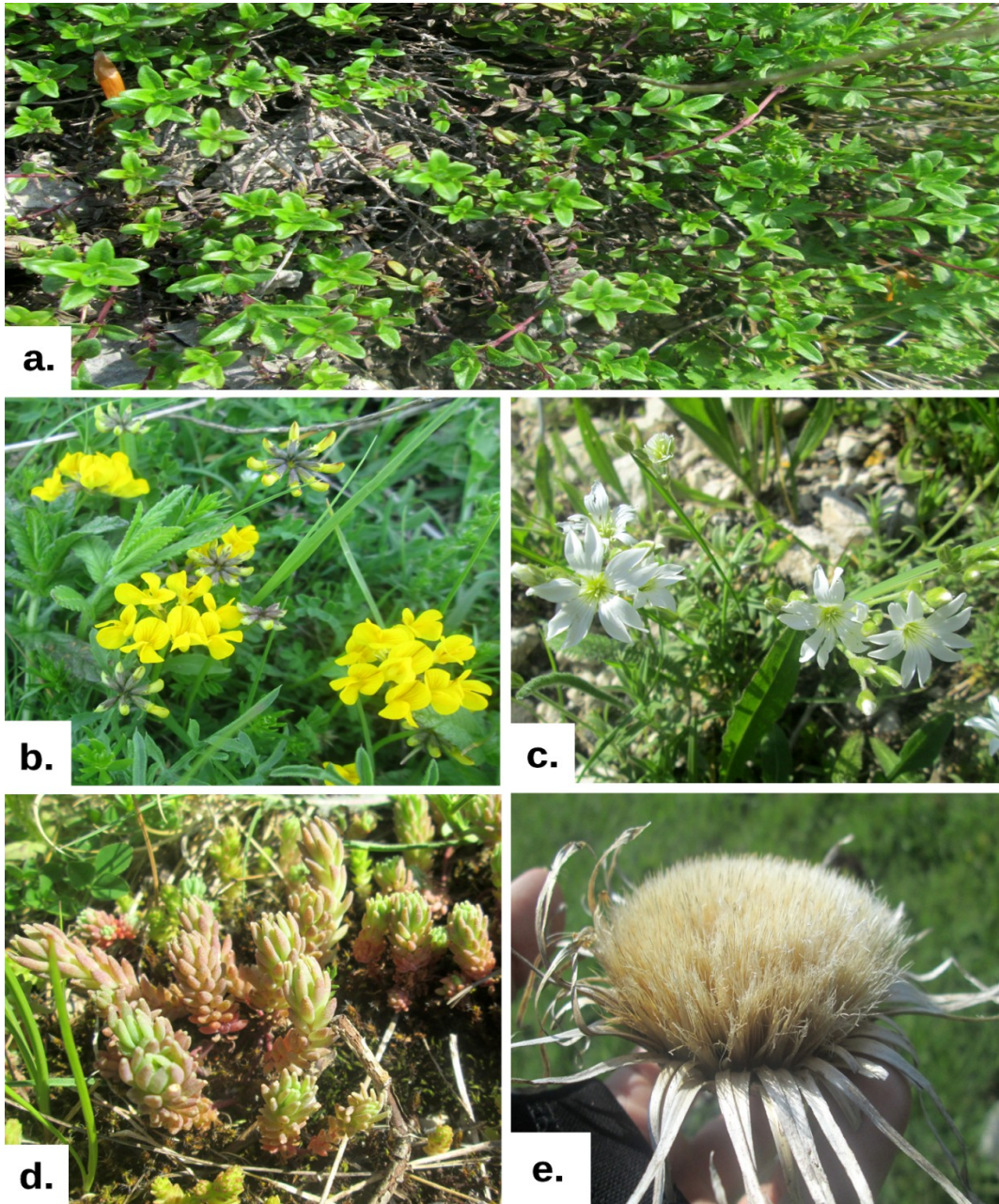


Figura 18. Algunas plantas huésped de la tribu Gnorimoschemini reportadas en el Viejo Mundo. a.) Asteraceae. b.) Zygophyllaceae y Fabaceae. c.) Caryophyllaceae. d.) Zygophyllaceae. e.) Asteraceae.

Otros huéspedes alternativos son las plantas de la familia Scrophulariaceae. El género *Digitalia* ha abierto una revolución en la medicina, como fuente de dioxinas. Estos compuestos se utilizan para el tratamiento de enfermedades cardíacas, asma y como diurético. Al margen de la importancia de las familias de plantas antes mencionadas en medicina y farmacia, los mecanismos de asimilación química en diferentes organismos no

son conocidos. Las micropolillas, en particular las larvas de los Gnorimoschemini, podrían funcionar como modelos biológicos en la medicina y podrían ser una alternativa para comprender esos mecanismos; estudiando su genoma y en la síntesis de nuevas moléculas químicas, en la elaboración de vacunas basadas en los principios de la terapia retroviral. De hecho, la iniciativa aplicada por Novavax en su nueva vacuna contra el coronavirus (SARS-COV-2) incluye baculovirus de lepidópteros (Wadman, 2020). Los nuevos descubrimientos tendrán un gran impacto para el mundo, incluida una amplia variedad de campos científicos, generando más puestos de trabajo para las personas, y moviendo una vez más las fronteras científicas y escribiendo nuevos capítulos en la historia de la ciencia.

Tabla 3. Lista de posibles plantas huésped para la tribu Gnorimoschemini y oficialmente reportadas en Panamá (STRI, 2016).

Familia	No. Especies de Plantas Huésped
Solanaceae	164
Asteraceae	303
Betulaceae	1
Rosaceae	19
Lamiaceae	35
Ericaceae	98
Amaranthaceae	2
Scrophulariaceae	55
Total	677

Tabla 4. Lista de plantas huésped para los miembros de la tribu Gnorimoschemini reportados en el Nuevo Mundo (tomado de Povolný, 1980; Rasmussen et al., 2001; Robinson et al., 2010; Corro Chang y Tarakanov, 2017; Vargas, 2020).

Especies	Plantas Huésped
<i>Ephysteris promptella</i>	Poaceae: <i>Triticum</i> sp., <i>Stipa</i> sp., <i>Saccharum officinarum</i>
<i>Eurysacca</i> sp.	Asteraceae: <i>Baccharis macranta</i>
<i>Eurysacca melanocampta</i>	Amaranthaceae: <i>Chenopodium quinoa</i> ; Asteraceae: <i>Baccharis macranta</i> ; Solanaceae: <i>Solanum tuberosum</i>
<i>Eurysacca quinoa</i>	Amaranthaceae: <i>Chenopodium quinoa</i>
<i>Gnorimoschema</i> sp.	Asteraceae: <i>Solidago</i> sp.; Solanaceae: <i>Capsicum annum</i> , <i>Nicotiana tabaccum</i> , <i>Solanum torvum</i>
<i>Gnorimoschema motasi</i>	Solanaceae: <i>Solanum saponaceum</i>
<i>Gnorimoschema saphirinella</i>	Asteraceae: <i>Parthenium hysterophorus</i>
<i>Keiferia colombiana</i>	Solanaceae: <i>Solanum muricatum</i> , <i>S. quitoense</i> , <i>S. saponaceum</i>
<i>Keiferia</i> (= <i>Tildenia</i>) <i>glocchinella</i>	Solanaceae: <i>Lycopersicon</i> sp., <i>Solanum carolinense</i> , <i>S. melongena</i> , <i>S. tuberosum</i>
<i>Keiferia</i> (= <i>Tildenia</i>) <i>gudmannella</i>	Solanaceae: <i>Capsicum annum</i> , <i>C. frutescens</i> , <i>Solanum</i> sp.
<i>Phthorimaea absoluta</i>	Solanaceae: <i>Datura stramonium</i> , <i>Lycopersicon esculentum</i> , <i>Nicotiana tabaccum</i> , <i>Solanum gracilius</i> , <i>S. melongena</i> , <i>S. saponaceum</i> , <i>S. tuberosum</i>

Tabla 4. Continuación.

Especies	Plantas Huésped
<i>Phthorimaea operculella</i>	**Brassicaceae: <i>Brassica oleracea</i> ; **Poaceae: <i>Zea mays</i> ; **Rubiaceae: <i>Coffea arabica</i> ; Solanaceae: <i>Brugmansia arborea</i> , <i>Capsicum annuum</i> , <i>Datura fastuosa</i> , <i>D. stramonium</i> , <i>Hyoceyamus</i> sp., <i>Lycopersicon esculentum</i> , <i>Lycium</i> sp., <i>Nicotiana alata</i> , <i>N. glauca</i> , <i>N. glutinosa</i> , <i>N. langsdorfii</i> , <i>N. nudicaulis</i> , <i>N. paniculata</i> , <i>N. rustica</i> , <i>N. sylvestris</i> , <i>N. tabacum</i> , <i>Physalis brasiliensis</i> , <i>P. pruinosa</i> , <i>Solanum capsicoides</i> , <i>S. melongena</i> , <i>S. paniculatum</i> , <i>S. racemiflorum</i> , <i>S. sisymbriifolium</i> , <i>S. torvum</i> , <i>S. tuberosum</i>
<i>Scrobipalpomima agustini</i>	Fabaceae: <i>Adesmia spinosissima</i>
<i>Scrobipalpula daturae</i>	Solanaceae: <i>Datura</i> sp.
<i>Scrobipalpula ilyella</i>	Solanaceae: <i>Nicotiana</i> sp.
<i>Scrobipalpula isochlora</i>	Solanaceae: <i>Solanum saponaceum</i> , <i>S. quitoense</i>
<i>Scrobipalpula motasi</i>	Solanaceae: <i>Solanum saponaceum</i>
<i>Symmetrischema borsaniella</i>	Solanaceae: <i>Capsicum annuum</i>
<i>Symmetrischema capsicum</i>	Solanaceae: <i>Capsicum</i> sp.
<i>Symmetrischema capsivorum</i>	Solanaceae: <i>Capsicum annuum</i> , <i>C. longum</i>
<i>Symmetrischema dulce</i>	Solanaceae: <i>Capsicum annuum</i>
<i>Symmetrischema striatella</i>	Solanaceae: <i>Solanum nigrum</i> , <i>S. torvum</i>
<i>Symmetrischema tangolias</i>	Solanaceae: <i>Capsicum annuum</i> , <i>Lycopersicon esculentum</i> , <i>Solanum nigrum</i> , <i>S. tuberosum</i> , <i>S. muricatum</i> , <i>S. aviculare</i> , <i>S. laciniatum</i>
<i>Tecia albinervella</i>	Asteraceae: <i>Baccharis nebulata</i>
<i>Tecia kiefferi</i>	Asteraceae
<i>Tecia solanivora</i>	Asteraceae: <i>Baccharis macranta</i> ; Cucurbitaceae: <i>Cucumis melo</i> ; Solanaceae: <i>Solanum tuberosum</i>
<i>Tecia venosa</i> (= <i>Tecia mendozella</i>)	Asteraceae: <i>Baccharis nebulata</i>
<i>Tuta atriplicella</i>	Amaranthaceae: <i>Atriplex lampa</i>

Tabla 5. Lista de plantas huésped para miembros de la tribu Gnorimoschemini reportados en el Nuevo Mundo.

No. de especies de la tribu Gnorimoschemini	Familia de planta huésped	No. de especies de plantas huésped reportadas en el Nuevo Mundo
8	Asteraceae	5
2	Amaranthaceae	2
2	Poaceae	4
1	Rubiaceae	1
22	Solanaceae	44

Lista de caracteres morfológicos y taxones

A continuación, se presenta una lista en inglés de los caracteres explorados y utilizados en la elaboración de la matriz de caracteres, previo a los análisis filogenéticos. Adicionalmente, en la Tabla 6, se listan los taxones empleados en los análisis filogenéticos, su distribución geográfica y su BIN (*Barcode Index Number System*). Este último

constituye el identificador de código de barras disponible en línea y que permite generar agrupaciones entre los taxones secuenciados.

1. Labial palps. (0) Recurved. (1) Upright.
2. Wingspan. (0) Less than 20 mm. (1) More than 20 mm.
3. Forewing design or color. (0) Mottled. (1) Streaks. (2) Uniform.
4. Hindwing situation. (0) Reduced. (1) Developed.
5. Hindwing morphology (Fig. 19). (0) Reduced. (1) Developed.

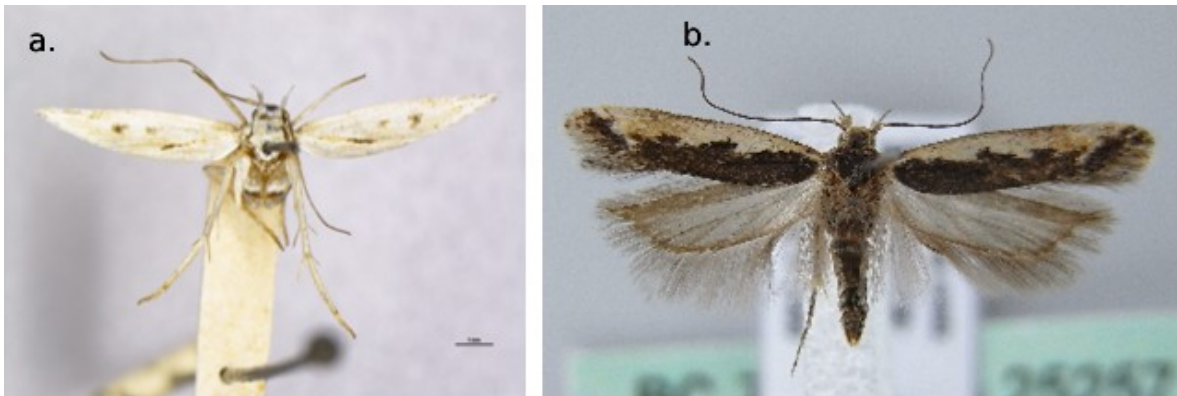


Figura 19. Morfología del ala posterior. a.) Braquiptería o no desarrollada. b.) Desarrollada.

6. I abdominal sclerite melanized (Fig. 20). (0) Absent. (1) Present.

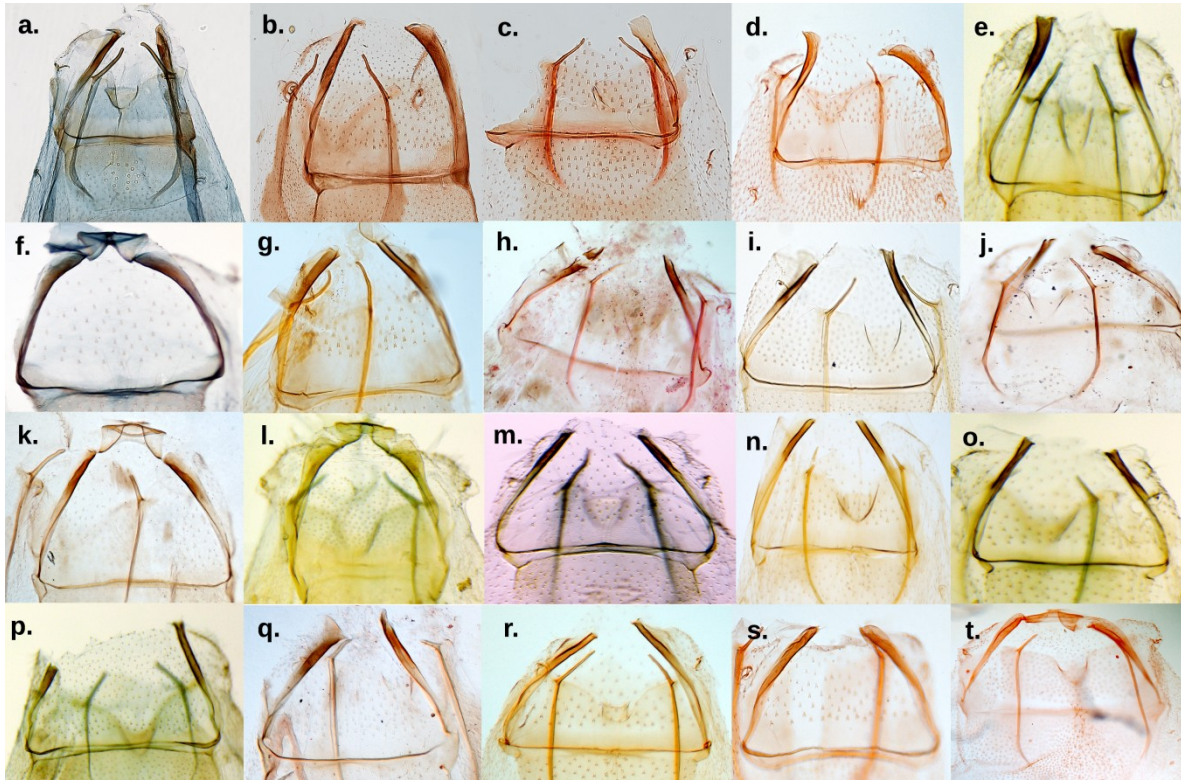


Figura 20. Primer esclerito abdominal con tendencia a la melanización. b.,c.,d.,l.,s.,t.) No melanizado (ausente). a.,e.,f.,g.,h.) Melanizado (presente). *Lista de taxones revisados:* a.) *Eurysacca melanocampta*. b.) *Scrobipalopsis petasitis*. c.) *Scrobipalpula psilella*. d.) *Ephysteris chersaea*. e.) *Cosmardia moritzella*. f.) *Klimeschiopsis* sp. g.) *Neopalpa neonata*. h.) *Neoschema klotsi*. i.) *Scrobipalpa atriplicella*. j.) *Scrobipalpoides obscurus*. k.) *Symmetrischema tangolias*. l.) *Tecia venosa*. m.) *Caryocolum leucomelanella*. n.) *Keiferia glochinella*. o.) *K. glochinella*. p.) *Sattleria dzieduczyckii*. q.) *Gobipalpa inexpectata*. r.) *Keiferia lycopersicella*. s.) *Ephysteris (Opacopsis) inustella*. t.) *Gnorimoschema gallaesolidaginis*.

7. Male coremata at S2 (base of the abdomen). (0) Absent. (1) Present.

8. Male coremata S8 (Fig. 21). (0) Absent. (1) Present.

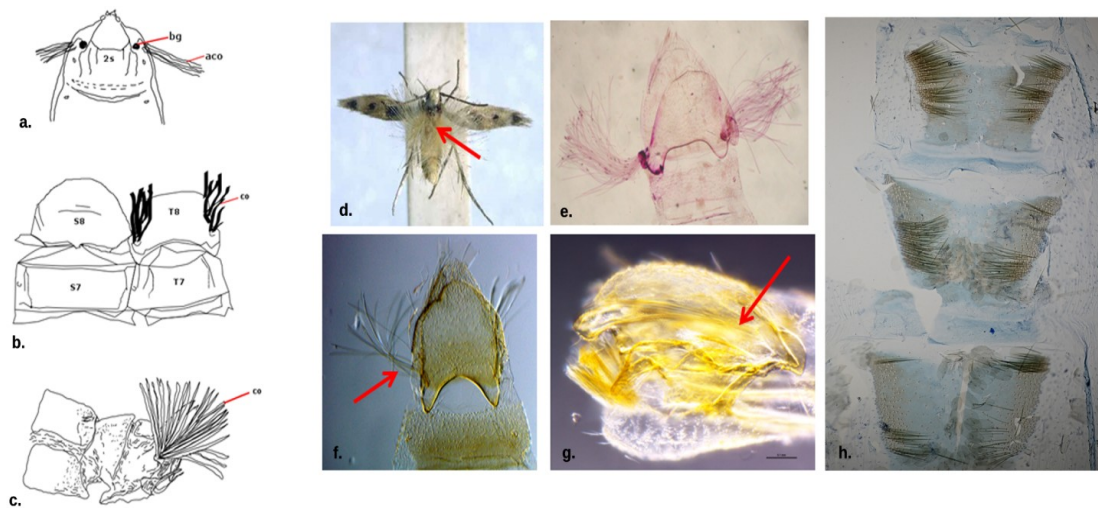


Figura 21. Variación en disposición de coremata. a.) Coremata abdominal con brochas de pelos en segmento abdominal II. b.) Coremata abdominal en posición lateral de T8. c.) Coremata abdominal en posición dorsal de T8. d.) Brochas de pelo en *Kiwaia jeanae*. e.) Coremata en *Kiwaia plearctica*. f.) Coremata en *Tecia venosa*. g.) Coremata en *Caryocolum leucomelanella*. h.) Brochas de pelos en *Pogochaetia solitaria*.

9. Glanductores (Fig. 22). (0) Absent. (1) Present.

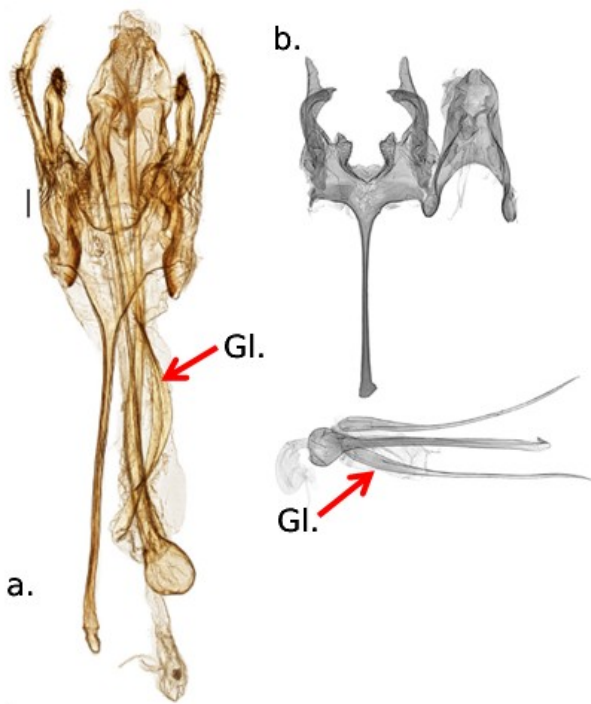


Figura 22. Desarrollo de glanductores. a.) Glanductores (Gl) en posición original. b.) Unrolling con glanductores extraídos.

10. Saccus shape: fusion lines at the base. (0) Two sets of fusion lines forming a diamond-shape, posterior sulci proceeding medially. (1) Posterior sulci missing, one thickened margin along edges of saccus.

11. Saccus shape (Fig. 23). (0) Petiolate. (1) Broad flattened.

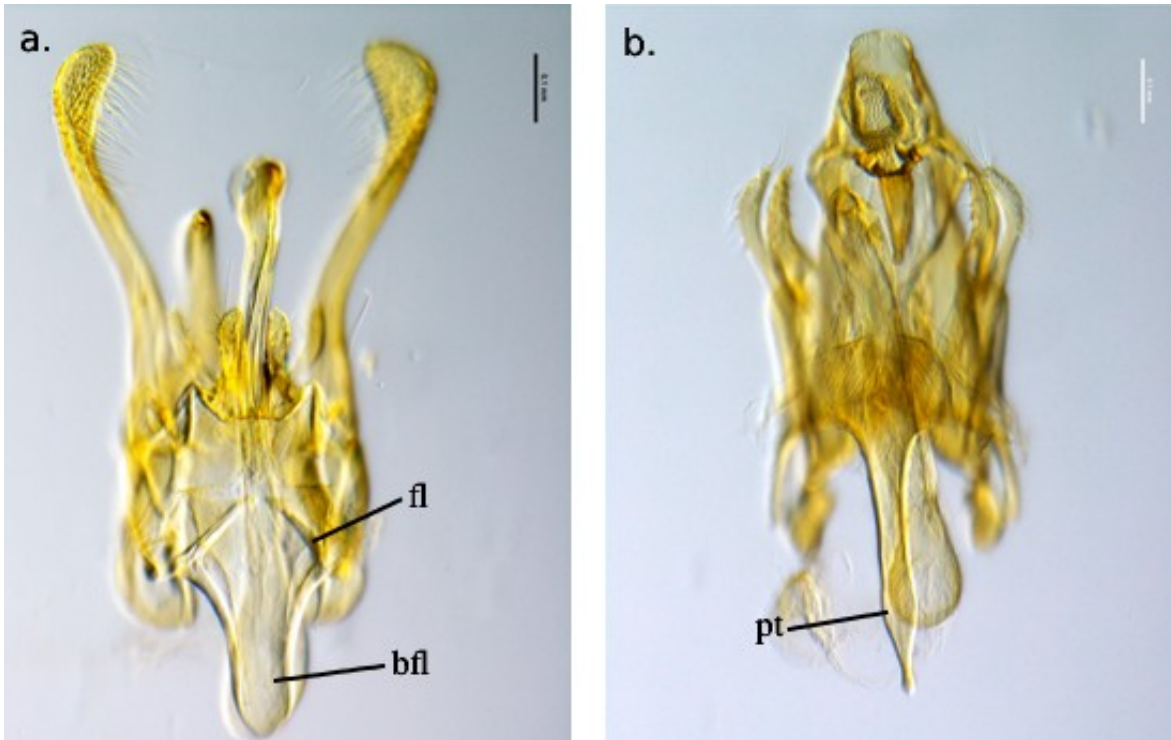


Figura 23. Morfología del saccus. a.) Saccus ancho. Abreviaciones: bfl=saccus ancho y aplastado; fl=desarrollo de dos escleritos en base del saccus con aspecto diamantado. b.) Saccus peciolado y delgado. Abreviaciones: pt=saccus peciolado.

12. Scoop-like apex of median sclerite of the gnathos (Fig. 24). (0) Absent. (1) Present.

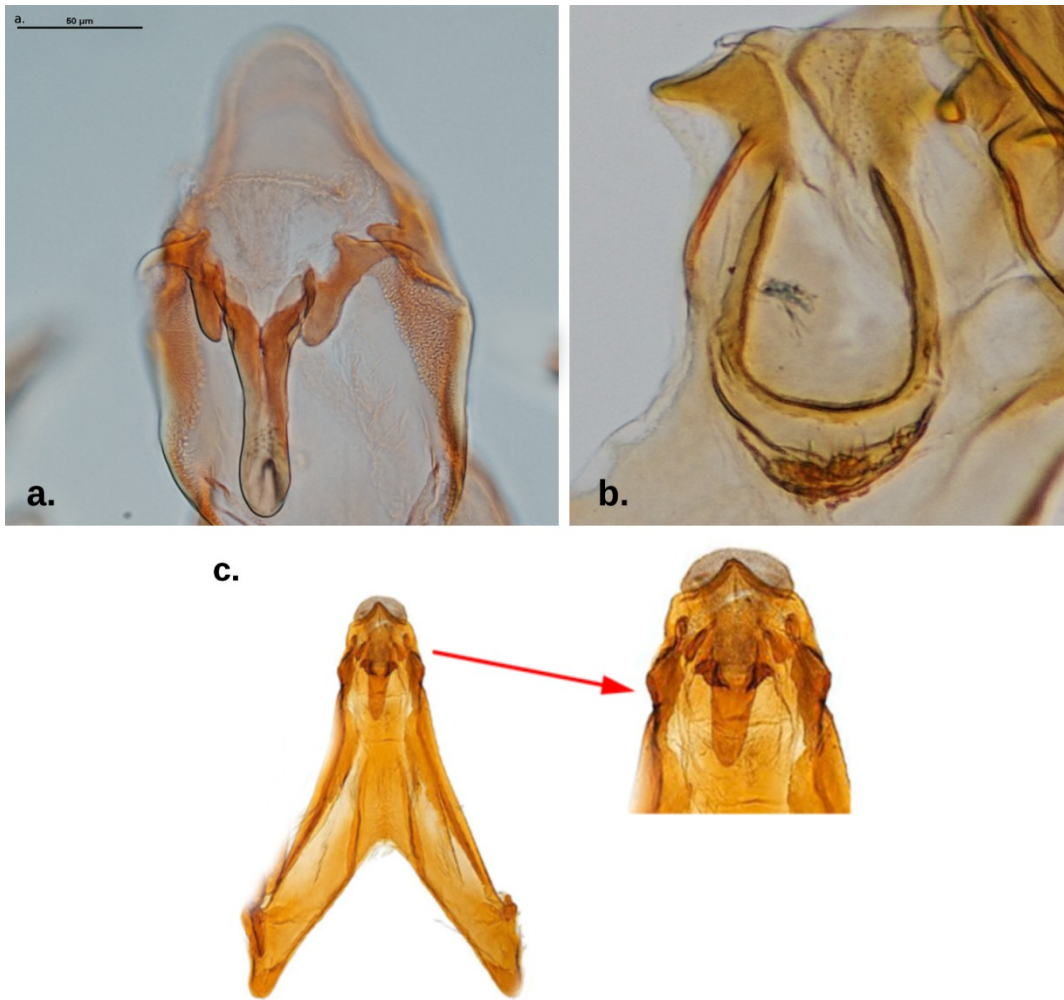


Figura 24. Morfología del esclerito medio del gnathos. a.) En forma de gancho presente en *Ephysteris*. b.) En forma de cuchara con zona media membranosa presente en *Keiferia*. c.) En forma de cuchara y completamente esclerosado presente en *Gnorimoschema*.

13. Articulation of median sclerite of the gnathos overlapping tegumen arms. (0) Absent.
 (1) Present.
14. Uncus apex (Fig. 25). (0) Rounded. (1) Projected. (2) Bifurcate. (3) Dentate.

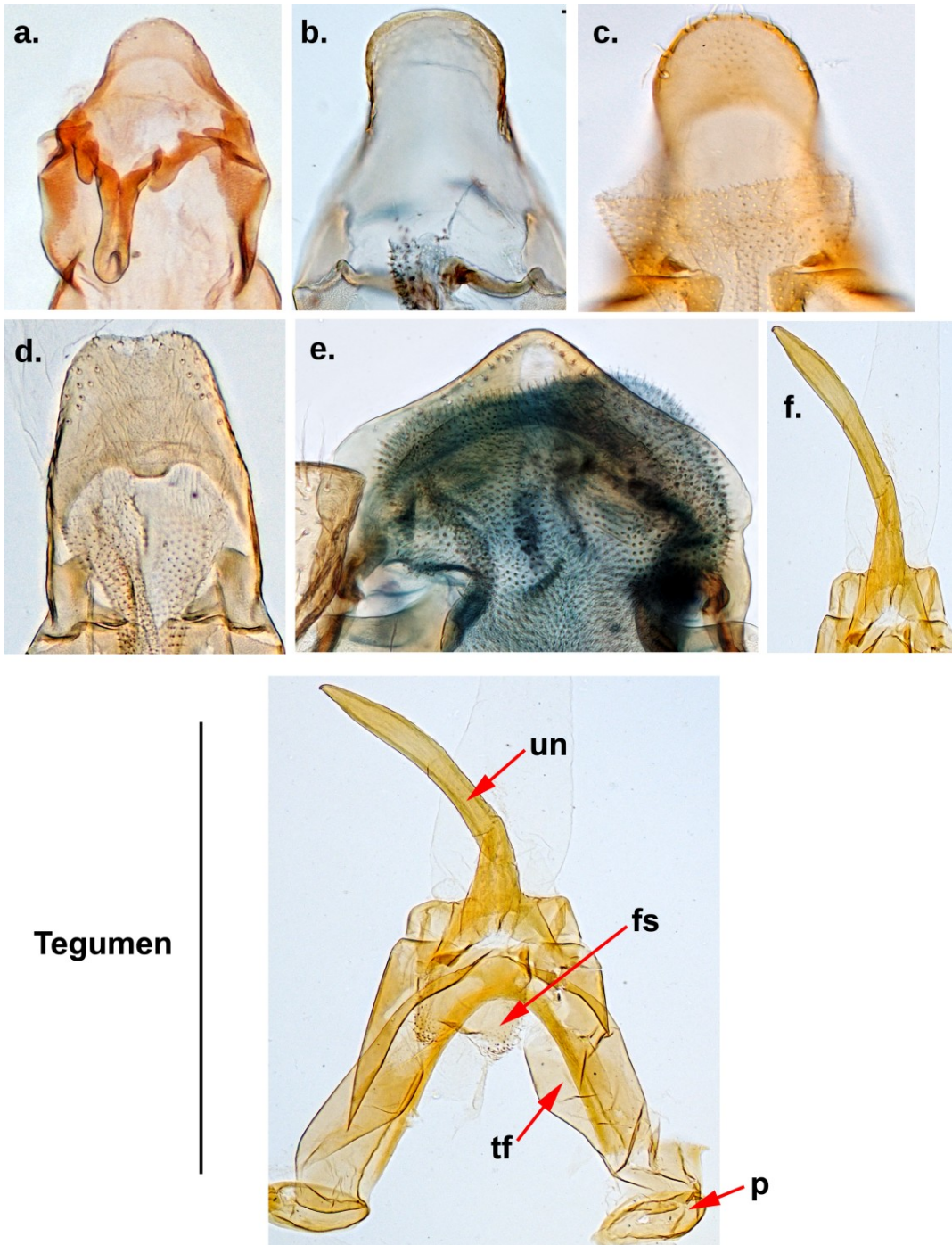


Figura 25. Morfología del margen externo del uncus. a.,b.,c.) Redondeado. d.) Bifurcado. e.) Dentado. f.) Proyectado. Abreviaciones: un=uncus, fs=futura superior, tf=borde del tegumen, p=pedúnculo. *Lista de taxones revisados:* a.) *Ephysteris chersaea*. b.) *Klimeschiopsis* sp. c.) *Neopalpa neonata*. d.) *Scrobipalpa atriplicella*. e.) *Tecia venosa*. f.) *Keiferia glochinella*.

15. Uncus apex microsculpture. (0) Absent. (1) Present.

16. Uncus apex setose. (0) Absent. (1) Present.

17. Setae arrangement on uncus. (0) Marginal. (1) Evenly distant.

18. Culcitula (Fig. 26). (0) Absent. (1) Present.

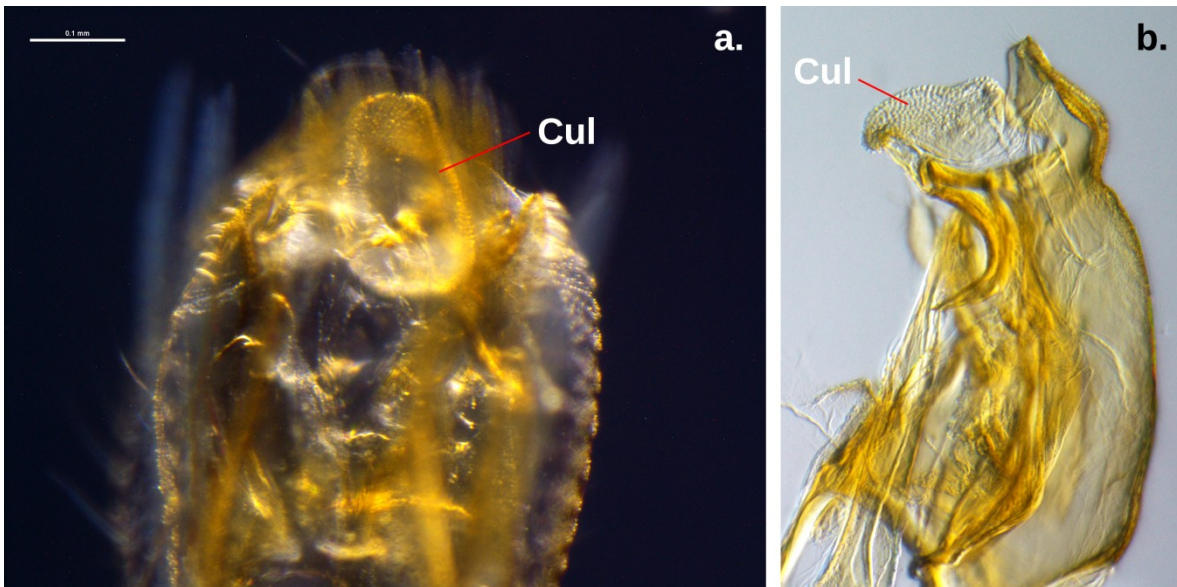


Figura 26. Desarrollo de la culcitula. a.) Culcitula en vista frontal. b.) Culcitula en vista lateral. Abreviaciones: Cul=culcitula.

19. Cucullus asymmetric. (0) Absent. (1) Present.

20. Cucullus shape of apex. (0) Simple. (1) Bifurcate.

21. Cucullus setose. (0) Absent. (1) Present.

22. Cucullus arrangement of setae. (0) Marginal. (1) Evenly distant.

23. Cucullus apex microsculpturated. (0) Absent. (1) Present.

24. Parabasal lobes. (0) Absent. (1) Present.

25. Parabasal lobes shape. (0) Protuberant. (1) Reduced.

26. Ventro medial process of vinculum. (0) Lobes do not overlap. (1) Lobes overlap.

27. Ventro medial process of vinculum. (0) Short. (1) Long.

28. Ventro medial process of vinculum. (0) Without pockets. (1) Pockets.

29. Gnathos size. (0) Not reduced. (1) Reduced.

30. Vinculum with pair of needle-shaped processes. (0) Absent. (1) Present.

31. Ventro medial process of vinculum. (0) Without lobes. (1) Lobes.

32. Saccus length. (0) Longer than wider, VNL+SAL. (1) Wider than longer, aprox.
VNL=SAL.

33. Phallus orientation (Fig. 27). (0) Straight. (1) Curved.



Figura 27. Orientación del phallus. a.) Recto y sin curvatura. b.) Con curvatura moderada.

- 34. Coecum reduced. (0) Absent. (1) Present.
- 35. Male pedunculus with sharp apex. (0) Absent. (1) Present.
- 36. Median projection of phallus. (0) Absent. (1) Present.
- 37. Lamina ducti ejaculatorii (Fig. 28). (0) Absent. (1) Present.



Figura 28. Desarrollo de lamina ducti ejaculatorii. Abreviaciones: Ldej=lamina ducti ejaculatorii.

- 38. Lamina ducti ejaculatorii size. (0) Protuberant. (1) Reduced.
- 39. Lamina ducti ejaculatorii orientation. (0) Flat. (1) Concave.
- 40. Signum. (0) Absent. (1) Present.
- 41. Shape of the signum (Fig. 29). (0) Acrinoid. (1) Rhomboidal.
- 42. Size of the signum (Fig. 29). (0) Small. (1) Large.



Figura 29. Variación en la morfología del signum. a.,b.) Signum acrinoideo. o.) Signum romboidal. En cuanto a si tamaño: a-j;l-n,p-y.) Protuberante. k.,o.) Reducido. *Lista de taxones revisados:* a.) *Gnorimoschema gallaesolidaginis*. b.) *Klimeschiopsis terroris*. c.) *Neopalpa neonata*. d.) *Neoschema klotsi*. e.) *Tecia venosa*. f.) *Scrobipalpa atriplicella*. g.) *Scrobipalpoides obscurus*. h.) *Symmetrischema tangolias*. i.) *Scrobipalpa aptatella*. j.) *Caryocolum leucomelanella*. k.) *Eurysacca melanocampta*. l.) *Scrobipalpopsis petasitis*. m.) *Scrobipalpula psilella*. n.) *Exceptia neopetrella*. o.) *Frumenta nundinella*. p.) *Keiferia lycopersicella*. q.) *Kiwaia medogia*. r.) *Phthorimaea operculella*. s.) *Gobipalpa inexpectata*. Vista frontal del signum. t.) *Canarischisma fuerteventura*. u.) *Agonochaetia intermedia*. v.) *Australioparpa communi*. w.) *Cosmardia moritzella*. x.) *Echinoglossa trinota*. y.) *Euscrobiopalpa indignella*.

43. Position of the signum. (0) Entrance of corpus bursae. (1) Half of corpus bursae.

44. Inner margin of signum dentate. (0) Absent. (1) Present.

45. Basal area of signum. (0) Smooth. (1) Dentate.

46. Corpus bursae surface (Fig. 30). (0) Smooth. (1) Striated.

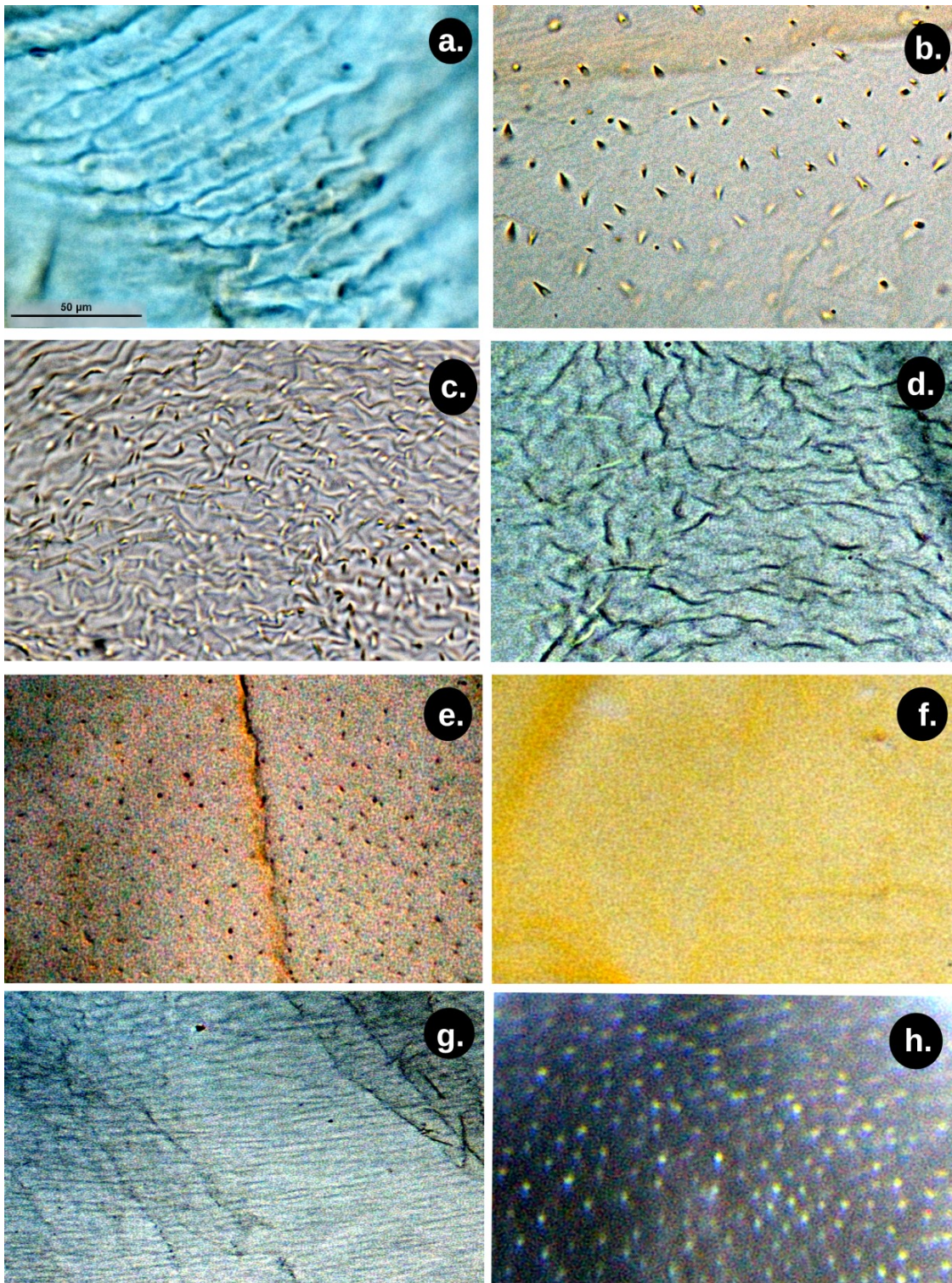


Figura 30. Superficie del corpus bursae. a.,b.,c.,d.,e.,g.,h.) Provista de microscultura u ornamentación. f.) Lisa.

47. Corpus bursae shape (Fig. 31). (0) Spherical. (1) Elongate. (2) Subvoid.

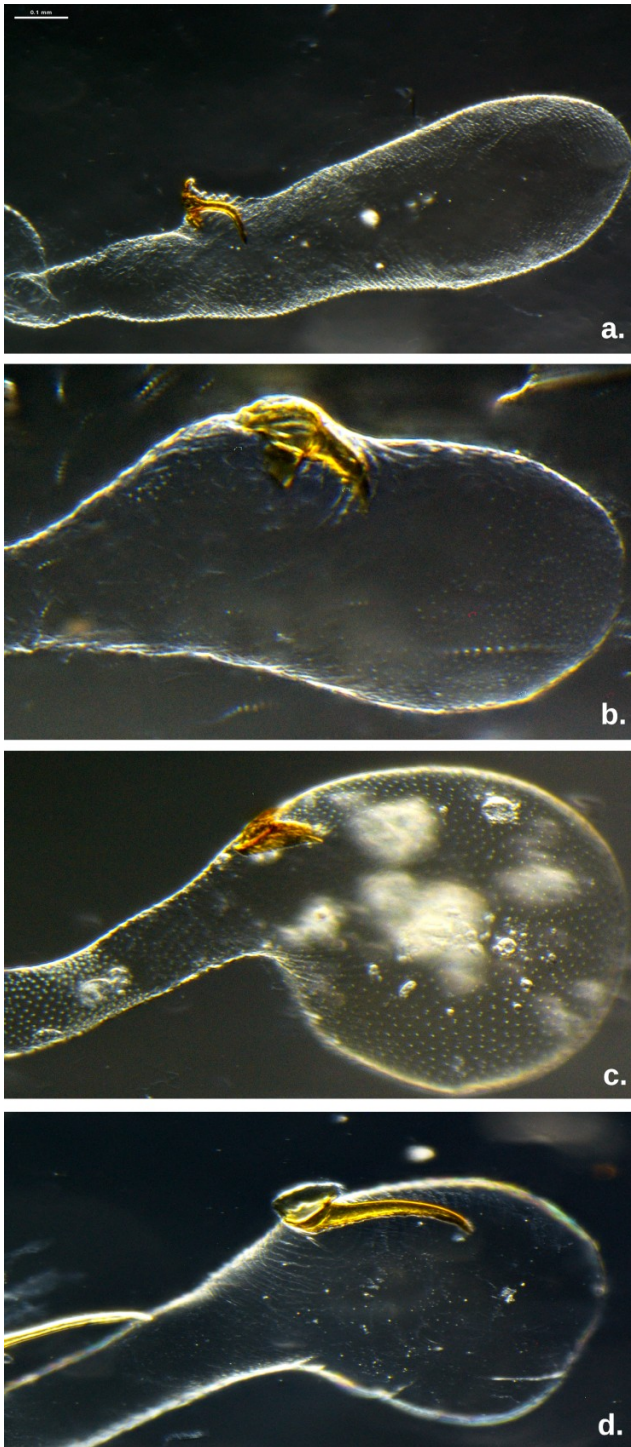


Figura 31. Variación en la morfología del corpus bursae. a.,b.) Elongado. c.,d.) Redondeado. Lista de taxones revisados: a.) *Caryocolum leucomelanella*. b.) *Klimeschiopsis terroris*. c.) *Neopalpa neonata*. d.) *Scrobipalopsis petasitis*.

48. Corpus bursae with setae. (0) Absent. (1) Present.

49. Ductus bursae length. (0) Short. (1) Long.
50. Ductus bursae partially sclerotized. (0) Absent. (1) Present.
51. Spermatheca: utriculus distal region (Fig. 32). (0) Elongated. (1) Coiled.
52. Spermatheca: utriculus distal region elongated with bifurcation (Fig. 32). (0) Absent. (1) Present.

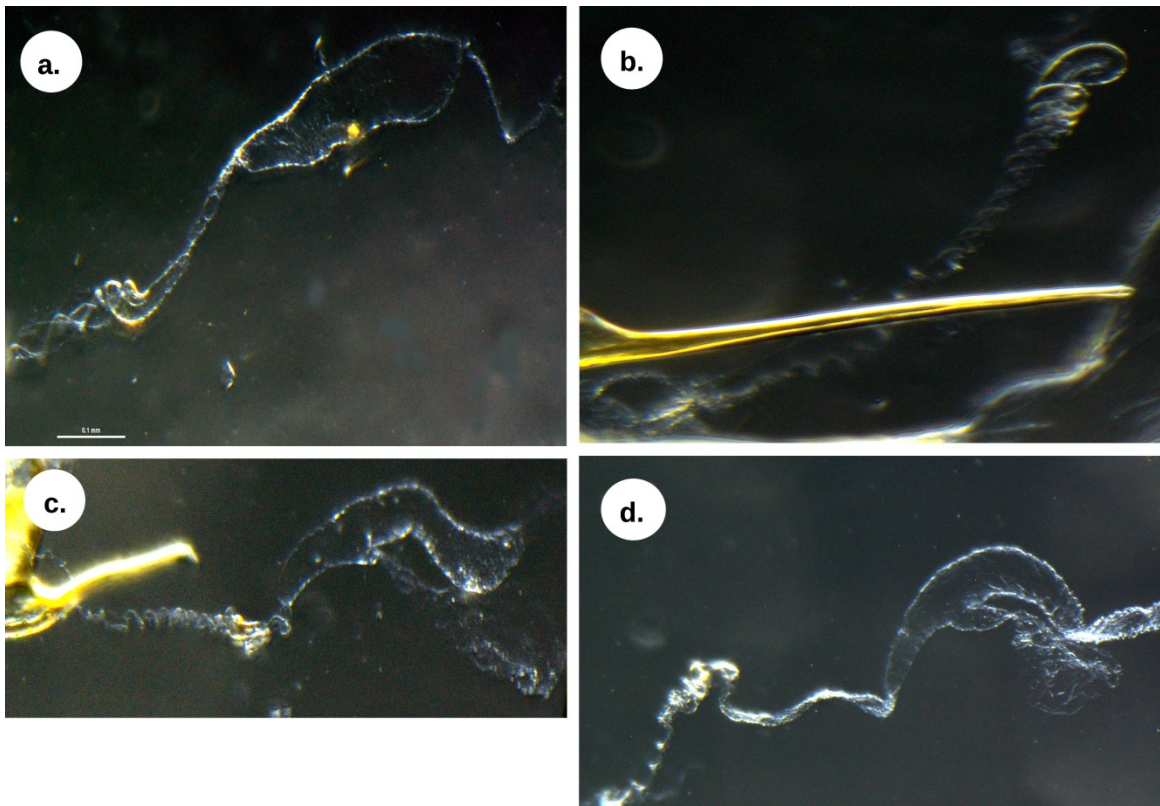


Figura 32. Variación en la morfología de la espermateca. Región distal de utrículo. a.) Elongado. b.) Helicoidal. Región distal de utrículo bifurcado. a.) Ausente. c.,d.) Presente. *Lista de taxones revisados:* a.) *Klimeschiopsis terroris*. b.) *Caryocolum leucomelanella*. c.) *Neopalpa neonata*. d.) *Scrobipalopsis petasitis*.

53. Subgenital plate texture. (0) Sclerotized. (1) Partially sclerotized.
54. Antrum shape. (0) Funel. (1) Tubular. (3) Rhomboidal. (4) Sub-triangular.
55. Antrum texture. (0) Sclerotized. (1) Partially sclerotized. (2) Membranous.
56. Annellus. (0) Absent. (1) Present.
57. Ventromedial portion of sternite VIII with paired depressions. (0) Absent. (1) Present.
58. Sub-ostial sclerites. (0) Absent. (1) Present.

59. Posterior part of ductus bursae. (0) With lateral sclerites. (1) Without lateral sclerites.
60. Larva with a single strategy. (0) Absent. (1) Present.
61. Adults are able to hibernate. (0) Absent. (1) Present.
62. Altitudinal gradient preference. (0) Lower lands, around 0 and 200 m.a.s.l. (1) Med altitudinal range, from 500 to 900 m.a.s.l. (2) High lands, around 1000 m.a.s.l. or higher.
63. Importance of the species. (0) Pest. (1) Indicator for conservation. (2) Rare. (3) Biological controller of invasive weeds.
64. Habitat preference. (0) Halophytic. (1) Mountainous. (2) Eremic. (3) Coastal dunes. (4) Alpine. (6) Stone seashore. (7) River. (8) Beach coast. (9) Xeric. (A) Rocky steppe. (B) Turbed.
65. Distribution. (0) Nearctic. (1) Neotropical. (2) Palaearctic. (3) Sub-Saharan Africa and Madagascar. (4) Indo Malaysia. (5) Australasia and New Zealand. (6) Cosmopolitan.
66. Diet. (0) Oligophagous, restricted to one family of plants. (1) Polyphagous, feeding on many families of plants.
67. Main host: origins. Amaranthaceae, latest Cretaceous. (0) Absent. (1) Present.
68. Main host origins: Asteraceae, Cretaceous period, more than 65 million years ago (Antarctica). (0) Absent. (1) Present.
69. Main host origins: Bethulaceae, upper Cretaceous. (0) Absent. (1) Present.
70. Main host origins: Caryophyllaceae, aprox. latest Cretaceous, Maastrichtian age. (0) Absent. (1) Present.
71. Main host origins: Lamiaceae, early Eocene (Asia). (0) Absent. (1) Present.
72. Main host origins: Poaceae, Cretaceous period, aprox. 66 million years ago (widespread). (0) Absent. (1) Present.
73. Main host origins: Rosaceae, diverse, aprox. 101 million years ago (widespread). (0) Absent. (1) Present.
74. Main host origins: Scrophulariaceae, diverse, still unsolved (Old World). (0) Absent. (1) Present.

75. Main host origins: Solanaceae, aprox. 10 million years ago (Andes, South America).
(0) Absent. (1) Present.
76. Main host origins: Zygophyllaceae, diverse, aprox. Early Oligocene (Asia). (0)
Absent. (1) Present.
77. Main host origins: Ericaceae, Latest Oligocene-Early Miocene (New Zealand). (0)
Absent. (1) Present.
78. Main host origins: Saxifragaceae, diverse, aprox. 38.37 million years ago Mid-Late
Eocene, aprox. 30.04 and 30.85 million years ago. (0) Absent. (1) Present.
79. Main host origins: Pinaceae, aprox. 140 million years ago (Northern hemisphere).
(0) Absent. (1) Present.
80. Larval feeding habit. (0) Predaceous. (1) Miner. (2) Skeletonizer. (3) Borer. (4) Gall
maker. (5) Roller.
81. Larval gregarism. (0) Absent. (1) Present.
82. Larval with shelter. (0) Absent. (1) Present.

Tabla 6. Lista de taxones considerados en el análisis filogenético.

Tribu/Subfamilia	Especies	Distribución geográfica	BIN
Anacampsinae	<i>Hypatima rhomboidella</i>	Palaearctic	BOLD:AAD1448
Anacampsinae	<i>Anacampsis populella</i>	Palaearctic	BOLD:AAD3256
Anacampsinae	<i>Anarsia lineatella</i>	Palaearctic	
Apatetrinae	<i>Chrysoesthia drurella</i>	Palaearctic	
Dichomeridinae	<i>Dichomeris ligulella</i>	North America	BOLD:AAA8109
Dichomeridinae	<i>Helcystogramma rufescens</i>	Palaearctic	BOLD:AAC1177
Gelechiini	<i>Gelechia rhombella</i>	Palaearctic	BOLD:AAE6372
Gelechiini	<i>Prolita sexpunctella</i>	Holarctic	
Pexicipiinae	<i>Sitotroga cerealella</i>	Cosmopolitan	BOLD:AAD0546
Physoptilinae	<i>Physoptila scenica</i>	Indo Malaysia	
Physoptilinae	<i>Physoptila sp.</i>	Indo Malaysia	BOLD:AA7586
Gelechiini	<i>Gelechia senticetella</i>	Palaearctic	BOLD:AAE6366
Gelechiini	<i>Chionodes mediofuscella</i>	North America	BOLD:AAA5871
	<i>Lysipatha cyanoschysta</i>	Australasia and New Zealand	
	<i>Magonympha chrysocosma</i>	Indo Malaysia	
	<i>Megacraspedus ribbeella</i>	Palaearctic	BOLD:ACZ9288
	<i>Phobetica ignobilis</i>	Australasia and New Zealand	
	<i>Phylopatris terpnodes</i>	Neotropical	
	<i>Phricogenes sophronopa</i>	Indo Malaysia	
Thiotrichinae	<i>Thiotricha margarodes</i>	Australasia and New Zealand	
Gnorimoschemini	<i>Gnorimoschema gallaesolidaginis</i>	Nearctic	BOLD:AAT9819
Gnorimoschemini	<i>Ephysteris chersaea</i>	Cosmopolitan	
Gnorimoschemini	<i>Eurysacca melanocampta</i>	Neotropical	BOLD:ADB5468
Gnorimoschemini	<i>Eurysaccoides gallaespinosae</i>	Nearctic	
Gnorimoschemini	<i>Echinoglossa trinota</i>	Cosmopolitan	
Gnorimoschemini	<i>Exceptia neopetrella</i>	Cosmopolitan	BOLD:ACG6919
Gnorimoschemini	<i>Frumenta nundinella</i>	Nearctic	BOLD:AAH5546
Gnorimoschemini	<i>Keiferia lycopersicella</i>	Cosmopolitan	BOLD:ABY9380
Gnorimoschemini	<i>Kiwaia cheradias</i>	Australasia and New Zealand	
Gnorimoschemini	<i>Magnifacia aulorrhhoa</i>	Neotropical	
Gnorimoschemini	<i>Neopalpa neonata</i>	Nearctic	BOLD:ABW8320
Gnorimoschemini	<i>Nevadopalpa striata</i>	Nearctic	
Gnorimoschemini	<i>Opacopsis inustella</i>	Palaearctic	BOLD:ACR2218
Gnorimoschemini	<i>Paraschema detectendrum</i>	Cosmopolitan	
Gnorimoschemini	<i>Phthorimaea operculella</i>	Cosmopolitan	BOLD:AAB9396
Gnorimoschemini	<i>Phthorimaea absoluta</i>	Widespread	BOLD:AAJ8033
Gnorimoschemini	<i>Schmidnielsenia nielseni</i>	Neotropical	BOLD:AAB9396
Gnorimoschemini	<i>Scrobipalpa atriplicella</i>	Cosmopolitan	BOLD:AAA9252
Gnorimoschemini	<i>Scrobipalpa aptatella</i>	Cosmopolitan	BOLD:AAW5797
Gnorimoschemini	<i>Scrobipalpoides obscurus</i>	Neotropical	
Gnorimoschemini	<i>Scrobipalpomima neuquenensis</i>	Neotropical	
Gnorimoschemini	<i>Scrobipalopsis petasitis</i>	Cosmopolitan	BOLD:AAE1641
Gnorimoschemini	<i>Scrobipalpula psilella</i>	Palaearctic	BOLD:AAF1106
Gnorimoschemini	<i>Scrobipalpulopsis stiroides</i>	Neotropical	
Gnorimoschemini	<i>Scrobipalpuloides inapparens</i>	Neotropical	
Gnorimoschemini	<i>Scrobitasta varians</i>	Palaearctic	
Gnorimoschemini	<i>Symmetrischema tangolias</i>	Neotropical	BOLD:ACN5889
Gnorimoschemini	<i>Tecia venosa</i>	Cosmopolitan	
Gnorimoschemini	<i>Microlechia chretieni</i>	Cosmopolitan	BOLD:AAU3189
Gnorimoschemini	<i>Neoschema klotsi</i>	Nearctic	BOLD:ACR1258
Gnorimoschemini	<i>Cosmardia moritzella</i>	Palaearctic	BOLD:AAJ5578
Gnorimoschemini	<i>Caryocolum leucomelanella</i>	Palaearctic	BOLD:AAM3503
Gnorimoschemini	<i>Canarischema fuerteventura</i>	Palaearctic	BOLD:ACZ6649

Tabla 6. Continuación.

