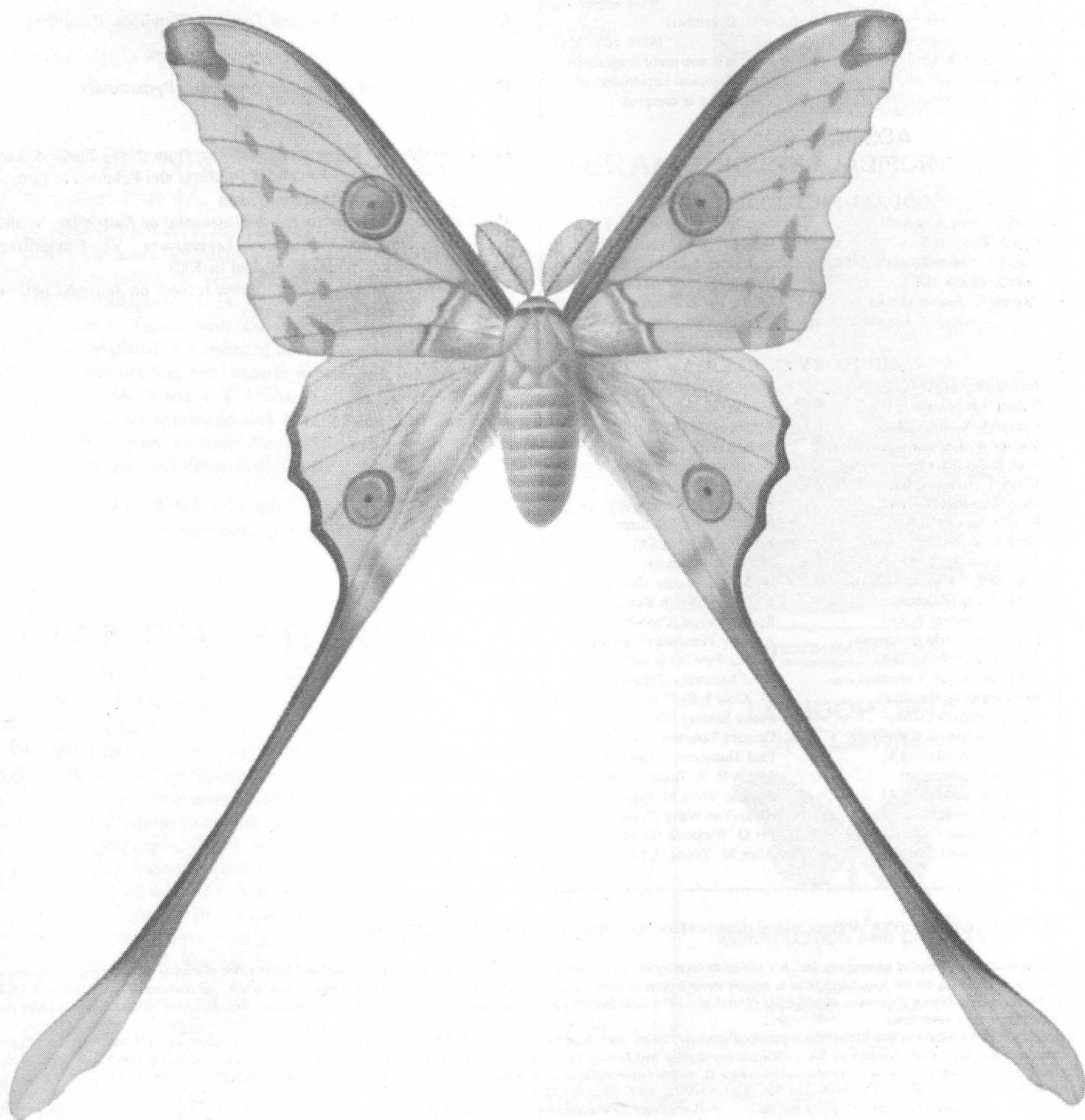


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No. 1-2

CONTENTS

- 1 HEPPNER: Tribal Classification of the Lepidoptera
- 23 HEPPNER: Distribution Notes on Taiwan Moths. 2. *Mimicia pseudolibatrix* (Pyrilidae: Pyralinae)
- 25 3. *Pyrausta mystica* (Pyrilidae: Pyraustinae)
- 27 4. Genera *Lixa* and *Tamraca* (Pyrilidae: Pyralinae)
- 29 5. *Udea stigmatalis* (Pyrilidae: Pyraustinae)
- 31 HEPPNER: Primitive Sedge Moths from New Zealand and Tasmania: Transfer of *Proditrix* and Relatives to Orthoteliinae (Glyphipterigidae)
- 43 LAMAS: Additions to the *Bibliography of Butterflies*, in the *Atlas of Neotropical Lepidoptera*. VI. Comprising mostly Works Published in 2001
- 56 HEPPNER: *Neurobathra* leafminer records on *Jatropha* new to Florida (Gracillariidae)

COVERS.— FRONT COVER: *Argema mittrei* (Guerín-Méneville), after Moucha (1962) (© 2005 ATL).

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TRIBAL CLASSIFICATION OF THE LEPIDOPTERA

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ABSTRACT.—The worldwide biodiversity of the Lepidoptera is discussed in terms of current classification from higher categories down to the tribal and subtribal level. All 125 known families are treated, with 294 subfamilies listed.

KEY WORDS: biodiversity, cladistics, families, fauna, groups, subfamilies, subtribes, superfamilies, systematics, taxonomy, tribes, world.

The family classification of the Lepidoptera has been noted in several recent publications (see Heppner, 1992, 1996, 1998a, 1998b; Kristensen *et al.*, 1999; Scoble, 1992), but the classification down to tribal level has not been uniformly proposed for many decades (Zerny and Beier, 1936-38). One reason for this is the great confusion of tribal names, their irregular usage — either as tribes, subtribes, or elevated to subfamilies and families — based on the varying ideas of classification of various specialists, and the vast number of genera yet to be adequately studied worldwide. In terms of Lepidoptera, one can point out the dozens of odd genera that were found to be in completely wrong families when the editors of the generic catalog project checked every genus, to the extent possible, to determine their correct family placement (Fletcher and Nye, 1975-91); and still the family placement of many genera remains uncertain. One can also note below the great number of tribal names, particularly in Geometridae and Noctuidae, many of which may prove to be only subtribes once further studied in relation to the world fauna of the groups (likewise, see the large number of subtribes listed for the tribe Geometrini).

We do not yet have enough comparative knowledge of all groups, on a world basis, to know if the name proliferation in some families represents real biodiversity, or only that some enthusiastic taxonomic splitters have been diligently naming every odd genus as another subtribe (which eventually may be relegated to some level below the subtribe). The difficulty for Lepidoptera studies is that few taxonomists work on a group worldwide, particularly for such huge families as Noctuidae, and, thus, cannot realistically judge tribal limits based only on their study of a small group in one region of the world. Thus, we have a large number of tribal names for European Geometridae and Noctuidae, for example, but with no adequate study to see which of these names may apply to related groups in tropical Africa or Asia. Many researchers fail (or refuse) to comprehend that to elevate tribes to subfamily level, or subfamilies to family level, without comparative study of all Lepidoptera, brings only chaos to the parameters of such groups: one cannot have a "family" for one group be equal to only a tribal level in some other family if one is trying to still have a logical and reasonable classification. The corollary to this is also that one cannot obtain a realistic classification based on current "political correctness" or general "global consensus" views, as some authors like to state, implying that the question is already solved. During the Middle Ages the general view was that the earth was flat: that was also a "global consensus" for that time, yet this did not represent reality. Consensus does not bring us a classification that resembles the reality in nature that we have, only facts and logic can do that.

The classification presented herein is the most up-to-date available, based on as uniform an adherence to parameters at each level (family, subfamily, and tribe) as possible at this time. It already varies somewhat from earlier reports at the subfamily level (see Heppner,

1992, 1996), since so much is still being discovered. A subtribe classification has been used only sporadically so far, but these names have been added herein to elucidate the classification, since many of these names may be found listed as tribes in other works. On the other hand, some families are not even subdivided into subfamilies, let alone tribal divisions (of course, there are also a few families that have only one known species: e.g., Heterobathmiidae and Carthaeidae). Thus far, 294 valid subfamilies are considered herein for the 125 known families of Lepidoptera in the world.

ANALYSIS

Most specialists are not involved in worldwide studies in Lepidoptera, instead working only on regional faunas or particular families, and usually species only of one faunal region. A few exceptions exist: e.g., the work of Minet (1986, 1991), who has been doing extensive worldwide studies of different family groups and odd genera, although he splits off many more monobasic groups than may be useful. Likewise, there are my studies over the years (Heppner, 1991, 1996, 1998a,b, 2004), as also some global reviews like those of Common (1970, 1975) and the later revision of that (Nielsen and Common, 1991), plus summaries like those of Ehrlich (1960), Kristensen (1999), Munroe (1982), and Scoble (1992). Other studies, like those of Kuznetsov and Stekolnikov in a series of papers since 1976 (see Kuznetsov and Stekolnikov, 1978, for a basic summary), while in depth for most families, are nonetheless flawed because their studies involved only a single segment of adult morphology: i.e., exclusively the musculature of the male genitalia (as if this somehow would provide the answer to lepidopteran phylogeny better than other characters or what one finds in the larvae and pupae, etc.).

Among various studies, however, the tribal names found in many regional works are often the result of what one might call a "provincial" view (with no detriment intended), inasmuch as what are used as tribes in one region may actually only be equivalent to subtribes when compared with the world biodiversity of Lepidoptera. And, all this varies from specialist to specialist, as well. This is not to say that the classification published herein is the final word either: there is so much remaining to be discovered among many groups that we are a long way yet from a reasonably complete and stable classification down to tribal level. Even so, considerable work has been done in the last 30 years to elucidate the true placement of many odd genera that were left of uncertain status or else were completely misplaced (see Heppner, 1977; Nye *et al.*, 1975-91), although much remains to be done. Families are now fairly stable, however, and even subfamilies in most families, but beyond that there is still much confusion in many of the larger families, particularly Geometridae and Noctuidae. At the subfamily level, one source of confusion is the continued elevation of odd tribes as subfamilies, then later perhaps again considered a tribe after more study, sometimes as part of a different subfamily than in the past, and so forth.

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Family-level changes at this time mainly involve the different views among specialists as to what constitutes a family: some split every odd group as a new family (the motto seems to be: better a new family than to try to work at it more and alter the parameters of an existing family), while others are at the opposite extreme and combine all kinds of groups together as larger families (remember that Linnaeus had only 3 "families" for all Lepidoptera, or at most 10, depending on how you view his groupings). There is also a major divergence of opinion on higher categories (families, subfamilies, tribes), between those who study only butterflies and those who only study moths. For example, some butterfly specialists once had almost every butterfly family as a superfamily in itself, rather than being all under the superfamily Papilionoidea: this is contrary to what the superfamily level is considered to be in the remainder of the Lepidoptera.

Since evolution is not always at the level where, when all the Lepidoptera are compared among each other, such that one has all category levels (from species on up) with distinct boundaries, we thus have intergrades as well: e.g., sibling-species for species that are just evolving into distinct species (and these are usually retained as a single species in our classifications at this time), so also it is reasonable to expect there to be "sibling" subfamilies and "sibling" families. This is part of what I view as the problem behind many disagreements as to what level various groups are: e.g., the controversy between Pyralidae and Crambidae, or more recently between such odd groups as Oenosandrinae in Notodontidae, etc. While I alter family definitions to incorporate odd tropical groups into existing families, if feasible, others tend to immediately split off such groups as separate entities, as already noted above. What may also be involved are what was just noted, a kind of "sibling" status. To engage this problem in a classification, I believe, the use of the "group" category below the family level is a useful option. Thus, we have the groups Crambina and Pyralina, since I do not consider the single main character dividing these two groups sufficient to warrant reverting to their split into two families, as was already done 100 years ago. Likewise, we have the case of the "families" Oenosandridae and Thaumetopoeidae, split off from Notodontidae: this case has been an on-going controversy (other than the newly segregated Oenosandridae) for decades. Yet again, I believe, this is a case of what could be termed "sibling" families, and thus, in the classification below these are listed as group names: Oenosandrinina, Thaumetopoeinina, and Notodontinina. Group names in a classification demonstrate that there is some level of difference between the groups greater than evident as subfamilies, yet not enough to warrant separate families. Of course, many cladists do not recognize this and elevate every odd group as a new higher taxon. Group names are also used in Arctiidae, Noctuidae, and Nymphalidae, and possibly more such arrangements may be needed in other families that are very diverse and may have "sibling" groupings; e.g., the Oecophoridae, where some authors have again elevated all the subfamilies as separate families (Kristensen *et al.*, 1999). Other candidates for the possible addition of "group" classifications may be Gracillariidae, Tineidae, and Zygaenidae, all with odd subfamilies that have sometimes been considered separate families (viz. Phyllocnistidae, for what now is subfamily Phyllocnistinae in Gracillariidae, and Hieroxestidae, for what now is subfamily Hieroxestinae in Tineidae). However, as with subgenera and subtribes, part of the problem therein is that many specialists simply refuse to use such relatively non-traditional categories, preferring instead to elevate all unusual taxa to the next higher level (yet among other insect orders subgroup usage is normal).

Until most specialists can agree on what is a family (subfamily, tribe, etc.) there will remain controversies as to what level any particular group should be classified as. For example, a recent work created a large number of "families" in Gelechioidea for odd groups that previously were maintained in Oecophoridae (see Hodges, 1999), this being a reversion back to a similar classification before

these groups were placed within Oecophoridae. So, back and forth from generation to generation, every 30 years or so, the family levels change when a new group of workers looks at the same problems and thinks of doing it differently again — *vive la différence!*, as it were — although in this particular case it was the result of an extreme interpretation of a cladistic analysis of the Gelechioidea that skewed (or rather, skewered) the results. Likewise, there are a larger number of monobasic superfamilies that have been proposed, simply because some specialists split off each odd family rather than redefine groupings to accommodate the odd, often tropical, species being studied. Remember that our classification was originally based mainly on European genera, and has since 1758 been repeatedly altered as more and more of the tropical diversity was discovered.

Current so-called "phylogenetic" cladistics (or Hennigian cladistics) is not any different or "better" than other recent taxonomic methodologies (e.g., actual phylogenetic taxonomy, as from Mayr and Simpson), being as inherently biased as past methodologies, although many specialists using cladistics generally do not acknowledge any subjectivity: their results, however, are as dependent on the characters chosen (and the computer program used when a computer analysis is involved) as older conclusions, and these results must also be interpreted (see the note above about Gelechioidea). Current methodologies are superior, however, at least in the one aspect that more and more specialists are using a wider array of more fundamental characters in family-level classification and their studies are more precise in assessments of synapomorphies, which is an improvement over what was done earlier in the past century; the only problem is that these same specialists may include wildly varying characters as family-level characters in trying to come to their conclusions (e.g., using various genitalic characters for family-level studies of inter-relationships is foregone to result in possibly erroneous conclusions simply because genitalic characters are mainly species specific, or generic-level, and will only rarely offer some characteristic that can be validly applied to family-level studies). In many families we also have varying classifications because one specialist uses only adult characters, while another makes use of larval and pupal characters, which often produces very different results: rather, all these characters should be integrated into an analysis, to thus provide a more solid framework for our classification. And finally, many of the cladists adhere to strict monophyly in groups (which actually is the most ideal), yet will then subjectively determine where to draw the line on what the family level is, or where the tribal level is, and so forth.

Another problem in achieving a stable classification is the lack of characters of the immature stages of a great many groups, even entire families. If we do not have the array of characters offered by larval and pupal morphology, then relationships can often be very inconclusive. Here is an area of study that students should make note of, since searching for the immature stages and biologies of families (and other unique groups), where these remain unknown, can bring great advances in our classification. For example, in Noctuidae the members of the highly unusual Papuan subfamily Cocytinae are completely unknown biologically, yet the larvae and pupae could offer many characters to show where their true affinities lie, since the adults are strange day-flying moths (only 2 species are known) that appear more like small sphingids than owlet moths. There are many other cases like this: entire families such as Neopseustidae, Eriocottidae, and Ratardidae, among others, are completely unknown biologically (see Heppner (1998) for a listing of other biologically unknown families and subgroups).

Thus, to reiterate, the classification below is based on a worldwide study of the groups involved, not just a regional understanding or bias. Various works have been consulted (see Heppner (1998) for listings of references), as well as personal studies over the last 30 years. While monophyly is the standard applied to groupings, differential rates of evolution have also split groups that could

otherwise be combined (e.g., for Sesiidae, and particularly for Zygaenoidea and Cossoidea), thus, a reasoned approach has been used overall.

