I.N. G.A.

NEWSLETTER OF THE INTERNATIONAL NETWORK OF GELECHIOID AFICIONADOS

Dear Gelechioid Aficionados,

The global pandemic has certainly impacted our lives, but despite the challenges we have faced this past year, research on Gelechioidea has been on-going. This can for example be assessed from the extensive list of recent publications on Gelechioidea (111 according to our records!) included in this issue.

In this year's I.N.G.A., we can also read the presentation of gelechioid aficionado Jukka Tabell (Finland) and learn about his work on *Pleurota*; Héctor Vargas (Chile) tells us about previously overlooked gelechiids in the amazing arid habitats of northern Chile; Patricia Corro (Panama) and Mark Metz (U.S.) write about the classification of the infamous *Tuta absoluta* based on cladistic analysis of morphology. In addition, a fantastic overview and figures of leafmining Gelechioidea in North America is provided by Charley Eiseman (U.S.). And finally, Vazrick Nazari and Tobias Malm explain the iconography of the frontispiece of Clerck's *Icones Insectorm Rariorum*, which includes an illustration of a gelechioid moth, *Chrysoclista linneella*.

We wish to thank all those who have contributed to this issue. A special thanks also to our readers who have given us encouraging feedback.

This is the 10th issue of I.N.G.A. so there is reason to celebrate!

Enjoy!

I.N.G.A. team

An Asian moth recently introduced to Europe and North America:

Cover image: *Scythris sinensis* on a leaf, macro shot with inverter ring, Bucharest, Romania

Photo by Andy Mash via Wikimedia Commons (CC BY-SA 4.0)

Gelechioid Aficionado:

(Photo by Huang Ying)

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Lepidoptera have nearly always been part of my life. The first moth that I remember collecting, at age four, was a green Large emerald (*Geometra papilionaria*). I watched it in the jar containing ethyl acetate and wondered why it turned into a Common brimstone! Well, the reason for that became clear to me later. Lepidoptera offered many experiences to a child. I remember the excitement when I found a "baby" Death's-head hawkmoth (actually a *Noctua pronuba*).

I became acquainted with microlepidoptera in my adolescence. In the springtime I would ride my bike with my brother Heikki to check the exterior walls of an old house, where we always found some species of Depressariidae: *Exaeretia ciniflonella, Depressaria pimpinellae* and *Agonopterix hypericella*. For a long time these stayed unidentified in my collection drawers as no identification literature was available at the time. In the 1970s, *Agonopterix hypericella* was still a rarity in Finland, there were only a few sites in which it had been found.

Of great importance to the continuation of my interest in collecting Lepidoptera was Jukka Jalava, who at the Zoological Museum in Helsinki identified the micros I had collected. He found the case-bearers *Coleophora partitella* and *C. chrysanthemi*, among others, in my collection. Other nice finds were also made, such as *Athrips amoenella* from the 1970s that probably were the first record of the species in Finland.

Little by little my interest shifted towards the case-bearer moth family Coleophoridae, partly because of their interesting life habits, and partly because of time limitations. I've spent quite a lot of time working on these moths! And much work awaits, for example, the large collection of *Coleophora* material by the Nupponen brothers from Eurasia, which includes over 50 new species awaiting description!

During my collecting trips I have not kept many lepidopterans other than specimens of the genera *Coleophora* and *Elachista*, at most a specimen or two of other interesting looking species. In 2014, I made a week-long collecting trip to Italy. As a result of this trip I

Fig 1. Two still undescribed species of *Pleurota* from Italy. These specimens sparked my interest in Pleurotinae. (Photos: Juha Tyllinen)

described a new case-bearer moth species, *C. sabina*, together with G. Baldizzone. From the same site I took a male specimen of *Pleurota pyropella* -looking moth. A day later, next to the highway widening, swarmed a similar species, and I kept as many as four specimens. With help from Marko Mutanen I had the specimens DNA-barcoded, and it turned out that genetically they greatly differed from *P. pyropella*, representing two different species. Because no one could tell me what species they were, I decided to deepen my knowledge on this genus. These specimens triggered my enthusiasm in *Pleurota*.

Getting deeper into studying the subfamily Pleurotinae has been confusing. The first source of bewilderment has been why these moths that can be so easily identified to genus and subfamily level have not been studied more intensively. Only a couple of new species have been described from Europe during the past decades. Second, the subfamily has surprised me by being so species-rich! A few collecting trips have shown that new species are easy to find, in some regions even more easily than finding species that have already been described. Third, a good deal of the species have proven to be very local and with very restricted distributions. For example, of the ca. 30 species found in Morocco, only one (*P. ericella*) has been found to occur in Europe. Compared for example to casebearer moths, this number is surprisingly small. Apparently, the dispersal ability of these moths is weak, which has led to strong speciation in mountainous regions. And finally, there is still a lot to decipher in the taxonomy of *Pleurota*, including misidentifications, strange distributions and a lot of erroneous synonymizations.

Together with some colleagues I have began to prepare a small scale revision of *Pleurota*. Thus far results have been published in three separate articles, in which we have described 18 new species and restored a few species from synonymization. As we get to study more type specimens, we will publish more results. For some species the type series includes two or even three different species, therefore studying type specimens in museums is of paramount importance. Luckily the museum staff have all responded favourably to our requests and thus facilitated our work. To counterbalance old samples we also need fresh material, and I encourage all amateurs and professionals interested in microlepidoptera to take part in our *Pleurota* project.

Fig 2. Specimens of *Pleurota honorella* from Spain. DNA barcodes of this species cluster into 12 different BINs. There are also differences in the wing pattern and coloration among specimens. (Photos: Juha Tyllinen)

Maybe it is because I work in the arts sector (as a musician) that I have an appreciation for meticulous preparation of specimens. In my youth I was nearly a perfectionist in that regard: If the antenna or a small piece of the wing broke off, the whole specimen went into the trash! The moth had to be reared; specimens collected in the wild were too worn off. For this reason, netting and light trapping came into the picture only a few years ago as I have lowered the bar a little. However, collecting at the sheet is still the only “right” way for me to collect nocturnal moths. Concentrating on specific families and rearing of specimens has caused astonishment for some and has been frowned upon by others, but this is my way of practicing this hobby.