Tribu/Subfamilia	Especies	Distribución geográfica	BIN
Gnorimoschemini	<i>Tila capsophilella</i>	Palearctic	BOLD:ACL7124
Gnorimoschemini	<i>Turcopalpa glaseri</i>	Palearctic	
Gnorimoschemini	<i>Pogochaetia solitaria</i>	Palearctic	BOLD:ACA9790
Gnorimoschemini	<i>Sattleria dzieduszyckii</i>	Palearctic	
Gnorimoschemini	<i>Synthesiopalpa fornacaria</i>	Africa and Sub Saharan	
Gnorimoschemini	<i>Ptycerata busckella</i>	Nearctic	
Gnorimoschemini	<i>Agonochaetia incredibilis</i>	Palearctic	
Gnorimoschemini	<i>Lutilabria lutilabrella</i>	Palearctic	BOLD:ABW4984
Gnorimoschemini	<i>Klimeschiopsis discontinuella</i>	Palearctic	BOLD:AAX0326
Gnorimoschemini	<i>Ephysteris subdiminutella</i>	Cosmopolitan	BOLD:AAH4553
Gnorimoschemini	<i>Vladimirea wiltshirei</i>	Palearctic	
Gnorimoschemini	<i>Insuloschema barbarae</i>	Nearctic	BOLD:ABV9404
Gnorimoschemini	<i>Australiopalpa commoni</i>	Australasia and New Zealand	BOLD:AAW5819
Gnorimoschemini	<i>Brachypsaltis subalbata</i>	Cosmopolitan	
Gnorimoschemini	<i>Vladimirea amseli</i>	Palearctic	
Gnorimoschemini	<i>Empista palaeartica</i>	Australasia and New Zealand	
Gnorimoschemini	<i>Phthorimaea ergasima</i>	Palearctic	
Gnorimoschemini	<i>Euscrobipalpa indigenella</i>	Palearctic	
Gnorimoschemini	<i>Fapua albinervella</i>	Neotropical	
Gnorimoschemini	<i>Gobipalpa inexpectata</i>	Palearctic	
Gnorimoschemini	<i>Ilseopsis peterseni</i>	Africa and Sub Saharan	
Gnorimoschemini	<i>Kiwaia jeanae</i>	Australasia and New Zealand	
Gnorimoschemini	<i>Lata kiefferi</i>	Cosmopolitan	
Gnorimoschemini	<i>Lerupsia seffnieri</i>	Africa and Sub Saharan	
Gnorimoschemini	<i>Megalocypha polyoptera</i>	Palearctic	
Gnorimoschemini	<i>Microcraspedus brachypogon</i>	Africa and Sub Saharan	
Gnorimoschemini	<i>Tildenia glochinella</i>	Nearctic	BOLD:AAH5052
Gnorimoschemini	<i>Phloeocecis cherregella</i>	Palearctic	
Gnorimoschemini	<i>Primischema elementare</i>	Neotropical	
Gnorimoschemini	<i>Sautereopsis terrestrella</i>	Palearctic	
Gnorimoschemini	<i>Schizovalva trisignis</i>	Africa and Sub Saharan	
Gnorimoschemini	<i>Scrobischema vergarai</i>	Neotropical	
Gnorimoschemini	<i>Symmetrischemulum nummulatum</i>	Neotropical	
Gnorimoschemini	<i>Zeempista cheradias</i>	Australasia and New Zealand	

Filogenia preliminar de la tribu Gnorimoschemini

Basándonos exclusivamente en la evidencia morfológica y tomando como grupos externos la especie *Physoptila scenica* y *Physoptila* sp., es pertinente mencionar algunas relaciones vistas a nivel de los taxones analizados (Figs. 36, 37) y es que la sinuación de las alas posteriores es apenas evidente en *Agonochaetia*, *Pogochaetia*, *Tila* y *Frumenta*. La misma situación es trasladable a las polillas que tienen alas anchas como *Helcystogramma* y *Dichomeris*. El resto de los géneros tiene una evidente sinuación de las alas posteriores.

La braquiptería es una condición compartida por los géneros *Paraschema*, *Scrobipalpula*, *Caryocolum*, *Kiwaia*, *Ephysteris*, *Gnorimoschema*, *Lutilabria* y *Sattleria*. El resto de los géneros ha desarrollado alas posteriores.

Los glandíductores son una condición compartida por los géneros *Canarischema*, *Agonochaetia*, *Pogochaetia*, *Tila* e *Insuloschema*. El resto de los géneros no tienen glandíductores.

El esclerito abdominal está melanizado en *Klimeschiopsis*, *Cosmardia*, *Gobipalpa*, *Scrobipalpa*, *Eurysacca*, *Symmetrischema*, *Keiferia*, *Neopalpa* y *Sattleria*. Esta característica se comparte con el grupo externo *Physoptila*. Los géneros restantes no tienen esta característica.

La base del saccus con dos pares de líneas de fusión que presentan una forma de diamante es una condición compartida por *Schmidtnielsenia*, *Eurysaccoides*, *Phthorimaea*, *Scrobipalpula*, *Tecia*, *Gobipalpa*, *Kiwaia*, *Scrobipalpa*, *Turcopalpa*, *Eurysacca*, *Symmetrischema*, *Frumenta*, *Keiferia*, *Gnorimoschema*, *Scrobipalpomima*, *Microlechia*, *Scrobitasta* y *Vladimirea*. El resto de los géneros tiene un margen engrosado en la base del saccus.

La forma del saccus es amplia y aplanada en los géneros *Eurysaccoides*, *Phthorimaea*, *Scrobipalpula*, *Tecia*, *Gobipalpa*, *Kiwaia*, *Scrobipalpa*, *Turcopalpa*, *Ephysteris*, *Ochrodia*, *Opacopsis*, *Eurysacca*, *Symmetrischema*, *Gnorimoschema*, *Scrobipalpomima*, *Lutilabria*, *Tuta*, *Neopalpa* y *Sattleria* (una condición compartida con el grupo externo, *Physoptila*). En los otros géneros, el saccus es estrecho y peciolado; por ejemplo, esta condición ocurre en *Schmidtnielsenia*, *Paraschema*, *Canarischema*, *Agonochaetia*, *Pogochaetia* y *Tila*.

El esclerito mesial del gnathos está presente en la mayoría de los géneros, excepto en *Agonochaetia*, *Pogochaetia* y *Tila*, como una condición compartida con un antepasado Gelechiini (*Gelechia*).

Son evidentes tres tendencias en la forma del esclerito mesial del gnathos: "en forma de cuchara" en *Gnorimoschema*, *Paraschema*, *Canarischema* y *Scrobipalpula*; "similar a absoluta", es decir, con márgenes sub-circulares y provisto de zona membranosa hacia la porción discal y provista moderadamente de microtrichia en *Schmidtnielsenia*, *Klimeschiopsis*, *Phthorimaea*, *Keiferia* y *Lutilabria*; o "en forma de gancho" en *Barticeja*, *Caryocolum*, *Cosmardia*, *Eurysaccoides*, *Exceptia*, *Insuloschema*, *Tecia* y *Ephysteris*.

En la mayoría de las especies la tendencia es tener un uncus ancho, pero en *Keiferia* y *Canarischema* se proyecta esta característica. Esta condición hace pensar al autor en una posible relación con miembros del género *Deltophora*, donde también se proyecta el uncus. El uncus puede ser subagudo en los géneros *Barticeja*, *Tecia*, *Gnorimoschema*, *Scrobipalpomima* y *Scrobitasta*.

El proceso sacular podría tener casi la misma longitud que la valva, una condición compartida entre *Canarischema*, *Agonochaetia*, *Tila*, *Klimeschiopsis*, *Cosmardia*, *Ephysteris*, *Lutilabria*, *Microlechia* y *Sattleria*. En los demás, el proceso sacular es corto y menos evidente.

El vinculum podría fusionarse como una placa engrosada como en *Schmidtnielsenia*, *Paraschema*, *Canarischema*, *Agonochaetia*, *Pogochaetia* y *Tila*. Un total de 18 géneros comparten este carácter con un antepasado Gelechiini (*Gelechia*). Los otros géneros, no tienen un vínculo fusionado.

El vinculum se proyecta en *Paraschema*, *Symmetrischema* y *Neopalpa*. Los otros géneros no tienen este carácter. Esta condición podría compartirse con un antepasado de Litini.

El phallus con curvatura está presente en *Schmidtnielsenia*, *Phthorimaea*, *Turcopalpa*, *Microlechia*, *Phloeocecis* y *Neopalpa*. La principal tendencia en estas polillas es un phallus recto.

El caecum se reduce en *Schmidtnielsenia*, *Agonochaetia*, *Pogochaetia*, *Tila*, *Frumenta*, *Keiferia*, *Lutilabria*, *Tuta*, *Microlechia* y *Phloeocecis*. Esta condición se comparte con un ancestro de Physoptilinae. En la mayoría de los géneros, el caecum se desarrolla como una gran pieza maciza.

La mayoría de los géneros han desarrollado un proceso apical del phallus: esta condición no se encuentra en *Pogochaetia*, *Insuloschema*, *Kiwaia*, *Frumenta*, *Gnorimoschema*, *Tuta* y *Phloeocecis*.

La lámina ducti ejaculatorii es una característica que siempre se olvida en las descripciones. En este ejercicio, esta característica se muestra en *Schmidtnielsenia*, *Canarischema*, *Pogochaetia*, *Klimeschiopsis*, *Caryocolum*, *Exceptia*, *Gobipalpa*, *Kiwaia*, *Scrobipalpa*, *Ephysteris*, *Eurysacca*, *Symmetrischema*, *Microlechia*, *Phloeocecis* y *Neopalpa*. El resto de los generos, no presentan esta característica.

La ausencia de un signum se comparte entre *Sattleria*, *Schmidtnielsenia* y un antepasado Gelechiini. El resto de los géneros tiene signum.

La reducción del signum está presente en *Eurysacca*, *Frumenta*, *Symmetrischema*, *Phthorimaea*, *Pogochaetia* y *Tila*. La mayoría de los géneros muestran un signum bien desarrollado.

El signum podría modificarse como un parche lateral en *Pogochaetia* y *Tila*. Esta asociación ha sido confirmada a través de la taxonomía integrativa ó evidencia total aplicada en este trabajo (Fig. 35) y a su vez alcanzada por métodos numéricos en la primera filogénia para la tribu Gnorimoschemini (Povolný y Sustek,1988).

Hay tres tendencias en la forma del corpus bursae, estas son:

- Alargado: *Klimeschiopsis*, *Caryocolum*, *Cosmardia*, *Exceptia*, *Phthorimaea*, *Scrobipalpula*, *Tecia*, *Eurysacca*, *Symmetrischema*, *Frumenta*, *Keiferia*, *Gnorimoschema* y *Vladimirea*.

- Redondeado: *Canarischema*, *Gobipalpa*, *Kiwaia*, *Scrobipalpa*, *Turcopalpa*, *Ephysteris*, *Microlechia*, *Neopalpa* y *Sattleria*.
- Subovoide: *Tila* y *Pogochaetia*.

La forma de embudo del antrum es una condición compartida entre *Phthorimaea absoluta*, *Phthorimaea*, *Fruventa*, *Keiferia* y *Microlechia*. Esta condición probablemente se comparte con un antepasado Gelechiini. Los otros géneros no tienen un antrum en forma de embudo.

El ductus bursa es largo en *Schmidtnielsenia*, *Canarischema*, *Klimeschiopsis*, *Caryocolum*, *Gobipalpa*, *Scrobipalpa*, *Ephysteris*, *Fruventa*, *Gnorimoschema*, *Scrobipalpomima* y *Scrobitasta*. Esta condición se comparte con el antepasado putativo de *Gelechia*.

Al plasmar lo anterior en una matriz exclusiva de caracteres morfológicos y luego la realización de un análisis de parsimonia bajo un consenso estricto (Fig. 33), es evidente la poca resolución en lo que respecta a relaciones filogenéticas, obteniendo índices de consistencia y retención bajos, 0,32 y 0,18, respectivamente. Esto puede deberse a la poca información que se logró obtener a partir de algunos ejemplares previamente disectados por Povolný, de los cuales caracteres importantes relacionados con estructuras membranosas no pudieron ser codificados ya que en muchos casos se descartaban estas estructuras. Se decidió dejar estos caracteres durante la elaboración de la matriz con miras de que en el futuro se pueda obtener mayor información y poder así codificarlos. Estos resultados confirman que la evidencia morfológica por sí sola es de utilidad, sin embargo, no es suficiente para resolver las complejas relaciones entre los miembros de la tribu Gnorimoschemini. Cabe resaltar que a través de la morfología se pudo confirmar la relación entre los géneros *Keiferia* y *Phthorimaea*. Adicionalmente, se confirman las sinonimias para el género *Tecia* y para el género *Gnorimoschema*. Entre otras relaciones interesantes y obtenidas de manera preliminar destacan el caso de *Sattleria* y *Lutilabria*; *Tila* y *Agonochaetia*; *Ephysteris* y *Neopalpa*; *Turcopalpa* y *Gobipalpa*. Mediante este tipo de análisis se ha llegado a la misma conclusión que Povolný en su análisis fenético, en particular, lo que respecta a las relaciones entre los géneros *Turcopalpa* y *Gobipalpa*.

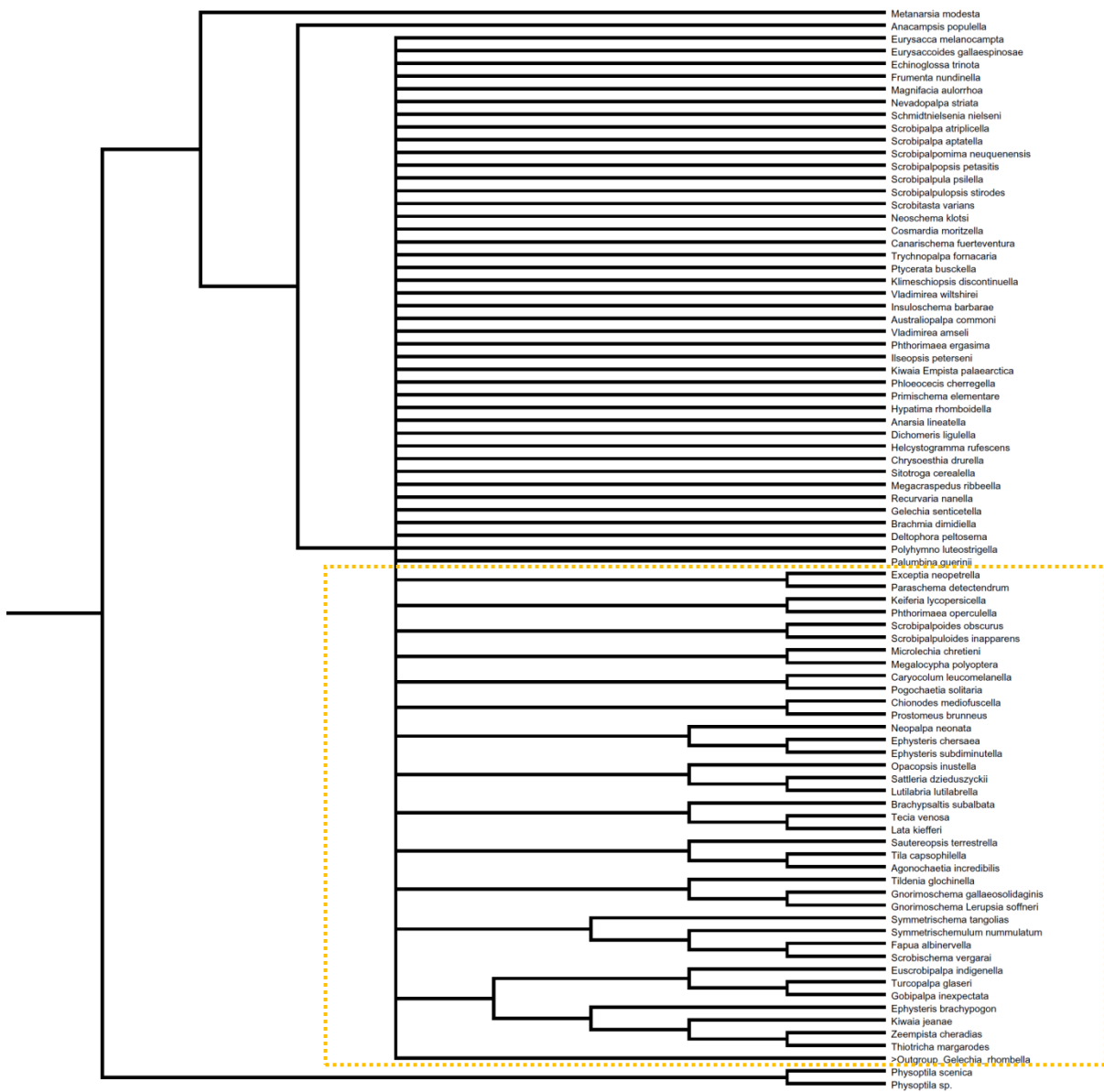


Figura 33. Relaciones filogenéticas preliminares basadas en aspectos morfológicos. Consenso estricto. En este árbol se utilizaron las especies *Physoptila scenica* y *Physoptila* sp. como grupos externos. Longitud del árbol= 4830. Índice de consistencia= 0,32. Índice de retención= 0,18.

En lo que respecta al análisis molecular se utilizó una especie de *Physoptila* como grupo externo y de manera independiente bajo un consenso estricto (Fig. 34) se obtuvieron algunos agrupamientos preliminares, sin embargo, como ya se expuso de manera inicial pocas son las secuencias que se disponían al momento de realizar el análisis. Tenemos que *Gnorimoschema* y *Neoschema* están relacionados, seguidamente el caso de *Scrobipalpa* y *Gobipalpa*, siendo *Frumenta* el ancestro más cercano. Adicionalmente, las especies alpinas forman una agrupación en la cual tenemos que *Tila* y *Pogochaetia* se relacionan siendo *Cosmardia* el ancestro más cercano. Luego *Caryocolum* y *Sattleria* están relacionados, seguidamente *Lutilabria* y *Klimeschiopsis*. Otra agrupación la pudimos observar entre los géneros *Brachmia* y *Helcystogramma* siendo *Dichomeris* su ancestro más cercano. Estas son relaciones de tipo preliminar y no deben ser tomadas como definitivas puesto a que no se dispuso de suficientes secuencias para tener resultados más claros. Sin embargo, la práctica demuestra la necesidad de mayor material y que el mismo sea secuenciado para elaborar análisis más precisos. En lo que respecta a los índices de consistencia y retención, los mismos fueron bajos, 0,33 y 0,20 respectivamente.

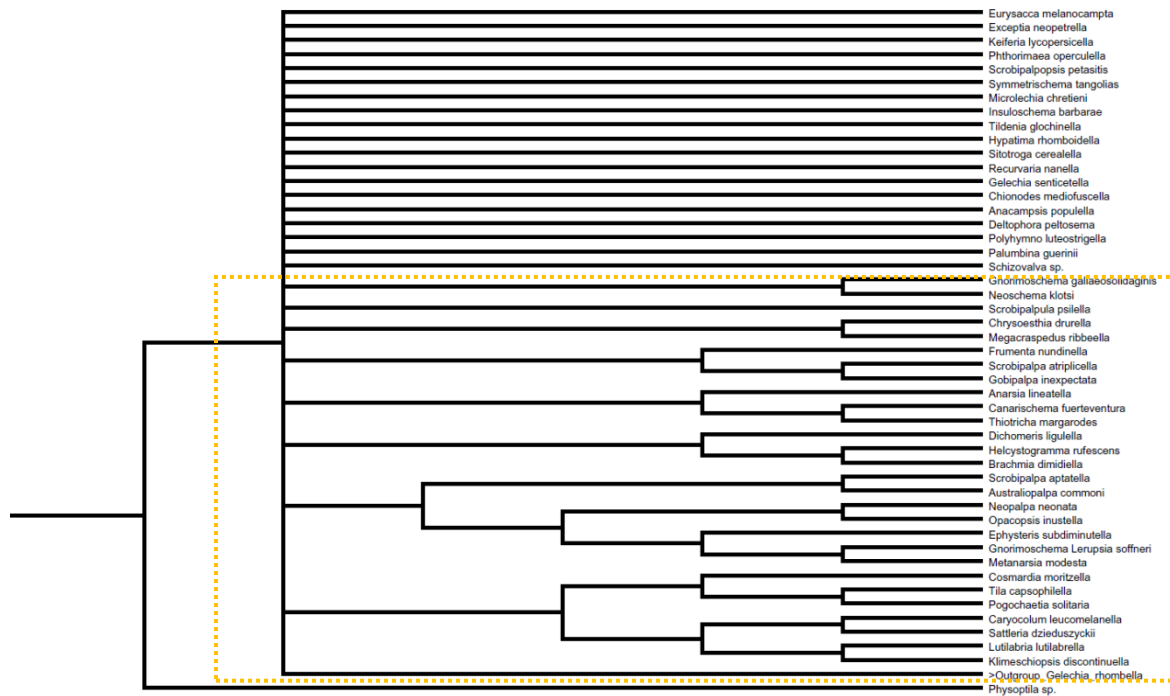


Figura 34. Relaciones filogenéticas preliminares basadas en aspectos moleculares (COI). Consenso estricto. En este árbol se utilizaron la especie *Physoptila* sp. como grupo externo. Longitud del árbol= 2932. Índice de consistencia= 0,33. Índice de retención= 0,20.

Definitivamente una de las herramientas que ha aportado un mayor conocimiento a la diversidad críptica de los Gnorimoschemini ha sido la integración de los códigos de barra del gen citocromo oxidasa I (COI). Existen estudios que advierten sobre los beneficios de su uso en estudios de biodiversidad de estos microlepidopteros y la utilidad al hacer las asociaciones de machos y hembras e inclusive en la toma de decisiones respecto a la descripción de nuevos taxones (Huemer et al., 2014; Huemer y Hebert, 2016; Kim et al., 2020). Por lo anterior, se decidió utilizar las secuencias disponibles e integrarlas a nuestra matriz de caracteres basándonos en la evidencia total.

La evidencia total, es decir, la inclusión de la morfología externa, los genitalia masculinos y femeninos, algunas tendencias ecológicas y los códigos de barra (Fig. 35) resultaron ser la mejor manera de estudiar la tribu Gnorimoschemini. En un análisis filogenético basado en la evidencia total, hemos encontrado al menos seis agrupaciones de clados para los taxones.

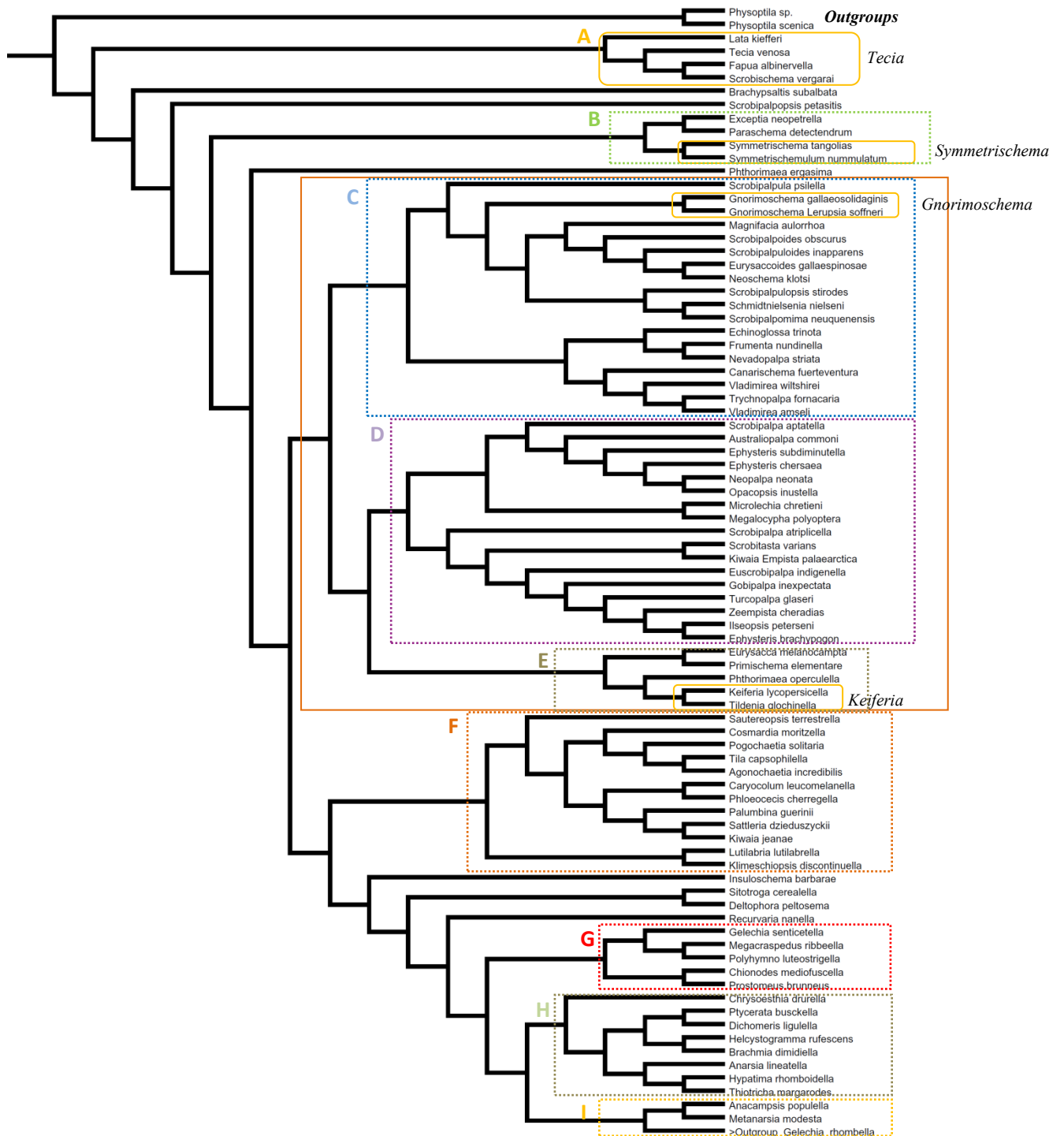


Figura 35. Relaciones filogenéticas preliminares basadas en la evidencia total (morfolología + COI+ecología). En este árbol se utilizaron *Physoptila scenica* y *Physoptila* sp. como grupos externos. Longitud del árbol= 4,234. Índice de consistencia= 0,37. Índice de retención= 0,33. El recuadro color crema señala la posición de los taxones pertenecientes a la tribu Gnorimoschemini.

Al seleccionar *Physoptila scenica* y *Physoptila* sp. como grupos externos (Fig. 35), podríamos sugerir información adicional sobre la mejor posición de algunos miembros de la tribu Gnorimoschemini que no coincide con la definición primaria basada en *Gnorimoschema*. Durante esta práctica no se logra confirmar la monofilia para la tribu Gnorimoschemini, destacando que algunos miembros de esta quedan posicionados externamente y de manera preliminar. Lo que pudiese representar cambios considerables en la sistemática y hasta la conformación de una nueva tribu de Gelechiidae, todo esto a medida que vaya incrementando la información sobre el grupo.

En el clado A, podemos observar una agrupación que corresponde al género *Tecia*, en la misma podemos ver que todas las sinonimias consideradas para este género quedan agrupadas, confirmando que *Lata kiefferi*, *Tecia venosa*, *Fapua albinervella* y *Scrobischema vergarai* están todas fuertemente vinculadas. La monofilia para estos taxones es soportada por la presencia de palpos labiales prorectos, margen externo del uncus dentado y una distribución cosmopolita. Las especies *Brachypsaltis subalbata* y *Scrobipalopsis petasitis* se mantienen en ramales externos.

El clado B, presenta que las especies *Symmetrichemulum numulatum* y *Symmetrischema tangolias* están estrechamente vinculadas, siendo este agrupamiento correspondiente al género *Symmetrischema*. Otra agrupación importante en este clado ocurre con las especies *Exceptia neopetrella* y *Paraschema detectendrum* las cuales están vinculadas. La especie *Phthorimaea ergasima* se mantiene en un ramal externo.

Los clados C, D y E comprenden a los miembros de la tribu Gnorimoschemini que cumplen con la definición de *Gnorimoschema*. Para el clado C podemos observar que las especies *Gnorimoschema gallaesolidaginis* y *Gnorimoschema Lerupsia soffneri* están estrechamente vinculadas, correspondiendo este agrupamiento al género *Gnorimoschema* y siendo *Scrobipalpula psilella* su ancestro común, más cercano. Seguidamente podemos observar que *Neoschema klotsi* y *Eurysaccoides gallaespinosae* están relacionadas siendo *Scrobipalpuloides inapparens* su grupo hermano y de manera externa se encuentra la especie *Scrobipalpuloides obscurus*. Adicionalmente, están relacionadas *Schmidnielsenia*

nielseni y *Scrobipalpomima neuquenensis* siendo su ancestro más cercano la especie *Scrobipalpulopsis stiroides*. En un ramal contiguo podemos observar la relación entre *Frumenta nundinella* y *Nevadopalpa striata*, su ancestro más cercano corresponde a *Echinoglossa trinota*. La especie *Canarischema fuerteventura* se mantiene en un ramal externo, mientras que *Vladimirea wilshirei*, *Trychnopalpa fornacaria* y *Vladimirea amseli* están relacionadas.

El clado D muestra que las especies *Neopalpa neonata* y *Opacopsis inustella* están relacionadas mientras que *Ephysteris chersaea* es el ancestro más cercano a ellas. Se mantienen en ramales externos las especies *Ephysteris subdiminutella*, *Australiopalpa commoni* y *Scrobipalpa aptatella*. Están relacionadas también *Microlechia chretieni* y *Megalocypha polyoptera*. En un segundo agrupamiento podemos observar que *Scrobipalpa atriplicella* se mantiene en un ramal externo. Las especies *Scrobitasta varians* y *Kiwaia Empista palearctica* se relacionan y especies como *Euscrobipalpa indigenella*, *Gobipalpa inexpectata*, *Turcopalpa glaseri* representan ramales independientes. Podemos ver que *Ilseopsis peterseni* y *Ephysteris brachypogon* se relacionan y la especie *Zeempista cheradias* es su ancestro más cercano.

El clado E presenta dos divisiones importantes, el primer lugar la relación entre *Eurysacca melanocampta* y *Primischema elementare*. En segundo lugar, la estrecha relación entre *Keiferia lycopersicella* y *Tildenia glochinella*, corroborando así la monofilia del género *Keiferia* y la sinonimia de *Tildenia*. Mientras que *Phthorimaea operculella* representa el grupo hermano de *Keiferia*. El estudio de estas plagas en particular mostrará en un futuro próximo conocimientos adicionales basados en la morfología, incluidas formas de identificarlas más fácilmente.

Externo a Gnorimoschemini, el clado F, representa un nuevo agrupamiento monofilético y lo que pudiese ser una nueva tribu para Gelechiidae. En dónde podemos observar que las especies *Lutilabria lutilabrella* y *Klimeschiopsis discontinuella* guardan una estrecha relación. Un agrupamiento contiguo muestra que *Kiwaia jeanae* y *Sattleria dzieduszyckii* están estrechamente relacionadas, siendo *Palumbina gueriini* su ancestro más cercano.

Seguidamente se observa que *Caryocolum leucomelanella* y *Phloeocecis cherregella* guardan relación. Las especies *Agonochaetia incredibilis* y *Tila capsophilella* se relacionan siendo *Pogochaetia solitaria* su grupo hermano y la especie *Cosmardia moritzella* su ancestro más cercano. La especie *Sauteropsis terrestrella* y la especie *Insuloschema barbarae* se mantienen en un ramal externo.

Fuera de Gnorimoschemini encontramos otros clados de interés, como el clado G en el que muestra las siguientes relaciones *Chionodes mediofuscella* y *Prostomeus brunneus*, *Polyhymno luteostrigella* y *Megacraspedus ribbella* siendo su ancestro más cercano la especie *Gelechia senticetella*. Seguidamente, el clado H nos muestra la relación entre *Hypathima rhomboidella* y *Thiotricha margarodes* siendo *Anarsia lineatella* su ancestro más cercano; otra asociación corresponde al caso de *Brachmia dimidiella* y *Helcystogramma rufescens*, de manera paralela tenemos el caso de *Ptycerata busckella* y *Dichomeris liguella* siendo *Chrysoestria drurella* el ancestro más cercano para todo el grupo. Finalmente, el clado I muestra la posible relación entre *Anacamptis populella* y *Metanarsia modesta*, siendo su ancestro más cercano la especie *Gelechia rhombella*.

La práctica durante la elaboración de los análisis, sugiere el estudio detallado de las biología de muchos de estos taxones. Hemos encontrado importantes lagunas de conocimiento en este aspecto, en particular se necesitan más estudios en entornos controlados. La inclusión de sus huéspedes y su comportamiento son objetivos sustanciales que se incluirán en los estudios ecológicos y complementarán el trabajo sistemático en un futuro próximo. Adicionalmente, es recomendable volver a los sitios históricos de colecta para obtener material fresco que permita la obtención de muestras genéticas para los taxones implicados, principalmente para aquellos descritos en la región Neotropical, pues la mayoría de estos no han sido secuenciados. La obtención de más material biológico permitirá la asociación de aquellos ejemplares conocidos por un solo ejemplar y permitirá la elaboración de disecciones de los genitalia como de cuerpo completo para el estudio de los nuevos caracteres sugeridos por la autora. Pese a la obtención de índices de consistencia y retención relativamente bajos, 0,37 y 0,33, respectivamente, este trabajo representa tan

solo el inicio de un estudio completo de la tribu Gnorimoschemini en el cual se incluye representabilidad de las especies tropicales.

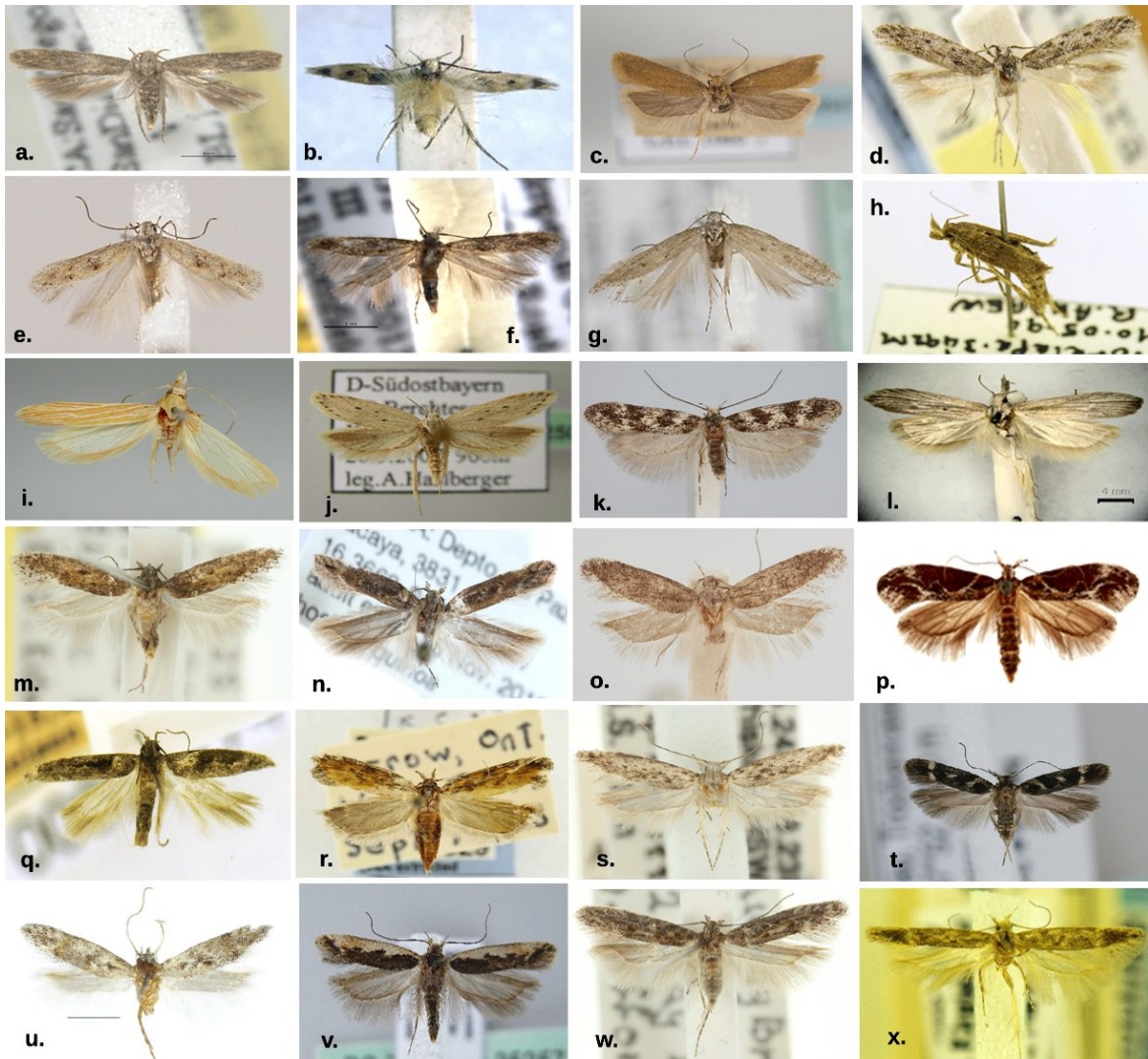


Figura 36. Material tipo de la tribu Gnorimoschemini, hábito dorsal. a.) *Keiferia lycopersicella*. b.) *Kiwaia jeanae*. c.) *Lutilabria lutilabrella*. d.) *Insuloschema barbarae*. e.) *Microlechia chretieni*. f.) *Neopalpa neonata*. g.) *Ephysteris inustella*. h.) *Paraschema detectendrum*. i.) *Fapua albinervella*. j.) *Scrobipalopsis petasitis*. k.) *Klimeschiopsis discontinuella*. l.) *Tecia venosa*. m.) *Ephysteris promptella*. n.) *Eurysacca melanocampta*. o.) *Exceptia neopetrella*. p.) *Gnorimoschema gallaesolidaginis*. q.) *Symmetrischemulum numulatum*. r.) *Frumenta nundinella*. s.) *Australiopalpa comuni*. t.) *Caryocolum leucomelanella*. u.) *Canarischema fuerteventura*. v.) *Cosmardia moritzella*. w.) *Ochrodia subdiminutella*. x.) *Gobipalpa inexpectata*.

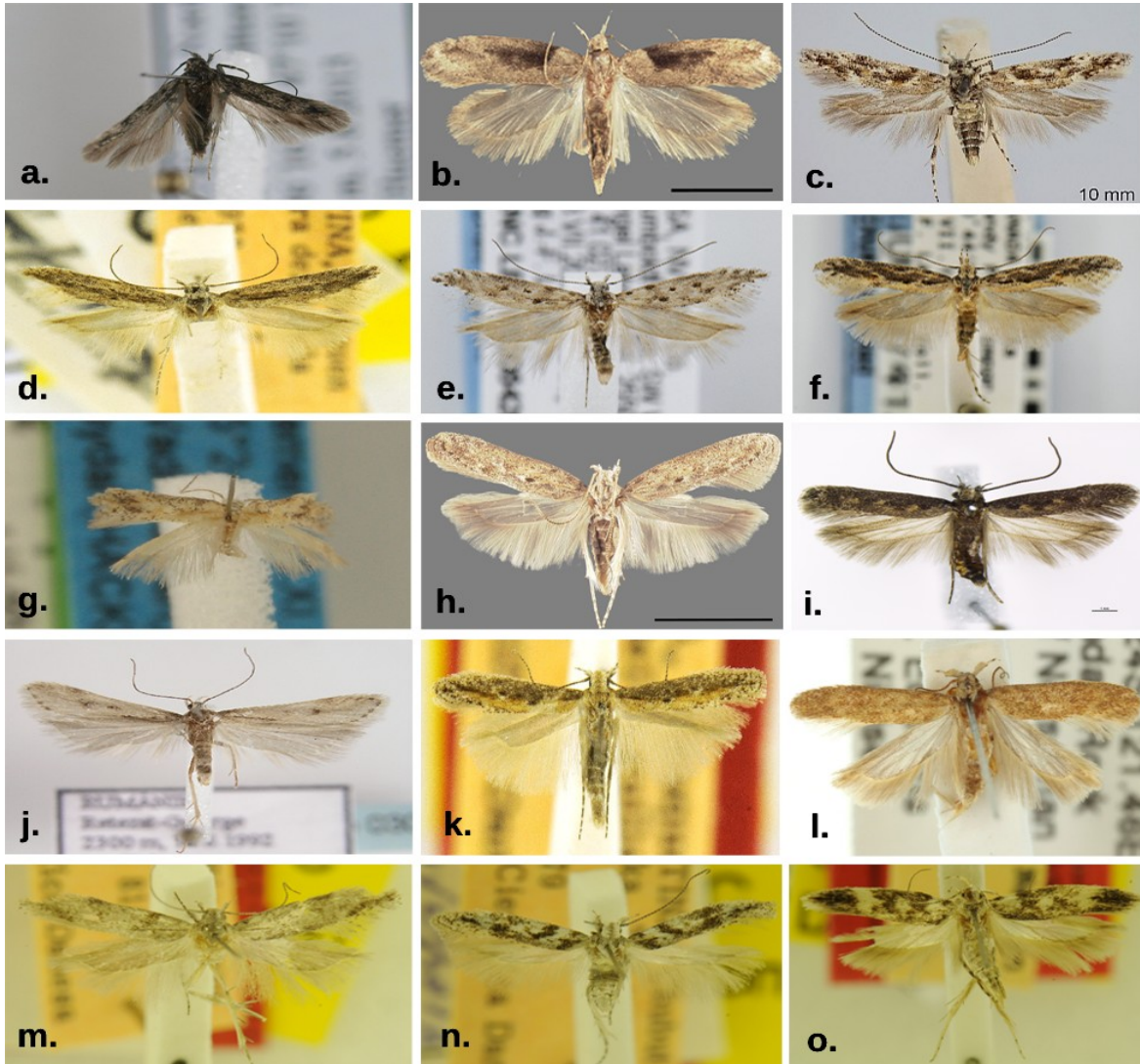


Figura 37. Material tipo de la tribu Gnorimoschemini, hábito dorsal. a.) *Tila capsophilella*. b.) *Symmetrischema tangolias*. c.) *Gnorimoschema (Lerupsia) soffnerii*. d.) *Magnificacia aulorrhoea*. e.) *Neoschema klotsi*. f.) *Nevadopalpa maculate*. g.) *Phloeocecis cherregella*. h.) *Phthorimaea operculella*. i.) *Pogochaetia solitaria*. j.) *Sattleria dzieduszyckii*. k.) *Schmidtnielsenia nielsenii*. l.) *Scrobipalpa aptatella*. m.) *Scrobipalpoides obscurus*. n.) *Scrobipalpomima neuquenensis*. o.) *Scrobitasta varians*.

Conclusiones

El estudio detallado de la tribu Gnorimoschemini permitió conocer de manera preliminar a través de un análisis filogenético que se confirman las sinonimias para los géneros *Tecia*, *Gnorimoschema*, *Symmetrischema* y *Keiferia*. Se confirma que *Phthorimaea* representa el grupo hermano de *Keiferia*. Queda confirmada de manera parcial la monofilia para la tribu Gnorimoschemini, destacando que algunos de sus miembros actuales pudiesen salir de la antigua clasificación basada en *Gnorimoschema* y en su lugar ser transferidos a una nueva tribu para la familia Gelechiidae.

En un aspecto filogenético, se puede concluir que a partir de la taxonomía integrativa ó evidencia total se reconocen al menos seis grupos monofiléticos dentro de Gnorimoschemini. De ellos, es pertinente resaltar la estrecha relación que comparten los miembros del género *Phthorimaea* con *Keiferia*, la cual es soportada por las siguientes apomorfias: esclerito medio del gnathos en forma de cuchara provisto de zona membranosa cubierta de microtrichia, caecum reducido, lamina ducti ejaculatorii presente y reducida, antrum en forma de embudo y moderadamente esclerosado, inmaduros con múltiples estrategias biológicas, es decir, desde minadores en estadios iniciales hasta perforadores de frutos en estados más avanzados, impacto económico como plagas en cultivos, distribución cosmopolita, preferencia por plantas de la familia Solanaceae y cuyos orígenes se remontan a la cordillera de Los Andes, aproximadamente 10 millones de años atrás. Adicionalmente, *Phthorimaea* y *Keiferia* presentan una evidente diferencia en el margen externo del uncus. En dónde *Phthorimaea* presenta un margen externo del uncus simple, mientras que en el caso de *Keiferia*, el margen externo del uncus se encuentra proyectado. El ancestro más cercano a estos dos géneros parece ser *Eurysacca*, cuya especie nominal *E. melanocampta* es considerada plaga en plantas de la familia Chenopodiaceae. El carácter del margen externo del uncus proyectado se ha manifestado en otras dos ocasiones dentro de nuestro análisis filogenético, para el género *Canarischema* dentro de Gnorimoschemini y externamente a esta tribu en el género *Deltophora*.

Seguidamente, la relación que comparte el grupo que contiene a los géneros *Scrobischema*, *Fapua*, *Tecia* y *Lata*. La monofilia para estos taxones es soportada por la presencia de palpos labiales prorectos, cuyo segundo segmento se encuentra cubierto de escamas dispuestas a manera de brocha, margen externo del uncus dentado y una distribución cosmopolita. Otras asociaciones como las vistas entre *Gnorimoschema* y *Lerupsia* ó aquellas entre *Symmetrischema* y *Symmetrischemulum*, sólo confirman que estos taxa son sinónimos directos, entre las apomorfías encontradas destaco: especies de envergadura amplia, es decir, mayor de 20 mm, saccus ancho y aplastado, antrum fuertemente esclerosado; para el caso particular de *Gnorimoschema* y *Lerupsia* destaca la forma del esclerito medio del gnathos en forma de cuchara, el cual es completamente esclerosado; el margen externo del uncus es dentado; el ductus bursae es alargado; las larvas se caracterizan por ser inductoras de agallas y han desarrollado la capacidad de refugiarse. Para el caso de *Symmetrischema* y *Symmetrischemulum* el esclerito medio del gnathos es a manera de gancho, pero al compararlo con otros géneros, su ápice no suele prolongarse y ahusarse tanto; adicionalmente, otra apomorfía para este género es la presencia de un proceso medial del vinculum, este se encuentra proyectado a manera de tubérculo con un ápice ahusado; el margen externo del uncus es simple; las larvas se caracterizan por ser barrenadoras.

En el clado F existen relaciones importantes en cuanto a las especies y su distribución, todas ellas comparten el hecho de ser Paleárticas excepto en el caso de *Kiwaia*, cuya especie nominal *K. jeanae* es de Nueva Zelanda. Para el caso de la relación entre los géneros *Tila*, *Agonochaetia* y *Pogochaetia* podemos resaltar que todas estas especies presentan machos con glandiductores; las hembras de *Tila* y *Pogochaetia* presentan un signum modificado a manera de parche lateral, el corpus bursae es subovoide. Pese a ser taxones que presentan glandiductores, en nuestro análisis, es apreciable que esta condición aparece en multiples ocasiones a lo largo de la historia evolutiva de las especies. Para el caso de *Tila* y *Agonochaetia*, parece ser que su ancestro más cercano corresponde al género *Pogochaetia* cuya distribución también es Paleártica. Mientras que *Cosmardia* se mantiene en un ramal externo. La relación entre taxones raros como los que ocurren dentro de los géneros *Lutilabria* y *Klimeschiopsis* es apoyada por las siguientes apomorfías el

esclerito medio del gnathos es reducido, el mismo tiene aspecto de cuchara provisto de zona membranosa cubierta de microtrichia, caecum reducido, la superficie del corpus bursae es lisa, la placa subgenital es parcialmente esclerosada, las especies suelen estar habitando por encima de los 1,000 metros sobre el nivel del mar, asociados a hábitats montañosos del Paleártico. La monofilia para los géneros *Caryocolum* y *Phloeocecis* incluye los siguientes caracteres: procesos ventro mediales del vinculum solapándose, el margen externo del uncus es simple, saccus es estrecho con aspecto de peciolo, cucullus simple, phallus con curvatura moderada y lámina ducti ejaculatorii convexa.

En el caso particular de *Sattleria* y *Kiwaia*, en ambos casos encontramos la braquiptería como condición compartida. Sin embargo, existen variaciones en el mismo carácter, pues en *Sattleria* podemos encontrar hembras braquípteras y machos alados; mientras que en *Kiwaia* encontramos la braquiptería en ambos sexos. Pese a ser taxones con distribuciones muy distintas, Paleártica y Nueva Zelanda respectivamente, los mismos pudiesen funcionar como posibles indicadores biológicos de los ambientes. Poco se conoce sobre la biología de la especie nominal del género *Kiwaia*, sin embargo, la misma ha sido incluida en la lista roja de especies por el contundente daño a su habitat.

En lo que respecta a otras clasificaciones y estudios filogenéticos previos, este trabajo confirma de manera parcial la estrecha relación entre los géneros *Caryocolum*, *Pogochaetia*, *Tila*, *Cosmardia*, *Klimeschiopsis* y *Lutilabria*, que ya había sido anunciada parcialmente en la primera filogenia para la tribu Gnorimoschemini realizada por métodos fenéticos y luego en la revisión para el género *Caryocolum* (Povolný y Sustek, 1988; Huemer, 1988). Sin embargo, nunca antes se había trabajado a la tribu Gnorimoschemini en un contexto amplio, que incluyera todo el material tipo para los géneros conocidos de Gnorimoschemini y representantes de las otras tribus de Gelechiidae, aspectos biológicos y sus secuencias disponibles; este trabajo representa el primer intento por métodos cladísticos; lo que lo diferencia de trabajos previos. En el caso de la primera filogenia realizada para la tribu, la misma se basó en métodos de la taxonomía numérica, en dónde se podían observar ciertas tendencias entre los géneros basadas en caracteres netamente subjetivos y no delimitados, lo que resta estabilidad a las clasificaciones generadas a través

de la escuela fenética. Al poder contar con una mayor representatividad de material, el acceso al material tipo y disponibilidad de material no disectado, se pudieron estudiar a profundidad la morfología de otras estructuras con valor taxonómico y que no habían sido visualizadas previamente por Povolný en su obra. Se realizaron disecciones que incluyen el método del “*unrolling*” pudiendo así interpretar de manera adecuada la orientación y disposición de las estructuras sin estas ser modificadas por los métodos clásicos de montaje y con el fin de dar continuidad a futuro al estudio de la morfología se conservaron las muestras en viales con glicerina.

Entre los caracteres derivados encontrados en el análisis puedo mencionar que el 90% de las especies han desarrollado alas en ambos sexos, el esclerito abdominal no se encuentra melanizado en la mayor parte de los miembros de la tribu Gnorimoschemini, la presencia de una culcitula es evidente en todos los miembros de Gnorimoschemini, la glándula sexual femenina en Gnorimoschemini los acerca a un posible ancestro de Gelechiini, la presencia de dos líneas fusionadas con aspecto diamantado y sulci posterior precediendo medialmente, el desarrollo de un antrum tubular, la presencia de un signum protuberante y el desarrollo de una lámina ducti ejaculatorii.

En lo que concierne a caracteres primitivos estudiados puedo destacar la braquiptería, la melanización de los escleritos abdominales, el desarrollo de coremata, la presencia de glandiuctores, el desarrollo de pseudognathos, el desarrollo de annellus, el antrum en forma de embudo, la ausencia de signum, la ausencia de lámina ducti ejaculatorii y el proceso ventro-medial del vinculum provisto de bolsillos.

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Capítulo II

CLASSIFICATION OF *TUTA ABSOLUTA* (MEYRICK, 1917) (LEPIDOPTERA: GELECHIIDAE: GELECHIINAE: GNORIMOSCHEMINI) BASED ON CLADISTIC ANALYSIS OF MORPHOLOGY

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Abstract

Tuta absoluta (Meyrick, 1917) is one of the most notorious pests of solanaceous plants in the World (Biondi et al. 2018), however, its supra-specific classification has been an historical point of contention. Its original genus, *Phthorimaea* Meyrick, 1902, was a catch-all within the family and the generic limits among its contained tribe, Gnorimoschemini Povolný, 1964, are unstable. This study represents the first attempt to classify *T. absoluta* among taxa of Gnorimoschemini using cladistic methodology. We constructed a tree hypothesis based on 22 morphological characters using the nominal taxa for the genera *Phthorimaea*, *Scrobipalpuloides* Povolný, 1987, and *Tuta* Kieffer and Jörgensen, 1910 among the ingroup; and the nominal taxon for the tribe Gnorimoschemini, *Gnorimoschema gallaesolidaginis* (Riley, 1869), as the outgroup. The parsimony analysis resulted in a single shortest tree with *T. absoluta* in a monophyletic clade that included *Phthorimaea operculella* (Zeller, 1873), the type species of *Phthorimaea*. The genus *Tuta* and *Scrobipalpuloides* were also resolved in the tree hypothesis. We propose the **reinstated combination** *Phthorimaea absoluta* Meyrick, 1917 and the **new combination** *Phthorimaea chiquitella* (Busck, 1910). The genera *Tuta* (with the single species *Tuta atriplicella* Kieffer and Jörgensen, 1910) and *Scrobipalpuloides* remain valid in Gnorimoschemini. We provide a history of the taxonomy of *Tuta absoluta* and a detailed character list and matrix used in our analysis.

Key words: Gelechioidea, gnorimoschemine moth, microlepidoptera, Neotropical, phylogeny, solanaceous leafminer, systematics.

Introduction

Tuta absoluta (Meyrick, 1917) (Gelechiidae: Gelechiinae: Gnorimoschemini) (tomato leafminer, tomato pinworm, South American tomato moth) is a polyphagous moth, but its preferred diet includes solanaceous plants, particularly tomato and potato. Its global economic impact was recently reviewed (Biondi et al. 2018, and references therein) wherein the authors reported up to 100% tomato crop loss when management methods were not “efficiently implemented.” Its type locality is Huancayo, Peru at an elevation of over 3200 m, and the overwhelming consensus is that the species has a widespread distribution in Central and South America. However, *T. absoluta* is also an invasive pest having been reported across the Mediterranean east through China, and in central and south African countries (Biondi et al. 2018). A search in the bibliographic index, Google Scholar, for all its scientific name combinations (September 2020) returns over 16,000 records.

Tuta absoluta, along with many other taxa classified in the tribe Gnorimoschemini Povolný 1964, has a history of unstable taxonomy. It has been placed in five different gnorimoschemine genera, some repeatedly, as authors have subjectively determined classification based on their choice of morphological and/or biological similarities and typological methodology (detailed below). In light of this taxon’s widespread impact, we make a much-needed, first attempt to classify *T. absoluta* to its proper genus using morphological cladistics.

Taxonomy of *Tuta absoluta* (Meyrick)

Classification of *T. absoluta* over time is difficult to follow. This is partly because it is the more infamous taxon associated with the genus *Tuta* Kieffer and Jörgensen, 1910, but not the nominal taxon. We therefore think it important to provide its history in detail.

Meyrick (1917) described *Phthorimaea absoluta* based on a single male specimen. This was part of a larger treatment of South American microlepidoptera that included 15 other new species he classified in the same genus and described on adjacent pages. Two were from the same type locality as *T. absoluta*. Of those 15, four are currently valid in the genus: *Phthorimaea exacta*, *P. involuta*, *P. perfidiosa*, and *P. urosema*. Two are synonyms

in Gnorimoschemini: *Keiferia lycopersicella* (Walsingham, 1897) (= *P. lenta*) and *Symmetrischema tangolias* (van Gyen, 1913) (= *P. aquilina*). Interestingly, the species *K. lycopersicella* is also known as the ‘tomato pinworm.’ The remaining nine are valid in four other gnorimoschemine genera: *Barticeja epitricha*, *Eurysacca melanocampta*, *Scrobipalpula crustaria*, *S. densata*, *S. gregalis*, *S. trichinaspis*, *Symmetrischema altisona*, *S. atrifascis*, and *S. loquax* (Povolný 1967, 1994). Through the history of gelechiid taxonomy, over 200 species-group taxa have been described in or combined in the genus *Phthorimaea*, many described by Meyrick. There are currently only 16 valid species in the genus, and ten of those species were originally described in *Phthorimaea*. While the catch-all nature of the genus is not surprising considering insect taxonomy in general, it’s notable that almost all the species that have been combined with *Phthorimaea* are currently either valid names or synonyms in the tribe Gnorimoschemini. This is indicative of both the stability of the tribe and instability of genus-level circumscriptions over time that have impacted the classification of *T. absoluta*.

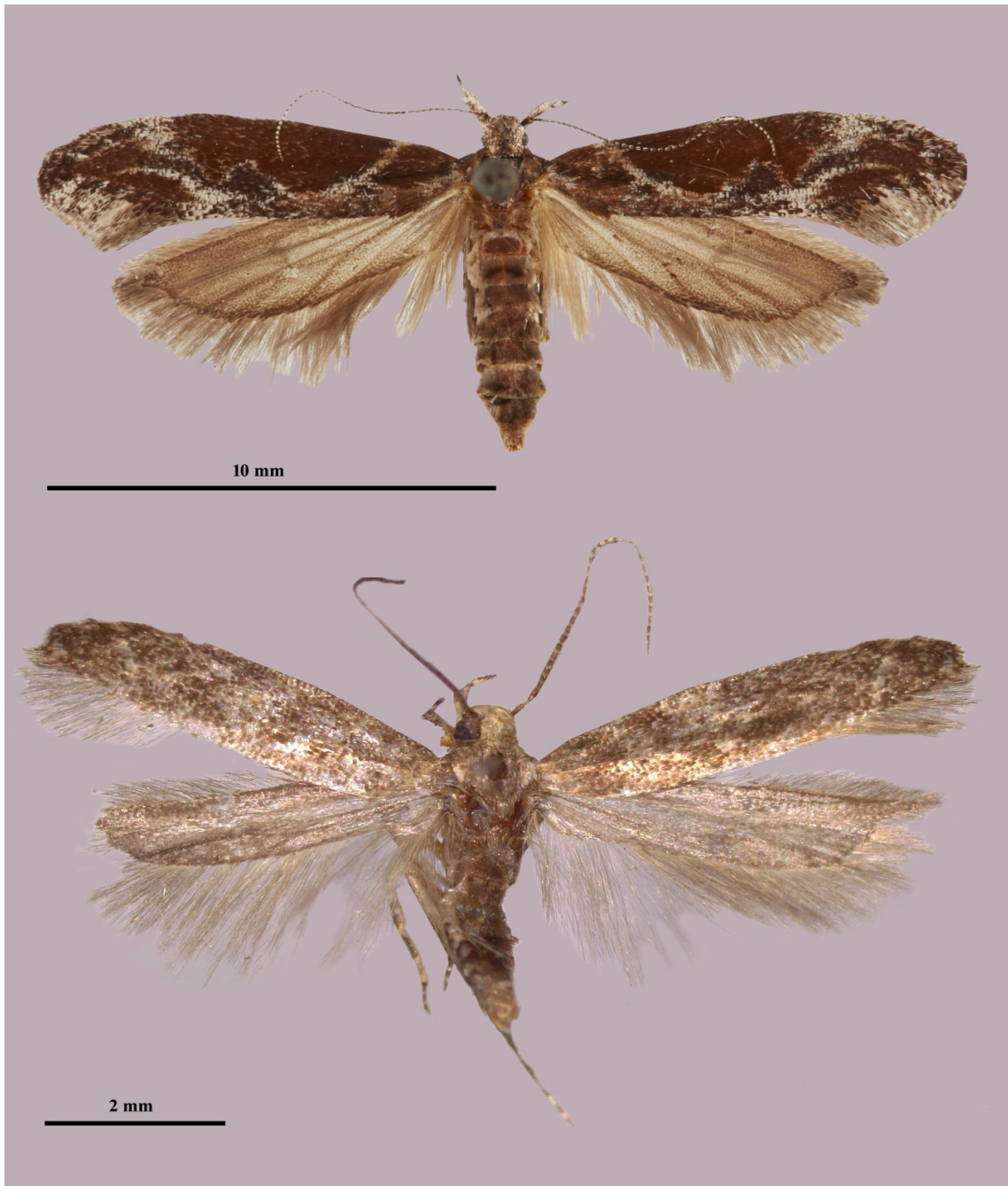
Meyrick (1902) created the genus *Phthorimaea* for *Gelechia operculella* Zeller, 1873, which Meyrick already knew was a widespread pest of potatoes and is currently known as the potato tuber moth. As was typical, Meyrick (1902) did not provide characters we would consider synapomorphic today for the genus-group taxon, only that he felt “a new genus should be founded for” Zeller’s species. Meyrick based his classifications on external characters only, unlike Busck who was making genitalia dissections, however, he wrote that Busck confirmed his decision to describe the new genus (1902). Busck had likely made genitalia and wing dissections of determined specimens. Kieffer and Jörgensen (1910) unintentionally made available Strand’s (1911) taxon and genus-group name *Tuta* Kieffer and Jörgensen, 1910 (as a subgenus of *Gnorimoschema* Busck, 1900) for Strand’s (1911) single species, *Gnorimoschema (Tuta) atriplicella* Kieffer and Jörgensen, 1910. Meyrick (1925) subsequently synonymized *Tuta* with *Gnorimoschema*, listing both *G. atriplicella* Strand [sic] and *G. absoluta* Meyrick in his work. This was the first classification wherein these taxa were congeneric. In that same work, Meyrick (1925) listed 208 valid species of *Phthorimaea*. The synonymy of *Gnorimoschema* and *Tuta* seemed to be stable and

reiterated by Sattler (1973) and Becker (1984), however, Meyrick's *P. absoluta* would be classified elsewhere.

Dálíbor Povolný (1924-2004) composed the modern synthesis of the tribe Gnorimoschemini based, mostly, on characters of male and female genitalia. He would ultimately describe dozens of genera and species, and the tribe itself, during his decades of work. In his first seminal treatment, he described the genus *Scrobipalpula* Povolný (Povolný 1964) and later (Povolný 1967) transferred *P. absoluta* to that genus calling it a “provisional” assignment. This was the classification used by Becker (1984). Thus, the two species would once again be classified in separate genera. Povolný then described a new gnorimoschemine genus, *Scrobipalpuloides* Povolný, 1987, in which he decided to place *P. absoluta*, but wrote that this “may not be strictly congeneric with the type species” of that new genus. So, while Povolný was formally publishing his genus-group hypotheses about gnorimoschemine taxa, he was tentative about his classification of *P. absoluta*.

