REVEALING GLOBAL BIODIVERSITY: NEPTICULIDAE

Inventorying of Biodiversity

(by Jonas R. Stonis)

Cite as: Stonis, J.R. (2022) Inventorying of Biodiversity. *In*: Stonis, J.R., Remeikis, A. & Diškus, A. *Neotropical Nepticulidae: a pictorial monograph introducing an electronic identification tool.* Vilnius, Nature Research Centre, 5–11 pp.

The time for exploring Earth's species and mapping their distribution in the biosphere has arrived (Wheeler *et al*., 2012b). The current life poses new, often existential, challenges related to climate change, the global biodiversity crisis as well as shortage of skilled professionals. The development of society is inconceivable without research and cognition of the structural elements of living nature, i.e., ecosystems and species (especially those of economic significance) (Stonis *et al*., 2022). The inventory of biodiversity is important not only because it gives knowledge of nature that surrounds us but also because of it provides tools for invoking prompt measures for the preservation of biodiversity. It is of utmost importance to understand the complicated mechanisms of the global biota. Because of the current fragmentation and destruction of natural habitats and global climate change, biodiversity is undergoing dramatic changes. Therefore, researchers in the field of biotaxonomy seem to be racing against time.

Therefore, it may appear that there is no longer a need to advocate for biodiversity inventories because so many various authors have already mentioned this topic. Nevertheless, in recent papers on Nepticulidae or related lepidopteran families, we were stressing again and again the importance of efficient biodiversity inventories (Stonis *et al*., 2020; Dobrynina *et al*., 2021, 2022). However, probably the best ever motivation for the inventorying of biodiversity and confronting challenges was provided by Q. D. Wheeler and his numerous co-authors in their paper "Mapping the biosphere: exploring species to understand the origin, organization and sustainability of biodiversity" (Wheeler *et al*., 2012b). Millions of the world's species still await discovery and documenting, and the task to describe and monitor the Earth's biodiversity is immense (Zhang, 2008, 2011; Cutko, 2009; La Salle *et al*., 2009; Pereira *et al*., 2010; Wheeler *et al*., 2012a, 2012b), but the speed is far from satisfactory (Schmeller *et al*., 2017). To speed up the global inventorying, the integration of the DNA barcoding into an ongoing inventory has been actively propagated (notably Janzen *et al*., 2009; Miller, 2015; Miller *et al*., 2016; Aagaard *et al*., 2017), and some seriously controversial attempts were recently undertaken (Dobrynina *et al*., 2021). It is particularly the case of a minimalist revision with the description of about four hundred new species of Costa Rican braconid parasitoid wasps (Sharkey *et al*., 2021) rejecting the usual standards for species description (Dobrynina *et al*., 2021).

According to Wheeler *et al*. (2012b), the exploration of the biosphere is much like exploring the Universe. The more we learn, the more complex and surprising the biosphere and its story turn out to be (Wheeler *et al*., 2012b). The closure of this knowledge gap, also known as the Linnean shortfall (Brito, 2010; Hortal *et al*., 2015) or Wallacean shortfall (Hortal *et al*., 2015), will require a strong renewed effort in the exploration and taxonomy as well as continuing effort to catalogue the existing biodiversity data in publicly available databases (Mora *et al*., 2011; Wheeler *et al*., 2012a; Dobrynina *et al*., 2022). The availability (and quality) of such information seems to be essential for our general understanding how global biota functions (Pereira *et al*., 2010). The documenting (description)

of new taxa (species in particular), as well as collecting and accumulation of various data about their ecological niches (including trophic relationships, i.e., feeding preferences), are fundamental tasks to be done for getting general knowledge about endangered segments of biodiversity (Dubois, 2011; Crisci *et al*., 2020). According to Vane-Wright (1992, 1996), this task is right within the field of biological systematics or taxonomy and has the ultimate goal of documenting and realizing the actual extent and significance of global biodiversity. Even in the 21st century, we still lack a clear picture of the total number of species in, probably, the majority of organism groups (Larsen *et al*., 2017) occurring both in terrestrial and aquatic habitats in order to reveal the composition (structure) and function of the Earth's ecosystems (May, 2011).

Another problem is that both regional or global species inventories are often restricted within groups of organisms which are the biggest, most "showy" or of the highest agricultural or medicinal priority (including vascular plants, butterflies, birds and mammals), and much less attention is paid to the remaining part of biodiversity (Puplesis, 2002; Hawksworth, 2011).

The world's smallest moths (Lepidoptera, also called Microlepidoptera) are also among these largely neglected and yet unstudied organisms. Nevertheless, data about these minusculous moths, like data on other organisms, can provide unique support for various hypotheses about the general genesis of the global biota and can also be used as outstandingly handy tools for rapid monitorying and actions to preserve biodiversity (Stonis *et al*., 2020). The first attempts to realize this have already been undertaken. Endobiotic (i.e., living in plant tissues, internal) insects are not only an integral part of every terrestrial biota, biome, ecosystem, and many habitats but also important indicators of faunogenetic processes (Diškus & Stonis, 2012). Moreover, given that tiny leaf-mining Lepidoptera (such as Nepticulidae) are pests or potential pests of some cultivated and diverse wild aromatic, medicinal or otherwise significant plants (Kuznetzov & Puplesis, 1994; Stonis *et al*., 2019, 2021a), various data about instar stages of these insects can also be highly useful and even of economic importance.

It should be noted that Nepticulidae are highly specialized, with many apomorphic features, but a phylogenetically primitive Lepidoptera family, which includes the world's smallest moths (Stonis *et al*., 2021b). Recently, in the paper "What are the smallest moths (Lepidoptera) in the world?" (Stonis *et al*., 2021b), we reported that about half of the world's total Nepticulidae species have a forewing length of less than 2.2 mm and a wingspan of less than 5 mm. The family is also very rich in small-size record holders with the lower limit for a known forewing length 1.13–1.3 mm, and a minimal wingspan 2.7–2.8 mm (Stonis *et al*., 2021b).

The Nepticulidae larvae have a specific and highly specialized life mode: they are obligatory miners in green (photosynthetic) plant tissues. Because of the larval life mode in plant tissues and changes in larval morphology, these insects are somewhat similar to parasites, but they are not considered parasites by many researchers (including the authors of this publication). On the other hand, being extremely small and larvae living in plant tissues, they are still understudied in many regions of the world: not only in the tropics and tropics but also in some parts of the Boreal region. There is also a serious lack of qualified specialists and available diagnostic tools that could be used not only by biotaxonomists but also by other users (including foresters, gardeners, conservationists, and educators).

It was estimated recently (Dobrynina *et al.*, 2022) that by the end of 2021, a thousand of Nepticulidae species were described; on average, it makes about four species a year. Given that the first species of Nepticulidae was described in 1767, the history of the family's global research counts about 255 years (Fig. 1). To date, two time periods, early 20th and early 21st centuries, seem to be the

most productive (Fig. 1). However, the authors of the study Dobrynina *et al.* (2022) also pointed out that there is great difference in the average of species described per year between the early 20th and early 21st centuries, and that, in general, the speed of discoveries tends to accelerate.

