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Taxonomic Paper

Review of recent taxonomic changes to the emerald moths (Lepidoptera: Geometridae: Geometrinae)

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Abstract

Background

The subfamily Geometrinae (Lepidoptera: Geometridae), commonly known as emerald moths, is an ecologically diverse group of moths with over 2,500 described species. Many taxonomic and phylogenetic studies of Geometrinae have been undertaken in the past decade, resulting in hundreds of new taxonomic changes since online publication of the most recent checklist in December 2007.

New information

This review synthesises the last 12 years of *alpha*-taxonomic research in Geometrinae. A comprehensive list of Geometrinae genus- and species-group descriptions, synonymies, combinations and other taxonomic changes, made since 2007, is provided. Since 2007, the known species richness of Geometrinae has increased from 2,529 to 2,642 species; an updated list of all these species is presented in a supplementary spreadsheet.

Keywords

Classification, Geometridae, Geometrinae

Introduction

The family Geometridae is an incredibly diverse lineage of moths that contains over 23,000 described species, making it the second-most speciose family in all of Lepidoptera (Scoble and Hausmann 2007, van Nieukerken et al. 2011). Although the subfamily Geometrinae only comprises roughly one-tenth of this species richness, it is one of the more recognisable geometrid subfamilies because of the green colouration found in most adults and some larvae. Geometrinae are consequently known as ‘emerald moths’ and have been the subjects of studies on phenotypic plasticity and polyphenism (Greene 1989, Canfield et al. 2008). Many authoritative taxonomic works on Geometrinae have been published over the years, but with many new species being described annually, it does not take long for an update to become necessary.

Parsons et al. (1999) published a two-volume catalogue of the geometrid moths of the world, which is currently the most recently printed work that contains a comprehensive checklist of the global emerald moth fauna. However, between 1999 and 2007, one of this checklist’s co-authors, Malcolm Scoble, worked with Axel Hausmann to update the checklist; these revisions are hosted on the Lepidoptera Barcode of Life website. At the time of the most recent update (December 2007), the online checklist contained 269 genera and 2,529 species of Geometrinae. Since then, hundreds of taxonomic changes have been made in this subfamily, including over 100 new species. In this review, we catalogue the last 12 years of emerald moth taxonomy and update the list of geometrines provided by Scoble and Hausmann (2007) to include all newly-described emerald moth species.

Materials and methods

Updates and changes to the online checklist of Geometrinae are presented in alphabetical order by genus, following the format used by Scoble and Hausmann (2007). Since their checklist was last updated in December 2007, the taxonomic literature published between January 2008 and December 2019, inclusive, was consulted. It was also found that some taxonomic works (e.g. Beljaev 2007) were published prior to December 2007, but were not incorporated into the update; these are consequently included in this review.

Within each genus section, valid species names are listed in alphabetical order, with junior synonyms placed on an indented line following the corresponding senior synonym. Only genus- and species-group taxonomic changes in Geometrinae are discussed here; a review of recent family-group taxonomic changes can be found in Ban et al. (2018) and Murillo-Ramos et al. (2019), both of whom have also proposed new taxonomic changes to the geometrine tribes and subtribes, based on molecular phylogenetic data. Scoble and

Hausmann (2007) did not include subspecies in their checklist, but post-2007 taxonomic changes to subspecies are discussed in this review.

The type of taxonomic change is indicated in parentheses. In this catalogue, the word 'new' and the abbreviation 'nov.' (novus, -a, -um) both denote that a taxonomic change was recent enough to not appear in the checklist of Scoble and Hausmann (2007). In this review, no taxonomic changes are proposed for the first time; this is further emphasised by the use of quotation marks surrounding each record of taxonomic change in the Results. Citations for recent taxonomic changes are provided in corresponding Remarks sections for each genus. The vast majority of taxonomic changes discussed here were proposed based solely on morphological evidence, such as variation in colour patterns, wing venation and genitalic characters of the adults. If molecular evidence were used to justify a taxonomic change, this is noted in the corresponding Remarks section.

If the status of a subspecies has been changed or a new synonymy has been proposed, the name of the associated valid species name is provided for context. Otherwise, species that have not undergone any taxonomic changes since the publication of Scoble and Hausmann (2007) are not included in the main text; a full list of all current Geometrinae species names is provided in the supplementary material. Similarly, synonyms that are not directly associated with a recent taxonomic change are excluded from the text.

Multiple Latin abbreviations for standard taxonomic terms are used throughout the text. Since the abbreviations themselves are not standardised across all taxonomic literature and do not appear at all in Scoble and Hausmann (2007), the notation used by Kitching et al. (2018) for a recent checklist of bombycoid moths was applied here in both the main text and supplementary material. These abbreviations and their definitions, are as follows:

“comb. nov.” – new combination

“comb. rev.” – revived combination

“gen. nov.” – new genus

“nom. nov.” – new replacement name

“nom. nud.” – nomen nudum (without description, thus unavailable)

“sp. nov.” – new species

“ssp. nov.” – new subspecies

“stat. nov.” – new status

“stat. rev.” – revived status

“syn. nov.” – new synonym

“syn. rev.” – revived synonym

Data resources

The list of taxonomic changes made in Geometrinae since publication of Scoble and Hausmann (2007) and the updated list of emerald moth species of the world are provided as tables (Excel format) in Suppl. material 1.

List of Geometrinae genera and species associated with recent taxonomic changes

Genus *Acidaliastis* Hampson, 1896

Nomenclature:

Acidaliastis porphyretica Prout, 1925

Acidaliastis subbrunnescens Prout, 1916

Notes: The AfroMoths database (De Prins and De Prins 2019) states, without a citation, that *Acidaliastis porphyretica* was transferred to the genus *Acidromodes* Hausmann, 1996 and that *Acidaliastis subbrunnescens* was transferred to *Hemidromodes* Prout, 1916. After searching the literature, these names were found on other online species lists, but there did not appear to be any formal publications that proposed these new combinations. Thus, *Acidaliastis porphyretica* and *Acidaliastis subbrunnescens* are currently considered the valid names for these species.