Hodges and Becker (1990) studied the Strand material, designated a neotype for *G. (Tuta) atriplicella*, and placed it as a valid species in *Phthorimaea*. This took the genus-group name *Tuta* out of synonymy with *Gnorimoschema*, and made it a new synonym of *Phthorimaea*. However, Povolný (1993) immediately rejected this hypothesis and reinstated *Tuta* as a valid taxon and synonymized his own genus, *Scrobipalpuloides*, with *Tuta*. This made the two taxa once again congeneric in *Tuta* based on synonymy, but because Povolný (1993) did not list species in that work, *P. absoluta* was still not formally in combination with *Tuta*. Povolný (1994) subsequently published the formal combination *Tuta absoluta* (Meyrick), and continued to recognize *Tuta* as a valid genus and described several new Nearctic species (Povolný 2000, Powell and Povolný 2001). He also continued to list *Scrobipalpuloides* as a junior synonym of *Tuta* (Povolný 2000, Powell and Povolný 2001, Povolný 2002). Lee et al. (2009) listed *Tuta* as a synonym (i.e., “rev. syn.”) of *Phthorimaea* and listed all Povolný's Nearctic species of *Tuta* under the valid genus *Scrobipalpuloides*. Lee et al. (2009) did not indicate that the status of *Scrobipalpuloides* was being changed nor, because it was a Nearctic checklist, did they list all the combinations that were at that time valid in *Tuta*, which included *T. absoluta*. Huemer and Karsholt (2010) acknowledged the taxonomic difficulty with the taxon, but treated it as

Tuta absoluta, which is also the prevailing usage at large. Here we use a morphological cladistic analysis to test the hypotheses that *Tuta*, *Scrobipalpuloides* and *Phthorimaea* are all separate, valid genera, and to shed light on the generic classification and nomenclatural status of *Tuta absoluta*.



Figures 1-2. Dorsal habitus. 1, *Gnorimoschema gallaesolidaginis* (outgroup). 2, *Tuta absoluta*.

Materials and methods

Taxon sampling.—Taxa were chosen to address specifically the generic classification of *T. absoluta*. Monophyly of Gnorimoschemini and the inclusion of selected taxa in the tribe is assumed a priori. Prior cladistic analysis (Karsholt et al. 2013) supported a monophyly that included species currently assumed to belong to the tribe, but did not include any nominal taxa. Ingroup taxa include *Gnorimoschema (Tuta) atriplicella* Kieffer and Jörgensen, *Phthorimaea operculella* (Zeller), and *Scrobipalpuloides inapparens* Povolný, 1987. These species were included because they are the nominal taxa for genera in which *T. absoluta* has been classified, so test the hypotheses of previous authors. Likewise, a review of the genitalia morphology, geographic distributions, and biology among taxa in the entire tribe suggest these genera contain species most similar to *T. absoluta*. Three additional taxa were included to assess diversity and stability of the morphology in the character matrix and monophyly among the genera: *Phthorimaea robusta*, *Scrobipalpuloides ascendens* Povolný, 1990, and *Scrobipalpuloides chiquitella* (Busck, 1910). The nominal taxon for the tribe, *Gnorimoschema gallaesolidaginis* (Riley, 1869), was chosen as the outgroup and for rooting character polarities.

Character assessment.—Characters from all aspects of morphology, biology, and parameters of the habitats for the included taxa were considered, particularly features found in the male and female genitalia (Figs. 1-4). Potential characters were assessed for independence, topological homology, and ambiguity. Putative homologies were reassessed until unambiguous interpretation could be reached by both authors. Assessments were made based on a survey of original descriptions and illustrations in the literature and from specimen dissections. Genitalia were examined by breaking off the abdomen and rinsing in 20% ethanol. The abdomen was then macerated in hot, 10% KOH for 13 minutes and rinsed. Dissections were performed in lactic acid and tissues stained in 1% orange G. Samples were dehydrated in isopropyl alcohol and slide-mounted in euparal. Some additional samples were stored in glycerine to allow the viewing of dissections from multiple angles. The morphological terms were taken from Hodges (1966), Landry (1991), and Huemer and Karsholt (1999, 2010). Images were created on a Leica stereoscope M205

A and a scope Leica DM3000 LED. All the images were digitally processed in the software Leica Application Suite (LAS), version 4.12 and edited with Adobe Photoshop 6.0.

Phylogenetic analysis.—The matrix was constructed and the evolution of characters were reviewed in Mesquite version 2.1 (Maddison and Maddison 2019). A minimum length parsimony search was conducted and a tree hypothesis estimated in TNT 1.5 64-bit Linux Willi Hennig Society edition (Goloboff and Catalano 2016) launched via Zephyr 3.11 build 150 (Maddison and Maddison 2020) using the following parameters:

rseed[; hold 10000; xlnact; xmult: rss css fuse 6 drift 6 ratchet 20 replic 100;
sec: slack 20; bbreak: tbr fillonly; xmult; bbreak; nelsen *;

Bootstrap support was calculated using the resample and boot commands with 100 replicates. Bremer support values were calculated using the bsupport command on a set of 843 trees in memory estimated from multiple iterations of TBR.

Results

Characters and states.—Twenty-two binary characters (18 informative, 4 uninformative) of the male and female genitalia were retained and used in the phylogenetic analysis (Table 1). All other assessed characters could not be scored unambiguously or without clear subjectivity by one or both of the authors. The four uninformative characters were retained as indicators of possible synapomorphy among these and associated taxa in future work (character 15) or in case females of the representative taxa were to be verified (characters 17, 18, 20). The characters and states used in the phylogenetic analysis are listed in Table 2 and briefly discussed below.

1. Apex of uncus (0) subacute, (1) rounded. A rounded apex of the uncus is a synapomorphy for *P. operculella* and *P. robusta*.
2. Uncus (0) longer than wide, (1) wider than long. A wider uncus is a synapomorphy for *P. absoluta* and *S. chiquitella*.
3. Valva (0) shorter than uncus, (1) longer than uncus. A valva longer than the uncus is a synapomorphy for *Phthorimaea*, but is reversed in *P. absoluta*.
4. Apex of valva (0) simple (1) spatulate. A spatulate terminal valva is a synapomorphy for *P. operculella* and *P. robusta*.

5. Groove at the base of saccular process (0) absent, (1) present. The presence of these grooves at the base of the saccular process is a *synapomorphy* for *P. operculella* and *P. robusta*.
6. Phallus (0) tubular, (1) nasute. A nasute phallus is a *synapomorphy* for the genera *Phthorimaea* and *Scrobipalpuloides*, but is reversed in *P. absoluta*.
7. Phallus with (0) rounded flange, (1) blunt flange. A phallus with a blunt flange is a *homoplasy* shared by *S. ascendens* and *T. atriplicella*.
8. Phallus (0) straight, (1) with curvature. A curved phallus is a *synapomorphy* for *S. inapparens* and *S. ascendens*.
9. Phallus (0) short, (1) long. A long phallus is a *synapomorphy* for all the ingroup taxa, but is reversed in *P. absoluta*.
10. Saccular process (0) conical, (1) quadrate. A quadrate saccular process is a *synapomorphy* for the genus *Phthorimaea*, but is reversed in *P. absoluta*.
11. Caecum (0) not reduced, (1) reduced. A reduced caecum is a *homoplasy* shared by *S. inapparens* and *P. operculella*.
12. Medial process of juxta extending (0) well beyond apex of sacculus, (1) short of apex of sacculus. A shorter medial process of the juxta is a *synapomorphy* for *P. operculella* and *P. robusta* and is a *homoplasy* shared with *S. inapparens*.
13. Medial process of juxta apex (0) not helicoid, (1) helicoid. A medial process of the juxta with a helicoid apex is a *synapomorphy* for *P. chiquitella* and *P. absoluta*.
14. Medial process of juxta (0) not laterally oriented, (1) laterally oriented. The medial process of juxta laterally oriented is a *synapomorphy* for the genera *Scrobipalpuloides* and *Phthorimaea*, but is reversed in *P. chiquitella*.
15. Tegumen fusion lines (0) visible, (1) not visible. The absence of visible fusion lines of the tegumen is an *autapomorphy* for *S. ascendens*.
16. Saccus (0) narrow, long; (1) broad, short. A broad, and short saccus is a *synapomorphy* for *P. operculella* and *P. robusta*.
17. Corpus bursa (0) long, (1) short. *Scrobipalpuloides chiquitella* has a short corpus bursa while the remaining taxa in the analysis have a long corpus bursa. We were unable to code this character for *S. inapparens*, *S. ascendens*, and *P. robusta* due to the lack of female specimens and the female *T. atriplicella* is unknown. We retain

this uninformative character in the analysis for benefit of reproducibility of future workers.

18. Position of signum (0) basal to middle of corpus bursae, (1) at middle of corpus bursae. The signum located in the middle of the corpus bursae is a potential synapomorphy for the genus *Phthorimaea*, but is not scored in the matrix for *P. robusta*.
19. Size of signum (0) large, (1) small. A small signum is a potential synapomorphy for the genera *Phthorimaea* and *Scrobipalpuloides*, but is not scored in the matrix for *P. atriplicella* and *S. ascendens*.
20. Ductus bursa (0) long, (1) short. A short ductus bursa is a potential synapomorphy for all the ingroup taxa. We were unable to code this character for *S. inapparens*, *S. ascendens*, and *P. robusta* due to the lack of female specimens and the female *T. atriplicella* is unknown. We retain this uninformative character in the analysis for benefit of reproducibility of future workers.
21. Antrum (0) not funneled shaped, (1) funnel shaped. A funnel shaped antrum is a synapomorphy for the genus *Phthorimaea*. The antrum is not funnel shaped in *S. inapparens*, but we were unable to code this character for *T. atriplicella* and *S. ascendens* to definitively estimate the changes of this character on the tree among the genera.
22. Length of entire male genital capsule (0) much greater than width, (1) subequal to width. A shorter male genital capsule is a synapomorphy for *P. absoluta* and *P. chiquitella*.

Table 1. Characters and states used in the parsimony analysis.

No.	Character	State 0	State 1
1	Apex of uncus	Subacute	Rounded
2	Uncus	Longer than wide	Wider than long
3	Valva	Shorter than uncus	Longer than uncus
4	Apex of valva	Simple	Spatulate
5	Groove at base of saccular process	Absent	Present
6	Phallus	Tubular	Nasute
7	Phallus with	Rounded flange	Blunt flange
8	Phallus orientation	Straight	With curvature
9	Phallus	Short	Long
10	Saccular process	Conical	Quadrate
11	Caecum	Not reduced	Reduced
12	Medial process of juxta extending	Beyond apex of sacculus	Short of apex of sacculus
13	Medial process of juxta apex	Not helicoid	Helicoid and apically oriented
14	Medial process of juxta	Not laterally oriented	Laterally oriented
15	Tegumen fusion lines	Visible	Not visible
16	Saccus	Narrow, long	Broad, short
17	Corpus bursa	Long	Short
18	Position of signum	Basal to middle of corpus bursae	At middle of corpus bursae
19	Size of signum	Large	Small
20	Ductus bursa	Long	Short
21	Antrum	Not funnel shaped	Funnel shaped
22	Length of dorsal genital capsule	Much longer than wide	Not very much longer than wide

Phylogenetic analysis.—Analysis of the matrix resulted in a single most parsimonious tree of 28 steps (CI = 0.69, RI = 0.58) (Fig. 5). An hypothesis for the generic placement of *P. absoluta* was supported. The genera *Phthorimaea*, *Scrobipalpuloides*, and *Tuta* were resolved among the ingroup with *P. absoluta* being part of a monophyly that included *P. operculella*. The classification of the included species based on the nominal taxa will be changed (see below), however, we will leave the untreated species in their current respective genera until a more comprehensive analysis for the tribe is completed. The genus *Phthorimaea* is supported by forward changes (0 > 1) in the characters: 3, 10, 18, 20, and 21. The genus *Scrobipalpuloides* is supported by a forward change in character 8.

Table 2. Character matrix used in the phylogenetic analysis. ? = missing data.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
<i>Gnorimoschema gallaesolidaginis</i> (Riley, 1869)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Phthorimaea operculella</i> (Zeller, 1873)	0	0	1	1	1	1	0	0	1	1	1	1	0	1	0	1	0	1	1	1	1	1	0
<i>Phthorimaea robusta</i> Povolný, 1989	0	0	1	1	1	1	0	0	1	1	0	1	0	1	0	1	?	?	1	?	1	0	
<i>Scrobipalpuloides inapparens</i> Povolný, 1987	1	0	0	0	0	1	0	1	1	0	1	1	0	1	0	0	?	?	1	?	0	0	
<i>Scrobipalpuloides ascendens</i> Povolný, 1990	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	0	?	?	?	?	?	0	
<i>Scrobipalpuloides chiquitella</i> (Busck, 1910)	1	1	1	0	0	1	0	0	1	1	0	0	1	0	0	0	1	1	0	1	1	1	
<i>Tuta absoluta</i> (Meyrick, 1917)	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	1	1	1	
<i>Tuta atriplicella</i> (Kieffer and Jörgensen, 1910)	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	?	?	?	?	?	0	

Proposed Species Classification for the Included Genera

Phthorimaea Meyrick, 1902:103

Type species: *Gelechia (Bryotropha) operculella* Zeller, 1873:262, by original designation.

absoluta Meyrick, 1917, **reinstated combination**

albicostella (Vorbrodts, 1928) (*Lita*)

chiquitella (Busck, 1910) (*Gnorimoschema*), **new combination**

euchthonia Meyrick, 1939

exacta Meyrick, 1917

ferella (Berg, 1875) (*Gelechia*)

impudica Walsingham, 1911

interjuncta Meyrick, 1931

involuta Meyrick, 1917

molitor (Walsingham, 1896)

operculella (Zeller, 1873) (*Gelechia*)

Gelechia terrella Walker, 1864

Bryotropha solanella Boisduval, 1874

Gelechia tabacella Ragonot, 1879
Gelechia sedata Butler, 1880
Gelechia piscipellis Howard, 1897
Phthorimaea argentinae Povolný, 1989
perfidiosa Meyrick, 1917
pherometopa Povolný, 1967
robusta Povolný, 1989
sphenophora (Walsingham, 1897) (*Gelechia*)
suavella (Caradja, 1920) (*Lita*)
tobisella Palm, 1947
urosema Meyrick, 1917

Scrobipalpuloides Povolný, 1987:59

Type species: *Scrobipalpuloides inapparens* Povolný, 1987:68, by original designation.

ascendens Povolný, 1990
chiquitelloides (Powell and Povolný, 2001) (*Tuta*)
congruens Povolný, 1987
dispar Povolný, 1990
elaborata (Povolný, 2000) (*Tuta*)
habitans Povolný, 1987
inapparens Povolný, 1987
insularis (Powell and Povolný, 2001) (*Tuta*)
isolata (Povolný, 2000) (*Tuta*)
spinosa (Povolný, 2000) (*Tuta*)
totalis (Povolný, 2000) (*Tuta*)
truncata (Povolný, 2000) (*Tuta*)

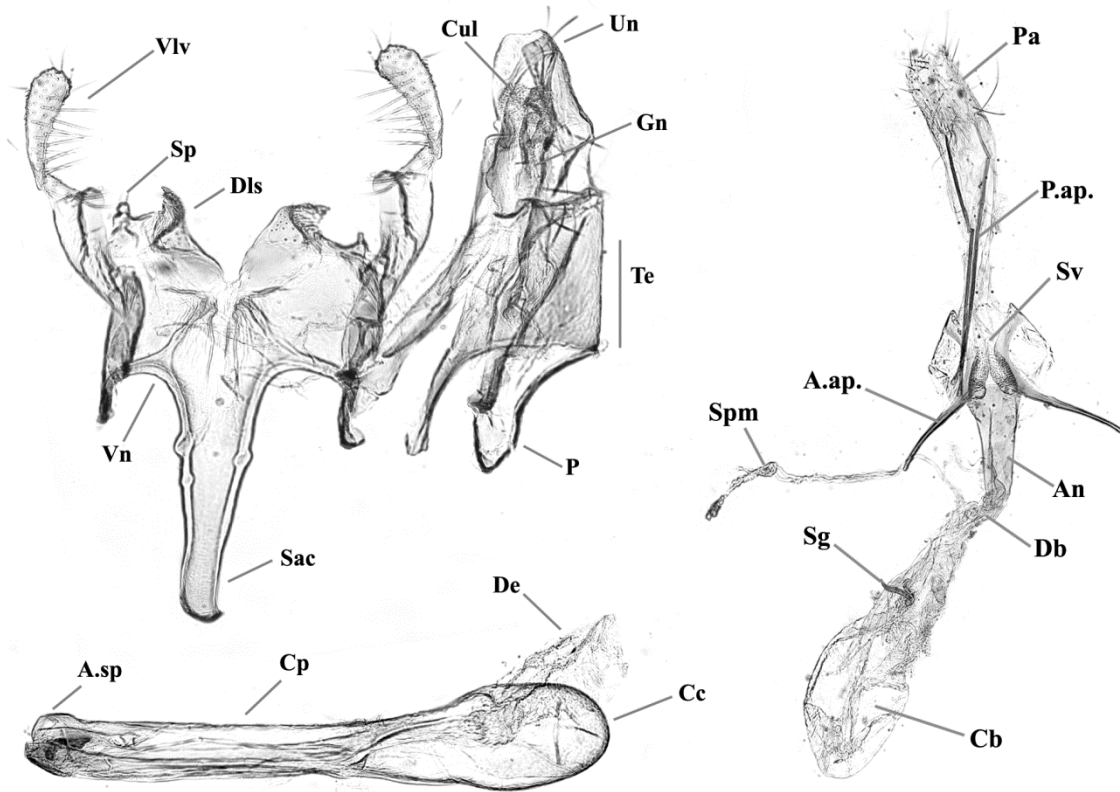
Tuta Kieffer and Jörgensen, 1910:363

Type species: *Gnorimoschema (Tuta) atriplicella* Kieffer and Jörgensen, 1910:363, by monotypy.

atriplicella Kieffer and Jörgensen, 1910

Discussion

Morphological homologies among these taxa are very difficult to qualify and quantify. Of the 34 characters assessed during this study, we retained only 22 characters from the male and female genitalia that we could both fairly call homologous and possibly provide support for relationships (i.e., synapomorphies). An additional historical problem is the lack of confidently-associated females with identified males. Fortunately, this was not the case in our study for *P. absoluta*, however the female of *T. atriplicella* remains unknown. With this low morphological confidence, it is little wonder why the classification of *P. absoluta* has changed so many times, even having been given different classifications twice by two different authors within only a few years (Meyrick 1917, 1925; Povolný 1987, 1993). None of the previous authors' taxonomic hypotheses were accompanied by any form of analysis or argumentation other than to say two or more taxa are more similar or dissimilar (Povolný 1993). Most previous changes in classification for *P. absoluta* were placements in lists after different genera with no explanation at all. So, in this respect, we provide at least a reproducible framework and data to support the placement of *P. absoluta* among its historical congeners. This group of taxa is an excellent candidate for comprehensive phylogenomics and we encourage such work in the future. Even obtaining COI barcode haplotypes would likely help with associating sexes. Such molecular work is beyond our intended scope and resources available at this time. In addition, there are no publicly available DNA barcodes of the species *Tuta atriplicella*, which is what is ultimately needed in order to test the placement of the taxon *absoluta* with DNA.



Figures 3-4. *Tuta absoluta* genitalia and terminology. 3, Male (gen. slide GL2000, P. Corro). 4, Female (gen. slide GL2022, P. Corro). Fig. 3. Male genitalia. Vlv=valva; Sp=saccular process; Dls=distal lobe of sacculus; Vn=vinculum; Sac=saccus; Un=uncus; Cul=culcitula; Gn=gnathos; Te=tegumen; P=pedunculus; A.sp=apical spine of phallus; Cp=corpus phallus; De=ductus ejaculatorius; Cc=caecum. Fig. 4. Female genitalia. Cb= corpus bursa; Sg=signum; Db=ductus bursa; An=antrum; Spm=spermatheca; A.ap.=apophyses anterioris; Sv=sinus vaginalis; P.ap.=apophyses posterioris; Pa=papilla analles.

One of the most diagnostic features of our ingroup is the morphology of the gnathos, which is distinctly developed in all Gnorimoschemini. Most species of Gelechiidae, Gnorimoschemini included, have a mesial process of the gnathos shaped like a hook with the terminal end curved and acutely pointed. It is solid throughout most of its length with a Y-shaped base fused into a single hook. In *P. absoluta* and related taxa, the mesial process of the gnathos forms a sub-circular hoop open at the anal cone with a broad, membranous central area. This central membrane is often textured with microtrichia similar to the culcitula. We did not score this character in the matrix because it is present in all ingroup taxa and, therefore, uninformative for the placement of *P. absoluta* among the nominal

taxa. This character, however, would be likely informative in a large study that includes additional gnorimoschemine genera.

In our analysis, a monophyletic *Phthorimaea* is supported by the presence of a longer valva (Character 3, State 1), a quadrate saccular process (Character 10, State 1), a signum located in the middle of the corpus bursae (Character 18, State 1), and a funnel shaped antrum (Character 21, State 1). Characters 3 and 10 are reversed in *P. absoluta* and the other two synapomorphies are in the female genitalia, which we could not score for all taxa. There is additional character support for sister-group relationships between *S. inapparens* and *S. ascendens*, *P. operculella* and *P. robusta*, and *P. absoluta* and *P. chiquitella* that also contribute to the most parsimonious tree topology recovered. Although not considered in our cladistic analysis, we know that *P. absoluta* shares with *P. operculella* a rare physiology, deuterotokous parthenogenesis, whereby both males and females can develop from unfertilized eggs (Caparros Megido et al. 2002; Liu et al. 2018). Deuterotokous parthenogenesis has been reported in Bombycidae, Gelechiidae, Geometridae, Gracillariidae, Lasiocampidae, Lymantriidae, Nepticulidae, Psychidae, Saturniidae, Sesiidae, and Sphingidae (Trehan and Bagal 1944, Portier 1949, Suomalainen 1962, Mitter and Futuyma 1977, Lynch 1984, Menken and Wiebosch-Steeman 1988, Mozuraitis et al. 2002, Caparros Megido et al. 2012, Abbes and Chermiti 2014). In addition, both species have similar life histories: Early larval instars are leaf miners which later become borers of tubers or fruits.

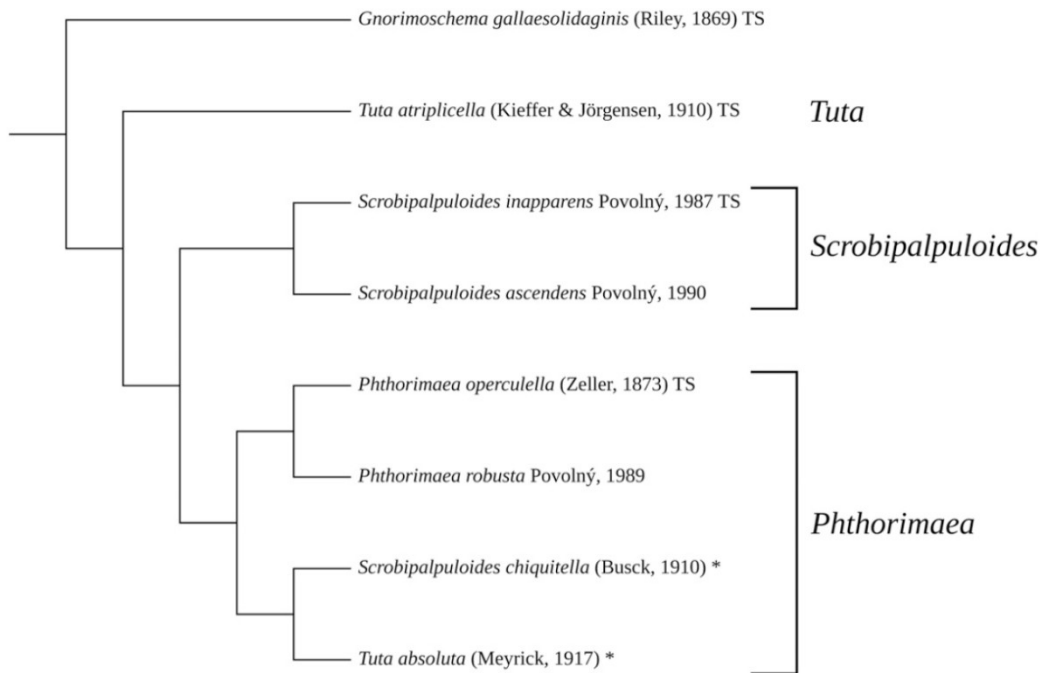


Figure 5. Single most parsimonious tree of 28 steps (CI = 0.69, RI = 0.58) resulting from a minimum length parsimony search on twenty-two binary characters (18 informative, 4 uninformative) of the male and female genitalia. The genera *Phthorimaea*, *Scrobipalpuloides*, and *Tuta* were resolved among the ingroup with *P. absoluta* being part of a monophyly that includes *P. operculella*. Values above nodes are bootstrap percentages above 50% and values below nodes are Bremer Support values. TS = type species for the genus, * indicates a taxon with a nomenclature change in this work (see text, “Proposed Species Classification for the Included Genera”).

Our results support a need for generic re-classification of the taxon *absoluta* under its original genus, *Phthorimaea*. The classification of *P. absoluta* is the pragmatic one should these genera all be synonymized in the future since *Phthorimaea* is the oldest genus-group name. Pragmatism aside there is character support in the character matrix and discovered tree topology and other data that support our placement of *P. absoluta*. A stable classification for this important pest is crucial for its future identification and management, and to give us any power to predict closely-related emergent pests. A recent search (10 September 2020) of BOLD (Ratnasingham and Hebert 2007) resulted in 877 specimens identified as the OTU “*Tuta absoluta*.” Of these, 860 specimens had COI barcodes and 529 are public records from 28 countries. These numbers suggest that countries all over the World are putting a great amount of effort on correctly identifying the species. There are already OTUs in BOLD determined as new species of “*Tuta*.” Whether these species and others are accurately classified in the future will, hopefully, be facilitated by this work.

Acknowledgments

We thank Jean-François Landry, Canacoll, for his help accumulating Povolny's literature and for discussions about morphological characters; the Universidad de Panama for laboratory equipment and facilities needed to complete this research; the SENACYT for financial support of the first author's Ph.D. studies in Panama; and Vazrick Nazari (Ottawa, Canada) and Alicia E. Timm (Fort Collins, Colorado) for critical reviews of the manuscript. Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the USDA; USDA is an equal opportunity provider and employer.

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Capítulo III

PANAMA MOTH NOTES, 8. THE NEOTROPICAL GENUS *PAVOLECHIA* (LEPIDOPTERA: GELECHIIDAE: ANACAMPSINAE)

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HEPPNER, J.B. y P. CORRO CHANG. 2017. Panama Moth Notes, 8. The Neotropical Genus *Pavolechia* (Lepidoptera: Gelechiidae: Anacampsinae). *Lepidoptera Novae*, 10(1-2), 67-70.

Abstract

The Neotropical genus *Pavolechia* Busck (1914) (Gelechiidae: Anacampsinae) is reviewed for three species: *Pavolechia argentea* Busck (1914) from Panama, *Pavolechia chrysostoma* (Meyrick, 1918) from Guyana, resurrected from synonymy, and a new species, *Pavolechia mimetica* n. sp., from Panama.

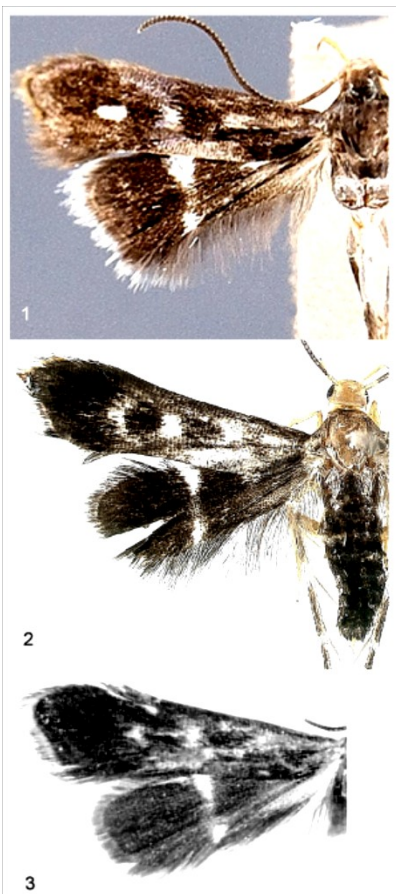
Key words: Brazil, Central America, Colon, *Desmaucha*, distribution, Gelechioidea, Guyana, Mesoamerica, Neotropical, Panama, *Pavolechia*, *Pavolechia mimetica* n. sp., South America, taxonomy.

Introduction

The genus *Pavolechia* Busck (1914) was described for an atypical gelechiid species from Panama, *Pavolechia argentea* Busck. Capture of another specimen of *Pavolechia* in Panama, prompted a study of the genus and the conclusion that this was a new species. Following further study, it also became clear that the synonymy of *P. argentea* presented by Clarke (1969) with another species described from Guyana by Meyrick, *Pavolechia chrysostoma* (Meyrick, 1918), was invalid. Meyrick had described the Guyana species in his own new genus, *Desmaucha* Meyrick (1918), for the single species, *D. chrysostoma*, but Meyrick's genus is a junior synonym of *Pavolechia*. While the adults are much the same in maculation, study of the female genitalia shows that the Guyana species differs from the Panama species, as well as from the new species from Panama.

The genital characters of the species are shown in Figs. 8-10: *P. argentea* (Fig. 8) has a differing ostium and antrum form than in *P. chrysostoma* (Fig. 10) as shown on the photo by Clarke (1969), as also from the new species (Fig. 9). The species certainly are all in the same genus and are all extremely similar, but clearly differ in genital features, although very closely related. Wing venation is shown in Fig. 5 for *P. chrysostoma* (after Clarke, 1969): note the rounded termen of the hindwing.

Meyrick (1925) considered his genus *Desmaucha* (= *Pavolechia*) to be related to *Strobisia* Clemens, which is now placed in the Anacampsinae (Anacampsiini) (Becker, 1984). Further generic studies may clarify this more. While the generic synonymy presented by Clarke (1969) is valid, with *Pavolechia* Busck (1914) the senior name over *Desmaucha* Meyrick (1918), Meyrick did not notice this and also left out the Busck genus in his *Genera Insectorum* treatise on the family (Meyrick, 1925). Later, Meyrick (1926) noted that a few genera had been missed in the family treatise the year before, but again he missed the genus *Pavolechia* among several Busck (1914) genera listed.



Figures 1-3. *Pavolechia* species: 1) *P. argentea*, holotype female (wingspan 11 mm), Panama (USNM); 2) *P. mimetica*, n. sp., holotype female (wingspan 10.2mm), Panama (MGCL); and 3) *P. chrysostoma*, lectotype female (wingspan 11 mm). Guyana (BMNH) (halftone, after Clarke, 1969).

The biology of *Pavolechia* is unknown, nor are the males known. Busck (1918) only noted that his specimen of *P. argentea* was collected during the daytime. The new species found in Panama, collected in 2014, was taken at lights.

Results

PAVOLECHIA Busck, 1914

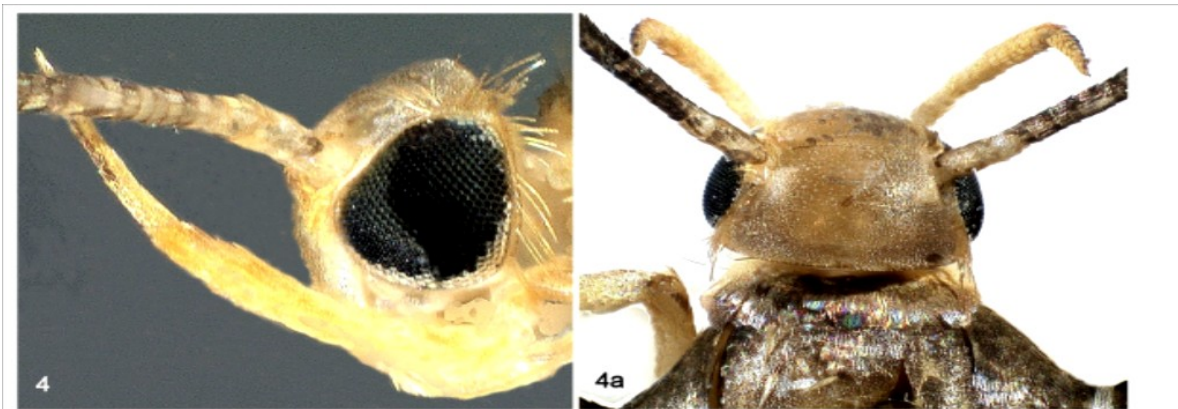
Pavolechia Busck, 1914

Type-species: *Pavolechia argentea* Busck, 1914

Desmaucha Meyrick, 1918

Type-species: *Desmaucha chrysostoma* Meyrick, 1918

The genus is distinguished by the atypical wing form in Gelechiidae, with the hindwings being rounded (Fig. 5) rather than the usual pointed and usually falcate apex, and vein M2 is absent with a broad open cell. As Busck (1914) noted, the labial palpi are very long and slender, recurved, and with a short terminal segment. Meyrick (1918, 1925) thought the genus (as *Desmaucha*) related to *Strobisia* Clemens, but this remains to be studied further. The abdomen has a single row of dorsal spiniform setae (Figs. 6-7), rare in Gelechiidae. With the new species described herein, in a compact species-complex of three closely related species, our present knowledge of the genus is confined only to females, since all three species are only known from females.



Figures 4-4a. Head views of *Pavolechia mimetica* n. sp.: 4) lateral view; and 4a) dorsal view.



Figure 5. Wing venation of *Pavolechia chrysostoma* (after Clarke, 1969).

Pavolechia argentea Busck, 1914

This species from Panama (Fig. 1) is very similar to *P. chrysostoma* and the new species, but has the forewing maculation with larger white spots and pale gray subtermen. In the female genitalia, the antrum is more evenly convex laterally (constricted posteriorly in *P. chrysostoma*). The antrum has a ventral V-shaped margin allowing the distal ends of a pair of projecting sclerite extensions from the antrum to be exposed (Fig. 8), which are not present in *P. chrysostoma* and large in the new species. The male is unknown. Busck (1914) described the genus and *P. argentea* from a single female specimen collected on the Trinidad River, Panama, in March 1912, probably at a site along this river that is now flooded by the Panama Canal lakes. The holotype (Fig. 1) is in the USNM (Type No.16679), Smithsonian Institution, Washington, DC.

Pavolechia mimetica **Heppner & Corro Chang new species**

Diagnosis: this species can be distinguished from congeners by the more curved distal white spots in the forewing (ovate in the other two species) and with a larger third white spot nearer the upper base (small in *P. chrysostoma* and more central in *P. argentea*). The hindwing has a white fringe at the apex, which is entirely white along the termen in *P. argentea* and *P. chrysostoma*. The head has golden-yellow scaling, which is dark brown in *P. argentea* and more brown in *P. chrysostoma*. In the female genitalia (Fig. 9), the antrum is ovate with interior sclerotized ridges in a long, bulging funnel (narrow and lacking large

ridges in *P. chrysostoma* and short in *P. argentea*). The ductus bursae is long in *P. argentea*, but shorter in *P. chrysostoma* and *P. mimetica*.

Wingspan: 10.2mm (n = 1).

Description. *Head* (Fig. 4): vertex and frons pale golden yellow (mostly denuded in holotype), with yellow eye margins ventrally; labial palpus golden, with slight brown edge line on apical segment; antenna dark brown, ventrally pale golden yellow; scape golden yellow. *Thorax*: dark brown, with silver on posterior end; tegulae same; patagia dull yellow; venter white; legs with coxae and femurs golden iridescence; fore- and midtibiae and tarsi golden with some tibial dorsal scaling of brown; hindtibia dark brown, with yellow-white as basal ring by each golden spur pair; hind tarsi dark brown with venter dull yellow and terminal segments yellow.

Forewing. (Fig. 2) black brown, with translucent white spots centrally at 1/3, 1/2, and 2/3, with outer spots somewhat convex to form a round black center between them; fringe black-brown except for orange on apex margin; venter black-brown and white spots repeated but larger; fringe black-brown. *Hindwing*: black-brown with white transverse fascia at 2/3, widened at costal margin and interrupted medially before smaller wedge at tornus; fringe black-brown but white along apex; venter same but fascia larger and not split medially, and also another white indistinct fascia at 1/3.

Abdomen. dorsally spined in single row each tergite (Fig. 7); dark brown, with silvery scales as posterior margins for each tergite; venter cream-white except for dark brown posterior two sternites; genital tuft dark brown. *Female genitalia* (Fig. 9): large setose papilla anales, with thin, and long apophyses; ostium bursa an ovate opening and a bulging funnel with strong interior ridge-like structures, with tips exposed posteriorly; ductus bursae scobinate and gradually thinner to ductus bursa junction; bursa copulatrix ovate and simple; signum absent. *Male genitalia*: unknown. Holotype female: Panama, Sierra Llorona Lodge (225m), Santa Rita Arriba, Colon, 7-9 Jun 2014, J.B. Heppner (MGCL).

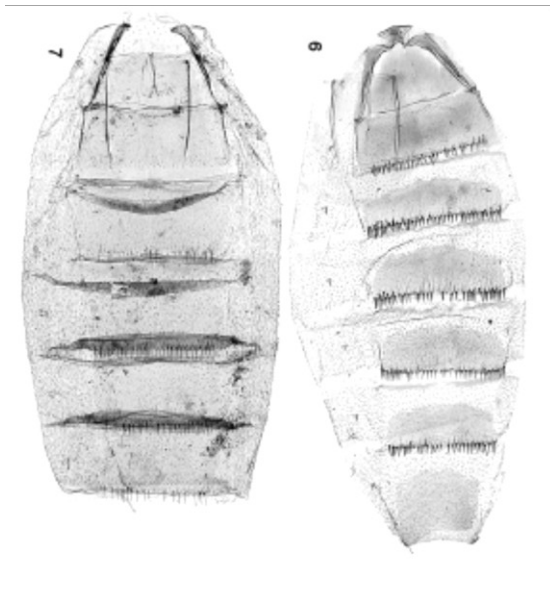
Etymology: named for its similar appearance to the other species of *Pavolechia*.

Distribution: known only from the type-locality in Panama.

Biology: unknown.

Discussion

The type-locality in Colon for *P. mimetica* is in the same region of Panama and not very distant from the Trinidad River locality for *P. argentea*, and only about 200m higher in elevation, yet the genitalia and wing markings of the two species differ. Likewise, the species from Guyana, *P. chrysostoma*, shows the differences already noted. It is another remarkable species complex of closely related species, as is often found in Neotropical genera.



Figures 6-7. Female abdomen of *Pavolechia*, 6) *P. argentea*; and 7) *P. mimetica* abdomen details, ventral view (genitalia slide JBH 3531).

Pavolechia chrysostoma (Meyrick, 1918)

This species from Guyana (Fig. 3) has adult maculation very much like *P. argentea* and *P. mimetica*, but the white markings are less prominent and smaller on the forewings. The female genitalia (Fig. 10) has the antrum constricted posteriorly before the ostium, while in

P. argentea the antrum is evenly convex laterally (Fig. 8a), and both do not show the large interior ridges present in *P. mimetica* (Fig. 9a). The ostium bursa is also evenly rounded and lacks the projecting antrum lobes found in *P. argentea*. The male is unknown.

Meyrick (1918) described *P. chrysostoma* (in *Desmaucha*) from Guyana (Bartica, Mallali), from two female specimens collected in March and December 1913 by Parish, one of his collectors in South America. Clarke (1969) made one of the females the lectotype. Meyrick (1925) notes Guyana and Brazil as the further distribution for *P. chrysostoma*. The figure by Meyrick (1925) is incorrect in showing only two forewing white spots.

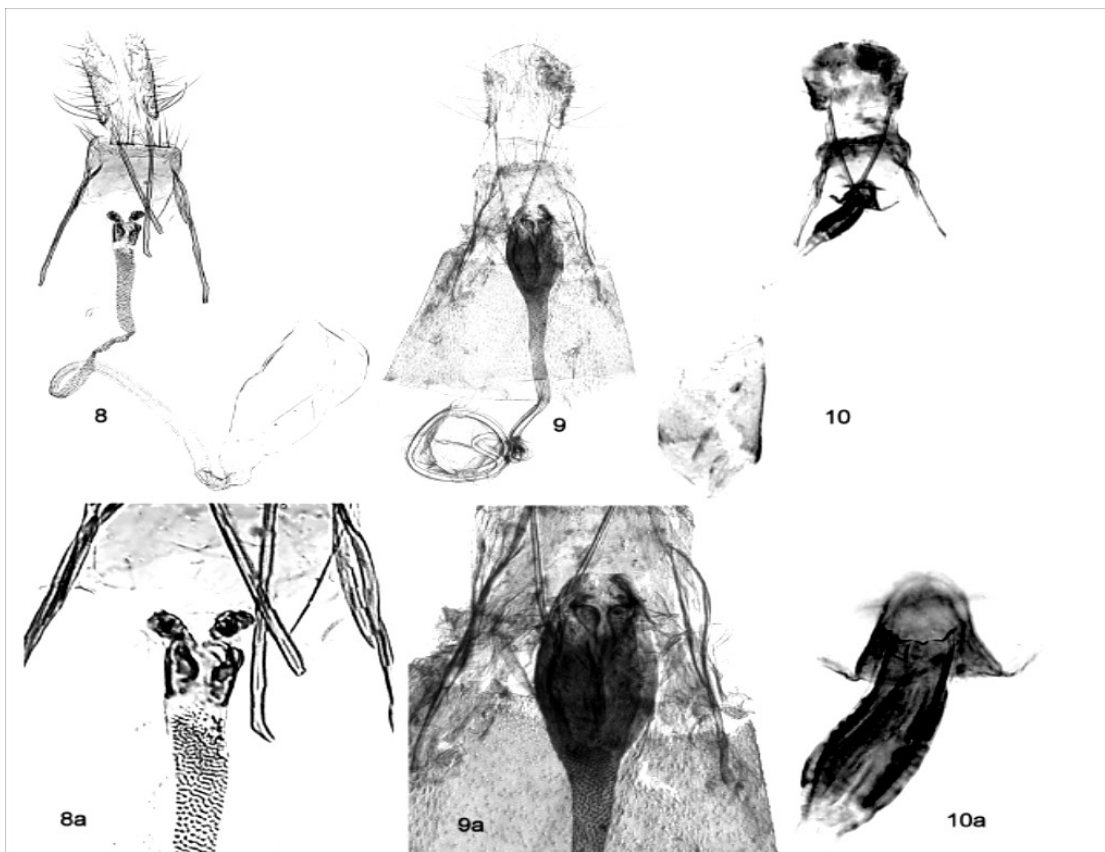


Figure 8-10. Female genitalia of *Pavolechia* species, with inset details for ostium and antrum (a): 8-8a.) *P. argentea*, holotype (Panama) (gen. slide USNM 10667); 9-9a.) *P. mimetica* n. sp., holotype (Panama) (gen. slide JBH 3531); 10-10a.) and 10-10a.) *P. chrysostoma*, lectotype (Guyana) (gen. slide JFGC 6005, BMNH) (after Clarke, 1969).

Acknowledgments

Our thanks to Dr. Annette Aiello and other staff of the Smithsonian Tropical Research Institute (STRI), Ciudad de Panamá, for help with permits and logistics for several expeditions to Panama (for JBH). Likewise, the Universidad de Panama, SENACYT, has likewise helped with support (for PC). Specimens at the U. S. National Museum of Natural History (USNM), Smithsonian Institution, Washington, DC, were kindly examined by Dr. Mark Metz (staff curator for Gelechioidea and with the Systematic Entomology Lab, USDA). Lepidoptera specimens are deposited in McGuire Center for Lepidoptera and Biodiversity (MCUF), Florida Museum of Natural History, University of Florida, Gainesville, Florida. The Florida State Collection of Arthropods (FSCA), Division of Plant Industry, Florida Dept. of Agriculture and Consumer Services, Gainesville, Florida, provided access to an Auto-Montage system for photographing the adult and genitalia of *P. mimetica*. Images of *P. chrysostoma* are from the picture files of J. F. G. Clarke (formerly with the USNM) of Meyrick types.

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Capítulo IV

A NEW SPECIES OF *COLONANTHES* MEYRICK (LEPIDOPTERA: GELECHIIDAE) FROM PANAMÁ AND THE PLACEMENT OF THE GENUS IN LITINI BRUAND (GELECHIINAE)

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CORRO CHANG, P. y M. METZ. 2020. A new species de *Colonanthes* Meyrick (Lepidoptera: Gelechiidae) from Panama and the placement of the genus in Litini Bruand (Gelechiinae). *Proceedings of the Entomological Society of Washington*, 122(2): 291-298.

Abstract

We diagnose and describe *Colonanthes korytkowskii* new species from Panamá and discuss the placement of the genus in Litini Bruand, 1859 (Gelechiinae). The genus was represented by a single species, *Colonanthes plectanopa* Meyrick, 1923, described from two male specimens collected at Manaus, Brazil and Yurimaguas, Peru. We include the first female description of a species in the genus and expand the distribution of the genus north by over 1000 km.

Key words: Gelechioidea, Neotropics, micromoth, systematics, glandiductor.

Introduction

Meyrick (1923) described the genus *Colonanthes* in Gelechiidae [=Gelechiidae] for the single species *C. plectanopa* Meyrick, 1923 based on two male specimens collected at Manaus, Brazil and Yurimaguas, Peru. Clarke (1969), in his treatment of Gelechiidae, designated the Peruvian specimen lectotype and provided photographs and an illustration of the specimen. Meyrick (1923) stated with the generic description that it was, “A development of *Compsosaris* [Meyrick, 1914],” which is a hypothesis likely based on wing pattern (Fig. 1) as he neither dissected, nor examined genitalia. The male genitalia of the type species of these two genera are considerable different with *C. plectanopa* having, among other differences, a strongly bifurcate median sclerite of the gnathos. Clarke (1969) included in his annotations of the lectotype, “(gnathos a double hook).” We know of no other gelechiid taxon with a similarly shaped gnathos.

The first author collected male and female specimens of an apparently new species of gelechiid moth while conducting sampling of insects in an area near Panamá City called Albrook. Scientists studied the Albrook area for many years due to its proximity to the canal and the potential impact of canal activity and increased commerce on the local flora and fauna. August Busck studied lepidopteran diversity in the area before the construction of the Panamá Canal in 1912, and subsequent workers monitored potential impacts to the

ecosystem over the decades. The first author detected the same species in samples from diverse habitats in other sites across the country. The male shared similarities with *C. plectanopa*, which included wing pattern and a strongly bifurcate median sclerite of the gnathos. In this work, we diagnose and describe the new species and discuss its inclusion in the tribe Litini Bruand, 1859. This marks the first published occurrence of the genus outside of South America and the first record of associated females.

Materials and methods

Specimens were collected using four different methods as indicated with the specimens: malaise trap with alcohol receptacle, UV light, mercury vapor light, and Skinner trap. How each individual specimen was collected is indicated by one of the methods above as part of the label data listed in the “Type material” section. Whole body dissections were made following Lee & Brown (2006) and dissections were preserved and stored in glycerol vials. Photographs were created with a Leica stereoscope M205 A, a phase contrast scope Leica DM3000 LED and an Olympus fluorescence microscope. All the images were processed in the software Leica Application Suite (LAS), version 4.12 and edited with Adobe Photoshop 6.0. The specimens were cleaned in alcohol 20%. The maceration of the abdomen was in KOH 10% for 12 minutes and rinsed with water. The material was stained in 1% Orange G in lactic acid. All the dissections were made in lactic acid and the vouchers were stored in micro vials with glycerine. The holotype and 2 male paratypes will be deposited at the Museo de Invertebrados Graham Bell Fairchild, Universidad de Panamá (MIUP). The remaining paratypes will be distributed as follows: 69 males, 18 females with Patricia Corro Chang at Programa Centroamericano de Maestría en Entomología (PCC); 2 males, 1 female with the U.S. National Insect Collection at the United States National Museum of Natural History (USNM); and 3 males with the Canadian National Collection (CNC). Morphological terms are taken from Huemer and Karsholt (1999) and Ehrlich (1958).

Results

Colonanthes korytkowskii Corro Chang new species

(Figs. 2-4, 6, 8, 10-14)

<http://zoobank.org/1BE3E2AC-9355-4B76-A7D3-9AED2625259A>

Etymology. The name is in honor of Prof. Ing. Cheslavo Korytkowski (1941-2016) who made important contributions to the field of entomology in Central and South America and was a founder of the Central American Program of Entomology in Panamá.

Diagnosis. The species is extremely similar to *C. plectanopa*, the only known species in the genus, however differs by having a shallowly emarginate anterior margin of tergite VIII (Fig. 12), a more rounded apex of the costal/cucullar part of the valva (Fig. 8) and a saccular process length 3X its width and its longitudinal axis parallel to the valva (Fig. 10).

Description. Head: Head white; sitophore broad, rounded, with campaniform sensillae arranged in the shape of a trapezoid wider than high (Fig. 3). Antenna prismatic, light brown. Ocellus present. Labial palp ringed, with brown. Second segment of labial palp, covered with tuft of scales, medially and apically; tuft of scales forming a triangular shape. Thorax: Dorsally (Fig. 2) with brown scales, except for the discal area of tegula yellow, apex of the tegula irrorated with white scales. Notum with three white bands. Mesoscutellum with two small patches of yellow scales near the margin and irrorated with white scales apically. Laterally with white scales except for a group of brown scales giving the aspect of two parallel bands. Ventrally with white scales. Female thorax mostly brown, except tegula light grey.

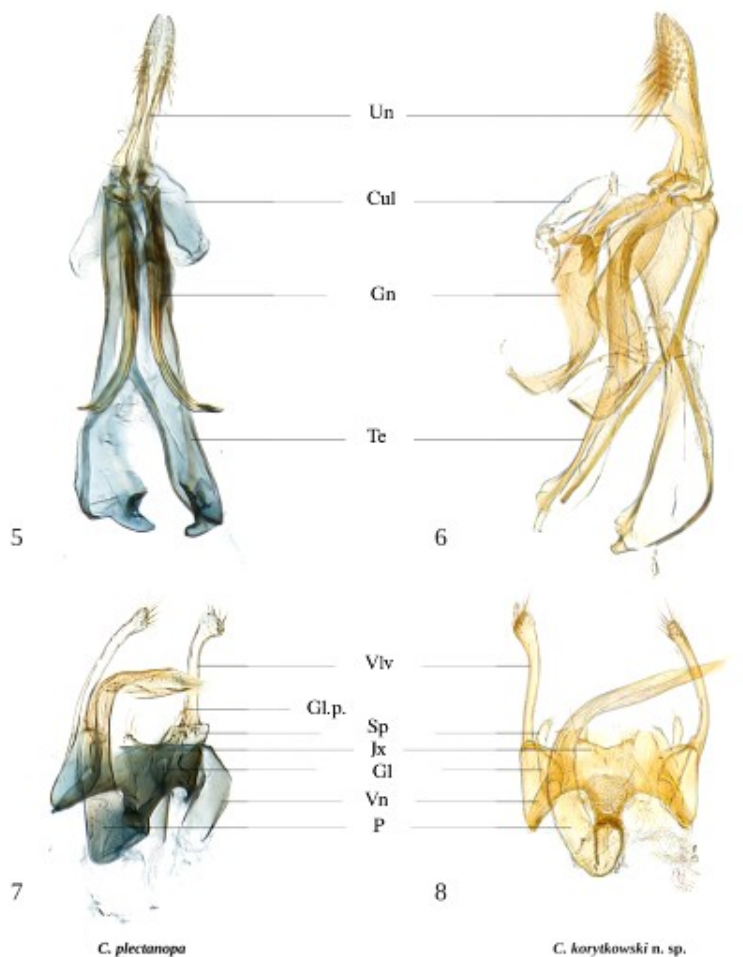
Wing: Forewing sub-lanceolate, with small, gray patches of raised scales on the dorsal surface, three patches distributed along the folding area; veins M1 and CuA near; M2 and M3 not fused. Hindwing sub-rectangular, outer margin with a distinctive sinuation, posterior margin of hindwing covered with abundant gray cilia.



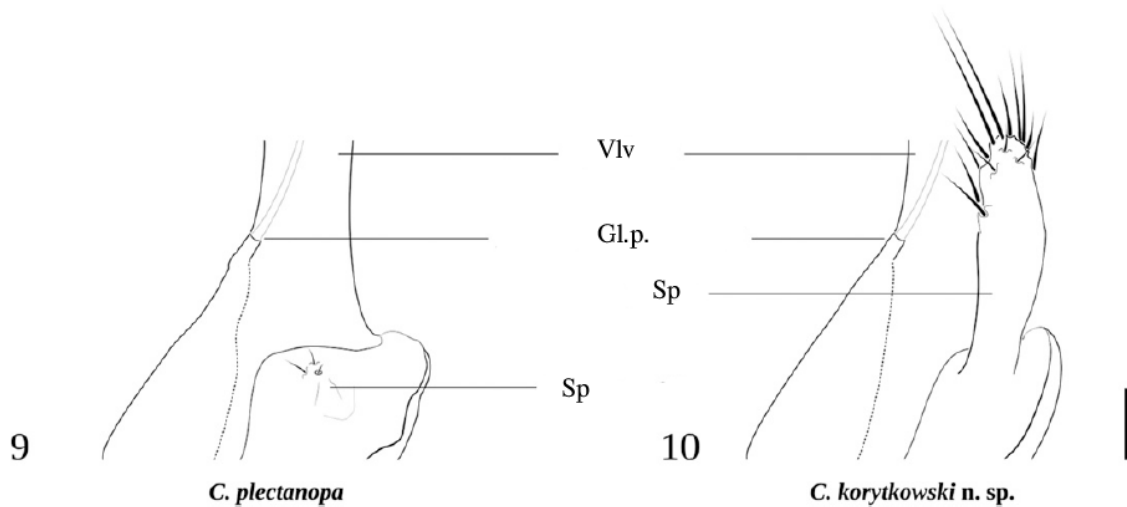
Figures 1-4. Imagos. 1, dorsal habitus of ♂ paralectotype *Colonanthes plectanopa* Meyrick. 2, dorsal habitus of ♀ paratype *Colonanthes korytkowskii* n. sp. Scale bar: 2 mm. 3. Cleared head of *Colonanthes korytkowskii* n. sp. Arrows indicate campaniform sensillae of the sitophore. Scale bar: 40 μ m. 4. Abdominal segment II of *Colonanthes korytkowskii* n. sp. Scale bar: 200 μ m.

Abdomen: Variable in color from light gray to brownish. Ventral support structure of sternite II with apodems (Fig. 4). Tergum VIII in the males, longer than wide, sub trapezoid, with discal coremata behind (Fig. 12). *Male genitalia.* Uncus projected, articulated basally, setose; setae in medial position are longer than those at the margins, evenly distant; gnathos double hook-like, elongated (Fig. 6); gnathos arms divergent, broad; culcitula broad, bilobed, between base of the gnathos; gnathos arms divergent, broader; tegumen longer than wider; valva short, almost 0.5 the length of the tegumen, slender; apex of valva simple, rounded, with evenly distant setae (Fig. 8); juxta lobes reduced, not overlapping and without pockets, bifurcated at its external margin with marginal setae, at least 14 setae, evenly distant and with same length; sacculus short, quadrate, 0.25 length of valva, saccular process length 3X width and oriented in a longitudinal axis with valva (Fig. 8); glandiductor developed, elongated; glandiductor exit pore reduced, fusiform, exiting on

excavated channel on ventromedial surface of costal part of valva; saccus broad, sub cylindrical and never flattened; vinculum broad, reduced, small bifurcation at its external margin, evenly distant setae covering the outer margin of the bifurcation; saccus broad, sub cylindrical, never flattened. Phallus proximally folded, without apical or medial spine process (Fig. 8); caecum reduced; lamina ducti ejaculatorii absent; cornuti present, minute and evenly distant, located at the discal portion of vesica.

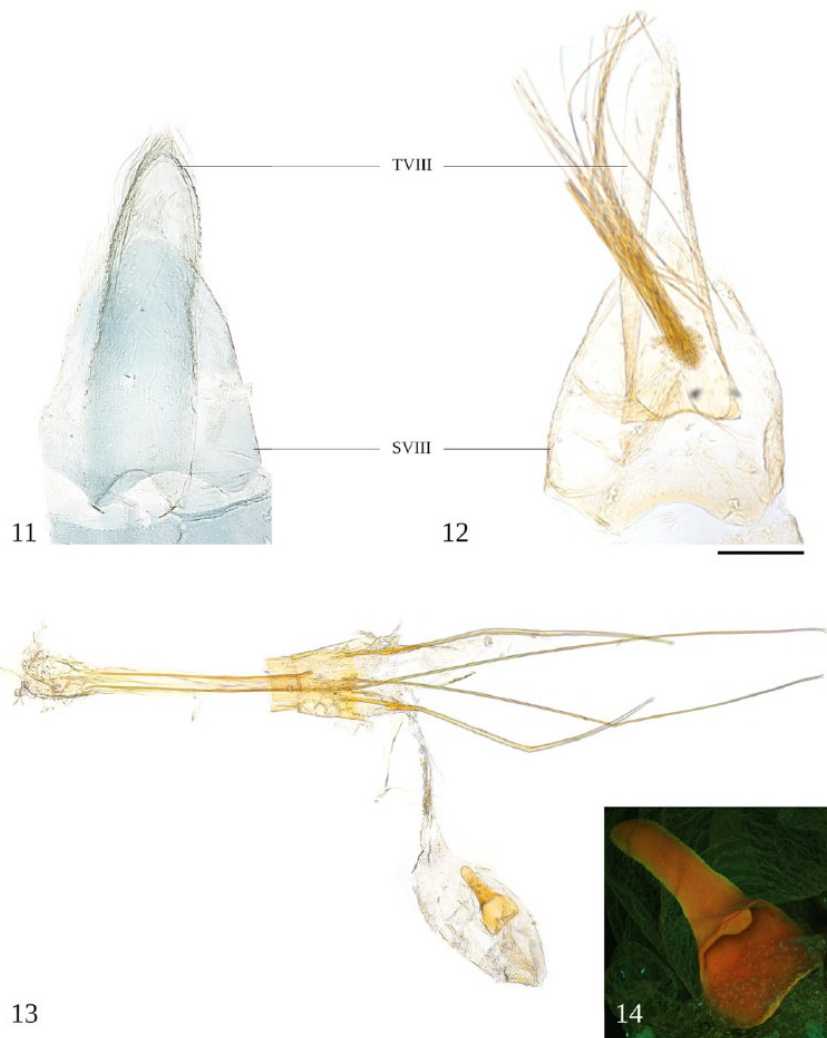


Figures 5-8. Male genitalia *Colonanthes* spp. 5, dorsal structures ♂ paralectotype *Colonanthes plectanopa* Meyrick. 6, dorsal structures ♂ paratype *Colonanthes korytkowskii* n. sp. 7, ventral structures ♂ paralectotype *Colonanthes plectanopa* Meyrick. 8, ventral structures ♂ paratype *Colonanthes korytkowskii* n. sp. Scale bar: 0.2 mm. Abbreviations: Un=uncus, Cul=culcitula, Gn=gnathos, Te=tegumen, Vlv=valva, Gl.p.=glandiductor pore, Sp=saccular process, Jx=juxta, Gl=glandiductor, Vn=vinculum, P=phallus.



Figures 9-10. Medial view right base of valva showing detail of saccular process *Colanthes* spp. 9. ♂ paralectotype *Colanthes plectanopa* Meyrick. 10. ♂ paratype *Colanthes korytkowskii* n.sp. Scale bar: 0.02 mm. Abbreviations: Vlv=valva, Gl.p.=glanductor pore, Sp=saccular process.

Female genitalia (Fig. 13). Papilla analis slender, sub-ovate, setae evenly distant; apophysis posterioris slender, as long as the corpus and ductus bursae together; apophysis anterioris elongated, as longer as apophysis posterioris; segment VIII sub quadrate, longer than broad; antrum partially sclerotized laterally; ductus bursae long, delicate, slender; spermatheca coiled; ductus bursa narrow, elongated, at least 0.75 X the length of apophysis anterioris, corpus bursa elongated, wrinkled, covered with fine microtrichia; signum rhomboid (Figs. 13, 14), distal portion elongated, blunt apex, inner margin finely dentate, located at mid-length corpus bursae.



Figures 11-14. Male abdominal segment VIII, tergite VIII (TVIII) and sternite VIII (SVIII). 11, paralectotype *Colonanthes plectanopa* Meyrick. 12, paratype *Colonanthes korytkowskii* n. sp. Scale bar: 0.2 mm. **Figure 13.** Female genitalia paratype *Colonanthes korytkowskii* n. sp. **Figure 14.** Magnified signum, paratype *Colonanthes korytkowskii* n. sp.

Type material. Panamá: Holotype ♂ Province Panamá, Albrook, 16.05-20.06.2019, Malaise Trap, leg. E. Medianero. Paratypes (77 ♂♂, 19 ♀♀): (1 ♀) Province Veraguas, Santa Fé, Alto de Piedra, 850 m, 11.06.2016, UV-Light, #009, leg. P. Corro and S. Tarakanov. (1 ♂) Province Veraguas, Santa Fe, Alto de Piedra, 1000 m, 14.06.2016, Mercury Vapor Light, #11, leg. P. Corro and S. Tarakanov. (1 ♀) Province Veraguas, Santa Fe, Alto de Piedra Lodge, 900 m, 20.01.2017, Mercury, leg. P. Corro and S. Tarakanov. (1 ♀) Province Veraguas, Santa Fe, Alto de Piedra Lodge, 900 m, 20.01.2017, Mercury Vapor Light, #128b, leg. P. Corro and S. Tarakanov. (13 ♂♂, 6 ♀♀) Province Veraguas, Alto de

Piedra Lodge, 900 m, 21.01.2017, Mercury Vapor Light, leg. P. Corro and S. Tarakanov. (4 ♂♂) Province Coclé, Chiguirí Arriba, Távada, 500 m, 18.01.2017, Skinner, leg. P. Corro and S. Tarakanov. (59 ♂♂, 10 ♀♀) Province Panamá, Parque Nacional Metropolitano, 16.05-20.06.2019, Malaise Trap, leg. E. Medianero.