The classification below is most tentative at the tribal level in Geometridae and Noctuidae. As noted previously, regional workers have often elevated what are subtribes to tribal level, such that more names have been proposed than for the biodiversity that is involved. Even herein, the tribal listings of some families may be too extensive (e.g., in Geometridae), and many of the names may be dropped to subtribe level in the future, following more extensive study and comparative review of each group. However, the large biodiversity of some families may require large numbers of tribes. And, if some genus is unique, it may require a separate tribe (or other category) even if monobasic (witness Carthaeidae, with a single unique species that requires its own family). Many families are so vast, however, that progress is slow and will require the work of many specialists willing to take on the task. Phylogenetic arrangements (from primitive to advanced taxa) also vary regionally and by specialist in some cases: as an example, most subfamily and tribal arrangements in the family Geometridae vary between works and specialists of the New World fauna (e.g., Ennominae as a more primitive group in the family, thus, near the beginning of the listing) and the Old World fauna (e.g., Ennominae at the end, or as the most advanced geometrids). As noted previously, many worldwide studies are still needed but cannot be realistically advantageous until the immature stages are known for all families, thus giving those crucial character sets their due consideration and possibly resolving the conflicts of classifications as we see in families like the Geometridae.

TRIBAL NAMES

Synonyms are not included in the classification listing below, but can be found in the index (1,984 names), with notation as to what the correct name is for each taxon. Some of the synonym names have been used by others simply due to the erroneous view that once an older generic name is added to a group then the higher level taxon must adopt the name of the oldest included genus: the new Zoological Code (ICZN, 1999) specifically advises against this kind of instability, thus the more stable names in the literature are used. One of the best examples of this is the continued erroneous usage of Roeslerstammiidae instead of the long-used name Amphitheridae (in this case merely because an older European genus was added to the formerly tropical family and the reviser, not being familiar enough with the Code, simply thought the family name had to then be changed; and oddly, other specialists who know the Code better continue to perpetuate this error). The name Roeslerstammiidae is also invalid, since the original usage did not even include any of the species currently in this group, thus the senior name is Amphitheridae, as well as being the only valid name (Heppner, 2005b).

Another erroneous usage is Acentropinae, instead of Nymphulinae, in Pyralidae; again because an older generic name is involved. In this case the ICZN has even made a formal ruling for the use of Acentropinae, but many specialists will ignore this since a strange ICZN commission vote was involved (the commissioners actually voted "against" Acentropinae but due to bureaucratic rules of the ICZN their lack of a quorum of voters automatically favored the ruling for Acentropinae!). Should one question the sanity of ICZN rules that leave it to some bureaucratic solution, rather than the logical choice that even Commission members voted for based on the Code and the facts? One also has the recent use of Macariini instead of Semiothisini in Geometridae, simply because the genus *Macaria* is now added to the *Semiothisa* group as a valid, but older genus (again erroneous usage). Likewise, there is the recent unconscionable use of Strepsimaninae (Kristensen *et al.*, 1999) instead of the well-known Hypenodinae in Noctuidae (in this case, because the older genus *Strepsimanes* has now been added to

Hypenodinae; again erroneous usage). Even more egregious is the new use of Erebiinae instead of the well-known Catocalinae by some researchers, again for supposed use of the oldest name. Contrarily, the use of Nepticulidae instead of Stigmellidae, is precisely the same type of case (*Stigmella* is the senior generic name over *Nepticula*), yet various researchers strangely in this case retain the use of the supposed junior name, Nepticulidae. If workers fail to read the Code and continue to erroneously change higher taxon names whenever an older genus is added to a group, or when it suits them, then we will continue to have a lot of name changes and cause continued instability and confusion.

DISCUSSIONS

Primitive Moths

Among those families considered the most primitive of lepidopterans, there is little controversy that Micropterigidae are the most basal group remaining among living Lepidoptera. Recent studies by Davis (1999), plus those of Minet (1986, 1991) and others, have clarified the basal divisions of the order Lepidoptera such that, barring any discoveries of other primitive taxa in remote tropical regions, we probably have a clear picture of the evolutionary development from Zeugloptera to Ditrysia, the remainder of lepidopteran families. The only recent addition is of a surprising new monotrysian family added to Nepticulina, the Andesianidae (Davis, 2003), for three Valdivian species previously misplaced among Cossidae.

Incurvarioidea

This group of families is still in need of further study, since some specialists continue elevating almost all the subfamilies as separate families, thus we have some listing Crinopterygidae, Lamproniidae, and Prodoxidae as separate families (Davis, 1999). As noted in the introduction, some specialists always make new families rather than incorporate new character states within the framework of an existing family, thus multiplying families right and left. As listed herein, the 5 families show cohesive characters with their included subfamilies.

Tineoidea

Among Tineoidea, the series category is used to demarcate Tineiformes and Gracillariiformes; some specialists, however, make these into two separate superfamilies. The basal area of the superfamily now has the Acrolophidae segregated as a separate family from the remaining Tineidae, the acrolophids being considered the most primitive group of the superfamily.

In Tineidae, there remains considerable study yet needed on a worldwide basis to clarify all the levels and relationships among the subfamilies and tribes listed, many of which have also been thought of as separate families in the past. Also, the presumed most advanced group, the Hieroxestinae, have recently again been presented as a separate family by some (Davis and Robinson, 1999).

Psychidae likewise need study for their subfamily classification, with some specialists still using family names for Lypusidae, so the relationships among all the psychid taxa remain uncertain.

The remaining families, comprising the Gracillariiformes, are all small except for the main leafminer group, the Gracillariidae. Amphitheridae is still unjustifiably called Roeslerstammiidae by many specialists, mainly just following each other without further question from a beginning point where someone incorrectly changed the family name.

In Gracillariidae, the Phyllocnistinae have often been viewed as a separate family, but cohesive characters do not warrant that. As in other such cases, to elevate this group as a separate family would require every subfamily of Lepidoptera to also be elevated to family-level, if one tried to treat all groups with the same arguments as used for having Phyllocnistidae as a separate family, thus giving us some 300 "families" worldwide.

Gelechioidea

As already noted in the introduction, this superfamily has reverted from few families to many families, back and forth, about once every generation of specialists. Currently, we have 11 families, but some specialists now want again to elevate practically every subfamily, especially among the Oecophoridae, as a distinct family (Hodges, 1999): this can easily be done, but the definition we would have of such "families" would require the elevation of all other subfamilies as well, as already mentioned above. The most recent modification of this view is by Kaila (2004), with at least 16 "families" indicated in his cladology, and others would push the total to over 20 families. Note again, that to elevate all these groups in Gelechioidea to family-level would require equal usage for the rest of the order, or about 300 "families" in total.

Is it useful to classify the Lepidoptera with 300 families or with 125 families? Should every odd group simply be called a "family" now? In Coleoptera, various specialists are also now engaged in a widespread "splitting" campaign, and thus have about 10 families of weevils for what previously was considered one family, for example. If one wishes, one can continue on such a path to the point where we have a "family" for every odd group, or as in birds where one has a different genus for almost every other species: obviously every species is different but we need some common sense in where to draw the lines for higher taxon groupings. The denegation of what a "genus" is has also been accelerating in recent decades as much as has the family concept: one can look at bird classification, where many "genera" now contain only a few or a single species. Some taxonomists have actually enunciated a belief that a genus should automatically not have more than 5 species, as if this were a fact of nature! Of course, these persons have never studied the genus *Coleophora* with over 1,000 species worldwide, among other such large genera! As noted earlier, the reduction in parameters for genera and families has been progressing since the time of Linnaeus, but in the last 100 years or so we have made a critical analysis of what a family should be and what a genus should be, notwithstanding taxonomically insane trends among higher animals, like bird classification.

In Oecophoridae, notwithstanding the above comments, there still remains a need for considerable study. The group is so vast worldwide that it has been difficult to handle by any one person, and most of the past classifications have mainly involved the European fauna instead of dealing with the vast tropical fauna. Ian Common (formerly of CSIRO, Canberra, Australia) is one of the few now trying to make some sense of the many genera of oecophorids from Australia, where most of the biodiversity appears to reside. The current subfamilies have been listed in Oecophoridae for some time and only recently has there again been an effort to split them all into separate families (Hodges, 1999). New developments have shown, however, that some odd groups, like the so-called Symmocidae and Holcopogonidae, previously either separate families or placed in Blastobasidae, may well best go in Oecophoridae, along with Glyphidocerini, in Autostichinae. The Oecophoridae are extremely diverse, yet have cohesive character traits, thus they are a very large family that has become very biodiverse, yet compared to other family characters across all Lepidoptera, are rightfully together as one family. Unfortunately, some researchers cannot comprehend (or refuse to do so) a "family" that is diverse and large (yet cohesive nonetheless), much as was noted above for the splitting of genera based on a maximum size of 5 species, as if this were not some arbitrary choice but some law of nature.

Lecithoceridae were long thought to belong in Gelechioidea, but are now considered more primitive and related more to Oecophoridae and Elachistidae.

Elachistidae are considered herein as a smaller family than some other researchers view it. A recent classification has relegated almost all Oecophoridae to an enlarged concept of Elachistidae (Minet, 1990), or even as a separate superfamily (Kuznetsov and

Stekolnikov, 1984), but this elevates all other groups, such that Gelechioidea would have to be a "suborder" of Lepidoptera, as Kaila (1999) also noted): clearly there is considerable elevation going on for different groups in the minds of some specialists, or splitting, as already alluded to in the introduction. The true Elachistidae (*sensu stricto*) have recently been studied on a worldwide basis by Kaila (1999), but he did not arrange the genera into a higher classification other than what his consensus tree showed: based on his studies, the classification used herein makes use of appropriate subfamily and tribal names but more study is needed.

Copromorphoidea

This small superfamily has only 4 included families: Copromorphidae, Alucitidae, Carposinidae, and Epermeniidae. The cohesive characters of this grouping have already been well established (Heppner, 1977). Recent attempts to continue splitting up this group into separate superfamilies for Epermeniidae and Alucitidae are based on erroneous conclusions of Minet (1986, 1991) as to what should be a superfamily, as well as continuing the taxonomic fiction that Alucitidae are somehow related to Pterophoridae (as was done even 150 years ago because both have split wings) (Dugdale *et al.*, 1999b).

Yponomeutoidea

This superfamily comprises 9 families at present: Ochsenheimeriidae, Glyphipterigidae, Plutellidae, Attetidae, Yponomeutidae, Argyresthiidae, Lyonetiidae, Acrolepiidae, and Heliodinidae. My studies had first considered Glyphipterigidae to belong in Copromorphoidea (Heppner, 1977), based especially on larval characters, but the family evidently best represents basal elements within Yponomeutoidea, as does Ochsenheimeriidae (earlier transferred from Tineoidea). Recent study has shown some primitive genera from New Zealand and Australia, thought to be Plutellidae, to actually belong to basal groups within Glyphipterigidae, subfamily Orthoteliinae (Heppner, 2005a). While splitters run rampant in other superfamilies, they oddly continue maintaining Attetidae as a subfamily in Yponomeutidae, yet segregate Ypsolophinae as a separate family from Plutellidae (Dugdale *et al.*, 1999a).

Immoidea

This is a monobasic superfamily, with only the family Immidae (Heppner, 1977, 1982). The family is pantropical, but mostly from tropical Asia. A recent addition is a subfamily classification due to the addition of Prodidactinae (new status), currently a *nomen nudum* published in a paper by Epstein and Brown (2003) that is invalid by nomenclatural rules of the zoological code (Art. 8.6 and 9.7): the name is listed herein in case the authors validate the name. Prodidactinae were defined as a family (Prodidactidae) but the characters indicate that the single genus is only of subfamily status in Immidae (another case where authors would rather have a "new family" than appropriately modify an existing family to accommodate a strange new tropical member).

Pyraloidea

The superfamily includes three families: Hyblaeidae, Thyrididae, and Pyralidae. Cladist splitters have split this into no less than three separate "superfamilies" (two subfamilies of Thyrididae are even split off by some as separate "families"). Larval characters in particular show superfamily cohesion for all the included groups.

One large controversy is the recent splitting of Pyralidae by elevating to family level its two groupings, as Crambidae and Pyralidae, whereby almost all genera commonly viewed as "pyralids" are now in Crambidae, leaving Pyralidae with only the minor subfamilies and the phycitines (Munroe and Solis, 1999). Minet (1991) even considered all the major subgroups as separate "families", thus with 5 families (including also "Acentropidae," Pyraustidae, and Phycitidae). There is nothing new in all this: all

has already been done over 100 years ago when another splitting craze in taxonomy was loose on the planet. Again, the cohesiveness of Pyralidae, with all the groupings included as subfamilies, has been viewed as logical for the family already for many decades, until recently. A recent paper has refined characters of the subfamilies of "Crambidae" (Solis and Maes, 2002), although it is based only on adult characters.

When one internal morphological character was discovered that did indeed segregate the pyralids from the crambines, Munroe (1972) chose the logical view to use a subgroup classification, as is often done in other insect orders where the family may be evolving but still retains enough other characters to remain as one family. Cladist purists cannot follow this (and others often refuse to use unconventional subgroups), so see only splitting as a solution, although if they simply lowered their "family" level cut on their cladology trees (where they arbitrarily have chosen a certain level of similarity to be called a subfamily or family), they would come to the conclusion also of having only one family Pyralidae. Using the "group" category below family level, of course, shows that there is a distinction between the two groups but also shows that this is not large enough a difference overall to segregate them as separate families.

Pterophoroidea

This superfamily includes the plume moths, Pterophoridae, plus two odd related tropical families, Tineodidae and Oxychirotidae (Heppner, 1997, 1998c). Some researchers now include Oxychirotidae within Tineodidae (Dugdale *et al.*, 1999b), but wing venation and larval biologies differ.

Sesioidea

This superfamily has been defined with modern character studies already since 1981 (Heppner and Duckworth, 1981), now including 4 families: Brachodidae, Sesiidae, Urodidae, and Choreutidae. The cladist splitters do not agree and split off Urodidae and Choreutidae as separate superfamilies, mainly based on studies of only adult characters and idiosyncratic levels of cohesion of groups to exclude (Edwards *et al.*, 1999). There has been some recent restructuring of the tribes within Sesiidae, plus the addition of tribes for odd tropical genera.

Zygaenoidea

The old concept of this superfamily has been shown to be heterogeneous, mainly due to groupings thought to be similar due to some traits (e.g., larval shape as slug caterpillars) that now are known to only indicate convergent evolution (Heppner, 1998b, 2005c). While the main family, Zygaenidae, is clear enough, the odd smaller groups that are related have always caused confusion. Thus, the families that actually are cossoid, and not zygaenoid, were moved to Cossoidea (Heppner, 1998b). Researchers focused only on apparent similarities (e.g., the similar larvae), fail to agree with this and forget that convergent evolution can provide such results as similar larvae (which nonetheless show differences as well). Families remaining in Zygaenoidea include Heterogynidae, Zygaenidae, Himantopteridae, Lacturidae, Somabrachyidae, and Megalopygidae. Some researchers continue attempts to split Zygaenidae into several "families" and others include Somabrachyidae within Megalopygidae, or split out groups like Aididae (Epstein *et al.*, 1999).

Cossoidea

This superfamily is actually the basal stem of the Cossina group of superfamilies that includes all the remaining Lepidoptera up to Noctuidae, being fundamentally evolved from different ancestors than where the Zygaenoidea ended up from. Cossoidea now include 6 families: Cossidae, Dudgeoneidae, Metarbelidae, Cyclotornidae, Epipyropidae, and Dalceridae. Again, the slug-like larvae of

Dalceridae have some researchers confused into believing they should be part of Zygaenoidea, while the family morphology shows an evolution derived from cossoid ancestors (Heppner, 1998b).

Castnioidea

This monobasic superfamily represents a basal, rather primitive family, the Castniidae, that appear to best be placed as a separate superfamily, although clearly also derived from cossoid-like ancestors.

Tortricoidea

We now place the Tortricidae in their own superfamily. The actual placement of the group in the overall classification varies among researchers, since some place the group near the Tineoidea (Horak, 1999), but in relation to all Lepidoptera they appear best placed in our linear format after the Castnioidea and at the end of what are termed the "microlepidoptera." The true layout of families in our classification would be better seen in three dimensions, whereby Tortricoidea would be seen to retain some primitive features like Tineoidea but otherwise advanced enough to place the group 3-dimensionally to the side in another lineage from tineoid-like ancestors; but, a paper layout requires placement linearly in only two dimensions (Heppner, 1998b).

Calliduloidea

This small Old World group includes only 3 families: Ratardidae, Pterothysanidae, and Callidulidae. All are day-fliers, and most callidulids even fly and perch like butterflies.

Uranoidea

This superfamily includes 5 families: Epicopeiidae, Apoprogonidae, Sematuridae, Uraniidae, and Epiplemididae. Most species are Old World, but at least Epiplemididae are found in all regions. Cladists have recently moved Epiplemididae into Uraniidae (Minet and Scoble, 1999), in a reversal from their usual splitting, but the groups are different enough to remain as separate families, particularly in terms of their larvae. The superfamily is rather closely related to Calliduloidea.