Further reading:

Tabell, J., Wikström, B., Mutanen, M., Bruckner, H. & Sihvonen, P. (2021) Subspecies of *Pleurota bicostella* (Clerck, 1759) revisited and descriptions of nine new species in the *P. bicostella* species group (Lepidoptera: Gelechioidea: Oecophoridae: Pleurotinae). Zootaxa 4941 (4): 451–486. https://doi.org/10.11646/zootaxa.4941.4.1

Tabell, J., Mutanen, M., Sihvonen, P. (2019) Three morphologically and genetically confirmed new *Pleurota* species from Morocco (Lepidoptera: Gelechioidea: Oecophoridae: Pleurotinae). Zootaxa 4624(3):442–450. https://doi.org/10.11646/zootaxa.4624.3.12

Kaila, L., Mutanen, M., Sihvonen, P., Tyllinen, J. & Tabell, J. (2018) Characterization of Pleurotinae, with review of *Pleurota* species close to *P. aristella* (Linnaeus) from Morocco (Lepidoptera: Gelechioidea: Oecophoridae). Zootaxa 4545 (4): 451–477. https://doi.org/10.11646/zootaxa.4545.4.1

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Holotype of *Scrobipalpomima agustini* Vargas, 2020 **(see next article)**

On previously overlooked gelechiids of the arid habitats of northern Chile

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The northernmost part of Chile at about 18° S harbors different arid environments along a wide elevational gradient from the lowlands (Fig. 1) of the Atacama Desert to the highlands (Fig. 2) of the Andes. When I was a child playing in the Azapa Valley near the sea level, I never thought that the scarce native plants growing there harboured unknown micromoths. However, just before the beginning of my graduate studies about 20 years ago, I was pleasantly surprised when I discovered minute larvae feeding on different organs of some of these plants. For simple curiosity, I collected the parts infested with larvae and placed them in plastic vials. I shortly was surprised by the emergence of a few small adults. Unfortunately, I was a bit disappointed by the great difficulty of identifying the emerged micromoths, because the information about taxonomy and natural history of non-pest species of northern Chile was almost non-existent at that time. After some searches of literature, I decided to contact some eminent lepidopterists to request help, all of which were always extremely kind, providing valuable support and encouragement. Some of these lepidopterists are John W. Brown, Richard L. Brown, Donald R. Davis, Jurate De Prins, Cees Gielis, Lauri Kaila, Sjaak Koster, Tosio Kumata, Bernard Landry, Jean-François Landry, Gilson R. P. Moreira, Józef Razowski and Yu-Feng Hsu, although I need to apologize for several names forgotten in this list, as these are many. As a result of subsequent rearings and collections, the micromoth fauna of this arid area is a bit better known and a few new genera and several new species, including Gelechioidea, have been discovered. Currently, as a professor at the Universidad de Tarapacá (Arica, Chile), I continue to study the micromoths of the amazing arid environments of the northernmost part of the country. This supposedly easy task is still incomplete, because the surprises have been much more than imagined.

The taxonomy of the Chilean Gelechiidae has been studied by only a few authors, among them Butler (1883), Gyen (1913), Meyrick (1914, 1931), Clarke (1965), Povolný (1985, 1986, 1987, 1989) and King & Montesinos (2012a, 2012b). Recently, Cepeda (2017) updated all the published information dealing with taxonomy, geographic distribution and biology of the Chilean fauna of Gelechiidae.

Fig. 1. The Azapa Valley, the type locality of *Scrobipalpula wilsoni* Vargas, at about 750 m elevation in the Atacama Desert of northern Chile.

Subsequently, Cepeda (2018) described an endemic genus, *Amplusuncus* (Litini), and two new species, and later (Cepeda 2019) added four species of Gnorimoschemini, two of which he described as new, while the two others were already described from other South American countries. Furthermore, Vargas (2019, 2020) added two new species of Gnorimoschemini from the northernmost part of the country. As a result, the Chilean fauna of Gelechiidae currently includes 34 described species belonging to 17 genera. This small number is not surprising, as many of the species known from Chile were collected by entomologists whose sampling efforts were mainly concentrated in southern Argentina (e.g. Povolný 1985, 1986, 1987, 1989). The current low diversity of Gelechiidae in Chile should be understood as a result of the low sampling and absence of lepidopterists interested in the study of this family in the country for a long time. This suggestion has been partially corroborated by the recent findings of King & Montesinos (2012a, b), Cepeda (2018, 2019) and Vargas (2019, 2020), as in all these cases, just a minimal amount of field work was sufficient to discover previously unknown species and to expand the geographic ranges of previously described species. Surprisingly, one of the recently described species native to Chile was discovered associated with a native plant in a highly human-modified urban environment (King & Montesinos 2012a), providing a clear example of the under sampling of these Chilean micromoths.

Fig. 2. Surroundings of Socoroma Village, the type locality of *Scrobipalpomima agustini* Vargas, at about 3400 m elevation on the Andes of northern Chile.

In the case of the Gelechiidae of the northernmost part of Chile, only four species were recorded until a few years ago, all widespread agricultural pests (Artigas 1994). The first surveys on native plants enabled the discovery of two native species: *Scrobipalpula wilsoni* Vargas, whose larvae are leaf tiers (Fig. 3) on the shrub *Baccharis salcifolia* (Asteraceae) in the coastal valleys of the Atacama Desert near the sea level (Vargas 2019), and *Scrobipalpomima agustini* Vargas, whose larvae induce stem galls (Fig. 4) on the shrub *Adesmia spinosissima* (Fabaceae) at about 3400 m elevation on the western slopes of the Andes (Vargas 2020).