Distribution. *Colonanthes korytkowskii* new species is known from the Panamanian provinces of Coclé, Veraguas, and Panamá.

Biology. Unknown.

Remarks. *Colonanthes korytkowskii* new species is indistinguishable from *C. plectanopa* using external characters alone. Males can be identified most easily by the much longer and posteriorly directed saccular process, which is half the length and turned medially in *C. plectanopa* (Figs. 9, 10). Specimens were collected at altitudes ranging from sea level to 1000m. It occurred in disturbed habitat near the city, habitat dominated by grasses, and in pristine mountainous tropical forest. It was attracted by both UV and mercury vapor light traps in large numbers, however comparable numbers were collected in malaise traps set for weeks at a time with alcohol receptacles.

Discussion

Colonanthes is currently unplaced in Gelechiinae (Becker 1984), however, it shares morphology with species in the tribe Litini including raised scales on the forewing, fusion of the base of the phallus to the juxta, and glandiductors (Huemer and Karsholt 1999, Lee and Brown 2008). These states are all present in the type species of the tribe, *Recurvaria nanella* (Denis & Schiffermüller, 1775). In both species of *Colonanthes* the glandiductor is fused with the costal part of the valva as in species of *Teleiodes* Sattler, 1960. The external “pore” of the glandiductor opens on to a channel or groove in the ventromedial surface of the costal part of the valva. This may provide capillary action to liquid issuing from the tip of the glandiductor.

The broad, bilobed culcitula is unique among known Litini, however a reduced culcitula is present in species of genera currently included in Litini such as *Arogalea* Walsingham, 1910; *Parastenolechia* Kanazawa, 1985; and *Stenolechia* Meyrick, 1894. Although Lee and Brown (2008) treated only the Holarctic fauna of Litini (=Teliadini) their morphological character support suggests inclusion of *Colonanthes* without formal cladistic analysis of a comprehensive sampling of Gelechiinae.

Acknowledgments

We thank the Secretaría Nacional de Ciencias y Tecnologías de Panamá (Senacyt) for the financial support; the Universidad de Panamá for the support with entomological supplies, optical equipment and lab facilities; Dr. Enrique Medianero for providing additional specimens; Mr. Jorge Ceballos and Smithsonian Tropical Research Institute (STRI) for all the support with the fluorescence microscope; the University of Florida for support with references; Canacoll for the Canacoll Foundation Grant for Curatorial works of the world Gelechiidae collection and for access to the protem material in their collection. Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the USDA; USDA is an equal opportunity provider and employer.

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Capítulo V

THREE NEW SPECIES OF GELECHIIDAE (LEPIDOPTERA) FROM PANAMA

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CORRO CHANG, P. y O. BIDZILYA. 2020. Three new species of Gelechiidae (Lepidoptera) from Panama. *Zootaxa*, 4890(3): 407-416.

Abstract

Aristotelia barriosi sp. nov. (Veraguas Province, Santa Fe NP), *Agnippe tarakanovi* sp. nov. (Herrera Province, Sarigua NP) and *Chionodes sariguaensis* sp. nov. (Herrera Province, Sarigua NP) are described from Panama. Adults and the genitalia of both sexes for all species and the habitats of two latter species are illustrated.

Key words: Neotropical region, Sarigua National Park, Santa Fe National Park.

Introduction

The present contribution is the next step towards study of biodiversity and taxonomy of Panamanian Gelechiidae. Following the recent publication of a provisional list of Gelechiidae from Panama (Lee & Mercado 2016), the pest species of Gnorimoschemini were revised (Corro Chang & Tarakanov 2017) and two new species were described from Panama (Heppner & Corro Chang 2017; Corro Chang & Metz 2020). The study of rich material collected by the first author in different provinces of Panama resulted in many new country and provincial records that are being incorporated in an updated list of Gelechiidae from Panama (Corro Chang et al. in prep.). Despite some progress in the study of several groups (Povolný 1987, 1990 and others; Sattler 1996) the Neotropical region remains the most poorly known with regards to its gelechiid fauna. The placement of many genera to their correct suprageneric categories and species to their correct genera remains problematic. The description of individual species without clear taxonomic placement, while providing formal names, may result in greater taxonomic confusion. Although numerous Panamanian species of Gelechiidae await description in the context of revisions of corresponding groups, some remarkable species belonging to broadly distributed and relatively well studied genera are worth describing separately without the need for inclusion into broader revisionary works. It is a case for the three new species described in this paper. Two of them belong to the global, relatively well studied genera *Chionodes* Hübner, 1825 and *Agnippe* Chamber, 1872. The third one, a species of *Aristotelia* Hübner, 1825 presents highly characteristic external coloration in the male, and can hardly be confused with any other species of this otherwise unrevised genus.

Materials and methods

The specimens in this study were collected following the methods presented in Corro Chang & Metz (2020). In addition, the authors organized several field trips in Panama, visiting the provinces of Veraguas, Los Santos, and Herrera, during the month of February 2020. The dissected material were preserved and stored in glycerol vials or mounted on permanent slides. The photographs of adults and the genitalia of *Aristotelia barriosi* sp. nov. were taken with a Leica stereoscope M205 A and a phase-contrast Leica DM3000 LED microscope. The images were processed with the software Leica Application Suite (LAS), version 4.12 and edited with Adobe Photoshop 6.0. The illustrations for *Agnippe tarakanovi* sp. nov. and *Chionodes sariguaensis* sp. nov. were prepared as described by Bidzilya & Budashkin (2017).

The depositories of the material are:

MIUP – Museo de Invertebrados Graham Bell Fairchild, Universidad de Panamá, Panamá, Rep. Panamá.

PCMENT – Programa Centroamericano de Entomología, Patricia Esther Corro Chang. Personal collection, Universidad de Panamá, Panamá, Rep. Panamá.

ZMKU – Zoological Museum, Kyiv Taras Shevchenko National University, Kyiv, Ukraine.

The terminology for genitalia and external characters of new species follows Hodges (1999) for *Chionodes*, Bidzilya & Li (2010) for *Agnippe*, and Huemer & Karsholt (1999, 2010) with little modifications for *Aristotelia*.

Results

Subfamily Anomologinae Meyrick, 1926

Tribe Anomologini Meyrick, 1926

***Aristotelia barriosi* sp. nov.**

Figs. 1-7

Type material. Holotype ♂, PANAMA, Prov.[incia] Veraguas, P.[arque] Nac.[ional] Santa Fe, Alto de Piedra Lodge, 900 m.a.s.l., 21.i.2017, Mercury Vapor Light, P. Corro and S. Tarakanov (MIUP, holotype number: ♂ gen. slide GL2015) (PCMENT). Paratypes: 4♂, 10♀, PANAMA, Prov.[incia] Veraguas, P.[arque] Nac.[ional] Santa Fe, Alto de Piedra Lodge, 900 m.a.s.l., 21.i.2017, Mercury Vapor Light, (♀ gen. slide GL2016; ♀ gen. slide GL2017, P. Corro) (P. Corro and S. Tarakanov) (PCMENT).

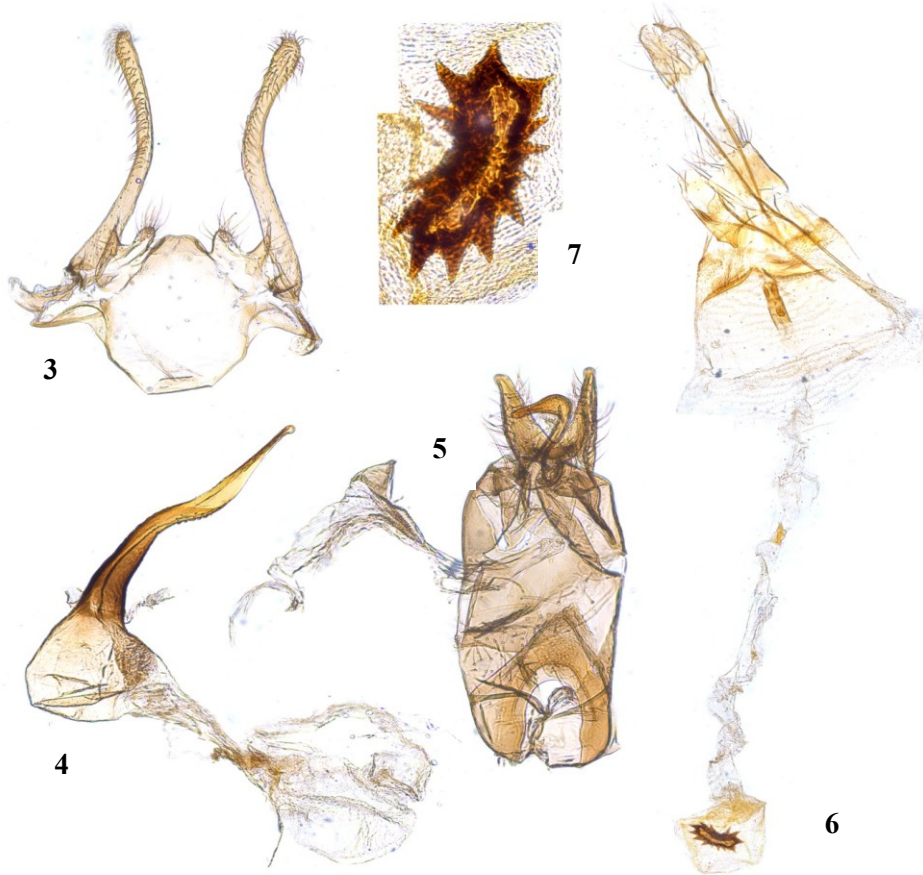
Diagnosis. *Aristotelia barriosi* sp. nov. is a rather distinctive species of *Aristotelia* that externally differs from others by the uniformly reddish-brown coloration and two ferruginous maculae at 1/3 of costa and at the apex of the forewing. The blackish-grey dorsum of the abdomen contrasting with the pale brown terminal segment in males is very characteristic too. The male genitalia are recognizable by the deeply bilobed uncus which is unique for *Aristotelia*. The female genitalia are characterized by a very long and coiled ductus bursae with a short, sclerotized antrum and a stellate signum.

Description. Adult (Figs. 1-2). Head light brown. Antenna light brown except for external margin of flagellomeres dark brown. Labial palp brown, second segment with tuft of scales on outer margin. Thorax light brown except for sprinkled dark brown scales covering apical portion of tegulae. Wingspan 8.5 mm in males and 11-13 mm in females. Forewing light brown, large dark brown irregular spot at 1/3 of costa, small dark brown spot before apex, pink points on costa just after large costal spot and before small apical spots, separated pink scales along veins in distal half of forewing and on dorsal margin before apex, costal margin suffused with dark brown in distal half, cilia brown black-tipped; hindwing blackish grey, cilia dark grey. Abdomen in female brown except for segment II melanized; in male abdominal terga black except for segment II brown. Tergum VIII in the males with dorso-lateral coremata, light brown.



Figures 1-2. *Aristotelia barriosi* sp. nov. Adult. 1. Male, holotype. 2. Female, paratype.

Male genitalia (Figs. 3-5) with uncus deeply bifurcated, inner margin setose, setae evenly distant; mesial sclerite of gnathos hook-shaped with blunt apex; tegumen elongate, about three times longer than broad, anteromedial emargination moderately narrow, reverse U-shaped, extended to 1/4 length of tegumen; valva slender, of even width, gradually bent in middle, apex with very short pointed tip, covered with short setae in distal half; sacculus about 1/8 length of valva, covered with long hair-like setae; posterior margin of vinculum with broad subtrapezoid projection extended to 2/3 length of sacculus; saccus broadly rounded, base with posterior sulci missing; phallus subequal length with tegumen, caecum rounded, 1/3-1/4 length of phallus, distal portion slender, weakly curved in middle, with fine teeth on dorsal surface just beyond middle, apical 1/4 gradually narrowed towards rounded apex; ductus ejaculatorius slightly shorter than phallus.



Figures 3-7. *Aristotelia bariosi* sp. nov. 3-5. Male genitalia, holotype (gen. slide GL2015, P. Corro). 3. Vinculum, valvae and sacculus. 4. Phallus. 5. Tegumen, uncus and gnathos. 6, 7. Female genitalia (gen. slide GL2016, P. Corro). 7. Signum enlarged.

Female genitalia (Figs. 6-7) with papillae anales subtriangular, rounded posteriorely, setose, setae evenly distant; apophysis posterior two times as long as apophysis anterior; segment VIII subquadrate, about half length of apophysis anterior, sternum VIII evenly sclerotized, posterior margin with deep narrow medial emargination; apophysis anterior straight; ductus bursae long, with five coils anteriorly, antrum sclerotized, approximately half length of apophysis anterior; corpus bursae rounded, covered with microtrichia; signum plate transverse elongate, about half length of corpus bursae, perimeter thickened edged with large triangular teeth.

Biology. Unknown. The type series was collected in the second half of June at 900 m.

Distribution. Panama: Veraguas, Santa Fe National Park.

Etymology. The species is named in honor to Prof. Hector Barrios Velazco, a founding member of the Central American Program of Entomology in Panama, in the recognition of his valuable contribution to the Panamanian systematic entomology.

Subfamily Gelechiinae Stainton, 1854

Tribe Gelechiini Stainton, 1854

***Agnippe tarakanovi* sp. nov.**

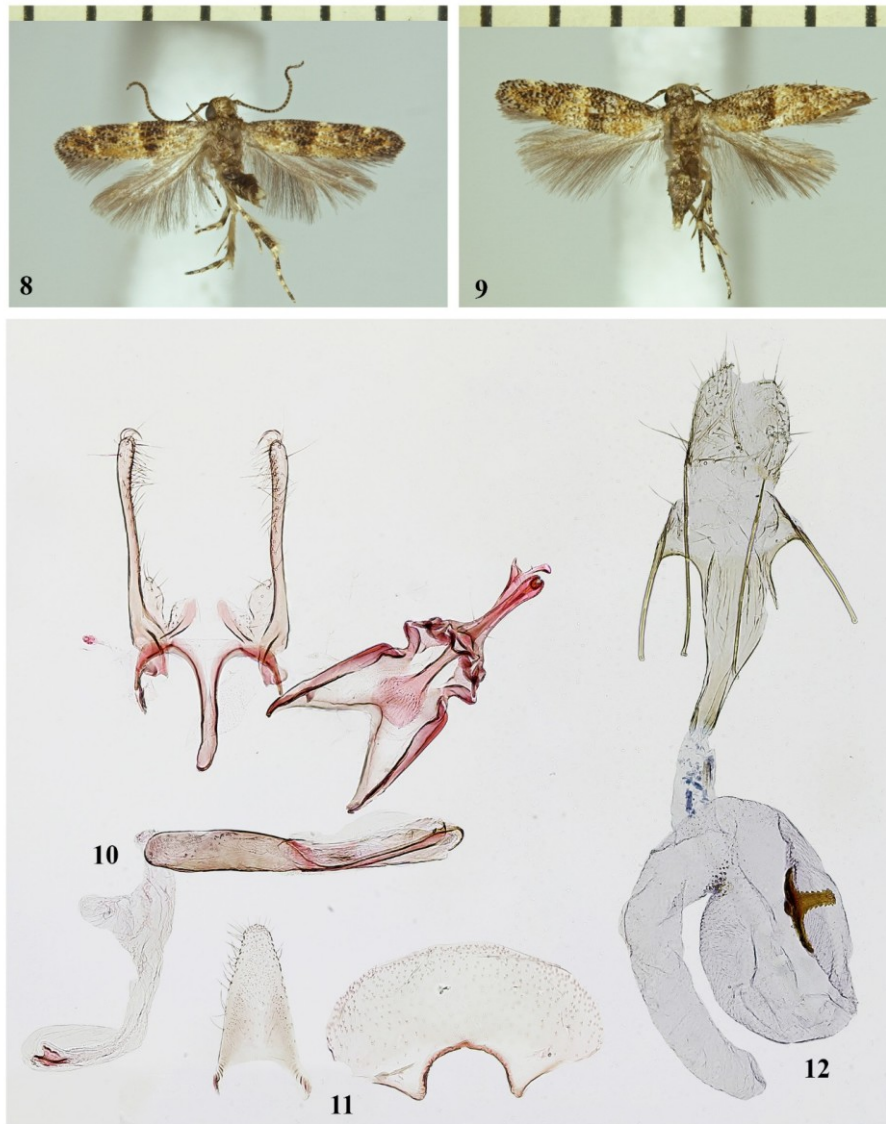
Figs. 8-12

Type material. Holotype ♂, Panama, prov. Herrera, Sarigua NP, 9.ii.2020, mercury (P. Corro, S. Tarakanov, O. Bidzilya) (ZMKU). Paratypes: 8♂, 2♀, same data as for holotype (gen. slide 36/20♂, 46/20♀, 51/20♀, O. Bidzilya) (MIUP, PCMENT, ZMKU).

Diagnosis. *Agnippe tarakanovi* sp. nov. is one of the smallest species of *Agnippe* Chambers, 1872. It is characterized externally by the brown forewing with a darker medial transverse fascia and veins mottled with dark yellow. *Agnippe plumata* (Meyrick, 1917), *A. bicolorella* (Chambers, 1872) and especially *A. omphalopa* (Meyrick, 1917) have a somewhat similar forewing pattern, but they are darker, more uniformly brown with indistinct black markings and without yellow suffusion along the veins. A markedly broadened, rounded ventral lobe of gnathos densely covered with microspines is characteristic of the male genitalia. The Palearctic species of *Agnippe* have trifold rather than rounded ventral lobe of gnathos without short spines (Bidzilya & Li 2010). A rounded gnathos is also present in the genus *Glauce* Chambers, 1875, but in the latter the valva not divided into cucullus and sacculus (Lee & Brown 2008:14). The female genitalia are unmistakably be recognized by the long antrum, accessory sac of the corpus bursae with a cluster of short spines at base, and a characteristic signum with long anterior lobe and very long and narrow medial sclerite.

Description. Adult (Figs. 8-9). Head covered with grey brown-tipped scales, frons white, labial palpus upcurved, segment 2 light grey with diffuse brown medial belt, inner and upper surface white, segment 3 white with brown basal and apical rings, slightly narrower and about 1/2 length of segment 3, acute; scape brown mottled with black, flagellomeres

blackish brown with narrow light-brown rings. Thorax and tegulae brown. Wingspan 5.6-6.0 mm. Forewing blackish brown, veins, subapical area and dorsal margin distinctly mottled with light brown to ochreous and dark yellow, costal margin and apical 1/4 mixed with black, medial black fascia at 1/3-1/2 of costal margin extended towards nearly half length of dorsal margin, diffuse black antemedial irregular patch at 2/3 of costal margin, white costal spot on half length after medial patch, and white elongate streak at 4/5 after postmedial patch, cilia grey. Hindwing and cilia grey. Abdomen greyish black, segments II-V light grey ventrally, segment VIII with white scales posteriorly; tergum VIII in male bean-shaped, posterior margin gradually rounded, anterior margin with distinct triangular processes separated with rounded medial incision; sternum VIII triangular, elongate, twice as long as broad at base, anterior margin broadly emarginate with short, narrow, elongate lateral corners.



Figures 8-12. *Agnippe tarakanovi* sp. nov. 8, 9. Adults. 8. Holotype, male. 9. Paratype, female. 10. Male genitalia (gen. slide 36/20, O. Bidzilya). 11. Male abdominal segment VIII: sternum (left), tergum (right). 12. Female genitalia (gen. slide 51/20, O. Bidzilya).

Male genitalia (Figs. 10-11) with uncus slender, weakly narrowed after half length, apex rounded with narrow medial incision; dorsal lobe of gnathos sickle-shaped with narrow medial process at 3/4, ventral lobe flat, parallel-sided to 2/3 length, distal 1/3 strongly expanded, rounded, densely covered with fine spines, as long as uncus; tegumen weakly narrowed apically, distinctly constricted at 4/5 length, lateral margins with well developed narrow folds, anteromedial emargination triangular, extended to about half length of tegumen and to apex of gnathos; cucullus slender, nearly straight, weakly broadened on

basal and distal portion, apex rounded, covered with long setae after 1/3 length, distinctly extended beyond apex of uncus; sacculus weakly sclerotized, digitate, ventral margin distinctly bent, dorsal margin nearly straight, apex weakly pointed, approximately 1/4-1/5 length of cucullus and slightly broader than its adjacent portion; vinculum narrow, band-shaped; juxta lobes subtriangular, membranous, with strongly sclerotized medial patches, separated by short triangular medial incision, extended to half length of sacculus; saccus narrow, elongate, extended far beyond apex of pedunculus, parallel-sided after 1/4 length, distal 1/4 weakly bent to the left, apex rounded; phallus about as long as cucullus and saccus combined, weakly curved, of even width, distal half with strongly sclerotized filament, apex rounded, strongly edged, ductus ejaculatorius subequal in length to phallus, anterior plate irregularly shaped with distinct narrow medial sclerite.

Female genitalia (Fig. 12) with papillae anales slender, covered with short setae, apophysis posterior slender, straight, twice as long as apophysis anterior, segment VIII about 2.5 times broader as long, weakly sclerotized, unmodified, apophysis anterior 2.5-3 times as long as segment VIII, extended to 2/3 length of antrum, ostium indistinct, antrum well defined, approximately 2/3-3/4 length of ductus bursae, folded along lateral margins, broadened in anterior 2/3, anterior 3/4 of ductus bursae membranous, weakly broadened towards corpus bursae, corpus bursae subovate, accessory bursa broader than ductus bursae, extended beyond anterior apex of corpus bursae, with cluster of short spines near entrance of corpus bursae on left side, signum large, posterior lobe very short, subrectangular, anterior lobe distinctly serrated, medial sclerite narrow, twice as long as anterior lobe.

Biology. Host plant unknown. Adults were collected at mercury-vapor lamp in forested habitats dominated by *Acacia* trees and shrubs during the dry season (Figs. 23, 24).

Distribution. Panama: Herrera Province, Sarigua National Park.

Etymology. The species is named in honor of Sergei Tarakanov, the many-years scientific collaborator of the first author and one of the collectors of this new species, in recognition of his active support during the collecting trip to Herrera, Los Santos and Veraguas Provinces of Panama in February 2020.

***Chionodes sariguaensis* spec. nov.**

Figs. 13-22

Type material. Holotype ♂, Panama, prov. Herrera, Sarigua NP, 9.ii.2020, at light (P. Corro, S. Tarakanov, O. Bidzilya) (ZMKU). Paratypes: Paratypes: 13♂, 15♀, same data as for holotype (gen. slide 36/20♂, 46/20♀, 51/20♀, O. Bidzilya) (MIUP, PCMENT, ZMKU).

Diagnosis. The new species is defined externally by brownish-black forewing with black markings in cell and yellow spots on the costal margin. The hindwing is characterized by presence of black hair-like scales in the basal portion. The male genitalia are distinguished by the long, slender, basally curved cucullus in combination with a very short sacculus and broad phallus with a caecum half as long. The evenly sclerotized segment VIII with lateral folds in combination with a large, rounded antrum, and elongate ductus bursae with comparatively large rounded signum are characteristic for the female genitalia. The slightly sclerotized sternum VIII in the male genitalia as well as membranous connection between apophyses anterior and laterally folded antrum in the female genitalia justify the placement of new species in the formosella species-group (Hodges 1999). Within this group, *C. sariguaensis* seems most closely related to species of the *gilvamaculella*-complex, particularly to *C. emptor* Hodges, 1999. The latter has a similar wing pattern except that the costal spot is white rather than yellow and males have androconial scales extended to 1/3 rather than to 1/2 length of the hindwing. The male genitalia of the new species differ from those of *C. emptor* in the cucullus with a more markedly curved base and longer (extended to half length rather than to base of uncus), the apically rounded rather than gradually narrowed saccus, and the caecum half as long as the phallus (longer than half length of phallus in *C. emptor*). In the female genitalia of *C. sariguaensis* sp. nov., the antrum is rounded rather than narrowed anteriorly, and the signum is rounded with short anterior and posterior protrusions, whereas it is ovate with a single large posterior protrusion in *C. emptor*.

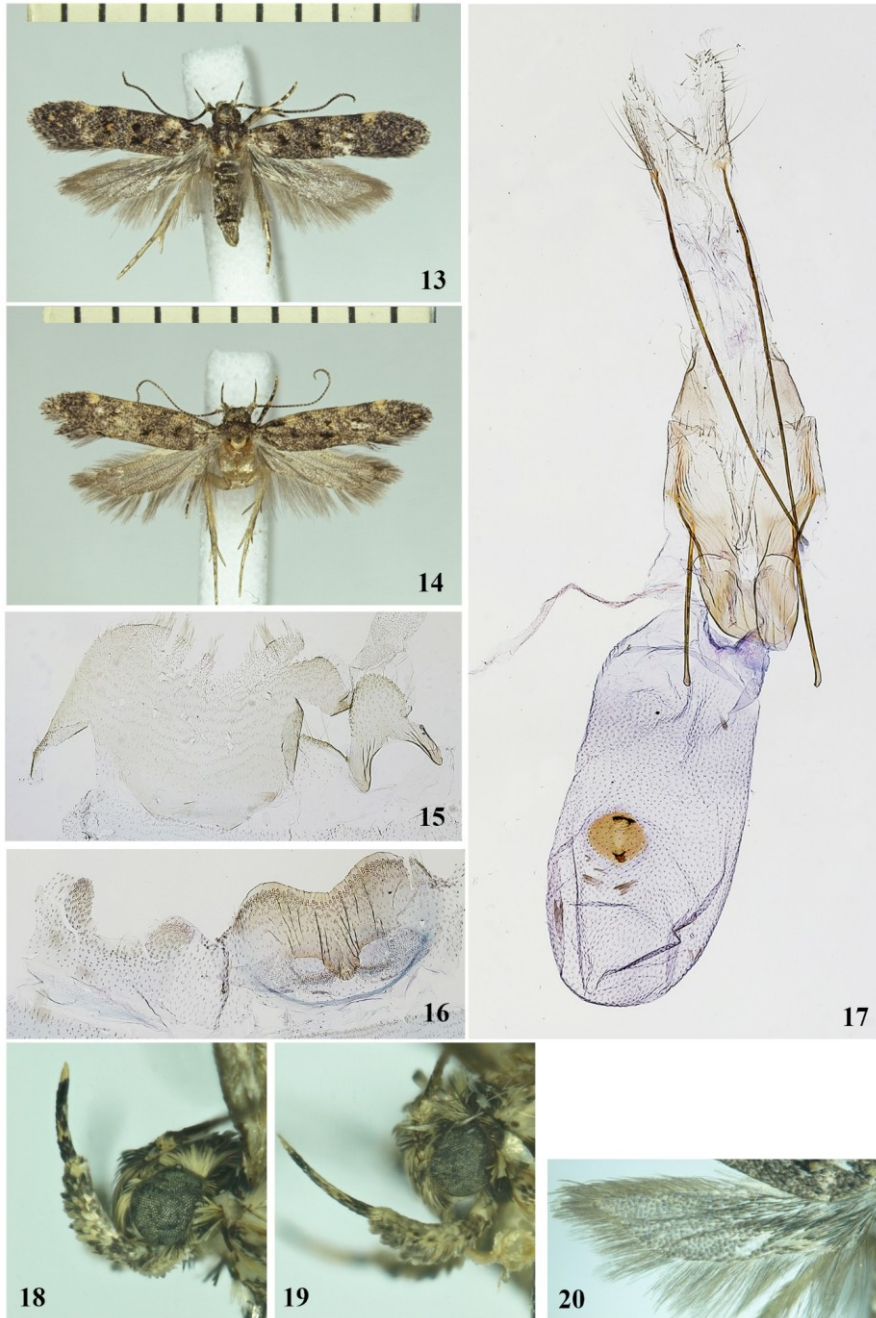
Description. Adult (Figs. 13, 14, 18-20). Head covered with grey black-tipped scales, frons light grey to dirty white, labial palpus upcurved, segment 2 light grey mixed with black- and yellow-tipped scales, diffuse black belt on base and narrow black rings before

yellowish-brown apex, inner and upper surface light grey to white, lower surface with brush of modified blackish-grey scales, segment 3 black with yellow apex and yellow medial ring, about as long and 1/2-1/3 width of segment 2, acute; scape black with light-brown apex, flagellomeres black with very narrow dark brown rings. Thorax and tegulae black. Wingspan 9.7-10.2 mm. Forewing covered with grey black-tipped scales, black spot at 1/4 in mid width, black spot edged with light brown in middle of cell, black spot in fold edged with yellow from both sides near mid length of dorsal margin, and two small black spots on 2/3 in cell corner separated by ochreous scales, four black streaks at 1/5, 1/3, 1/2 and 2/3 of costal margin, diffuse small yellow spot at 1/3 and 1/2 of costal margin, large yellow spot on 3/4 of costa, termen yellow spotted, subcostal veins mottled with yellow in basal half, cilia grey black-tipped. Hindwing dark grey to black with black androconial scales in basal half in male. Abdomen. Tergum VIII in male (Fig. 15) tongue-shaped, about half as long as sternum VIII, apically rounded, anterior margin with deep rounded emargination extended nearly to half length of tergum. Sternum VIII (Fig. 15) subrectangular, posteromedial corners rounded, posterior margin weakly emarginate medially, anterior margin with short triangular medial emargination. Tergum VII in female (Fig. 16) twice broader than long, with rounded posteromedial emargination extended to about half length of tergum VII, anterior margin straight; sternum VII (Fig. 16) bean-shaped, posterior margin with shallow medial emargination, anterior margin gradually rounded, posterior 2/3 distinctly sclerotized and weakly folded in medial 1/3, with short anteromedial lobe extended towards anterior margin.

Male genitalia (Figs. 21, 22) with uncus subrectangular, slightly broadened distally, covered laterally with hair-like setae, posterolateral corners and posterior margin rounded, about 1/2 length of tegumen, distal sclerite of gnathos slender, strongly curved at 1/4, then straight, apex weakly curved, subequal length with uncus; tegumen parallel-sided in distal portion and trapezoidal, weakly narrowed posteriorly in proximal portion, anteromedial emargination triangular, extending to about half length of tegumen, posterolateral corners distinct, triangular; cucullus very slender, strongly curved at 1/6 length, then straight, distal 1/4 curved, acute, slightly exceeding half length of uncus; sacculus very short, approximately 1/9 length of cucullus; vinculum slender, gradually narrowed posteriorly, with distinct transition to a rod saccus, extended far beyond apex of pedunculus; phallus as

long as vinculum plus tegumen and uncus combined, nearly parallel-sided, as broad as width of uncus, rounded apically, vesica with irregular sclerites and patch of numerous spicules, caecum very slender, half as long as phallus, ductus ejaculatorius extended to 2/3-3/4 length of caecum, anterior sclerite of irregular shape.

Female genitalia (Fig. 17) with papillae anales slender, covered base with long setae, apophysis posterior approximately 3 times as long as apophysis anterior, segment VIII subrectangular slightly longer than broad, posterior margin with deep narrow triangular medial emargination extended to about anterior margin, weakly sclerotized, with stronger sclerotized folds along lateral margins extended to anterior margin of antrum, apophysis anterior slightly longer than segment VIII, straight, antrum weakly narrower than segment VIII, rounded, extended to 2/3 length of apophysis anterior; ductus bursae very short, narrow; corpus bursae elongate, 3 times as long as broad, densely covered with small spines except posterior portion, ductus seminalis narrow, connected to anterior margin of corpus bursae on its left side; signum rounded, with paired posterior tooth and one anterior short dentate process.



Figures 13-20. *Chionodes sariguaensis* sp. n. 13, 14. Adults. 13. Holotype, male. 14. Paratype, female (gen. slide 48/20, O. Bidzilya). 15. Male abdominal segment VIII (gen. slide 54/20, O. Bidzilya). 16. Female abdominal segment VII (gen. slide 48/20, O. Bidzilya). 17. Female genitalia (gen. slide 48/20, O. Bidzilya). 18, 19. Head, lateral view. 18. Male. 19. Female. 20. Male left hindwing with black androconial scales.



Figures 21-22. *Chionodes sariguaensis* sp. nov. Male genitalia, paratypes. 21. Ventral view, phallus with vesica everted (gen. slide 54/20, O. Bidzilya). 22. Unrolled aspect (gen. slide 44/20, O. Bidzilya).

Biology. Host plant unknown. Adults were collected at mercury-vapor lamp in forested habitats dominated by *Acacia* trees and shrubs during the dry season (Figs. 23, 24).



Figures 23-24. Sarigua National Park. 23. General view of landscape. 24. Collecting site of *A. tarakanovi* sp. nov. and *C. sariguaensis* sp. nov.

Distribution. Panama, Herrera Province, Sarigua National Park.

Etymology. The specific name is derived from the type locality, Sarigua National Park in Herrera Province.

Acknowledgments

The authors extend their thanks to the Secretaría Nacional de Ciencias y Tecnologías de Panamá (Senacyt) for Ph.D. grant No.002-2015 to PECC and a grant for international mobilization. Thanks are also extended to the Universidad de Panama for support with entomological supplies, optical equipment and lab facilities to conduct this research; to the University of Florida for entomological references. The first author would like to thank Jean-François Landry and the Canacoll Foundation for a supporting grant to visit the Canadian National Collection of Insects, Arachnids and Nematodes. We express our gratitude to Klaus Sattler for providing helpful suggestions on an early version of the manuscript. Jean-François Landry and Peter Huemer provided constructive comments and corrected linguistically the final version. The second author carried out his part of the work on this article in the framework of the implementation of the State Budget Program “Support for the Development of Priority Areas of Scientific Research”, Ukraine (Code: 6541230).

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Capítulo VI

**AN UPDATED AND ANNOTATED CHECKLIST OF THE GELECHIIDAE
(LEPIDOPTERA) OF PANAMÁ**

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CORRO CHANG, P.; O. BIDZILYA; METZ, M.; JF. LANDRY y HEPPNER, JB. 2021. An updated and annotated checklist of the Gelechiidae (Lepidoptera) of Panamá. *Proceedings of the Entomological Society of Washington*, 123(1): 55-74.

Abstract

An updated checklist of the 82 species of Gelechiidae recorded from Panamá is provided, along with type depositories, type localities, records from the literature, and a map of all collecting sites, recent and historical. Eleven species are newly recorded for the country, and for one of these, *Anacamptis phytomiella* Busck, the male genitalia are described for the first time. *Iphimachaera picticollis* (Walsingham, 1912) is transferred to Depressariidae, and therefore is excluded from the list.

Key words: New species, new records, distribution, Neotropical region.

Introduction

Gelechiidae are a family of microlepidoptera with more than 4,500 described species worldwide (Hodges 1998), 855 of which are recorded from the Neotropics (Heppner 1991). Species are morphologically diverse (Figs. 1-9), and the fauna of the Neotropical Region is undersampled and poorly known (Sattler 1996).

The biogeography and systematics of the Lepidoptera of Panamá, including Gelechiidae, are of considerable interest owing to the unique geographic position of this isthmus country, linking the faunas of North and South America. The earliest descriptions of Gelechiidae from Panamá were by Francis Walker (1864) and Philipp Christoph Zeller (1877). Lord Walsingham (1910, 1911), August Busck (1911, 1914), and Edward Meyrick (1914, 1915) also contributed considerably to our knowledge of Panamánian Gelechiidae, describing 58 species and providing several new records for the country. Almost 100 years passed between these early works and more contemporary treatments. Li and Sattler (2012) recorded *Mesophleps adustipennis* (Walsingham, 1897) from Panamá in a World revision of the genus, and Lee and Mercado (2016) provided a preliminary list of the Panamánian Gelechiidae that included 49 species. However, these works combined barely scratch the surface of the rich, Panamanian gelechiid fauna.

Intensive collecting by PECC and JH during the last decade has resulted in samples from several different provinces of Panamá. Recently published taxonomic studies of this material include a review of the pest species of Gnorimoschemini by Corro Chang and Tarakanov (2017) and new species by Heppner and Corro Chang (2017), Corro Chang and Bidzilya (2020) and Corro Chang and Metz (2020). In this work, we report new records of Gelechiidae from several provinces in Panamá. We also provide a synopsis of the 82 species of Panamánian Gelechiidae along with their type localities, type depositories, and records from Panamá. The previous list of Gelechiidae from Panamá (Lee and Mercado 2016) is updated with both new and overlooked records.

Materials and methods

Specimens contributing to new biogeographic knowledge reported in this study were collected according to the methods reported in Corro Chang and Metz (2020) from the Provinces of Panamá, Colón, Herrera, Veraguas, Chiriquí and Los Santos and recorded in the “Materials examined” sections for each species. Specimen vouchers and their depositories are indicated among the list of examined specimens. Dissected specimens were preserved and stored in glycerol vials or in permanent slides. Adult habitus photographs were taken with a Visionary Digital Imaging system, and the genitalia images were captured with a Leica stereoscope M205 A and a phase contrast micro scope Leica DM3000 LED. Dorsal habitus images were edited with GIMP photo-editing software, and the genitalia images were processed with Leica Application Suite (LAS) version 4.12 and edited with Adobe Photoshop 6.0. The distributional map was created in the software GRASS GIS version 7.8.

The depositories of the material are:

ANSP – Academy of Natural Sciences of Drexel University, Philadelphia, USA.

MCZ – Museum of Comparative Zoology, Cambridge, Massachusetts, USA.

MfN – Museum für Naturkunde, Berlin, Germany.

MGCL – McGuire Center for Lepidoptera and Biodiversity, University of Florida, Gainesville, USA.

MIUP – Museo de Invertebrados Graham Bell Fairchild, Universidad de Panamá, Panamá, Rep. Panamá.

NHMUK – Natural History Museum, London, Great Britain.

PCMENT – the Programa Centroamericano de Entomología, Patricia Corro Personal collection, Universidad de Panamá, Panamá, Rep. Panamá.

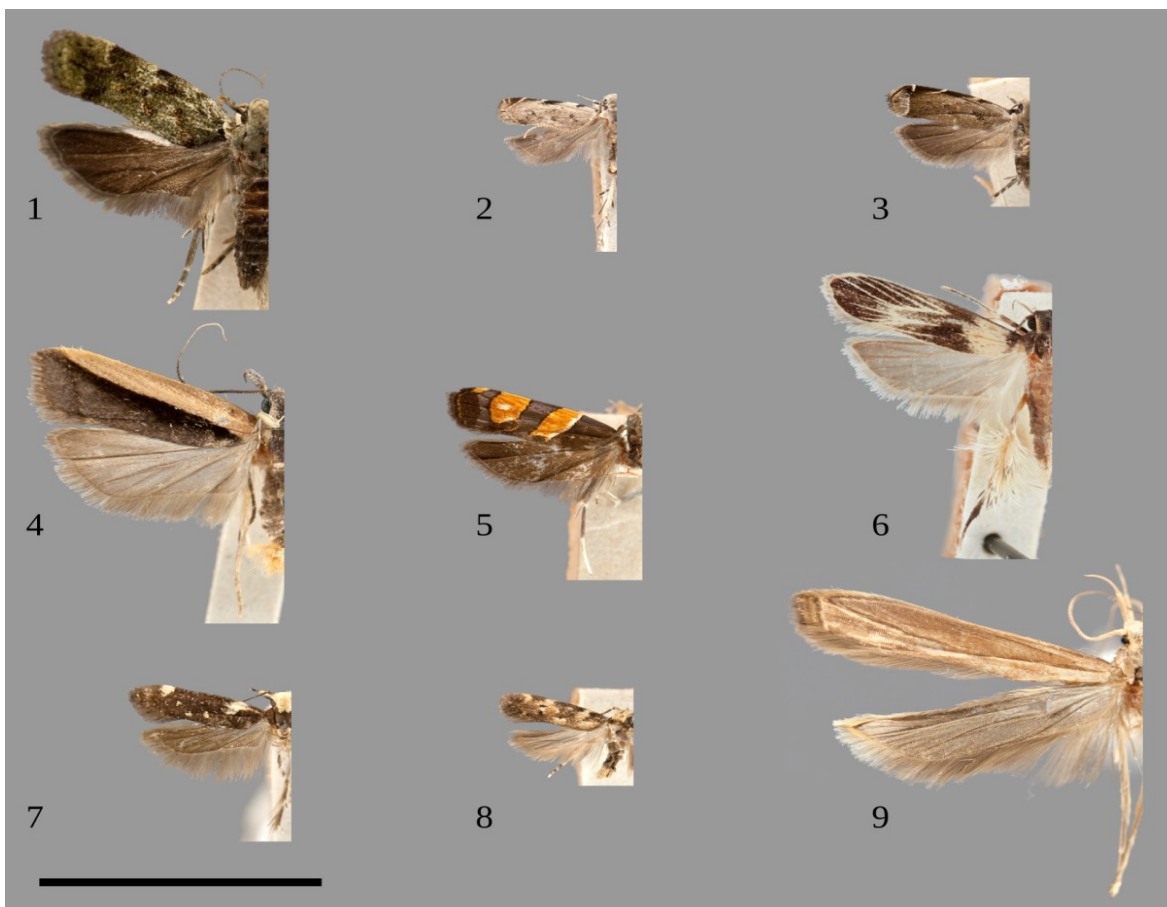
SMNK – Staatliches Museum für Naturkunde Karlsruhe, Germany.

STRI – Smithsonian Tropical Research Institute, Panamá, Rep. Panamá.

USNM – United States National Museum, Washington, USA.

ZMKU – Zoological Museum, Kyiv Taras Shevchenko National University, Kyiv, Ukraine.

We follow the subfamilial classification of Karsholt et al. (2013) and Heikkilä et al. (2014). The sequence of genera within the subfamily Dichomeridinae follows Ponomarenko (2009). Species of the genus *Chionodes* Hübner, 1825 are arranged according to Hodges (1999). Otherwise, genera within tribes, and species within genera are listed alphabetically.



Figures 1-9. Dorsal habitus of some Panamanian Gelechiidae (All described by August Busck). Figs. 1-3 Anacampsinae. Fig. 1, *Anacampsis phytomiella* (holotype, USNMENT00835562). Fig. 2, *Battaristis bistrigella* (holotype of *Anacampsis bistrigella*, USNMENTUSNMENT00834757). Fig. 3, *Battaristis curtella* (holotype of *Anacampsis curtella*, USNMENTUSNMENT00834907). Figs. 4, 5 Dichomeridinae. Fig. 4, *Dichomeris costalis* (holotype, USNMENT00834886). Fig. 5, *Dichomeris luminosa* (holotype, USNMENT00835316). Fig. 6, Pexicopiinae, *Galtica venosa* (holotype, USNMENT00835857). Figs. 7, 8 Gelechiinae. Fig. 7, *Chionodes soronella* (holotype of *Arogalea soronella*, USNMENT00835724). Fig. 8, *Telphusa medulella* (holotype, USNMENT00835349). Fig. 9, Incertae sedis, *Fortinea auriciliella* (holotype, USNMENT00834716).

Results

Iphimachaera picticollis (Walsingham, 1912) was classified in the subfamily Depressariinae (Oecophoridae sensu Becker 1984a) by Becker (1984a) as one of many taxonomic “modifications” in preparation for a checklist of Neotropical microlepidoptera (Becker 1984b). However, the species was still classified as Gelechiidae in the published checklist (Becker 1984b). Lee and Mercado (2016) followed Becker (1984b). We reinstate

the previous assignment of this species to *Depressariinae* in the family *Depressariidae* based on the revised classification of Heikkilä et al. (2014) and remove it from the list of Panamánian *Gelechiidae*.

New Records of *Gelechiidae* from Panama

Subfamily *Anacampsinae* Bruand

Tribe *Anacampsini* Bruand

Anacampsis coverdalella Kearfott

Anacampsis coverdalella Kearfott, 1903:162, pl. 9, f. 13. TL: Natchitoches Parish, Louisiana, USA.

Material examined. 1 ♀, Colón, Sardinilla, Salamanca Lodge, 24.v.2017, UVL (P. Corro and S. Tarakanov) (gen. slide GL2001, P. Corro); 1 ♂, Los Santos, Pedasí, 11.ii.2020, mercury vapor light (P. Corro, S. Tarakanov and O. Bidzilya) (gen. slide GL2002, P. Corro) (all PCMENT).

Host plant. Unknown.

Distribution. USA; Panamá: Colón and Los Santos.

Anacampsis phytomiella Busck

Anacampsis phytomiella Busck, 1914:8; TL: Panamá: Alajuela, Cabima and Portobelo. Records. Busck 1914:8.

Material examined. 2 ♂♂, Gamboa, Pipeline Road, 9.iii.2017, UV Light (P. Corro and S. Tarakanov) (gen. slide GL2003, P. Corro); 2 ♂♂, Parque Nacional Metropolitano, 16.v.2019, Malaise + alcohol (E. Medianero) (all PCMENT).

Host plant. Unknown.

Distribution. Panamá: Alajuela, Gamboa, La Cabima, Ciudad de Panamá (new record), Portobelo.

Remarks. The species was described based on an unspecified number of specimens (“thirty-odd”) from Alajuela, Gamboa, and Portobelo. The specimen labelled “type, No. 15820” from Cabima is considered one of 25 syntypes in the collection of USNM (Brown et al. 2004:112).

Here we describe the male genitalia of this species for the first time.

Male genitalia. (Fig. 10) Uncus elongated, broad in basal $\frac{1}{4}$, then strongly constricted and weakly narrowed apically, posterolateral corners rounded, posterior margin straight, paired patch of modified scales in middle. Arms of gnathos broadened at base, then narrow, curved under at right angle, distal sclerite short, semicircular. Tegumen parallel-sided, slightly longer than uncus, length slightly exceeding width, anteromedial emargination broadly rounded, extending to about $\frac{1}{4}$ length of tegumen. Valva broad at base, then strongly narrowed with very slender medial $\frac{1}{3}$, apical $\frac{1}{3}$ strongly broadened, subtriangular, posterior corner rounded, lateral corner produced into a pointed process, extending beyond base of gnathos. Sacculus broad at base, middle portion narrow, apical $\frac{1}{4}$ distinctly broadened, posterolateral corner rounded, apex narrow, curved inward. Vinculum narrow, band-shaped. Juxta projections elongated, weakly narrowed apically, extending to top of sacculus, densely covered with hairs, especially in distal $\frac{1}{3}$ - $\frac{1}{4}$, forming dense tube around phallus. Saccus very short. Phallus as long as valva, basal $\frac{1}{2}$ ovate, weakly inflated, distal $\frac{1}{2}$ tapered towards pointed apex.

Notes: *Anacamptis phytomiella* is externally rather remarkable. It can be recognized by its dark green forewing mottled with black and brown, black costal patches edged outwardly with white and dark, and a blackish-brown hindwing. Despite a presence of a well-developed sacculus, *A. phytomiella* shares with most species of the genus a characteristic uncus with patches of modified scales, short curved distal sclerite of the gnathos, and a juxta processes forming the tube around the phallus. The generic assignment of the species should be reevaluated in the context of a global revision of *Anacamptis* and related genera (*Compsolechia* Meyrick, 1918; *Battaristis* Meyrick, 1914).



Figure 10. *Anacampsis phytomiella*, male genitalia (gen. slide GL2003, P. Corro).

Compsolechia chrysoplaca (Meyrick)

Anacampsis chrysoplaca Meyrick, 1912:694; TL: Venezuela: Ciudad Bolívar.

Material examined. 2 ♂♂, 1 ♀, Coclé, Chiguirí Arriba, Tavidá, 500 m, 18.i.2017, Skinner (P. Corro and S. Tarakanov) (♂ gen. slide GL2004, ♀ GL2005 P. Corro), 1 ♀, Tortí, 30.vi.2019, light (P. Corro and S. Tarakanov) (PCMENT); 1 ♀, Arraijan, Loma del Río, 8.9407-79.6568, light, 15.v. 2009 (A. Aiello) (STRI).

Host plant. Unknown.

Distribution. Panamá: Coclé, Panamá (first record from Panamá); Venezuela: Ciudad Bolívar (Meyrick 1912).

Remarks. The species was described from a single female holotype from Venezuela. Specimens from Panamá match photographs of the holotype, both externally and in the female genitalia (Clarke 1969a:478, pl. 238, Figs. 4-4b).

Compsolechia salebrosa Meyrick

Compsolechia salebrosa Meyrick, 1918:140; TL: Colombia: Caldas; Guiana: Bartica.

Material examined. 1 ♂, Los Santos, Pedasí, Eco Venao, 10.ii.2020 (P. Corro, S. Tarakanov, and O. Bidzilya) (gen. slide 143/20, O. Bidzilya) (ZMKU).

Host plant. The larva was recorded from the flower buds of *Desmodium incanum* (Fabaceae) in the Galápagos Islands (Landry and Roque-Albelo 2010).

Distribution. Panamá (Los Santos) (first record from Panamá); Colombia; Guiana; and Ecuador (Galápagos) (Landry and Roque-Albelo 2010).

Mesophleps adustipennis (Walsingham)

Lathontogenus adustipennis Walsingham, 1897:88; TL: West Indies: Grenada.

Lipatia crotalariella Busck, 1910:244; TL: Trinidad.

Records. Li and Sattler 2012:28-29.

Material examined. 1 ♂, Coclé, Chiguirí Arriba, Tavidá, 500 m, 18.i.2017, Skinner (P. Corro and S. Tarakanov) (♂ gen. slide GL2005) (PCMENT).

Host plant. The larva of this species bores in seeds and fruits of different Fabaceae (Li and Sattler 2012:28).

Distribution. Southern USA (California, Texas, Mississippi, Florida); Mexico; Honduras; Costa Rica; Cuba; West India; Venezuela; Ecuador (Galápagos); Peru; Brazil (Landry and Roque-Albelo 2010; Li and Sattler 2012:28-29); and Panamá: La Chorrera, Coclé (new record).

Tribe Chelariini Le Marchand

Porpodryas prasinantha Meyrick

Porpodryas prasinantha Meyrick, 1920:305; TL: French Guiana, Maroni River.

Material examined. 1 ♂, Los Santos, Pedasí, Eco Venao, 10.ii.2020 (P. Corro, S. Tarakanov and O. Bidzilya) (gen. slide 57/20, O. Bidzilya) (ZMKU).

Host plant. Unknown.

Distribution. Panamá: Los Santos (first record from Panamá); and French Guiana.

Remarks. The species was described from a single male from French Guiana. The specimen from the Province of Los Santos matches photographs of the holotype, both externally and in the genitalia (Clarke 1969b: pl. 161, Figs. 1-1d).

Anthistarcha geniatella (Busck)

Gelechia geniatella Busck, 1914:13; TL: Panamá: Portobelo, Trinidad R., Alajuela, Paraiso, Corozal.

Records. Busck 1914:13.

Material examined. 7 ♂♂, 8 ♀♀, Prov. Veraguas, Santa Fe, Alto de Piedra, 21.i.2017, mercury vapor light (♂#m gen. slide GL2006, ♀#f gen. slide GL2007, P. Corro) (P. Corro and S. Tarakanov) (PCMENT).

Host plant. Unknown.

Distribution. Panamá: Alajuela, Corozal, Paraiso, Portobelo, Río Trinidad; Veraguas: Alto de Piedra (new record).

Remarks. The species was described from Corozal, Canal Zone, Panamá. Samples from Panamá indicate that it occurs at 900 m in the mountainous regions of the Province of Veraguas.

Subfamily Dichomeridinae Hampson

Helcystogramma adaequata Meyrick

Helcystogramma adaequata Meyrick, 1914:271; TL: Guiana: Mallali.

Material examined. 1 ♀, Veraguas, Parque Nacional Santa Fe, Alto de Piedra, 850 m, No.003 12.vi.2016, mercury vapor light (gen. slide GL2009, P. Corro) (P. Corro and S. Tarakanov); 1 ♀, Veraguas, Parque Nacional Santa Fe, Alto de Piedra, 850 m, No.007, 12.vi.2016, mercury vapor light (P. Corro and S. Tarakanov) (all PCMENT).

Host plant. Unknown.

Distribution. Guiana: Mallali; Panamá: Veraguas (first record from Panamá).

Helcystogramma cornuta (Busck)

Dichomeris cornuta Busck, 1914:20; TL: Panamá: Corozal and Trinidad River.

Records. Busck 1914:20.

Material examined. 1 ♂, Veraguas, Parque Nacional Santa Fe, Alto de Piedra, 1000 m, 13.vi.2016, raised in the lab (♂#m gen. slide GL2008, P. Corro) (P. Corro and S. Tarakanov).

Host plant. The larva of this species was reared from a leaf-roll on *Paullinia costata* (Sapindaceae).

Distribution. Panamá: Coclé (new record), Corozal, Río Trinidad.

Helcystogramma luminosa (Busck)

Dichomeris luminosa Busck, 1914:19; TL: Panamá, Portobelo.

Teuchophanes leucopleura Meyrick, 1914:274; TL: Guiana; Bartica and Mallali.

Records. Busck 1914:19.

Material examined. 1 ♂, Panamá, Darién, Tallo Lodge, Metetí (145 m), 16-20.v.2014 (J.B. Heppner) (MGCL).

Host plant. Unknown.

Distribution. Panamá: Portobelo, Darien (new record).

Dichomeris ligulella Hübner

Dichomeris ligulella Hübner, 1818:25, pl. [25], f. 143-144; TL: USA: Georgia.

Elasmion ligulella Hübner, 1808:6. Unavailable name.

Rhinosia pometella Harris, 1853:349. USA: New England.

Chaetochilus contubernaellus Fitch, 1853:39. TL: USA: Salem, New York.

Chaetochilus malifoliellus Fitch, 1856:463. TL: USA: Salem, New York.

Ypsolophus pauciguttellus Clemens, 1863:123; TL: USA: Easton, Pennsylvania.

Ypsolophus flavivittellus Clemens, 1864:429; TL: USA: Virginia.

Ypsolophus quercipominella Chambers, 1872:222; TL: USA: Kentucky.

Ypsolophus reedella Chambers, 1872:222; TL: USA: Kentucky.

Material examined. 2 ♂♂, 1 ♀, Chiriquí, Cerro Punta Lodge, 2000 m, 31.vii.2016, UV Light (♂ gen. slide GL2010, ♀ gen. slide GL2011, P. Corro) (P. Corro and S. Tarakanov); 3 ♂♂, Chiriquí, Cerro Punta Lodge, 2000 m 1.viii.2016, UV Light (P. Corro and S.

Tarakanov); 2 ♀♀, Coclé, Chiguirí Arriba, Tavidá, 500 m, 18.i.2017, Skinner (P. Corro and S. Tarakanov) (all PCMENT).

Records. Walsingham 1911:92.

Host plant. Larvae feed on a wide range of plants, including *Populus tremuloides*, *P. grandidentata* (Salicaceae), *Tilia americana* (Malvaceae), *Carya* sp. (Juglandaceae), *Quercus alba*, *Q. macrocarpa*, *Q. rubra* (Fagaceae), *Acer saccharum* (Sapindaceae), *Betula papyrifera* (Betulaceae), *Juglans nigra* (Juglandaceae), *Castanea dentata* (Fagaceae), *Vaccinium corymbosum* (Ericaceae), *Oxydendrum arboretum* (Ericaceae), *Hybanthus prunifolius* (Violaceae) and *Rinorea sylvatica* (Violaceae) (Hodges 1986; Aiello and Becker 2004).

Distribution. USA; Mexico; Panamá: Chiriquí, Coclé (new record); Colombia; Brazil; and Jamaica.

Remarks. This species is a defoliator of hardwoods and is considered a pest (USDA, 1979). The larvae are leaf skeletonizers, folding and rolling leaves while feeding.

Subfamily Thiotrichinae Karsholt, Lee, and Kaila

Polyhymno luteostrigella Chambers

Polyhymno luteostrigella Chambers: 247; TL: USA: Texas.

Polyhymno fuscostrigella Chambers: 30; TL: USA: Texas.

Material examined. 1 ♂, Coclé, Chiguirí Arriba, Tavidá, 500 m, 18.i.2017, Skinner (gen. slide GL2012, P. Corro) (P. Corro and S. Tarakanov) (PCMENT).

Host plant. Unknown.

Distribution. USA (Texas); Panamá: Coclé (new record from Panamá).

Thiotricha sciurella (Walsingham)

Polyhymno sciurella Walsingham, 1897:78; TL: USA: Virgin Islands: St. Thomas.

Thiotricha argoxantha Meyrick, 1914:237; TL: British Guiana: Bartica, Georgetown and Mallali.

Material examined. 3 ♂♂, Coclé, Chiguirí Arriba, Tavidá, 18.i.202017, 500 m, Skinner trap (gen. slide GL2013, P. Corro) (P. Corro and S. Tarakanov); 1 ♂, 1 ♀, Colón,

Sardinilla, Salamanca Lodge, 24.v.2017, UV (P. Corro and S.Tarakanov); 1 ♂, Veraguas, Parque Nacional Santa Fe, Alto de Piedra Lodge, 11.vi.2016, 1000 m mercury vapor light (P. Corro and S. Tarakanov); 1 ♂, 2 ♀♀, Veraguas, Parque Nacional Santa Fe, Alto de Piedra Lodge, 14.vi.2016, 1000 m mercury vapor light (♀ gen. slide GL2014, P. Corro) (P. Corro and S. Tarakanov); 3 ♂♂, 5 ♀♀, Veraguas, Parque Nacional Santa Fe, Alto de Piedra Lodge, 21.i.2017, 900 m, mercury vapor light (P. Corro and S. Tarakanov); 5 ♂♂, 1 ♀♀, Gamboa, Pipeline Road, 7-20.v.2017, UV (P. Corro and S. Tarakanov) (all PCMENT); 1 ♂, Los Santos, Pedasí, Eco Venao, 10.ii.2020 (P. Corro, S. Tarakanov and O. Bidzilya) (gen. slide 158/20, O. Bidzilya) (ZMKU).

Host plant. Unknown.

Distribution. USA (Virgin Islands); Brazil; Guiana; Panamá: Los Santos, Coclé, Colón, Veraguas, Panamá. First records from Panamá.

Subfamily Anomologinae Meyrick

Tribe Anomologini Meyrick

Aristotelia barriosi Corro Chang and Bidzilya, 2020

Aristotelia barriosi Corro Chang and Bidzilya, 2020:408, TL: Panamá: Santa Fe NP, Veraguas

Material examined. 5♂, 10♀, Veraguas, P. Nac. Santa Fe, Alto de Piedra Lodge, 900 m, 21.i.2017, Mercury Vapor Light, (♂ gen. slide GL2015, ♀ gen. slide GL2016; ♀ gen. slide GL2017, P. Corro) (P. Corro and S. Tarakanov) (MIUP, PCMENT).

Host plant. Unknown.

Distribution. *Aristotelia barriosi* is known from the Panamánian province of Veraguas.

Remarks. The specimens were collected at altitude of 900 m (Corro Chang and Bidzilya, 2020).

Aristotelia sarcodes Walsingham

Aristotelia sarcodes Walsingham, 1910:26, pl. 1, f. 23; TL: Panamá: Canal Zone (Tabernilla).

Records. Walsingham 1910:26.

Material examined. 2 ♂♂, 1 ♀♀, Colón, Salamanca Lodge, 23.v.2017, UV Light (P. Corro and S. Tarakanov); 1 ♀, Colón, Salamanca Lodge, 24.v.2017, UV Light (P. Corro and S. Tarakanov); 1 ♀, Herrera, Santa María, El Rincón, Cañaveral, 100 m, 17.i.2017, UV Light (P. Corro and S. Tarakanov); 1 ♀, Los Santos, El Ejido, Finca Toño Batista, 16 i.2017, mercury vapor light (P. Corro and S. Tarakanov); 1 ♂, 6 ♀♀, Veraguas, Parque Nacional Santa Fe, Alto de Piedra, 1000 m 14.vi.2016, mercury vapor light (P. Corro and S. Tarakanov); 1 ♀, Ciudad de Panamá, Bella Vista, Calle 44 Este, 8.i.2017, Skinner (P. Corro) (all PCEMENT); 1 ♂, Los Santos, Pedasí, Eco Venao, 10.ii.2020 (P. Corro, S. Tarakanov, and O. Bidzilya) (gen. slide 155/20, O. Bidzilya) (ZMKU).

Host plant. Unknown.

Distribution. Panamá: Ciudad de Panamá, Colón, Herrera, Los Santos, Tabernilla, Veraguas (new records); Ecuador: Isla Galápagos: Floreana, San Cristóbal, Santa Cruz, Seymor Norte (Landry and Roque-Albelo 2010).

Subfamily Gelechiinae Stainton

Tribe Gelechiini Stainton

Agnippe tarakanovi Corro Chang and Bidzilya, 2020

Agnippe tarakanovi Corro Chang and Bidzilya, 2020:410, TL: Panamá: Sarigua, Herrera.

Material examined. 9♂, 2♀, Herrera, Sarigua NP, 9.ii.2020, mercury (P. Corro, S. Tarakanov, O. Bidzilya) (gen. slide 36/20♂, 46/20♀, 51/20♀, O. Bidzilya) (MIUP, PCMENT, ZMKU).