Geometroidea

The family Geometridae, being such a biodiverse family (21,150 spp. worldwide), still requires considerable study to conform all the higher category (subfamily and tribe) names by region, such that what a tribe is in Europe has the same meaning as a tribe in North America or Asia: currently, there is wide disagreement on this matter between North American specialists and European specialists. What we have now are numerous tribal names that remain of uncertain status: are they tribes or only subtribes? For example, most of the group names in the subfamily Geometrinae have been treated as tribes in the past, but recently Holloway (1996) probably correctly noted that there should be only two tribes and all remaining names ought to be at most subtribes. Likewise, to follow the use of subtribes in Geometrinae, many of the Ennominae tribes probably only warrant subtribal status as well, but which do and how they should be arranged remains unclear: e.g., one can identify about 6 groupings of tribes in Ennominae, so perhaps these should be tribes and the remaining names only subtribes. Holloway (1996) also now uses an enlarged concept of Boarmiini that would put many other groups as subtribes therein, even more than listed herein. Consequently, the listing of tribes in Geometridae herein is still tentative. The listed arrangement of the tribes within each subfamily is also tentative, since this also varies regionally: most classifications in Europe have Ourapterygini, for example, near the middle of Ennominae, while in North America it is towards the end of the subfamily. One needs to also determine which groups are considered the most advanced: most specialists now agree that such subfamilies as Archiarinae and Oenochrominae are more primitive geometrids,

but some place Ennominae as advanced while others place Larentiinae as advanced. The classification of Geometridae herein is an attempt to show the relationships of the various tribes and subfamilies, but it is far from final and mainly represents revision of conventional arrangements by specialists that often do not like to use subtribes (thus, all such names are tribes in their mind). Additionally, more odd tropical groups are discerned all the time, so much work remains to be done with this large family.

Hedyliidae are retained in Geometroidea herein. While they may indeed represent the evolutionary development that gave us the butterflies, their base characters retain them more to Geometroidea than they do to Papilionoidea (Heppner, 1998b). Obviously, others disagree and put them as part of the butterflies, or else make the usual split as a separate superfamily, Hedyloidea (Minet and Scoble, 1999).

Papilionoidea

The butterfly workers have often had considerably differing classifications over the years, from the 7 families we now list to many more and even added superfamilies for the larger families of butterflies. Again, putting the classification in the perspective of world lepidopteran biodiversity, one finds that most butterflies are not that different from each other (e.g., nymphalids are all in one family and not in their own superfamily) in relation to how moths are classified. To maintain a uniform family level one cannot have more splitting among the butterflies. Some researchers now include Libytheidae within the Nymphalidae (Ackery *et al.*, 1999), but this is unrealistic given their great morphological differences. Hesperidae are split by some into their own superfamily, but this is not necessary when one uses the "series" subgrouping to show that their divergence from higher butterflies is not so great that a separate superfamily is needed. Riodinidae follows the new Neotropical catalog (Lamas *et al.*, 2004).

Drepanoidea

A small superfamily, including 4 families: Axiidae, Thyatiridae, Cyclidiidae, and Drepanidae. Most species are Old World.

Bombycoidea

This well-known grouping of moths now includes 13 families: Carthaeidae, Eupterotidae, Apatelodidae, Bombycidae, Mimallonidae, Anthelidae, and Lasiocampidae in the series Bombyciformes, and Endromidae, Lemoniidae, Brahmaeidae, Oxytenidae, Cercophanidae, and Saturniidae in the series Saturniiformes (Heppner, 1998b). Sphingidae are generally excluded to their own superfamily, but some workers keep them within Bombycoidea (Lemaire and Minet, 1999).

Sphingoidea

The single family Sphingidae comprises this monobasic superfamily of well-known moths, the hawk moths (or sphinx moths). Some alterations of the tribes have been made in recent years (Lemaire and Minet, 1999).

Noctuoidea

Almost a third of all Lepidoptera belong to Noctuoidea, including 6 families: Notodontidae, Dioptidae, Thyretidae, Lymantriidae, Arctiidae, and Noctuidae (Heppner, 1991, 1998b). Various odd members of the families have more recently been segregated as several "families" of their own, again based mainly on cladist artificial rules on what level a researcher considers a family to be defined. In our classification we use subgroupings to show what differences there are, rather than do unnecessary splitting: this is especially needed in Noctuidae, where recent splitting has not only given us Aganinae and Hermiinae, but now also include a complete splitting of the Noctuidae to include also the "families" Erebiidae (even the Catocalinae name is changed!), Nolidae,

Acronictidae, Pantheidae, etc. Tribes are noted in the listing below but subtribes are mostly not included, as has been done to a profuse extent for Europe (Beck, 1999b), since the rest of the world fauna has not had equivalent treatment and many of the European subtribal names may be simply excessive splitting (many of these European subtribes are monobasic, representing only a single genus) (Kitching and Rawlins, 1999).

The splitting trend in noctuids has been progressing for the past 20 years or so (see Kitching, 1984; Speidel *et al.*, 1996), what cladists consider a correct trend due to "rigorous application of cladistic principles" rather than past vague group definitions, as Speidel *et al.* (1996) put it: the problem with this is as noted already, the results are from whatever their computer program version and cladology analysis gives them, which is not necessarily correct but based only on these current parameters and their subjective analysis. This is no different than past work, just with more precise characters and the use of computers, but the result is still subjective as always and dependent on how experienced a taxonomist the compiler actually is — the problem is that some cladists fervently believe their methodology is akin to reassembling the phylogenetic lineage from God himself (or DNA) and the results cannot thus be questioned other than possibly with slight refinements using another computer program, all the while forgetting that it is they (not God) who decide where to draw the line on what a family is or what a genus is.

Again, the noctuid workers cannot split odd subgroups away in Noctuidae as "families" without also having all other Lepidoptera subfamilies elevated to family-level in their view of what a family constitutes. There has to be concordance throughout the order for all higher groupings. Of course, if one can agree with a classification where a "family" is defined one way among micros and another way among butterflies and another way among noctuids, then perhaps the mad hatters tea party can resume and all logic for an overall classification of all the Lepidoptera can be ignored. Is it rational to have three different definitions of what a "family" is within the classification of one order of insects? Clearly, each level of a classification must be maintained in as rational a cohesive form throughout an order as possible, given all our human subjectivities in any case and based on what the evolution of the order shows us, not cladist fantasies based on a narrow view of only one group. In Noctuidae, for example, various attempts have continued for the past 100 years to resurrect "Nolidae" about every generation as new taxonomists studied the group: they otherwise conform well to the overall concept of the family Noctuidae. The Nolinae (or Nolidae) may represent an offshoot, also supported by larval characters, but this shows more a development from lithosine Arctiidae than from Noctuidae (Beck, 1999a), however what may be involved here is again a basal element remaining in the family, much as with some of the oecophorids that are herein retained within Oecophoridae. Holloway (2003) has expanded this segregation to include other subfamilies within an enlarged Nolidae, based on his views of the group for the Asian tropics. Likewise, the use of non-conventional subgroups also retains such odd tropical groups as Aganinae within the Noctuidae, so Nolinae may have to be handled similarly if the evidence mounts.

CONCLUSIONS

Since few researchers study all Lepidoptera from all regions of the world, the specialist studying a single group, perhaps only for one faunal region, quickly can find any odd tropical group to require a "new" family. To classify our Lepidoptera one can only resort to uniformity of what each level of the classification is to mean, at least insofar as is humanly possible. The pure cladist view is to simply draw a line on their computer trees for each level, but this methodology, while seemingly simple and clear, is not so when we are dealing with nature: too many character variables negate this from being perfectly applicable to each group for the entire order.

Likewise, the methodology of making all characters in a computer analysis equal (i.e., some hair on a leg being equal in value to having 6 legs, for example) does not work in nature, since some characters are more fundamental than others (e.g., the 6 legs versus only 4 legs!). The true phylogenetic taxonomist, on the other hand, modifies each grouping to conform not only to an overall level within the classification but also to the evolution of the group involved; thus, there are sometimes shifts needed on the cladist trees on where the line is for different groups, yet in such a way that the definition of the level chosen is not compromised. What is meant here is that different "rates" of evolution need to be included in a valid classification, not simply just morphology, and this is something the cladologists do not fully acknowledge (thus, the errors, as for example, in not seeing convergent evolution in the case of some Zygaenoidea and Cossoidea, or to see that Brachodidae are related to Sesiidae even though the Sesiidae advanced very rapidly from their brachodid-like ancestors). To split families, like Noctuidae, into many "families" and yet be ignorant of what a family is among primitive moths, or among butterflies, will not give us a stable or logical classification: we need conformity of level throughout the Lepidoptera in order to arrive at a reasonable classification that approximates their evolution and phylogeny.

We can proceed with splitting and end up with 300 or so "families" in Lepidoptera — the beetle people are nearly there already, in their cladist frenzy of splitting (there are even 10 or more "families" just for weevils alone!) — but a rational classification will keep groups about equal throughout, from micros to noctuids. For the past 100 years or so the concept of what a "family" is in Lepidoptera has been relatively stable, until recently. If we want, we can have 300 families of Lepidoptera. Is this reasonable? Is this useful? These are questions we need to consider when continuing the efforts to split off odd groups from families that they can otherwise reside in. One can actually modify family definitions: this is something that some Lepidoptera researchers seem unaware of, thinking instead that somehow the original description of a family is sacred and that any group falling outside this first definition requires a "new" family to be named. We have refined family definitions since the time of Linnaeus, so modifying a family definition to include some odd group, if it really can be included, can be done. What we find is simply that many researchers refuse to change families and instead name a new family. This is more political than rational or scientific. There are more synonyms to family names than there are valid families, as many researchers have learned over the years. Thus, further erosion of what constitutes a "family" should be discouraged, otherwise to be rational in our classifications then all lepidopteran subfamilies would need to be elevated to family level: you cannot have "Nolidae" or "Danaiidae" without also elevating all other groups currently at the subfamily level. You either have logic derived from what the evolution of the Lepidoptera shows us to be different families, their characters, or you have a mad hatters party.

Finally, what you see in the listing below of families, subfamilies, tribes, and in some cases subtribes, is not the final word on Lepidoptera classification. Only recently was a valid new family added to the list for an odd tropical group (Andesianidae), so as more remote areas of the world are further surveyed it is reasonable to assume that a few more odd groups may yet be discovered. Likewise, further knowledge and study of some obscure groups, as for example those families where we as yet do not know the larvae, may yet modify our classification in unforeseen ways. Nonetheless, the present classification, I believe, best represents a uniform and rational view of lepidopteran evolution and phylogeny as we currently know it to be, and with concordant values of higher groupings throughout the order Lepidoptera.

Trying to make a classification based not on fact, but on a "consensus" view of the facts is nonsensical, just like it was when the "global consensus" was that the earth was flat: the "global

consensus" can be wrong, as was discovered in 1492 (and already earlier by the Chinese). Many other erroneous "consensus" views abound even today, such as the current view that the Incas built the monuments in Cuzco, Peru (when they themselves told the early Spanish explorers that the buildings were already there and very old when their people first came into the valley of Cuzco and made use of them, yet the consensus archaeologists maintain the fiction that these are ruins built by the Incas); or, the view that the Egyptians somehow built the great pyramid and sphinx at Giza, Egypt (when we know that the early Egyptians did not have the mathematical or engineering skill to make such perfect buildings, while their own pyramid attempts were all inferior copies and the sphinx was even stated by them to be there from ancient days long before their people were even civilized, yet consensus egyptologists continue the fiction that these monuments were built by the Egyptians). Plate tectonics was also fully dismissed as complete fantasy 45 years ago by the then-prevalent "global consensus" of geologists, yet we all know that this is a proven fact and is now taught in every high school in the world as a basic tenet of modern geology. Even crustal displacement is gaining ground as a possibly valid theory of earth movements. Let the archaeologists and egyptologists continue with their heads in the sand, but we need not follow their wooden-headed examples in our work on Lepidoptera classification.

Classification is not a political game of consensus building, but a reasoned study of the species we are dealing with as they are in nature and as they evolved to the present day, whereby we then attempt to outline this evolution into some kind of order showing the relationships among the included groups. It also is not based on a single methodology, such as computer generated cladologies using the most recent cladistics computer program that uses all possible characters equally (no matter how nonsensical that may be), and which is then deemed the only methodology possible for classification. As noted earlier, no matter what classification is used, the classification outline should even be seen 3-dimensionally to better show relative evolution in different lineages, but we have to organize it 2-dimensionally to get it linearly on paper.

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LEPIDOPTERA

Suborder ZEUGLOPTERA

MICROPTERIGOIDEA

1. MICROPTERIGIDAE - Mandibulate Archaic Moths
Micropteriginæ
Sabatincinæ

Suborder AGLOSSATA

AGATHIPHAGOIDEA

2. AGATHIPHAGIDAE - Kauri Moths

Suborder HETEROBATHMIINA

HETEROBATHMIOIDEA

3. HETEROBATHMIIDAE - Valdivian Archaic Moths

Suborder GLOSSATA

Cohort DACNONYPHA

Infraorder DACNONYPHA

ERIOCRANIOIDEA

4. ERIOCRANIIDAE - Sparkling Archaic Sun Moths
5. ACANTHOPTEROCTETIDAE - Archaic Sun Moths
Acanthopteroctetinae
Catapterginae

Infraorder LOPHOCORONINA

LOPHOCORONOIDEA

6. LOPHOCORONIDAE - Australian Archaic Sun Moths

Cohort MYOGLOSSATA

Subcohort MYOGLOSSATA

Infraorder NEOPSEUSTINA

NEOPSEUSTOIDEA

7. NEOPSEUSTIDAE - Archaic Bell Moths

Subcohort NEOLEPIDOPTERA

Infraorder EXOPORIA

MNESARCHAEOIDEA

8. MNESARCHAEIDAE - New Zealand Primitive Moths

HEPIALOIDEA

9. NEOTHEORIDAE - Amazonian Primitive Ghost Moths
10. ANOMOSETIDAE - Australian Primitive Ghost Moths
11. PROTOHEORIDAE - African Primitive Ghost Moths
12. HEPIALIDAE - Ghost Moths
13. PALAEOSSETIDAE - Miniature Ghost Moths

Infraorder HETERONEURA

Division MONOTRYZIA

Section NEPTICULINA

ANDESIANOIDEA

14. ANDESIANIDAE - Valdivian Forest Moths

NEPTICULOIDEA

15. NEPTICULIDAE - Pygmy Moths
Pectinivalvinae
Nepticulinae
Nepticulini
Trifurculini
16. OPOSTEGIDAE - Eye-Cap Moths

TISCHERIOIDEA

17. TISCHERIIDAE - Trumpet Leafminer Moths

PALAEPHATOIDEA

18. PALAEPHATIDAE - Gondwanaland Moths

Section INCURVARIINA

INCURVARIOIDEA

19. INCURVARIIDAE - Leafcutter Moths
Incurvariinae
Crimpteryginae
20. CECIDOSIDAE - Gall Moths
21. PRODOXIDAE - Yucca Moths
Lamproniinae
Prodoxinae
22. ADELIDAE - Longhorned Fairy Moths
Nematopogoninae
Adelinae
23. HELIOZELIDAE - Shield Bearer Moths

Division DITRYZIA

Section TINEINA

Subsection TINEINA

TINEOIDEA

Series Tineiformes

24. ACROLOPHIDAE - Tube Moths
Amydriinae
Acrolophinae
25. TINEIDAE - Fungus Moths
Euplocaminae
Myrmecozelinae
Harmacoloninae
Meessiinae
Infurcitineini
Meessiini
Dryadulinae
Scardiinae
Nemapogoninae
Tineinae
Setomorphinae
Perissomasticinae
Hapsiferinae

Hieroxestinae
 Erechthiinae
 Siloscinae
 Stathmopolitinae
 Teichobiinae

26. ERIOCOTTIDAE - Old World Spiny-Winged Moths

Eriocottinae
 Compocteninae

27. PSYCHIDAE - Bagworm Moths

Lypusinae
 Naryciinae
 Narycini
 Dahlicini
 Taleporiinae
 Eotaleporiini
 Taleporiini
 Placodomini
 Typhoniinae
 Penestoglossini
 Dissoctenioidini
 Typhoniini
 Scoriodytini
 Psychinae
 Psychini
 Peloponnesini
 Epichnopterygini
 Stichobasini

Oiketinae
 Metasini
 Acanthopsychini
 Oreopsychini
 Phalacropterygini
 Apteronomini
 Oiketini