I continue to survey for larvae of Gelechiidae (and other micromoths) on native plants. I am also involved in a collaboration with the friends Gislene L. Gonçalves and Gilson R. P. Moreira (Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil) to study the systematics and natural history of *Symmetrischema* Povolný from the Andes of northern Chile.

Fig. 3. Leaves of *Baccharis salicifolia* (Asteraceae) tied by larvae of *Scrobipalpula wilsoni* Vargas.

Fig. 4. Stem gall (left) induced by larvae of *Scrobipalpomima agustini* Vargas on *Adesmia spinosissima* (Fabaceae).

Literature cited:

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Butler, A. G. (1883) Heterocerous Lepidoptera collected in Chili by Thomas Edmonds, Esq. *Transactions of the Entomological Society of London* 31: 49–90.
Cepeda, D. E. (2017) Contribution to the knowledge of Chilean Gelechiidae (Lepidoptera: Gelechioidea). *Insecta Mundi* 584: 1–8.
Cepeda, D. E. (2018) A new genus and two new species of Litini (Lepidoptera: Gelechiidae) from Chile. *Revista Chilena de Entomología* 44: 373–383.
Cepeda, D. E. (2019) Descriptions of two new species of the genus *Scrobipalpomima* Povolný (Lepidoptera: Gelechiidae) and two new records of Gnorimoschemini from Chile. *Revista Chilena de Entomología* 45: 21–30.
Clarke, J. F. G. (1965) Microlepidoptera of the Juan Fernandez Islands. *Proceedings of the United States National Museum* 117: 1–105.
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Povolný, D. (1985) Gnorimoschemini of southern South America I: The Scrobipalpuloid genera (Insecta, Lepidoptera, Gelechiidae). *Steenstrupia* 11: 1–36.
Povolný, D. (1986) Gnorimoschemini of southern South America II: The genus *Eurysacca* (Insecta, Lepidoptera, Gelechiidae). *Steenstrupia* 12: 1–47.
Povolný, D. (1987) Gnorimoschemini of southern South America III: The scrobipalpuloid genera (Insecta, Lepidoptera, Gelechiidae). *Steenstrupia* 13: 1–91.
Povolný, D. (1989) Gnorimoschemini of southern South America V: Corrections and additions to parts I–III (Insecta, Lepidoptera, Gelechiidae). *Steenstrupia* 15: 137–160.
Vargas, H. A. (2019) A new species of *Scrobipalpula* Povolný (Lepidoptera: Gelechiidae) associated with *Baccharis salicifolia* (Asteraceae) in the Atacama Desert of northern Chile. *Studies on Neotropical Fauna and Environment* 54: 217–224.
Vargas, H. A. (2020) A new species of *Scrobipalpomima* Povolný (Lepidoptera: Gelechiidae) reared from stem galls of *Adesmia spinosissima* Meyen (Fabaceae) in the Andes of northern Chile. *Transactions of the American Entomological Society* 146: 521–533.

A synopsis on the classification of the "tomato leafminer", *Tuta absoluta* (Meyrick, 1917) (Gelechiidae, Gelechiinae, Gnorimoschemini) based on cladistic analysis of morphology

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Tuta absoluta (Meyrick, 1917) is not the nominal taxon for the genus, but it is the most infamous, causing up to 100% tomato crop loss when management methods were not "efficiently implemented.". It's type locality is Huancayo, Peru at an elevation of 3,200 m, but has a widespread distribution in Central and South America; and is an invasive pest reported across the Mediterranean east through China, central and south African countries (Biondi et al. 2018).One of species's not so endearing qualities is that over its taxonomic history it has been placed in five different genera of Gnorimoschemini, and authors have subjectively determined these classifications based on their choice of morphological characters, biological similarities, and typological methods.

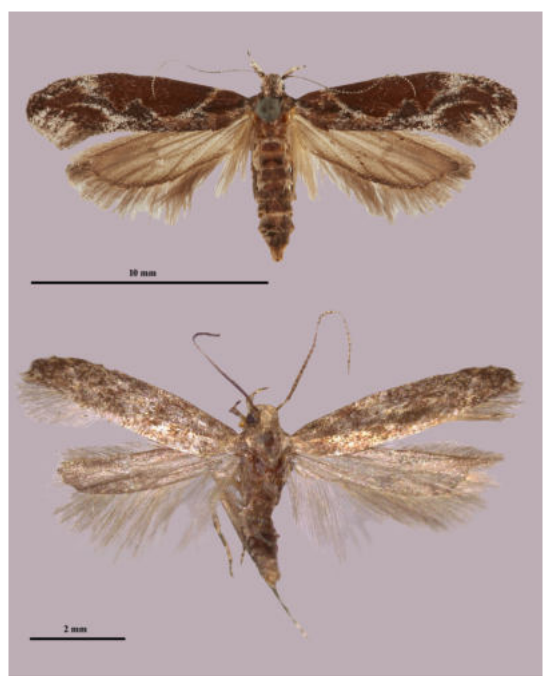

Fig. 1. Dorsal habitus of *Gnorimoschema gallaesolidaginis* (top) and *Tuta absoluta* (bottom)

Fig. 2. adult, larva, and mines on tomato.

In a recent publication, Corro Chang and Metz (2021) report the first attempt to classify the taxon *absoluta* to genus using morphological cladistic methods. The authors mined for characters and ultimately scored a morphological matrix composed of 22 binary characters (18 informative, 4 uninformative) of the male and female genitalia and a sampling of eight taxa, which included the nominal taxa of the genera *Phthorimaea*, *Scrobipalpuloides*, *Tuta* and the nominal taxon for the tribe Gnorimoschemini, *G. gallaesolidaginis*. The four uninformative characters were retained by the authors, as indicators of possible synapomorphy among these and associated taxa in for the benefit of authors of future works. The phylogenetic and character analyses were carried out in Mesquite 2.1 spawning TNT 1.5 launched via Zephyr 3.11 build 150 to calculate the minimum tree length parsimony hypothesis. Bootstrap support was calculated by the resample and boot commands with 100 replicates, and Bremer support values were calculated using the bsupport command on a set of 843 trees in memory estimated from multiple iterations of TBR.