Host plant. Unknown.

Remarks. Adults were collected at mercury-vapor lamp in forested habitats dominated by *Acacia* trees and shrubs during the dry season (Corro Chang and Bidzilya, 2020).

Chionodes abdominella (Busck)

Gelechia abdominella Busck, 1903:862; TL: USA: Phoenix, Arizona.

Material examined. 1 ♀, Coclé, 10.i.2017, skinner (♂#m gen. slide GL2018, P. Corro) (P. Corro and S. Tarakanov); 1 ♂, 1 ♀, Coclé, 18.i.2017, skinner (P. Corro and S. Tarakanov) (all PCMENT).

Host plant. Unknown.

Distribution. USA: Texas, New Mexico, Arizona, California and Nevada; Panamá: Coclé (first records from Panamá).

Chionodes donatella (Walker)

Gelechia donatella Walker, 1864:596; TL: Jamaica.

Material examined. 3 ♂♂, 1 ♀, Los Santos, El Ejido, Finca Toño Batista, 16.i.2017, mercury vapor light (P. Corro and S. Tarakanov). 1 ♂, 1 ♀, Coclé, Chiguirí Arriba, Tavidá, 18.i.2017, skinner (P. Corro and S. Tarakanov) (all PCMENT).

Host plant. Unknown.

Distribution. USA: Florida; Jamaica; Cuba; Panamá: Coclé, Los Santos (first records from Panamá).

Chionodes sariguaensis Corro Chang and Bidzilya, 2020

Chionodes sariguaensis Corro Chang and Bidzilya, 2020:412, TL: Panamá: Sarigua, Herrera.

Material examined. 14♂, 15♀, Herrera, Sarigua NP, 9.ii.2020, at light (P. Corro, S. Tarakanov, O. Bidzilya) (gen. slide 36/20♂, 46/20♀, 51/20♀, O. Bidzilya) (MIUP, PCMENT, ZMKU).

Host plant. Unknown.

Remarks. Adults were collected at mercury-vapor lamp in forested habitats dominated by *Acacia* trees and shrubs during the dry season (Corro Chang and Bidzilya, 2020).

Stegasta zygotoma Meyrick

Stegasta zygotoma Meyrick, 1917:48; TL: Colombia: Cali and La Crumbre; Ecuador: Huigra; Peru: Lima and Chosica.

Material examined. 2 ♀♀, Los Santos, El Ejido, Finca Toño Batista, 16.i.2017, mercury vapor light, (gen. slide GL2019, P. Corro) (P. Corro and S. Tarakanov) (PCMENT).

Host plant. Unknown.

Distribution. Colombia; Ecuador: Galápagos; Peru; Panamá: Los Santos (first records from Panamá).

Tribe Gnorimoschemini Povolný

Phthorimaea absoluta (Meyrick)

Phthorimaea absoluta Meyrick, 1917:45; TL: Peru, Huancayo, 10650 ft.

Records. Corro Chang and Tarakanov 2017:77-84.

Material examined. 3 larvae on tomato, 3 pupae, 10 ♂♂, 4 ♀♀, Chiriquí, Río Guisado, Renacimiento, 10-14.viii.2016, Manual (♀ #f gen. slide GL2022, ♂#m gen. slide GL2000, P. Corro) (P. Corro, S. Tarakanov); 4 larvae feeding on tomato fruits, head capsules, pupae, 3 ♀♀, 1 ♂♂, Chiriquí, Boquete, Alto Dorado, Legufruit, 20-30.ix.2016, Manual (P. Corro, S. Tarakanov); head capsules, pupae, 2 ♀♀, 1 ♂, Ciudad de Panamá, Tumba Muerto, local supermarket, 27.vii.2017 larvae feeding on packed tomato, Manual (P. Corro) (all PCMENT).

Host plant. The larvae feed on solanaceous plants and are a pest on *Solanum lycopersicum* (Solanaceae).

Distribution. Costa Rica; Dominican Republic; Panamá; Chiriquí Río Guisado, Boquete, Panamá (new records); Ecuador; Venezuela; Colombia; Peru; Brazil; Bolivia; Paraguay; Uruguay; Argentina; and Chile. This Neotropical species was introduced to Europe in 2007 (Huemer and Karsholt 2010:206), and is now known from most countries of Africa, the Middle East, and Central and South Asia (CABI 2019).

Phthorimaea operculella (Zeller)

Gelechia terrella Walker, 1864:1024; TL: Moreton Bay.

Gelechia operculella Zeller, 1873:262, pl. 3, f. 17; TL: Texas.

Gelechia tabacella Ragonot, 1879:147; TL: Algeria, Hussein-Dey.

Gelechia piscipellis Zeller, *sensu* Howard, 1897:76; USA: North Carolina.

Phthorimaea argentinae Povolný, 1989:95, TL: Argentina.

Records. Corro Chang and Tarakanov 2017:68-70.

Material examined. 2 ♂♂, Chiriquí, Cerro Punta, No.18, 2000 m, 2.viii.2016, UV Light (gen. slide GL2020, gen. slide GL2021, P. Corro) (P. Corro and S. Tarakanov) (PCMENT).

Host plant. The species feeds on solanaceous plants and is a pest of potato, *Solanum tuberosum* (Solanaceae).

Distribution. This is a cosmopolitan species that is widespread in Panamá; the species has a preference for the agroecosystems in the Province of Chiriquí, at 2000 m.

Keiferia lycopersicella (Walsingham)

Eucatoptus lycopersicella Walsingham, 1897:71; TL: USA: Virgin Islands (St. Croix).

Phthorimaea lenta Meyrick, 1917:41; TL: Peru: Lima.

Records. Corro Chang and Tarakanov 2017:65-68.

Material examined. 7 ♂♂, 13 ♀♀, head capsules, pupae, Los Santos, El Ejido, 16.i.2017, Manual (P. Corro, S. Tarakanov) (PCMENT).

Host plant. The species feeds on solanaceous plants, and it is occasionally a pest of potato and tomato crops.

Distribution. Canada; United States; Mexico; Bermuda; Honduras; El Salvador; Guatemala; Nicaragua; Costa Rica; Panamá: Los Santos (new record); Cuba; Jamaica; Hispaniola; Virgin Islands; Trinidad and Tobago; Ecuador; Venezuela; Colombia; Peru; Guiana; Bolivia; and Oceania: Hawaii (Patterson 2011; EPPO 2017; Plantwise 2017).

Tecia solanivora (Povolný)

Scrobipalopsis solanivora Povolný, 1973:133; TL: Costa Rica: Cartago: Liano Grande.

Records. Corro Chang and Tarakanov 2017:70-76.

Material examined. 16 ♂♂, 6 ♀♀, Chiriquí, Cerro Punta, 2000 m, 31.vii-1.viii.2016, UV light (♂#m gen. slide GL202, P. Corro) (P. Corro and S. Tarakanov); 6 eggs, 15 larvae, head capsules, 2 ♀♀, Chiriquí, Cerro Punta, Finca ANEF, 2000 m, 13.viii.2016, raised on potato (P. Corro and S. Tarakanov) (all PCMENT).

Host plant. This species is a major pest of potato, *Solanum tuberosum* (Solanaceae), in Latin America.

Distribution. North America: Mexico; Central America: Honduras, El Salvador, Guatemala, Nicaragua, Costa Rica, Panamá: Cerro Punta (new record); South America: Ecuador, Venezuela, Colombia. Spain, Canary Islands (CABI 2017; Corro Chang and Tarakanov 2017; EPPO 2017).

Tribe Litini Bruand

Colonanthes korytkowskii Corro Chang

Colonanthes korytkowski Corro Chang, 2020:292 [original misspelling]; TL: Panamá, Albrook.

Material examined. 1 ♀, Veraguas, Santa Fe, Alto de Piedra, 850 m, 11.06.2016, UV-Light, #009, leg. P. Corro and S. Tarakanov. 1 ♂, Veraguas, Santa Fe, Alto de Piedra, 1000 m, 14.06.2016, mercury vapor light, #11, leg. P. Corro and S. Tarakanov. 1 ♀, Veraguas, Santa Fe, Alto de Piedra Lodge, 900 m, 20.01.2017, mercury, leg. P. Corro and S. Tarakanov. 1 ♀, Veraguas, Santa Fe, Alto de Piedra Lodge, 900 m, 20.01.2017, mercury vapor light, #128b, leg. P. Corro and S. Tarakanov. 13 ♂♂, 6 ♀♀, Veraguas, Alto de Piedra Lodge, 900 m, 21.01.2017, mercury vapor light, leg. P. Corro and S. Tarakanov. 4 ♂♂, Coclé, Chiguirí Arriba, Tavidá, 500 m, 18.01.2017, Skinner, leg. P. Corro and S. Tarakanov. 59 ♂♂, 10 ♀♀, Parque Nacional Metropolitano, 16.05-20.06.2019, Malaise Trap, leg. E. Medianero.

Host plant. Unknown.

Distribution. *Colonanthes korytkowskii* is known from the Panamanian provinces of Coclé, Veraguas, and Panamá.

Remarks. Specimens were collected at altitudes ranging from sea level to 1000 m. It occurred in disturbed habitat near the city, habitat dominated by grasses, and in pristine mountainous tropical forest. It was attracted by both UV and mercury vapor light traps in large numbers, however, comparable numbers were collected in malaise traps set for weeks at a time with alcohol receptacles.

Telphusa callitechna Meyrick

Telphusa callitechna Meyrick, 1914:236; TL: Guiana: Bartica and Mallali.

Mompha praefinita Meyrick, 1917:53; TL: French Guiana, R. Maroni.

Material examined. 1 ♂, Veraguas, Alto de Piedra Lodge, 14.vi.2016, MVL (gen. slide GL2023, P. Corro) (P. Corro and S. Tarakanov); 2 ♀♀, Veraguas, Alto de Piedra Lodge, 14.vi.2016, MVL (gen. slide GL2024, P. Corro) (P. Corro and S. Tarakanov) (all PCMENT).

Host plant. Unknown.

Distribution. Guiana, French Guiana, Panamá (first records for Panamá).

Remarks. *Mompha praefinita* was described based on a single female from French Guiana. Clarke (1969a:446, pl. 222, Figs. 1-1c) illustrated the holotype and its genitalia, transferred the species to *Chionodes*, and synonymized it with *Telphusa callitechna* Meyrick, 1914 from Guiana (Clarke 1969b:428, pl. 214, Figs. 1-1b). Two specimens (male and female) examined from the province of Veraguas match *T. callitechna* in all details, both externally and in the genitalia.

Telphusa obligata Busck

Telphusa obligata Busck, 1914:15; TL: Panamá: La Chorrera.

Records. Busck 1914:15.

Material examined. 1 ♀, Los Santos, Pedasí, Eco Venao, 10.ii.2020 (P. Corro, S. Tarakanov and O. Bidzilya) (gen. slide 58/20, O. Bidzilya) (ZMKU).

Host plant. Unknown.

Distribution. Panamá: La Chorrera, Los Santos (new record).

Remarks. The female genitalia of *T. obligata* do not correspond to those of the genus *Telphusa* Chambers, 1872 (Lee and Brown 2008); therefore the generic assignment of the species requires clarification pending the discovering of the male.

Incertae Sedis

Zelosyne poecilosoma Walsingham

Zelosyne poecilosoma Walsingham, 1911:51, f. 13, pl. 2, f. 11; TL: Panamá: Canal Zone, Tabernilla.

Records. Walsingham 1911:51.

Material examined. 1 ♂, Veraguas, Parque Nacional Santa Fe, Alto de Piedra, 1000 m, 20.i.2017, mercury vapor light (P. Corro and S. Tarakanov); 1 ♀, Panamá, Gamboa, Pipeline Road, 13.v.2017, UV Light (gen. slide GL2026, P. Corro) (P. Corro and S. Tarakanov) (all PCMENT); 1 ♂, Los Santos, Pedasí, Eco Venao, 10.ii.2020 (P. Corro, S. Tarakanov and O. Bidzilya) (gen. slide 76/20, O. Bidzilya) (ZMKU).

Host plant. Unknown.

Distribution. Los Santos, Veraguas, Gamboa (new records).

Remarks. The genus *Zelosyne* Walsingham, 1911 currently comprises two species, one known from French Guiana and the other known from Panamá. The systematic position of the genus has not been adequately addressed. Becker (1984a) placed the genus within Gelechiidae among “unplaced genera.” The male genitalia of both species of *Zelosyne* are rather specialized having strongly modified asymmetrical processes of the posterior margin of the vinculum, asymmetrical valvae, and a very long ductus ejaculatorius. The female genitalia are characterized by both pair of apophyses very short, typical for some genera of the tribe Apatetrini (*Chrysoesthia* Hübner, 1825). Further taxonomic studies are required for authoritative placement of this genus into a meaningful suprageneric category.

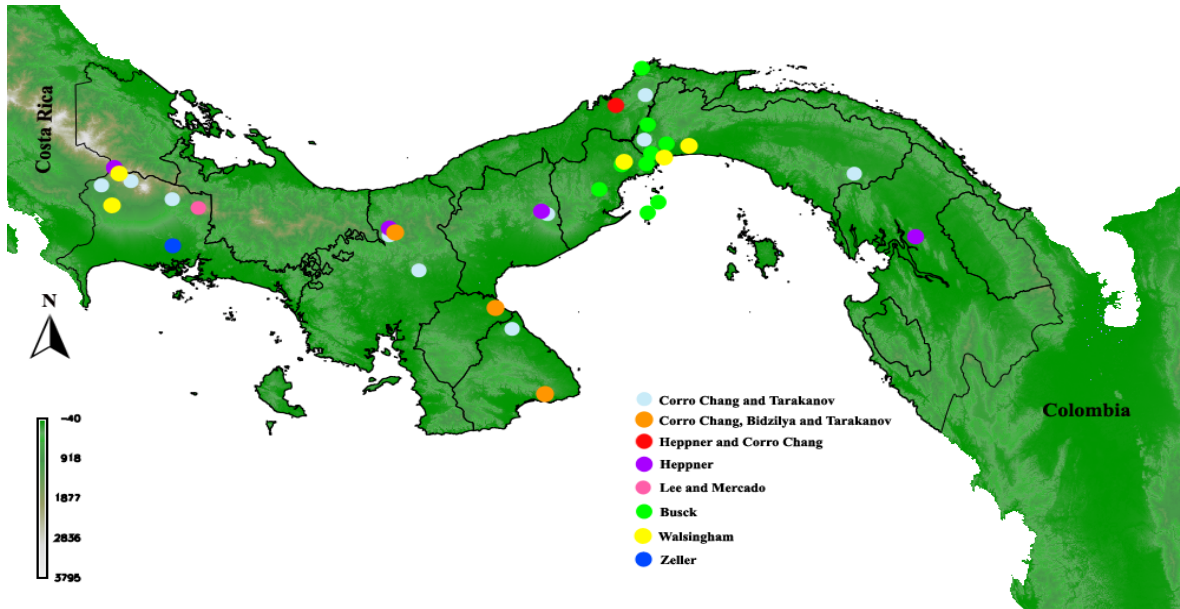


Figure 11. Collecting sites in the Republic of Panamá. Map scale includes the altitudinal gradient in meters above sea level.

Table 1. An annotated checklist of the Gelechiidae of Panamá.

Subfamily, tribe, species	Type locality	Deposition of type	Records from Panamá
Subfamily Anacampsinae			
Tribe Anacampsini			
<i>Anacampsis coverdalella</i> Kearfott, 1903	USA (Louisiana: Natchitoches, Parish)	USNM	First record
<i>Anacampsis lagunculariella</i> Busck, 1900	USA (Florida: Palm Beach)	USNM	Lee and Mercado, 2016 (La Chorrera, Corozal)
<i>Anacampsis phytomiella</i> Busck, 1914	Panamá (Alajuela, La Cabima, Portobelo)	USNM	Busck, 1914 (Alajuela, La Cabima, Portobelo); Lee and Mercado, 2016
<i>Battaristis bistrigella</i> (Busck, 1914)	Panamá (Alajuela)	USNM	Busck, 1914 (Alajuela); Lee and Mercado, 2016 (Alajuela, Cabima)
<i>Battaristis curtella</i> (Busck, 1914)	Panamá (Trinidad River)	USNM	Busck, 1914 (Trinidad River); Lee and Mercado, 2016
<i>Battaristis emissurella</i> (Walker, 1864)	Brazil (Ega)	NHMUK	Busck, 1914 (La Chorrera, Portobelo, Trinidad River); Lee and Mercado, 2016
<i>Battaristis unistrigella</i> (Busck, 1914)	Panamá (Taboga Island)	USNM	Busck, 1914 (Taboga Island); Lee and Mercado, 2016
<i>Belthea picolella</i> Busck, 1914	Panamá (Cabima)	USNM	Busck, 1914 (Cabima); Lee and Mercado, 2016
<i>Besciva longitudinella</i> Busck, 1914	Panamá (Trinidad River)	USNM	Busck, 1914 (Trinidad River); Lee and Mercado, 2016
<i>Charistica walkeri</i> (Walsingham, 1911)	Panamá (Panamá)	NHMUK	Walsingham, 1911 (Panamá); Lee and Mercado, 2016
<i>Commatica falcatella</i> (Walker, 1864)	Brazil (Ega)	NHMUK	Aiello and Becker 2004 (Panamá); Lee and Mercado, 2016 (Panamá)
<i>Commatica cryptina</i> (Walsingham, 1911)	Mexico (Tabasco, Teapa)	NHMUK	Aiello and Becker 2004 (Panamá)
<i>Compsolechia chrysoplaca</i> (Meyrick, 1912)	Venezuela: Ciudad Bolivar	NHMUK	First record
<i>Compsolechia epibola</i> (Walsingham, 1910)	Mexico (Veracruz, Atoyac)	NHMUK	Walsingham, 1910 (Tabernilla)
<i>Compsolechia peculella</i> (Busck, 1914)	Panamá (Canal Zone: Paraíso)	USNM	Busck, 1914 (La Chorrera, Paraíso, Portobelo, Trinidad River); Lee and Mercado, 2016

Table 1. Continue.

Subfamily, tribe, species	Type locality	Deposition of type	Records from Panamá
<i>Compsolechia perlatella</i> (Walker, 1864)	Brazil (Ega)	NHMUK	Aiello 1977 (Panamá; cit. after Adamsky and Boege 2009: 305).
<i>Compsolechia salebrosa</i> Meyrick, 1918	Colombia (Caldas); British Guiana (Bartica)	NHMUK	First record
<i>Compsolechia stelliferella</i> (Walker, 1864)	Brazil (Ega)	NHMUK	Walsingham, 1910 (Chiriquí: Bugaba) (as <i>speciosella</i> Walker, 1864)
<i>Compsolechia suffectella</i> (Walker, 1864)	Brazil (Ega)	NHMUK	Walsingham, 1910 (Tabernilla)
<i>Compsolechia terrenella</i> (Busck, 1914)	Panamá (Colón: Portobelo)	USNM	Busck, 1914 (Portobelo); Lee and Mercado, 2016
<i>Mesophleps adustipennis</i> (Walsingham, 1897)	Grenada	NHMUK	Li and Sattler, 2012 (La Chorrera)
<i>Pavolechia argentea</i> Busck, 1914	Panamá (Trinidad River)	USNM	Busck, 1914 (Trinidad River); Lee and Mercado, 2016
<i>Pavolechia mimetica</i> Heppner and Corro Chang, 2017	Panamá (Colón: Sierra Llorona Lodge, Santa Rita Arriba)	MGCL	Heppner and Corro Chang, 2017 (Colón: Sierra Llorona Lodge, Santa Rita Arriba)
Tribe Chelariini			
<i>Porpodryas prasinantha</i> Meyrick, 1920	French Guiana (Maroni River)	NHMUK	First record
<i>Anthistarcha geniatella</i> (Busck, 1914)	Panamá (Canal Zone: Corozal)	USNM	Busck, 1914 (Canal Zone: Corozal); Lee and Mercado, 2016 (Alajuela, Corozal, Paraíso, Portobelo, Trinidad River)
<i>Haplochela trigonota</i> (Walsingham, 1911)	Mexico (Tabasca: Teapa)	NHMUK	Walsingham, 1911 (La Chorrera)
<i>Hypatima hora</i> (Busck, 1914)	Panamá (Alajuela)	USNM	Busck, 1914 (Alhajuella); Lee and Mercado, 2016
Subfamily Dichomeridinae			
<i>Helcystogramma aedaquata</i> Meyrick, 1914	Guiana (Mallali)	NHMUK	First record
<i>Helcystogramma cornuta</i> (Busck, 1914)	Panamá (Corozal and Trinidad River)	USNM	Busck, 1914 (Corozal, Trinidad River); Lee and Mercado, 2016

Table 1. Continue.

Subfamily, tribe, species	Type locality	Deposition of type	Records from Panamá
<i>Helcystogramma jugata</i> (Walsingham, 1911)	Mexico (Tabasca, Teapa)	NHMUK	Walsingham, 1911 (Volcán de Chiriquí)
<i>Helcystogramma luminosa</i> (Busck, 1914)	Panamá (Panamá: Portobelo)	USNM	Busck, 1914 (Portobelo); Lee and Mercado, 2016
<i>Helcystogramma melissia</i> (Walsingham, 1911)	Panamá (Tabernilla)	USNM	Walsingham, 1911 (Tabernilla); Lee and Mercado, 2016
<i>Helcystogramma perceptella</i> (Busck, 1914)	Panamá (Panamá: La Chorrera and Cabima)	USNM	Busck, 1911 (La Chorrera, Cabima); Lee and Mercado, 2016
<i>Helcystogramma ribbeella</i> Zeller, 1877	Panamá (Chiriquí)	MfN	Zeller, 1877 (Chiriquí); Lee and Mercado, 2016
<i>Helcystogramma stellatella</i> (Busck, 1914)	Panamá (Taboga Island)	USNM	Busck, 1914 (Taboga Island); Lee and Mercado, 2016
<i>Helcystogramma tegulella</i> (Walsingham, 1897)	Grenada (Balthazar)	NHMUK	Walsingham, 1911 (Tabernilla) (as <i>Dichomeris servillis</i>) Walsingham, 1911
<i>Dichomeris auritogata</i> (Walsingham, 1911)	Panamá (Chiriquí: Bugaba)	NHMUK	Walsingham, 1911 (Chiriquí: Bugaba); Lee and Mercado, 2016
<i>Dichomeris cinnamicostella</i> (Zeller, 1877)	Panamá (Chiriquí)	MfN	Zeller, 1877 (Chiriquí); Lee and Mercado, 2016
<i>Dichomeris costalis</i> Busck, 1914	Panamá (Portobelo, Taboguilla Island)	USNM	Busck, 1914 (Portobelo, Taboguilla Island); Lee and Mercado, 2016
<i>Dichomeris evitata</i> Walsingham, 1911	Panamá (Volcán de Chiriquí)	NHMUK	Walsingham, 1911 (Volcán de Chiriquí); Lee and Mercado, 2016
<i>Dichomeris excavata</i> Busck, 1914	Panamá (Portobelo)	USNM	Busck, 1914 (Portobelo); Lee and Mercado, 2016
<i>Dichomeris habrochitona</i> Walsingham, 1911	Panamá (Tabernilla)	USNM	Walsingham, 1911 (Tabernilla); Lee and Mercado, 2016
<i>Dichomeris ligulella</i> Hübner, [1818]	USA (Georgia)	Not traced, lost	Walsingham, 1911 (Volcán de Chiriquí)
<i>Dichomeris mistipalpis</i> (Walsingham, 1911)	Panamá (Tabernilla)	USNM	Walsingham, 1911 (Tabernilla); Lee and Mercado, 2016

Table 1. Continue.

Subfamily, tribe, species	Type locality	Deposition of type	Records from Panamá
<i>Dichomeris nessica</i> Walsingham, 1911	Panamá (La Chorrera)	NHMUK	Walsingham, 1911 (La Chorrera); Lee and Mercado, 2016
<i>Dichomeris punctipennella</i> (Clemens, 1860)	USA (Pennsylvania: Easton)	ANSP	Walsingham, 1911 (Tabernilla)
<i>Dichomeris stignota</i> (Walsingham, 1911)	Panamá (Volcán de Chiriquí)	NHMUK	Walsingham, 1911 (Volcán de Chiriquí)
<i>Dichomeris terracotta</i> (Walsingham, 1911)	Panamá (Volcán de Chiriquí)	NHMUK	Walsingham, 1911 (Volcán de Chiriquí); Lee and Mercado, 2016
<i>Dichomeris tristicta</i> Busck, 1914	Panamá (Trinidad River)	USNM	Busck, 1914 (Trinidad River); Lee and Mercado, 2016
Subfamily Apatetrinae			
Tribe Pexicopiini			
<i>Galtica venosa</i> Busck, 1914	Panamá (Colón: Portobelo)	USNM	Busck, 1914 (Portobelo); Lee and Mercado, 2016
<i>Semophylax apicepuncta</i> (Busck, 1911)	French Guiana; Panamá; Costa Rica	USNM	Busck, 1911 (Panamá)
Subfamily Thiotrichinae			
<i>Polyhymno luteostrigella</i> Chambers, 1874	USA (Texas)	Not traced (Miller and Hodges 1990: 63)	First record
<i>Thiotricha sciurella</i> (Walsingham, 1897)	USA (Virgin Islands: St. Thomas)	NHMUK	First record
Subfamily Anomologinae			
<i>Aristotelia barriosi</i> Corro Chang and Bidzilya, 2020	Panamá (Veraguas, Sta. Fe)	MIUP, PCMENT	Corro Chang and Bidzilya, 2020
<i>Aristotelia sarcodes</i> Walsingham, 1910	Panamá (Tabernilla)	USNM	Walsingham, 1910 (Tabernilla); Lee and Mercado, 2016
Subfamily Gelechiinae			
Tribe Gelechiini			
<i>Agnippe tarakanovi</i> Corro Chang and Bidzilya, 2020	Panamá (Herrera, Sarigua)	MIUP, PCMENT, ZMKU	Corro Chang and Bidzilya, 2020

Table 1. Continue.

Subfamily, tribe, species	Type locality	Deposition of type	Records from Panamá
<i>Chionodes sariguaensis</i> Corro Chang and Bidzilya, 2020	Panamá (Herrera, Sarigua)	MIUP, PCMENT, ZMKU	Corro Chang and Bidzilya, 2020
<i>Chionodes soronella</i> (Busck, 1914)	Panamá (La Chorrera)	USNM	Busck, 1914 (La Chorrera); Lee and Mercado, 2016 (Cabima, La Chorrera)
<i>Chionodes abdominella</i> (Busck, 1903)	USA (Phoenix, Arizona)	USNM	First record
<i>Chionodes mediofuscella</i> (Clemens, 1863)	USA (Easton, Pennsylvania)	ANSP	Walsingham, 1911 (Chiriquí)
<i>Chionodes donatella</i> (Walker, 1864)	Jamaica	NHMUK	First record
<i>Gelechia dolbyi</i> (Walsingham, 1911)	Panamá (La Chorrera)	NHMUK	Walsingham, 1911 (La Chorrera); Lee and Mercado, 2016
<i>Gelechia traducella</i> Busck, 1914	Panamá (La Chorrera)	USNM	Busck, 1914 (La Chorrera); Lee and Mercado, 2016
<i>Parastega chionostigma</i> (Walsingham, 1911)	Panamá (Canal Zone: Tabernilla)	USNM	Walsingham, 1911 (Tabernilla); Lee and Mercado, 2016
<i>Parastega niveisignella</i> (Zeller, 1877)	Panamá (Chiriquí)	MfN	Zeller, 1877 (Chiriquí); Busck, 1914 (Portobelo, Trinidad River and La Chorrera) (as <i>curvatella</i>); Lee and Mercado, 2016
<i>Parastega trichella</i> Busck, 1914	Panamá (Portobelo, Trinidad River)	USNM	Busck, 1914 (Portobelo, Trinidad River); Lee and Mercado, 2016
<i>Stegasta zygotoma</i> Meyrick, 1917	Colombia (Cali and La Crumbre); Ecuador (Huigra); Peru (Lima and Chosica)	NHMUK	First record
Tribe Gnorimoschemini			
<i>Keiferia lycopersicella</i> (Walsingham, 1897)	USA (Virgin Islands: St. Croix)	NHMUK	Corro Chang and Tarakanov, 2017
<i>Phthorimaea impudica</i> Walsingham, 1911	Panamá (Canal Zone and Tabernilla)	USNM	Walsingham, 1911 (Canal Zone, Tabernilla); Lee and Mercado, 2016

Table 1. Continue.

Subfamily, tribe, species	Type locality	Deposition of type	Records from Panamá
<i>Phthorimaea operculella</i> (Zeller, 1873)	USA (Texas)	NHMUK	Corro Chang and Tarakanov, 2017
<i>Tecia solanivora</i> (Povolný, 1973)	Costa Rica (Cartago)	SMNK	Corro Chang and Tarakanov, 2017
<i>Phthorimaea absoluta</i> (Meyrick, 1917)	Peru (Huancayo)	NHMUK	Corro Chang and Tarakanov, 2017
Tribe Litini			
<i>Colanthes korytkowskii</i> (Corro Chang, 2020)	Panamá (Albrook)	MIUP	Corro Chang and Metz, 2020 (Coclé, Veraguas, Panamá)
<i>Comptosaris flavidella</i> (Busck, 1914)	Panamá (Isthmian Canal Zone, Paraíso)	USNM	Busck, 1914 (Isthmian Canal Zone, Paraíso); Lee and Mercado, 2016
<i>Recurvaria putella</i> Busck, 1914	Panamá (La Chorrera, Isthmian Canal Zone, Paraíso)	USNM	Busck, 1914 (La Chorrera, Isthmian Canal Zone, Paraíso); Lee and Mercado, 2016
<i>Tabernillaia ephialtes</i> Walsingham, 1911	Panamá (Tabernilla)	USNM	Walsingham, 1911 (Tabernilla); Lee and Mercado, 2016
<i>Telphusa callitechna</i> Meyrick, 1914	Guiana: Bartica and Mallali	USNM	First record
<i>Telphusa medulella</i> Busck, 1914	Panamá (Portobelo, Trinidad River)	USNM	Busck, 1914 (Portobelo, Trinidad River); Lee and Mercado, 2016
<i>Telphusa obligata</i> Busck, 1914	Panamá (La Chorrera)	USNM	Busck, 1914 (La Chorrera); Lee and Mercado, 2016
Genera incertae sedis			
<i>Eunomarcha violacea</i> (Busck, 1914)	Panamá (Trinidad River)	USNM	Busck, 1914 (Trinidad River); Lee and Mercado, 2016
<i>Fortinea auriciliella</i> Busck, 1914	Panamá (Colón: Portobelo)	USNM	Busck, 1914 (Portobelo); Lee and Mercado, 2016
<i>Zelosyne poecilosoma</i> Walsingham, 1911	Panamá (Tabernilla)	USNM	Walsingham, 1911 (Tabernilla); Lee and Mercado, 2016

Discussion

Eighty-two species of Gelechiidae are documented from Panamá. This number certainly does not reflect the true richness of the family in the country. Widely distributed pests, such

as *Pectinophora gossypiella* (Saunders, 1844) and *Sitotroga cerealella* (Olivier, 1789), are reported from neighboring countries, so their absence in Panamá is probably an artifact of undersampling. Likewise, the number of undescribed taxa is likely large, with comprehensive, revisional treatments absent due to the lack of expertise in the group. Many specimens from the collections of PCMENT, MGCL, and other institutions remain under studied. Most of them need to be reviewed within regional or global revisions of corresponding taxonomic groups with evaluation of broad comparative material and type specimens.

Our current knowledge of type specimens of the Panamánian Gelechiidae is satisfactory, and provides a good foundation on which to continue the study of the biodiversity and taxonomy of Gelechiidae in Panamá. Most of the type-specimens of Gelechiidae described from Panamá are deposited in USNM. Among them are types of 39 taxa described by August Busck and Lord Walsingham, which were catalogued by Brown et al. (2004). Images of the adults of most are available on the website of the Smithsonian Institution (https://www.si.edu/search/collection-images?edan_q=type%20specimens%20Gelechiidae). Most of these type specimens were examined by Ronald Hodges and others experts. As a result, the original generic combinations were changed and many species were re-assigned to other genera. The types of the other 24 species known from Panamá described by Lord Walsingham, Edward Meyrick, and Francis Walker are deposited in NHMUK. Most of them were examined (Clarke 1969a,b; Sattler 1973; Hodges 1986) and their generic assignments were clarified. Most of the other species mentioned from Panamá were reviewed in several publications (Povolný 1967; Becker 1984b; Hodges 1999; Lee et al. 2009; Li and Sattler 2012 and others) and their generic assignments reflect current taxonomic views and opinions.

However, several taxa described from Panamá need revision based on the examination of type specimens or study of additional authoritatively identified material. This is the case for taxa such as *Hypatima hora* (Busck, 1914) (K. Sattler, pers. comm.), *Gelechia traducella* Busck, 1914, *Gelechia dolbyi* (Walsingham, 1911), and *Telphusa meduella* Busck, 1914, which are known from partially destroyed or unique, poorly studied specimens.

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Capítulo VII

**A SURVEY OF MOTHS (LEPIDOPTERA, HETEROCERA) AFFECTING MAJOR
AGRICULTURAL CROPS IN PANAMA**

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Abstract

For years Panamanian agriculture has become unsustainable. As direct impacts are the loss of local biodiversity, pollution, decrease of resources like water and the increment of insect pests putting on risk the crop production of the country. The lack of political will to produce new regulations including migratory controls on the borders, introduction of exotic species and ship transit through the Canal, are some elements that needs particular attention. This preliminary study provides an updated checklist of the moths related to Panamanian agriculture, including their life histories, hostplant records, updates on their distributional patterns and new records across the Americas. Preliminary surveys included interviews with farmers, technical visits to 30 farms with agricultural activity in five provinces of Republica de Panama. I report the incidence of 56 genera, 69 species, 17 families of Lepidoptera (Heterocera) of economic importance and new records inside the country. The poor understanding of pests identity, their impact, and their crop associations are factors that justify this study. As a result of this work, I suggest the establishment of educational activities including environmental education in all scholar levels, intensive monitoring programs in order to detect new outbreaks of pests that appear as a consequence of unsustaible agricultural practices, climate change and the strategic geographic position of the country.

Key words: Agroecosystem, impact, hostplant, climate change, environmental modification, pests, invasive species.

Introduction

INEC (2011) reports that Panama produces around 34 types of crops. Detailed studies made by the Ministerio de Desarrollo Agropecuario (MIDA) reveal that the principal products of Panamanian agriculture are basic grains such as: rice, corn, and different varieties of beans. Crop and cattle production together, constitute at the same time an opportunity to diversify, including additional products such as forage, cacao, guava, annatto, papaya, roots, pepper, and flowers. The provinces of Chiriquí, Veraguas, Los Santos, Herrera and Panama; have

agricultural, ranching, and livestock activities. But the main production comes from Chiriquí, traditionally called “Tierras Altas” or the highlands. The province of Chiriquí has altitudinal gradients between 1,400 and 2,300 m a.s.l., with an annual precipitation of 2,000 mm, and temperatures around 24 and 16°C. This province produces 85% of the vegetables and supplies all of Panama. In contrast, the provinces of Herrera and Los Santos, together called “Tierras Bajas” or the lowlands, produce 5% and 2% of the vegetables, respectively. With altitudinal levels between 10 and 100 m a.s.l., temperatures between 18 and 29°C, irregular annual precipitation that fluctuates from 1,000 to 1,500 mm; it constitutes another environment for the production of vegetables (IICA, 1999; MIDA, 2014). The items with highest demand within the country are tomatoes of varieties “media” and “individual.” The variety “individual” is highly produced in Panama with a production of 290,000 hectares per year, followed by the production of pepper, lettuce and carrot. In the year 2004, the production of vegetables generated 200,705 jobs valued \$2,173,801.30 and provided jobs to populations located in remote areas of the country (MIDA, 2014). During the last decades, effects of climate change, long droughts, and pest pressure have been the main foes to Panamanian agriculture. In addition, the illegal introduction of products through Panamanian borders, exotic plants, immigration and ship transit through the Panama Canal; are elements that promote exotic, invasive species and produce new outbreaks of pests within the country. The need for contingency plans and accurate guides to pest control are elements that justify this preliminary inventory. The aims of this work are: a.) to create a checklist of the main species of moths associated with the annual agriculture of Panama; b.) to provide knowledge about and descriptions of the damage produced by moths in annual crops; c.) to update the taxonomic status of well known pests according to recent classifications, and a taxonomic review of previous works around the world.

Materials and methods

This work was complemented by rearings of biological material under laboratory conditions, following standardized parameters of 12 hours light and 12 hours darkness; between 15°C and 29°C, and 65% humidity including the addition of absorbant paper to reduce moisture inside the rearing chambers. The field work began in June of 2016, and finished in June 2017. The detailed information about collecting sites and coordinates are

shown on Table 1. Our results were complemented with visits to insect collections located in Panama, and the McGuire Lepidoptera Center, University of Florida. Background studies in agriculture and applied entomology in Panama were important to our research, providing fundamental knowledge about the different control techniques that have been used in different areas of Panama. The distributional records in this work were focused on the American Continent. The specimens images were obtained with a digital camera Nikon D5300 integrated in a Macro Stand (Albinar High Load, 28”, Copy Macro Stand with 15.75”x 19” Base). The genitalic dissections of microlepidoptera were performed following Pitkin (1986). The images of genitalic dissections were obtained using a stereomicroscope Leica S9i and arrangements of the plates were in Adobe Photoshop©, version 6.0. The processed genitalia were stored in vials with glycerine. The map was created in Grass GIS version 7.2.2. The specimens raised for this work are deposited in the personal collection of Patricia Corro (PCORRO) at Programa Centroamericano de Entomología, Universidad de Panamá (PCMENT) and duplicates of major pests have been deposited at the Museo de Invertebrados Graham Bell Fairchild (MIUP), Universidad de Panama, República de Panama.

Table 1. Collecting localities in Panama.

Province	Locality and code	Latitude	Longitude	Altitude (m.a.s.l.)	Habitat
Chiriquí	Cerro Punta No. 1	8.8526	-82.57538	1960	Mountainous
Chiriquí	Cerro Punta No. 2	8.84046	-82.5738	2150	Mountainous
Chiriquí	Cerro Punta No. 3	8.8564	-82.58547	1870	Mountainous
Chiriquí	Río Guisado	8.83082	-82.80122	960	Mountainous
Los Santos	Llano Largo	7.91195	-80.36389	28	Eremic
Herrera	Santa Maria	8.11141	-80.64739	10	Xeric
Herrera	Chitré	7.96896	-80.48661	10	Xeric
Herrera	Divisa	8.11279	-80.62408	14	Eremic
Herrera	Santa María, El Rincón	8.12002	-80.5895	8	Eremic
Veraguas	Santa Fé	8.51432	-81.11685	850	Mountainous
Coclé	Churuquita	8.2599	-80.976	110	Humid forest and rocky river
Coclé	Tavidá	8.66829	-80.17234	450	Mountainous

Results

Species account

Family Castniidae (1 Genus, 1 Species)

Genus *Telchin* Hübner, 1825

Telchin licus (Drury, 1773)

Material examined. 4 specimens: Panamá, Prov. Chiriquí, Cerro Punta No.1 [Manual] 31.vii.2016, P. Corro, S. Tarakanov leg. (2 larvae), PCORRO; Panamá, unknown locality, no date of collection, [Manual] C. Korytkowski leg. (1 pupa, 1 female), PCMENT.

Identification. (Fig. 1) Wingspan 30-80 mm; brownish, with greenish shades on the thorax; cream-whitish transverse band and apical spotted band on the forewing. The hindwing is dark brown with a white transverse band.

Hosts. The larvae feed in the stems of monocots, including banana, pineapple, and sugarcane.

Remarks. The species is Neotropical, with records on Central America: Costa Rica, Nicaragua, Panama; Caribbean: Trinidad and Tobago; South America: Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Paraguay, Peru, Suriname, Venezuela (Rodríguez et al., 1999; Ríos and Gonzáles, 2011; Valencia et al., 2014; INATEC, 2016; EPPO, 2017; Plantwise, 2017).



Figure 1. *Telchin licus*. a.) Larva, dorsal habitus. b.) Pupa. c.) Adult, dorsal habitus.

Family Choreutidae (1 Genus, 1 Species)

Genus *Brenthia* Clemens, 1860

Brenthia pavonacella Clemens, 1860

Material examined. 2 specimens: Panamá, Prov. Chiriquí, Río Guisado, [Manual] 2.viii.2016, P. Corro, S. Tarakanov leg. (1 female, 1 male), PCORRO.

Identification. Closer to *B. hibiscusae* externally. Wingspan 7-10 mm. The male genitalia shows a characteristic annellus, while the secondary anterior appendages are present.

Hosts. The larvae skeletonize leaves of Fabaceae.

Remarks. The adults of the species have a particular display of the wing, like a peacock (Aiello and Becker, 2004). It is distributed throughout the USA to Tamaulipas, Mexico (Heppner, 1985), while studies based on genitalic dissections has shown its presence in Panama.

Family Crambidae (13 Genera, 17 Species)

Genus *Compacta* Amsel, 1956

Compacta hirtalis (Guenée, 1854)

Material examined. 7 specimens: Panamá, Prov. Coclé, Churuquita, [Manual] 18-20.i.2017, P. Corro, S. Tarakanov leg. (1 larva, head capsules, pupae, 3 females, 3 males), PCORRO.

Identification. Wingspan 20-27 mm; yellow to creamish. Forewing with a brownish macula, located at the basal portion of the wing. Hindwing with oval, yellowish macula; the marginal portion of the wing is fuscous.

Hosts. It is considered a minor pest of sweet potato, as a borer in the tubers.

Remarks. The distribution includes North America: Mexico, USA; Central America: Costa Rica, Honduras, Panama; South America: Brazil, French Guiana (Saunders et al., 1998; Rodríguez and Solís, 1999; Nuss et al., 2003; Patterson, 2011).

Genus *Diaphania* Hübner, 1818

Diaphania hyalinata (Linnaeus, 1767)

Material examined. 3 specimens: Panamá, Prov. Los Santos [UV Light] 16-17.i.2017, P. Corro, S. Tarakanov leg. (2 females, 1 male), PCORRO.

Identification. Wingspan 21-31 mm. The forewing is whitish with a blackish marginal band. The hindwing is white becoming fuscous internally. The last abdominal segment and coremata are blackish.

Remarks. The species occurs throughout the American continent, being Chile its distributional border including the Caribbean (Saunders et al., 1998; Vargas et al., 1999).

Diaphania indica (Saunders, 1851)

Material examined. 1 specimen: Panamá, Prov. Panamá, no collecting data, (1 female), Saunders det., PCMENT: Pests.

Identification. Externally similar to *D. hyalinata*, but differs on the last three abdominal segments dark brownish. The coremata is whitish with an apical portion of the brush with dark and light brownish shades. Wingspan 13-24 mm. The species differs from *D. hyalinata* based on the female genitalia, the corpus bursa is spherical and it is partially covered with microtrichia.

Remarks. The species is present in the world tropics. The possible origin to this pest is Asia and it is the main problem on export varieties of Cucurbitaceae.

Diaphania nitidalis (Stoll, 1781)

Material examined. 2 specimens: Panama, Prov. Panamá, larvae feeding on cucumber, [Manual] 10-21.iii.2017, P. Corro leg. (head capsules, pupae, 2 females), PCORRO.

Identification. Wingspan 25-30 mm. Externally forewing and hindwing covered with a wide marginal band, brownish, with iridescent shades; discally a wide creamy macula. The coremata is dark brown. The female genitalia is provided with a round corpus bursa followed by a long ductus bursa; antrum is reduced as a sclerotized patch.

Remarks. The species distribution includes the American continent. North America: Canada, United States, Bermuda; Central America: Belize, Costa Rica, Honduras, Nicaragua, Panama; Caribbean: Cuba, Dominica, Guadalupe, Hispaniola, Jamaica, Martinique, Puerto Rico, Saint Kitts and Nevis, Saint Martin, Trinidad and Tobago, Virgin Islands; South America: Argentina, Brazil, Chile, Colombia, French Guiana, Galapagos Islands, Guyana, Paraguay, Peru, Suriname, Venezuela, Uruguay (MNHN, 2003; Patterson, 2011; Landry, 2016; EPPO, 2017; Plantwise, 2017).

Genus *Diatraea* Guilding, 1828

Diatraea lineolata (Walker, 1856)

Material examined. 1 specimen: Panamá, Prov. Herrera, nr. road to El Rincón, Santa María, [UV Light] 17-18.i.2017, P. Corro, S. Tarakanov leg. (1 male), PCORRO.

Identification. Wingspan 20-42 mm. The forewing and hindwing are creamy. Without external characters for the identification; males without brush on the third leg. The identification at species level should include genitalic dissections.

Remarks. The species is distributed throughout the American continent and the Caribbean. There are detailed records in North America: Mexico, USA; Central America: Belize, Costa Rica, Guatemala, Nicaragua, Panama, El Salvador; Caribbean: Bahamas, Cuba, Grenada, Trinidad and Tobago; South America: Colombia, Ecuador, French Guiana, Guyana, Venezuela (CABI, 2017).

Diatraea saccharalis (Fabricius, 1794)

Material examined. 4 specimens: Panamá, Prov. Herrera, nr. road to El Rincón, Santa María, [UV Light] 17-18.i.2017, P. Corro, S. Tarakanov leg. (3 females, 1 male), PCORRO.

Identification. Wingspan 18-28 mm. Similar to *D. tabernella*, but males show a reduced greyish brush on the third leg.

Remarks. The distribution of the species includes the American continent. North America: Mexico, United States; Central America: Belize, Costa Rica, Guatemala, Honduras,

Nicaragua, Panamá, El Salvador; Caribbean: Antigua and Barbuda, Barbados, Cuba, Dominica, Grenada, Guadalupe, Hispaniola, Jamaica, Martinique, Montserrat, Puerto Rico, Saint Kitts and Nevis, Saint Vincent and Grenadines, Saint Lucia, Trinidad and Tobago, Virgin Islands; South America: Argentina, Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Paraguay, Perú, Suriname, Venezuela, Uruguay (CABI, 2017; EPPO, 2017; Plantwise, 2017).

Diatraea tabernella Dyar, 1911

Material examined. 4 specimens: Panamá, Prov. Herrera, nr. road to El Rincón, Santa María, [UV Light] 17-18.i.2017, P. Corro, S. Tarakanov leg. (2 females, 2 males), PCORRO.

Identification. The male has a distinctive dark brush on the third leg.

Remarks. There are records of the species in Colombia, Costa Rica, Honduras, Nicaragua and Panama (Box, 1931; Bleszynski, 1969; Rodríguez et al., 2004; Vargas et al., 2013).

Genus *Herpetogramma* Lederer, 1863

Herpetogramma phaeopteralis (Guenée, 1854)

Material examined. 2 specimens: Panamá, Prov. Panamá, no collecting data, C. Korytkowski leg. (2 females), PCMENT: Pests.

Identification. Wingspan 18-20 mm. Brownish species without external characters. The identification at species level should include genitalic dissections.

Remarks. The presumptive origin of this species is in North America, but it is widespread.

Genus *Maruca* Walker, 1859

Maruca vitrata (Fabricius, 1787)

Material examined. 5 specimens: Panamá, Prov. Herrera, Santa María, [UV Light] 17.i.2017, P. Corro, S. Tarakanov leg. (1 female, 3 males), PCORRO; Panamá, Prov.

Coclé, Tavidá, 450 m, [UV Light], 26-27.vi.2016, P. Corro, S. Tarakanov leg. (1 male), PCORRO.

Identification. Wingspan 18-25 mm. Forewing light brown with small whitish maculae. The hindwing is white; except marginally which is brown.

Remarks. Widespread; with updated records to North America: Mexico; Central America: Belize, Costa Rica, Guatemala, Honduras, Panama, El Salvador; Caribbean: Cuba, Guadalupe, Hispaniola, Jamaica, Puerto Rico, Trinidad and Tobago, Virgin Islands; South America: Argentina, Bolivia, Brazil, Colombia, Ecuador, French Guiana, Galapagos Islands, Guyana, Paraguay, Peru, Suriname, Venezuela, Uruguay (MNHN, 2003; Patterson, 2011; Landry, 2016; EPPO, 2017; Plantwise, 2017).

Genus *Megastes* Guenée, 1854

Megastes grandalis Guenée, 1854

Material examined. 3 specimens: Panamá, Prov. Herrera, Chitré, [Manual] 7.ix.2016, P. Corro, S. Tarakanov leg. (head capsule, pupa, 1 female), PCORRO; Panamá, Prov. Herrera, Chitré, [UV Light], 6-10.ix.2016, P. Corro, S. Tarakanov leg. (2 males), PCORRO.

Identification. Wingspan 28-40 mm. The forewing is light orange with dark brown maculae. The hindwing is whitish with brown margins.

Remarks. There are distributional records for the species in Central America: Costa Rica, Panama; Caribbean: Trinidad and Tobago; South America: Argentina, Brazil, French Guiana, Guyana, Peru and Venezuela (Saunders et al., 1998; EPPO, 2017; Plantwise, 2017).

Genus *Neoleucinodes* Capps, 1948

Neoleucinodes elegantalis (Guenée, 1854)

Material examined. 1 specimen: Panamá, Prov. Chiriquí, Renacimiento, [Manual] 10-14.viii.2016, larva feeding on green tomato, P. Corro, S. Tarakanov leg. (head capsule, pupa, 1 female), PCORRO.

Identification. Wingspan 15-33 mm. The forewing is hyaline whitish, provided with three irregular maculae: one ferruginous at the discus and two dark apical dots. Hindwing white provided with scattered black dots.

Remarks. The species distribution includes North America: Mexico; Central America: Costa Rica, Guatemala, Honduras, Panama; Caribbean: Cuba, Jamaica, Grenada, Puerto Rico, Trinidad and Tobago; South America: Argentina, Brazil, Colombia, Ecuador, Galapagos Island, Guyana, Paraguay, Peru, Suriname, Venezuela, Uruguay (Landry, 2016; EPPO, 2017; Plantwise, 2017).

Genus *Pseudopyrausta* Amsel, 1956

Pseudopyrausta acuntangulalis (Snellen, 1875)

Material examined. 12 specimens: Panamá, Prov. Veraguas, Santiago [Manual] 15.vi.2016, P. Corro, S. Tarakanov leg. (2 larvae, 1 pupa), PCORRO; Panamá, Prov. Coclé, Tavidá, [UV Light] 25-27.vi.2016, P. Corro, S. Tarakanov leg., (4 females, 5 males), PCORRO.

Identification. Wingspan 12-15 mm. The specimen is mostly whitish; provided with brown and yellowish markings in both wings.

Remarks. The distribution of this species includes South America. It was introduced to Hawaii as a biological controller of the species *Lantana cámara* (Verbenaceae).

Genus *Polygrammodes* Guenée, 1854

Polygrammodes elevata (Fabricius, 1794)

Material examined. 8 specimens: Panamá, Prov. Veraguas, Santa Fe, [UV Light] 20-22.i.2017, P. Corro, S. Tarakanov leg. (5 females, 3 males), PCORRO.

Identification. Wingspan 17-27 mm. Forewing and hindwing mostly yellow, covered with scattered purple maculae and golden margins.

Remarks. The distribution of the species includes North America: Mexico, USA; Central America: Costa Rica, Honduras, Nicaragua, Panama; Caribbean: Barbados, Cuba, Guadalupe, Hispaniola, Jamaica, Martinique, Puerto Rico, Saint Vincent; South America:

French Guiana (Gibbs, 1992; Heppner, 1995; Saunders et al., 1998; MNHN, 2003; Nuss et al., 2003; Patterson, 2011; Martínez and Flores, 2014).

Genus *Rhectocraspeda* Warren, 1892

Rhectocraspeda periusalis (Walker, 1859)

Material examined. 3 specimens: Panamá, Prov. Chiriquí, Cerro Punta No. 1, [Manual] 1-2.i.2016, P. Corro, S. Tarakanov leg. (head capsule, pupa, 1 female), PCORRO; Panamá, Prov. Coclé, Tavidá, [UV light] 21-27.vi.2016, P. Corro, S. Tarakanov leg. (2 males), PCORRO.

Identification. Wingspan 18-22 mm. The specimens are brownish with iridescent. The forewing is provided with three transverse bands; two last posterior bands extending to the hindwing. Male genitalia with uncus reduced, bifid; valva oval, pubescent, with spine process extending to the sacculus. Female genitalia with bursa mostly elongated, provided with long appendix adjacent to the antrum. Antrum protuberant, longer than corpus bursae.

Remarks. The distribution of this species includes North America: Mexico, USA; Central America: Costa Rica, Honduras, Panama; Caribbean: Cuba, Hispaniola, Jamaica, Puerto Rico, Trinidad and Tobago, Virgin Islands; South America: Argentina, Brazil, Colombia, Galapagos Islands, Guyana, Peru, Suriname, Venezuela (Patterson, 2011; Hayden et al., 2013; Landry, 2016).

Genus *Rupela* Walker, 1863

Rupela albinella (Stoll, 1781)

Material examined. 35 specimens: Panamá, Prov. Herrera, Parita, Villa Suiza, [UV Light] 5-6.ix.2016, P. Corro, S. Tarakanov leg., (12 females, 1 male), PCORRO; Panamá, Prov. Herrera, El Rincón, Santa María, [UV Light] 6-7.ix.2016, P. Corro, S. Tarakanov leg., (12 females, 10 males), PCORRO.

Identification. Wingspan 19-45 mm. Mostly whitish specimens without external markings; provided with orange to whitish coremata.

Remarks. The species distribution includes the American continent; with detailed records to North America: Mexico; Central America: Costa Rica, Guatemala, Honduras, Nicaragua, Panama; Caribbean: Cuba; South America: Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, Venezuela (Saunders et al., 1998; Savela, 1999; Vera Veas, 2013).

Genus *Salbia* Guenée, 1854

Salbia haemorrhoidalis Guenée, 1854

Material examined. 1 specimen: Panamá, Prov. Panamá, Chepo, no collecting date, C. Korytkowski leg. (1 female), PCMENT: Pests.

Identification. Wingspan 20 mm. Mostly brownish specimens; except for a transverse, white band that extends from the margin of the forewing and continues crossing the hindwing.

Remarks. The species distribution includes records for Central America, the Caribbean and United States. There are records of the caterpillars feeding on *Lantana camara*.

Genus *Spoladea* Guenée, 1854

Spoladea recurvalis (Fabricius, 1775)

Material examined. 4 specimens: Panamá, Prov. Coclé, Churuquita, 18-20.i.2017 [UV Light], P. Corro, S. Tarakanov leg. (2 females), PCORRO; Panamá, Prov. Panamá, Tocumen, Facultad de Agronomía, 22.04.2012 [Manual], P. Corro leg. (2 females), PCMENT: Pests.

Identification. Wingspan 17-23 mm. The specimens are mostly brownish with purple shades. The forewing has two transverse white bands; the first discally crossing the whole wing; the second extending 0.5 of the wing with two adjacent whitish dots. Hindwing with a diagonal white band. Abdomen mostly brown, covered with whitish scales between terga.

Host. The species represents a serious problem to the industry of sweet potato in Nigeria and some authors suggest that it should to be considered in international control programs

(Uwaidem et al., 2018). In Panamá, does not represent a risk to the sweet potato crop, but its presence needs attention.

Remarks. Widespread. The updated distribution of this species include Bermuda, Canada, Mexico, USA; Central America: Costa Rica, Honduras, Panama; Caribbean: Anguilla, Antigua and Barbuda, Bahamas, Barbados, Cuba, Dominica, Grenada, Guadalupe, Hispaniola, Jamaica, Martinique, Montserrat, Puerto Rico, Saint Barthélemy, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and Grenadines, Trinidad and Tobago, Virgin Islands; South America: Brazil, Chile, Colombia, French Guiana, Galapagos Island, Paraguay, Peru, Suriname, Venezuela (MNHN, 2003; Balcázar-Lara, 2004; Patterson, 2011; Landry, 2016; CABI, 2017; Plantwise, 2017).

Family Cosmopterigidae (1 Genus, 1 Species)

Genus *Anatrachyntis* Meyrick, 1915

Anatrachyntis rileyi (Walsingham, 1882)

Material examined. 2 specimens: Panamá, Prov. Coclé, Churuquita, 18-20.i.2017 [UV Light], P. Corro, S. Tarakanov leg. (1 female, 1 male), PCORRO.

Identification. Wingspan 10 mm. Without external characters for the identification at the species level. It is similar to *A. badia*, but females differ in the morphology of the corpus bursa and papilla analles. The first is constricted medially; while the second is bifid in this species. The male has developed, long valvae, densely covered with setae; anellus lobe is blunt apically.

Remarks. The distribution of this species includes North America: Mexico, USA; Central America: Honduras, Panama, El Salvador; Caribbean: Cuba, Hispaniola, Jamaica, Virgin Islands; South America: Ecuador, Venezuela; Europe: England, France, Italy, Spain (Saunders et al., 1998; Garraway et al., 2007; Plantwise, 2017).

Family Erebididae (3 Genera, 3 Species)

Genus *Estigmene* Hope, 1840

Estigmene acrea (Drury, 1773)

Material examined. 2 specimens: Panamá, Prov. Chiriquí, Cerro Punta No.1, [UV Light] 1-2.i.2016, P. Corro, S. Tarakanov leg. (1 female, 1 male), PCORRO.

Identification. Wingspan 35-60 mm. The species is dimorphic. Males have whitish forewing; yellow at the basal area of the hindwing. The female has forewing with black maculae. The abdomen is orange with discal dark spots at each tergum.

Remarks. The species distribution includes Canada, Mexico throughout Central America to Colombia (Saunders et al., 1998; Bendicho-López, 1998).

Genus *Gonodonta* Hübner, 1818

Gonodonta pyrgo (Cramer, 1777)

Material examined. 3 specimens: Panamá, Prov. Veraguas, [Mercury VL] 11-16.vi.2016, P. Corro, S. Tarakanov leg. (3 males), PCORRO.

Identification. Wingspan 19-27 mm. The species of the genus *Gonodonta* are mostly darkish, without external characters for the species identification. It differs from other species in the morphology of the phallus which is straight, with spine cornuti. The female has an elongate, smooth corpus bursa; ductus bursae elongate, sclerotized; antrum sub-triangular, sclerotized.

Remarks. There are specific records of the species occurring in North America: Mexico, United States; Central America: Costa Rica, Guatemala, Honduras, Panama; South America: Bolivia, Brazil, Colombia, Ecuador, Guyana, Paraguay, Peru, Venezuela (Todd, 1959).

Genus *Utetheisa* Hübner, 1819

Utetheisa ornatix (Linnaeus, 1758)

Material examined. 5 specimens: Panamá, Prov. Los Santos, El Ejido, [UV light] 16.i.2017, P. Corro, S. Tarakanov leg., (2 females, 1 male), PCORRO; Panamá, Prov. Panamá,

Tocumen, Facultad de Agronomía, [Manual] 22.04.2012, P. Corro leg. (2 males), PCMENT: Pests.

Identification. Wingspan 43 mm.

Remarks. The species is widespread throughout the Americas.

Family Gelechiidae (4 Genera, 5 Species)

Genus *Keiferia* Busck, 1939

Keiferia lycopersicella (Walsingham, 1897)

Material examined. 20 specimens: Panamá, Prov. Los Santos, El Ejido, [Manual] 16.i.2017, P. Corro, S. Tarakanov leg. (head capsules, pupae, 13 females, 7 males), PCORRO.

Identification. Wingspan 5-12 mm. Mostly cryptic species, hindwing sinuated in both sexes and without external characters for the identification at the species level. The abdominal sclerites are partially melanized. The male genitalia is slender, delicate. Cucullus arms are curved, pubescent. Saccus narrow, with two sets of fusion lines forming a diamond shape, basally. Gnathos circular. Uncus prolonged, sharp at the tip. Culcitula present, reduced. Phallus slender, straight. The female genitalia is weakly sclerotized. Antrum elongated, sclerotized. Corpus bursa smooth, glomerular. Signum rhomboid, sharp tip.

Remarks. The species distribution includes North America: Bermuda, Canada, Mexico, United States; Central America: Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador; Caribbean: Cuba, Hispaniola, Jamaica, Trinidad and Tobago, Virgin Islands; South America: Bolivia, Colombia, Ecuador, Guyana, Peru, Venezuela; Oceania: Hawaii (Patterson, 2011; EPPO, 2017; Plantwise, 2017).

Genus *Phthorimaea* Meyrick, 1902

Phthorimaea absoluta (Meyrick, 1917)

Material examined. 20 specimens: Panamá, Prov. Chiriquí, Río Guisado, Renacimiento, [Manual] 10-14.viii.2016, P. Corro, S. Tarakanov leg. (3 larvae on tomato, 3 pupae, 10 males, 4 females), PCORRO. Panamá, Prov. Chiriquí, Boquete, Alto Dorado, Legufruit,

[Manual] 20-30.ix.2016, P. Corro, S. Tarakanov leg. (4 larvae feeding on tomato fruits, head capsules, pupae, 3 females, 1 male), PCORRO. Panamá, Prov. Panamá, Tumba Muerto, local supermarket, 27.vii.2017 [Manual], larvae feeding on packed tomato, P. Corro leg. (head capsules, pupae, 2 females, 1 male), PCORRO.