28. ARRHENOPHANIDAE - Tropical Lattice Moths

Series Gracillariiformes

29. AMPHITHERIDAE - Double-Eye Moths
 30. SCHRECKENSTEINIIDAE - Bristle-Legged Moths
 31. DOUGLASIIDAE - Douglas Moths
 32. BUCCULATRICIDAE - Ribbed-Cocoon Maker

Moths

33. GRACILLARIIDAE - Leafminer Moths
 Gracillariinae
 Lithocolletinae
 Phyllocnistinae

GELECHIOIDEA

34. OECOPHORIDAE - Concealer Moths

Depressariinae
 Depressariini
 Depressariina
 Epigraphiina
 Telechrysidina
 Amphisbatini
 Cryptolechiini
 Cacochroina
 Cryptolechiina
 Hypercalliini
 Ethmiinae
 Peleopodinae
 Acriini
 Peleopodini
 Autostichinae
 Autostichini
 Oegoconiini
 Symmocini
 Glyphidocerini
 Oeciini
 Schistonoeini

Xyloryctinae
 Stenomatininae
 Oecophorinae
 Oecophorini
 Oecophorina
 Herrichiina
 Denisiina

Deoclonini
 Philobotini
 Syringopaini
 Stathmopodini
 Lamprysticini
 Pleurotini

Hypertrophinae
 Chimabachinae
 Carcinini
 Chimabachini

Deuteroniinae
 Deuteroniini
 Aeolanthini

35. LECITHOCERIDAE - Tropical Longhorned Moths

Ceuthomadarinae
 Oditinae
 Scythropiodini
 Oditini

Lecithocerinae
 Torodorinae

36. ELACHISTIDAE - Grass Miner Moths

Coelopoetinae
 Elachistinae
 Mendesiini
 Perittiini
 Stephensiini
 Elachistini

37. PTEROLONCHIDAE - Lance-Wing Moths

38. GELECHIIDAE - Twirler Moths

Physoptilinae
 Gelechiinae
 Apatetrini
 Anomologini
 Gelechiini
 Gnorimoschemini
 Pexicopiinae
 Pexicopiini
 Anacampsini
 Chelariini

Dichomeridinae

39. BLASTOBASIDAE - Scavenger Moths

Holcocerinae
 Blastobasinae
 Blastobasini
 Pigritiini

40. COLEOPHORIDAE - Casebearer Moths

Coleophorinae
 Batrachedrinae
 Epimartini
 Batrachedrini

41. MOMPHIDAE - Mompha Moths

42. AGONOXENIDAE - Palm Moths

Agonoxeninae
 Blastodacninae
 Blastodacnini
 Parametriotini

43. COSMOPTERIGIDAE - Cosmet Moths

Antequerinae
 Cosmopteriginae
 Chrysopeteiinae

44. SCYTHRIDIDAE - Flower Moths

COPROMORPHOIDEA

- 45. COPROMORPHIDAE - Tropical Fruitworm Moths
- 46. ALUCITIDAE - Many-Plumed Moths
- 47. CARPOSINIDAE - Fruitworm Moths
- 48. EPERMENIIDAE - Fringe-Tufted Moths
 - Epermeniinae
 - Ochromolopinae

YPONOMEUTOIDEA

- 49. OCHSENHEIMERIIDAE - Cereal Stem Moths
- 50. GLYPHIPTERIGIDAE - Sedge Moths
 - Orthoteliinae
 - Glyphipteriginae
- 51. PLUTELLIDAE - Diamondback Moths
 - Ypsolophinae
 - Plutellinae
 - Scythropiinae
 - Praydinae
- 52. ATTEVIDAE - Tropical Ermine Moths
- 53. YPONOMEUTIDAE - Ermine Moths
 - Saridoscelinae
 - Yponomeutinae
 - Niphonymphini
 - Yponomeutini
 - Cedestinae
- 54. ARGYRESTHIIDAE - Shiny Head-Standing Moths
- 55. LYONETIIDAE - Lyonet Moths
 - Cemistominae
 - Lyonetiinae
 - Bedelliinae
- 56. ACROLEPIIDAE - False Diamondback Moths
- 57. HELIODINIDAE - Sun Moths

IMMOIDEA

- 58. IMMIDAE - Imma Moths
 - Prodidactinae
 - Imminae

PYRALOIDEA

- 59. HYBLAEIDAE - Teak Moths
- 60. THYRIDIDAE - Picture-Winged Leaf Moths
 - Simaethistinae
 - Whalleyaninae
 - Argyrotypinae
 - Thyridinae
 - Siculodinae
 - Siculodini
 - Rhodoneurini
 - Striglininae
- 61. PYRALIDAE - Snout Moths
 - Group Crambinae
 - Crambinae
 - Ancylolomiini
 - Diptychophorini
 - Argyriini
 - Haimbachiiini
 - Chilonini
 - Myelobiini
 - Erupini
 - Crambini
 - Schoenobiinae
 - Cybalomiinae
 - Linostinae
 - Scopariinae
 - Scopariini
 - Eudoniini
 - Heliothelini

- Musotiminae
- Midilinae
- Nymphulinae
 - Nymphulini
 - Argyractini
- Noordinae
- Odontiinae
 - Hercynini
 - Odontiini
 - Eurrhypini
- Wurthiinae
- Evergestinae
 - Evergestini
 - Orenaiini
- Glaphyriinae
 - Glaphyriini
 - Hydririni
 - Cathariini
 - Dichogamini
- Pyraustinae
 - Pyraustini
 - Spilomelini
- Group Pyralininae
- Pyralinae
 - Pyralini
 - Endotrichini
- Chrysauginae
- Galleriinae
 - Galleriini
 - Megarhridini
 - Tirathabini
 - Cacotherapiini
- Epipaschiinae
- Phycitinae
 - Cryptoblabini
 - Phycitini
 - Acrobasiina
 - Phycitina
 - Anerastiini
 - Peoriini

PTEROPHOROIDEA

- 62. TINEODIDAE - False Plume Moths
- 63. OXYCHIROTIDAE - Tropical Plume Moths
- 64. PTEROPHORIDAE - Plume Moths
 - Macropiratininae
 - Agdistinae
 - Ochyroticinae
 - Deuterocopininae
 - Pterophorinae
 - Platyptiliini
 - Pterophorini

Subsection SESIINA

SESIOIDEA

- 65. BRACHODIDAE - Little Bear Moths
 - Pseudocossinae
 - Brachodinae
 - Phycodinae
- 66. SESIIDAE - Clearwing Moths
 - Tinhiinae
 - Tinhiini
 - Similipepsini
 - Pennisetiini
 - Paraglosseceini
 - Paranthreninae
 - Paranthrenini
 - Cissuvorini

Sesiinae
 Osminiini
 Melittiini
 Sesiini
 Synanthedonini
 Bembeciini

67. URODIDAE - False Burnet Moths

Galacticinae
 Urodinae

68. CHOREUTIDAE - Metalmark Moths

Millieriinae
 Brenthiinae
 Choreutinae

ZYGAENOIDEA

69. HETEROGYNIDAE - Mediterranean Burnet Moths

70. ZYGAENIDAE - Burnet Moths

Zygaeninae
 Phaudinae
 Charideinae
 Chalcosiinae
 Agalopini
 Chalcosiini

Anomoeotinae
 Callizygaeninae
 Procridinae

Procridini
 Artonini

71. HIMANTOPTERIDAE - Long-Tailed Burnet Moths

72. LACTURIDAE - Tropical Burnet Moths

73. SOMABRACHYIDAE - Mediterranean Flannel Moths

74. MEGALOPYGIDAE - Flannel Moths

Aidinae
 Megalopyginae
 Trosiinae

Section COSSINA**Subsection COSSINA****COSSOIDEA****Series Cossiformes**

75. COSSIDAE - Carpenterworm Moths

Chilecomadiinae
 Hypoptinae
 Cossulinae
 Cossinae
 Zeuzerinae

76. DUDGEONEIDAE - Dudgeon Carpenterworm Moths

77. METARBELIDAE - Tropical Carpenterworm Moths

Series Limacodiformes

78. CYCLOTORNIDAE - Australian Parasite Moths

79. EPIPYROPIDAE - Planthopper Parasite Moths

Epipyropinae
 Heteropsychinae

80. DALCERIDAE - Tropical Slug Caterpillar Moths

Acraginae
 Dalcerinae

81. LIMACODIDAE - Slug Caterpillar Moths

82. CHRYSOPOLOMIDAE - African Slug Caterpillar Moths

Ectropinae
 Chrysopolominae

CASTNIOIDEA

83. CASTNIIDAE - Giant Butterfly Moths

Synemoninae
 Neocastniinae

Castniinae

Castniini
 Gazerini

TORTRICOIDEA

84. TORTRICIDAE - Leafroller Moths

Tortricinae

Phricanthini
 Schoenotenini
 Cnephasiini
 Cochylini
 Euliini
 Tortricini
 Ceracini
 Archipini
 Epitimyriini
 Atteriini
 Niasomini
 Sparganothini

Chlidanotinae

Polyorthini
 Hilarographini
 Chlidanotini

Olethreutinae

Gatesclarkeaniini
 Bactrini
 Microcorsini
 Olethreutini
 Eucosmini
 Grapholithini

Subsection BOMBYCINA**CALLIDULOIDEA**

85. RATARDIDAE - Oriental Parnassian Moths

86. PTEROTHYSANIDAE - Parnassian Moths

Pterothysaninae
 Hibridinae

87. CALLIDULIDAE - Old World Butterfly Moths

Griveaudiinae
 Callidulinae

URANIOIDEA

88. EPICOPEIIDAE - Oriental Swallowtail Moths

Schistomitridinae
 Epicopeiinae

89. APOPROGONIDAE - African Skipper Moths

90. SEMATURIDAE - American Swallowtail Moths

91. URANIIDAE - Swallowtail Moths

Uraniinae
 Microniinae

92. EPIPLEMIDAE - Crenulate Moths

Auzeinae
 Epipleminae

GEOMETROIDEA

93. GEOMETRIDAE - Geometer Moths

Archiearinae
 Oenochrominae
 Alsophilini
 Oenochromini
 Diptychini
 Ametridini

Orthostixinae
 Ennominae

Abraxini
 Cassymini
 Eutoeini

Semiothisini
 Boarmiini
 Apochimina
 Wilemaniina
 Phaseliina
 Gnophina
 Angeronina
 Bupalina
 Cystidiina
 Desertobiina
 Cheimoptenina
 Boarmiina
 Melanchroiini
 Melanolophiini
 Bistonini
 Bistonina
 Erranina
 Milioniini
 Obeidiini
 Diptychini
 Anagogini
 Scardamiini
 Baptini
 Plutodini
 Sphacelodini
 Emplociini
 Lithini
 Palyadini
 Caberini
 Theriini
 Epionini
 Colotoini
 Onychorini
 Prosoplophini
 Azelinini
 Odontoperini
 Thinopterygini
 Nacophorini
 Gonodontini
 Oxydiini
 Campaeini
 Ennomini
 Epiranthini
 Ourapterygini
 Desmobathrinae
 Eumeleini
 Desmobathrini
 Geometrinae
 Dysphaniini
 Geometrini
 Pseudoterpnina
 Geometrina
 Timandromorphina
 Neohipparchina
 Aracimina
 Nemoriina
 Rhomboristina
 Lophochoristina
 Comibaenina
 Synchlorigina
 Hemitheina
 Microloxiina
 Hierochthoniina
 Dichordophorina
 Sterrhinae
 Sterrhini
 Scopulini
 Cyllopodini
 Rhodostrophini
 Cosymbiini
 Timandrini

Rhodometrini
 Larentiinae
 Trichopterygini
 Lythriini
 Cataclysmiini
 Xanthorhoini
 Larentiini
 Hydriomenini
 Stamnodini
 Cidariini
 Operophterini
 Athenini
 Phileremini
 Rheumapterini
 Solitaneini
 Melanthiini
 Perizomini
 Eudulini
 Eupitheciini
 Chesiadini

94. HEDYLIDAE - American Butterfly Moths

PAPILIONOIDEA**Series Hesperiiiformes**

95. HESPERIIDAE - Skipper Butterflies

Coeliadinae
 Pyrrhopyginae
 Pyrrhopygini
 Passovini
 Oxynetrini
 Zoniini
 Pyrginae
 Eudamini
 Pyrgini
 Trapezitinae
 Heteropterinae
 Megathyminae
 Aegialini
 Agathymini
 Megathymini
 Hesperinae

Series Papilioniformes

96. PAPILIONIDAE - Swallowtail Butterflies

Baroniinae
 Parnassiinae
 Parnassiini
 Zerynthiini
 Papilioninae
 Troidini
 Battina
 Troidina
 Leptocercini
 Graphiina
 Leptocercina
 Teinopalpini
 Papilionini

97. PIERIDAE - Yellow-White Butterflies

Pseudopontiinae
 Dismorphiinae
 Leptideini
 Dismorphiini
 Pierinae
 Pierini
 Anthocharidini
 Coliadinae
 Colotini
 Coliadini
 Gonepterygini

98. LYCAENIDAE - Gossamer-Winged Butterflies

Lipteninae
 Pentilini
 Liptenini
 Poritiinae
 Liphyrinae
 Miletinae
 Spalgini
 Lachnocnemini
 Miletini
 Tarakina
 Miletina
 Curetinae
 Lycaeninae
 Theclinae
 Eumaeini
 Eumaeina
 Tomarina
 Deudorigina
 Luciini
 Theclini
 Ogyrina
 Arhopalina
 Theclina
 Zesiini
 Amblypodini
 Aphnaeini
 Iolaini
 Iolaina
 Remelanina
 Hypolycaenina
 Horagini
 Oxylidina
 Hypotheclina
 Catapaecilmatina
 Loxurina
 Horagina
 Cheritrina
 Polyommatainae
 Lycaenesthina
 Candalidini
 Polyommadini
 Zizeerina
 Lampidina
 Everina
 Lycaenopsina
 Scolitantidina
 Polyommatina
 Niphandina

99. RIODINIDAE - Metalmark Butterflies

Styginae
 Hamearinae
 Euselasiinae
 Corrachiinae
 Riodininae
 Mesosemiini
 Mesosemiina
 Napaecina
 Eurybiini
 Riodinini
 Symmachini
 Charitini
 Helicopini
 Emesini
 Nymphidiini
 Aricorina
 Lemoniadinina
 Nymphidiina
 Theopina
 Stalachtini

100. LIBYTHEIDAE - Snout Butterflies

101. NYMPHALIDAE - Brush-Footed Butterflies

Group Nymphaliniina
 Tellervinae
 Danaina
 Danaini
 Amaurina
 Danaina
 Euploeini
 Euploeina
 Ideina
 Lycoreini
 Itunina
 Lycoreina
 Ithomiinae
 Tithoreini
 Melinaeini
 Mechanitini
 Napeogenini
 Ithomiini
 Oleriini
 Dircennini
 Godyridini
 Acraeinae
 Acraeini
 Pardopsini
 Heliconiinae
 Argynniini
 Heliconiini
 Nymphalinae
 Coeini
 Nymphalini
 Kallimini
 Melitaeini
 Euphydryina
 Melitaeina
 Phyciodina
 Neptini
 Pseudergolini
 Euthaliini
 Catagrammini
 Limenitidini
 Cyrestidini
 Biblidini
 Biblidina
 Eurytelina
 Epicaliina
 Ageroniina
 Epiphilina
 Eubagina
 Callicorina
 Group Satyriniina
 Calinaginae
 Apaturinae
 Apaturini
 Charaxini
 Anaeini
 Zaretini
 Preponini
 Prothoini
 Amathusiinae
 Morphinae
 Antirrheini
 Morphini
 Brassolini
 Biini
 Brassolini
 Naropini
 Satyrinae
 Lethini
 Satyrini
 Pronophilina

Maniolina
 Erebiina
 Hypocystina
 Euptychiina
 Coenonymphina
 Melanargiina
 Satyrina
 Hipparchiina
 Melanitini
 Haeterini
 Elymniini
 Parargina
 Elymniina
 Mycalesini
 Ypthimini

DREPANOIDEA

102. AXIIDAE - Gold Moths
 103. THYATIRIDAE - False Owlet Moths

Thyatirinae
 Thyatirini
 Habrosynini
 Macrothyatirini
 Tetheini

Polyplocinae
 Ceranemotini
 Polyplocini

104. CYCLIDIIDAE - Giant Hooktip Moths
 105. DREPANIDAE - Hooktip Moths

Drepaninae
 Drepanini
 Cilicini

Oretinae
 Nidarinae

BOMBYCOIDEA**Series Bombyciformes**

106. CARTHAEIDAE - Australian Silkworm Moths
 107. EUPTEROTIDAE - Giant Lappet Moths

Janinae
 Eupterotinae
 Panacelinae

108. APATELODIDAE - American Silkworm Moths

Apatelodinae
 Epiinae
 Phiditiinae

109. BOMBYCIDAE - Silkworm Moths

Bombycinae
 Prismostictinae

110. MIMALLONIDAE - Sackbearer Moths

111. ANTHELIDAE - Australian Lappet Moths

Munychryiinae
 Anthelinae

112. LASIOCAMPIDAE - Lappet Moths

Chondrosteginae
 Chionopsychinae
 Poecilocampinae
 Macromphaliinae
 Lasiocampinae
 Gonometini
 Gastropachini
 Lasiocampini
 Malacosomatini