This search resulted in a single most parsimonious tree of 28 steps (CI = 0.69, RI = 0.58), where an hypothesis for the generic placement of *absoluta* in the genus *Phthorimaea* was supported *Phthorimaea*, *Scrobipalpuloides,* and *Tuta* were resolved among the ingroup with *Phthorimaea absoluta* being part of a monophyly that included *P. operculella*, the nominal species for the genus. The authors proposed changing the classification of the included species based on the nominal taxa, however, they left untreated species in their current respective genera until a more comprehensive analysis for the tribe Gnorimoschemini is completed.

In general terms, morphological homologies among these species are difficult to qualify and quantify. Of the 34 characters studied during this work, the authors retained only 22 from the male and female genitalia that could be fairly called homologous and were still

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	Taxon \ Character	Apex of uncus	Uncus wider than long	Valva longer than unc	Apex of valva simple	Groove at base of sacc	Shape of phallus	Phallus with rounded f	Phallus with curvature	Length of aedeagus	Saccular process shap	Caecum reduced	Medial process of juxta	Medial process of juxta	Medial process of juxta	Tegumen fusion lines	Saccus
1	Gnorimoschema gallaeosolidaginis	Subacute	False	False	True	False	Tubular	False	False	Short	Conical	False	True	False	False	Visible	Narrow, long
2	Phthorimaea operculella	Subacute	False	True	False	True	Nasute	False	False	Long	Quadrate	True	False	False	True	Visible	Broad, short
3	Phthorimaea robusta	Subacute	False	True	False	True	Nasute	False	False	Long	Quadrate	False	False	False	True	Visible	Broad, short
4	Scrobipalpuloides inapparens	Rounded	False	False	True	False	Nasute	False	True	Long	Conical	True	False	False	True	Visible	Narrow, long
5	Scrobipalpuloides ascendens	Rounded	False	False	True	False	Nasute	True	True	Long	Conical	False	True	False	True	Not visible	Narrow, long
6	Scrobipalpuloides chiquitella	Rounded	True	True	True	False	Nasute	False	False	Long	Quadrate	False	True	True	False	Visible	Narrow, long
7	Tuta absoluta	Rounded	True	False	True	False	Tubular	False	False	Short	Conical	False	True	True	True	Visible	Narrow, long
8	Tuta atriplicella	Rounded	False	False	True	False	Tubular	True	False	Long	Conical	False	True	False	False	Visible	Narrow, long

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	Character \ State	State 0	State 1	State 2	State 3	State 4
1	Apex of uncus	Rounded	Subacute			
2	Uncus wider than long	False	True			
3	Valva longer than uncus	False	True			
4	Apex of valva simple	False	True			
5	Groove at base of saccular process	False	True			
6	Shape of phallus	Tubular	Nasute			
7	Phallus with rounded flange	False	True			
8	Phallus with curvature	False	True			
9	Length of aedeagus	Short	Long			
10	Saccular process shape	Quadrate	Conical			
11	Caecum reduced	False	True			
12	Medial process of juxta extending well be	False	True			
13	Medial process of juxta helicoid and apic	False	True			
14	Medial process of juxta laterally oriented	False	True			
15	Tegumen fusion lines	Not visible	Visible			
16	Saccus	Narrow, long	Broad, short			
17	Corpus bursa elongated	False	True			
18	Position of signum at half of corpus bursa	False	True			
19	Size of signum	Small	Large			
20	Ductus bursa short	False	True			
21	Funnel like shape of antrum	False	True			
22	Length of dorsal genital capsule	Much longer than wide	Not very much longer than wide			

Fig. 3. The matrix of characters was created in the software Mesquite 2.1. Top: Preview of the matrix; Bottom: View of the characters and states.

informative. One historical problem with species in these genera is the lack of confidently associated females with identified males. Fortunately, this was not the case in the study of *P. absoluta*, however, the female of *T. atriplicella* is unknown. With the low morphological confidence, it is a wonder why the classification of *P. absoluta* has changed so many times, even having been given different classifications twice separately by Meyrick and Povolný (Meyrick, 1917, 1925; Povolný, 1987, 1993). None of the previous authors« taxonomic hypotheses were accompanied by any analysis or argumentation other than to subjectively say two or more taxa are more similar or dissimilar (Povolný 1993). In the recent publication, Corro Chang and Metz (2021) provide a reproducible framework and data to support the placement of *Phthorimaea absoluta* among its historical congeners.