Identification. Wingspan 8.5-9 mm. Mostly cryptic species, light to dark grey, hindwing sinuated in both sexes and without external characters for the identification at the species level. The abdominal sclerites are not melanized. The male genitalia is fragile. Cucullus arms spatulated with scattered setae. Culcitula present, reduced. Gnathos circular. Saccus broad, with two sets of fusion lines forming a diamond shape, basally. Aedeagus sclerotized, straight, not modified at the tip. The female genitalia is reduced, delicate. Corpus bursae longer than wide, smooth. Antrum sclerotized, funnel-shaped. Signum elongated, reduced, rhomboid, blunt tipped.

Remarks. This is a neotropical species with distributional records on Central America: Costa Rica, Panama; South America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Venezuela, Uruguay (Barrientos et al., 1998; Botto et al., 2000; Desneux et al., 2010; Desneux et al., 2011; Bloem and Spaltenstein, 2011; Pfeiffer et al., 2013; CABI, 2017; EPPO, 2017; Plantwise, 2017). The species was recently reported in Haiti, putting on the alert Dominican Republic and plant health authorities in Central America (Verheggen and Bertin Fontus, 2019).

Phthorimaea operculella (Zeller, 1873)

Material examined. 13 specimens: Panamá, Prov. Chiriquí, Cerro Punta No. 3, [Manual] 01.viii.2016, P. Corro, S. Tarakanov leg. (head capsules, pupae, 9 females, 4 males), PCORRO.

Identification. Wingspan 10-17 mm. Mostly cryptic species, hindwing sinuated in both sexes and without external characters for the identification at the species level. The abdominal sclerites are melanized. The male genitalia is well developed. Cucullus arms spatulated with scattered setae. Culcitula present and developed. Gnathos circular. Saccus broad, with two sets of fusion lines forming a diamond shape, basally. Phallus is moderately curved. The female genitalia is well developed. Corpus bursa is longer than

wider, smooth. Antrum partially sclerotized, funnel-shaped. Signum reduced, rhomboid, blunt at the tip.

Remarks. Widespread. There are updated distributional records of the species occurring in North America: Bermuda, Mexico, United States; Central America: Costa Rica, Honduras, Panama; Caribbean: Antigua and Barbuda, Cuba, Hispaniola, Jamaica, Puerto Rico, Saint Vincent and Grenadines, Virgin Islands; South America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela (Léon, 1979; Patterson, 2011; EPPO, 2017; Plantwise, 2017).

Genus *Sitotroga* Heinemann, 1870

Sitotroga cerealella (Olivier, 1789)

Material examined. 15 specimens: Panamá, Prov. Herrera, Santa María, El Rincón, [Manual] 17.i.2017, feeding on corn, P. Corro, S. Tarakanov leg. (head capsules, pupae, 8 females, 7 males), PCORRO.

Identification. Wingspan 5-16 mm. Mostly cryptic species, light brown, hindwing sinuated in both sexes and without external characters for the identification at the species level. The male genitalia shows a reduced tongue-shaped saccus; pubescent and modified valvae; apex of the valve has a spine process.

Hosts. The field observations in Panamá has shown that larvae could be feeding on decaying corn crops.

Remarks. Cosmopolitan, with more abundance in warm places and particularly associated with stored products.

Genus *Tecia* Kieffer and Jörgensen, 1910

Tecia solanivora (Povolný, 1973)

Material examined. 70 specimens: Panamá, Prov. Chiriquí, Cerro Punta No. 2, [Manual] 1-30.viii.2016, (6 eggs, 15 larvae, head capsules, 3 pupae, 21 females, 25 males), PCORRO.

Identification. Wingspan 17-21 mm. Mostly cryptic species, light to dark brown, sometimes dark bands, hindwing sinuated in both sexes and without external characters for the identification at the species level. The abdominal sclerites are melanized. The male genitalia is well developed. Cucullus arms spatulated, smooth. Culcitula protuberant. Gnathos developed, spike-shaped. Saccus broad, with two sets of fusion lines forming a diamond shape, basally. Aedeagus straight, not modified apically. The female genitalia is well developed. Corpus bursae smooth, narrow, moderately prolonged. Antrum sclerotized. Signum protuberant, rhomboid, sharped tip.

Remarks. The species distribution includes North America: Mexico; Central America: Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador; South America: Colombia, Ecuador, Venezuela. Spain, Canary Islands (CABI, 2017; EPPO, 2017).

Family Gracillariidae (1 Genus, 1 Species)

Genus *Phyllocnistis* Zeller, 1848

Phyllocnistis citrella Stainton, 1856

Material examined. 2 specimens: Panamá, Prov. Coclé, Churuquita, 18-20.i.2017 [UV Light], P. Corro, S. Tarakanov leg. (1 female, 1 male), PCORRO.

Identification. Wingspan 4 mm. Mostly whitish specimens. The forewing is white with apical yellow shade and black spot. Hindwing reduced as a filament with abundant marginal fringes. The female has an elongated, smooth corpus bursa; 2 elongated signa; ductus bursae long; antrum weakly sclerotized.

Remarks. This species was originally from Asia, while its distribution has become wider. Its introduction throughout the Americas is a result of lacks of an efficient plant protection program.

Family Noctuidae (11 Genera, 18 Species)

Genus *Agrotis* Ochsenheimer, 1816

Agrotis ipsilon (Hufnagel, 1766)

Material examined. 8 specimens: Panamá, Prov. Herrera, Divisa, [Manual] 22.i.2017 (3 larvae, head capsules, pupae, 1 female, 4 males), PCORRO.

Identification. Wingspan 35-55 mm. The forewing is grey with dark maculae, transverse. Hindwing pearl white with greyish margin. The specimens are densely covered with greyish setae.

Remarks. Cosmopolitan; with updated records on North America: Canada, Mexico, Saint Pierre and Miquelon, USA; Central America: Honduras, Nicaragua, Panama; Caribbean: Hispaniola; South America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Peru, Suriname, Uruguay and Venezuela (MNHN, 2003; Lezcano and Hurtado, 2004; Martínez and Flores, 2014; Patterson, 2011; CABI, 2017; Plantwise, 2017).

Genus *Feltia* Walker, 1856

Feltia subterranea (Fabricius, 1794)

Material examined. 11 specimens: Panamá, Prov. Herrera, Divisa, [Manual] 22-23.i.2017 (8 females, 3 males), PCORRO.

Identification. Wingspan 31-43 mm. The forewing is light brown with dark markings. The female has darker coloration and distally could have lighter shades. Hindwing whitish; light brown at the margins.

Remarks. The distribution of this species includes updated records in North America: Mexico, USA; Central America: Costa Rica, Honduras, Nicaragua, Panama; Caribbean: Cuba, Dominica, Guadalupe, Hispaniola, Jamaica, Martinique, Montserrat, Puerto Rico, Saint Kitts and Nevis, Saint Vincent, Virgin Islands; South America: Brazil, Chile, Colombia, Peru, Venezuela (Zagatti et al., 1995; Savela, 1999; Patterson, 2011; Martínez and Flores, 2014).

Genus *Anticarsia* Hübner, 1818

Anticarsia gemmatalis Hübner, 1818

Material examined. 12 specimens: Panamá, Prov. Veraguas, Santa Fe, [MV Light] 11-14.vi.2016, P. Corro, S. Tarakanov leg. (6 females, 6 males), PCORRO.

Identification. Wingspan 26-38 mm. Mostly cryptic. The forewing is variable in color, from brown to dark purple or greyish. Hindwing mostly brownish, with light maculae at the margins.

Remarks. There are active records of the species in North America: Canada, Mexico, USA; Central America: Honduras, Panama; Caribbean: Antigua and Barbuda, Cuba, Dominica, Guadalupe, Hispaniola, Jamaica, Martinique, Montserrat, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and Grenadines, Saint Martin, Virgin Islands; South America: Argentina, Brazil, Chile, Colombia, Ecuador, Suriname, Venezuela (Zagatti et al., 1995; MNHN, 2003; Patterson, 2011; Corro-Chang, 2017; Plantwise, 2017).

Genus *Chloridea* Duncan and Westwood, 1841

Chloridea virescens (Fabricius, 1777)

Material examined. 13 specimens: Panamá, Prov. Los Santos, El Ejido, [Manual] 16.i.2017 (2 larvae, head capsules, pupae, 6 females, 5 males), PCORRO.

Identification. Wingspan 27-35 mm. The forewing is light brown with three bands, oblique. Each band with creamy margins and could be darker on the female. The hindwing is mostly white with dark margins.

Remarks. The distribution of this species includes North America: Bermuda, Canada, Mexico, USA; Central America: Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador; Caribbean: Antigua and Barbuda, Antilles, Bahamas, Barbados, Cayman Islands, Cuba, Dominica, Grenada, Guadalupe, Hispaniola, Jamaica, Martinique, Montserrat, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and Grenadines, Trinidad and Tobago, Virgin Islands; South America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Galapagos Islands, French Guiana, Guyana, Paraguay, Peru, Uruguay, Venezuela; Oceania: Hawaii (Zagatti et al., 1995; Patterson, 2011; EPPO, 2017; Plantwise, 2017).

Genus *Chrysodeixis* Hübner, 1821

Chrysodeixis includens (Walker, 1858)

Material examined. 8 specimens: Panamá, Prov. Herrera, Santa María, El Rincón, 17.i.2017 [Manual], (2 larvae, 2 pupa, 2 females, 2 males), PCORRO.

Identification. Wingspan 29-39 mm. The forewing is light brown, provided with a “Y” marking at the discus. Hindwing light brown. Thorax with a brownish fringe of scales.

Remarks. The distribution of this species includes North America: Bermuda, Canada, Mexico, Saint Pierre and Miquelon, USA; Central America: Costa Rica, Honduras, Nicaragua, Panama; Caribbean: Cuba, Dominica, Guadalupe, Hispaniola, Jamaica, Martinique, Montserrat, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and Grenadines, Saint Barthélemy, Virgin Islands; South America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, French Guiana, Guyana, Peru; Oceania: Australia (Zagatti et al., 1995; Capinera, 2001; MNHN, 2003; Patterson, 2011; Ruíz-Corral et al., 2013; Plantwise, 2017).

Genus *Helicoverpa* Harwick, 1965

Helicoverpa zea (Boddie, 1850)

Material examined. 7 specimens: Panamá, Prov. Herrera, Santa María, [Manual] 17.i.2017, P. Corro, S. Tarakanov leg. (larvae feeding on corn, 4 females, 3 males), PCORRO.

Identification. Wingspan 35-40 mm. The forewing is brown with dark transverse bands. Hindwing light brown with dark margins.

Remarks. The distribution of this species includes North America: Bermuda, Canada, Mexico, Saint Pierre and Miquelon, USA; Central America: Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador; Caribbean: Antigua and Barbuda, Bahamas, Barbados, Cuba, Dominica, Guadalupe, Hispaniola, Jamaica, Martinique, Montserrat, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and Grenadines, Trinidad and Tobago, Virgin Islands; South America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Galapagos Islands, French Guiana, Guyana, Paraguay, Peru, Suriname, Uruguay,

Venezuela; Oceania: Hawaii; Asia: China (Zagatti et al., 1995; Hernández, 2000; MNHN, 2003; Patterson, 2011; EPPO, 2017; Plantwise, 2017).

Genus *Marimatha* Walker, 1866

Marimatha piscimala Ferris and Lafontaine, 2010

Material examined. 8 specimens: Panamá, Prov. Veraguas, Santa Fe, Alto de Piedra [MV Light] 11-14.vi.2016, P. Corro, S. Tarakanov leg. (4 females, 4 males), PCORRO.

Identification. Wingspan 14-20 mm. Mostly yellowish specimens; except for two black discal dots, evanescent transverse band and external margin of the forewing, black. The hindwing is creamy with brown shades apically. In this species the female has an elongated, sub-triangular, smooth corpus bursae; ductus bursae partially sclerotized; antrum sclerotized, sub-triangular.

Remarks. The species distribution includes the USA, the Southwestern to Arizona southward to Panama (Ferris and Lafontaine, 2010). With this work, we confirm the presence of the species in Panama with a new record for the Province of Veraguas.

Marimatha nigrofimbria (Guenée, 1852)

Material examined. 6 specimens: Panamá, Prov. Panamá, Cerro Azul, 13.06.2015, P. Polanco leg. (1 male), PCORRO; Panamá, Prov. Coclé, Tavidá, 21-27.vi.2016 [UV light], P. Corro, S. Tarakanov leg. (3 females, 2 males), PCORRO.

Identification. Wingspan 16-20 mm. Mostly yellowish specimens, except for two black discal dots, the external margin of the forewing is black. Hindwing light brown. In this species the female has an oval corpus bursa; ductus bursae sclerotized; antrum sclerotized, quadrate.

Remarks. The distribution of this species includes the USA, Puerto Rico, Costa Rica, Panama, French Antilles and Argentina (Zagatti et al., 1995; Saunders et al., 1998; Patterson, 2011).

Genus *Mocis* Hübner, 1823

Mocis latipes (Guenée, 1852)

Material examined. 20 specimens: Panamá, Prov. Herrera, Divisa, [Manual] 22.i.2017 (3 larvae, 5 females, 1 male), PCORRO; Panamá, Prov. Los Santos, El Ejido, [UV Light] 16.i.2017 (11 males), PCORRO.

Identification. Wingspan 35-40 mm. Mostly brown specimens. The forewing is brown with dark maculae at the discus. Hindwing light brown. Males with fringe on the hind tibia.

Remarks. The distribution of the species includes North America: Canada, Mexico, USA; Central America: Belize, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador; Caribbean: Antigua and Barbuda, Barbados, Cayman Islands, Cuba, Dominica, Grenada, Guadalupe, Hispaniola, Jamaica, Martinique, Puerto Rico, Saint Martin, Saint Barthélemy, Trinidad and Tobago, Virgin Islands; South America: Argentina, Brazil, Colombia, Ecuador, French Guiana, Guyana, Paraguay, Peru, Venezuela (MNHN, 2003; Patterson, 2011; Plantwise, 2017).

Genus *Mythimna* Ochsenheimer, 1816

Mythimna unipuncta (Haworth, 1809)

Material examined. 3 specimens: Panamá, Prov. Chiriquí, Cerro Punta No. 3, [Manual] 01.viii.2016, P. Corro, S. Tarakanov leg. (3 males), PCORRO.

Identification. Wingspan 30-40 mm. The forewing is ferruginous with brownish maculae, at the discus. Hindwing white with grey shades, marginally.

Remarks. Widespread. An updated distribution of this species includes North America: Canada, Mexico, Saint Pierre and Miquelon, USA; Central America: Costa Rica, Guatemala, Panama; Caribbean: Bahamas, Cuba, Hispaniola, Jamaica, Puerto Rico; South America: Argentina, Bolivia, Brazil, Chile, Colombia, Paraguay, Uruguay, Venezuela (MNHN, 2003; Patterson, 2011; CABI, 2017; Plantwise, 2017).

Genus *Spodoptera* Guenée, 1852

Spodoptera albula (Walker, 1857)

Material examined. 4 specimens: Panamá, Prov. Los Santos, El Ejido, 16.i.2017 [Manual] larva feeding on bell pepper, P. Corro, S. Tarakanov leg. (1 larva, 2 females, 1 male), PCORRO.

Identification. Wingspan 26-27 mm. Mostly cryptic species, similar to *S. eridania* but differs on a posterior black band on the head. The larva has whitish sub-dorsal abdominal maculae. The caterpillars raised in this study; were feeding on green bell peppers.

Remarks. The distribution of the species includes North America: Mexico, USA; Central America: Belize, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador; Caribbean: Antigua and Barbuda, Bahamas, Barbados, Cayman Islands, Cuba, Dominica, Grenada, Guadalupe, Hispaniola, Jamaica, Martinique, Puerto Rico, Saint Lucia, Saint Kitts and Nevis, Saint Barthélemy, Saint Vincent and Grenadines, Virgin Islands; South America: Argentina, Brazil, Chile, Colombia, Ecuador, French Guiana, Guyana, Paraguay, Venezuela (Zagatti et al., 1995; Saunders et al., 1998; Pogue, 2002; Angulo et al., 2008; Montezano et al., 2013).

Spodoptera dolichos (Fabricius, 1794)

Material examined. 100 specimens: Panamá, Prov. Veraguas, Santa Fe, 12.vi.2016 [Manual] P. Corro, S. Tarakanov leg. (45 larvae, 30 pupae, 20 females, 5 males), PCORRO.

Identification. Wingspan 40-50 mm. Mostly greyish, cryptic without external characters. Forewing with orange maculae, distally. Hindwing creamy. Thorax with two dark bands, distally. The larva has two subdorsal markings, black, sub-trapezoidal.

Remarks. The distribution of this species comprise North America: Mexico, USA; Central America: Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador; Caribbean: Bahamas, Cuba, Dominica, Grenada, Guadalupe, Hispaniola, Jamaica, Puerto Rico, Saint Lucia, Saint Vincent and Grenadines, Saint Barthélemy, Trinidad and Tobago, Virgin Islands; throughout South America except Chile (Zagatti et al., 1995; Pogue, 2002; MNHN, 2003; Angulo et al., 2008; Montezano et al., 2015).

Spodoptera eridania (Stoll, 1781)

Material examined. 5 specimens: Panamá, Prov. Veraguas, Santa Fe, [Manual] 14.vi.2016, P. Corro, S. Tarakanov leg. (1 larva, 2 females, 2 males), PCORRO.

Identification. Wingspan 16-20 mm. The forewing is grey with dark maculae at the discus. Hindwing white. The larva has sub-spiracular yellow band, extending anteriorly, without interruption to the first abdominal segment. The head is variable in color, with darkish areas.

Remarks. The distribution of this species includes North America: Bermuda, Mexico, USA; Central America: Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador; Caribbean: Antigua and Barbuda, Bahamas, Barbados, Cuba, Dominica, Grenada, Guadalupe, Hispaniola, Jamaica, Martinique, Puerto Rico, Saint Lucia, Saint Vincent and Grenadines, Trinidad and Tobago; South America: Argentina, Brazil, Ecuador, Chile, Colombia, French Guiana, Galapagos Islands, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela; Europe: Guernsey Bay. In addition, the species has been reported in Africa: Benin, Cameroon, Gibon and Nigeria (Pogue, 2002; Patterson, 2011; CABI, 2017; EPPO, 2017; Plantwise, 2017).

Spodoptera exigua (Hübner, 1808)

Material examined. 13 specimens: Panamá, Prov. Los Santos, El Ejido, [Manual] 16.i.2017, P. Corro, S. Tarakanov leg. (5 larvae, 4 females, 4 males), PCORRO.

Identification. Wingspan 25-30 mm. The forewing is grey; a discal orange macula at the discus. Hindwing white, dark venation.

Remarks. This species has a worldwide distribution except for Antarctica. With this work, we confirm its presence in Panama. This is the only species of the genus *Spodoptera* able to do long migrations and with established populations in countries like Latvia, Sweden, and Finland (Mikkola and Salmensuu, 1965).

Spodoptera cosmioides (Walker, 1858)

Material examined. 3 specimens: Panamá, Prov. Coclé, Tavidá, [Manual] 22.vi.2016, P. Corro, S. Tarakanov leg. (1 larva, head capsules, pupae, 2 females, 2 males), PCORRO.

Identification. Wingspan 40 mm. Dimorphic. Females are light brown; males dark brown. The forewing is brown with white designs. Hindwing whitish.

Remarks. The species distribute throughout Panama to Trinidad and Tobago, including South America to Argentina. The updated records suggest the presence of this species in Central America: Costa Rica and we confirm its presence in Panama with a particular preference to the lowlands of the country; Caribbean: Trinidad and Tobago; South America: Argentina, Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Paraguay, Peru, Venezuela (Pogue, 2002).

Spodoptera frugiperda (Smith, 1797)

Material examined. 20 specimens: Panamá, Prov. Los Santos, El Ejido, [Manual] 16.i.2017, P. Corro, S. Tarakanov leg. (5 larvae, 3 pupae, 6 females, 6 males), PCORRO.

Identification. Wingspan 32-40 mm. The forewing is grey; males have light brown maculae and creamish bands at the discus. Hindwing white.

Remarks. Widespread. An updated distribution of this species comprise North America: Bermuda, Canada, Mexico, USA; Central America: Belize, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador; Caribbean: Anguilla, Antigua and Barbuda, Bahamas, Barbados, Cayman Islands, Cuba, Dominica, Grenada, Guadalupe, Hispaniola, Jamaica, Martinique, Montserrat, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and Grenadines, Trinidad and Tobago, Virgin Islands; South America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, French Guiana, Galapagos Islands, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela (Pogue, 2002; CABI, 2017; EPPO, 2017; Plantwise, 2017).

Spodoptera latifascia (Walker, 1856)

Material examined. 1 specimen: Panamá, Prov. Chiriquí, Cerro Punta No. 1, [UV Light] 1-2.i.2016, P. Corro, S. Tarakanov leg. (1 female), PCORRO.

Identification. Wingspan 40-50 mm. The forewing is mostly grey, with an orange band at the discal area. Females mostly light grey. Hindwing white.

Remarks. The species distribution comprises the Southwest of the USA to Costa Rica, in South America, it is replaced by the sibling species *S. cosmioides* (Zagatti et al., 1995; Pogue, 2002). During our study we have raised one female of this species from the highlands of Panama, detailed distribution throughout the isthmus of Panama is needed to study.

Genus *Trichoplusia* McDunnough, 1944

Trichoplusia ni (Hübner, 1803)

Material examined. 20 specimens: Panamá, Prov. Coclé, Tavidá, [Manual] 21-27.vi.2016, P. Corro, S. Tarakanov leg. (10 larvae, 3 pupae, 4 females, 3 males), PCORRO.

Identification. Wingspan 30-38 mm. The forewing is dark brown, with cream, protuberant maculae at the discus. Hindwing light brown.

Remarks. Widespread. An updated distribution of this species includes North America: Bermuda, Canada, Mexico, USA; Central America: Costa Rica, Nicaragua, Panama, El Salvador; Caribbean: Barbados, Cuba, Hispaniola, Jamaica, Puerto Rico, Saint Barthélemy, Trinidad and Tobago, Virgin Islands; South America: Argentina, Bolivia, Brazil, Chile, Colombia, French Guiana, Uruguay, Venezuela (Léon, 1979; Alonso-Padilla, 1986; MNHN, 2003; Patterson, 2011; Plantwise, 2017).

Family Oecophoridae (Fig. 2; 2 Genera, 2 Species)

Genus *Cerconota* Meyrick, 1915

Cerconota anonella (Sepp, 1830)

Material examined. 25 specimens: Panamá, Prov. Panamá, Capira, “El Caimito”, feeding on soursop, 7-30.vi.2016 [Manual], P. Corro, S. Tarakanov leg. (6 larvae, 12 females, 7 males), PCORRO.

Identification. Wingspan 18-23 mm. The specimens are mostly light brown, except forewing which is white, iridescent, with incrustations of brown scales at the discus and three transverse lines, laterally. Hindwing brown.

Remarks. The distribution of this species includes North America: Mexico; Central America: Costa Rica, Honduras, Panama; Caribbean: Trinidad and Tobago; South America: Brazil, Colombia, Ecuador, French Guiana, Peru, Suriname, Venezuela (Boscán and Godoy, 1989; Peña and Bennett, 1995; Vildozola et al., 1998; Savela, 1999; Coto and Saunders, 2001; Hernández et al., 2013; Hernández et al., 2014).

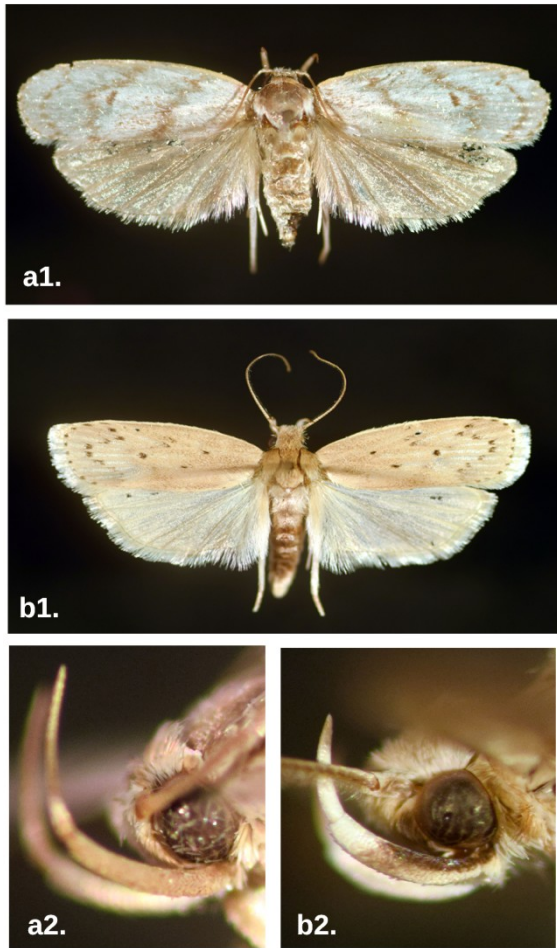


Figure 2. Oecophoridae. a.1-2) *Cerconota anonella*. b.1-2) *Stenoma catenifer*.

Genus *Stenoma* Zeller, 1839

Stenoma catenifer Walsingham, 1912

Material examined. 5 specimens: Panamá, Prov. Panamá, feeding on avocado, 7-20.vi.2016 [Manual], R. Chang leg. (1 larva, 2 females, 2 males), PCORRO.

Identification. Wingspan 27-30 mm. Mostly light brown. The forewing is modified as arch at its coastal margin; with series of dark spots simulating an “S” pattern. Hindwing white with marginal fringe.

Remarks. The distribution of the species include North America: Mexico; Central America: Belize, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador; South America: Argentina, Brazil, Colombia, Guyana, Ecuador, Peru, Venezuela (CABI, 2017; EPPO, 2017; Plantwise, 2017).

Family Plutellidae (1 Genus, 1 Species)

Genus *Plutella* Schrank, 1802

Plutella xylostella (Linnaeus, 1758)

Material examined. 165 specimens: Panamá, Prov. Chiriquí, Cerro Punta No. 2, feeding on cabbage, 1-30.viii.2016 [Manual], P. Corro, S. Tarakanov leg. (20 eggs, 45 larvae, 10 pupae, 38 females, 52 males), PCORRO.

Identification. Wingspan 12-15 mm. The forewing is grey; dorsal macula with rhomboid aspect, creamish and more evident when species are in rest. Hindwing light brown with fringe.

Remarks. Widespread. An updated distribution of this species comprise North America: Bermuda, Canada, Greenland, Mexico, USA; Central America: Belize, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador; Caribbean: Anguila, Antigua and Barbuda, Aruba, Bahamas, Barbados, Cuba, Dominica, Grenada, Guadalupe, Hispaniola, Jamaica, Martinique, Montserrat, Netherlands Antilles, Saint Kitts and Nevis, Saint Lucia, Trinidad and Tobago, Virgin Islands; South America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela (Paez, 2015; CABI, 2017; Plantwise, 2017).

Family Psychidae (1 Genus, 1 Species)

Genus *Oiketicus* Guilding, 1827

Oiketicus kirbyi Guilding, 1827

Material examined. 5 specimens: Panamá, Prov. Panamá, Vista Hermosa, organic garden, [Manual] 17-13.ix.2017, feeding on aromatic herbs “rosemary”, Z. Cheng leg. (2 larvae, 2 females, 1 male), PCORRO.

Identification. Wingspan 40-42 mm (males). The female is neotenic. Both sexes have reduced mouthparts.

Hosts. The larvae are polyphagous exposed feeders of the leaves. There are reports of its serious impacts on oil palm, banana, cacao, coconut, almonds, citrus and eucalyptus. The experience in Panama has suggested that basil is a new host for the species, and in high abundance could represent an incident pest on this crop.

Remarks. The distribution of this species includes North America: Mexico; Central America and South America (Mexzón et al., 2003). Our field experience has confirmed its presence throughout Panamanian isthmus.

Family Pterophoridae (1 Genus, 1 Species)

Genus *Lantanophaga* Zimmerman, 1958

Lantanophaga pusillidactyla (Walker, 1864)

Material examined. 5 specimens: Panamá, Prov. Chiriquí, Cerro Punta No. 2 [UV light] 31.vii.2016, P. Corro, S. Tarakanov leg. (3 females, 2 males), PCORRO.

Identification. Wingspan 8-9 mm.

Remarks. This species has its origin in the Caribbean. Actually, it is widespread and has as main host the species *Lantana camara* (Verbenaceae).

Family Pyralidae (5 Genera, 5 Species)

Genus *Elasmopalpus* Blanchard, 1852

Elasmopalpus lignosellus (Zeller, 1848)

Material examined. 3 specimens: Panamá, Prov. Herrera, nr. road to El Rincón de Santa María [UV Light] 17-18.i.2017, P. Corro, S. Tarakanov leg. (1 larva, 2 males), PCORRO.

Identification. Wingspan 15-25 mm. The forewing is dark brown, with grey margins. Hindwing light grey.

Remarks. The distribution of this species includes North America: Bermuda, Mexico, USA; Central America: Costa Rica, Guatemala, Nicaragua, Panama, El Salvador; Caribbean: Barbados, Cuba, Dominica, Greater Antilles, Hispaniola, Jamaica, Puerto Rico, Trinidad and Tobago, Virgin Islands; South America: Argentina, Bolivia, Brazil, Chile, Colombia, French Guiana, Guyana, Paraguay, Peru, Uruguay, Venezuela; Oceania: Hawaii; Asia: Vietnam (Léon, 1979; Patterson, 2011; CABI, 2017; Plantwise, 2017).

Genus *Etiella* Zeller, 1839

Etiella zinckenella (Treitschke, 1832)

Material examined. 8 specimens: Panamá, Prov. Los Santos, El Ejido, [Manual] 16.i.2017, larvae feeding on “pigeon pea”, P. Corro, S. Tarakanov leg. (3 larvae, 2 pupae, 1 female, 2 males), PCORRO.

Identification. Wingspan 19-27 mm. The forewing is light brown with black, brown and creamy transverse bands. Hindwing light grey, black venation; with modified light scales, as a fringe.

Remarks. The distribution of this species is worldwide.

Genus *Ephestia* Guenée, 1845

Ephestia kuhniella Zeller, 1879

Material examined. 8 specimens: Panamá, Prov. Veraguas, Santa Fé, Alto de Piedra [Manual] 13.vi.2016, P. Corro, S. Tarakanov leg. (1 larva, head capsules, pupae, 2 females, 3 males), PCORRO.

Identification. Wingspan 15-20 mm. The forewing is light brown, with dark brown irrorations. Hindwing white, dark venation.

Hosts. The larvae are borers of the dry cloves of garlic.

Remarks. The species is widely distributed. In our studies, we confirm its presence in Panama affecting stored products, such as stored garlic.

Genus *Galleria* Fabricius, 1798

Galleria mellonella (Linnaeus, 1758)

Material examined. 2 specimens: Panamá, Prov. Veraguas, Santa Fé, Alto de Piedra [UV Light] 20-22.i.2017, P. Corro, S. Tarakanov leg. (1 female, 1 male), PCORRO.

Identification. Wingspan 11-14 mm. The forewing is dark brown. The female is dark grey. Males are light brown with scattered grey scales.

Remarks. This is an introduced species, it is native to Eurasia. This species is the main problem on beehives, causing the "galleriosis disease".

Genus *Hypsipyla* Ragonot, 1888

Hypsipyla grandella (Zeller, 1848)

Material examined. 3 specimens: Panamá, Prov. Coclé, Tavidá, [Manual] 22.vi.2016, P. Corro, S. Tarakanov leg. (1 larva, 1 male), PCORRO; Panamá, Prov. Colón, Sardinia nr. Salamanca [UV Light] 24.v.2017, P. Corro, S. Tarakanov leg. (1 male), PCORRO.

Identification. Wingspan 23-40 mm.

Remarks. This species is native from the Caribbean, while its distribution comprises West Indies, Mexico throughout South America except for Chile.

Family Saturniidae (2 Genera, 2 Species)

Genus *Citheronia* Hübner, 1819

Citheronia bellavista Draudt, 1930

Material examined. 5 specimens: Panamá, Prov. Veraguas, Santa Fe, [MV Light] 11-14.vi.2016, P. Corro, S. Tarakanov leg. (3 females, 2 males), PCORRO.

Identification. Wingspan 100 mm. The forewing is mostly light brown with yellow maculae. Hindwing yellow with dark brown spots near the base. Thorax and abdomen are banded, with orange and yellow scales.

Remarks. The distribution of this species includes Central America: Costa Rica, Nicaragua, Panama; South America: Colombia, Ecuador, Venezuela (Maes, 2004; Maes et al., 2017).

Genus *Rothschildia* Grote, 1896

Rothschildia lebeau (Guérin-Meneville, 1868)

Material examined. 13 specimens: Panamá, Prov. Chiriquí, larva feeding on “butterhead” lettuce, 2.viii.2016, P. Corro, S. Tarakanov leg. (1 larva, 1 cocoon, 2 females, 1 male), PCORRO; Panamá, Prov. Veraguas, Santa Fe, Alto de Piedra, 11-14.vi.2016 [Mercury VL], P. Corro, S. Tarakanov leg. (3 females, 2 males), PCORRO; Panamá, Prov. Coclé, Tavidá, [Mercury VL] 21-27.vi.2016, P. Corro, S. Tarakanov leg. (4 males), PCORRO.

Identification. Wingspan 107.43 mm. Mostly ferruginous except for white and black markings. The forewing with a sub-triangular area, without scales. Hindwing with the sub-triangular area, without scales.

Remarks. The distribution of this species includes the USA throughout South America (Janzen, 1984; Hernández-Chavarria and Sittenfeld, 2004).

Family Sphingidae (4 Genera, 5 Species)

Genus *Agrius* Hübner, 1819

Agrius cingulatus (Fabricius, 1775)

Material examined. 7 specimens: Panamá, Prov. Coclé, Tavidá, 22.vi.2016, P. Corro, S. Tarakanov leg. (4 larvae, head capsules, pupae, 2 females, 1 male), PCORRO.

Identification. Wingspan 80-100 mm. Green specimens. The forewing is green with a coloration pattern that includes light brown, black markings. Hindwing pink at the base, three black, concentric bands. Abdomen pink with dark, transverse bands.

Remarks. This species is widespread, with long migrations it is able to habit Canada throughout Patagonia and Argentina. It has established populations in Africa and West Europe (Bauer and Traub, 1980; Marabuto, 2006; Ballesteros-Mejia et al., 2011; STRI, 2017).

Genus *Erinnyis* Hübner, 1819

Erinnyis alope (Drury, 1770)

Material examined. 3 specimens: Panamá, Prov. Herrera, Santa María, El Rincón, [Manual] 16.i.2017, P. Corro leg. (2 larvae, head capsules, pupae, 1 female, 1 male), PCORRO.

Identification. Wingspan 33-55 mm. Similar to *E. ello*, but differs on the coloration of the forewing; which is brownish. The hindwing is yellow with a dark marginal band.

Remarks. The distribution of this species is widespread throughout the American continent and the Caribbean. This is a new record of the species occurring on the Province of Herrera, Panamá.

Erinnyis ello (Linnaeus, 1758)

Material examined. 4 specimens: Panamá, Prov. Veraguas, Santa Fe, [Manual] 22.i.2017, P. Corro, S. Tarakanov leg. (1 larva, head capsules, 1 pupa, 2 females), PCORRO.

Identification. Wingspan 56-90 mm. The forewing is dark apically, light brown with dark markings. Hindwing light ferruginous.

Remarks. The distribution of this species includes North America: Canada, Mexico, USA; Central America: Belize, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador; Caribbean: Antigua and Barbuda, Bahamas, Barbados, Cayman Islands, Cuba, Dominica, Grenada, Guadalupe, Hispaniola, Jamaica, Martinique, Montserrat, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and Grenadines, Saint Martin, Saint Barthélemy, Trinidad and Tobago, Virgin Islands; South America: Argentina, Bolivia, Brazil, Colombia, Ecuador, French Guiana, Galapagos Islands, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela (MNHN, 2003; EPPO, 2017; Plantwise, 2017).

Genus *Manduca* Hübner, 1807

Manduca sexta (Linnaeus, 1763)

Material examined. 2 specimens: Panamá, Prov. Veraguas, Santa Fe, [UV Light] 20-22.i.2017, P. Corro, S. Tarakanov leg. (1 female, 1 male), PCORRO.

Identification. Wingspan 90-115 mm. The forewing is light brown, with grey markings. Hindwing black with greyish markings. Abdomen mostly black with yellow patches at each margin of terga.

Remarks. The distribution of this species includes North America: Canada, Mexico, USA; Central America: Belize, Costa Rica, Guatemala, Honduras, Nicaragua, Panama; Caribbean: Antigua and Barbuda, Bahamas, Barbados, Cayman Islands, Cuba, Dominica, Grenada, Guadalupe, Hispaniola, Jamaica, Martinique, Montserrat, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and Grenadines, Saint Martin, Saint Barthélemy, Trinidad and Tobago, Virgin Islands; South America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, French Guiana, Galapagos Islands, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela; Oceania: Papua New Guinea (Saunders et al., 1998; MNHN, 2003; EPPO, 2017; Plantwise, 2017).

Genus *Xylophanes* Hübner, 1819

Xylophanes tersa (Linnaeus, 1771)

Material examined. 3 specimens: Panamá, Prov. Azuero, Rincón de Santa María, [Manual] 26.i.2016, P. Corro leg., (1 larva feeding on moringa), PCORRO; Panamá, Prov. Azuero, Rincón de Santa María, 10-17.i.2017, [UV Light], P. Corro, S. Tarakanov leg., (1 female, 1 male), PCORRO.

Identification. Wingspan 57-80 mm. Light brown. The forewing is brown, with thin transverse bands, being light those in the discal area. Hindwing black, with seven yellow, marginal marks, aspect sub-triangular.

Remarks. The distribution of the species includes Canada throughout the American continent to Argentina (Zagatti et al., 1995; Briceño, 2015).

Family Tineidae (2 Genera, 2 Species)

Genus *Opogona* Zeller, 1853

Opogona omoscopa (Meyrick, 1893)

Material examined. 51 specimens: Panamá, Prov. Chiriquí, Cerro Punta No. 2, [UV Light] 31-2.viii.2017, P. Corro, S. Tarakanov leg., (21 females, 30 males), PCORRO.

Identification. Wingspan 15-21 mm. Uniformly dark fuscous specimens. Without external characters for the identification at the species level.

Remarks. The species was originally described from Australia. The current distribution includes tropical and subtropical regions of the world. The larvae appear to be little economic significance feeding on dead and decaying plant material, cork, sugarcane, decaying stems of cucumber, amaranthus and eucalyptus (Davis, 1978).

Genus *Phaeoses* Forbes, 1922

Phaeoses sabinella Forbes, 1922

Material examined. 113 specimens: Prov. Los Santos, El Ejido, [UV Light] 16.i.2017, P. Corro, S. Tarakanov leg., (23 males), PCORRO. Panamá, Prov. Herrera, Santa María, El Rincón, 100 m, [UV Light] 15-17.i.2017, P. Corro, S. Tarakanov leg., (64 females, 20 males), PCORRO. Panamá, Panamá, Prov. Colón, Sardinia nr. road to Salamanca, [UV Light] 24.v.2017, P. Corro, S. Tarakanov leg. (3 females, 3 males), PCORRO.

Identification. Wingspan 6-10 mm. Pale, uniformly light brown specimens. Without external characters for the identification at the species level.

Remarks. This species is widespread throughout the Panamanian isthmus, with a particular preference to the lowlands of Panama where it was highly abundant. The species have a preference to moist habitats, adjacent to rivers and estuaries. The larvae are general scavengers feeding on dead and decaying plant material (Davis, 1978).

Family Tortricidae (3 Genera, 3 Species)

Genus *Crociosema* Zeller, 1847

Crociosema aporema (Walsingham, 1914)

Material examined. 20 specimens: Panamá, Prov. Veraguas, Santa Fe, Alto de Piedra [Manual] 21-22.i.2017, P. Corro, S. Tarakanov leg. (6 larvae, 4 pupae, 6 females, 4 male), PCORRO.

Identification. Wingspan 9-10 mm. The forewing is light brown. Hindwing grey.

Remarks. The updated distributional records to this species comprise North America: Mexico, USA; Central America: Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador; Caribbean: Grenada, Hispaniola, Jamaica; South America: Argentina, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Uruguay, Venezuela (Saunders et al., 1998; Horas, 2009; Gilligan and Passoa, 2014; Plantwise, 2017).

Genus *Ecdytolopha* Zeller, 1875

Ecdytolopha fabivora (Meyrick, 1928)

Material examined. 6 specimens: Panamá, Prov. Veraguas, Santa Fe, Alto de Piedra, [Manual] 20-22.i.2017, P. Corro, S. Tarakanov leg. (1 larva, 1 female, 4 males), PCORRO.

Identification. Wingspan 12-15 mm. The forewing is dark brown. Hindwing light brown. The male genitalia has sub-triangular cucullus, with a spine. Female genitalia with ductus bursae partially sclerotized; signa modified as two spine processes.

Remarks. This is a widespread species, with important incidence throughout Central America and South America (Gilligan and Epstein, 2014).

Genus *Platynota* Clemens, 1860

Platynota rostrana (Walker, 1863)

Material examined. 13 specimens: Panamá, Prov. Los Santos, El Ejido, [UV Light] 16.i.2017, P. Corro, S. Tarakanov leg., (5 females, 6 males), PCORRO; Panamá, Prov.

Coclé, Penonomé, Chiguirí Arriba, Tavidá, 450 m, [UV Light] 21-27.vi.2016, P. Corro, S. Tarakanov leg., (1 female, 1 male), PCORRO.

Identification. Wingspan 20-22 mm. The forewing is light brown, reticulated. Hindwing light orange.

Remarks. The distribution of this species includes North America: Mexico, USA; Central America: Guatemala, Honduras, Nicaragua, Panama; Caribbean: Cuba, Grenada, Hispaniola, Jamaica, Puerto Rico, Saint Lucia, Trinidad and Tobago; South America: Brazil, Colombia, Venezuela; Europe: Portugal, United Kingdom (Heppner and Habeck, 1976; Moron and Terron, 1988; Maes, 2004; Nava et al., 2006; NPPO, 2014).

Discussion

We report a total of 69 species, 56 genera, and 17 families of Lepidoptera (Heterocera) of economic importance, affecting major crops of Panamá. The presence of these species has also an important impact on Central American crops, and with this work, we confirm their presence on Panamanian territory. The biological observations obtained from the rearings; suggest that caterpillars predominant feeding habits include: borers, leaf miners, and exposed feeders (Fig. 3). At least 96% of the species were polyphagous, while 4% of the species prefer a specific hostplant. The three families with highest impacts on mayor crops are the family Crambidae represented by 17 species and 13 genera; Pyralidae, represented by 5 species and 5 genera; Noctuidae with 18 species in 11 genera; and Gelechiidae with 5 species and 5 genera. Five plant families serve as main hosts: Poaceae perhaps hosts 13% of the families of moths reported in this study, Solanaceae and Fabaceae (each host 9% of the families), Brassicaceae (6%) and Cucurbitaceae (5%). In Table 2, its summarized the major crops of Panama and moths associated within.

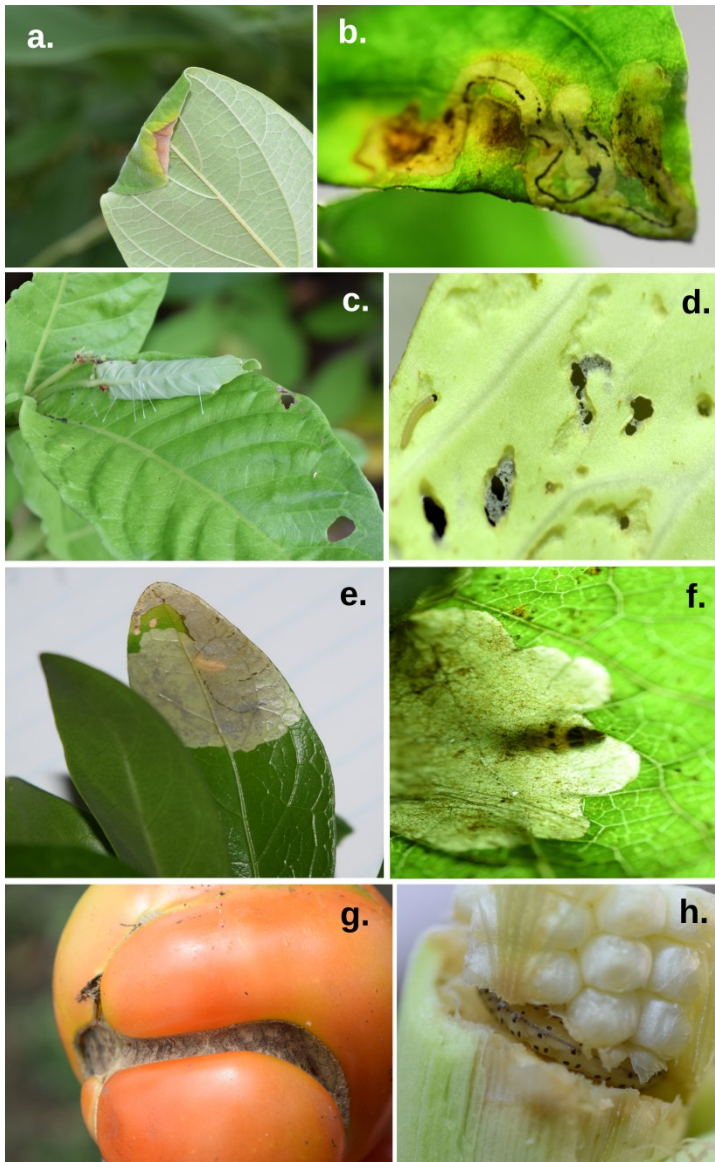


Figure 3. The most common feeding habits in immature forms of Lepidoptera: a.) Folds. b., e., f.) Mines. c.) Rolls. d.) Exposed. g, h.) Borers.

The field observations confirm that damages in the highlands of Panama were caused by *Plutella xylostella* (Plutellidae), *Phthorimaea absoluta*, and *Tecia solanivora* (Gelechiidae: Gnorimoschemini). Most of the damage to Panamanian Brassicaceae are caused by *Plutella xylostella* (Plutellidae), which concentrates in crops at elevations around 1,000 meters above sea level (Figs. 4, 5).

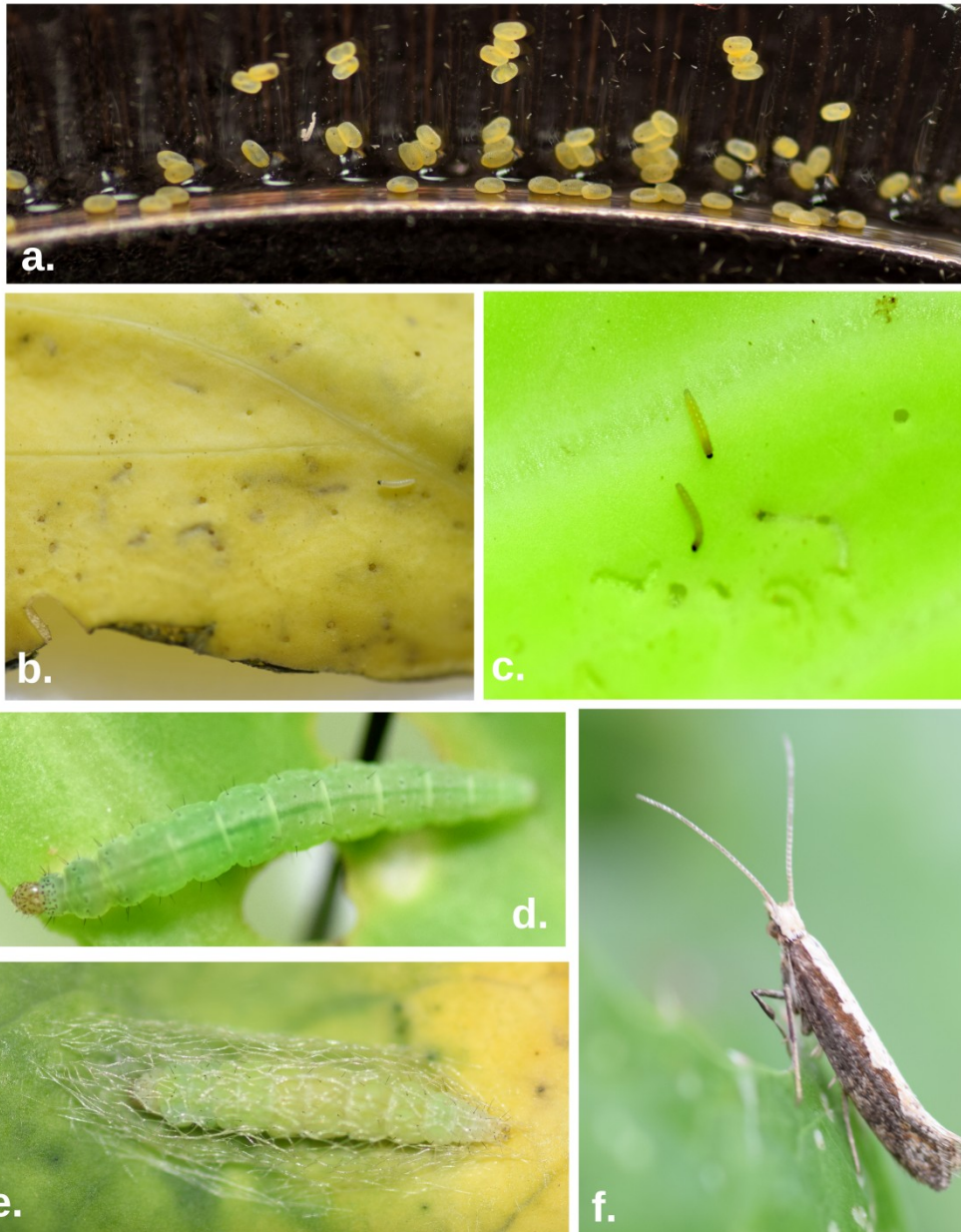


Figure 4. The life history of *Plutella xylostella* (Plutellidae) feeding on green cabbage. a.) Eggs. b.) First instar larvae. c.) Second instar larvae. d.) Third instar larva. e.) Pupa. f.) The emergence of the adult.

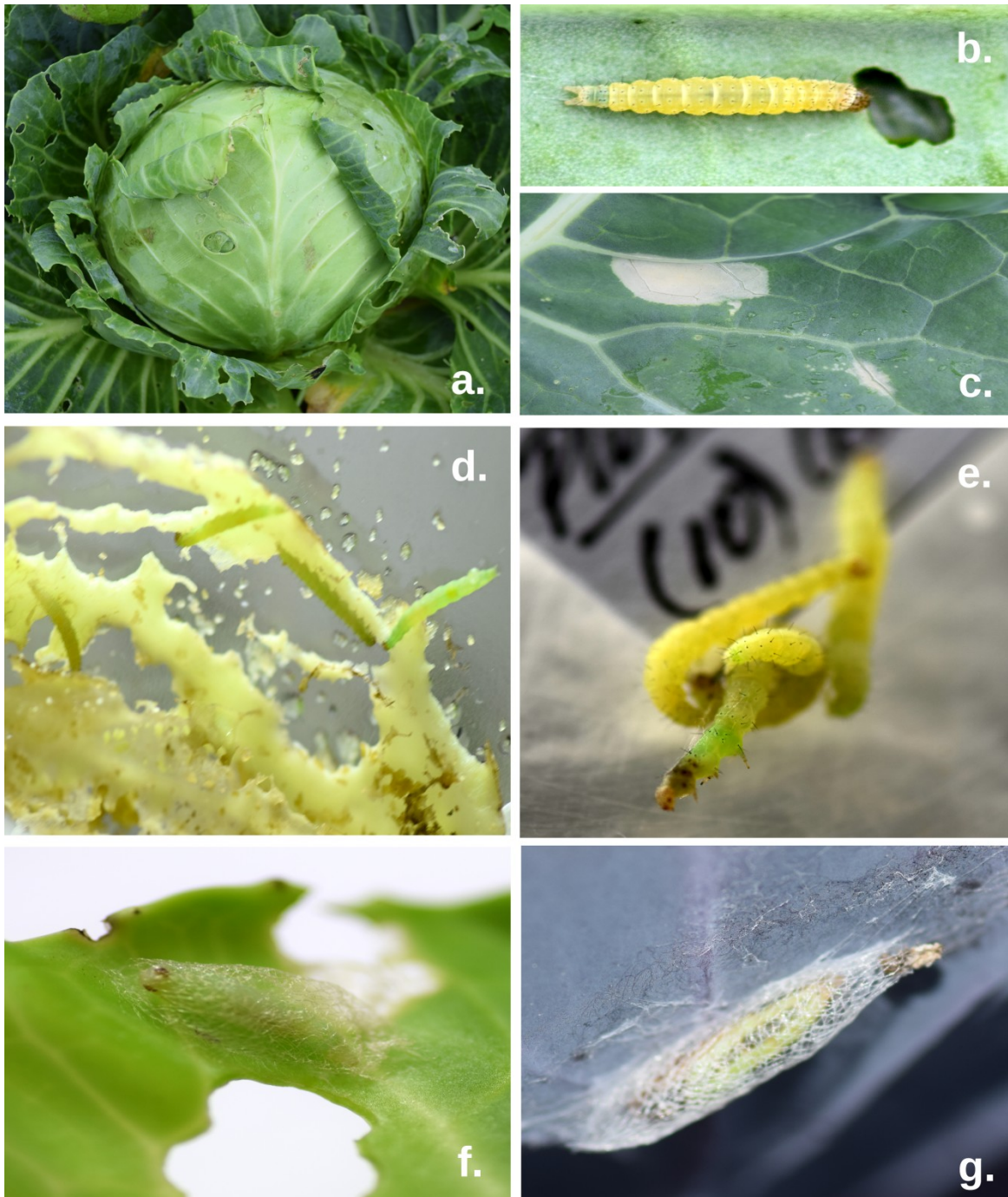


Figure 5. Behavioral notes on *Plutella xylostella* (Plutellidae) on the field and in laboratory conditions. a.) External damage to green cabbage. b.) The larva is an exposed feeder. c.) The color change is evidence of a larva feeding on the under the surface of the leaf, leaving the epidermis intact. d.) Damage caused by the reared larvae under laboratory conditions. e.) Unusual behavior of the larvae including rolls. f.) Initiation of the pupa. g.) Pupa on a purple variety of cabbage.

The species *P. xylostella* (Figs. 4, 5) is recognized as an exposed feeder causing important damage to cabbage, including decoloration of the leaf associated with the underleaf feeding

habit of the larva. The damage caused by this species were described and calculated at a nearly 100% loss to the cabbage crop; while increase of this pest during the last two decades has reached a loss around the world valued at 4 to 5 billion dollars. Unfortunately, the wide variety of alternatives available for its control are not efficient enough to regulate or reduce percentages of damage. It has been shown to have resistance to almost 95 of the chemical products been used in its control, and studies under controlled environments suggest it is tolerant to *Bacillus thuringiensis*. *P. xylostella* is one of the 3 insect species that has shown this particular resistance (Furlong et al., 2013; Whalon et al., 2017).

The families Noctuidae, Pyralidae and Crambridae (Figs. 6-8) have a particular preference for crops located in the lowlands of Panama, the main problems are caused by borers of the genera *Diatraea* and *Spodoptera*. Detailed studies of the impacts of *Diatraea* and yield loss on sugarcane crops in Panama were done recently by Atencio and collaborators (Atencio Valdespino and Goebel, 2015; Atencio et al., 2017). The biological work suggests a new hostplant record for the species *Spodoptera albula*, which feeds on green pepper. The detailed life history, distribution of the species and nomenclatural annotations were made recently by Corro Chang and Tarakanov (Corro Chang and Tarakanov, 2017).

The species *Tecia solanivora* (Gelechiidae) (Figs. 9, 10) is causing per year 15% of the loss to potato crops after the application of chemical products. Without any treatment or pest control strategy, the loss could be around 30%. The damages caused by this insect in Central America fluctuates from 40 to 95%, while 90% of the damages were reported in South America. Actual estimations of damages are close to the forecasts made by Dalibor Povolný in the year 1972, who calculate the losses produced by this pest in Costa Rica around 900,000 dollars. The introduction of the species in Tenerife brings an important reduction in the yields productivity, calculated around 50% (Povolný, 1973; 2004; Kutinkova et al., 2016).

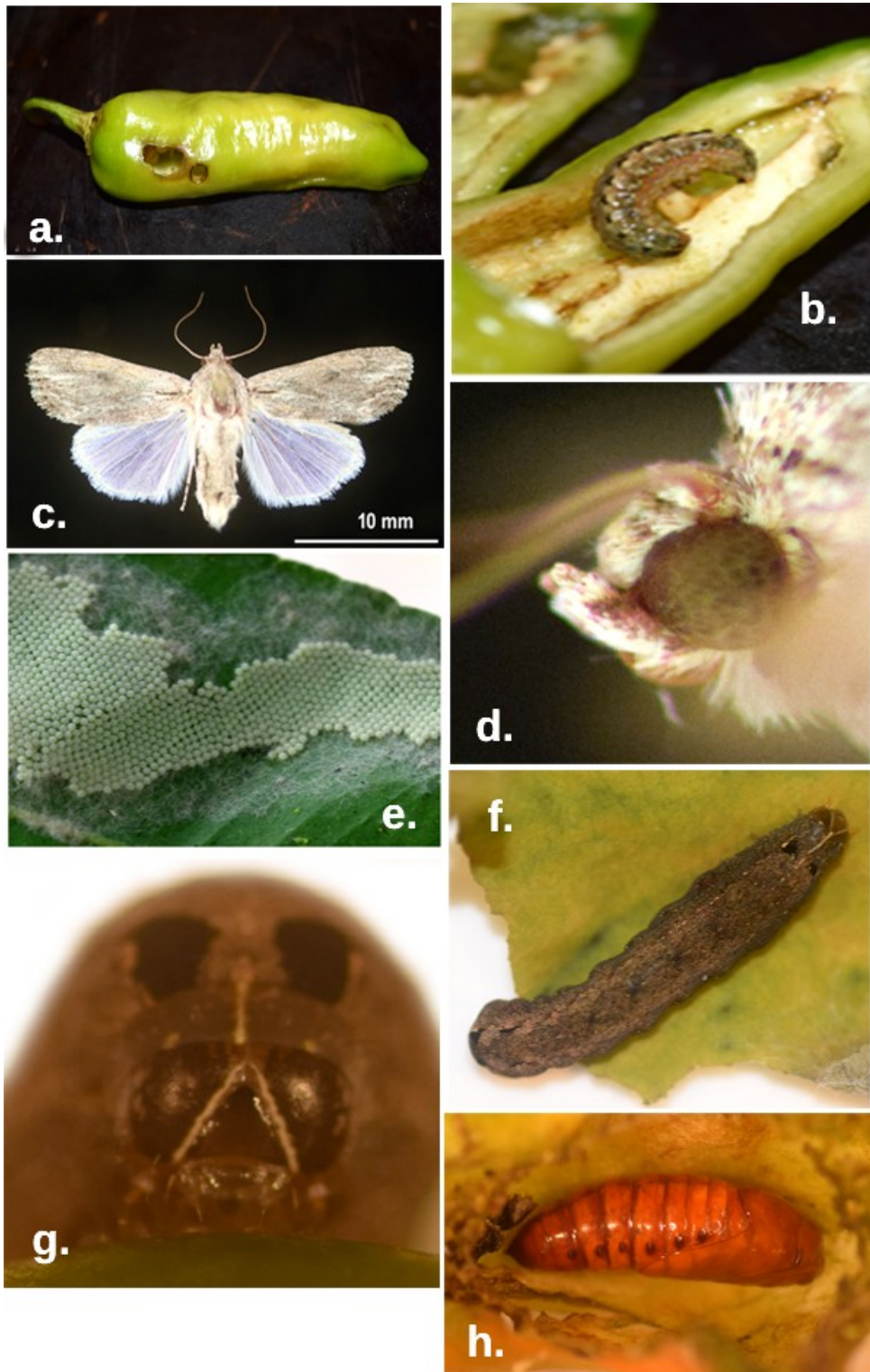


Figure 6. a.) *Spodoptera albula* (Noctuidae), external damage to green pepper. b.) Final instar resting inside the fruit before pupation. c.) Adult, dorsal habitus. d.) Head. e.) *S. dolichos* eggs covered with scales of the female. f.) *S. dolichos*, larva, dorsal view. g.) *S. dolichos* larva, Head. h.) *S. dolichos*, Pupa.