Genus *Agathia* Guenée, [1858]

Nomenclature:

Agathia microlaetata Goyal, Kirti & Saxena, 2018 ("sp. nov.")

Notes: The name and locality of *Agathia microlaetata* appeared in Kirti et al. (2012), but this new species was not formally described until it appeared in Goyal et al. (2018).

Genus *Albinospila* Holloway, 1996

Nomenclature:

Albinospila juancarlosi Tautel & Barrion-Dupo, 2017 (“sp. nov.”)

Albinospila variifrons (Prout, 1917) (“comb. nov.”)

Notes: One new species was described (Tautel and Barrion-Dupo 2017). *Albinospila variifrons* was transferred from *Comostola* Meyrick, 1888 by Tautel and Barrion-Dupo (2017).

Genus *Aoshakuna* Matsumura, 1925 ("stat. rev.")

Nomenclature:

Nipponogelasma Inoue, 1946 ("syn. nov.")

Aoshakuna lucia (Thierry-Mieg, 1916) ("comb. nov.")

Aoshakuna sachalinensis Matsumura, 1925 ("syn. nov.")

Aoshakuna lucia ussurica Beljaev, 2007 ("ssp. nov.")

Notes: One new subspecies was described (Beljaev 2007).

Aoshakuna was previously a junior synonym of *Chlorissa* Stephens, but was re-instated by Beljaev (2007). In the same revision, Beljaev (2007) subsequently designated *Nipponogelasma* a junior synonym of *Aoshakuna.* As a result of this synonymy, *Nipponogelasma lucia* was transferred to *Aoshakuna*, creating the new combination *A. lucia*. Beljaev (2007) then synonymised this species with *A. sachalinensis*, the type species of *Aoshakuna*.

Genus *Assachlora* Viidalepp & Lindt, 2012 ("gen. nov.")

Nomenclature:

Assachlora assa (Druce, 1892) ("comb. nov.")

Assachlora julietae Viidalepp & Lindt, 2012 ("sp. nov.")

Assachlora mitigata (Prout, 1912) ("comb. nov.")

Notes: One new species was described in this new genus (Viidalepp and Lindt 2012). *Assachlora assa* and *A. mitigata* were transferred from *Phrudocentra* Warren, 1895 by Viidalepp and Lindt (2012). *Assachlora* currently contains three species, with *A. assa* designated as the type species.

Genus *Bathycolpodes* Prout, 1912

Nomenclature:

Bathycolpodes parexplanata Karisch & Hoppe, 2010 ("sp. nov.")

Bathycolpodes roehrichti Karisch, 2010 ("sp. nov.")

Bathycolpodes scheeli Karisch & Hoppe, 2010 ("sp. nov.")

Bathycolpodes subferrata Prout, 1930 ("stat. nov.")

Bathycolpodes subfuscata (Warren, 1902)

Notes: Three new species were described (Karisch 2010). Although Henri Hoppe is credited with co-authorship of the new species *Bathycolpodes parexplanata* and *B. scheeli* in Karisch (2010), he is not credited as an author of the publication.

The subspecies *Bathycolpodes subfuscata subferrata* was elevated to the species *B. subferrata* by Karisch (2010).

Genus *Bustilloxia* Expósito, 1979

Nomenclature:

Bustilloxia saturata (Bang-Haas, 1996)

Bustilloxia saturata iberica Hausmann, 1995 (“syn. nov.”, followed by “stat. rev.”)

Notes: Leraut (2009) changed the status of *Bustilloxia saturata iberica* from a subspecies to a junior synonym of *B. saturata*. Müller et al. (2019) later revived *B. s. iberica* as a valid subspecies.

Genus *Chlorissa* Stephens, 1831

Nomenclature:

Chlorissa archipelago Tautel, 2016 (“sp. nov.”)

Chlorissa obliterata (Walker, 1863) (“syn. nov.”, followed by “stat. rev.”)

Chlorissa viridata (Linnaeaus, 1758)

Notes: One new species was described (Tautel 2016). Leraut (2009) synonymised *Chlorissa obliterata* with *C. viridata* and Müller et al. (2019) subsequently revived its status as a valid species.

Genus *Chloristola* Holloway, 1996

Nomenclature:

Chloristola murzini Tautel, 2016 (“sp. nov.”)

Notes: One new species was described (Tautel 2016).

Genus *Chlorochromodes* Warren, 1896

Nomenclature:

Comostolodes Warren, 1896 (“syn. nov.”)

Chlorochromodes albicatena (Warren, 1896) (“comb. nov.”)

Chlorochromodes chlorochromodes (Prout, 1916) (“comb. nov.”)

Chlorochromodes dialitha (West, 1930) (“comb. nov.”)

Chlorochromodes rhodocraspeda Han, Galsworthy & Xue, 2012 (“sp. nov.”)

Chlorochromodes tenera (Warren, 1896) (“comb. nov.”)

Chlorochromodes tumona Tautel, 2016 (“sp. nov.”)

Notes: Two new species were described (Han et al. 2012, Tautel 2016). *Comostolodes* was designated a junior synonym of *Chlorochromodes* by Han et al. (2012), who consequently formed new combinations for four species formerly in *Comostolodes*.

Genus *Chloroglyphica* Warren, 1894

Nomenclature:

Chloroglyphica glaucochrista (Prout, 1916)

Chloroglyphica glaucochrista grearia (Oberthür, 1916) ("syn. nov.")

Notes: The status of *Chloroglyphica glaucochrista grearia* was changed from subspecies to junior synonym of *C. glaucochrista* by Han and Xue (2011a).

Genus *Chlororithra* Butler, 1889

Nomenclature:

Chlororithra fea Butler, 1889

Chlororithra missioniaria Oberthür, 1916 ("stat. nov.")

Notes: *Chlororithra missioniaria* was originally described as a variation of *C. fea* by Oberthür (1916). Parsons et al. (1999) instead treated *C. missioniaria* as a junior synonym of *C. fea*, so the name was absent from the checklist of Scoble and Hausmann (2007); however, prior to the publication of the checklist, *C. missioniaria* was designated a distinct species of *Chlororithra* by Han et al. (2006).