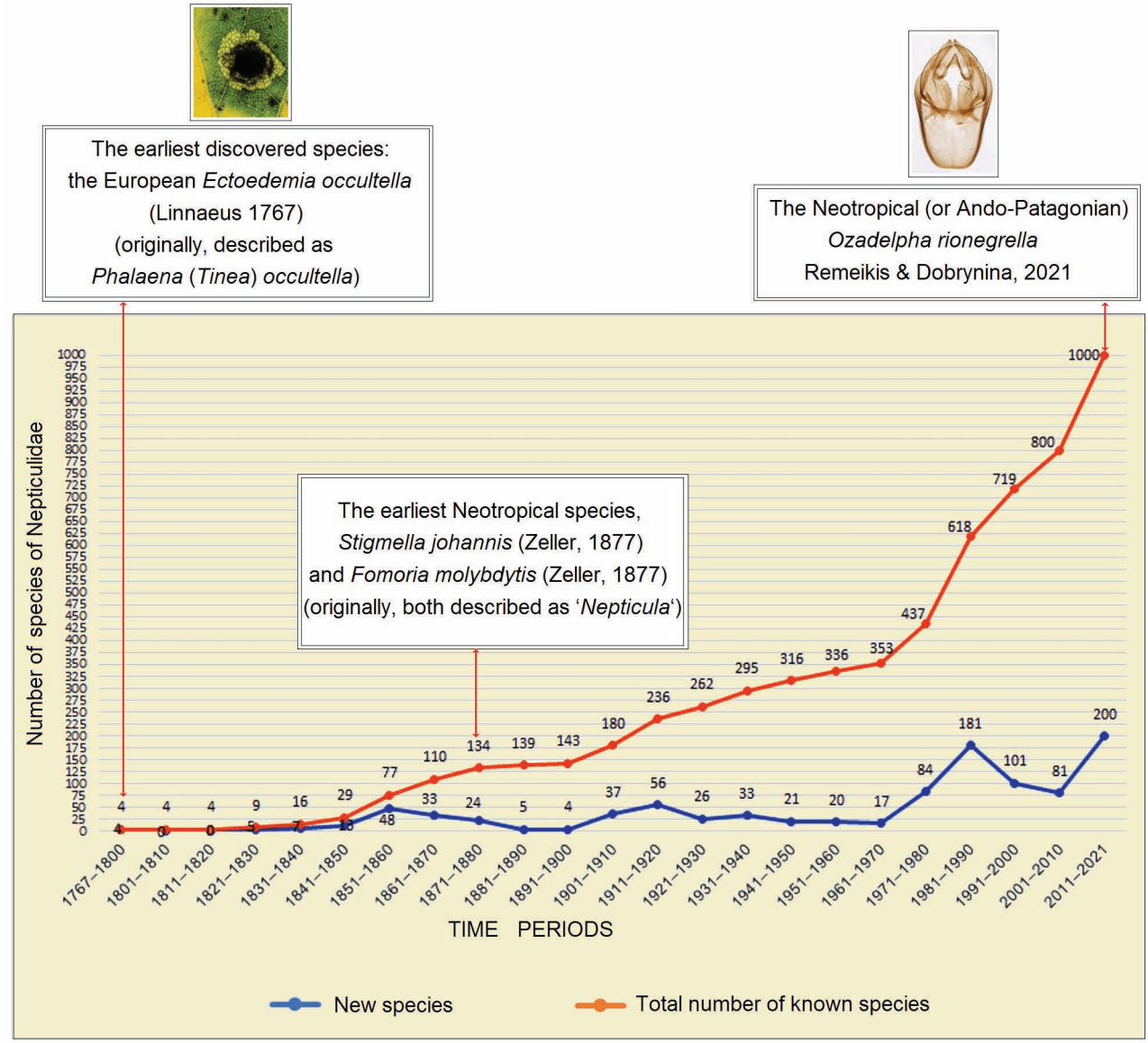

Figure 1. Dynamics of new Nepticulidae species discoveries and rise of the cumulative number of species during various time periods (after Dobrynina *et al*., 2022; modified).

The early stage of the Neotropical Nepticulidae research has been briefly outlined by Puplesis & Robinson (2000) and later continued by Stonis *et al*. (2016). The authors reported that the first two species documented from the Neotropics, *Stigmella johannis* and *Fomoria molybditis*, had been described by Zeller (1877) (as belonging to *Nepticula*) from Colombian material collected by Johann and Nolcken in 1871 (Puplesis & Robinson, 2000). Subsequently, five more species were described from Peru and two, from Guyana by Meyrick (1915); however, one of the Guyanese species (the externally purple shiny *Enteucha cyanochlora*) was incorrectly placed in the Lyonetiidae and recognized as a species of the pygmy moth family only about 70 years later (Davis, 1985). According to Puplesis & Robinson (2000), after Meyrick's descriptions, before the boom of investigations

in the 21st century, there were, in fact, no investigations of the Neotropical Nepticulidae, except for sporadic descriptions of a few new species from the Caribbean (Forbes & Leonard, 1930) and Argentina (Meyrick, 1931; Bourquin, 1962) and a few descriptions of nepticulid taxa with obvious Neotropical affinities from Florida, USA (Davis, 1978; Wilkinson, 1981).

The summarizing of the inventory of the global Nepticulidae allowed to estimate that, to date, a total of 131 individual researchers participated in the description of the world's fauna of Nepticulidae (Dobrynina *et al*., 2022). The publication by Dobrynina *et al*. (2022) names the researchers who have made the biggest contribution to the inventory of the global Nepticulidae (Fig. 2) and the related Opostegidae and Tischeriidae (see Dobrynina *et al*. 2022). The provided graph includes only those