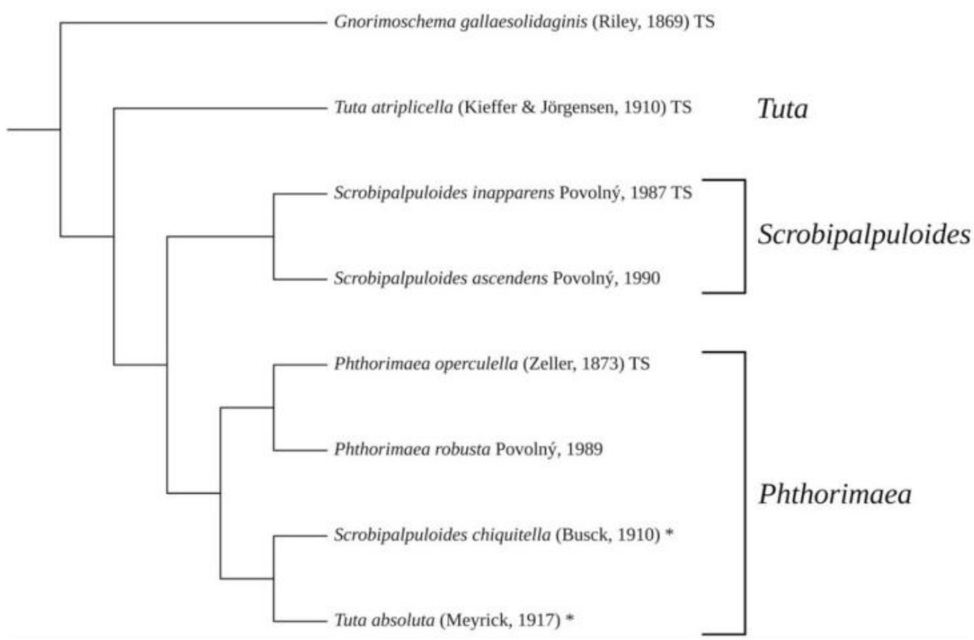

Fig. 4. Single most parsimonious tree of 28 steps (CI=0.69, RI=0.58).

The genus *Phthorimaea* is supported by the presence of a longer valva, a quadrate saccular process, a signum located in the middle of corpus bursae, and a funnel-shaped antrum. The length of the valva and the shape of the saccular process are reversed in *P. absoluta*, but it shares the position of the signum in the middle of corpus bursae and the funnel shaped antrum. Although not included in the cladistic analysis, the authors cite research that *P. absoluta* and *P. operculella* share a rare physiology, deuterotokous parthenogenesis, whereby both males and females can develop from unfertilized eggs. This type of parthenogenesis has been reported in 11 families of Lepidoptera. In addition, both species have similar life histories: early larval instars are leaf miners which later become borers of tubers and fruits. These results support a need for generic re-classification of *absoluta*, under its original genus, *Phthorimaea*; and from this work, the authors expect to facilitate the determination and management of the species and closely related emergent pests, by providing an accurate classification.

Fig. 5. Mark Metz, Patricia Corro Chang and J.-F. Landry during a visit to the USNM in 2017.

The first author is an entomologist and lecturer at Programa Centroamericano de Entomología, Universidad de Panamá. She is finishing her Ph.D. studies in Entomology at Universidad de Panamá; an institution where she expects to continue supporting training new generations of entomologists, and researching on the Neotropical Gnorimoschemini. Patricia has supported different extensional scientific programs organized by the Secretar'a Nacional de Ciencias y Tecnolog'as (Senacyt) in Panamá, sharing her experiences with students at different academic levels, and as an active volunteer of Mashav, Panamá.

Original publication:

Corro Chang, P. and M. Metz. 2021. Classification of *Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae: Gelechiinae: Gnorimoschemini) based on cladistic analysis of morphology. *Proceedings of the Entomological Society of Washington,* 123(1):41-54.

Some research cited in the text:

Biondi, A., R. N. C. Guedes, F. H. Wan, and N. Desneux. 2018. Ecology, worldwide spread, and management of the invasive South American tomato pinworm, *Tuta absoluta*: past, present and future. Annual Review of Entomology 63: 239–258. https://doi.org/10.1146/annurev-ento-031616-034933.

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Povolný, D. 1993. Zur taxonomie und Nomenklatur der amerikanischen gnorimoschemoiden Gattungen *Tuta* Strand, *Tecia* Strand, *Scrobipalpopsis* Povolný und *Keiferia* Busck (Insecta: Lepidoptera: Gelechiidae). Reichenbachia (Staatliches Museum fŸr Tierkunde Dresden) 30(14): 85–98.

Fig. 6. Collecting microlepidoptera in Panama (left: Patricia Corro Chang)

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Gelechioid Leafminers

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Leafminers are insect larvae that feed between the epidermal layers of leaves, and their feeding patterns are known as mines. They are typically quite host-specific, and the form of the mine varies considerably depending on what insect produces it. As a result, it is often possible to identify the responsible insect using only the hostplant and mine characteristics. I became fascinated by leafminers while writing a guide to the evidence left behind by insects and other invertebrates (Eiseman & Charney 2010), and have spent the past decade compiling a "complete" guide to the leafminers of North America north of Mexico (Eiseman 2019). Because new information is becoming available all the time, I am continually updating this guide and currently working on a revised second edition, which, like the first, is in the form of a serial e-book that I am making available to subscribers as each chapter is finished.

Beyond a massive literature review, this project has involved collecting and rearing leafminers throughout the USA (and a little bit in Canada), and I have published 35 peer-reviewed papers documenting new natural history information about them. Two beetle species have been described from my reared specimens, and with the help of taxonomic specialists I have coauthored two sawfly species, North America's only two known leaf-mining dark-winged fungus gnat species, and 62 agromyzid fly species. So far I have only had the opportunity to name three moth species—*Marmara viburnella* Eiseman & Davis, 2017, *Macrosaccus coursetiae* Eiseman & Davis, 2017 (both Gracillariidae), and *Grapholita thermopsidis* Eiseman & Austin, 2020 (Tortricidae)—but I have specimens of dozens of other undescribed or taxonomically problematic species awaiting study. I have been able to publish two papers on leaf-mining gelechioids thanks to identifications from Terry Harrison and Jean-François Landry (Eiseman 2016, 2018), and Terry and I plan to collaborate on a paper on Cosmopterigidae.