Genus *Comibaena* Hübner, [1823]

Nomenclature:

Comibaena auromaculata Han, Galsworthy & Xue, 2012 ("sp. nov.")

Comibaena bellula Han, Galsworthy & Xue, 2012 ("sp. nov.")

Comibaena birectilinea Han, Galsworthy & Xue, 2012 ("sp. nov.")

Comibaena decora Han, Galsworthy & Xue, 2012 ("sp. nov.")

Comibaena levequei Leraut, 2009 ("sp. nov.")

Comibaena nigromacularia (Leech, 1897)

Comibaena delicatior (Warren, 1897) ("syn. nov.")

Comibaena parornataria Han, Galsworthy & Xue, 2012 ("sp. nov.")

Comibaena pictipennis Butler, 1880

Comibaena pictipennis superornataria (Oberthür, 1916) ("syn. nov.")

Comibaena sheni Han, Galsworthy & Xue, 2012 ("sp. nov.")

Comibaena tibetensis Han, Galsworthy & Xue, 2012 ("sp. nov.")

Comibaena theodori Hausmann & Parisi, 2014 (“sp. nov.”)

Notes: Nine new species were described (Han et al. 2012, Hausmann et al. 2014).

Müller et al. (2019) noted that *Comibaena levequei* may be identical to *C. pseudoneriaria* Wehrli, 1926, but tentatively accepted it as a distinct species. *Comibaena delicatior* was synonymised with *C. nigromacularia* by Han and Xue (2011a). *Comibaena pictipennis superornataria* had its status changed from subspecies to junior synonym of *C. pictipennis* by Han et al. (2012).

Genus *Comostola* Meyrick, 1888

Nomenclature:

Comostola christinaria (Oberthür, 1916) (“comb. nov.”)

Comostola desdemona Tautel, 2015 (“sp. nov.”)

Comostola romblonensis Tautel & Barrion-Dupo, 2017 (“sp. nov.”)

Comostola stueningi Tautel & Barrion-Dupo, 2017 (“sp. nov.”)

Notes: Three new species were described (Tautel 2015, Tautel and Barrion-Dupo 2017). *Comostola christinaria* was transferred from *Hemistola* Warren, 1893 by Han and Xue (2009).

Genus *Crypsiphona* Meyrick, 1888

Nomenclature:

Crypsiphona tasmanica Õunap & Viidalepp, 2009 (“sp. nov.”)

Notes: One new species was described (Õunap and Viidalepp 2009).

Genus *Dindica* Moore, 1888

Nomenclature:

Dindica purpurata Bastelberger, 1911

Dindica wytsmani Prout, 1927 (“stat. rev.”)

Notes: *Dindica purpurata wytsmani* was elevated from subspecies to species by Pitkin et al. (2007).

Genus *Dindicodes* Prout, 1912

Nomenclature:

Dindicodes albodavidaria (Xue, 1992) (“comb. nov.”)

Dindicodes apicalis (Moore, 1888)(“comb. rev.”)

Dindicodes apicalis hunana (Xue, 1992) (“comb. nov.”)

Dindicodes costiflavens (Wehrli, 1933) (“comb. nov.”)

Dindicodes davidaria (Poujade, 1895) (“comb. rev.”)

Dindicodes ectoxantha (Wehrli, 1933) (“comb. nov.”)

Dindicodes euclidiaria (Oberthür, 1913) (“comb. rev.”)

Dindicodes harutai (Yazaki, 1992) (“comb. nov.”)

Dindicodes harutai infuscatus (Yazaki, 1992) (“comb. nov.”)

Dindicodes leopardinata (Moore, 1868) (“comb. rev.”)

Dindicodes moelleri (Warren, 1893) (“comb. rev.”)

Notes: The 11 species and subspecies listed here were formally transferred from the genus *Pachyodes* Guenée, [1858] to *Dindicodes* by Pitkin et al. (2007).

Genus *Dioscore* Warren, 1907

Nomenclature:

Dioscore kirke Lindt, Lennuk & Viidalepp, 2017 (“sp. nov.”)

Dioscore vilu Lindt, Lennuk & Viidalepp, 2017 (“sp. nov.”)

Notes: Two new species were described (Lindt et al. 2017a).

Genus *Dysphania* Hübner, [1819]

Nomenclature:

Dysphania discalis aureolina Inoue, 2007 (“ssp. nov.”)

Notes: One new species was described (Inoue 2007).

Genus *Epichrysodes* Han & Stüning, 2007 (“gen. nov.”)

Nomenclature:

Epichrysodes tienmuensis Han & Stüning, 2007 (“sp. nov.”)

Notes: *Epichrysodes* is currently a monotypic genus containing only the type species, *E. tienmuensis*; both the genus and the species were described by Han et al. (2007).

Genus *Epipristis* Meyrick, 1888

Nomenclature:

Epipristis pullusa Han & Xue, 2009 (“sp. nov.”)

Epipristis roseus Expósito & Han, 2009 (“sp. nov.”)

Notes: Two new species were described (Han et al. 2009a).

Genus *Episothalma* Swinhoe, 1893

Nomenclature:

Episothalma cuspidata Xue & Wang, 2009 (“sp. nov.”)

Episothalma irrobustaria Xue & Wang, 2009 (“sp. nov.”)

Notes: Two new species were described (Xue et al. 2009).

Genus *Eucyclodes* Warren, 1894

Nomenclature:

Eucyclodes aphrodite (Prout, 1933) (“stat. nov.”)

Eucyclodes gavissima (Walker, 1861)

Eucyclodes hiyasata Tautel, 2016 (“sp. nov.”)

Eucyclodes insolita Han & Zhang, 2019 (“sp. nov.”)

Eucyclodes omeica (Chu, 1981) (“comb. nov.”)

Notes: Two new species were described (Tautel 2016, Zhang et al. 2019). Han and Xue (2011a) elevated *Eucyclodes gavissima aphrodite* (Prout, 1933) from subspecies to species and transferred *Chloromachia omeica* Chu, 1981 to *Eucyclodes*. *Chloromachia* was already considered a junior synonym of *Eucyclodes* (Parsons et al. 1999), but Han and Xue (2011a) were the first to formally publish the new combination *E. omeica*.