Series Saturniiformes

113. ENDROMIDAE - Glory Moths

Endrominae
 Mirininae

114. LEMONIIDAE - Autumn Silkworm Moths
 Lemoniinae

- Sabaliinae
 115. BRAHMAEIDAE - Brahmin Moths
 Dactyloceratinae
 Brahmaeinae

116. OXYTENIDAE - Tropical American Silkworm Moths

117. CERCOPHANIDAE - Andean Moon Moths

Cercophaninae
 Janiodinae

118. SATURNIIDAE - Emperor Moths

Arsenurinae
 Arsenurini
 Almeidaiini
 Ceratocampinae
 Hemileucinae
 Hemileucini
 Polythysanini

Agliinae
 Ludiinae
 Salassinae
 Saturniinae
 Saturniini
 Attacini
 Urotini

SPHINGOIDEA

119. SPHINGIDAE - Hawk Moths

Sphinginae
 Acherontiini
 Sphingini
 Smerinthinae
 Sphingulini
 Ambulycini
 Smerinthini

Macroglossinae
 Dilophonotini
 Philampelini
 Macroglossini

NOCTUOIDEA

120. NOTODONTIDAE - Prominent Moths

Group Oenosandrinina
 Oenosandrinae
 Group Thaumatopoeinina
 Thaumatopoeinae
 Group Notodontinina
 Pygaerinae

Pygaerini
 Rosemini

Platychasmatinae
 Notodontinae

Notodontini
 Dicranurini

Phalerinae
 Dudusinae

Dudusini
 Scraanciini

Heterocampinae
 Heterocampini
 Stauropini
 Hemiceratini
 Hapigini
 Hylaeorini
 Desmeocraerini
 Ceirini
 Acrotenini

Nystaleinae
 Meiceratinae

121. DIOPTIDAE - American False Tiger Moths
 Doinae

Dioprinae
 122. THYRETIDAE - African Maiden Moths
 123. LYMANTRIIDAE - Tussock Moths
 Orgyiinae
 Lymantriinae
 Lymantriini
 Euproctidini
 124. ARCTIIDAE - Tiger Moths
 Group Pericopina
 Pericopinae
 Group Arctiinina
 Lithosiinae
 Phryganopterygini
 Acsalini
 Lithosiini
 Eudesmiini
 Cisthenini
 Nudariini
 Endrosini
 Arctiinae
 Callimorphini
 Callimorphina
 Nyctemerina
 Utetheisini
 Arctiini
 Phaegopterini
 Group Ctenuchinina
 Ctenuchinae
 Syntominae
 Syntomini
 Euchromiini
 125. NOCTUIDAE - Owlet Moths
 Group Aganainina
 Aganainae
 Group Herminiinina
 Herminiinae
 Group Noctuinina
 Hypenodinae
 Strepsimanini
 Hypenodini
 Rivulinae
 Hypeninae
 Catocalinae
 Ophiderini
 Pangraptina
 Aventiina
 Ophiderina
 Toxocampina
 Tytina
 Polydesmina
 Aediina
 Catephiina
 Drasteriina
 Euclidiina
 Achaeina
 Ophiusina
 Thysaniina
 Gonopterini
 Anomiini
 Catocalini
 Euteliinae
 Stictopterinae
 Sarothripinae
 Eligmini
 Risobini
 Blenini
 Afridini
 Sarothripini
 Collomenini
 Chloephorinae
 Westermanniini

Eariadini
 Chloephorini
 Careini
 Camptolomini
 Ariolicini
 Nolinae
 Plusiinae
 Abrostolini
 Argyrogrammatini
 Plusiini
 Autoplusiina
 Euchalciina
 Plusiina
 Acontiinae
 Cydosini
 Eustrotiini
 Eublemini
 Acontiini
 Bagisarini
 Condicinae
 Condicini
 Leuconyctini
 Amphipyridae
 Amphipyridini
 Phosphilini
 Stiriinae
 Psaphidinae
 Psaphidini
 Nocloini
 Triocnemidini
 Feraliini
 Azeniini
 Grotellini
 Agaristinae
 Agaristini
 Eucocytiini
 Cocytiinae
 Heliothinae
 Acronictinae
 Acronictini
 Raphiini
 Pantheinae
 Pantheini
 Dilobini
 Bryophilinae
 Cuculliinae
 Cuculliini
 Xylenini
 Xylenina
 Antitypina
 Oncocnemidini
 Hadeninae
 Apameini
 Eriopini
 Elaphriini
 Hadenini
 Eriopygini
 Glottulini
 Noctuinae
 Agrotini
 Agrotina
 Austrandesiina
 Aniclini
 Noctuini
 Ufeini

INDEX TO FAMILY-LEVEL NAMES

The index includes 1,984 names (including synonyms). Highlighted names are higher category names (above family level) and are capitalized (except for series names). Valid family names are also capitalized, but not highlighted. Synonyms have been added to the index as currently known; these are not noted in the classification listing but can be found in the index with notation to the current correct name (synonyms are all lower case in italics). All names are referred by family number; higher category names are referred to the next listed family number. A large number of subtribal names noted for European Noctuidae by Beck (1999b) are not included herein since the rest of the world is not defined equivalently to subtribal level in this family.

As in all zoological naming, the names are spelled according to specified rules as to endings, although there is irregularity in some of the higher category names: order names end in *-tera*; suborder, cohort, subcohort, infraorder names vary and end in *-tera*, *-ata*, or *-ina*; division names end in *-trysia*; section and subsection names end in *-ina*; superfamily names end in *-oidea*; series names end in *-formes*; family names end in *-idae*; group names end in *-inina*; subfamily names end in *-inae*; tribal names end in *-ini*; and subtribe names end in *-ina* (sometimes written with *-idi* or *-iti* endings). The actual taxon names are modified in some cases due to the spelling of the name-bearing generic-base name that a tribe, subfamily, or family is derived from: the spellings are corrected herein as currently known about (e.g., in Riodinidae, the misformed tribal name *Lemoniini* is corrected to *Lemoniadini* (as already noted in Hall and Heppner, 1999. *Trop. Lepid.*, 10:30) (now *Lemoniadini*), since the generic-base name, *Lemonias*, is different from the name *Lemonia*, in the moth family *Lemoniidae*).

- Abraxinae* (= *Abraxini*), 93
Abraxini (*Geometridae*), 93
Abrostolini (*Noctuidae*), 125
Acanthopsychinae (= *Oiketiciinae*), 27
Acanthopsychini (*Psychidae*), 27
ACANTHOPTEROCTETIDAE, 5
Acanthopteroctetinae (*Acanthopteroctetidae*), 5
Acentriinae (= *Nymphulinae*), 61
Acentropidae (= *Nymphulinae*), 61
Acentropinae (= *Nymphulinae*), 61
Acentropodinae (= *Nymphulinae*), 61
Achaecini (= *Achaecina*), 125
Achaecina (*Noctuidae*), 125
Acherontiinae (= *Sphinginae*), 119
Achinagidae [sic] (= *Oecophoridae*), 34
Acidaliidae (= *Sterrhinae*), 93
Acidaliinae (= *Sterrhinae*), 93
Acidaliini unavail. (= *Scopulini*), 93
Acontiidae (= *Acontiinae*), 125
Acontiinae (*Noctuidae*), 125
Acontini (*Noctuidae*), 125
Acraeidae (= *Acraeinae*), 101
Acraeinae (*Nymphalidae*), 101
Acraeini (*Nymphalidae*), 101
Acraginae (*Dalceridae*), 80
Acriinae (= *Acriini*), 34
Acriini (*Oecophoridae*), 34
Acrobasiina (*Pyrilidae*), 61
ACROLEPIIDAE, 56
ACROLOPHIDAE, 24
Acrolophinae (*Acrolophidae*), 24
Acronictinae (*Noctuidae*), 125
Acronictini (*Noctuidae*), 125
Acronyctidae [sic] (= *Acronictinae*), 125
Acronyctinae [sic] (= *Acronictinae*), 125
Acrotenini (*Notodontidae*), 120
Acsalini (*Arctiidae*), 124
ADELIDAE, 22
Adelinae (*Adelidae*), 22
Adelocephalidae (= *Ceratocampinae*), 118
Adelocephalinae (= *Ceratocampinae*), 118
Adeloidea (= *Incurvarioidae*), 19
Adscitinae (= *Procridae*), 70
Aechmiidae (= *Glyphipterigidae*), 50
Aecophoridae [sic] (= *Oecophoridae*), 34
Aediinae (= *Aediina*), 125
Aedini (= *Aediina*), 125
Aediina (*Noctuidae*), 125
Aegeriidae (= *Sesiidae*), 66
Aegeriinae (= *Sesiinae*), 66
Aegeriini (= *Sesiini*), 66
Aegerioidea (= *Sesioidea*), 65
Aegeroniina (*Nymphalidae*), 101
Aegeroniini (= *Limnitiidini*), 101
Aegialini (*Hesperiidae*), 95
Aeolanthidae (= *Aeolanthini*), 34
Aeolanthinae (= *Aeolanthini*), 34
Aeolanthini (*Oecophoridae*), 34
Afridini (*Noctuidae*), 125
Agalopini (*Zygaenidae*), 70
Aganaiidae (= *Aganainae*), 125
Aganainae (*Noctuidae*), 125
Aganainina (*Noctuidae*), 125
Agapetidae (= *Cochylini*), 84
Agapetinae (= *Satyrini*), 101
Agaristidae (= *Agaristinae*), 125
Agaristinae (*Noctuidae*), 125
Agaristini (*Noctuidae*), 125
AGATHIPHAGIDAE, 2
AGATHIPHAGOIDEA, 2
Agathymini (*Hesperiidae*), 95
Agdistinae (*Pterophoridae*), 64
Agdistopidae [sic] (= *Macropiratinidae*), 46
Ageroniini (= *Ageroniina*), 101
Ageroniina (*Nymphalidae*), 101
Agliinae (*Saturniidae*), 118
AGLOSSATA, 2
Aglossinae (= *Pyrilini*), 61
AGONOXENIDAE, 42
Agonoxeninae (*Agonoxenidae*), 42
Agrophilidae (= *Acontiinae*), 125
Agroterinae (= *Pyrastinae*), 61
Agrotidae (= *Noctuidae*), 125
Agrotini (*Noctuidae*), 125
Agrotina (*Noctuidae*), 125
Aidinae (*Megalopygidae*), 74
Aletinae (= *Scopulini*), 93
Aletini (= *Scopulini*), 93
Almeidaiini (*Saturniidae*), 118
Alsophilinae (= *Alsophilini*), 93
Alsophilini (*Geometridae*), 93
ALUCITIDAE, 46
Amathusiidae (= *Amathusiinae*), 101
Amathusiinae (*Nymphalidae*), 101
Amatidae (= *Ctenuchinae*), 124
Amaurina (*Nymphalidae*), 101
Amathysini (*Lycenidae*), 98
Amblyptiliinae (= *Pterophoridae*), 64
Ambulicini (= *Smerinthini*), 119
Ametridini (*Geometridae*), 93
Amphidasidae (= *Bistonini*), 93
Amphidasini (= *Bistonina*), 93
Amphipyridae (= *Amphipyridinae*), 125
Amphipyridinae (*Noctuidae*), 125
Amphipyryni (*Noctuidae*), 125
Amphisbatidae (= *Amphisbatini*), 34
Amphisbatini (*Oecophoridae*), 34
AMPHITHERIDAE, 29
Amydriinae (*Acrolophidae*), 24
Anacampsidae (= *Anacampsiini*), 38
Anacampsinae (= *Anacampsiini*), 38
Anacampsiini (*Gelechiidae*), 38
Anaeni (*Nymphalidae*), 101
Anagogini (*Geometridae*), 93
Anaphinae (*Thaumetopoeinae*), 120
Anaphoridae (= *Acrolophidae*), 24
Anarsiidae (*Gelechiidae*), 38
Anarsiinae (= *Chelariini*), 38
Anchiniinae (= *Hypercalliini*), 34
Anchyloperidae (= *Tortricinae*), 84
Anchyloperinae (= *Olethreutini*), 84
Ancylolomiini (*Pyrilidae*), 61
ANDESIAIDAE, 14
ANDESIAINOIDEA, 14
Anerastiinae (= *Anerastiini*), 61
Anerastiini (*Pyrilidae*), 61
Angeronini (= *Angeronina*), 93
Angeronina (*Geometridae*), 93
Aniclini (*Noctuidae*), 125
Animulidae (= *Psychidae*), 27
Anomiini (*Noctuidae*), 125
Anomoeotinae (*Zygaenidae*), 70
Anomologidae (= *Anomologini*), 38
Anomologinae (= *Anomologini*), 38
Anomologini (*Gelechiidae*), 38
ANOMOSSETIDAE, 10
Antequerinae (*Cosmopterigidae*), 43
ANTHELIDAE, 111
Anthelinae (*Anthelidae*), 111
Antirrhini (*Nymphalidae*), 101
Anthocharinae (= *Anthocharidini*), 97
Anthocharidini (*Pieridae*), 97
Anthroceridae (= *Zygaenidae*), 70
Anthrocerinae (= *Zygaeninae*), 70
Anthroceroidae (= *Zygaenoidea*), 69
Antitypina (*Noctuidae*), 125
Anuini (= *Ophiurina*), 125
Ancylolomiidae (= *Ancylolomiini*), 61
Ancylolomiinae (= *Ancylolomiini*), 61
Apameidae (= *Apameini*), 125
Apameini (*Noctuidae*), 125
Apatelinae (= *Acronictinae*), 125
APATELODIDAE, 108
Apatelodinae (*Apatelodidae*), 108
Apatetrinae (= *Apatetrini*), 38
Apatetrini (*Gelechiidae*), 38
Apaturidae (= *Apaturinae*), 101
Apaturinae (*Nymphalidae*), 101
Apaturini (*Nymphalidae*), 101
Apeirini (= *Ennomini*), 93
Apheliidae unavail. (= *Bactrini*), 84
Apheliinae unavail. (= *Bactrini*), 84
Apheloseitidae (= *Elachistidae*), 36
Aphnaecini (*Lycenidae*), 98
Aplotinae (= *Coleophorinae*), 40
Apochimini (= *Apochimina*), 93
Apochimina (*Geometridae*), 93
Apodidae (= *Limacodidae*), 81
Apopestini (= *Toxocampina*), 125
APOPROGONIDAE, 89
Aporiinae (= *Pierinae*), 97
Apteroinae (= *Oiketiciinae*), 27
Apteroini (*Psychidae*), 27
Aracimini (= *Aracimina*), 93
Aracimina (*Geometridae*), 93
Arbelidae (= *Metarbelidae*), 77
Archaeobalbina (= *Pseudoterpnina*), 93
Archaeopachinae (= *Metarbelidae*), 77
Archeariinae [sic] (= *Archearinae*), 93
Archearinae (*Geometridae*), 93
Archimeessiinae (= *Dryadaulinae*), 25
Archipini (*Tortricidae*), 84
ARCTIIDAE, 124
Arctiinae (*Arctiidae*), 124
Arctiini (*Arctiidae*), 124
Arctiniina (*Arctiidae*), 124
Argynnidae (= *Argynniini*), 101
Argynniinae (= *Argynniini*), 101
Argynniini (*Nymphalidae*), 101
Argyactini (*Pyrilidae*), 61
ARGYRESTHIDAE, 54
Argyriini (*Pyrilidae*), 61
Argyrogrammatini (*Noctuidae*), 125
Argyroplocini (= *Olethreutini*), 84
Argyropyti (*Thyrididae*), 60
Arhopalina (*Lycenidae*), 98
Aricorina (*Riodinidae*), 99
Ariolicini (*Noctuidae*), 125
Aristotelinae (= *Anomologini*), 38
ARRHENOPHANIDAE, 28
Arsenurinae (*Saturniidae*), 118
Arsenurini (*Saturniidae*), 118
Arttonini (*Zygaenidae*), 70
Ascalaphini (= *Thysaniina*), 125
Ascotinae (= *Boarmiini*), 93
Ascotinae (= *Boarmiina*), 93
Ascotini (= *Boarmiina*), 93
Asemanophorae [sic] (= *Sphinginae*), 119
Asemanophorinae (= *Sphinginae*), 119
Ashinagidae (= *Oecophoridae*), 34
Asopiidae (= *Pyrilidae*), 61
Asopiinae (= *Pyrilini*), 61
Aspilatidae (= *Angeronini*), 93
Aspilatini [sic] (= *Angeronina*), 93
Aspitatini (= *Angeronina*), 93
Asteroscopia (= *Psaphini*), 125
Astheninae (= *Asthenini*), 93
Asthenini (*Geometridae*), 93
Attacidae (= *Saturniidae*), 118
Attacinae (= *Saturniinae*), 118
Attacini (*Saturniidae*), 118
Attacoidae (= *Saturniiformes*), 113
Atteridae [sic] (*Atterini*), 84
Atterini (*Tortricidae*), 84
ATTEVIDAE, 52
Arychidae (= *Brachodidae*), 65
Augasmiidae (= *Coleophoridae*), 40
Austrandiina (*Noctuidae*), 125
Autographini (= *Elachistidae*), 125
Automerinae (= *Hemileucinae*), 118
Autoplusiina (= *Autoplusiina*), 125
Autoplusiina (*Noctuidae*), 125
Autostichidae (= *Autostichinae*), 34
Autostichinae (*Oecophoridae*), 34
Autostichini (*Oecophoridae*), 34
Auzeinae (*Epiplemidae*), 92
Aventiidae (= *Ophiderini*), 125
Aventiini (*Aventiina*), 125
Aventina (*Noctuidae*), 125
AXIIDAE, 102
Axioidae (= *Axiidae*), 102
Azelini (*Geometridae*), 93
Azeniini (*Noctuidae*), 125
Azinidae (= *Ethmiinae*), 34
Bactrini (*Tortricidae*), 84
Bagisarinae (= *Bagisarini*), 125
Bagisarini (*Noctuidae*), 125
Baptini (*Geometridae*), 93
Baroniinae (*Papilionidae*), 96
Batrachedridae (= *Batrachedrinae*), 40
Batrachedrinae (*Coleophoridae*), 40
Batrachedrini (*Coleophoridae*), 40
Battina (*Papilionidae*), 96
Bedelliidae (= *Lyonetiidae*), 55
Bedelliinae (*Lyonetiidae*), 55
Bembecini (= *Synanthedonini*), 66
Beninae (= *Chloephorini*), 125
Biblidina (*Nymphalidae*), 101
Biblidini (*Nymphalidae*), 101
Biblini [sic] (= *Biblidini*), 101
Biini (*Nymphalidae*), 101
Bijuginae (= *Psychinae*), 27
Biselachistini (= *Elachistini*), 36