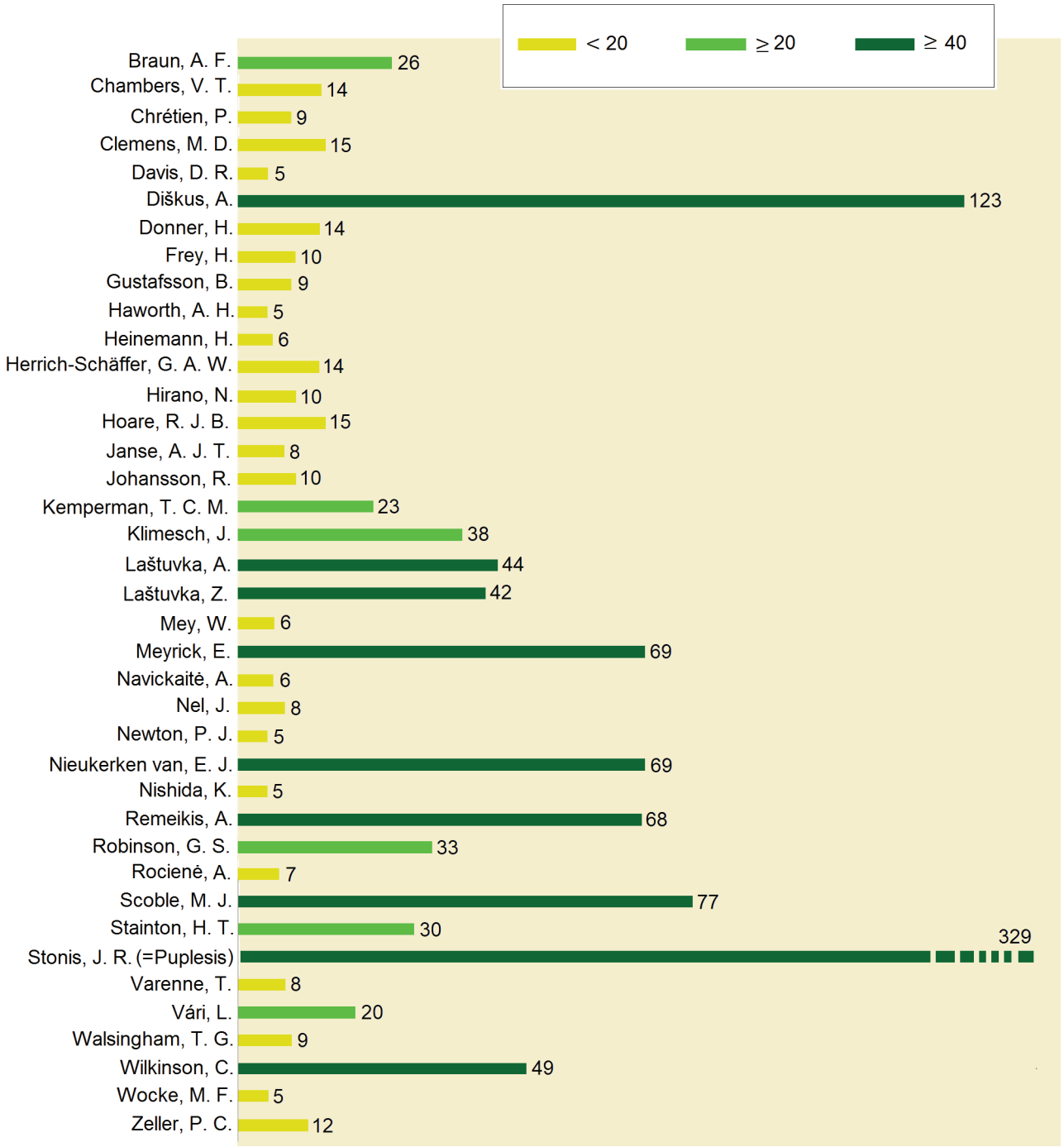

Figure 2. Individual researchers who made the largest contribution as authors or co-authors to the discovery and description of the global fauna of Nepticulidae (Note. The graph does not include researchers who described fewer than five new species) (after Dobrynina *et al*., 2022).

authors who described at least five Nepticulidae species (there are, in total, 39 such authors). Among these researchers, nine authors participated in the description of ≥ 40 species, and a few, according to Dobrynina *et al.* (2022) made an exceptional contribution to the taxonomic inventory of the global Nepticulidae (Fig. 2).

Investigations continue and gather momentum in spite of the paucity of qualified experts and insufficient funding (it is still not uncommon for enthusiasts of biodiversity research to not only face bureaucratic obstacles but also to self-finance their field work).

Within this project, a team of authors, in cooperation and collaboration with various foreign colleagues, sought to develop and provide a freely available tool for today's consumers for the identification of known Nepticulidae taxa. Therefore, together with this pictorial monograph, the first electronic diagnostic system for Nepticulidae species has been created and uploaded, and it will be accessible via mobile electronic devices. A such freely accessible, user-friendly and involving system is an innovative product of biotaxonomy that provides today's consumers with a means to identify Nepticulidae. The current publication and the electronic diagnostic system for Nepticulidae are intended to provide a foundation upon which we and others can build a more detailed account of the diversity of the Neotropical Nepticulidae. We hope that this publication and the electronic diagnostic system will stimulate further studies in Neotropical Nepticulidae and contribute to a more detailed account of the diversity of the Neotropical and the world's leaf-mining insects in general.

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CHECKLIST OF NEPTICULIDAE SPECIES FROM THE NEOTROPICS AND ADJACENT AREAS

(by A. Diškus, J. R. Stonis)

Cite as: Diškus, A. & Stonis, J.R. (2022) Checklist of Nepticulidae species from the Neotropics and adjacent areas. *In*: Stonis, J.R., Remeikis, A. & Diškus, A. *Neotropical Nepticulidae: a pictorial monograph introducing an electronic identification tool.* Vilnius, Nature Research Centre, 101–122 pp.

Genus ***Simplimorpha*** Scoble, 1983

Subgenus *Myrtinepticula* Stonis & Diškus, 2018

Simplimorpha cercaria Diškus & Stonis, 2018
Simplimorpha (*Myrtinepticula*) *cercaria* Diškus & Stonis, in Stonis *et al*., 2018c: 159–163.

Simplimorpha nielseni Remeikis & Stonis, 2018
Simplimorpha (*Myrtinepticula*) *nielseni* Remeikis & Stonis, in Stonis *et al*., 2018c: 163–170.

Simplimorpha kailai Stonis & Diškus, 2018
Simplimorpha (*Myrtinepticula*) *kailai* Stonis & Diškus, in Stonis *et al*., 2018c: 170–173.

Simplimorpha sapphirella Remeikis & Stonis, 2018
Simplimorpha (*Myrtinepticula*) *sapphirella* Remeikis & Stonis, in Stonis *et al*., 2018c: 173–174.

Genus ***Johanssoniella*** Koçak, 1981

Johanssoniella hilli (Puplesis & Robinson, 2000)
Enteucha hilli Puplesis & Robinson, 2000: 19–20.

Johanssoniella contracolorea (Puplesis & Robinson, 2000)
Enteucha contracolorea Puplesis & Robinson, 2000: 20.

Johanssoniella acuta (Puplesis & Diškus, 2002)
Enteucha acuta Puplesis & Diškus, in Puplesis *et al*., 2002: 21–22.

Species of uncertain placement in *Johanssoniella*

Johanssoniella terricula (Puplesis & Robinson, 2000)
Enteucha terricula Puplesis & Robinson, 2000: 20–21.

Johanssoniella bina Remeikis & Stonis, 2018
Johanssoniella bina Remeikis & Stonis, in Stonis *et al*., 2018: 117–118.

Genus ***Brachinepticula*** Stonis & Diškus, 2018

Brachinepticula plurilobata Diškus & Stonis, 2018
Brachinepticula plurilobata Diškus & Stonis, in Stonis *et al*., 2018b: 106–111.

Brachinepticula elongata Remeikis & Stonis, 2018
Brachinepticula elongata Remeikis & Stonis, in Stonis *et al*., 2018b: 104–106.

Genus ***Enteucha*** Meyrick, 1915

Enteucha cyanochlora Meyrick, 1915
Enteucha cyanochlora Meyrick, 1915: 241.

Enteucha gilvafascia (Davis, 1978)
Artaversala gilvafascia Davis, 1978: 221–223.

Enteucha snaddoni Puplesis & Robinson, 2000
Enteucha snaddoni Puplesis & Robinson, 2000: 21–22.

Genus ***Manoneura*** Davis, 1979

Manoneura basidactyla (Davis, 1978)
Oligoneura basidactyla Davis, 1978: 218–219.