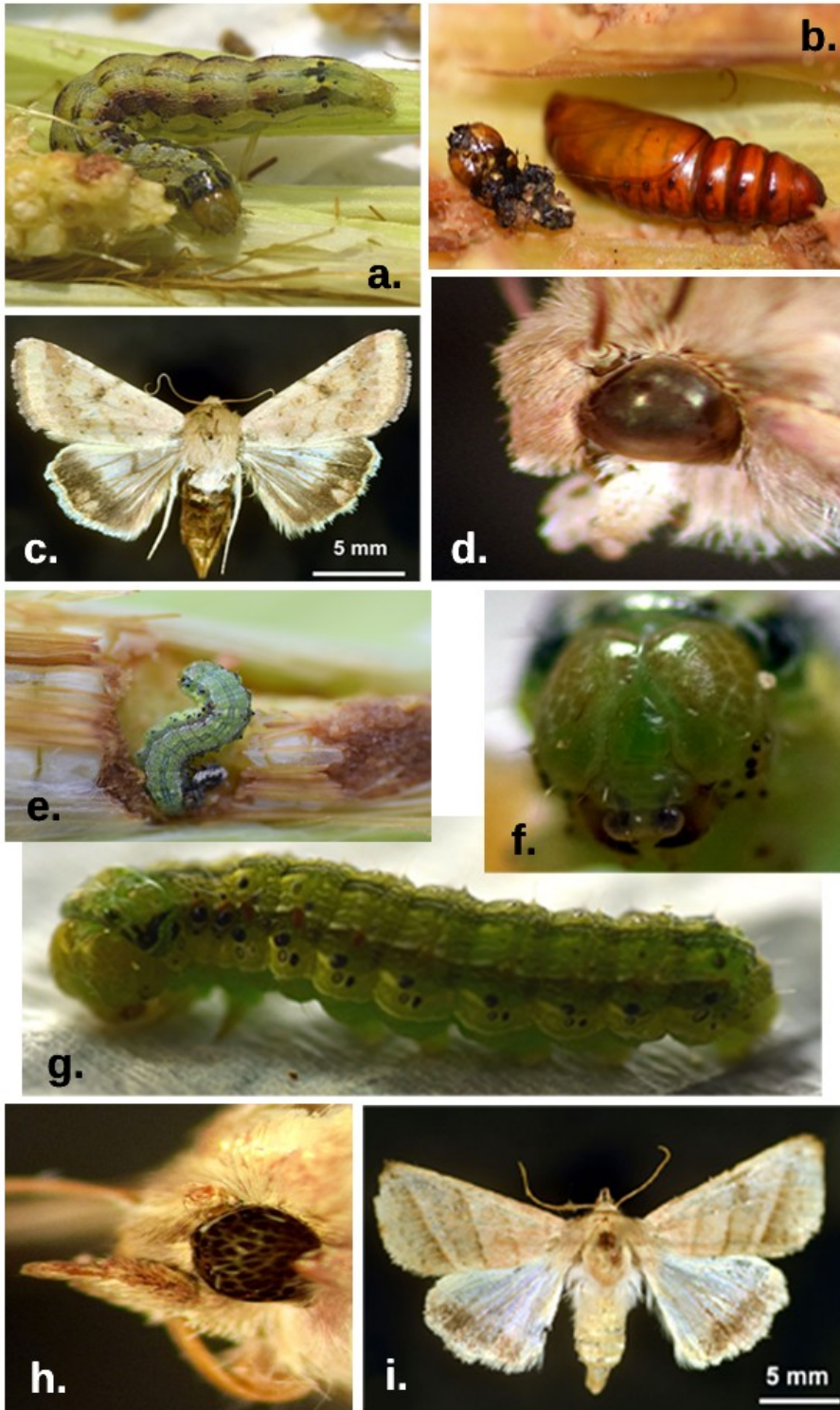


Figure 7. a.) *Helicoverpa zea* (Noctuidae) feeding on corn. b.) Pupa lateral view and head capsule. c.) Adult of *Helicoverpa zea* (Noctuidae), dorsal habitus. d.) Head. e.) *Chloridea virescens* (Noctuidae) feeding on corn. f.) Head. g.) Larva, lateral view. h.) Adult of *Chloridea virescens* (Noctuidae). i.) Dorsal habitus.

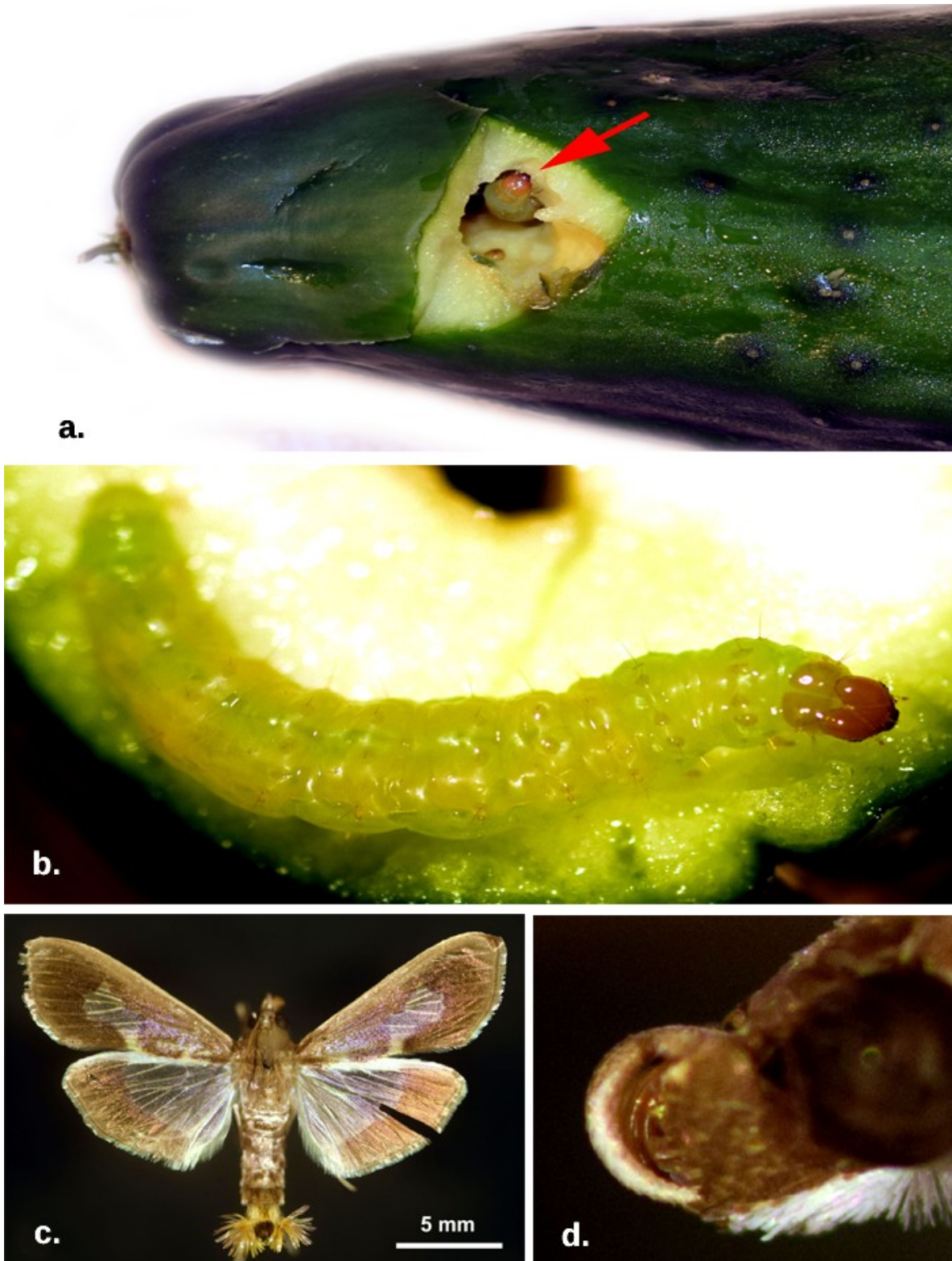


Figure 8. a.) External damage produced on cucumber by the species *Diaphania nitidalis* (Crambidae). b.) Last instar larva of *D. nitidalis* (Crambidae) outside a fruit of cucumber. c.) Adult, dorsal habitus (male). d.) Head.

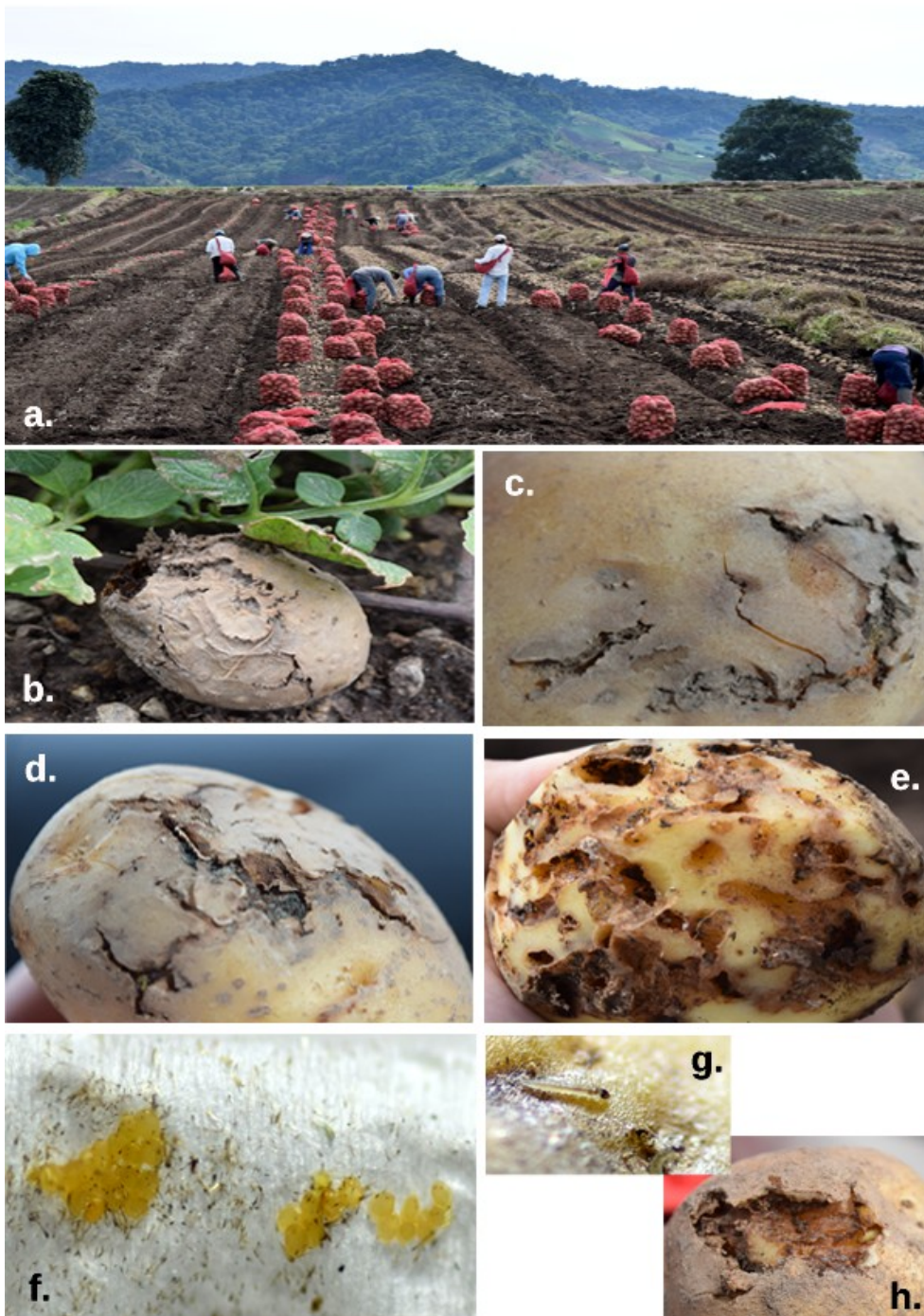


Figure 9. The highlands of Chiriquí, potato crops. a.) Harvest season, 2016. b-d.) External damages to potato tubers. e.) Internal damages to potato caused by *Tecia solanivora* (Gelechiidae: Gnorimoschemini); Life history of *Tecia solanivora* (Gelechiidae: Gnorimoschemini) feeding on a potato. f.) Eggs. g.) First instar larva. h.) Fifth instar larva and damages.

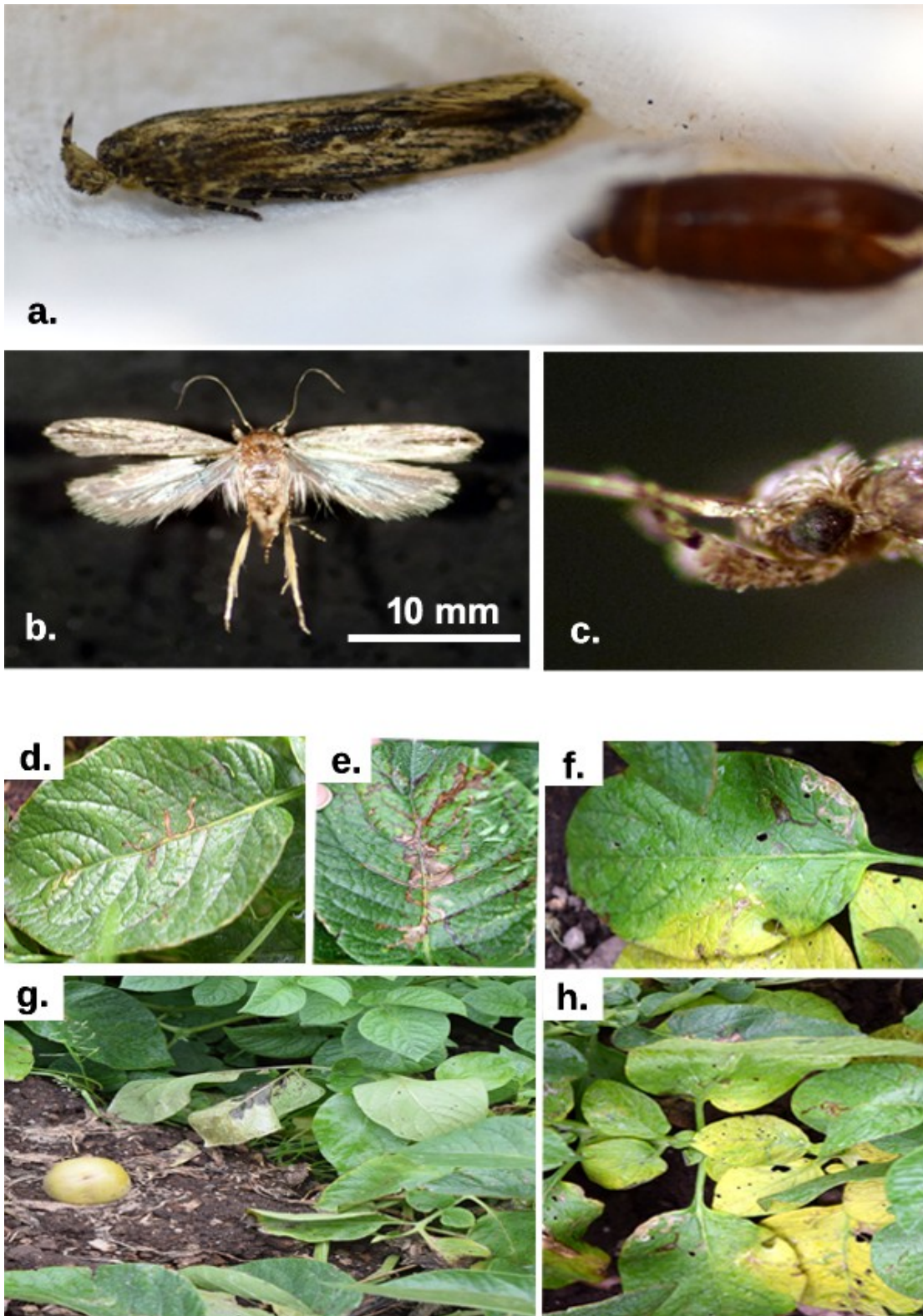


Figure 10. a.) *Tectia solanivora* (Gelechiidae: Gnorimoschemini), adult. b.) Dorsal habitus. c.) Head; Potato crop diseases. d-f.) Mines. g.) Infections caused by mildew. f, h.) Scars and changes of color in the leaf.

The species *Phthorimaea absoluta* (Gelechiidae) (Figs. 11, 12) continue affecting tomato crops at Río Sereno, Río Guisado and Boquete, the three localities are in the province of Chiriquí, República de Panama. In this location, the larvae could affect leaves, stems, and fruits of tomato. The infestation produced by the presence of the pest in Panama is 100%, concentrated on the stems and flower buds of the plant (Corro and Tarakanov, 2017). We also report the presence of damage fruits on packed products found in supermarkets in the city of Panama. The field experience shows that the larva has a particular behavior during the first instars; it hides inside the floral buds of the tomato plant making a small shelter. The shelter is covered with silk threads and pieces of frass. During the second and third instar, it moves on the leaf, feeding on them as a leaf miner. As evidence of a larva inside the leaf, the author describes a wet mine provided with pieces of black fecula. The last instar could be inside the fruit, piercing the peduncle or producing abnormal growth. In other latitudes of the world, application of biological control agents such as entomopathogen nematodes like *Steinernema carpocapsae* and *Heterorhabditis bacteriophora* has shown an optimistic perspective in the treatment of this pest including 100% of mortality in larvae, 10% in pupae and around 77 to 92% of parasitism inside the galleries (Batalla-Carrera et al., 2010, López, 2013).

The effects of climate change have an important influence on the life histories of some species, changing their usual behavior and host preferences. This preliminary study shows unusual feeding habits in the species *Rothschildia lebeau* (Figs. 13, 14), feeding on *Lactuca sativum* of the variety butterhead. The eggs were collected in the high lands of Chiriquí in a small polyculture farm and reared under laboratory conditions by the author (Figs. 13, 14). This changes in their feeding habits could be related to modifications of the environment, pressure on the species to find alternative hostplants. Also, the abuse of high concentrations of pesticides, modification of the environment and low densities of their usual hostplants have a strong influence on their behavior. As main hostplants to the species has been reported 5 families of plants, which includes Anacardiaceae and Rutaceae (Robinson et al., 2002); and in this work, we report Asteraceae as an alternative hostplant to the species in extremely modified ecosystems.

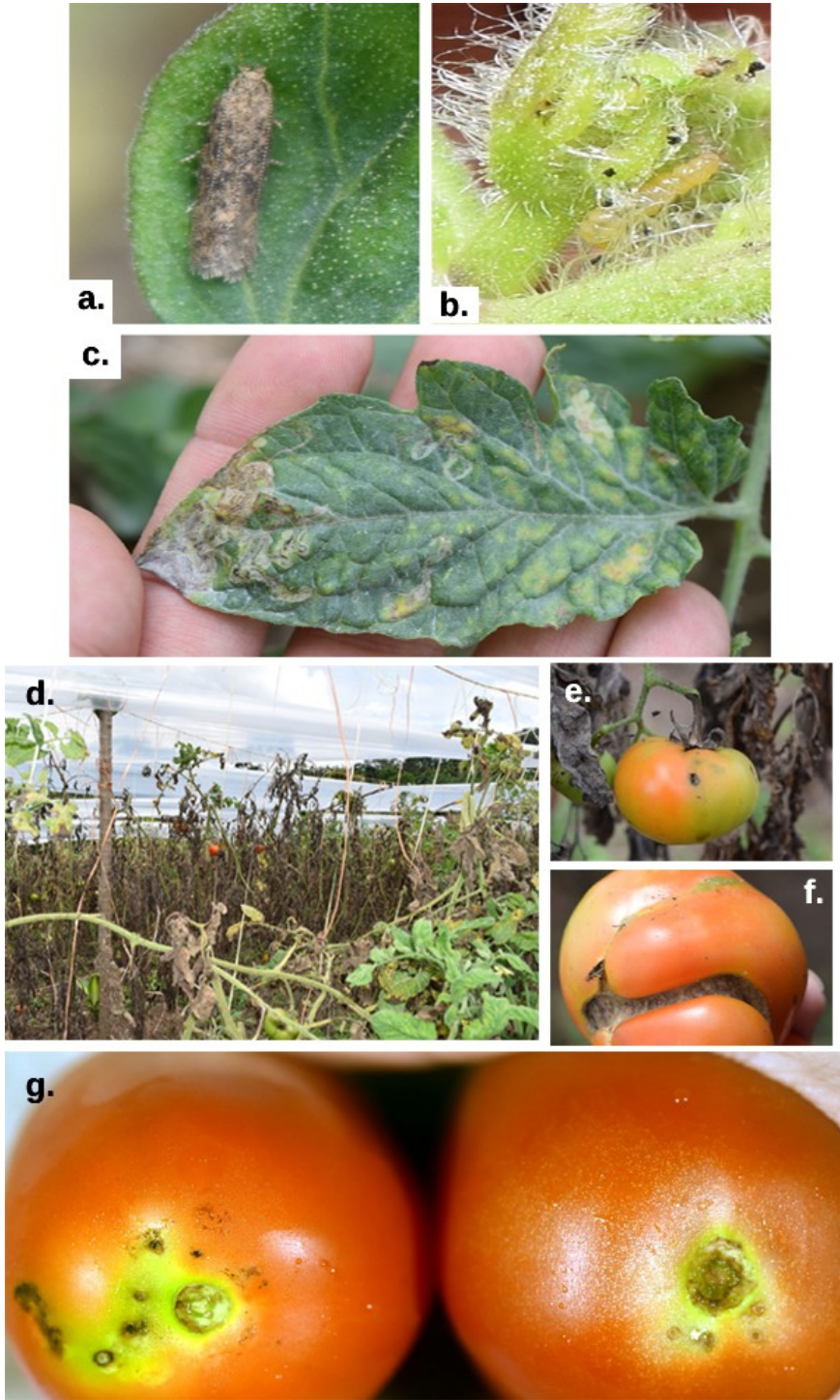


Figure 11. Life history of *Phthorimaea absoluta*. a.) Adult, with daily activity. b.) First instar larva inside the shelter in flower buttons. c.) Mines in tomato variety 3x3. d.) Yield reduction. e.) External damage on tomato variety 3x3. f.) Abnormal growth of the fruit and boring. g.) External damage at the peduncle in tomato fruit, produced at Boquete, Chiriquí.

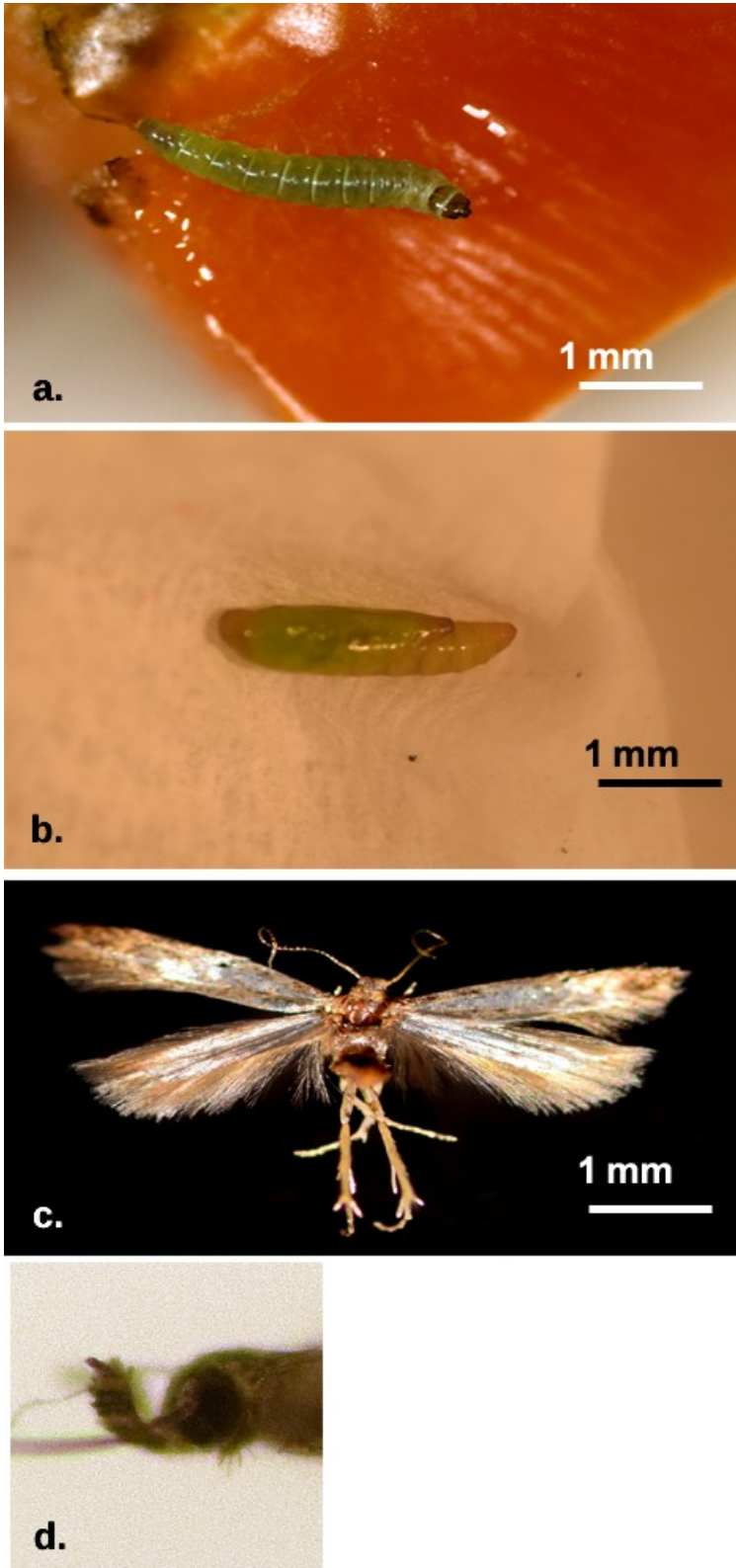


Figure 12. *Phthorimaea absoluta* (Gelechiidae: Gnorimoschemini). a.) Fourth instar larva. b.) Pupa. c.) Dorsal habitus. d.) Head.

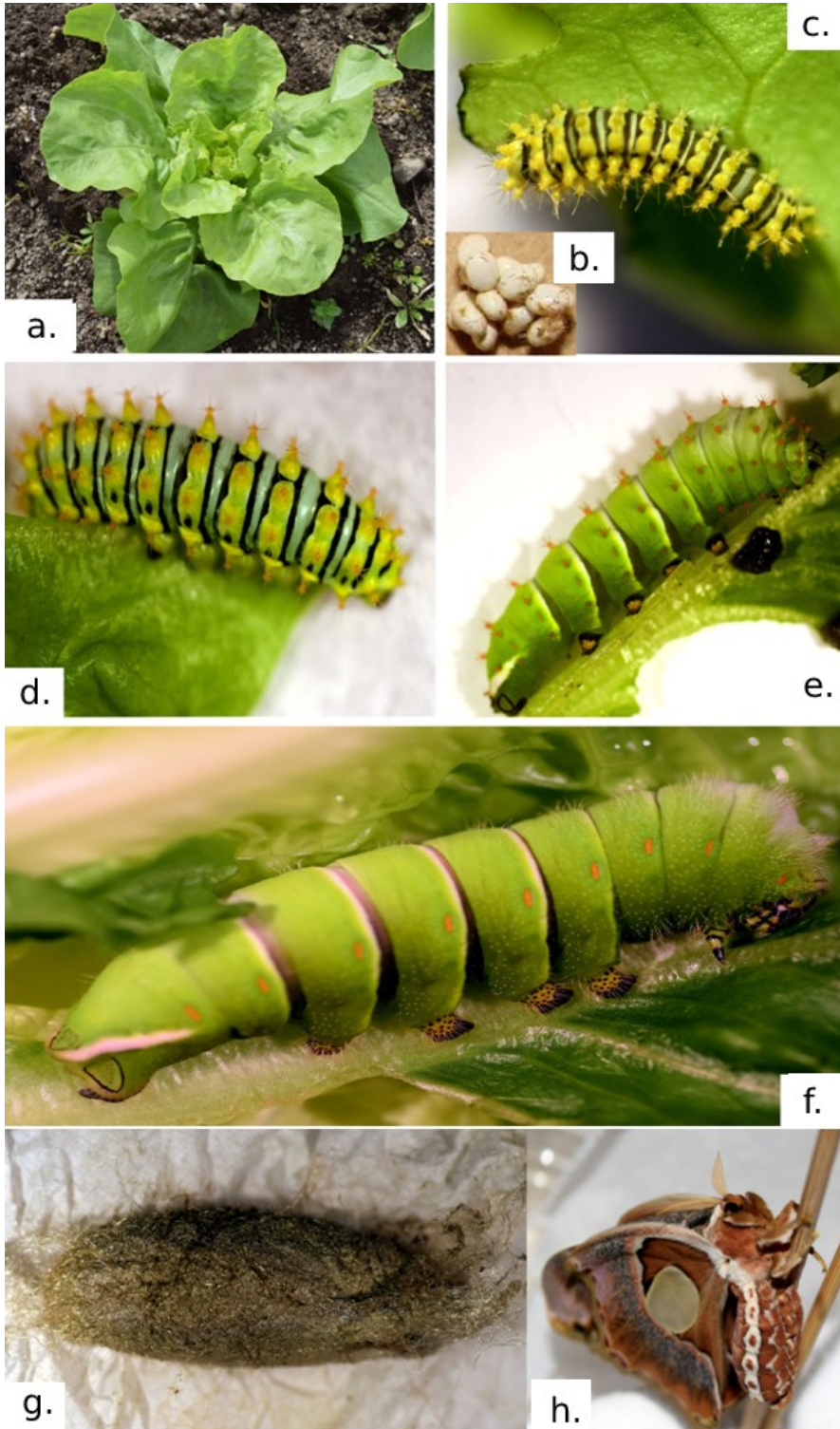


Figure 13. Life history of *Rothschildia lebeau* (Saturniidae) in lettuce. a.) Butterhead lettuce. b.) Eggs. c.) First instar larva. d.) Second instar larva. e.) Third instar larva. f.) Fourth instar larva. g.) Cocoon. h.) Adult.



Figure 14. a.) *Rothschildia lebeau* (Saturniidae) feeding on butterhead lettuce. b.) In just one day this larva can feed on medium size lettuce.

The species *Xylophanes tersa* (Fig. 15) has been associated with 7 families of plants and reported as an important pest in corn, bean, and eucalyptus (Robinson et al., 2002). In the lower lands of Panama, this species uses an alternative hostplant the species *Moringa oleifera* (Moringaceae). The plant is native from India and has been introduced to Panama. It has become popular in alternative medicine as a treatment to diabetes, cancer and neural diseases (Anwar et al., 2007). In this study, we report *M. oleifera* as an alternative hostplant to the species *X. tersa* on modified ecosystems.

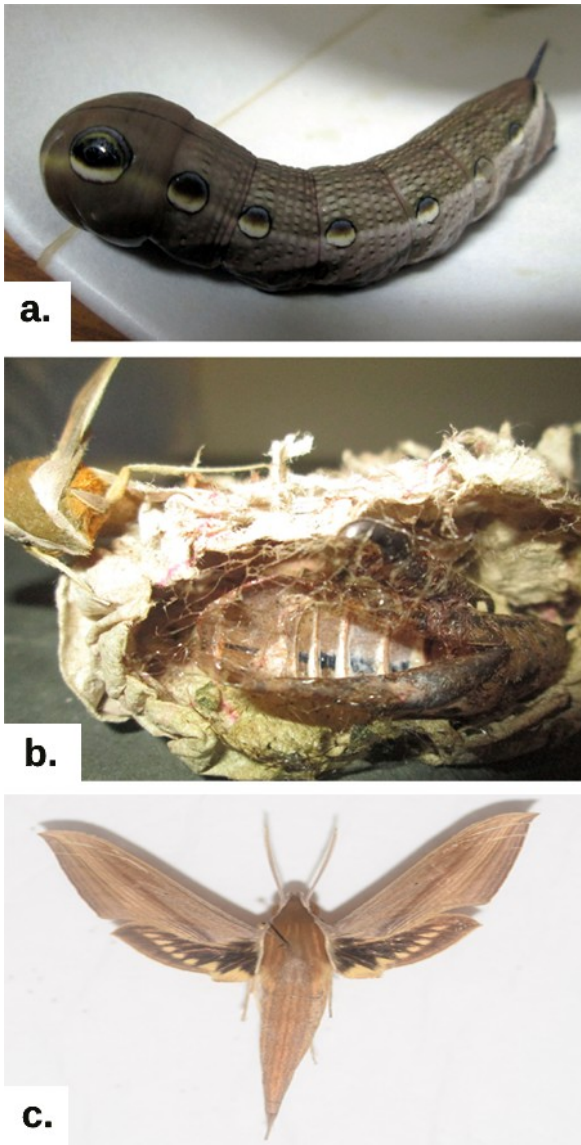


Figure 15. a.) Last instar larva of *Xylophanes tersa*. b.) Adult outside the cocoon. c.) Dorsal habitus, *Xylophanes tersa* reared under lab condition feeding on *Moringa oleifera* (Moringaceae).

This is the first record of the species *Oiketicus kirbyi* (Psychidae) (Fig. 16) feeding on basil. The particular feeding habit of the species represents a new risk to the industry of aromatic plants and urban gardens.



Figure 16. *Oiketicus kirbyi* (Psychidae). a.) Male, pupa on basil. b.) Larva feeding on basil. Photos: Zinia Chen, Litho Editorial Chen, Panama.

The species *Opogona omoscopa* and *Phaeoses sabinella* (Tineidae) (Figs. 17, 18) were highly abundant in our study. Both species were collected in the lower lands of Panama and they might be associated with sugarcane and decaying cucumber crops, all them located in the study area.

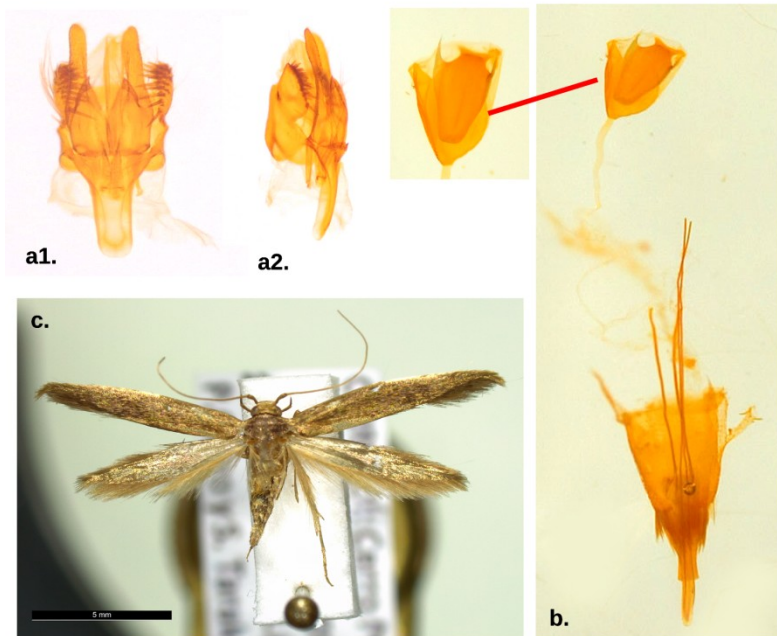


Figure 17. *Opogona omoscopa* (Meyrick, 1893). a.1-2). Male genitalia. b.) Female genitalia and signum. c.) Adult, dorsal habitus.

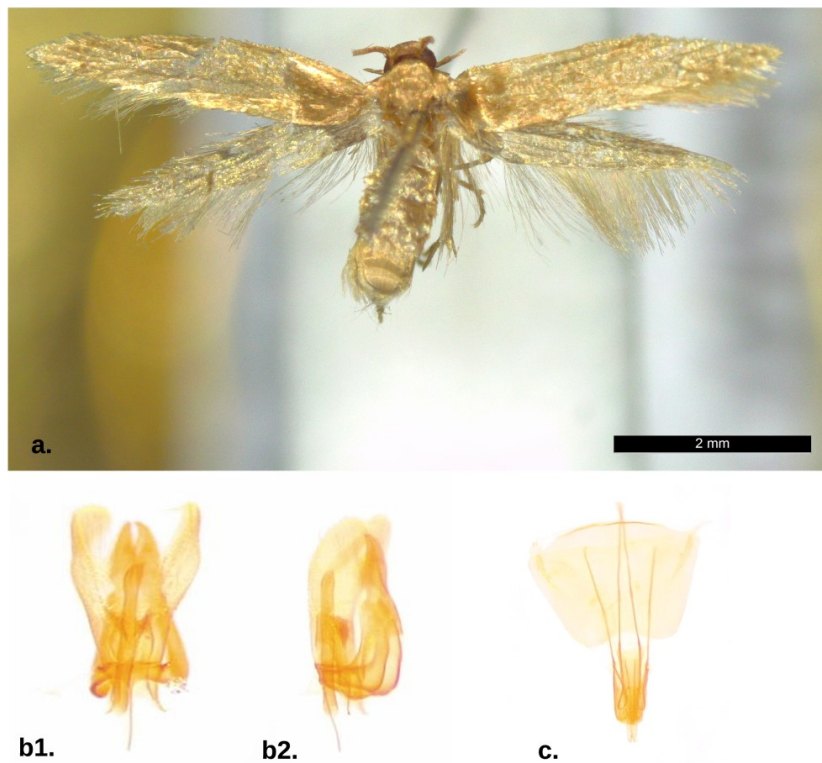


Figure 18. *Phaeoses sabinella* Forbes, 1922. a.) Adult, dorsal habitus. b.1-2) Male genitalia. c.) Female genitalia.

The index of hostplants (Table 2) summarize the main cultivated crops of the Republica de Panama, their common names in Spanish and English. We have included species of Lepidoptera raised in the study with previously reported and new hosts.

Table 2. Index of Hostplants: Moths associated with Central American Agriculture. The table includes the main cultivated crops of the Republica de Panama, their common names in Spanish and English. The information was taken from Sifuentes and Young 1961; Saunders et al. 1998; Rodríguez et al. 1999; Capinera 2001; Robinson et al. 2002; Mexzón et al. 2003; Garraway et al. 2007; Navarro Campos et al. 2010; Salazar 2013; Cagnotti 2014; Gilligan and Epstein 2014; Kahl et al. 2016; Pinzón-García et al. 2016; Solís and Metz 2016; Corro Chang and Tarakanov 2017; Chen 2017 (Personal communication).

Hostplant	Families and species of moths
Apiaceae	
“Apio, celery” <i>Apium graveolens</i>	Erebidae: <i>Estigmene acrea</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Chrysodeixis includens</i> , <i>Helicoverpa zea</i> , <i>Mythimna unipuncta</i> , <i>Spodoptera eridania</i> , <i>S. exigua</i> , <i>Trichoplusia ni</i> ; Plutellidae: <i>Plutella xylostella</i>
“Zanahoria, carrot” <i>Daucus carota</i>	Crambidae: <i>Spoladea recurvalis</i> ; Erebidae: <i>Estigmene acrea</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Feltia subterranea</i> , <i>Mythimna unipuncta</i> , <i>Spodoptera eridania</i> , <i>S. exigua</i> ; Plutellidae: <i>Plutella xylostella</i>
Amaranthaceae	
“Remolacha, beet” <i>Beta vulgaris</i>	Crambidae: <i>Spoladea recurvalis</i> ; Erebidae: <i>Estigmene acrea</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Chrysodeixis includens</i> , <i>Feltia subterranea</i> , <i>Helicoverpa zea</i> , <i>Mythimna unipuncta</i> , <i>Spodoptera eridania</i> , <i>S. exigua</i> , <i>S. frugiperda</i> , <i>S. latifascia</i> , <i>Trichoplusia ni</i> ; Pyralidae: <i>Elasmopalpus lignosellus</i>
Annonaceae	
“Anón and Guanábana; sweetsop and soursop ” <i>Annona squamosa</i> ; <i>A. muricata</i>	Depresaridae: <i>Cerconota anonella</i> ; Erebidae: <i>Gonodonta pyrgo</i> ; Plutellidae: <i>Plutella xylostella</i> ; Psychidae: <i>Oiketicus kirbyi</i>
Araceae	
“Otoe, taro ” <i>Colocasia esculenta</i>	Cosmopterigidae: <i>Anatrachyntis rileyi</i> ; Crambidae: <i>Diaphania hyalinata</i> ; Noctuidae: <i>Agrotis ipsilon</i>

Table 2. Continue.

Hostplant	Families and species of moths
Asteraceae	
“Lechuga, lettuce” <i>Lactuca sativa</i>	Erebidae: <i>Estigmene acrea</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Chloridea virescens</i> , <i>Chrysodeixys includens</i> , <i>Feltia subterranea</i> , <i>Helicoverpa zea</i> , <i>Mythimna unipuncta</i> , <i>Spodoptera exigua</i> , <i>S. latifascia</i> , <i>Trichoplusia ni</i> ; Saturniidae: <i>Rothschildia lebeau</i> ; Sphingidae: <i>Manduca sexta</i>
Alliaceae	
“Cebolla, onion” <i>Allium cepa</i>	Erebidae: <i>Estigmene acrea</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Feltia subterranea</i> , <i>Helicoverpa zea</i> , <i>Mythimna unipuncta</i> , <i>Spodoptera dolichos</i> , <i>S. eridania</i> , <i>S. exigua</i> , <i>S. frugiperda</i> , <i>S. latifascia</i>
“Cebollina” <i>Allium fistulosum</i>	Noctuidae: <i>Agrotis ipsilon</i>
Brassicaceae	
“Brócoli, broccoli” <i>Brassica oleracea italic</i>	Noctuidae: <i>Agrotis ipsilon</i> , <i>Chrysodeixys includens</i> , <i>Spodoptera exigua</i> , <i>Trichoplusia ni</i> ; Plutellidae: <i>Plutella xylostella</i>
“Coliflor, cauliflower” <i>Brassica oleracea</i> var. <i>botrytis</i>	Erebidae: <i>Estigmene acrea</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Chrysodeixys includens</i> , <i>Feltia subterranea</i> , <i>Helicoverpa zea</i> , <i>Mocis latipes</i> , <i>Mythimna unipuncta</i> , <i>Spodoptera exigua</i> , <i>S. frugiperda</i> , <i>Trichoplusia ni</i> ; Plutellidae: <i>Plutella xylostella</i>
“Rábano, radish” <i>Raphanus sativus</i>	Erebidae: <i>Estigmene acrea</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Chloridea virescens</i> , <i>Chrysodeixys includens</i> , <i>Feltia subterranea</i> , <i>Mocis latipes</i> , <i>Mythimna unipuncta</i> , <i>Spodoptera eridania</i> , <i>S. exigua</i> , <i>S. frugiperda</i> , <i>S. latifascia</i> , <i>Trichoplusia ni</i> ; Plutellidae: <i>Plutella xylostella</i> ; Pyralidae: <i>Elasmopalpus lignosellus</i> ; Sphingidae: <i>Manduca sexta</i>
“Repollo, cabbage” <i>Brassica oleracea</i> var. <i>capitata</i>	Erebidae: <i>Estigmene acrea</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Chrysodeixys includens</i> , <i>Feltia subterranea</i> , <i>Helicoverpa zea</i> , <i>Mocis latipes</i> , <i>Mythimna unipuncta</i> , <i>Spodoptera exigua</i> , <i>S. frugiperda</i> , <i>Trichoplusia ni</i> ; Plutellidae: <i>Plutella xylostella</i> ; Pyralidae: <i>Elasmopalpus lignosellus</i>
Bromeliaceae	
“Piña, pineapple” <i>Anana comosus</i>	Castniidae: <i>Telchin licus</i> ; Cosmopterygidae: <i>Anatrachyntis rileyi</i> ; Pyralidae: <i>Elasmopalpus lignosellus</i> ; Tortricidae: <i>Platynota rostrana</i>

Table 2. Continue.

Hostplant	Families and species of moths
Convolvulaceae	
“Camote, sweet potato” <i>Ipomoea batatas</i>	Crambidae: <i>Compacta hirtalis</i> , <i>Megastes grandalis</i> , <i>Polygrammodes elevata</i> , <i>Spoladea recurvalis</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Chrysodeixys includens</i> , <i>Feltia subterranea</i> , <i>Helicoverpa zea</i> , <i>Mythimna unipuncta</i> , <i>Spodoptera eridania</i> , <i>S. exigua</i> , <i>S. frugiperda</i> , <i>S. latifascia</i> ; <i>Trichoplusia ni</i> ; Pyralidae: <i>Elasmopalpus lignosellus</i> ; Sphingidae: <i>Agrius cingulatus</i>
Cucurbitaceae	
“Chayote” <i>Sechium edule</i>	Crambidae: <i>Diaphania hyalinata</i> , <i>D. nitidalis</i>
“Melón, melon” <i>Cucumis melo</i>	Crambidae: <i>Diaphania hyalinata</i> , <i>D. indica</i> , <i>D. nitidalis</i> , <i>Rhectocraspeda periusalis</i> ; Noctuidae: <i>Feltia subterranea</i> , <i>Helicoverpa zea</i> , <i>Mythimna unipuncta</i> , <i>Spodoptera exigua</i> , <i>Trichoplusia ni</i> ; Pyralidae: <i>Elasmopalpus lignosellus</i> ; Sesiidae: <i>Melittia cucurbitae</i>
“Pepino, cucumber” <i>Cucumis sativus</i>	Crambidae: <i>Diaphania hyalinata</i> , <i>D. indica</i> , <i>D. nitidalis</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Chrysodeixis includens</i> , <i>Feltia subterranea</i> , <i>Helicoverpa zea</i> , <i>Mythimna unipuncta</i> , <i>Spodoptera eridania</i> , <i>S. exigua</i> , <i>S. frugiperda</i> , <i>Trichoplusia ni</i> ; Sesiidae: <i>Melittia cucurbitae</i>
“Sandía, watermelon” <i>Citrullus lanatus</i>	Crambidae: <i>Diaphania hyalinata</i> , <i>D. indica</i> , <i>D. nitidalis</i> ; Erebidae: <i>Estigmene acrea</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Chrysodeixys includens</i> , <i>Feltia subterranea</i> , <i>Helicoverpa zea</i> , <i>Mythimna unipuncta</i> , <i>Spodoptera eridania</i> , <i>S. exigua</i> , <i>S. frugiperda</i> , <i>Trichoplusia ni</i> ; Sesiidae: <i>Melittia cucurbitae</i>
“Zapallo, pumpking” <i>Cucurbita moschata</i>	Crambidae: <i>Diaphania hyalinata</i> , <i>D. nitidalis</i> ; Noctuidae: <i>Chloridea virescens</i> , <i>Helicoverpa zea</i> , <i>Spodoptera eridania</i> ; Sesiidae: <i>Melittia cucurbitae</i>
Euphorbiaceae	
“Yuca, manioc” <i>Manihot esculenta</i>	Noctuidae: <i>Agrotis ipsilon</i> , <i>Spodoptera eridania</i> ; Sphingidae: <i>Erinnyis alope</i> , <i>E. ello</i>
Dioscoreaceae	
“Ñame, yam” <i>Dioscorea</i> sp.	Noctuidae: <i>Agrotis ipsilon</i>

Table 2. Continue.

Hostplant	Families and species of moths
Fabaceae	
“Frijoles, beans” <i>Phaseolus vulgaris</i>	Choreutidae: <i>Brenthia pavonacella</i> ; Cosmopterigidae: <i>Anatrachyntis rileyi</i> ; Crambidae: <i>Diaphania indica</i> , <i>Maruca vitrata</i> , <i>Spoladea recurvalis</i> ; Erebidae: <i>Estigmene acrea</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Anticarsia gemmatalis</i> , <i>Chrysodeixis includens</i> , <i>Feltia subterranea</i> , <i>Helicoverpa zea</i> , <i>Mythimna unipuncta</i> , <i>Spodoptera albula</i> , <i>S. dolichos</i> , <i>S. eridania</i> , <i>S. exigua</i> , <i>S. frugiperda</i> , <i>S. latifascia</i> , <i>Trichoplusia ni</i> ; Pyralidae: <i>Elasmopalpus lignosellus</i> , <i>Etiella zinckenella</i> ; Sphingidae: <i>Xylophanes tersa</i> ; Tortricidae: <i>Crociosema aporema</i> , <i>Ecdyolopha fabivora</i> , <i>Platynota rostrana</i>
“Guandú, pigeon pea” <i>Cajanus cajan</i>	Crambidae: <i>Maruca vitrata</i> ; Noctuidae: <i>Anticarsia gemmatalis</i> , <i>Chloridea virescens</i> , <i>Chrysodeixis includens</i> , <i>Helicoverpa zea</i> , <i>Spodoptera frugiperda</i> ; Pyralidae: <i>Etiella zinckenella</i> ; Tortricidae: <i>Platynota rostrana</i>
“Soya, soybean” <i>Glycine max</i>	Choreutidae: <i>Brenthia pavonacella</i> ; Crambidae: <i>Diaphania indica</i> , <i>Maruca vitrata</i> , <i>Spoladea recurvalis</i> ; Erebidae: <i>Estigmene acrea</i> ; Noctuidae: <i>Anticarsia gemmatalis</i> , <i>Chloridea virescens</i> , <i>Chrysodeixys includens</i> , <i>Helicoverpa zea</i> , <i>Mocis latipes</i> , <i>Spodoptera albula</i> , <i>S. cosmioides</i> , <i>S. eridania</i> , <i>S. exigua</i> , <i>S. frugiperda</i> , <i>S. latifascia</i> , <i>Trichoplusia ni</i> ; Pyralidae: <i>Elasmopalpus lignosellus</i> , <i>Etiella zinckenella</i> ; Tortricidae: <i>Crociosema aporema</i> , <i>Ecdyolopha fabivora</i>
Lamiaceae	
“Albahaca, Amazonian basil” <i>Ocimum campechianum</i>	Psychidae: <i>Oiketicus kirbyi</i>
Lauraceae	
“Aguacate, avocado” <i>Persea americana</i>	Oecophoridae: <i>Stenoma catenifer</i> ; Psychidae: <i>Oiketicus kirbyi</i> ; Noctuidae: <i>Spodoptera eridania</i>
Musaceae	
“Banano, banana” <i>Musa x paradisiaca</i>	Castniidae: <i>Telchin licus</i> ; Cosmopterygidae: <i>Anatrachyntis rileyi</i> ; Psychidae: <i>Oiketicus kirbyi</i> ; Tortricidae: <i>Platynota rostrana</i>

Table 2. Continue.

Hostplant	Families and species of moths
Poaceae	
“Arroz, rice” <i>Oryza sativa</i>	Crambidae: <i>Diatraea lineolata</i> , <i>D. saccharalis</i> , <i>Maruca vitrata</i> , <i>Rupela albinella</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Anticarsia gemmatalis</i> , <i>Feltia subterranea</i> , <i>Helicoverpa zea</i> , <i>Marimatha nigrofimbria</i> , <i>Mocis latipes</i> , <i>Mythimna unipuncta</i> , <i>Spodoptera cosmioides</i> , <i>S.</i> <i>exigua</i> , <i>S. frugiperda</i> ; Pyralidae: <i>Elasmopalpus lignosellus</i>
“Caña de Azúcar, sugar cane” <i>Saccharum officinarum</i>	Castniidae: <i>Telchin licus</i> ; Crambidae: <i>Diatraea saccharalis</i> , <i>D. tabernella</i> ; Cosmopterigidae: <i>Anatrachyntis rileyi</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Helicoverpa zea</i> , <i>Mocis latipes</i> , <i>Mythimna unipuncta</i> , <i>Spodoptera exigua</i> , <i>S. frugiperda</i> ; Pyralidae: <i>Elasmopalpus lignosellus</i>
“Maíz, maize, corn” <i>Zea mays</i>	Cosmopterigidae: <i>Anatrachyntis rileyi</i> ; Crambidae: <i>Diatraea lineolata</i> , <i>D.</i> <i>saccharalis</i> , <i>Spoladea recurvalis</i> ; Erebidae: <i>Estigmene acrea</i> ; Gelechiidae: <i>Phthorimaea operculella</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Chrysodeixys includens</i> , <i>Feltia</i> <i>subterranea</i> , <i>Helicoverpa zea</i> , <i>Mocis latipes</i> , <i>Mythimna unipuncta</i> , <i>Spodoptera albula</i> , <i>S.</i> <i>cosmioides</i> , <i>S. dolichos</i> , <i>S. eridania</i> , <i>S. exigua</i> , <i>S. frugiperda</i> , <i>S. latifascia</i> , <i>Trichoplusia</i> <i>ni</i> ; Plutellidae: <i>Plutella xylostella</i> ; Pyralidae: <i>Elasmopalpus lignosellus</i> ; Sphingidae: <i>Xylophanes tersa</i> ; Tortricidae: <i>Crociosema aporema</i>
“Sorgo, sorgum” <i>Sorghum bicolor</i>	Cosmopterigidae: <i>Anatrachyntis rileyi</i> ; Crambidae: <i>Diatraea lineolata</i> , <i>D.</i> <i>saccharalis</i> , <i>Maruca vitrata</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Chloridea virescens</i> , <i>Feltia</i> <i>subterranea</i> , <i>Helicoverpa zea</i> , <i>Mocis latipes</i> , <i>Mythimna unipuncta</i> , <i>Spodoptera albula</i> , <i>S.</i> <i>cosmioides</i> , <i>S. exigua</i> , <i>S. frugiperda</i> ; Pyralidae: <i>Elasmopalpus lignosellus</i>
Rubiaceae	
“Café, coffee” <i>Coffea arabica</i>	Cosmopterigidae: <i>Anatrachyntis rileyi</i> ; Gelechiidae: <i>Phthorimaea operculella</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Feltia subterranea</i> , <i>Helicoverpa zea</i> , <i>Mocis latipes</i> , <i>Spodoptera dolichos</i> , <i>S. exigua</i> ; Psychidae: <i>Oiketicus kirbyi</i> ; Pyralidae: <i>Elasmopalpus</i> <i>lignosellus</i>

Table 2. Continue.

Hostplant	Families and species of moths
Rutaceae	
<p>“Cítricos: limón, mandarina, naranja, toronja; citrus: lemon, tangerine, orange, passionfruit”</p> <p><i>Citrus lemon, C. tangerina, C. sinensis, C. x paradisi</i></p>	<p>Cosmopterigidae: <i>Anatrachyntis rileyi</i>; Crambidae: <i>Spoladea recurvalis</i>; Gracillariidae: <i>Phyllocnistis citrella</i>; Noctuidae: <i>Feltia subterranea, Gonodonta pyrgo, Helicoverpa zea, Spodoptera eridania, S. frugiperda, S. latifascia</i>; Psychidae: <i>Oiketicus kirbyi</i>; Saturniidae: <i>Rothschildia lebeau</i>; Tortricidae: <i>Platynota rostrana</i></p>
Solanaceae	
<p>“Ají, pepper”</p> <p><i>Capsicum annuum</i></p>	<p>Cosmopterigidae: <i>Anatrachyntis rileyi</i>; Crambidae: <i>Neoleucinodes elegantalis</i>; Gelechiidae: <i>Keiferia lycopersicella, Phthorimaea operculella</i>; Noctuidae: <i>Agrotis ipsilon, Chloridea virescens, Chrysodeixys includens, Feltia subterranea, Helicoverpa zea, Mythimna unipuncta, Spodoptera dolichos, S. eridania, S. exigua, S. frugiperda, S. latifascia, Trichoplusia ni</i>; Pyralidae: <i>Elasmopalpus lignosellus</i>; Sphingidae: <i>Manduca sexta</i>; Tortricidae: <i>Platynota rostrana</i></p>
<p>“Berenjena, eggplant”</p> <p><i>Solanum melongena</i></p>	<p>Cosmopterigidae: <i>Anatrachyntis rileyi</i>; Crambidae: <i>Neoleucinodes elegantalis, Rhectocraspeda periusalis, Spoladea recurvalis</i>; Gelechiidae: <i>Keiferia lycopersicella, Phthorimaea absoluta, P. operculella</i>; Noctuidae: <i>Agrotis ipsilon, Feltia subterranea, Helicoverpa zea, Spodoptera eridania, S. exigua, S. frugiperda</i>; Plutellidae: <i>Plutella xylostella</i>; Sphingidae: <i>Manduca sexta</i></p>
<p>“Papa, potato”</p> <p><i>Solanum tuberosum</i></p>	<p>Crambidae: <i>Rhectocraspeda periusalis</i>; Erebidae: <i>Estigmene acrea</i>; Gelechiidae: <i>Keiferia lycopersicella, Phthorimaea absoluta, P. operculella, Tecia solanivora</i>; Noctuidae: <i>Agrotis ipsilon, Chloridea virescens, Chrysodeixis includens, Feltia subterranea, Helicoverpa zea, Spodoptera dolichos, S. eridania, S. exigua, S. frugiperda, S. latifascia, Trichoplusia ni</i>; Pyralidae: <i>Elasmopalpus lignosellus</i>; Sphingidae: <i>Manduca sexta</i></p>

Table 2. Continue.

Hostplant	Families and species of moths
“Tomate, tomato” <i>Solanum lycopersicum</i>	Crambidae: <i>Neoleucinodes elegantalis</i> , <i>Rhectocraspeda periusalis</i> , <i>Spoladea recurvalis</i> ; Erebidae: <i>Estigmene acrea</i> ; Gelechiidae: <i>Keiferia lycopersicella</i> , <i>Phthorimaea absoluta</i> , <i>P. operculella</i> ; Noctuidae: <i>Agrotis ipsilon</i> , <i>Chloridea virescens</i> , <i>Chrysodeixis includens</i> , <i>Feltia subterranea</i> , <i>Helicoverpa zea</i> , <i>Spodoptera albula</i> , <i>S. dolichos</i> , <i>S. eridania</i> , <i>S. exigua</i> , <i>S. frugiperda</i> , <i>S. latifascia</i> , <i>Trichoplusia ni</i> ; Sphingidae: <i>Erinnyis ello</i> , <i>Manduca sexta</i>

Conclusions

This preliminary study has provided valuable data about identity, hosts, life histories and damages caused by lepidopteran species on major crops in Panama. With this work, the author promotes intensive monitoring programs in the country in order to create contingency plans against new outbreaks of pests. This exercise has provided enough evidence and valuable material in order to train new generations of entomologists, plant health technicians, and farmers. In turn, the information provided with this study will allow them to identify and detect the incidence of these species in time. At the end of this work, the author has established important contacts for years of collaborative work on the Neotropical lepidopteran fauna.