Genus *Geometra* Linnaeus, 1758

Nomenclature:

Geometra neovalida Han, Galsworthy & Xue, 2009 (“sp. nov.”)

Notes: One new species was described (Han et al. 2009b).

Genus *Gnophosema* Prout, 1912

Nomenclature:

Gnophosema isometra (Warren, 1888)

Gnophosema leucites Wiltshire, 1980 (“stat. nov.”)

Notes: *Gnophosema isometra leucites* Wiltshire, 1980 was elevated from subspecies to species by Hausmann (2009).

Genus *Haruchlora* Viidalepp & Lindt, 2014 ("gen. nov.")

Nomenclature:

Haruchlora maesi Viidalepp & Lindt, 2014 ("sp. nov.")

Notes: *Haruchlora* is currently a monotypic genus containing only the type species, *H. maesi*; both the genus and the species were described by Viidalepp and Lindt (2014).

Genus *Hemistola* Warren, 1893

Nomenclature:

Hemistola arcilinea Han & Xue, 2009 ("sp. nov.")

Hemistola asymmetra Han & Xue, 2009 ("sp. nov.")

Hemistola flavifimbria Han & Xue, 2009 ("sp. nov.")

Hemistola flavitincta Warren, 1897 ("comb. rev.")

Hemistola fui Chang & Wu, 2013 ("sp. nov.")

Hemistola glauca Han & Xue, 2009 ("sp. nov.")

Hemistola hanae Wu, 2019 ("sp. nov.")

Hemistola liliana (Swinhoe, 1892) ("comb. rev.")

Hemistola orbiculosoides Han & Xue, 2009 ("sp. nov.")

Hemistola piceacola Chang & Wu, 2013 ("sp. nov.")

Hemistola stueningi Han & Xue, 2009 ("sp. nov.")

Hemistola taiwanensis Chang & Wu, 2013 ("sp. nov.")

Hemistola viridimargo Han & Xue, 2009 ("sp. nov.")

Notes: Eleven new species were described (Han and Xue 2009, Chang and Wu 2013, Wu 2019). The species *Hemistola flavitincta* and *Hemistola liliana* were transferred to *Herochroma* Swinhoe, 1893 by Parsons et al. (1999). Pitkin et al. (2007) implied this was an editorial error and, citing a complete absence of *Herochroma* diagnostic characters, transferred both species back to *Hemistola*.

Genus *Hemithea* Duponchel, 1829

Nomenclature:

Hemithea aestivaria (Hübner, 1789)

Hemithea aestivaria alboundulata (Hedemann, 1879) ("stat. nov.", followed by "syn. rev.")

Notes: *Hemithea alboundulata* was a junior synonym of *H. aestivaria* until Leraut (2009) elevated it to subspecies. Müller et al. (2019) found the justification for this

taxonomic change to be too vague and, consequently, revived its status as a synonym of *H. aestivaria*.

Genus *Herochroma* Swinhoe, 1893

Nomenclature:

Herochroma costata Kirti, Goyal & Kaur, 2012 (nom. nud.)

Herochroma subspoliata (Prout, 1916)

Herochroma xuthopletes (Prout, 1934) (“stat. rev.”)

Notes: The name and locality of *Herochroma costata* were published in Kirti et al. (2012), but its description and diagnosis can only be found in the first author’s unpublished thesis. This species name is thus considered a nomen nudum.

Herochroma subspoliata xuthopletes (Prout, 1934) was elevated from subspecies to species by Pitkin et al. (2007).

Genus *Hypobapta* Prout, 1912

Nomenclature:

Hypobapta tachyhalotaria Hausmann & Sommerer, 2009 (“sp. nov.”)

Notes: One new species was described (Hausmann et al. 2009).

Genus *Jodis* Hübner, [1823]

Nomenclature:

Jodis altitudinis Tautel, 2016 (“sp. nov.”)

Jodis argentea Tautel, 2016 (“sp. nov.”)

Jodis berde Tautel, 2016 (“sp. nov.”)

Jodis mystica Tautel, 2016 (“sp. nov.”)

Jodis omeiensis (Chu, 1981) (“comb. nov.”)

Jodis orientalis Wehrli, 1923 (“stat. nov.”)

Jodis angulata Inoue, 1961 (“syn. nov.”)

Jodis putata (Linnaeus, 1758)

Jodis sibuyana Tautel, 2016 (“sp. nov.”)

Jodis tomopunctata Tautel, 2016 (“sp. nov.”)

Notes: Six new species were described (Tautel 2016).

Han and Xue (2011a) created the new combination *Jodis omeiensis*, stating that this species was transferred from the genus *Gelasma* Warren, 1893; however, *Gelasma* had been designated a junior synonym of *Maxates* Moore, [1887] by Holloway (1996). Despite this synonymy, the combination *Maxates omeiensis* (Chu, 1981) does not appear to have ever been published between 1996 and 2011.

Beljaev (2007) elevated *Jodis putata orientalis* Wehrli, 1923 from subspecies to species and subsequently synonymised it with *J. angulata*.

Genus *Kuchleria* Hausmann, 1995

Nomenclature:

Kuchleria menadiara Thierry-Mieg, 1893

Kuchleria insignata Hausmann, 1995 (“syn. nov.”, followed by “stat. rev.”)

Kuchleria garciapitai Expósito, 2006 (“syn. nov.”)

Notes: *Kuchleria garciapitai* was designated a junior synonym of *K. insignata* by Leraut (2009). In the same publication, Leraut (2009) claimed that *K. insignata* was a “synonym or subspecies” of *Kuchleria menadiara* Thierry-Mieg, 1893. Müller et al. (2019) treated this claim as a formal synonymy of *K. insignata* and *K. menadiara* and, subsequently, provided molecular and morphological evidence to justify elevating it back to species. *Kuchleria garciapitai* remains a junior synonym of *K. insignata*.