Manoneura trinaria Puplesis & Robinson, 2000
Manoneura trinaria Puplesis & Robinson, 2000: 23.

Manoneura forcipis Remeikis & Stonis, 2017
Manoneura forcipis Remeikis & Stonis, in Stonis *et al*., 2017a: 51–52, 58.

Genus ***Ozadelpha*** van Nieukerken, 2016

Ozadelpha ovata (Puplesis & Robinson, 2000)
Stigmella ovata Puplesis & Robinson, 2000: 39.

Ozadelpha rionegrella Remeikis & Dobrynina, 2021
Ozadelpha rionegrella Remeikis & Dobrynina, 2021: 284–286.

Ozadelpha conostegiae van Nieukerken & Nishida, 2016
Ozadelpha conostegiae van Nieukerken & Nishida, in van Nieukerken *et al*., 2016: 28–35.

Ozadelpha guajavae (Puplesis & Diškus, 2002)
Enteucha guajavae Puplesis & Diškus, in Puplesis *et al*., 2002: 22–23.

Ozadelpha nigella Diškus & Stonis, 2019
Ozadelpha nigella Diškus & Stonis, in Stonis *et al*., 2019a: 224–229.

Genus ***Stigmella*** Schrank, 1802

The *maya* group

Stigmella maya Remeikis & Stonis, 2013
Stigmella maya Remeikis & Stonis, in Stonis *et al*., 2013c: 224–226.

Stigmella condaliafoliella (Busck, 1900)
Nepticula condaliafoliella Busck, 1900: 238.

Stigmella gossypii (Forbes & Leonard, 1930)
Nepticula gossypii Forbes & Leonard, 1930: 149.

Stigmella schinivora van Nieukerken, 2016
Stigmella schinivora van Nieukerken in van Nieukerken *et al*., 2016: 15–19.

The *tiliella* group

Stigmella kimae Puplesis & Robinson, 2000
Stigmella kimae Puplesis & Robinson, 2000: 35–36.

The *barbata* group

Stigmella barbata Puplesis & Robinson, 2000
Stigmella barbata Puplesis & Robinson, 2000: 37–38.

Stigmella austroamericana Puplesis & Diškus, 2002
Stigmella austroamericana Puplesis & Diškus, in Puplesis *et al*., 2002: 25–26.

Stigmella plumosetaeella Newton & Wilkinson, 1982
Stigmella plumosetaeella Newton & Wilkinson, 1982: 455–456.

The *purpurimaculae* group

Stigmella purpurimaculae Remeikis & Stonis, 2014
Stigmella purpurimaculae Remeikis & Stonis, Stonis *et al*., 2014: 323–324.

Stigmella cana Remeikis & Stonis, 2014
Stigmella cana Remeikis & Stonis, in Stonis *et al*., 2014: 324–325.

Stigmella truncata Remeikis & Stonis, 2014
Stigmella truncata Remeikis & Stonis, in Stonis *et al*., 2014: 326–327.

Stigmella sceptra Remeikis & Stonis, 2014
Stigmella sceptra Remeikis & Stonis, in Stonis *et al*., 2014: 327–328.

Stigmella concreta Remeikis & Stonis, 2014
Stigmella concreta Remeikis & Stonis, in Stonis *et al*., 2014: 328.

Stigmella pseudoconcreta Remeikis & Stonis, 2014
Stigmella pseudoconcreta Remeikis & Stonis, in Stonis *et al*., 2014: 329.

Stigmella quadrata Remeikis & Stonis, 2014
Stigmella quadrata Remeikis & Stonis, in Stonis *et al*., 2014: 329–330.

The *intronia* group

Stigmella semilactea Remeikis & Stonis, 2014
Stigmella semilactea Remeikis & Stonis, Stonis *et al*., 2014: 330–331.

Stigmella costaricensis van Nieukerken & Nishida, 2016
Stigmella costaricensis van Nieukerken & Nishida, in van Nieukerken *et al*., 2016: 19–21.

Stigmella intronia van Nieukerken & Nishida, 2016
Stigmella intronia van Nieukerken & Nishida, in van Nieukerken *et al*., 2016: 20–21.

The *eurydesma* group

Stigmella eurydesma (Meyrick, 1915)
Nepticula eurydesma Meyrick, 1915: 255.

Stigmella albilamina Puplesis & Robinson, 2000
Stigmella albilamina Puplesis & Robinson, 2000: 33–34.

Stigmella fuscilamina Puplesis & Robinson, 2000
Stigmella fuscilamina Puplesis & Robinson, 2000: 34.

The *salicis* group

Stigmella molinensis van Nieukerken & Snyers, 2016
Stigmella molinensis van Nieukerken & Snyers, in van Nieukerken *et al*., 2016: 22–26.

The *rubeta* group

Stigmella rubeta Puplesis & Diškus, 2002
Stigmella rubeta Puplesis & Diškus, in Puplesis *et al*., 2002: 24, 25.

Stigmella nubimontana Puplesis & Diškus, 2002
Stigmella nubimontana Puplesis & Diškus, in Puplesis *et al*., 2002: 24.

The *lobata* group

Stigmella lobata Remeikis & Stonis, 2016
Stigmella lobata Remeikis & Stonis, in Stonis *et al*., 2016d: 69, 73–75.

Stigmella decora Diškus & Stonis, 2017
Stigmella decora Diškus & Stonis, in Stonis *et al*., 2017d: 8–11.

Stigmella unicaudata Remeikis & Stonis, 2017
Stigmella unicaudata Remeikis & Stonis, in Stonis *et al*., 2017d: 12–14.

The *kristenseni* group

Stigmella kristenseni Diškus & Stonis, 2016
Stigmella kristenseni Diškus & Stonis, in Stonis *et al*., 2016d: 69–72.

The *imperatoria* group

Stigmella imperatoria Puplesis & Robinson, 2000
Stigmella imperatoria Puplesis & Robinson, 2000: 30–31.

Stigmella rubiphagiella Diškus & Stonis, 2016
Stigmella rubiphagiella Diškus & Stonis, in Stonis *et al*., 2016b: 254–256.

Stigmella polylepiella Diškus & Stonis, 2016
Stigmella polylepiella Diškus & Stonis, in Stonis *et al*., 2016e: 86–90.

Satellite species unplaced in the *imperatoria* group

Stigmella ampla Diškus & Stonis, 2016
Stigmella ampla Diškus & Stonis, in Stonis *et al*., 2016d: 54–55, 57–58.

Stigmella altiplanica Diškus & Stonis, 2016
Stigmella altiplanica Diškus & Stonis, in Stonis *et al*., 2016d: 39.

Stigmella racemifera Šimkevičiūtė & Stonis, 2009
Stigmella racemifera Šimkevičiūtė & Stonis, in Šimkevičiūtė *et al*., 2009: 270–272.

Stigmella angusta Diškus & Stonis, 2016
Stigmella angusta Diškus & Stonis, in Stonis *et al*., 2016d: 61–62.

The *circinata* group

Stigmella circinata Diškus & Stonis, 2016
Stigmella circinata Diškus & Stonis, in Stonis *et al*., 2016b: 251–254.