- Bistoninae* (= *Bistonini*), 93
Bistonini (Geometridae), 93
Blabophaninae (= *Tineidae*), 25
Blabophaninae (= *Tineinae*), 25
BLASTOBASIDAE, 39
Blastobasinae (Blastobasidae), 39
Blastobasini (Blastobasidae), 39
Blastodacnidae (= *Agonoxenidae*), 42
Blastodacninae (Agonoxenidae), 42
Blastodacnini (Agonoxenidae), 42
Blenini (Noctuidae), 125
Boarmiidae (= *Boarmiini*), 93
Boarmiinae (= *Boarmiini*), 93
Boarmiini (Geometridae), 93
Boarmiini (Geometridae), 93
Boletobiidae (= *Ophiderini*), 125
Bolinidae (= *Ophiderini*), 125
Bolorini (= *Argynnini*), 101
BOMBYCIDAE, 109
Bombyciformes, 106
BOMBYCINA, 85
Bombycinae (Bombycidae), 109
BOMBYCOIDEA, 106
Botyidae (= *Pyraustinae*), 61
Botynae (= *Pyraustinae*), 61
Braccini (= *Boarmiina*), 93
Brachmiinae (= *Dichomeridinae*), 38
BRACHODIDAE, 65
Brachodinae (Brachodidae), 65
Bradypodicolinae (= *Chrysauginae*), 61
BRACHMAEIDAE, 115
Brahmaeinae (Brahmaeidae), 115
Brassolidae (= *Brassolinae*), 101
Brassolinae (Nymphalidae), 101
Brassolini (Nymphalidae), 101
Brenthiinae (Choreutidae), 68
Bryoleucini (= *Bryophilinae*), 125
Bryophilidae (= *Bryophilinae*), 125
Bryophilinae (Noctuidae), 125
BUCCULATRICIDAE, 32
Bucculatrigenidae [sic] (= *Bucculatricidae*), 32
Bupalini (= *Bupalina*), 93
Caberidae (= *Caberini*), 93
Caberini (Geometridae), 93
Cacochroini (= *Cacochroina*), 34
Cacochroina (Oecophoridae), 34
Cacocinae (= *Tortricinae*), 84
Cacociini (= *Tortricini*), 84
Cacotherapiini (Pyralidae), 61
Calamini (= *Apameini*), 125
Calinaginae (Nymphalidae), 101
Callicorina (Nymphalidae), 101
Callidryinae (= *Gonepterygini*), 97
Callidryini (= *Gonepterygini*), 97
CALLIDULIDAE, 87
Callidulinae (Callidulidae), 87
CALLIDULOIDEA, 85
Callimorphidae (= *Callimorphini*), 124
Callimorphinae (= *Callimorphini*), 124
Callimorphini (Arctiidae), 124
Callimorphina (Arctiidae), 124
Callizygaeninae (Zygaenidae), 70
Callophryini (= *Theclini*), 98
Caloptiliidae (= *Gracillariidae*), 33
Caloptiliinae (= *Gracillariinae*), 33
Calothysanini (= *Timandrinini*), 93
Calpidae (= *Ophiderini*), 125
Calpini (= *Ophiderini*), 125
Campaeini (Geometridae), 93
Campotomini (Noctuidae), 125
Canephoridae (= *Psychidae*), 27
Canephorinae (= *Oiketiciinae*), 27
Caradrinidae (= *Hadeninae*), 125
Carcinidae (= *Carcinini*), 34
Carcininae (= *Carcinini*), 34
Carcinini (Oecophoridae), 34
Careini (Noctuidae), 125
Carpocapsidae (= *Grapholitini*), 84
Carpocapsinae (= *Grapholitini*), 84
CARPOSINIDAE, 47
Carterocephalinae (= *Heteropterinae*), 95
CARTHAEDIAE, 106
Cassymini (Geometridae), 93
CASTNIIDAE, 83
Castniinae (Castniidae), 83
Castmini (Castniidae), 83
CASTNIOIDEA, 83
Cataclymini (Geometridae), 93
Catagrammini (Nymphalidae), 101
Catapaeicilmatina (Lycanidae), 98
Catapterigidae (= *Catapteriginae*), 5
Catapteriginae (Acanthopteroctetidae), 5
Catephiidae (= *Catephiina*), 125
Catephiini (= *Catephiina*), 125
Catephiina (Noctuidae), 125
Catharinae (= *Odontinae*), 61
Catharini (Pyralidae), 61
Catocalidae (= *Catocalinae*), 125
Catocalinae (Noctuidae), 125
Catocalini (Noctuidae), 125
Catopyrrhinae (= *Caberini*), 93
Catopyrrhinae (= *Caberini*), 93
Catopyrrhini (= *Caberini*), 93
Cecidosetidae [sic] (= *Cecidosidae*), 20
CECIDOSIDAE, 20
Cedestinae (Yponomeutidae), 53
Ceirini (Notodontidae), 120
Celastrini (= *Everina*), 98
Cemistomidae (= *Lyonetiidae*), 55
Cemistominae (Lyonetiidae), 55
Ceracidae (= *Ceracini*), 84
Ceracini (Tortricidae), 84
Ceranemotini (Thyatiridae), 103
Ceratocampidae (= *Ceratocampinae*), 118
Ceratocampinae (Saturniidae), 118
CERCOPHANIDAE, 117
Cercophaninae (Cercophanidae), 117
Cerostominae (= *Ypsolophinae*), 51
Cerurinae (= *Dicranurini*), 120
Ceuthomadariae (Lecithoceridae), 35
Chaerocampini [sic] (= *Macroglossinae*), 119
Chalcosiinae (Zygaenidae), 70
Chalcosiini (Zygaenidae), 70
Chaliinae (= *Psychinae*), 27
Chapmaniidae (= *Eriocraniidae*), 4
Charaxidae (= *Charaxini*), 101
Charaxidinae (Charaxini), 101
Charaxinae (Charaxini), 101
Charaxini (Nymphalidae), 101
Charideinae (Thyrididae), 60
Charitini (Riodinidae), 99
Chaulioididae (= *Epermeniidae*), 48
Cheimatobiini (= *Therini*), 93
Cheimoptenini (= *Cheimoptenina*), 93
Chelariinae (= *Chelariini*), 38
Chelariini (Gelechiidae), 38
Cheloniidae (= *Arctiidae*), 124
Cheritina (Lycanidae), 98
Chesiadinae (= *Chesiadini*), 93
Chesiadini (Geometridae), 93
Chilecomadiinae (Cossidae), 75
Chilonidae (= *Chilonini*), 61
Chiloninae (= *Chilonini*), 61
Chilonini (Pyralidae), 61
Chimabacchidae [sic] (= *Chimabachinae*), 34
Chimabachidae (= *Chimabachinae*), 34
Chimabachinae (Oecophoridae), 34
Chimabachini (Oecophoridae), 34
Chimatophilidae (= *Tortricini*), 84
Chionopsychinae (Lasiocampidae), 112
Chlidanotinae (= *Chlidanotini*), 84
Chlidanotinae (Tortricidae), 84
Chlidanotini (Tortricidae), 84
Chloephorinae (Noctuidae), 125
Chloephorini (Noctuidae), 125
Chlorochromidae (= *Geometrinini*), 93
Chlorochrominae (= *Geometrininae*), 93
Chlorochromini (= *Hemitheina*), 93
Choerocampinae (= *Macroglossinae*), 119
Chondrosteginae (Lasiocampidae), 112
CHOREUTIDAE, 68
Choreutinae (Choreutidae), 68
Choreutoidea (= *Sesiioidea*), 65
Chrysaugidae (= *Chrysauginae*), 61
Chrysauginae (Pyralidae), 61
Chrysoesthiidae (Gelechiidae), 38
Chrysopeliidae (= *Chrysopeliinae*), 43
Chrysopeliinae (Cosmopterigidae), 43
Chrysopelioidae (= *Gelechioidea*), 34
Chrysophaninae (= *Lycaninae*), 98
Chrysophanini (= *Lycaninae*), 98
CHRYSOPOLOMIDAE, 82
Chrysopolominae (Chrysopolomidae), 82
Cidaridae (= *Cidariini*), 93
Cidarinae (= *Cidariini*), 93
Cidariini (Geometridae), 93
Cilicidae (= *Cilicini*), 105
Cilicini (Drepanidae), 105
Cimeliidae (= *Axiidae*), 102
Cingilini (= *Ennomini*), 93
Cissuvorini (Sesiidae), 66
Cisthenini (Arctiidae), 124
Citheroniidae (= *Ceratocampinae*), 118
Citheroniinae (= *Ceratocampinae*), 118
Cledeobinae (= *Pyralinae*), 61
Cleophanini unavail. (= *Oncocnemidini*), 125
Cleorini (= *Boarmiina*), 93
Cnephasiidae (= *Cnephasiini*), 84
Cnephasiini (Tortricidae), 84
Cnethocampinae (Thaumetopoeinae), 120
Cochlididae (= *Limacodidae*), 81
Cochlididae (= *Limacodidae*), 81
Cochliopodi unavail. (= *Limacodidae*), 81
Cochylidae (= *Cochylini*), 84
Cochylini (Tortricidae), 84
Cocytinae (Noctuidae), 125
Coeni (Nymphalidae), 101
Coeliadinae (Hesperiidae), 95
Coelopoetidae (= *Elachistinae*), 36
Coelopoetinae (Elachistidae), 36
Coenonymphinae (= *Satyrini*), 101
Coenonymphini (= *Coenonymphina*), 101
Coenonymphina (Nymphalidae), 101
COLEOPHORIDAE, 40
Coleophorinae, 40
Coleophoroidea (= *Gelechioidea*), 34
Coliadidae (= *Coliadinae*), 97
Coliadinae (Pieridae), 97
Coliadini (Pieridae), 97
Collomenini (Noctuidae), 125
Coloburini (= *Coeini*), 101
Colotini (Pieridae), 97
Colotoini (Geometridae), 93
Comibaenini (= *Comibaenina*), 93
Comibaenina (Geometridae), 93
Commophiliidae (= *Cochylini*), 84
Comostolini (= *Hemitheina*), 93
Compsoctenidae (= *Compsocteninae*), 26
Compsocteninae (Eriocottidae), 26
Compsopterini (= *Proposopolini*), 93
Conchylidae [sic] (= *Cochylini*), 84
Condicinae (Noctuidae), 125
Condicini (Noctuidae), 125
COPROMORPHIDAE, 45
COPROMORPHOIDEA, 45
Corachiinae (Riodinidae), 99
Cosmiidae (= *Hadeninae*), 125
Cosmiinae (= *Hadeninae*), 125
Cosmiotini (= *Elachistini*), 36
Cosmodesmids (= *Leptocircini*), 96
COSMOPTERIGIDAE, 43
Cosmopteriginae (Cosmopterigidae), 43
Cosmopterigoidea (= *Gelechioidea*), 34
Cosmopterigidae [sic] (= *Cosmopterigidae*), 43
COSSIDAE, 75
Cossiformes, 75
COSSINA, 75
Cossinae (Cossidae), 75
COSSOIDEA, 75
Cossulinae (Cossidae), 75
Cosymbiinae (= *Cosymbiini*), 93
Cosymbiini (Geometridae), 93
Crambinae (Pyralidae), 61
Crambini (Pyralidae), 61
Crambina (Pyralidae), 61
Crinopterygidae (= *Crynopteryginae*), 19
Crynopteryginae (Incurvariidae), 19
Crocullini (= *Ennomini*), 93
Cryptoblabini (Pyralidae), 61
Cryptolechiidae (= *Cryptolechiini*), 34
Cryptolechiini (Oecophoridae), 34
Cryptolechiina (Oecophoridae), 34
Cryptophasidae (= *Oecophoridae*), 34
Cryptopyrrhini [sic] (= *Caberini*), 93
Ctenuchidae (= *Ctenuchinae*), 124
Ctenuchinae (Arctiidae), 124
Ctenuchina (Arctiidae), 124
Cucullidae (= *Cuculliinae*), 125
Cuculliinae (Noctuidae), 125
Cuculliini (Noctuidae), 125
Curetinae (Lycanidae), 98
Cyanirini (= *Polyommata*), 98
Cybalominae (Pyralidae), 61
CYCLIDIIDAE, 104
Cyclopedinae [sic] (Heteropterinae), 95
Cyclophoridae (= *Cosymbiini*), 93
Cyclophorini (= *Cosymbiini*), 93
Cyclophorinae nom. oblit. (Heteropterinae), 95
CYCLOTORNIDAE, 78
Cynodiidae (= *Elachistidae*), 36
Cynodioidae (= *Gelechioidea*), 34
Cydosiini (Noctuidae), 125
Cynodidae [sic] (= *Elachistidae*), 36
Cyllopodidae (= *Cyllopodini*), 93
Cyllopodini (Geometridae), 93
Cymatophoridae (= *Thyatiridae*), 103
Cyrestidini (Nymphalidae), 101
Cyrestini [sic] (= *Cyrestidini*), 101
Cystidiini (= *Cystodiina*), 93
Cystidiina (Geometridae), 93
DACNONYPHA, 4
Dactyloceratinae (Brahmaeidae), 115
Dahlicini (Psychidae), 27
DALCERIDAE, 80
Dalcerinae (Dalceridae), 80
Daliminae (= *Boarmiini*), 93
Dalimini (= *Boarmiina*), 93
Danaidae (= *Danainae*), 101
Danainae (Nymphalidae), 101
Danaini (Nymphalidae), 101
Danaina (Nymphalidae), 101
Danaoidea (= *Danainae*), 101
Dasyceridae (= *Oecophoridae*), 34
Dasycerinae (= *Oecophoridae*), 34
Dasychiridae (= *Lymantiridae*), 123
Dasydiini (= *Gnophina*), 93
Deiliniinae (= *Caberini*), 93
Deiliniini (= *Caberini*), 93
Dendroneurinae (= *Hieroxestinae*), 25
Dendroneurinae (= *Tineidae*), 25
Denisiina (Oecophoridae), 34
Denisiini (= *Denisiina*), 34
Deoclonidae (= *Deoclonini*), 34
Deoclonini (Oecophoridae), 34
Depressariidae (= *Depressariinae*), 34
Depressariinae (Oecophoridae), 34
Depressariini (Oecophoridae), 34
Depressariina (Oecophoridae), 34
Desertobiini (= *Desertobiina*), 93
Desertobiina (Geometridae), 93
Desmoeaerini (Notodontidae), 120
Desmobathrinae (Geometridae), 93
Desmobathrini (Geometridae), 93
Deudorigina (Lycanidae), 98
Deuterocopinae (Pterophoridae), 64
Deuterogoniinae (Oecophoridae), 34
Deuterogoniini (Oecophoridae), 34
Deuteroteneidae (= *Eriocottinae*), 26
Deuteroteneinae (= *Eriocottinae*), 26
Dichocrociinae (= *Pyraustinae*), 61
Dichogaminae (= *Dichogamini*), 61
Dichogamini (Pyralidae), 61
Dichomeridae (= *Dichomeridinae*), 38
Dichomeridinae (Gelechiidae), 38
Dichomerinae [sic] (= *Dichomeridinae*), 38
Dichomerisinae [sic] (= *Dichomeridinae*), 38
Dichopinae (= *Psaphidinae*), 125
Dichordophorini (= *Dichordophorina*), 93
Dichordophorina (Geometridae), 93
Dicranurini (Notodontidae), 120
Dilobidae (= *Dilobini*), 125
Dilobinae (= *Dilobini*), 125
Dilobini (Noctuidae), 125
Dilophonotidae (= *Dilophonotini*), 119
Dilophonotinae (= *Dilophonotini*), 119
Dilophonotini (Sphingidae), 119
DIPTIDAE, 121
Diopinae (Diopidae), 121
Diphtherinae (= *Pantheinae*), 125
Diplodomidae (= *Psychidae*), 27
Diplodominae (= *Taleporinae*), 27
Diplosaridae (= *Cosmopterigidae*), 43
Diptychinae (= *Diptychini*), 93
Diptychini (Geometridae), 93
Diptychini (Geometridae), 93
Diptychophorini (Pyralidae), 61
Dircenini (Nymphalidae), 101
Dirrhidae [sic] (= *Hemileucinae*), 118
Dirrhinae (= *Hemileucinae*), 118