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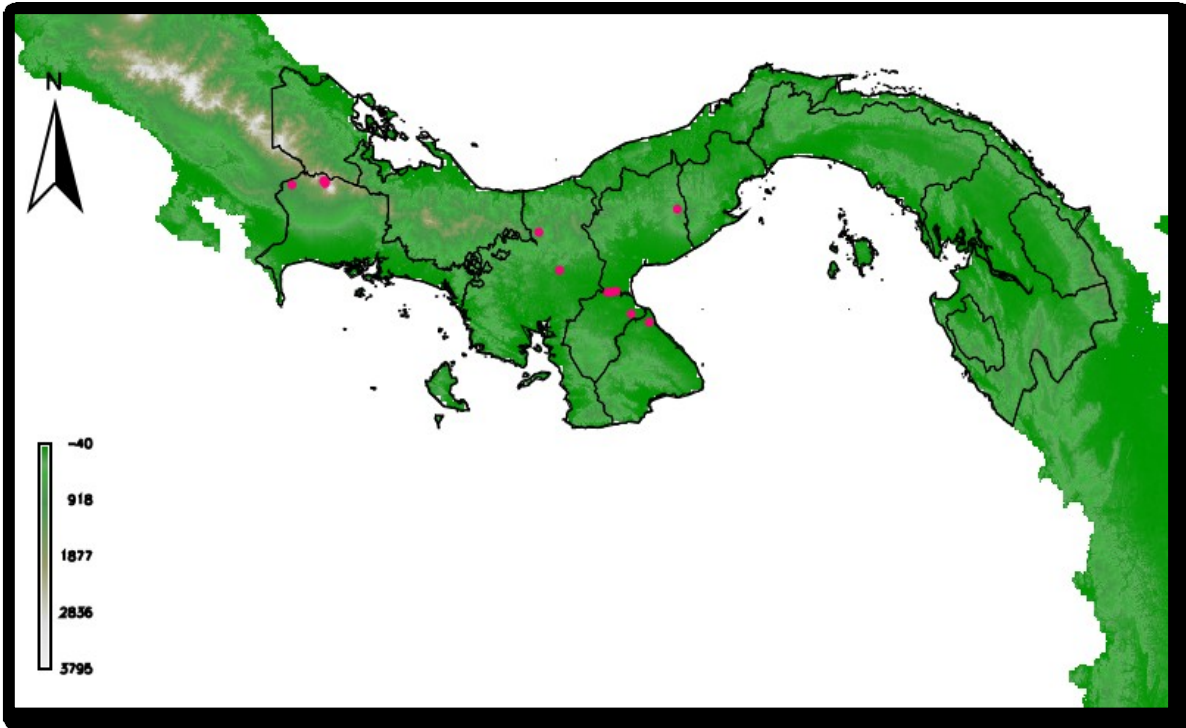
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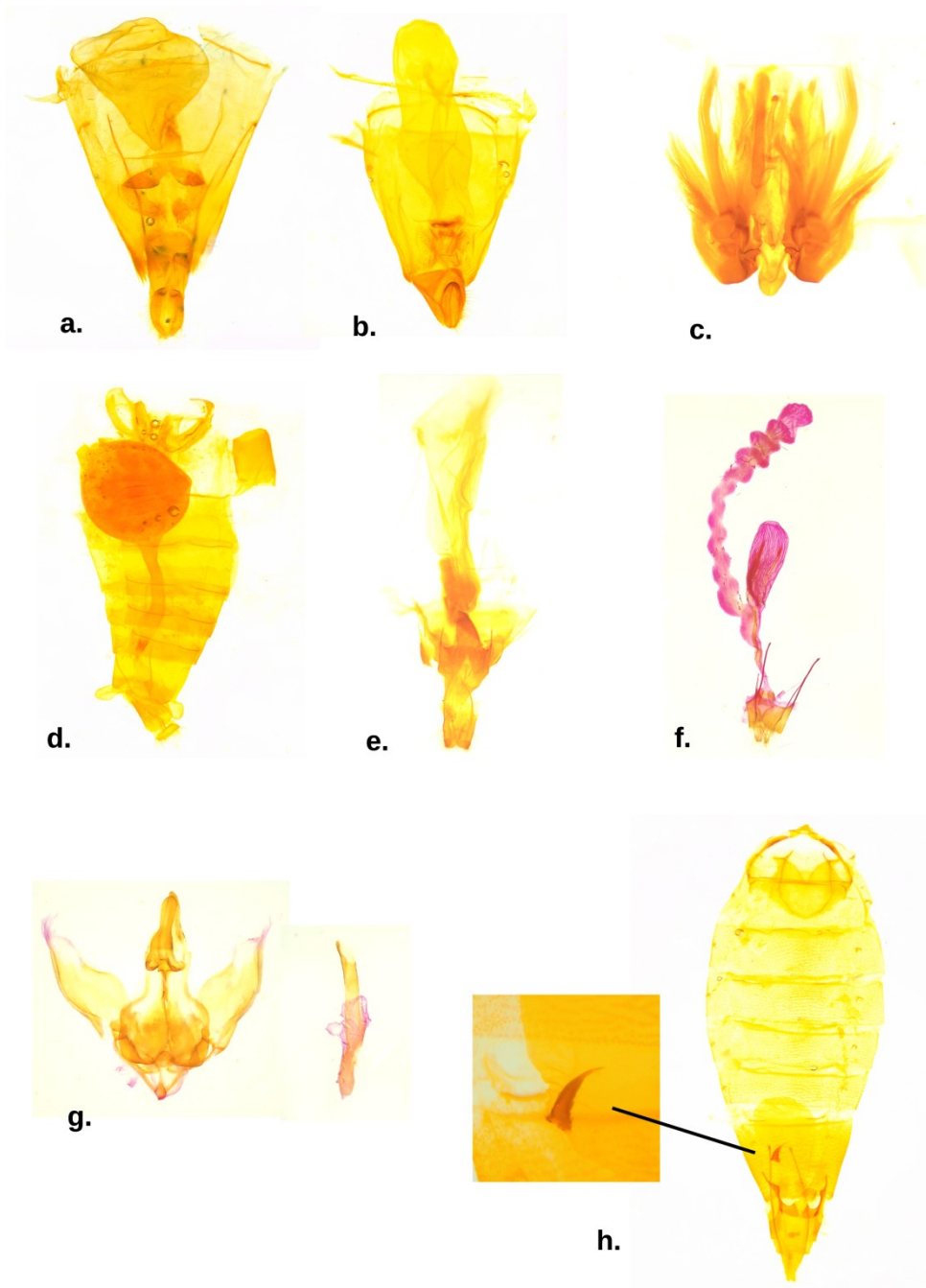
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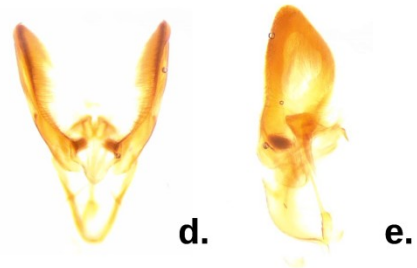
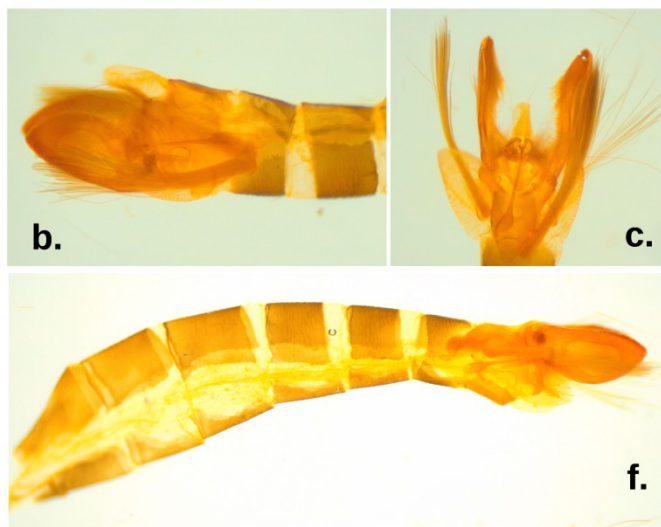
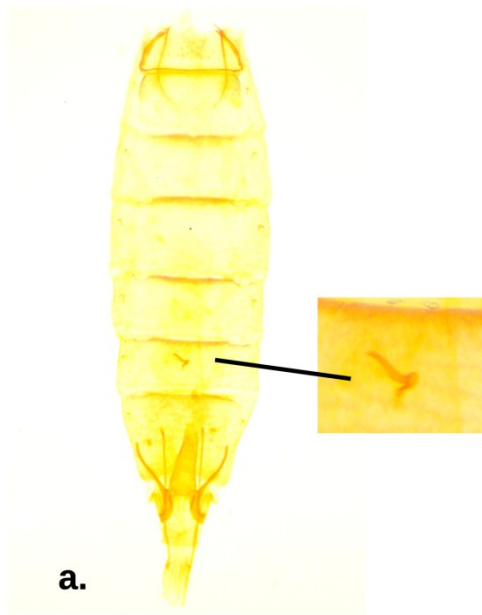
Supplementary Images



Supplementary data I. Map of the Republic de Panamá. The dots represent our sampling locations, which are main provinces of Panama with agricultural production. The scale bar shows the land elevation in m.a.s.l.



Supplementary data II. Genital dissections of major pests in Panamanian agriculture. a.) *Diatraea tabernella* Dyar, 1911. b.) *Diatraea lineolata* (Walker, 1856). c.) *Maruca vitrata* (Fabricius, 1787). d.) *Diaphania nitidalis* (Stoll, 1781). e.) *Marimatha piscimata* Ferris and Lafontain, 2010. f.) *Helicoverpa zea* (Boddie, 1850). g.) *Rupela albinella* (Stoll, [1781]). h.) *Tecia solanivora* (Povolný, 1973) and magnification of the signum.



Supplementary data III. Genitalic dissections of major pests in Panamanian agriculture. a.) *Phthorimaea absoluta* (Meyrick, 1917) and magnification of the signum. b-f.) *Plutella xylostella* (Linnaeus, 1758). male: b-c.) Detail of the abdomen and insertion of the coremata. d-e.) genitalia frontal and lateral. f.) lateral view of the abdomen.



Supplementary data IV. The field work in the agroecosystems. a.) Pepper crop in the Province of Los Santos, Panama. b.) The mercury vapor light was installed inside the crop area, to study the adult populations. c.) Lucent light trap to study the adult populations at the margins of the cultivated yield. d.) Annotations of the crop state, presence of larvae and damages during the day.



Supplementary data V. The laboratory work included rearings and photographs of the life histories. a-b.) Massive rearing. c-d.) Videos and photographs of the material was possible using a macro stand.

Conclusiones Generales

La tribu Gnorimoschemini se compone de un total de 68 géneros, de los cuales 33 pueden considerarse válidos y 35 sinónimos. Estudios de las relaciones filogenéticas que incluyen la morfología, la evidencia total y secuencias disponibles auguran significativos cambios en la clasificación de los taxones. Algunos géneros deberán ser transferidos a otras tribus de Gelechiidae y otros deberán ser sinonimizados a futuro.

El estudio morfológico de la tribu Gnorimoschemini permite encontrar elementos esenciales para su definición. Entre ellos es pertinente mencionar la relevancia que cobran las disecciones de los genitalia masculinas y femeninas. Por ejemplo, el estudio de estructuras como el saccus y los escleritos basales del saccus, que pueden o no fusionarse, dando un aspecto diamantado. Este último elemento resulta ser especialmente relevante en la definición de aquellos taxones pertenecientes a la tribu. De igual manera, es preciso observar la morfología del phallus y la presencia de una lamina ductis ejaculatoria; siendo el último aspecto muchas veces descuidado en las descripciones. En lo que respecta a los genitalia femeninas, cabe resaltar la importancia de la morfología del corpus bursae, la posición del signum en el corpus bursae y su forma. Estos caracteres son extremadamente relevantes en el estudio de las relaciones filogenéticas del grupo.

Caracteres como la braquiptería y la sinuación del ala posterior deben ser considerados al estudiar a la familia Gelechiidae, pues dentro de la familia resultan ser diagnósticos. Existen ciertas excepciones como en los géneros *Nealyda* (con especies reportadas para el Neotrópico) y *Dactylotula* (europeo).

No siempre la disposición de los palpos recurvados o dirigidos al dorso resultan ser diagnósticos para la familia Gelechiidae. Esto puede verse en los géneros *Dichomeris*, *Ptycerata* y *Tecia*. En estos géneros pueden encontrarse especies con los palpos prorectos.

La revisión de la literatura a nivel mundial demuestra un limitado conocimiento sobre las formas inmaduras de los Gelechiidae y particularmente de los Gnorimoschemini

Neotropicales. Cualquier esfuerzo destinado al estudio de su biología resulta extremadamente valioso, permitiendo conocer las relaciones de estos insectos con sus plantas huésped.

Para la región Neotropical se reporta la presencia de 17 géneros con tan sólo 199 especies conocidas de Gnorimoschemini. La mayor parte de este conocimiento deriva de exploraciones realizadas en América del Sur. Se sugiere expandir esfuerzos de muestreos hacia América Central y la región norte de América del Sur con el fin de ampliar el conocimiento del grupo y su distribución.

El estudio detallado de la tribu Gnorimoschemini permitió conocer de manera preliminar a través de un análisis filogenético que se confirman las sinonimias para los géneros *Tecia*, *Gnorimoschema*, *Symmetrischema* y *Keiferia*. Se confirma que *Phthorimaea* representa el grupo hermano de *Keiferia*. Queda confirmada de manera parcial la monofilia para la tribu Gnorimoschemini, destacando que algunos de sus miembros actuales pudiesen salir de la antigua clasificación basada en *Gnorimoschema* y en su lugar ser transferidos a una nueva tribu para la familia Gelechiidae.

Para Panamá, se confirma la presencia de tan sólo cinco especies de Gnorimoschemini asociadas a cultivos de solanáceas. Exploraciones y colectas realizadas en las zonas xéricas del país, Provincias Centrales, destacan la presencia de individuos de la familia Gelechiidae asociados a ecosistemas frágiles como lo es el Parque Nacional Sarigua, patrimonio natural del país.

El registro de la especie *Symmetrischema striatellum* resulta ser dudoso, pese a los esfuerzos de colecta realizados en el país, la especie no pudo ser colectada y se desconocen detalles del sitio de colecta exacto reportado por Povolný, en su lista sinóptica para el Neotrópico.

De las especies de la tribu Gnorimoschemini conocidas de Panamá, se decidió estudiar a profundidad la problemática que representó el taxón "*Tuta absoluta*". Durante décadas esta

especie ha mantenido una posición sistemática incierta, habiendo sido transferido cinco veces a diferentes géneros de la tribu Gnorimoschemini sin ninguna hipótesis filogenética que sustentara dichos cambios. Por primera vez, se proveen elementos morfológicos que sugieren que el taxon “*absoluta*” debe ser transferido al género *Phthorimaea* basándose en un análisis cladístico de la morfología.

A partir de la transferencia del taxon “*absoluta*” a *Phthorimaea*, se sugieren las siguientes combinaciones: *Phthorimaea chiquitella* comb. nov y se reinsta la combinación *Phthorimaea absoluta*. Adicionalmente, se mantienen válidos los géneros *Scrobipalpuloides* y *Tuta*.

Se describe una nueva especie para el género *Pavolechia* cuya distribución es Neotropical. La especie *Pavolechia mimetica* se encuentra asociada a ecosistemas montañosos de la provincia de Colón, localidad de Sierra Llorona. Se discute la posición sistemática tentativa del género dentro de la subfamilia Anacampsinae.

Los esfuerzos de colecta realizados a lo largo de Panamá permitieron la descripción de una nueva especie para el género *Colonanthes*, *C. korytkowskii* Corro Chang, 2020; a partir de este trabajo se pudo hacer la asociación de machos con sus respectivas hembras, para el género *Colonanthes*. Las hembras permanecían completamente desconocidas.

Se discute la posición sistemática del género *Colonanthes* en la tribu Litini, basándonos en el estudio detallado de caracteres morfológicos distintivos como son las escamas levantadas en las alas anteriores, la fusión basal del phallus con la juxta y la presencia de glandiuctores. Todos estos elementos morfológicos se encuentran presentes en las especies tipo de los géneros de la tribu Litini.

Se describen tres especies asociadas a ecosistemas frágiles de las provincias centrales de Panamá. Estos son: *Agnippe tarakanovi* Corro Chang y Bidzilya, 2020; *Chionodes sariguaensis* Corro Chang y Bidzilya, 2020 y *Aristotelia barriosi* Corro Chang y Bidzilya, 2020.

La especie *Iphimachaera picticollis* (Walsingham, 1912) se excluye del listado de Gelechiidae de Panamá y es transferido a la familia Depresariidae.

Las exploraciones a las distintas provincias de Panamá resultaron en 12 nuevos registros de Gelechiidae para el país, un total de 82 especies y la descripción de un total de 5 nuevas especies por la autora de esta obra.

El estudio de los agroecosistemas de Panamá permitió reportar de manera inicial la presencia de 69 especies de Lepidoptera, Heterocera asociados a la agricultura de Panamá. De estos muestreos se logró coleccionar ejemplares de la especie *Sitotroga cerealella* asociados a cultivos de maíz en estado avanzado y decayente.

Queda acotar qué elementos como el cambio climático y la urbanización están afectando los patrones de comportamiento usuales de las especies. En muchos casos, se está favoreciendo la aparición de nuevos brotes de especies que usualmente se encontraban en la región pero aumentando en gran número sus poblaciones, a tales niveles que pudiesen representar un riesgo para actividades agrícolas.

Especies como *Opogona omoscopia* y *Phaeoses sabinella* (Lepidoptera: Tineidae) se encuentran en gran número a lo largo de las provincias centrales de Panamá. Se comprueba su presencia a través de disecciones de los genitalia y se les asocia a cultivos en estados avanzados.

Appendix
Other publications in Lepidoptera

**BEHAVIOURAL NOTES AND ATTRACTION ON LEPIDOPTERA AROUND
THE GEHRY'S BIODIVERSITY MUSEUM (CAUSEWAY, CALZADA DE
AMADOR, PANAMÁ, REPÚBLICA DE PANAMÁ)**

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Abstract

This work represents a study of the diversity of Lepidoptera on the Gehry's Biodiversity Museum (MBG), in an attempt to generate a list of the diversity of butterflies and moths visiting the coastal ecosystem of the Causeway, Amador. Collection of insects was performed manually, over a period of ten months (June 16, 2014 to March 18, 2015) and photographic records of the behavior of other species preying on Lepidoptera were also included. A total of 326 specimens, representing 13 families were collected. These included 6 butterfly and 8 moth families and 52 genera, and 60 species. This study represents a contribution to the knowledge of species that frequent the area, and encourages the conservation and development of the Calzada de Amador as an important touristic site in the city of Panama.

Key words: Richness of species, abundance, butterflies, moths, Causeway.

Introduction

Monterrubio et al. (2013) suggest ecotourism as a mechanism for environmental conservation, economical growth, and improvement of local livelihoods. The improvement

of a botanical garden in Frank Gehry's new attraction, the Biodiversity Museum, promises a new source for environmental conservation of the nearby areas and as a butterfly house near the city of Panamá. The new building painted with bright colors represents the ethnical groups in Panamá, is a tribute to the wealth of fauna and flora within Panamá, and is a message to the world about how the Panamanian isthmus changed the world forever. Behind the museum there is more to discover and on the walls of this building, each day, thousand of species are interacting, resting and completing their lives histories. With this contribution we would like to: a.) study the diversity of Lepidoptera on the MBG, b.) generate a preliminary species checklist and c.) report notes of behavior including interactions between Lepidoptera and new habitats made by human intervention; particularly detaching the role of bright colors, and the addition of a botanical garden in the nearby areas, as possible attractants for the insects.

Materials and methods

Study area

This study was carried out in the botanical garden and near-by areas of the Gehry's Biodiversity Museum MBG (8°55'55.5"N, 79°32'41.7"W), Causeway, Calzada de Amador, Panamá Province, República de Panamá. The botanical garden covers 3 hectares of land, five different stations that recover the ethno botanical impact of plants through natural medicine, production and agriculture by the traditional use of different grasses in the erosion control of the soils. The Causeway is compound of four small islands by the Pacific entrance to the Panama Canal which are joined by a road (the Causeway), linked by rocks extracted from the Corte Culebra during the construction of the Panama Canal in 1913. The study area is characterized as coastal, interfered aquatic habitat with patches of forest. Most of them, modified by the human activity and constructions. The annual mean temperature is 28°C, with an annual precipitation of 1642 mm and it is located at sea level.

Sampling and preservation

Specimens were collected with entomological nets, killed by a soft pressure over the thorax, and stored in wax paper envelopes. All the biological material collected was stored at 0°C, in hermetic plastic boxes until it was processed in lab facilities at Programa Centroamericano de Maestría en Entomología (PCMENT), Universidad de Panamá. Each envelope contained the collection data label, including the names of the collectors and the dates. Observation and collection were done daily, and continuously during June of 2014 and March of 2005; between 08:00 to 13:00 hours near to the main entrance of the museum in a 50 m long transect that includes bushes and shrubs that attract butterflies, including *Lantana camara*, during sunny days without heavy rains or strong winds. Specimens were set with #1 and #2 entomological pins. Processing and spreading techniques for Lepidoptera samples were done following Triplehorn and Johnson (2005).

Identification

Determinations were made by comparisons with the material previously deposited at the Programa Centroamericano de Maestría en Entomología (Universidad de Panamá) already identified by specialists, and by review of DeVries (1987). We consulted Lamas (2004), Atlas of Neotropical Lepidoptera for updates on taxonomy and names of Papilionoidea and Hesperioidea; Heppner (1995), Heppner (1996) for updates of Pyraloidea and Sphingoidea; Gardwood and Leeman (2011), Gardwood and Leeman (2013), Gardwood and Leeman (2012) for recognition of the species during their flight; and Korytkowski (2013) for taxonomical keys to the moth groups. We also reviewed the classic literature to comprehend the descriptions of Panamanian moths collected during the Biological Survey (1910-1912) along the Panama Canal Area (Busck 1914, Dyar 1914). Part of the material collected during the research is deposited at the PCMENT entomology collection and in the personal collection of the author.

Results and discussion

A total of 326 specimens, representing 13 families (6 butterfly and 8 moth families) distributed in 52 genera and 60 species were collected at the MBG (Table 1). The highest proportion of the abundance was found in Nymphalidae (32%, Fig. 4) and Hesperidae (20%, Fig. 5) representing diurnally active Lepidoptera (Fig. 1); Papilionidae (5%) represented by 3 species (Fig. 2) and Pieridae (7%) with 4 species (Fig. 3). Moths were most abundant in the families Uraniidae (8%), Erebiidae (Fig. 9) and Crambidae (Fig. 6), each one of them represented by a 5% of the total (Fig. 1). Richness in this work was represented by the families Nymphalidae and Hesperidae with a total of 15 and 14 species, respectively. Meanwhile, moth richness was highly represented by 5 species corresponding to the family Erebiidae (Figs. 1, 9).

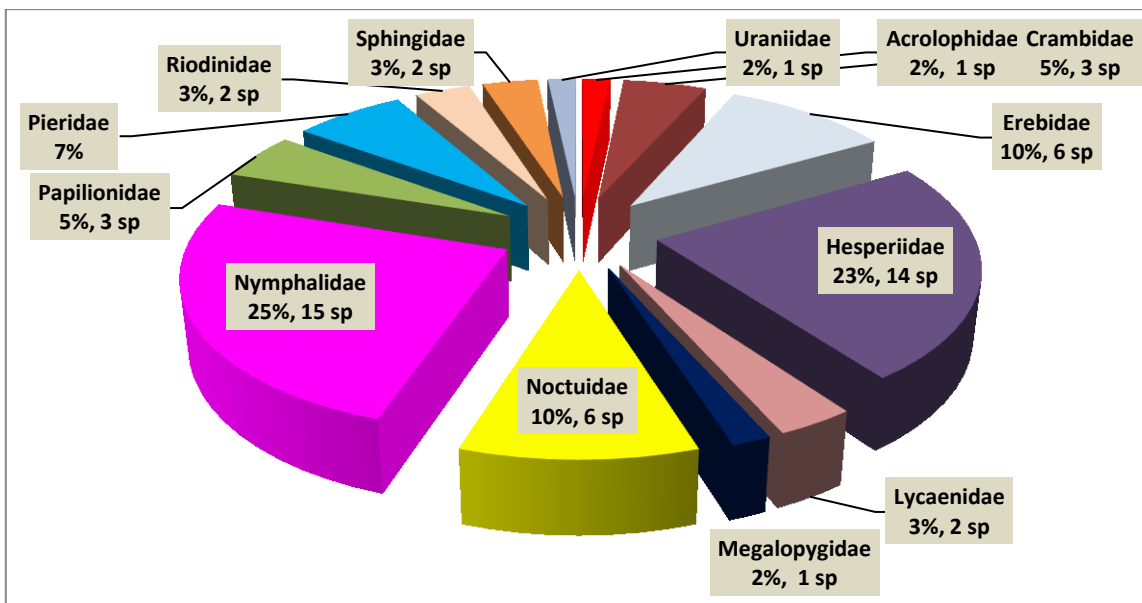


Figure 1. Percent representation of the abundance per Lepidoptera family.

Table 1. Checklist of Lepidoptera species around the Gehry's Biodiversity Museum.

Family	Subfamily	Tribe	Species	Common name (English)*
Acrolophidae			<i>Acrolophus panamae</i> Busck, 1914	Panama Grass Tube-worm Moth
Crambidae	Pyraustinae		<i>Herpetogramma phaeopteralis</i> (Guenée, 1854)	Sod Webworm Moth
Crambidae	Pyraustinae	Spilomelini	<i>Palpita flegia</i> (Cramer, 1777)	
Crambidae	Pyraustinae	Spilomelini	<i>Samea eclessialis</i> Guenée, 1854	
Erebidae	Arctiinae		<i>Calonotos metallicus</i> Druce, 1884	
Erebidae	Arctiinae	Arctiini	<i>Halysidota</i> sp.	
Erebidae	Arctiinae	Arctiini	<i>Horama plumipes</i> (Drury, 1773)	Wasp moth
Erebidae	Arctiinae	Arctiini	<i>Munona iridescens</i> Schaus, 1894	
Erebidae			<i>Spilosoma congrua</i> (Walker, 1855)	Agreeable Tiger Moth
Erebidae			<i>Uranophora leucotelus</i> (Butler, 1876)	
Hesperiidae	Hesperiinae	Anthoptini	<i>Anthoptus epictetus</i> (Fabricius, 1793)	Trailside Skipper
Hesperiidae	Pyrginae	Eudamini	<i>Astraptus fulgurator</i> (Walch, 1775)	Two-barred Flasher
Hesperiidae	Pyrginae	Eudamini	<i>Astraptus talus</i> (Cramer, 1777)	Green Flasher
Hesperiidae	Pyrginae	Pyrgini	<i>Bolla cupreiceps</i> (Mabille, 1891)	Copper-headed Sootywing
Hesperiidae	Hesperiinae	Calpodini	<i>Carystoides lebbaeus</i> (Hewitson, 1876)	Lebbaeus Rubyeye
Hesperiidae	Pyrginae	Pyrgini	<i>Nisoniades panama</i> Evans, 1953	Panamanian Tufted-Skipper
Hesperiidae	Hesperiinae	Moncini	<i>Parphorus nr. oegrus</i> (Godman, 1900)	Tawny-washed Skipper
Hesperiidae	Pyrginae	Pyrgini	<i>Pellicia arina</i> Evans, 1953	Glazed Tufted-Skipper
Hesperiidae	Pyrginae	Eudamini	<i>Phanus marshalli</i> (W.F. Kirby, 1880)	Common Ghost Skipper
Hesperiidae	Pyrginae	Achlyodini	<i>Quadrus cerialis</i> (Stoll, 1782)	Common Blue-Skipper
Hesperiidae	Hesperiinae	Calpodini	<i>Saliana esperi</i> Evans, 1955	Saliana
Hesperiidae	Pyrginae	Pyrgini	<i>Staphylus ascalaphus</i> (Staudinger, 1876)	Central American Sootywing
Hesperiidae	Pyrginae	Eudamini	<i>Urbanus dorantes</i> (Stoll, 1790)	Dorantes Longtail
Hesperiidae	Pyrginae	Eudamini	<i>Urbanus procne</i> (Plötz, 1880)	Brown Longtail
Lycaenidae	Theclinae	Eumaeini	<i>Calycopis drusilla</i> Field, 1967	Drusilla Groundstreak
Lycaenidae	Theclinae	Eumaeini	<i>Magnastigma hirsuta</i> (Prittwitz, 1865)	Hirsuta Hairstreak
Megalopygidae	Megalopyginae		<i>Megalopyge lanata</i> (Stoll, 1780)	Mangrove Flannel Moth
Noctuidae	Catocalinae		<i>Anticarsia gemmatalis</i> (Hübner, 1818)	Velvetbean Caterpillar Moth
Noctuidae	Catocalinae		<i>Ascalapha odorata</i> Linnaeus, 1758	Black Witch
Erebidae			<i>Letis</i> sp.	Marbled Witch
Noctuidae	Plusiinae		Noctuid sp. 1	
Noctuidae	Catocalinae		Noctuid sp. 2	
Noctuidae	Amphipyrynae		<i>Spodoptera</i> sp.	
Nymphalidae	Heliconiinae	Heliconiini	<i>Agraulis vanillae</i> (Linnaeus, 1758)	Passion butterfly
Nymphalidae	Nymphalinae	Kallimini	<i>Anartia fatima</i> (Fabricius, 1793)	Banded Peacock
Nymphalidae	Nymphalinae	Kallimini	<i>Anartia jatrophae</i> (Linnaeus, 1763)	White Peacock
Nymphalidae	Nymphalinae	Phyciodini	<i>Anthanassa frissia tulcis</i> (H.W. Bates, 1864)	Pale-banded Crescent
Nymphalidae	Brassolinae	Brassolini	<i>Brassolis isthmia</i> Bates, 1864	Small-spotted Owlet
Nymphalidae	Morphinae	Brassolini	<i>Caligo atreus</i> (Kollar, 1850)	Atreus/ Banded Giant Owl
Nymphalidae	Nymphalinae	Coeini	<i>Colobura dirce</i> (Linnaeus, 1758)	Dirce/Small Beauty

Table 1. Continue.

Family	Subfamily	Tribe	Species	Common name (English)*
Nymphalidae	Danainae	Danaini	<i>Danaus gillippus thersippus</i> (H.W.Bates, 1863)	Queen
Nymphalidae	Heliconiinae	Heliconiini	<i>Dryadula phaetusa</i> (Linnaeus, 1758)	Banded Orange
Nymphalidae	Heliconiinae	Heliconiini	<i>Dryas iulia</i> (Fabricius, 1775)	Julia
Nymphalidae	Heliconiinae	Argynnini	<i>Euptoieta hegesia</i> (Cramer, 1779)	Mexican Fritillary
Nymphalidae	Biblidinae	Biblidini	<i>Hamadryas laudamia</i> (Cramer, 1777)	Starry Night
Nymphalidae	Nymphalinae	Kallimini	<i>Junonia evarete</i> (Cramer, 1779)	Tropical Buckeye
Nymphalidae	Brassolinae	Brassolini	<i>Opsiphanes cassina</i> C. Felder & R. Felder, 1862	Split-banded Owlet
Nymphalidae	Nymphalinae	Kallimini	<i>Siproeta stelenes</i> (Linnaeus, 1758)	Malachite
Papilionidae	Papilioninae	Troidini	<i>Battus polydamas</i> (Linnaeus, 1758)	Polydamas Swallowtail
Papilionidae	Papilioninae	Papilionini	<i>Heraclides rumiko</i> (Shiraiwa & Grishin, 2014)	Western-giant Swallowtail
Papilionidae	Papilioninae	Troidini	<i>Parides anchisiades farfan</i> K.S. Brown, 1994	Anchises Cattleheart
Pieridae	Coliadae	Coliadini	<i>Eurema arbela gratiosa</i> (Doubleday, 1847)	Disjunct Yellow
Pieridae	Coliadae	Coliadini	<i>Eurema daira eugenia</i> (Wallengren, 1860)	Barred Yellow/ Barred sulphur
Pieridae	Coliadae	Coliadini	<i>Phoebis argante</i> (Fabricius, 1775)	Apricot Sulphur
Pieridae	Coliadae	Coliadini	<i>Phoebis sennae</i> (Linnaeus, 1758)	Cloudless Sulphur
Riodinidae	Theclinae	Eumaeini	<i>Eumaeus godartii</i> (Boisduval, 1870)	White-tipped Cycadian
Riodinidae	Riodininae	Riodinini	<i>Melanis pixe sanguinea</i> (Stichel, 1910)	Red-bordered Pixie
Sphingidae	Macroglossinae	Dilophonotini	<i>Isognathus scyron</i> (Cramer, 1780)	
Sphingidae	Sphinginae	Sphingini	<i>Manduca rustica rustica</i> (Fabricius, 1775)	Rustic Sphinx
Uraniidae	Uraniinae		<i>Urania fulgens</i> (Walker, 1854)	Urania Swallowtail

The elaboration of the present checklist (Table 1) is a compilation of the species that inhabit the coastal ecosystem of Amador, day by day. The area is visited by tourists from all over the world that keep their sight in this attractive point of Panama. MBG has a strategic position, is surrounded by the Pacific Ocean, and which shows the contrast between the city of Panama and a non intervened main land of Fort Kobbe and Veracruz, that still nonurbanized. The distance between Fort Kobbe (largely vegetated) and the Causeway shows that most of the species could be flying actively across the narrow strip of ocean and stopping at the MBG botanical garden exploiting food sources and new habitats provided by human intervention. In addition, the bright color of the building attracts the attention of many species of birds and butterflies (Suppl. materials 1, 2). Other researchers suggests that constructions such as buildings and wind power facilities could be involved in species mortality during their daily activity; they frequently retrieve carcasses of bats, birds and insects (Kerns and Kerlinger 2004; Piorkowski 2006; Long et al. 2010). Studies in Scandinavia demonstrate that the addition of bright color and different constructions, such

as wind turbines, plays an important role on the fauna with impacts on their activities including their migratory patterns (Ahlén et al. 2007), if we compare the results from this study and the preliminary observations of our work it is possible to create relationships with the Gehry's museum situation. It is contributing to insect activities, is an attractant, and also is an artificial barrier during bird migratory season (Fig. 8). Studies on the impacts including effects of new architectural concepts still leave gaps in our knowledge (Long et al. 2010) and particularly in Panama; this is the first contribution in this topic.

Some notes related to behavior and interaction patterns were registered over the colored surfaces of the building (Suppl. materials 1, 2). *Saliana esperii* shows a particular preference for the yellowish surfaces of the building; many times, this species was observed visiting the walls and posing over it, extending its proboscis and constantly searching for nutritional sources on different portions of the wall surface. Walls of the MBG building also function as an arena for predators, developing complex nets of interactions (Fig. 7). Females of the species *Pelegrina variegata* Arachnida: Salticidae, are frequent all over the walls of the building, opportunistically catching various species of insects that lie on different portions of the wall. As of this work we have witnessed predation of the crambid moth *Samea ecclesialis* by *P. variegata* and its preference for this particular species of moth (Figs. 6, 7). The yellow walls of the building also serve as resting place for *Urania fulgens* during their migration across Panama in the months of March and June, each year (Smith 1983). But glass of the building also represents a risk to other species such as birds during their migration times, many species of bird hit the window glass (Fig. 8). Meanwhile, diurnal moths such as *Horama plumipes*, lie on the glass that connects to the Gehry's temporary exhibits, displaying their perfectly mimicry to wasps of the family Sphecidae (Fig. 9).

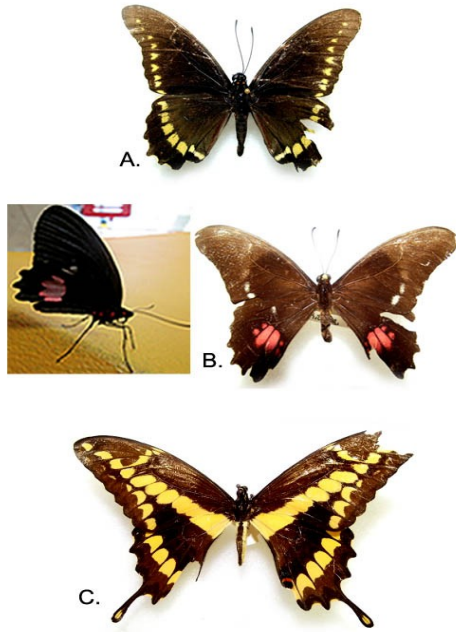


Figure 2. Papilionidae. A). *Battus polydamas*; B). *Parides anchisiades*; C). *Heraclides rumiko*.

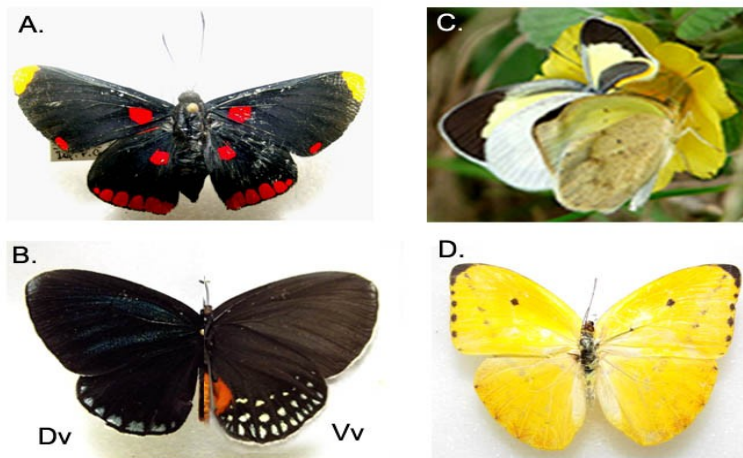


Figure 3. Riodinidae. A). *Melanis pixie*; B). *Eumaeus godartii* Dv:dorsal; Vv:ventral; Pieridae. C). *Eurema dairia eugenia*; D). *Phoebis argante*.

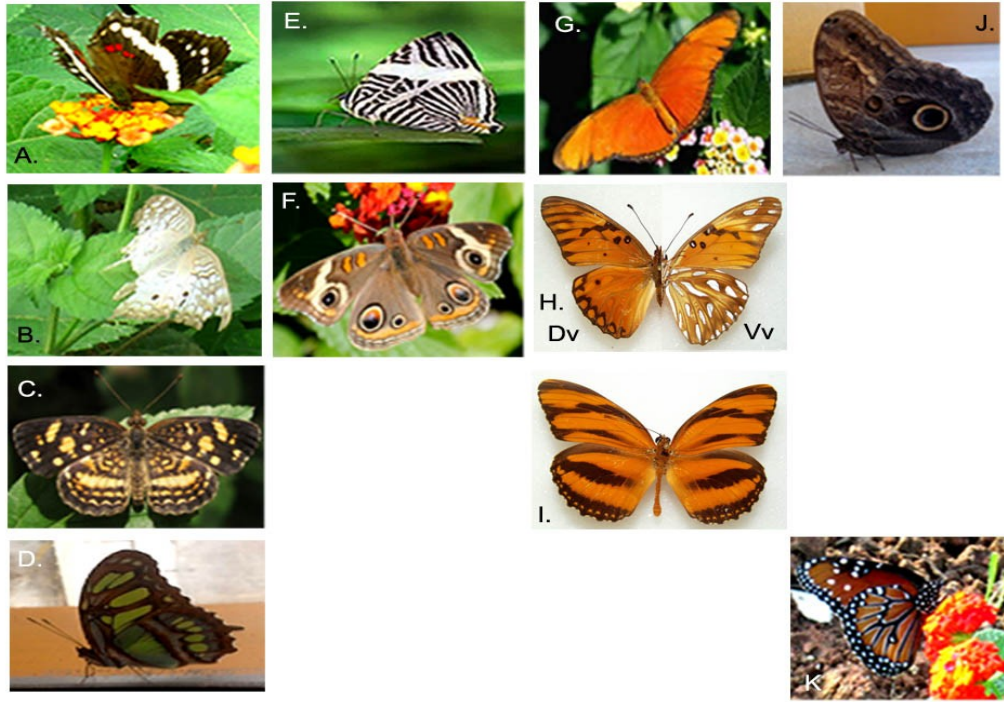


Figure 4. Nymphalidae. Nymphalinae. A). *Anartia Fatima*; B). *A. jatrophae*; C). *Anthanassa tulcis*; D). *Siproeta stelenes*; E). *Colobura dirce*; F). *Junonia evarete*; Heliconiinae. G). *Dryas iulia*; H). *Agraulis vanilla*; I). *Dryadula phaetusa*; Morphinae. J). *Caligo atreus*; Danainae. K). *Danaus gillipus*.

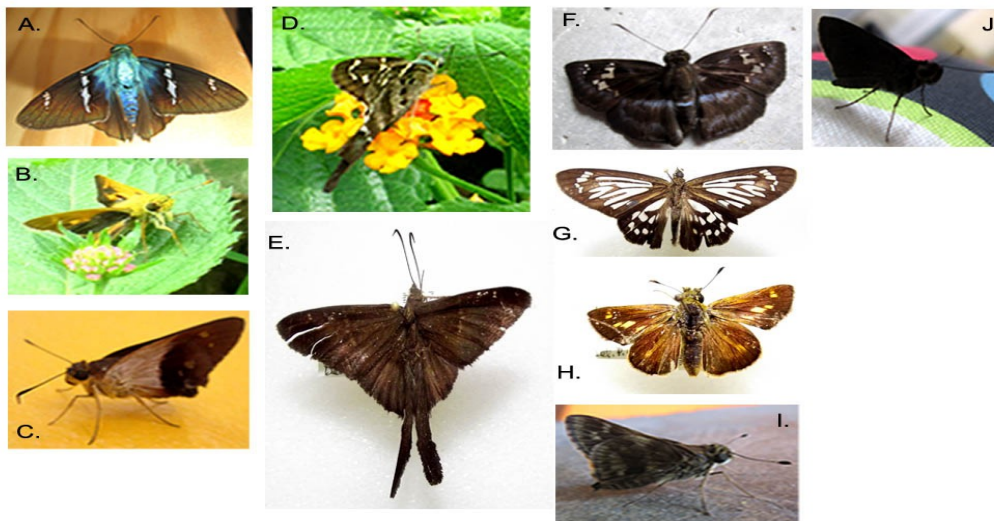


Figure 5. Hesperidae. A). *Astrartes fulgerator*; B.) *Anthoptus epictetus*; C). *Saliana esperi*; D). *Urbanus dorantes*; E). *U. procne*; F). *Quadrus cerialis*; G). *Phanus marshalli*; H). *Parphorus nr. oegrus*; I). *Pellicia arina*; J.) *Bolla* sp.

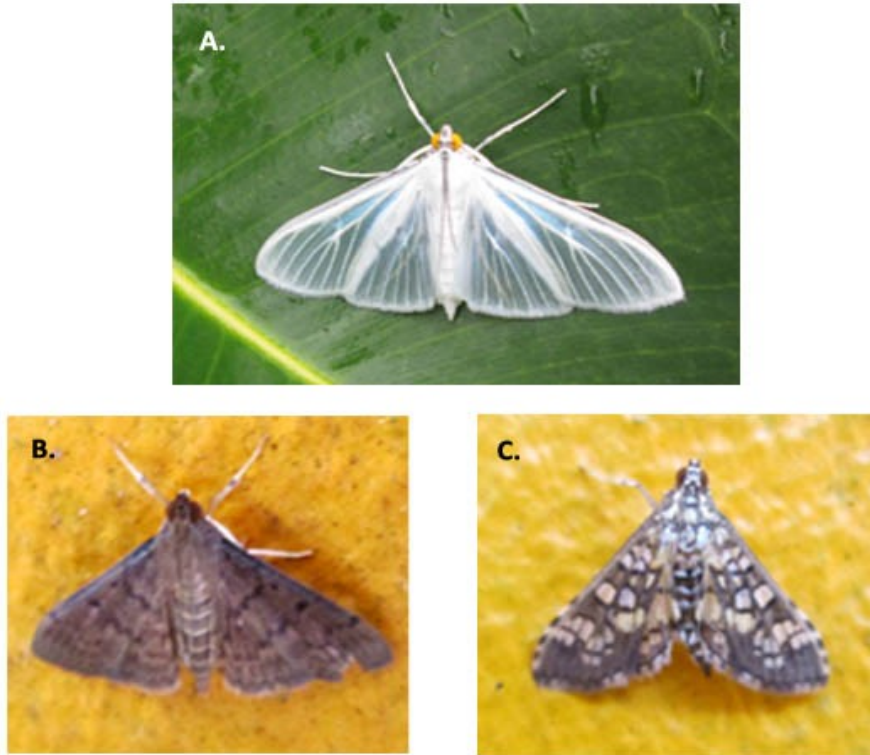


Figure 6. Crambidae. A.) *Palpita flegia*; B.) *Herpetogramma phaeopteralis*; C.) *Samea ecclesialis*.

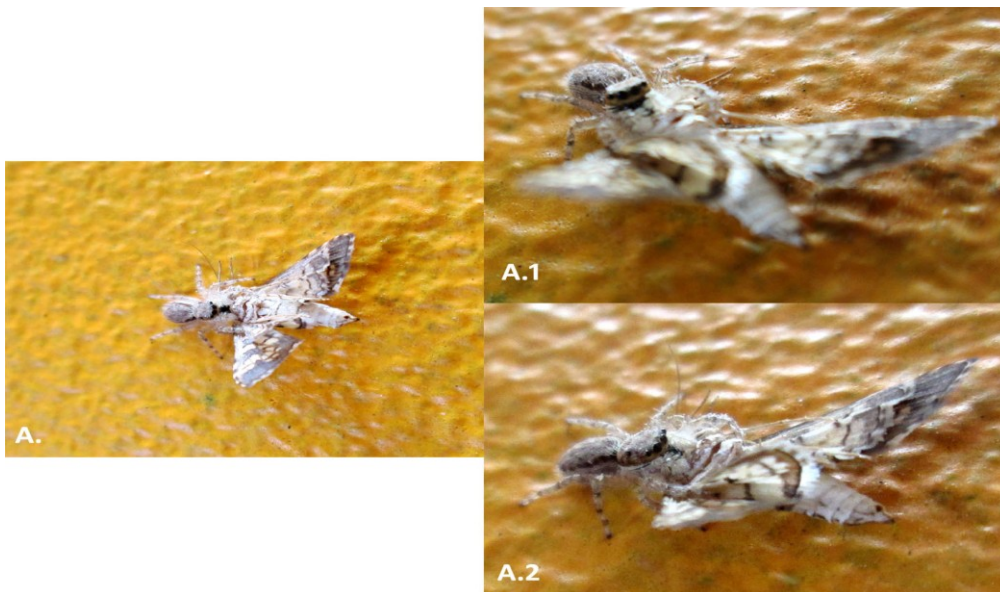


Figure 7. A female of *Pelegrina variegata* (Pickard-Cambridge F., 1901) predating *Samea ecclesialis* Guenée, 1854 perched on the walls of the Gehry's Biodiversity Museum.



Figure 8. Some birds hit the glass of the Gehry's temporary exhibition corner during their migratory season.

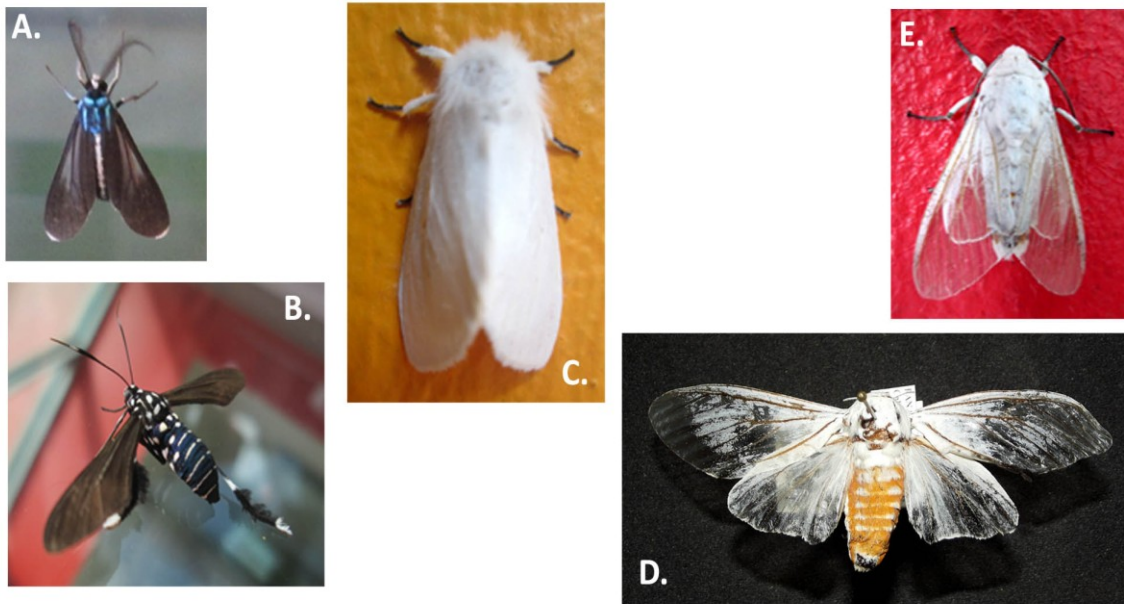


Figure 9. Erebidae. A.) *Uranophora leucotelus*; B.) *Horama plumipes*; C.) *Spilosoma congrua*; D.) *Halysidota* sp.; E.) *Munona iridescens*.

Conclusions

The coastal ecosystem of Amador has a rich Lepidoptera fauna, besides the strong human intervention in this area; species exploit the various sources that the MBG offers. The addition of colors, a botanical garden and shapes on this construction serve as attractants for day active species and variety of interactions. This work represents a preliminary contribution to our knowledge of the species of Lepidoptera active in the Calzada de Amador, and will answer many of the questions asked by visitors interested in the fauna of this important tourist point of Panamá, thus promoting its conservation.

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**PANAMA MOTHS: NOTES ON THE LIFE HISTORY OF *GONODONTA*
INCURVA (SEPP, [1840]) (EREBIDAE, CALPINAE)**

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Abstract

The Neotropical genus *Gonodonta* Hübner, 1818 includes 39 species for Panamá, and a total of 55 barcodes with several new species to be described. This work presents behavioral notes and a new altitudinal record for *G. incurva* (Sepp, [1840]), in Panamá.

Key words: Panama moth series, conservation, wildlife biology.

Introduction

Todd^{1,2} reviewed the neotropical genus *Gonodonta* Hübner, 1818, reporting 39 species. The species have a significant impact on agriculture, feeding on fruits of the families Annonaceae, Anacardiaceae, Solanaceae and Rutaceae. The adult moths pierce the strong cuticles of the fruits, thus reducing their commercial value. This feeding habit gives them the common name of “*fruit piercing moths.*” Some studies suggest that in the Neotropics larvae affect 85% of the cultivated yields and 30% defoliation^{3,4}. Besides their agricultural impact, species of the genus *Gonodonta* can live in non cultivated areas, feeding on a wide variety of plants. The adults on flight are important pollinators of Neotropical plants, including endangered species of orchids. However, to understand their possible associations and beneficial relationships to different species; it is important to increase studies on life histories and behavioral patterns in the Neotropics. The following work is part of the Panamanian moth’s series that will provide notes on behavior and life histories, and promote conservation of the moth fauna and wildlife sources in Latin American countries.

GONODONTA HÜBNER, 1818

Gonodonta uncina Hübner, 1818

Athysania Hübner, 1823

Phalaena chorinea Stoll, 1780

Dosa Walker, 1865

Dosa obesa Walker, 1865

The genus *Gonodonta* Hübner, 1818 was described based on a Brazilian species, *G. uncina* Hübner. Morphological studies based on dissections of the genitalia suggest that *G. uncina* is a junior synonym of *G. sicheas* (Cramer, 1777). It is likely that a considerable number of species remain unknown to science. Through basic studies of the group; we can learn about their life histories, and thus their important niches within ecosystems. That information will provide valuable insights into the natural history of the rich Neotropical moth fauna that awaits study.

***Gonodonta incurva* (Sepp, [1840])**

Phalaena incurva Sepp, 1832, **synonym**

Larva. 5 instars. Length at maturity: 6-30 mm; blackish, prothorax with yellow dots, laterally; abdomen with orange maculae on each segment, laterally. In preparation for pupation, the final stage larva (prepupa) builds a cocoon consisting of pieces of leaves, pasted together with silk threads (Fig. 1C).

Pupa. Length: 21.91 mm; dark brown, punctuate dorsally; inside cocoon (Fig. 2A).

Adult. Wingspan: 38.33 mm; brownish except head, which is partially covered with yellow scales. Abdomen: brownish, yellow ventrally. Forewings: light brown, termen provided with purple patches; hind wings gray, with a round yellow macula, evanescent, on the discal cell. The adult assumes a tented resting position, which is cryptic on dry wood surfaces (Fig. 2B). The adults can live 20 days feeding on nectar, while the complete life

history can span 65 days at 20° C. The males are attracted to mercury vapor lights on warm nights with no moon and after rain, when moisture increases.

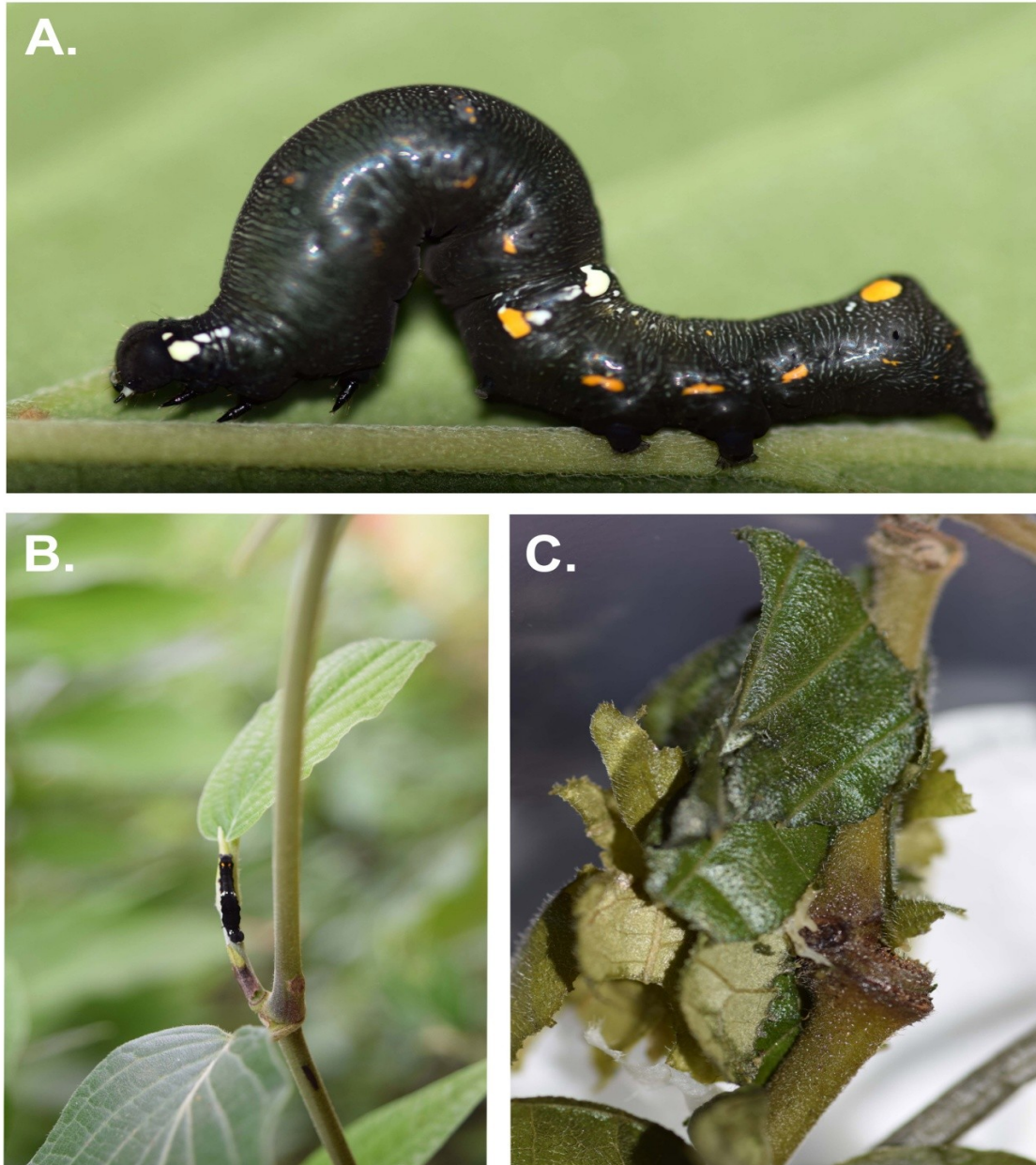


Figure 1. Life history of *Gonodonta incurva* (Sepp, [1840]). **A.** Final stadium larva of *G. incurva* before construction of the cocoon; **B.** Second stadium of *G. incurva* feeding on *Piper duckei* (Piperaceae); **C.** Cocoon made by *G. incurva* under standardized lab conditions.



Figure 2. *Gonodonta incurva* (Sepp, [1840]). **A.** Cocoon opened to show the dorsal view of the pupa inside; **B.** Dorsal view, adult of *G. incurva* (Sepp, [1840]) reared under standardized lab conditions.

♂ **Genitalia.** Coremata tuft-like, ventrally inserted at segment VIII (Fig. 3C); tegumen sub-rectangular, elongated; vinculum sub-triangular; juxta lobes sub-quadrangular, bifurcate

distally; hook-like uncus, covered with erect setae; valva (Fig. 4); saccus protuberant, sclerotized, sub-triangular, 0.5 times length of valva; aedeagus sub-rectangular, sclerotized, cornuti minute, sclerotized, tooth-like, distally.



Figure 3. A. *Gonodonta incurva* (Sepp, [1840]) abdomen; B. Abdominal pelts of *Gonodonta* species, showing ventral view; C. tuft-like coremata.

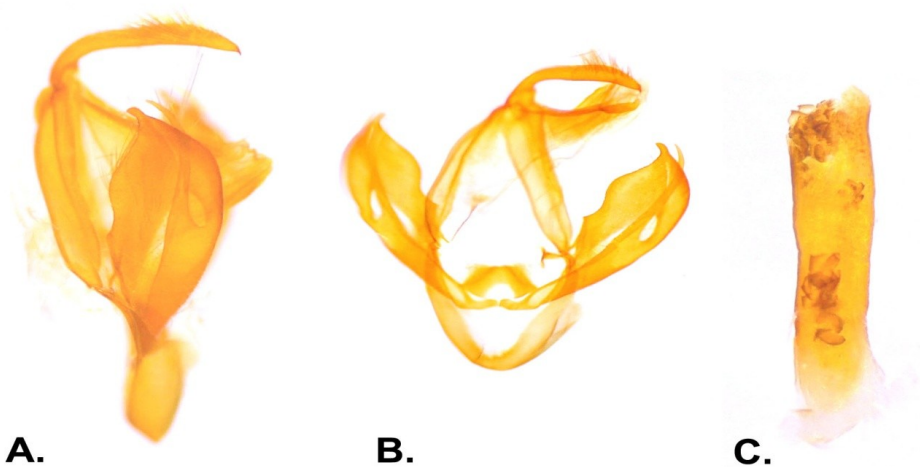


Figure 4. *Gonodonta incurva* (Sepp, [1840]) male, genitalia. A. Lateral view; B. Frontal; C. Phallus.

Remarks. According to Todd ¹, the type specimen of *G. incurva* (Sepp, [1840]) has been lost, and the original description was based on material from Suriname.

Biology. The larvae reared in this study ate *Piper duckei* C. D. (Piperaceae). The literature states that the species can be found from 400 to 1,000 m.a.s.l.¹. But the inventories carried out in Panamá show that *G. incurva* (Sepp, [1840]) can occur as low as 110 m.a.s.l. representing a new altitudinal record for the species. Our field observations suggest a particular preference for environments with high humidity, 70% to 90% in areas with moderate anthropogenic disturbance.

Distribution. Widespread throughout the Americas except arid areas¹. This study confirms the presence of the species in Panamá.

The larvae raised in this study were collected in Veraguas Province, at El Mirador, on a trail near a river (08.2599° N; 080.9760° W), República de Panamá. The life history records include larva: 12 days; pupa: 20 days; adult: 5 days. The material was collected at the beginning of the rainy season (June, 2016). The reared material and vouchers of plant damage are deposited in the personal collection of Patricia Corro Chang, at Programa Centroamericano de Maestría en Entomología (PCMENT).

Conclusions

This work is a short contribution to the knowledge of life histories of the rich diversity of Panamanian moths. The author encourages systematic inventories in the region in order to understand patterns of seasonality, and provide biological information about the Neotropical fauna.

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Conflict of interest

The author declares that there is no conflict of interest.

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Glossary

Anellus: small lobular sclerite present on the male genitalia of some Lepidoptera.

Brachypterous: a condition of developing short wings.

Caecum: in male Lepidoptera, it is a sac-like or tube-like structure with one opening, located at the basal part of the phallus.

Campaniform sensilla: mechanoreceptor visible externally as an area of thin cuticle, domed and usually with an oval shape. It is present at the base of the wing on some Diptera and in the head of some Lepidoptera.

Chaetosemata: a cluster of sensory bristles on the head of some adult Lepidoptera.

Chaetotaxy: the arrangement and nomenclature of the setae or bristles on any part of the exoskeleton of an insect. In Lepidoptera, it is important in the determination of the larvae.

Coremata: a pair of eversible sacs located laterally, ventrolaterally, dorsally or terminally on the abdominal segments I, VII, VIII, IX or a combination of these; typically containing long hair-pencils or brushes of modified hairs or scales, presumably for scent distribution.

Crochet: small hook-like organ; in Lepidoptera larvae these are curved spines located on the planta of the prolegs.

Culcitula: a cushion-like membranous structure that usually extends the base of the gnathos (male genitalia). This structure could be crucial in the definition of the tribes Gnorimoschemini and Litini.

Dalibor Povolný: a Czech entomologist (Nov. 13, 1924 – Nov. 6, 2004), who dedicated his life on the study of Lepidoptera and Diptera. Povolný authored more than 52 taxa, and described for the first time the tribe Gnorimoschemini in 1984.

Evanescent: fading coloration.

Gall-maker: these are phytophagous insects (larva) able to colonize the plant and produce abnormal growths on it.

Glandiductor: needle-like processes located near the base of the phallus (male genitalia), and a presumptive primitive condition in the Gelechiidae.

Gnorimoschemini: tribe of Gelechiidae described on 1984 by Dalibor Povolný.

Lamina ducti ejaculatorii: shield-like sclerite sometimes prominent, located over the bulbus ejaculatorius in some Lepidoptera. This is a poorly studied character in male Lepidoptera, and its presence in the Gnorimoschemini can be diagnostic.

Leafminer: phytophagous insects (larva) able to feed in leaf tissue of the plant. The pattern of the mine could be in some cases characteristic for the species.

Melanization: unusual darkening of color owing to increased amounts of dark pigment.

Micro-moth: artificial grouping of moths families, commonly known as “small-moths”, but not all the micro-moths are small. For example members of the families Cossidae, Hepialidae, Crambidae and Pyralidae belong to this grouping.

Morphology: science dedicated to the study of form; it is a branch of the biology that studies the wide variety of forms of living organisms, and the relationships between their structures.

Obsolescent: becoming obsolete or going out of use.

Shelter: temporary place that gives protection to the larva during first instars.

Single strategy (larva): a unique life strategy of the larva during its development. For example, *Gnorimoschema gallaesolidaginis* (Gnorimoschemini) is a gall-maker in all the instars.

Sinuation: a sharpened apical apex of the hindwing and very characteristic in the Gelechiidae.

Sitophore: the cibarium or cibarial sclerite.

Spermatheca: in the females, it is the sperm receptacle during coition. In the Lepidoptera, the morphology of this structure has been poorly studied.

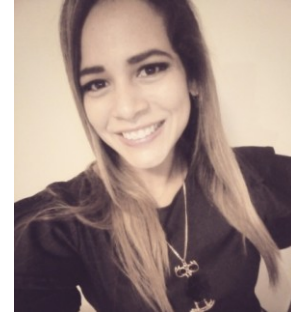
Venation: it is the arrangement of veins in an insects wing.

Wingspan: the maximum extent across the wing of a Lepidoptera, from wing tip to wing tip and including the thorax.

Curriculum vitae

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