The *bipartita* group

Stigmella bipartita Diškus & Stonis, 2016
Stigmella bipartita Diškus & Stonis, in Stonis *et al*., 2016c: 107–110.

Stigmella sanmartini Remeikis & Stonis, 2017
Stigmella sanmartini Remeikis & Stonis, in Stonis *et al*., 2017d: 12, 15–17.

Stigmella aeneola Diškus & Stonis, 2018
Stigmella aeneola Diškus & Stonis, in Stonis *et al*., 2018a: 866, 869–872.

Stigmella bracteata Diškus & Stonis, 2018
Stigmella bracteata Diškus & Stonis, in Stonis *et al*., 2018a: 874–876.

Stigmella violea Diškus & Stonis, 2018
Stigmella violea Diškus & Stonis, in Stonis *et al*., 2018a: 872, 873, 875.

Stigmella serpentina Diškus & Stonis, 2015
Stigmella serpentina Diškus & Stonis, in Stonis *et al*., 2015: 576–580.

Stigmella pangorica Diškus & Stonis, 2015
Stigmella pangorica Diškus & Stonis, in Stonis *et al*., 2015: 580–582.

Stigmella tripartita Diškus & Stonis, 2016
Stigmella tripartita Diškus & Stonis, in Stonis *et al*., 2016c: 110–111.

Satellite species unplaced in the *bipartita* group

Stigmella paramica Diškus & Stonis, 2016
Stigmella paramica Diškus & Stonis, in Stonis *et al*., 2016d: 22–25.

Stigmella spatiosa Diškus & Stonis, 2018
Stigmella spatiosa Diškus & Stonis, in Stonis *et al*., 2018a: 878, 881–882, 884–885.

Stigmella hamata Puplesis & Robinson, 2000
Stigmella hamata Puplesis & Robinson, 2000: 30.

The *schoorli* group

Stigmella schoorli Puplesis & Robinson, 2000
Stigmella schoorli Puplesis & Robinson, 2000: 29–30.

Stigmella alticosma Remeikis & Stonis, 2016
Stigmella alticosma Remeikis & Stonis, in Stonis *et al*., 2016d: 63–64.

Stigmella paracosma Remeikis & Stonis, 2017
Stigmella paracosma Remeikis & Stonis, in Stonis *et al*., 2017a: 12, 14, 19.

Stigmella epicosma (Meyrick, 1915)
Nepticula epicosma Meyrick, 1915: 255.

The *expressa* group

Stigmella expressa Remeikis & Stonis, 2017
Stigmella expressa Remeikis & Stonis, in Stonis *et al*., 2017a: 21–22.

Stigmella pseudorobusta Remeikis & Stonis, 2016
Stigmella pseudorobusta Remeikis & Stonis, in Stonis *et al*., 2016d: 41–44.

Stigmella lachemillae Diškus & Stonis, 2016
Stigmella lachemillae Diškus & Stonis, in Stonis *et al*., 2016d: 27–28.

Stigmella robusta Remeikis & Stonis, 2016
Stigmella robusta Remeikis & Stonis, in Stonis *et al*., 2016d: 41.

Stigmella evanida Diškus & Stonis, 2016
Stigmella evanida Diškus & Stonis, in Stonis *et al*., 2016d: 58–59, 61.

Stigmella acalyphae Diškus & Stonis, 2017
Stigmella acalyphae Diškus & Stonis, in Stonis *et al*., 2017a: 24–25.

Stigmella lepida Diškus & Stonis, 2017
Stigmella lepida Diškus & Stonis, in Stonis *et al*., 2017a: 26–27.

The *magnispinella* group

Stigmella magnispinella Remeikis & Stonis, 2016
Stigmella magnispinella Remeikis & Stonis, in Stonis *et al*., 2016f: 571–572.

Stigmella olekarsholti Remeikis, Diškus & Stonis, 2016
Stigmella olekarsholti Remeikis, Diškus & Stonis, in Stonis *et al*., 2016f: 569–570.

Stigmella varispinella Diškus & Stonis, 2016
Stigmella varispinella Diškus & Stonis, in Stonis *et al*., 2016f: 565–569.

Stigmella dolia Remeikis & Stonis, 2016
Stigmella dolia Remeikis & Stonis, in Stonis *et al*., 2016f: 572–574.

Stigmella patagonica Remeikis & Stonis, 2016
Stigmella patagonica Remeikis & Stonis, in Stonis *et al*., 2016f: 574–575.

The *pseudodigitata* group

Stigmella pseudodigitata Remeikis & Stonis, 2014
Stigmella pseudodigitata Remeikis & Stonis, in Stonis *et al*., 2014: 332.

Stigmella azulella Diškus & Stonis, 2017
Stigmella azulella Diškus & Stonis, in Stonis *et al*., 2017a: 48–50.

The *nivea* group

Stigmella nivea Remeikis & Stonis, 2016
Stigmella nivea Remeikis & Stonis, in Stonis *et al*., 2016d: 63, 65.

Stigmella olyritis (Meyrick, 1915)
Nepticula olyritis Meyrick, 1915: 256.

Stigmella ageratinae Diškus & Stonis, 2016
Stigmella ageratinae Diškus & Stonis, in Stonis *et al*., 2016d: 75–79.

Stigmella apicibrunella Diškus & Stonis, 2017
Stigmella apicibrunella Diškus & Stonis, in Stonis *et al*., 2017d: 3–8.

Stigmella cuprata (Meyrick, 1915)
Nepticula cuprata Meyrick, 1915: 255.

Stigmella eiffeli Diškus & Stonis, 2017
Stigmella eiffeli Diškus & Stonis, in Stonis *et al*., 2017a: 41–42.

Stigmella inca Diškus & Stonis, 2017
Stigmella inca Diškus & Stonis, in Stonis *et al*., 2017a: 39–41.

The *saginella* group

Stigmella crassifoliae Remeikis & Stonis, 2015
Stigmella crassifoliae Remeikis & Stonis, 2015: 410–411.
Stigmella nigriverticella (Chambers, 1875) [*partim*], in Stonis *et al*., 2013b: 2–4.

Stigmella robleae Remeikis & Stonis, 2015
Stigmella robleae Remeikis & Stonis, 2015: 411–412.

Stigmella jaguari Remeikis & Stonis, 2013
Stigmella jaguari Remeikis & Stonis, in Stonis *et al*., 2013b: 5–6.

Stigmella lauta Diškus & Stonis, 2013
Stigmella lauta Diškus & Stonis, in Stonis *et al*., 2013b: 6–8.

Stigmella sublauta Remeikis & Stonis, 2013
Stigmella sublauta Remeikis & Stonis, in Stonis *et al*., 2013b: 8.

Stigmella aurifasciata Diškus & Stonis, 2013
Stigmella aurifasciata Diškus & Stonis, in Stonis *et al*., 2013b: 8–10.

The *quercipulchella* group

Stigmella guatemalensis Diškus & Stonis, 2013
Stigmella guatemalensis Diškus & Stonis, in Stonis *et al*., 2013b: 10.

Stigmella quercilobatae Diškus & Stonis, sp. nov.
Stigmella species 515, in Stonis *et al*., 2013b: 21–22.