- Dismorphiinae (Pieridae), 97
 Dismorphiini (Pieridae), 97
Dissoctenidae (= Psychidae), 27
Dissocteninae (= Penestoglossinae), 27
 Dissoctenioidini (Psychidae), 27
DITRYZIA, 24
Diurninae (= Chimabachinae), 34
Diurnidae (= Chimabachinae), 34
Divianini (= Phycitini), 61
 Doinae (Dipteridae), 121
Doritinae (= Parnassinae), 96
 DOUGLASIIDAE, 31
Drasteriini (= Drasteriinae), 125
 Drasteriina (Noctuidae), 125
 DREPANIDAE, 105
 Drepaninae (Drepanidae), 105
DREPAENOIDEA, 102
 Dryadulinae (Tineidae), 25
Dryocampinae (= Ceratocampinae), 118
Dryocampini (= Ceratocampinae), 118
 DUDGEONEIDAE, 76
 Dudusinae (Notodontidae), 120
 Dudusini (Notodontidae), 120
Dysphaniinae (= Dysphaniini), 93
 Dysphaniini (Geometridae), 93
 Eariadini (Noctuidae), 125
Ectomyelisinini (= Phycitini), 61
 Ectropinae (Chrysopolomidae), 82
 ELACHISTIDAE, 36
 Elachistinae (Elachistidae), 36
 Elachistini (Elachistidae), 36
Elachistoidea (= Gelechioidea), 34
Elaphriinae (= Elaphriini), 125
 Elaphriini (Noctuidae), 125
 Eligmini (Noctuidae), 125
Elymniinae (= Elymniini), 101
 Elymniini (Nymphalidae), 101
Elymniini (= Elymniinae), 101
 Elymniina (Nymphalidae), 101
 Emesini (Riodinidae), 99
Emmeliinae (= Acontinae), 125
Empedopsychinae (= Oiketecinae), 27
Emploctidae (= Ennominae), 93
 Emploctini (Geometridae), 93
Emydiidae (= Arctiidae), 124
Endotherini (= Bactrini), 84
Endotrichinae (= Endotrichini), 61
 Endotrichini (Pyralidae), 61
 ENDROMIDAE, 113
Endromididae (= Endromidae), 113
 Endrominae (Endromidae), 113
Endrosinae (= Endrosini), 124
 Endrosini (Arctiidae), 124
Enicostominae (= Depressariinae), 34
 Ennomidae (= Ennominae), 93
 Ennominae (Geometridae), 93
 Ennomini (Geometridae), 93
Ennychiidae (= Pyraustinae), 61
Ennychiinae (= Pyraustinae), 61
Entephrinae (= Larentiini), 93
 Eotaleporini (Psychidae), 27
 EPERMENIDAE, 48
 Epermeniinae (Epermeniidae), 48
Ephestiini (= Phycitini), 61
Ephyridae (= Cosymbiini), 93
Ephyriini unavail. (= Cosymbiini), 93
Epialidae [sic] (= Hepialidae), 12
Epibleminae (= Eucosmini), 84
 Epicaliina (Nymphalidae), 101
Epicaliini (= Limenitidini), 101
Epichnopterigidae (= Psychidae), 27
Epichnopteriginae (= Psychinae), 27
Epichnopterigidae [sic] (= Psychidae), 27
Epichnopteriginae [sic] (= Psychinae), 27
Epichnopterigini (Psychidae), 27
Epichnopterigidae [sic] (= Psychidae), 27
Epichnopterigidae (= Heterogynidae), 69
Epicominae (Thaumetopoeinae), 120
 EPICOPEIIDAE, 88
 Epicopeinae (Epicopeidae), 88
Epigraphiidae (= Epigraphiinae), 34
Epigraphiinae (= Depressariinae), 34
Epigraphiini (= Epigraphiinae), 34
 Epigraphiina (Oecophoridae), 34
 Epiinae (Apatelodidae), 108
 Epimartini (Coleophoridae), 40
Epinephelini (= Maniolinae), 101
 Epionidae (= Epionini), 93
 Epionini (Geometridae), 93
 Epipaschiinae (Pyralidae), 61
 Epiphilina (Nymphalidae), 101
Epiplemidae (= Eucosmini), 84
 EPIPLEMIDAE, 92
 Epibleminae (Epiplemidae), 92
 EPIPYROPIDAE, 79
 Epipyropinae (Epipyropidae), 79
 Epiranthini (Geometridae), 93
Epirrhoinae (= Xanthorhoini), 93
Episemidae (= Oncocnemidini), 125
 Epitimyrini (Tortricidae), 84
Eranninae (= Bistonini), 93
Erannini (= Eranninae), 93
Erastrinae [sic] (= Acontinae), 125
Erastridae (= Acontinae), 125
Erastrinae (= Acontinae), 125
Erastrinae (= Caberini), 93
Erastrini (= Caberini), 93
Erebidae (= Catocalinae), 125
 Erebiina (Nymphalidae), 101
Erebiinae [sic] (= Catocalinae), 125
Erebiinae (= Satyrini), 101
Erebiini (= Erebiinae), 101
Erebiniae (= Catocalinae), 125
Erechthiidae (= Erechthiinae), 25
 Erechthiinae (Tineidae), 25
Eriocephalidae (= Micropterigidae), 1
 ERIOCOTTIDAE, 26
 Eriocottinae (Eriocottidae), 26
Eriocraniidae [sic] (= Eriocraniidae), 4
 ERIOCRANIIDAE, 4
ERIOCRANIOIDEA, 4
Eriopidae (= Eriopini), 125
 Eriopini (Noctuidae), 125
 Eriopygini (Noctuidae), 125
 Erupini (Pyralidae), 61
Erycinidae (= Riodinidae), 99
Erycininae (= Riodinidae), 99
Eryninae (= Pyrginae), 95
Ethmiidae (= Ethmiinae), 34
 Ethmiinae (Oecophoridae), 34
Etimonotrysia (= Tischerioidea), 17
 Eubagina (Nymphalidae), 101
Eubleminae (= Eublemini), 125
 Eublemini (Noctuidae), 125
Euboliidae (= Xanthorhoini), 93
Euboliinae (= Xanthorhoini), 93
Eubolini (= Xanthorhoini), 93
Eubyinae (= Bistonini), 93
Eubyini (= Bistoninae), 93
Eucestidae (= Gracillariidae), 33
Euchalcinae (= Euchalcinae), 125
 Euchalcina (Noctuidae), 125
Eucheliidae (= Arctiidae), 124
Euchloini (= Anthocharini), 97
Euchloini (= Anthocharini), 97
Euchlorini (= Comibaeninae), 93
Euchromiinae (= Euchromiini), 124
 Euchromiini (Arctiidae), 124
Euclostinae (= Pyraustinae), 61
Eucleidae (= Limacodidae), 81
Euclidiidae (= Euclidiinae), 125
Euclidiini (= Euclidiinae), 125
 Euclidiina (Noctuidae), 125
Eucnemidophorinae (= Pterophorinae), 64
 Eucocytiini (Noctuidae), 125
Eucosmidae (= Eucosmini), 84
Eucosminae (= Eucosmini), 84
 Eucosmini (Tortricidae), 84
 Eudamini (Hesperiidae), 95
 Eudesmiini (Arctiidae), 124
 Eudoniini (Pyralidae), 61
 Eudulini (Geometridae), 93
Eulechriidae [sic] (= Oecophoridae), 34
Eulechriidae (= Oecophoridae), 34
Eulepidoptera (= Heteroneura), 15
 Euliini (Tortricidae), 84
 Eumacini (Lycanidae), 98
 Eumacina (Lycanidae), 98
Eumeleinae (= Eumeleini), 93
 Eumeleini (Geometridae), 93
Eumeninae (= Satyrini), 101
 Euphydryina (Nymphalidae), 101
Euphydryini (= Melitaeini), 101
Euphyiini (= Xanthorhoini), 93
Eupistidae (= Coleophoridae), 40
Eupitheciinae (= Eupitheciini), 93
 Eupitheciini (Geometridae), 93
Euplocamidae (= Euplocaminae), 25
 Euplocaminae (Tineidae), 25
 Euploeini (Nymphalidae), 101
 Euploeina (Nymphalidae), 101
 Euproctidini (Lymantriidae), 123
 EUPTEROTIDAE, 107
 Eupterotinae (Eupterotidae), 107
 Euptychiina (Nymphalidae), 101
Eurhipidae (= Euteliinae), 125
Eurhipiinae (= Euteliinae), 125
Eurrhypinae (= Eurrhypini), 61
 Eurrhypini (Pyralidae), 61
 Eurybiini (Riodinidae), 99
 Eurytelina (Nymphalidae), 101
Eurytelini (= Limenitidini), 101
Eurythmasini (= Phycitini), 61
Euschmididae (= Dysphaniini), 93
Euschmini (= Dysphaniini), 93
 Euselasinae (Riodinidae), 99
Eustrotiidae (= Eustrotiini), 125
 Eustrotiini (Noctuidae), 125
Eustrotiini (= Eublemini), 125
 Eutelinae (Noctuidae), 125
 Euthaliini (Nymphalidae), 101
Euthalini [sic] (= Euthaliini), 101
 Eutoeni (Geometridae), 93
Euxoinae (= Noctuidae), 125
Euzopherini (= Phycitini), 61
 Evergestinae (Pyralidae), 61
 Evergestini (Pyralidae), 61
Everinae (= Everinae), 98
Everini (= Everinae), 98
 Everina (Lycanidae), 98
Exapatidae (= Cnephasiini), 84
EXOPORIA, 8
Falkovitshiinae (= Coleophorinae), 40
 Feraliini (Noctuidae), 125
Fernaldellinae (= Semiothisini), 93
Fernaldellini (= Semiothisini), 93
Fidoniidae (= Boarmiini), 93
Fidoniinae (= Boarmiini), 93
Fidoniini (= Boarmiinae), 93
Fumariinae (= Psychinae), 27
Fumeidae (= Psychidae), 27
Fumeinae (= Psychinae), 27
 Galacticinae (Urodidae), 67
Galleriidae (= Galleriinae), 61
 Galleriinae (Pyralidae), 61
 Galleriini (Pyralidae), 61
 Gastropachini (Lasiocampidae), 112
 Gatesclarkeani (Tortricidae), 84
 Gazerini (Castniidae), 83
 GELECHIIDAE, 38
 Gelechiinae (Gelechiidae), 38
 Gelechiini (Gelechiidae), 38
GELECHIOIDEA, 34
 GEOMETRIDAE, 93
 Geometrinae (Geometridae), 93
 Geometrini (Geometridae), 93
 Geometrina (Geometridae), 93
GEOMETROIDEA, 93
 Glaphyriinae (Pyralidae), 61
 Glaphyriini (Pyralidae), 61
Glaucopsychinae (= Scolitantidinae), 98
Glaucopsychini (= Scolitantidinae), 98
GLOSSATA, 4
Glottulidae (Glottulini), 125
Glottulinae (Glottulini), 125
 Glottulini (Noctuidae), 125
 Glyphidocerini (Oecophoridae), 34
 GLYPHIPTERIGIDAE, 50
 Glyphipteriginae (Glyphipterigidae), 50
Glyphipterigidae (= Yponomeutoidea), 49
Glyphipterigidae [sic] (= Glyphipterigidae), 50
Gnophidae (= Boarmiini), 93
Gnophini (= Gnophinae), 93
 Gnophina (Geometridae), 93
 Gnorimoschemini (Gelechiidae), 38
 Godryidini (Nymphalidae), 101
 Gonapterygini (Pieridae), 97
Goniadallini (= Sterrhini), 93
 Gonodontini (Geometridae), 93
 Gonometini (Lasiocampidae), 112
Gonopteridae (= Ophiderinae), 125
 Gonopterini (Noctuidae), 125
Gortynidae (= Eriopini), 125
Gortyninae (= Eriopini), 125
Gracillariidae [sic] (= Gracillariidae), 33
Gracillariidae [sic] (= Gracillariidae), 33
GRACILLARIIDAE, 33
Gracillariiformes, 29
 Gracillariinae (Gracillariidae), 33
Gracillarioidea (= Gracillariiformes), 29
Grallsini (= Saturnini), 118
 Graphiina (Papilionidae), 96
Graphiini (= Graphiinae), 96
Grapholithidae [sic] (= Grapholitini), 84
Grapholithinae [sic] (= Grapholitini), 84
Grapholitinae (= Grapholitini), 84
 Grapholitini (Tortricidae), 84
 Griveaudiinae (Callidulidae), 87
 Grotellini (Noctuidae), 125
 Habrosynini (Thyatiridae), 103
Hadapameini (= Apameini), 125
Hadenidae (= Hadeninae), 125
 Hadeninae (Noctuidae), 125
 Hadenini (Noctuidae), 125
Haemilidae (= Oecophoridae), 34
Haemylidae [sic] (= Oecophoridae), 34
 Haeterini (Nymphalidae), 101
 Haimbachini (Pyralidae), 61
 Hamearinae (Riodinidae), 99
Hamearinae (= Riodinidae), 99
Hapaliinae (= Pyraustinae), 61
 Hapigini (Notodontidae), 120
Haploptilidae (= Coleophoridae), 40
Hapsiferinae (= Hapsiferini), 25
 Hapsiferini (Tineidae), 25
Harmacilonidae (= Harmaciloninae), 25
 Harmaciloninae (Tineidae), 25
Hazidae (= Dysphaniini), 93
Hazini (= Dysphaniini), 93
Heccmeyerinae [sic] (= Psychinae), 27
Heccmeyerinae (= Psychinae), 27
HECCEMEYERIDAE, 94
Hedyloidea (= Hedyliidae), 94
Heliconiidae (= Heliconiinae), 101
 Heliconiinae (Nymphalidae), 101
 Heliconiini (Nymphalidae), 101
 Helicopini (Riodinidae), 99
HELIODINIDAE, 57
Heliotheini [sic] (= Rhomboristinae), 93
Heliotheini (= Rhomboristinae), 93
Heliothelinae (= Heliothelini), 61
 Heliothelini (Pyralidae), 61
Heliothidae (= Heliothinae), 125
Heliothidinae (= Heliothinae), 125
 Heliothinae (Noctuidae), 125
HELIOZOELIDAE, 23
Hemerophilidae (= Choreutidae), 68
Hemiceratinae (= Hemiceratini), 120
 Hemiceratini (Notodontidae), 120
 Hemileucinae (Saturniidae), 118
 Hemileucini (Saturniidae), 118
Hemistolini (= Hemitheinae), 93
Hemithidae (= Hemitheinae), 93
Hemithinae (= Hemitheinae), 93
Hemithini (= Hemitheinae), 93
 Hemitheina (Geometridae), 93
Heodinae (= Lycanidae), 98
Heodininae (= Lycanidae), 98
HEPIALIDAE, 12
HEPIALOIDEA, 9
Hepialidae [sic] (= Hepialidae), 12
Hercynidae (= Hercynini), 61
Hercyninae (= Hercynini), 61
 Hercynini (Pyralidae), 61
Hermiiniidae (= Hermiiniinae), 125
 Hermiiniinae (Noctuidae), 125
 Hermiiniina (Noctuidae), 125
Herrichinae (= Herrichinae), 34
 Herrichini (= Herrichinae), 34
 Herrichina (Oecophoridae), 34
HERPERIIDAE, 95
Hesperiiformes, 95
 Hesperinae (Hesperiidae), 95
Hesperioidea (= Hesperioformes), 95
HETEROBATHMIIDAE, 3
HETEROBATHMIINA, 3
HETEROBATHMIODEA, 3
 Heterocampinae (Notodontidae), 120
 Heterocampini (Notodontidae), 120
Heterogeneidae (= Limacodidae), 81
HETEROGYNIDAE, 69