Genus *Lindachlora* Viidalepp & Lindt, 2012 (“gen. nov.”)

Nomenclature:

Lindachlora flaccida (Warren, 1909) (“comb. nov.”)

Lindachlora tanystys (Prout, 1931) (“comb. nov.”)

Notes: The genus *Lindachlora* currently contains two species, both of which were transferred from *Phrudocentra* Warren, 1895 by Viidalepp and Lindt (2012), with *L. flaccida* designated as the type species.

Genus *Linguisaccus* Han, Galsworthy & Xue, 2012 (“gen. nov.”)

Nomenclature:

Linguisaccus minor Han, Galsworthy & Xue, 2012 (“sp. nov.”)

Linguisaccus subhyalina (Warren, 1899) (“comb. nov.”)

Notes: *Comostolodes subhyalina* Warren, 1899 was transferred to *Comibaena* by Han and Xue (2011a) and then designated as the type species of the new genus *Linguisaccus* by Han et al. (2012).

Genus *Lissocentra* Viidalepp & Lindt, 2012 ("gen. nov.")

Nomenclature:

Lissocentra hydatodes (Warren, 1906) ("comb. nov.")

Lissocentra vitiosaria (Dognin, 1912) ("comb. nov.")

Notes: The recently described genus *Lissocentra* currently contains two species, both of which were transferred from *Phrudocentra* by Viidalepp and Lindt (2012), with *L. hydatodes* designated as the type species.

Genus *Lissochlora* Warren, 1900

Nomenclature:

Lissochlora hinojosae Lindt & Viidalepp, 2014 ("sp. nov.")

Lissochlora janamariae Lindt & Viidalepp, 2014 ("sp. nov.")

Lissochlora klausi Viidalepp & Lindt, 2019 ("sp. nov.")

Lissochlora niveiceps (Prout, 1912) ("comb. nov.")

Lissochlora senescens (Prout, 1917) ("comb. nov.")

Notes: Three new species were described (Lindt and Viidalepp 2014, Viidalepp and Lindt 2019a). One of those species, *Lissochlora hinojosae*, was described in Lindt et al. (2014) with the specific epithet spelled '*hinoyosae*', the first time it appears in both the English and Spanish versions of the abstract. However, it is spelled '*hinojosae*' the first time it appears in the main text. The etymological remarks provided in Lindt et al. (2014) confirm that '*hinojosae*' is the intended spelling (cf. § 24.2; 32.2.1.; 32.5 Code ICZN).

Lissochlora niveiceps and *L. senescens* were transferred from *Phrudocentra* by Viidalepp and Lindt (2012).

Genus *Lophophelma* Prout, 1912

Nomenclature:

Lophophelma albapex (Inoue, 1988) ("comb. nov.")

Lophophelma costistrigaria (Moore, 1868) ("comb. rev.")

Lophophelma iterans (Prout, 1926) ("comb. nov.")

Lophophelma pingbiana (Chu, 1981) ("comb. nov.")

Lophophelma taiwana (Wileman, 1912) ("comb. rev.")

Lophophelma tanatoraja Sommerer, Stüning & Tautel, 2015 ("sp. nov.")

Lophophelma varicoloraria (Moore, 1868) ("comb. rev.")

Notes: One new species was described (Sommerer et al. 2015). Pitkin et al. (2007) transferred six species to *Lophophelma*: five from the genus *Pachyodes* (*Lophophelma albapex*, *L. costistrigaria*, *L. iterans*, *L. taiwana*, *L. varicoloraria*) and one from the genus *Terpna* Herrich-Schäffer, 1854 (*Lophophelma pingbiana*).

Genus *Loxochila* Butler, 1881 ("stat. rev.")

Nomenclature:

Loxochila burmensis (Han, Galsworthy & Xue, 2009) ("sp. nov.")

Loxochila fragilis (Oberthür, 1916) ("comb. nov.")

Loxochila kina (Swinhoe, 1893) ("comb. nov.")

Loxochila sinoisaria (Oberthür, 1916) ("comb. nov.")

Loxochila smaragdus (Butler, 1880) ("comb. rev.")

Loxochila tibeta (Chu, 1982) ("comb. nov.")

Notes: One new species was described (Han et al. 2009b). *Loxochila* was treated as a junior synonym of *Geometra* in Parsons et al. (1999) and Scoble and Hausmann (2007). Han et al. (2009b)retained this classification in their revision of *Geometra*, which divided the genus into two species groups. The type species of *Loxochila*, at the time named *Geometra smaragdus* (Butler), served as the eponymous taxon of the *smaragdus* species group. The molecular phylogeny of Ban et al. (2018) demonstrated that the *smaragdus* group is a strongly-supported clade that also contains one species from a different genus (*Tanaorhinus kina* Swinhoe). Ban et al. (2018) consequently re-instated the generic status of *Loxochila* and transferred the species in the *smaragdus* group, including *T. kina*, to this genus.

Genus *Maxates* Moore, [1887]

Nomenclature:

Maxates acyra (Prout, 1935) ("comb. nov.")

Maxates dissimulata (Walker, 1861)

Maxates semiprotrusa (Inoue, 1989) ("syn. nov.")

Maxates elegante Tautel, 2015 ("sp. nov.")

Maxates persona Tautel, 2016 ("sp. nov.")

Maxates szechwanensis (Chu, 1981) ("comb. nov.")

Notes: Two new species were described (Tautel 2015, Tautel 2016). *Maxates acyra* was transferred from *Hemistola* by Han and Xue (2009) and *M. szechwanensis* was transferred from *Jodis* by Han and Xue (2011a). Han and Xue (2011a) also synonymised *M. semiprotrusa* with *M. dissimulata*.

Genus *Metaterpna* Yazaki, 1992

Nomenclature:

Metaterpna batangensis Han & Stüning, 2016 (“sp. nov.”)

Notes: One new species was described (Jiang et al. 2016).

Genus *Microloxia* Warren, 1893

Nomenclature:

Microloxia aistleitneri Hausmann, 2009 (“sp. nov.”)