The *procrastinella* group

Stigmella humboldti Remeikis & Stonis, 2015
Stigmella humboldti Remeikis & Stonis, 2015: 412–413.

The *incaica* group

Stigmella incaica Diškus & Stonis, 2021
Stigmella incaica Diškus & Stonis, in Stonis *et al*., 2021b: 276–281.

Stigmella auripurpurata Diškus & Stonis, 2017
Stigmella auripurpurata Diškus & Stonis, in Stonis *et al*., 2017b: 117–121.

Stigmella boehmeriphaga Diškus & Stonis, 2017
Stigmella boehmeriphaga Diškus & Stonis, in Stonis *et al*., 2017b: 114–117.

Stigmella lata Diškus & Stonis, 2017
Stigmella lata Diškus & Stonis, in Stonis *et al*., 2017b: 112–114.

Stigmella singularia Diškus & Stonis, 2017
Stigmella singularia Diškus & Stonis, in Stonis *et al*., 2017b: 108–112.

Stigmella scutellariae Remeikis & Stonis, 2017
Stigmella scutellariae Remeikis & Stonis, in Stonis *et al*., 2017c: 131–136.

Stigmella lamiacifoliae Remeikis & Stonis, 2017
Stigmella lamiacifoliae Remeikis & Stonis, in Stonis *et al*., 2017c: 129–135.

Stigmella coronaria Diškus & Stonis, 2017
Stigmella coronaria Diškus & Stonis, in Stonis *et al*., 2017a: 37, 44–45.

The *jungiae* group

Stigmella jungiae Diškus & Stonis, 2018
Stigmella jungiae Diškus & Stonis, in Stonis *et al*., 2018a: 861–864.

Stigmella mustelina Remeikis & Stonis, 2016
Stigmella mustelina Remeikis & Stonis, in Stonis *et al*., 2016d: 58, 60–61.

Stigmella misera Diškus & Stonis, 2017
Stigmella misera Diškus & Stonis, in Stonis *et al*., 2017a: 31–33.

Stigmella patula Remeikis & Stonis, 2017
Stigmella patula Remeikis & Stonis, in Stonis *et al*., 2017d: 17–19.

The *mentholica* group

Stigmella mentholica Diškus & Stonis, 2021
Stigmella mentholica Diškus & Stonis, in Stonis *et al*., 2021a: 365–367, 371–372, 377.

Stigmella clinopodiella Diškus & Stonis, 2016
Stigmella clinopodiella Diškus & Stonis, in Stonis *et al*., 2016d: 79–82.

Stigmella aromatica Diškus & Stonis, 2021
Stigmella aromatica Diškus & Stonis, in Stonis *et al*., 2021a: 366, 368, 371, 373, 376–377.

Stigmella odora Diškus & Stonis, 2021
Stigmella odora Diškus & Stonis, in Stonis *et al*., 2021a: 367, 374, 378.

Stigmella tomentosella Diškus & Stonis, 2021
Stigmella tomentosella Diškus & Stonis, in Stonis *et al*., 2021a: 369, 371, 375, 378, 379.

The *marmorea* group

Stigmella marmorea Puplesis & Robinson, 2000
Stigmella marmorea Puplesis & Robinson, 2000: 26–27.

Stigmella peruanica Puplesis & Robinson, 2000
Stigmella peruanica Puplesis & Robinson, 2000: 27–28.

Stigmella altimontana Remeikis & Stonis, 2016
Stigmella altimontana Remeikis & Stonis, in Stonis *et al*., 2016d: 51–53.

Stigmella auriargentata Remeikis & Stonis, 2016
Stigmella auriargentata Remeikis & Stonis, in Stonis *et al*., 2016d: 44–45.

Stigmella johannis (Zeller, 1877)
Nepticula johannis Zeller, 1877: 456–457.

Stigmella andina (Meyrick, 1915)
Nepticula andina Meyrick, 1915: 255–256.

Stigmella auripennata Diškus & Stonis, 2018
Stigmella auripennata Diškus & Stonis, in Stonis *et al*., 2018a: 886, 889–892.
Stigmella species 610, in Stonis *et al*., 2016: 111–115.

Stigmella arequipica Remeikis & Stonis, 2017
Stigmella arequipica Remeikis & Stonis, in Stonis *et al*., 2017a: 36, 43.

Stigmella sinuosa Remeikis & Stonis, 2016
Stigmella sinuosa Remeikis & Stonis, in Stonis & Remeikis, 2016: 310–311.

Stigmella mevia Remeikis & Stonis, 2016
Stigmella mevia Remeikis & Stonis, in Stonis & Remeikis, 2016: 311, 316.

Stigmella hylomaga (Meyrick, 1931)
Nepticula hylomaga Meyrick, 1931: 415.

Stigmella torosa Remeikis & Stonis, 2017
Stigmella torosa Remeikis & Stonis, in Stonis *et al*., 2017d: 20, 23–24.

Stigmella monstrata Remeikis & Stonis, 2017
Stigmella monstrata Remeikis & Stonis, in Stonis *et al*., 2017d: 24–26.

Stigmella calceolariae Diškus & Stonis, 2016
Stigmella calceolariae Diškus & Stonis, in Stonis *et al*., 2016d: 33–36.

Stigmella costalimai (Bourquin, 1962)
Nepticula costalimai Bourquin, 1962: 31–32.

Stigmella latifoliae Remeikis, Diškus & Stonis, 2016
Stigmella latifoliae Remeikis, Diškus & Stonis, in Stonis *et al*., 2016c: 115–119.

Stigmella baccharicola Diškus & Stonis, 2016
Stigmella baccharicola Diškus & Stonis, in Stonis *et al*., 2016c: 119–122.

Stigmella confertae Diškus & Stonis, 2016
Stigmella confertae Diškus & Stonis, in Stonis *et al*., 2016c: 124–126.

Stigmella emarginatae Diškus & Stonis, 2016
Stigmella emarginatae Diškus & Stonis, in Stonis *et al*., 2016c: 104–107.

Stigmella guittonae (Bourquin, 1962)
Nepticula guittonae Bourquin, 1962: 32–34.

Stigmella podanthae Diškus & Stonis, 2016
Stigmella podanthae Diškus & Stonis, in Stonis *et al*., 2016a: 120–121.

Stigmella rudis Puplesis & Robinson, 2000
Stigmella rudis Puplesis & Robinson, 2000: 26.

Stigmella gynoxyphaga Diškus & Stonis, 2016
Stigmella gynoxyphaga Diškus & Stonis, in Stonis *et al*., 2016d: 28, 31–33.

Stigmella montanotropica Puplesis & Diškus, 2002
Stigmella montanotropica Puplesis & Diškus, in Puplesis *et al*., 2002: 23.

Stigmella pandora Remeikis & Stonis, 2016
Stigmella pandora Remeikis & Stonis, in Stonis *et al*., 2016d: 54–56.

Stigmella huahumi Remeikis & Stonis, 2017
Stigmella huahumi Remeikis & Stonis, in Stonis *et al*., 2017d: 26–27.

Stigmella calceolarifoliae Diškus & Stonis, 2016
Stigmella calceolarifoliae Diškus & Stonis, in Stonis *et al*., 2016d: 79, 84–85.