North American leaf-mining Lepidoptera include over 1200 described species from 40 families and 18 superfamilies. Over a third of these belong to nine families of Gelechioidea, which I review below, arranged in ascending order by the number of miners they are known to include. In general, gelechioid leafminers have the ability to exit their mines and establish new ones in fresh leaves, which is not the case with major leaf-mining groups such as Eriocraniidae, Heliozelidae, Nepticulidae, Tischeriidae, and many Gracillariidae. They also differ from these groups (as well as from Tortricidae) in having a pupa that remains in place when the adult emerges, rather than being thrust from the cocoon. Many gelechioids are miners only in early

Plate 1 – Gelechioid leafminers and reared adults, top to bottom: *Batrachedra concitata* (Batrachedridae) on *Agave* (Asparagaceae) in Arizona; *Landryia impositella* (Scythrididae) on calico aster (Asteraceae: *Symphyotrichum lateriflorum*) in Massachusetts; *Mompha locupletella* (Momphidae) on fringed willow-herb (Onagraceae: *Epilobium ciliatum*) in Massachusetts; *Coleophora leucochrysella* (Coleophoridae) on American chestnut (Fagaceae: *Castanea dentata*) in Massachusetts; *Cosmopterix astrapias* (Cosmopterigidae) on morning glory (Convolvulaceae: *Ipomoea purpurea*) in North Carolina.

instars, and/or spend some of their time in a silken retreat or portable case outside the mine. Most gelechioids form full-depth mines, meaning that all green tissue between the two leaf epidermises is consumed, in contrast with the flatter larvae of some more specialized leaf-mining groups that form shallower mines, visible only from one of the two leaf surfaces. With the exception of a few coleophorids, each species is restricted to hosts in a single plant family, and usually in a single genus.

Batrachedridae – The European species *Batrachedra pinicolella* (Zeller), which mines into spruce needles from a frass-coated silk tube, was recently discovered in northeastern North America. In Arizona I reared *B. concitata* Meyrick from larvae mining into agave leaves from small sheets of silk, and there are six other related species in the southwestern USA that may do the same but none have been reared.

Pterolonchidae – Two *Coelopoeta* species form blotch mines in leaves of California Boraginales, spinning silk inside that causes the leaf to curl or forms a gall-like swelling. Nothing is known of the larval biology of the third species, which occurs in Yukon.

Scythrididae – The genus *Landryia* includes six described species, of which three have been reared. All of these spin webs on the undersides of leaves, forming irregular, frass-free blotch mines with the entry hole at the basal edge—two on Asteraceae and one on Poaceae.

Momphidae – Of the 47 described *Mompha* species documented in North America, 12 are known to be leafminers, with eight feeding on Onagraceae, three on Rubiaceae, and one on Cistaceae. The larvae feed belly-up, typically first forming a linear mine, in which the granular frass may form a central line, and later a blotch in which oblong fecal pellets are scattered at random. *Mompha terminella* (Westwood), on enchanter's nightshade (Onagraceae: *Circaea*), is apparently unique in expelling some of its frass through holes at the margins of the blotch. A few species form a more or less linear mine throughout. The dense, flat, whitish to brown cocoon is typically spun outside the mine; a few species spin it within the mine, and a few on Rubiaceae cut out an oval pupal case from the finished mine.

Depressariidae – Four of the twelve Nearctic *Exaeretia* species are known to be leafminers, two on Asteraceae and two on Malvaceae. At least some of these species, which are all western, mine in conjunction with leaf folding or webbing. Larvae of *Agonopterix fusciterminella* Clarke are initially full-depth leafminers, usually later exiting to feed within rolled or tied leaves. Terry Harrison has determined that *Ethmia trifurcella* (Chambers), which skeletonizes leaves of wild comfrey (Boraginaceae: *Andersonglossum*), feeds as a leafminer in its first instar, forming an irregular mine from which the frass is expelled. Valeriu Albu has reared *Antaeotricha lindseyi* (Barnes & Busck) from pupae found in oak leaf shelters that includedfrass-free blotch mines, evidently made by the larvae. Also on oak, *Menesta melanella* Murtfeldt is said to mine briefly before forming what I call a "pseudomine," in which the larva feeds beneath a sheet of silk that can be mistaken for the loosened epidermis of the leaf. Probably many other depressariids start out as miners, but these are all the ones I know about.

Plate 2 – Gelechioid leafminers and reared adults, top to bottom: *Exoteleia pinifoliella* (Gelechiidae) on pitch pine (Pinaceae: *Pinus rigida*) in Massachusetts; "*Recurvaria*" *consimilis* (Gelechiidae) on New Jersey tea (Rhamnaceae: *Ceanothus americanus*) in Massachusetts; *Scrobipalpa scutellariaeella* (Gelechiidae) on hoary skullcap (Lamiaceae: *Scutellaria incana*) in Ohio; *Chrysoesthia sexguttella* (Gelechiidae) on maple-leaved goosefoot (Amaranthaceae: *Chenopodiastrum simplex*) in Massachusetts; *Elachista cucullata* (Elachistidae) on *Carex* (Cyperaceae) in Massachusetts.

Coleophoridae – About 70 of the described Nearctic *Coleophora* species are leafminers with known hosts; they occur on a wide variety of woody and herbaceous plants. The larva initially feeds as a typical leafminer, but then cuts out a piece of its mine and fashions this into a portable case. From then on it forms characteristic blotch mines by attaching the mouth of the case to the underside of a leaf, chewing a circular hole in the lower epidermis, and consuming the mesophyll in all directions, expelling its frass through a two- or three-valved opening at the posterior end of its case. Depending on the species, the growing larva may enlarge its case by adding pieces cut from later mines, or it may abandon its case for a larger one cut from a mine or made entirely of silk; some species cover their silk cases with grains of sand. Larvae overwinter and then, with or without additional feeding, pupate in their cases in the spring.