Microloxia chlorissoides (Prout, 1912) (“comb. nov.”)

Microloxia herbaria (Hübner, 1813)

*Microloxia herbaria viridecilia*ta (Bubacek, 1926) (“syn. nov.”, followed by “stat. rev.”)

Notes: One new species was described (Hausmann 2009).

After synonymising *Aoshakuna* and *Nipponogelasma*, Beljaev (2007) transferred *Nipponogelasma chlorissoides* (Prout, 1913) to *Microloxia*.

Leraut (2009) synonymised *Microloxia herbaria viridecilia*ta with *M. h. herbaria* (Hübner, 1813). Müller et al. (2019) cited molecular and morphological evidence to justify elevating *M. h. viridecilia*ta back to subspecies.

Genus *Nemoria* Hübner, 1818

Nomenclature:

“*Nemoria*” *erina* (Dognin, 1896)

“*Nemoria*” *nigrisquama* (Dognin, 1904)

Nemoria yellowrosea Koçak & Kemal, 2008 (“nom. nov.”)

Nemoria albilineata Cassino, 1927

Notes: The molecular phylogeny of Murillo-Ramos et al. (2019) indicates that the current concept of *Nemoria* Hübner is polyphyletic and that *N. erina* (Dognin) and *N. nigrisquama* (Dognin) do not belong in *Nemoria*, though there is insufficient evidence to describe new genera or create new combinations for these two species. Brehm et al. (2019) consequently suggested that their generic names are listed in quotation marks, pending further taxonomic study.

In her revision of Neotropical *Nemoria*, Pitkin (1993) transferred *Lissochlora albilineata* Warren, 1909 to the genus *Nemoria*. This new combination, *Nemoria albilineata* (Warren, 1909) consequently became a senior homonym of the Texan species *Nemoria albilineata* Cassino, 1927. This homonymy went unnoticed for over a decade, until Koçak and Kemal (2008) designated a replacement name for the junior homonym.

Genus *Neochloroglyphica* Han & Skou, 2019 ("gen. nov.")

Nomenclature:

Neochloroglyphica perbella Han & Skou, 2019 ("sp. nov.")

Notes: *Neochloroglyphica* is currently a monotypic genus containing only the type species, *N. perbella*; both the genus and the species were described by Han et al. (2019).

Genus *Neohipparchus* Inoue, 1944

Nomenclature:

Neohipparchus maculata (Warren, 1897)

Chloroglyphica orhanti Herbulot, 1994 ("syn. nov.")

Notes: *Chloroglyphica orhanti* was synonymised with *Neohipparchus maculata* by Han and Xue (2011a).

Genus *Neromia* Staudinger, 1898

Nomenclature:

Neromia integrata Hausmann, 2009 ("sp. nov.")

Notes: One new species was described (Hausmann and Hebert 2009).

Genus *Oenospila* Swinhoe, 1892

Nomenclature:

Oenospila sacculstrix Kirti, Goyal & Kaur, 2012 (nom. nud.)

Notes: The name and locality of this species were formally published in Kirti et al. (2012), but its description and diagnosis can only be found in the first author's unpublished thesis. This species name is thus considered a nomen nudum.

Genus *Oospila* Warren, 1897

Nomenclature:

Oospila absaloni Lindt, Hausmann & Viidalepp, 2018 ("sp. nov.")

Oospila agnetaforslundae Lindt, Hausmann & Viidalepp, 2018 ("nom. nov.")

Oospila bifida Lindt, Hausmann & Viidalepp, 2018 ("sp. nov.")

Oospila brehmi Lindt, Hausmann & Viidalepp, 2018 ("sp. nov.")

Oospila bulava Lindt & Viidalepp, 2015 ("sp. nov.")

Oospila cristae Lindt, Hausmann & Viidalepp, 2018 ("sp. nov.")

Oospila ehakernae Lindt, Hausmann & Viidalepp, 2018 (“sp. nov.”)

Oospila falcata Lindt, Hausmann & Viidalepp, 2018 (“sp. nov.”)

Oospila imula Dognin, 1911 (“stat. nov.”)

Oospila loreenae Lindt, Hausmann & Viidalepp, 2018 (“sp. nov.”)

Oospila moseri Lindt, Hausmann & Viidalepp, 2018 (“sp. nov.”)

Oospila pallidaria boliviensis Lindt, Hausmann & Viidalepp, 2018 (“ssp. nov.”)

*Oospila pipa*Lindt, Hausmann & Viidalepp, 2018 (“sp. nov.”)

Oospila poirieri Lévêque & Viidalepp, 2015 (“sp. nov.”)

Oospila similiplaga Warren, 1900 (“stat. nov.”)

Oospila similiplaga bolarpata Lindt, Hausmann & Viidalepp, 2018 (“ssp. nov.”)

Notes: Eleven species and two subspecies were described (Lévêque and Viidalepp 2015, Lindt and Viidalepp 2015, Lindt et al. 2018). Lindt et al. (2018) designated *Oospila agnetaforslundae* as a replacement name for *Oospila marginata* (Schaus, 1912), which had previously been erroneously synonymised with *Oospila permagna* (Warren, 1909) by Cook and Scoble (1995). The replacement name was necessary because *O. marginata* (Schaus, 1912) is a junior secondary homonym of *O. marginata* Warren, 1897. Lindt et al. (2018) also raised *O. imula* from synonymy with *O. miccularia* Guenée, [1858] and raised *O. similiplaga* from synonymy with *O. arpata* (Schaus, 1897).

Genus *Ornithospila* Warren, 1894

Nomenclature:

Ornithospila explorator Tautel, 2015 (“sp. nov.”)

Notes: One new species was described (Tautel 2015).

Genus *Orothalassodes* Holloway, 1996

Nomenclature:

Orothalassodes leucospilota (Moore, [1887])

Thalassodes albomaculata Hampson, 1895

Orothalassodes albomaculata Kirti, Goyal & Kaur, 2012

Notes: Kirti et al. (2012) published the name *Orothalassodes albomaculata* as a new combination for *Thalassodes albomaculata*. However, *T. albomaculata* had already been synonymised with *Thalassodes leucospilota* Moore by Hampson (1896), which was then transferred to *Orothalassodes* by Holloway (1996). Thus, the current valid name for this species is still *Orothalassodes leucospilota*.