Stigmella venezuelica Remeikis & Stonis, 2017
Stigmella venezuelica Remeikis & Stonis, in Stonis *et al.*, 2017d: 26, 28–29.

Stigmella pallatangai Diškus & Stonis, sp. nov.
Stigmella species 763*,* in Stonis *et al*., 2016e: 90–91, 94.

Non-grouped species

Stigmella pauta Diškus & Stonis, sp. nov.
Stigmella species 764*,* in Stonis *et al*., 2016e: 93–94.

Stigmella pruinosa Puplesis & Robinson, 2000
Stigmella pruinosa Puplesis & Robinson, 2000: 38–39.

Stigmella virginica Remeikis & Stonis, 2017
Stigmella virginica Remeikis & Stonis, in Stonis *et al.*, 2017d: 29–30.

Stigmella sparsella Diškus & Stonis, 2017
Stigmella sparsella Diškus & Stonis, in Stonis *et al*., 2017a: 19, 54–55.

Stigmella brutea Remeikis & Stonis, 2014
Stigmella brutea Remeikis & Stonis, in Stonis *et al*., 2014: 331–332.

Stigmella lilliputica Remeikis & Stonis, 2017
Stigmella lilliputica Remeikis & Stonis, in Stonis & Remeikis, 2017: 231–235.

Stigmella mimosae Diškus & Stonis, 2018
Stigmella mimosae Diškus & Stonis, in Stonis *et al*., 2018d: 849, 851–853.

Stigmella rigida Diškus & Stonis, 2016
Stigmella rigida Diškus & Stonis, in Stonis *et al*., 2016d: 36–39.

Stigmella gallicola van Nieukerken & Nishida, 2016
Stigmella gallicola van Nieukerken & Nishida, in van Nieukerken *et al*., 2016: 7–14.

Stigmella foreroi Stonis & Vargas, 2019
Stigmella foreroi Stonis & Vargas, in Stonis *et al*., 2019: 48–55.

Genus ***Ectoedemia*** Busck, 1907

Subgenus *Zimmermannia* Hering, 1940

Ectoedemia obrutella (Zeller, 1873)
Trifurcula obrutella Zeller, 1873: 316, 317.
Ectoedemia piperella Wilkinson & Newton, 1981: 77–78.
Ectoedemia reneella Wilkinson, 1981: 104–105.

Ectoedemia bosquella (Chambers, 1878)
Nepticula bosquella Chambers, 1878: 106.
Ectoedemia castaneae Busck, 1913: 103.
Ectoedemia heinrichi Busck, 1914: 149.
Ectoedemia helenella Wilkinson, 1981: 105–107.

Ectoedemia mesoloba Davis, 1978
Ectoedemia mesoloba Davis, 1978: 209–212.
Ectoedemia coruscella Wilkinson, 1981: 99–100.

Ectoedemia multicristata Remeikis sp. nov.
Ectoedemia species 29105 Puplesis & Robinson, 2000: 41–42.

Subgenus *Ectoedemia* Busck, 1907

The *angulifasciella* group

Ectoedemia morae Diškus & Stonis, 2016
Ectoedemia (*Ectoedemia*) *morae* Diškus & Stonis, in Stonis *et al*., 2016b: 256, 258–260.

The *fuscivittata* group

Ectoedemia fuscivittata Puplesis & Robinson, 2000
Ectoedemia fuscivittata Puplesis & Robinson, 2000: 42.

A species of uncertain placement in *Ectoedemia*

Ectoedemia bulbosa Remeikis & Stonis, 2018
Ectoedemia bulbosa Remeikis & Stonis, 2018: 459–461.

Genus ***Hesperolyra*** van Nieukerken, 2016

Hesperolyra diskusi (Puplesis & Robinson, 2000)
Fomoria diskusi Puplesis & Robinson, 2000: 43.

Hesperolyra molybditis (Zeller, 1877)
Nepticula molybditis Zeller, 1877: 455, 456.

Hesperolyra repanda (Puplesis & Diškus, 2002)
Fomoria repanda Puplesis & Diškus, in Puplesis *et al*., 2002: 26–27.

Hesperolyra saopaulensis van Nieukerken, 2016
Hesperolyra saopaulensis van Nieukerken, in van Nieukerken *et al.,* 2016: 52–55.

Hesperolyra robinsoni Stonis, 2017
Hesperolyra robinsoni Stonis, in Stonis *et al*., 2017d: 34, 36.
Fomoria species 29122, in Puplesis & Robinson, 2000: 44–45.

Hesperolyra guajavifoliae Stonis & Vargas, 2019
Hesperolyra guajavifoliae Stonis & Vargas, in Stonis *et al*., 2019b: 92–100.

Genus ***Fomoria*** Beirne, 1945

Species of uncertain placement in *Fomoria*

Fomoria tabulosa Puplesis & Diškus, 2002
Fomoria tabulosa Puplesis & Diškus, in Puplesis *et al*., 2002: 27.

Fomoria cornijuxtata Remeikis & Stonis, 2018
Fomoria cornijuxtata Remeikis & Stonis, in Stonis & Remeikis, 2018: 462–463.

Genus *Acalyptris* Meyrick, 1921

The *murex* group

Acalyptris murex Diškus & Stonis, 2017
Acalyptris murex Diškus & Stonis, in Stonis *et al*., 2017a: 58–60.

Acalyptris minimus Diškus & Stonis, 2018
Acalyptris minimus Diškus & Stonis, in Stonis *et al*., 2018d: 844–849.

Acalyptris marmor Stonis & Diškus, 2020
Acalyptris marmor Stonis & Diškus, in Stonis *et al.*, 2020: 207, 210–211.

Acalyptris barbudo Stonis & Remeikis, 2020
Acalyptris barbudo Stonis & Remeikis, in Stonis *et al.*, 2020: 210, 212.

Satellite species unplaced in the *murex* group

Acalyptris hispidus Puplesis & Robinson, 2000
Acalyptris hispidus Puplesis & Robinson, 2000: 48.

Acalyptris jareki Stonis & Diškus, 2020
Acalyptris jareki Stonis & Diškus, in Stonis *et al.*, 2020: 213–214.
Acalyptris species 29135, in Puplesis & Robinson, 2000: 53–54.

Acalyptris novenarius Puplesis & Robinson, 2000
Acalyptris novenarius Puplesis & Robinson, 2000: 48–49.

Acalyptris caribbicus Diškus & Stonis, 2013
Acalyptris caribbicus Diškus & Stonis, in Stonis *et al*., 2013a: 106–109.

The *trifidus* group

Acalyptris trifidus Puplesis & Robinson, 2000
Acalyptris trifidus Puplesis & Robinson, 2000: 50–51.
Acalyptris species 29140, in Puplesis & Robinson, 2000: 55–56.

Acalyptris laxibasis Puplesis & Robinson, 2000
Acalyptris laxibasis Puplesis & Robinson, 2000: 52–53.

Acalyptris rotundus Puplesis & Diškus, 2002
Acalyptris rotundus Puplesis & Diškus, in Puplesis *et al.*, 2002: 31–32.