Cosmopterigidae – Ninety described species in this family are known or presumed to be leaf or stem miners. Thirty-one of these are in the genus *Cosmopterix* and mostly feed on grasses and sedges, often expelling their frass through a hole at the basal end of the mine; a few are found on Convolvulaceae, Asteraceae, Fabaceae, and Urticaceae. Other leaf-mining cosmopterigines include *Pebobs ipomoeae* (Busck) on morning glories (Convolvulaceae: *Ipomoea*), *Teladoma helianthi* Busck on Heliantheae (Asteraceae), and southwestern species of *Anoncia* (five on Lamiales and one on Primulaceae: *Dodecatheon*); the Holarctic *Limnaecia phragmitella* Stainton is said to mine initially in the pith of cattail (Typhaceae: *Typha*) leaf sheaths before moving to the seedheads. Among Chrysopeleiinae are *Chrysopeleia purpuriella* Chambers and several species of *Stilbosis*, which form distinctive blotch mines on oaks (one instead on Betulaceae: *Ostrya*), arranging their frass in two rows within the mine and/or tying it with silk to one or both leaf surfaces. *Stilbosis rhynchosiae* (Hodges), known only from Tennessee, is a leafminer of twining snoutbean (Fabaceae: *Rhynchosia tomentosa*); in California an undescribed species of *Periploca* mines leaves of jojoba (Simmondsiaceae: *Simmondsia chinensis*), and a chrysopeleiine possibly representing an undescribed genus mines in hymenopteran leaf galls on Florida Keys blackbead (Fabaceae: *Pithecellobium keyense*).

Gelechiidae – I am aware of just over 100 described species of gelechiids that are leafminers at least in early instars, scattered across six subfamilies but mostly in Gelechiinae. The Litini include numerous species of *Coleotechnites* and *Exoteleia* that mine in conifer needles, as well as a *Coleotechnites* on St. John's wort (Hypericaceae: *Hypericum*), and four species of "*Recurvaria*" and *Xenolechia* on *Ceanothus* (Rhamnaceae); young larvae of one or two *Agnippe* species and the introduced European species *R. nanella* (Denis & Schiffermüller) mine leaves of rosaceous trees and shrubs, and those of the Holarctic *X. aethiops* (Humphreys & Westwood) in heather and heath (Eriaceae: Ericoideae), before transitioning to other feeding modes. At least 27 species of Gnorimoschemini are leafminers, mostly on Asteraceae and Solanaceae but with a few on Amaranthaceae, Elaeagnaceae, Lamiaceae, Polemoniaceae, Rosaceae, and Salicaceae; some deposit frass outside their mines, and several of these tie it together with silk to form a tubular retreat. In Gelechiini, at least three *Chionodes* species do a combination of leafmining and leaftying (on Fabaceae, Polygonaceae, and Pinaceae); *Filatima* *loowita* Adamski does the same on lupine, and *Rifseria fuscotaeniaella* (Chambers) forms blotch mines in leaves of cudweeds and everlastings (Asteraceae: Gnaphalieae).

A distant second to Gelechiinae is Anomologinae, with 11 species of known, alleged, or presumed leafminers, including species of *Aristotelia* (Onagraceae, Fabaceae), *Monochroa* (Cyperaceae), *Nealyda* (Nyctaginaceae, Phytolaccaceae), and *Tosca* (Rosaceae). The Anacampsinae include five species of *Aproaerema* that tie and mine leaves of legumes. In Apatetrinae, probably all four species of *Chrysoesthia* are leafminers of Amaranthaceae, although the California species *C. versicolorella* (Kearfott) has not been reared. At least one (as yet undetermined) Asteraceae-feeding species of *Dichomeris* (Dichomeridinae) is initially a miner before feeding in a leaf shelter, and young larvae of the introduced *D. marginella* (Fabricius) mine in juniper needles. Finally, a Florida thiotrichine, *Calliprora leucaenae* Lee & Hayden, ties and mines leaves of leadtree (Fabaceae: *Leucaena leucocephala*).

Elachistidae – As far as is known the Nearctic Elachistinae are all leafminers. They include 135 species of *Elachista*, which all feed on grasses, sedges, or possibly rushes, but most are only known from caught adults. Unlike most *Cosmopterix*, the larvae deposit all of their frass in the mines. The pupa is usually attached to a leaf or twig by the tip of the abdomen and by a silken girdle around the abdomen. In some species it is covered by a web or sheet of silk. Three *Perittia* species form blotch mines on Caprifoliaceae, and the hosts of the other four are unknown. The midwestern *Stephensia cunilae* Braun forms linear-blotch mines on common dittany (Lamiaceae: *Cunila origanoides*), and *S. major* (Kearfott) is known only from three adults caught in the Black Mountains of North Carolina.

If any gelechioid aficionados out there are aware of North American leafminers I may have missed, or are interested in helping to put names to unidentified and undescribed species I have reared, please let me know!

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On *Chrysoclista linneella* (Lepidoptera: Agonoxenidae) on the frontispiece of Clerck's *Icones Insectorm Rariorum* (1759)

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Carl Alexander Clerck (1709-1765) was a Swedish entomologist, arachnologist, and a contemporary of Linnaeus. As a young man in 1739 he attended a lecture by Linnaeus in Stockholm and this sparked his interest in natural history. Later in life he became a friend and correspondent of Linnaeus, who greatly appreciated his work and sponsored him for membership in the Royal Society of Sciences in Uppsala in 1756 and in Royal Swedish Academy of Sciences in 1764. Beside his publications on Swedish spiders, Clerck is famous for his *Icones insectorum rariorum*, a series of detailed but uncommented plates illustrating numerous species of butterflies and moths that were left unfinished after the third fascicle (1766) upon Clerck's death. The series includes 62 colour and seven supplementary plates. Plates 1-12 contain 183 figures of Swedish moths, including very small tortricids, crambids etc, and plates 13-55 show only tropical species, mostly large butterflies.