Genus *Pachyodes* Guenée, [1858]

Nomenclature:

Pachyodes jianfengensis Han & Xue, 2008 (“sp. nov.”)

Pachyodes novata Han & Xue, 2008 (“sp. nov.”)

Notes: Two new species were described (Han and Xue 2008).

Genus *Paramaxates* Warren, 1894

Nomenclature:

Paramaxates fournieri Tautel, 2016 (“sp. nov.”)

Paramaxates vagata (Walker, 1861)

Paramaxates hainana Chu, 1981 (“syn. nov.”)

Notes: One new species was described (Tautel 2016). *Paramaxates hainana* was synonymised with *P. vagata* by Han and Xue (2011a).

Genus *Paromphacodes* Warren, 1897

Nomenclature:

Paromphacodes alpha Lindt, Tasane, Õunap & Viidalepp, 2017 (“sp. nov.”)

Paromphacodes alticola Lindt, Tasane, Õunap & Viidalepp, 2017 (“sp. nov.”)

Paromphacodes onae Lindt, Tasane, Õunap & Viidalepp, 2017 (“sp. nov.”)

Paromphacodes spina Lindt, Tasane, Õunap & Viidalepp, 2017 (“sp. nov.”)

Paromphacodes summita Lindt, Tasane, Õunap & Viidalepp, 2017 (“sp. nov.”)

Notes: Five new species were described (Lindt et al. 2017b).

Genus *Pelagodes* Holloway, 1996

Nomenclature:

Pelagodes bellula Han & Xue, 2011 (“sp. nov.”)

Pelagodes cancriformis Viidalepp, Han & Lindt, 2012 (“sp. nov.”)

Pelagodes paraveraria Han & Xue, 2011 (“sp. nov.”)

Pelagodes simplvalvae Han & Xue, 2011 (“sp. nov.”)

Pelagodes sinuspinae Han & Xue, 2011 (“sp. nov.”)

Notes: Five new species were described (Han and Xue 2011b, Viidalepp et al. 2012).

Genus *Prasinocyma* Warren, 1897

Nomenclature:

Prasinocyma amharensis Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma angolica pseudopedicata Hausmann, Sciarretta & Parisi, 2016 (“ssp. nov.”)

Prasinocyma angolica yemenicola Hausmann & Wildfeuer, 2017 (“ssp. nov.”)

Prasinocyma angulifera Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma aquamarina Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma batesi distans Hausmann, Sciarretta & Parisi, 2016 (“ssp. nov.”)

Prasinocyma baumgaertneri Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma beryllaria Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma bongaensis Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma camerunalta (Herbulot, 1986) (“comb. nov.”)

Prasinocyma discipuncta Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma fallax Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma fusca Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma gemmifera Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma getachewi Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma immaculata (Thunberg, 1784)

Prasinocyma unipuncta Warren, 1897 (“syn. nov.”)

Prasinocyma immaculata thiaucourti Herbulot, 1993 (“stat. nov.”)

Prasinocyma leveneorum Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma lutulenta Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma magica Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma monikae Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma nereis Townsend, 1952 (“comb. rev.”)

Prasinocyma pedicata aethiopica Hausmann, Sciarretta & Parisi, 2016 (“ssp. nov.”)

Prasinocyma robusta Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma saba Hausmann & Wildfeuer, 2017 (“sp. nov.”)

Prasinocyma septentrionalis Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma shoa yabellensis Hausmann, Sciarretta & Parisi, 2016 (“ssp. nov.”)

Prasinocyma stefani Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma trematerrai Hausmann, Sciarretta & Parisi, 2016 (“sp. nov.”)

Prasinocyma trematerraisimienensis Hausmann, Sciarretta & Parisi, 2016 ("ssp. nov.")

Notes: Twenty new species and six new subspecies were described (Hausmann et al. 2016, Hausmann and Wildfeuer 2017). Hausmann et al. (2016) transferred *Thalassodes camerunalta* Herbulot, 1986 and *Eretmopus nereis* (Townsend, 1952) to the genus *Prasinocyma*. They also synonymised *P. unipuncta* with *P. immaculata* and changed the status of *P. thiaucourti* Herbulot, 1993 from a species to a subspecies of *P. immaculata*.

Genus *Protuliocnemis* Holloway, 1996

Nomenclature:

Protuliocnemis candida Han, Galsworthy & Xue, 2012 ("sp. nov.")

Protuliocnemis dissimilis Han, Galsworthy & Xue, 2012 ("sp. nov.")

Protuliocnemis falcipennis (Yazaki, 1991) ("comb. nov.")

Notes: Two new species were described (Han et al. 2012). *Protuliocnemis falcipennis* was transferred from the genus *Comibaena* by Han and Xue (2011a).

Genus *Pseudepisothalma* Han, 2009 ("gen. nov.")

Nomenclature:

Pseudepisothalma ocellata (Swinhoe, 1893) ("comb. nov.")

Notes: *Pseudepisothalma* is currently a monotypic genus containing only the type species, *P. ocellata*, which was transferred from the genus *Episothalma*. The new genus description and new combination were presented in Xue et al. (2009), though only the third author (Han) is credited with authorship.

Genus *Psilotagma* Warren, 1894

Nomenclature:

Psilotagma pictaria (Moore, 1888) ("comb. nov.")

Notes: *Psilotagma pictaria* was transferred from the genus *Pachyodes* by Pitkin et al. (2007).

Genus *Pyrochlora* Warren, 1895

Nomenclature:

Pyrochlora kuklase Viidalepp, 2009 ("sp. nov.")

Pyrochlora motilonia Viidalepp, 2009 ("sp. nov.")

Pyrochlora vogli Viidalepp, 2009 ("sp. nov.")

Notes: Three new species were described (Viidalepp 2009).

Genus *Rhanidopsis* West, 1930

Nomenclature:

Rhanidopsis kogeri Viidalepp & Lindt, 2010 (“sp. nov.”)