Acalyptris hilli Stonis & Diškus, 2020
Acalyptris hilli Stonis & Diškus, in Stonis *et al.*, 2020: 217–219.

Acalyptris amazonius Puplesis & Diškus, 2002
Acalyptris amazonius Puplesis & Diškus, in Puplesis *et al.*, 2002: 32–33.

Acalyptris hyacinthum Stonis & Vargas, 2020
Acalyptris hyacinthum Stonis & Vargas, in Stonis *et al*., 2020: 217, 219–220.

Acalyptris mortalis Diškus & Stonis, 2020
Acalyptris mortalis Diškus & Stonis, in Stonis *et al*., 2020: 220–225.

Acalyptris miranda (Diškus & Stonis, 2017)
Fomoria miranda Diškus & Stonis, in Stonis *et al*., 2017d: 31, 33–35.

The *bifidus* group

Acalyptris lascuevella Puplesis & Robinson, 2000
Acalyptris lascuevella Puplesis & Robinson, 2000: 49–50.

Acalyptris bifidus Puplesis & Robinson, 2000
Acalyptris bifidus Puplesis & Robinson, 2000: 50.

Acalyptris yucatani Remeikis & Stonis, 2013
Acalyptris yucatani Remeikis & Stonis, in Stonis *et al*., 2013c: 227–229.

Acalyptris argentosa (Puplesis & Robinson, 2000)
Glaucolepis argentosa Puplesis & Robinson, 2000: 57.

The *peteni* group

Acalyptris tenuijuxtus (Davis, 1978)
Microcalyptris tenuijuxtus Davis, 1978: 216–217.

Acalyptris unicornis Puplesis & Robinson, 2000
Acalyptris unicornis Puplesis & Robinson, 2000: 51–52.

Acalyptris peteni Diškus & Stonis, 2013
Acalyptris peteni Diškus & Stonis, in Stonis *et al*., 2013a: 102, 104–106.

Acalyptris trigonijuxtus Remeikis & Stonis, 2015
Acalyptris trigonijuxtus Remeikis & Stonis, in Stonis & Remeikis, 2015: 83–84.

Acalyptris dominicanus Remeikis & Stonis, 2015
Acalyptris dominicanus Remeikis & Stonis, in Stonis & Remeikis, 2015: 85–86.

The *statuarius* group

Acalyptris bicornutus (Davis, 1978)
Microcalyptris bicornutus Davis, 1978: 212–214.

Acalyptris statuarius Diškus & Stonis, 2013
Acalyptris statuarius Diškus & Stonis, in Stonis *et al*., 2013a: 109–111.

Acalyptris nigrisignum Remeikis & Stonis, 2015
Acalyptris nigrisignum Remeikis & Stonis, in Stonis & Remeikis, 2015: 81–83.

The *scirpi* group

Acalyptris bipinnatellus (Wilkinson, 1979)
Microcalyptris bipinnatellus Wilkinson, 1979: 75–77.

Acalyptris postalatratus (Wilkinson, 1979)
Microcalyptris postalatratus Wilkinson, 1979: 77–78.

Satellite species unplaced in the *scirpi* group

Acalyptris solaris Remeikis & Stonis, 2018
Acalyptris solaris Remeikis & Stonis, in Stonis & Remeikis, 2018: 462–465.

The *fortis* group

Acalyptris fortis Puplesis & Robinson, 2000
Acalyptris fortis Puplesis & Robinson, 2000: 47–48.

Acalyptris martinheringi Puplesis & Robinson, 2000
Acalyptris martinheringi Puplesis & Robinson, 2000: 46–47.

Acalyptris basihastatus Puplesis & Diškus, 2002
Acalyptris basihastatus Puplesis & Diškus, in Puplesis *et al*., 2002: 29–30.

Acalyptris pseudohastatus Puplesis & Diškus, 2002
Acalyptris pseudohastatus Puplesis & Diškus, in Puplesis *et al*., 2002: 30.

Acalyptris articulosus Puplesis & Diškus, 2002
Acalyptris articulosus Puplesis & Diškus, in Puplesis *et al*., 2002: 30–31.

Acalyptris platygnathos Puplesis & Robinson, 2000
Acalyptris platygnathos Puplesis & Robinson, 2000: 54–55.

Acalyptris basicornis Remeikis & Stonis, 2013
Acalyptris basicornis Remeikis & Stonis, in Stonis *et al*., 2013a: 102–103.

Acalyptris extremus Stonis & Diškus, 2020
Acalyptris extremus Stonis & Diškus, in Stonis *et al*., 2020: 234, 237–239.

The *bovicorneus* group

Acalyptris bovicorneus Puplesis & Robinson, 2000
Acalyptris bovicorneus Puplesis & Robinson, 2000: 45–46.

Acalyptris terrificus Šimkevičiūtė & Stonis, 2009
Acalyptris terrificus Šimkevičiūtė & Stonis, in Šimkevičiūtė *et al*., 2009: 275.
Acalyptris species AG015, in Šimkevičiūtė *et al*., 2009: 275–276.

Acalyptris janzeni van Nieukerken & Nishida, 2016
Acalyptris janzeni van Nieukerken & Nishida, 2016, in van Nieukerken *et al*., 2016: 55–58.

The *latipennata* group

Acalyptris latipennata (Puplesis & Robinson, 2000)
Fomoria latipennata Puplesis & Robinson, 2000: 45.

Acalyptris dividua Puplesis & Robinson, 2000
Acalyptris dividua Puplesis & Robinson, 2000: 54.

Acalyptris paradividua Šimkevičiūtė & Stonis, 2009
Acalyptris paradividua Šimkevičiūtė & Stonis, in Šimkevičiūtė *et al*., 2009: 272–274.

Acalyptris ecuadoriana Puplesis & Diškus, 2002
Acalyptris ecuadoriana Puplesis & Diškus, in Puplesis *et al*., 2002: 27–28.

Acalyptris onorei Puplesis & Diškus, 2002
Acalyptris onorei Puplesis & Diškus, in Puplesis *et al*., 2002: 28–29.

Acalyptris amazonensis Stonis & Diškus, 2018
Acalyptris amazonensis Stonis & Diškus, 2018: 192–198.

Acalyptris insolentis Puplesis & Diškus, 2002
Acalyptris insolentis Puplesis & Diškus, in Puplesis *et al*., 2002: 33.

A species of uncertain placement in *Acalyptris*

Acalyptris distaleus (Wilkinson, 1979)
Microcalyptris distaleus Wilkinson, 1979: 78–81.

Genus ***Glaucolepis*** Braun, 1917

The *flagellata* group

Glaucolepis flagellata Remeikis & Stonis, 2017
Glaucolepis flagellata Remeikis & Stonis, in Stonis *et al*., 2017e: 495–500.

Glaucolepis pseudoflagellata Remeikis & Stonis, 2017
Glaucolepis pseudoflagellata Remeikis & Stonis, in Stonis *et al*., 2017e: 496–501.

Glaucolepis gielisorum (Nieukerken, 2016)
Neotrifurcula gielisorum Nieukerken, in Nieukerken *et al*., 2016: 38–39.

A non-grouped species

Glaucolepis aerifica (Meyrick, 1915)
Nepticula aerifica Meyrick, 1915: 255.

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