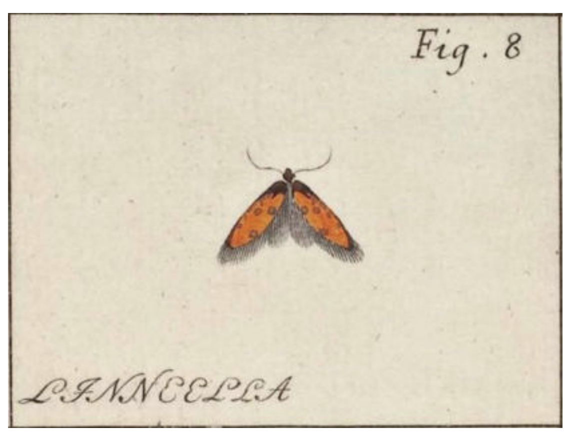

Fig. 1. Image courtesy of project Runeberg (http://runeberg.org/iconinsect)

The original specimens illustrated in Clerck's book come from either Linnaeus' collection, or from the collection of Her Majesty Queen Louisa Ulrika (1720–1782). The text consists of an elaborate dedication to The Queen and four pages of introduction, mostly talking about Linnaeus and other famous scientists. There is no text describing the

CAROLI CLERCK

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ICONES INSECTORUM RARIORUM.

Sect SECUNDA

Cum Nominibus Trivialibus Locisque E

Nob: Equ: *LINNÆI* Systemate Naturali Adjectis.

Holmiæ *1764*.

Fig. 2. Image courtesy of The Goettingen State and University Library (gdz.sub.uni-goettingen.de/id/PPN368290107)

illustrated specimens, however species names published by Linnaeus are clearly engraved on the plates with reference to the species numbers in *Systema naturae*. Clerck's work therefore may be considered as illustrations of the species described by Linnaeus. Clerck illustrated *Phalaena linneella* on plate 12, figure 8 of the first volume of *Icones*, with the caption *"LINNEELLA"* (Fig. 1). It is among the 60 or so moths that Clerck named in *Icones*. He named this one in honor of Linnaeus, who included it later in part 2 of the first volume of *Systema naturae* (1767). The same moth appears on the frontispiece of the second volume of *Icones* in an elaborate scene (Fig. 2). Two putti are shown alongside a female figure, presumably Queen Louisa Ulrika dressed as Minerva - the goddess of wisdom, war, art, schools, justice and commerce. She is in full military costume with a feathered helmet, cape, and a spear. The putti are helping her carry her shield, which is engraved with an image of the moth, towards a steep uphill trail. On top of the hill is a pergola, above which an angel is blowing the horn announcing the arrival of the Queen. Inside the temple is another putto, or maybe Cupid, standing next to the National Emblem of Sweden (the Three Crowns), holding an open book. With this symbolic scene, Clerck perhaps intended to demonstrate the difficult path to inclusion of his moth in Linnaeus' *Systema naturae*, and the help and approval that he received from Queen Louisa Ulrika (Fig. 3). With a single image, Clerck paid tribute to Linnaeus, the Queen, and the Swedish Crown, all at the same time.

Fig. 3. Queen Louisa Ulrika, painting by Lorens Pasch the Younger, 1768 (via Wikimedia Commons)

Chrysoclista linneella is an attractive little moth sporting metallic leaden blotches against a bright orange ground color (Fig. 4). It is found in most of Europe, Turkey, Russia and Ukraine, and it has been introduced to North America where it was first reported in New York City in 1928. In the United States there are records from other parts of New York State, New Jersey, Massachusetts, Connecticut, and Vermont. In Canada, it is known from British Columbia, Ontario, Quebec, New Brunswick and Nova Scotia. Its larvae feed on lime trees (*Tilia* species) and are difficult to locate except for the existence of brownish frass on the surface of the trunk. They mine the bark of their host plant.

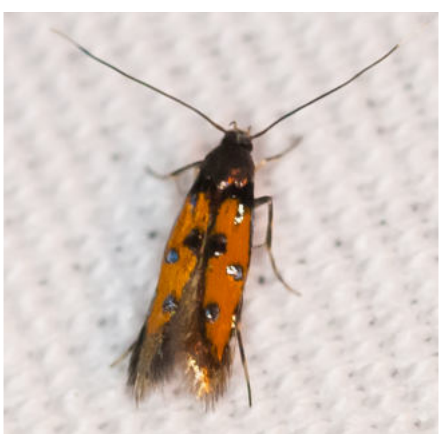


Fig. 4. Image from Wikimedia Commons

* * *

Congress Announcement

Because of the continuing COVID pandemic, the Lepidopterists' Society has determined that an in-person meeting during the summer of 2021 will not be possible. Instead they will be holding a first **Virtual Annual Meeting from August 18-20, 2021.** Check https://www.lepsoc.org/content/annual-meeting# for updates. The 2022 Annual Meeting is planned to be held in North Carolina in June. You can email meeting@lepsoc.org with any questions regarding LepSoc meetings.

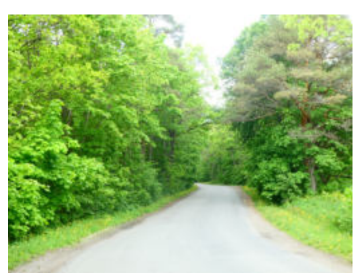
* * *

The **22nd European Congress of Lepidopterology**, organized by University of Tartu and Societas Europaea Lepidopterologica, to be held at Laulasmaa (40 km W of Tallinn), Estonia, is now **postponed** to June 06-11, 2022.

For preliminary queries, contact Toomas Tammaru at toomas.tammaru@ut.ee. (Photos: Toomas Tammaru)

Congress website: https://sel2022.ut.ee/avaleht






Recent Publications on Gelechioidea

Initially Compiled by Mark A. Metz

Articles dealing with pest or biocontrol issues are not included unless they contain data pertaining to systematics.

2019 additions (1)

Please see I.N.G.A. issue 9 for other articles published in 2019:
https://mississippientomologicalmuseum.org.msstate.edu/Researchtaxapages/Lepidoptera/Gelechioidea/INGA/INGA_issues/I.N.G.A._9_2020.pdf

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