Notes: One new species was described (Viidalepp and Lindt 2010).

Genus *Rhuma* Walker, 1860

Nomenclature:

Sterictopsis Warren, 1898 (“syn. nov.”)

Oxyphanes Turner, 1936 (“syn. nov.”)

Rhuma argyraspis (Lower, 1893) (“comb. nov.”)

Rhuma divergens (Goldfinch, 1929) (“comb. nov.”)

Rhuma thiobapta (Turner, 1936)(“comb. nov.”)

Notes: Pitkin et al. (2007) designated *Sterictopsis* and *Oxyphanes* as junior synonyms of *Rhuma* and consequently transferred *S. argyraspis* (Lower, 1893), *S. divergens* Goldfinch, 1929 and *O. thiobapta* Turner, 1936 to this genus.

Genus *Tachyphyle* Butler, 1881

Nomenclature:

Tachyphyle nielseni Viidalepp & Lindt, 2017 (“sp. nov.”)

Tachyphyle selini Viidalepp & Lindt, 2017 (“sp. nov.”)

Notes: Two new species were described (Viidalepp and Lindt 2017).

Genus *Tanaorhinus* Butler, 1879

Nomenclature:

Tanaorhinus baruensis Orhant, 2014 (“sp. nov.”)

Tanaorhinus guitinguensis Tautel, 2014 (“sp. nov.”)

Tanaorhinus sultan Tautel, 2014 (“sp. nov.”)

Notes: Three new species were described (Orhant 2014, Tautel 2014).

Genus *Telotheta* Warren, 1900

Nomenclature:

Telotheta fresei Lindt & Viidalepp, 2014 (“sp. nov.”)

Telotheta unoi Lindt & Viidalepp, 2014 (“sp. nov.”)

Notes: Two new species were described (Lindt and Viidalepp 2014).

Genus *Thalera* Hübner, [1823]

Nomenclature:

Hethemia Ferguson, 1969 (“syn. nov.”)

Thalera pistasciaria (Guenée, 1858) (“comb. nov.”)

Notes: *Hethemia* sensu Ferguson was a monotypic genus, containing only the type species *H. pistasciaria*. Ban et al. (2018) provided morphological and molecular evidence to justify the designation of *Hethemia* as a junior synonym of *Thalera*, creating the new combination *T. pistasciaria*.

Genus *Thetidia* Boisduval, 1840

Nomenclature:

Thetidia chlorophyllaria (Hedemann, 1879)

Thetidia pekingensis (Chu, 1981) (“comb. nov.”, followed by “syn. nov.”)

Notes: The name *Thetidia pekingensis* (Chu, 1981) was first published in Han and Xue (2011a); it was not designated a new combination, but since *Euchloris* Hübner, [1823] was already known to be a synonym of *Thetidia* (Parsons et al. 1999), Han and Xue (2011a) were presumably transferring *Euchloris pekingensis* Chu, 1981 to *Thetidia.* This was confirmed by Han et al. (2012), who subsequently synonymised *T. pekingensis* with *T. chlorophyllaria*.

Genus *Timandromorpha* Inoue, 1944

Nomenclature:

Timandromorpha inouei Stüning & Yazaki, 2008 (“sp. nov.”)

Timandromorpha pinratanai Stüning & Yazaki, 2008 (“sp. nov.”)

Timandromorpha wangi Stüning & Yazaki, 2008 (“sp. nov.”)

Timandromorpha xuedayongi Orhant, 2013 (“sp. nov.”)

Notes: Four new species were described (Stüning and Yazaki 2008, Orhant 2013).

Genus *Vallichlora* Viidalepp & Lindt, 2019 (“gen. nov.”)

Nomenclature:

Vallichlora rara Viidalepp & Lindt, 2019 (“sp. nov.”)

Vallichlora selva Viidalepp & Lindt, 2019 (“sp. nov.”)

Notes: Two new species were described (Viidalepp and Lindt 2019b).

Genus *Xenozancla* Warren, 1893

Nomenclature:

Yinchie Yang, 1978 (“syn. nov.”)

Xenozancla versicolor Warren, 1893

Yinchie zaohui Yang, 1978 (“syn. nov.”)

Notes: Han et al. (2008) synonymised *Yinchie zaohui* with *Xenozancla versicolor*. Since *Y. zaohui* was the type species of its genus, *Yinchie* was consequently designated a junior synonym of *Xenozancla*.

Other species affiliated with Geometrinae

Pseudobiston pinratanai Inoue, 1994

Notes: *Pseudobiston pinratanai* Inoue, 1994, was classified as a geometrine in Scoble and Hausmann (2007) but was recently transferred to the new family Pseudobistonidae by Rajaei et al. (2015).

Cerura melanoglypta (Lower, 1905)

Notes: One species in the Scoble and Hausmann (2007) checklist, *Cerura melanoglypta* (Lower, 1905), is classified as a geometrine (Ollerenshaw 2012), but has never formally been transferred from the notodontid genus *Cerura* Schrank, 1802. We agree that this species should eventually be assigned to a genus in Geometrinae, but it is technically not in Geometrinae at this time.

Discussion

In summation, nine new genera, 128 new species and ten new subspecies of emerald moths have been described since the publication of Scoble and Hausmann (2007), along with over 80 new genus- and species-group changes within subfamily Geometrinae. Since 2007, the known species richness of Geometrinae has increased by ~4.5%, from 2,529 species (Scoble and Hausmann 2007) to 2,643 species.

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Supplementary material

Suppl. material 1: List of the Geometrinae species of the world doi

Authors: David Plotkin
Data type: Taxonomical checklist

Brief description: This table provides a list of all new species descriptions, combinations and other taxonomic changes in the subfamily Geometrinae (Lepidoptera: Geometridae) since 2007 (Sheet 1: "Taxonomic changes since 2007"). This table also provides a list of the 2,643 current valid species names in the subfamily Geometrinae (Lepidoptera: Geometridae), with their authorship and year of description (Sheet 2: "All current Geometrinae species").
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