HETERONEURA, 15

Heteropsychinae (Epipyropidae), 79
 Heteropterinae (Hesperiidae), 95
Hiberniidae [sic] (= Bistonini), 93
Hibridinae (Pterothysanidae), 86
Hibridini (Pterothysanidae), 86
Hierochthoniini (= Hierochthoniina), 93
Hierochthoniina (Geometridae), 77
Hieroxestidae (= Hieroxestinae), 25
Hieroxestinae (Tineidae), 25
Hilarographini (Tortricidae), 84
HIMANTOPTERIDAE, 71
Hipparchiidae (= Satyrinae), 101
Hipparchiini (= Satyrini), 101
Hipparchiini (= Hipparchiina), 101
Hipparchiina (Nymphalidae), 101
Hoffmanniinae (= Yponomeutinae), 53
Holcocerinae (Blastobasidae), 39
Holcogonogonidae (= Symmocini), 34
Hollandiidae (= Metarbelidae), 77
Holocerinae (= Ludiinae), 118
Homalochroinae (= Pyralinae), 61
Homoeosomini (= Phycitini), 61
Homophysidae (= Glaphyrinae), 61
Homophysinae (= Glaphyrinae), 61
Horagini (Lycaenidae), 98
Horagina (Lycaenidae), 98
Hybernini (= Bistonina), 93
HYBLAEIDAE, 59
Hydriomeninae (= Hydriomenini), 93
Hydriomenini (Geometridae), 93
Hydririni (Pyralidae), 61
Hydrocampidae (= Nymphulinae), 61
Hydrocampinae (= Nymphulinae), 61
Hyemidae [sic] (= Oecophoridae), 34
Hylophilinae (= Chloephorinae), 125
Hymentinae (= Pyraustinae), 61
Hypatiminae (= Chelariini), 38
Hypenidae (= Hypeninae), 125
Hypeninae (Noctuidae), 125
Hypenodinae (Noctuidae), 125
Hypenodini (Noctuidae), 125
Hypercallinae (= Hypercalliini), 34
Hypercalliini (Oecophoridae), 34
Hypertrophidae (= Hypertrophinae), 34
Hypertrophinae (Oecophoridae), 34
Hypochrosidae (= Anagogini), 93
Hypochrosini (= Anagogini), 93
Hypocystina (Nymphalidae), 101
Hypogymnidae (= Lymantriidae), 123
Hypolimnini (= Nymphalini), 101
Hypolycaena (Lycaenidae), 98
Hyponomeutidae [sic] (= Yponomeutidae), 53
Hyponomeutinae [sic] (= Yponomeutinae), 53
Hypoptinae (Cossidae), 75
Hypothecina (Lycaenidae), 98
Hypotinae (= Pyralinae), 61
Hysidae (= Aganinae), 125
Hysilophidae [sic] (= Plutellidae), 51
Hysilophinae [sic] (= Ypsolophinae), 51
Hypsotropinae (= Phycitinae), 61
Hypsotropinae (= Peoriini), 61
Hysterosiinae unavail. (= Cochylini), 84
Hysterosiini (= Cochylini), 84
Idaeidae (= Sterrhini), 93
Idaeini (= Sterrhini), 93
Ideina (Nymphalidae), 101
IMMIDAE, 58
Imminae (Immidae), 58
IMMOIDEA, 58
INCURVARIIDAE, 19
INCURVARIINA, 19
Incurvariinae (Incurvariidae), 19
INCURVARIODEA, 19
Infurcitineinae (= Infurcitineini), 25
Infurcitineini (Tineidae), 25
Iolaini (Lycaenidae), 98
Iolaina (Lycaenidae), 98
Ipimorphinae (= Hadeninae), 125
Ipimorphini (= Hadenini), 125
Ithomiidae (= Ithomiinae), 101
Ithomiinae (Nymphalidae), 101
Ithomiini (Nymphalidae), 101
Itunina (Nymphalidae), 101
Janinae (Eupterotidae), 107
Janioidinae (Cercophanidae), 117

Jaspidiinae (= Acontiinae), 125
Jodini [sic] (= Hemitheina), 93
Jodini (= Hemitheina), 93
Kallimini (Nymphalidae), 101
Lacariini (= Lithini), 93
Lachnidae (= Lasiocampidae), 112
Lachnocnemini (Lycaenidae), 98
Lacosomidae (= Mimalonidae), 110
LACTURIDAE, 72
Lampidina (Lycaenidae), 98
Lampidinae (= Lampidina), 98
Lampidini (= Lampidina), 98
Lamproniidae (= Prodoxidae), 21
Lamproniinae (Prodoxidae), 21
Lampropterinae (= Leptocircini), 96
Lampropterini (Lampropterina), 96
Lamprysticini (Oecophoridae), 34
Larentiidae (= Larentiinae), 93
Larentiinae (Geometridae), 93
Larentini (Geometridae), 93
Lariidae (= Lymantriidae), 123
LASIOCAMPIDAE, 112
Lasiocampinae (Lasiocampidae), 112
Lasiocampini (Lasiocampidae), 112
Lasiocampoidae (= Lasiocampidae), 112
Laspeyresinae (= Grapholitini), 84
Laspeyresiini (= Grapholitini), 84
Lathrotelidae (= Nymphulinae), 61
Lavernidae (= Myphidae), 41
LECITHOCERIDAE, 35
Lecithocerinae (Lecithoceridae), 35
Lemoniidae [sic] (= Lemoniidae), 114
Lemoniadiina (Riodinidae), 99
Lemoniadiini (= Lemoniadiina), 99
LEMONIIDAE, 114
Lemoniinae (Lemoniidae), 114
Lemonini (= Lemoniadiini), 99
Lepidarbelidae (= Metarbelidae), 77
Leptideinae (= Leptideini), 97
Leptideini (Pieridae), 97
Leptocercinae (= Leptocircini), 96
Leptocircini (Papilionidae), 96
Leptopteriginae (= Oiketiciinae), 27
Leptopteriginae [sic] (= Oiketiciinae), 27
Lethini (Nymphalidae), 101
Leucanidae (= Hadenini), 125
Leucaniinae (= Hadeninae), 125
Leucomidae (= Lymantriidae), 123
Leuconyctini (Noctuidae), 125
Leucopteriginae (= Cemiostominae), 55
Leucopterinae (= Cemiostominae), 55
LIBYTHEIDAE, 100
Libytheinae (= Libytheidae), 100
Ligidae [sic] (= Prosoplophini), 93
Ligiidae (= Prosoplophini), 93
Ligiini unavail. (= Prosoplophini), 93
LIMACODIDAE, 81
LIMACODIFORMES, 78
Limacodoidae (= Limacodiformes), 78
Limenitidinae (Limenitidini), 101
Limenitidini (Nymphalidae), 101
Limenitinae (Limenitidini), 101
Limenitini [sic] (= Limenitidini), 101
Linostinae (Pyralidae), 61
Liparidae (= Lymantriidae), 123
Liphyrinae (Lycaenidae), 98
Lipteninae (Lycaenidae), 98
Liptenini (Lycaenidae), 98
Lipusinae [sic] (= Lypusinae), 27
Lithini (Geometridae), 93
Lithocolletidae (= Lithocolletinae), 33
Lithocolletinae (Gracillariidae), 33
Lithophanini (= Xyleniini), 125
Lithosiidae (= Lithosiinae), 124
Lithosiinae (Arctiidae), 124
Lithosiini (Arctiidae), 124
Litidae (Gelechiidae), 38
Lobophorinae (= Trichopterygini), 93
Lobophorini (= Trichopterygini), 93
Lophochoristini (= Lophochoristina), 93
Lophochoristina (Geometridae), 93
LOPHOCORONIDAE, 6
LOPHOCORONINA, 6
LOPHOCORONOIDEA, 6
Loxurina (Lycaenidae), 98
Lozoperidae (= Cochylini), 84
Lucini (Lycaenidae), 98
Ludiinae (Saturniidae), 118

Luehdorfiinae (= Zerynthiini), 96
Luehdorfini (= Zerynthiini), 96
Luffiidae (= Psychidae), 27
Luffiinae (= Psychinae), 27
Lycaenesthini (Lycaenidae), 98
LYCAENIDAE, 98
Lycaeninae (Lycaenidae), 98
Lycaenoidea (= Lycaenidae), 98
Lycaenopsinae (= Lycaenopsina), 98
Lycaenopsini (= Lycaenopsina), 98
Lycaenopsina (Lycaenidae), 98
Lycoreinae (= Lycorini), 101
Lycorini (Nymphalidae), 101
Lycoreina (Nymphalidae), 101
LYMANTRIIDAE, 123
Lymantriinae (Lymantriidae), 123
Lymantriini (Lymantriidae), 123
LYONETIIDAE, 55
Lyonetinae (Lyonetiidae), 55
Lypusidae (= Lypusinae), 27
Lypusinae (Psychidae), 27
Lyrceini unavail. (= Oenochromini), 93
Lythriini (Geometridae), 93
Macariidae (= Semiothisini), 93
Macariinae (= Semiothisini), 93
Macariini (= Semiothisini), 93
Macroglossinae (Sphingidae), 119
Macroglossini (Sphingidae), 119
Macromphaliinae (Lasiocampidae), 112
Macropiratinidae (Pterophoridae), 64
Macrothecinae (= Galleriinae), 61
Macrothecini (= Cacotherapiini), 61
Macrothyatirini (Thyatiridae), 103
Madopidae (= Ophiderini), 125
Malacosomatinae (= Malacosomatini), 112
Malacosomatini (Lasiocampidae), 112
Maniidae (= Eriopini), 125
Maniolinae (= Satyrini), 101
Maniolini (= Maniolina), 101
Maniolina (Nymphalidae), 101
Marasmarchinae (= Pterophorinae), 64
Margarodidae (= Pyraustinae), 61
Margarodinae (= Pyraustinae), 61
Margaroniidae (= Pyraustinae), 61
Marpesiinae (= Marpesiini), 101
Marpesiini (= Cyrestidini), 101
Mechanitini (Nymphalidae), 101
Meoceratini (= Ametridini), 93
Meessiinae (Tineidae), 25
Meessiini (Tineidae), 25
Megalophaninae (= Oiketiciinae), 27
MEGALOPYGIDAE, 74
Megalopygina (= Megalopygidae), 74
Megalopyginae (Megalopygidae), 74
Megarhridini (Pyralidae), 61
Megathyminae (Hesperiidae), 95
Megathymini (Hesperiidae), 95
Meiceratinae (Notodontidae), 120
Melanargiinae (= Satyrini), 101
Melanargiina (Nymphalidae), 101
Melanochroinae (= Melanchroini), 93
Melanochroini (Geometridae), 93
Melanippidae (= Rheumapterini), 93
Melanitini (Nymphalidae), 101
Melanolophidae (= Olethreutini), 84
Melanolophiini (Geometridae), 93
Melanthiini (Geometridae), 93
Melasininae (= Penestoglossinae), 27
Melicleptriinae (= Heliethinae), 125
Melinaeini (Nymphalidae), 101
Melitacinae (= Melitacini), 101
Melitacina (Nymphalidae), 101
Melitacini (Nymphalidae), 101
Melittiini (Sesiidae), 66
Mendesiini (= Peritiini), 36
Mesosemiina (Riodinidae), 99
Mesosemiini (Riodinidae), 99
Metachandidae (= Oecophoridae), 34
Metachrostinae (= Bryophilinae), 125
METARBELIDAE, 77
Metasini (Psychidae), 27
Methonini (= Mechanitini), 101
Metriotinae (= Coleophorinae), 40
Metrocampidae (= Campaeini), 93
Metrocampini (= Campaeini), 93
Metzneriidae (Gelechiidae), 38
Metznerinae (= Anomologini), 38

Micrarctiinae (= Callimorphini), 124
Microcorsini (Tortricidae), 84
Microloxini (= Microloxina), 93
Microloxina (Geometridae), 93
Microniinae (Uraniidae), 91
Micropinidae (= Cyllopodini), 93
Micropini unavail. (= Cyllopodini), 93
Micropsychiidae (= Psychidae), 27
Micropsychiiniidae (= Psychidae), 27
MICROPTERIGIDAE, 1
Micropteriginae (Micropterigidae), 1
MICROPTERIGOIDEA, 1
Micropterygidae [sic] (= Micropterigidae), 1
Midilinae (Pyralidae), 61
Miletinae (Lycaenidae), 98
Miletini (Lycaenidae), 98
Miletina (Lycaenidae), 98
Milionini (Geometridae), 93
Millierinae (Choreutidae), 68
MIMALLONIDAE, 110
Mirininae (Endromidae), 113
MNESARCHAEIDAE, 8
MNESARCHAEIOIDEA, 8
Moffatiinae (= Psychinae), 27
Mominae (= Pantheinae), 125
MONIPHIDAE, 41
Monocetiinae (= Oenochromini), 93
Monocetiini (= Oenochromini), 93
Monopidae (= Tineidae), 25
Monopinae (= Tineinae), 25
MONOTRYSLA, 15
Morphidae (= Morphinae), 101
Morphinae (Nymphalidae), 101
Morphini (Nymphalidae), 101
Munychryiinae (Anthelidae), 111
Musotimidae (= Musotiminae), 61
Musotiminae (Pyralidae), 61
Mycalini (Nymphalidae), 101
Myelobiini (Pyralidae), 61
MYGLOSSATA, 7
Myrmecozelinae (Tineidae), 25
Myrmecozelini (Tineidae), 25
Nacophorini (Geometridae), 93
Napaena (Riodinidae), 99
Napeogenini (Nymphalidae), 101
Naropini (Nymphalidae), 101
Naryciidae (= Taleporinae), 27
Naryciinae (= Taleporinae), 27
Naryciini (Psychidae), 27
Nemapogoninae (Tineidae), 25
Nematophoridae [sic] (= Adelidae), 22
Nematopogoninae (Adelidae), 22
Nemeobiidae (= Riodinidae), 99
Nemeobiinae (= Riodinidae), 99
Nemophoridae (= Adelidae), 22
Nemoriinae (= Nemorina), 93
Nemoriini (= Nemorina), 93
Nemoriina (Geometridae), 93
Neoblastobasini (Blastobasidae), 39
Neocastiminae (Castniidae), 83
Neohipparchini (= Neohipparchina), 93
Neohipparchina (Geometridae), 93
NEOLEPIDOPTERA, 8
NEOPSEUSTIDAE, 7
NEOPSEUSTINA, 7
NEOPSEUSTOIDEA, 7
NEOTHEORIDAE, 9
Nephodiinae (= Ourapterygini), 93
NEPTICULIDAE, 15
NEPTICULINA, 15
Nepticulinae (Nepticulidae), 15
Nepticulini (Nepticulidae), 15
NEPTICULOIDEA, 15
Neptini (Nymphalidae), 101
Niasomini (Tortricidae), 84
Nidarinae (Drepanidae), 105
Niphonymphinae (= Niphonymphini), 53
Niphonymphini (Yponomeutidae), 53
Noctloini (Noctuidae), 125
NOCTUIDAE, 125
Noctuinae (Noctuidae), 125
Noctuini (Noctuidae), 125
Noctuina (Noctuidae), 125
NOCTUOIDEA, 120
Nolidae (= Nolinae), 125
Nolinae (Noctuidae), 125
Nomophilinae (= Pyraustinae), 61
Nonagriinae (= Eriopini), 125

- Noordinae (Pyralidae), 1
NOTODONTIDAE, 120
Notodontinae (Notodontidae), 120
Notodontini (Notodontidae), 120
Notodontinina (Notodontidae), 120
Nudariinae (= Nudariini), 124
Nudariini (Arctiidae), 124
Nyctemerinae (= Callimorphini), 124
Nyctemerini (= Callimorphini), 124
Nyctemerina (Arctiidae), 124
Nycteolidae (= Sarrothripinae), 125
Nycteolinae (= Sarrothripinae), 125
NYMPHALIDAE, 101
Nymphalinae (Nymphalidae), 101
Nymphalini (Nymphalidae), 101
Nymphalinina (Nymphalidae), 101
Nymphaloidea (= Nymphalidae), 101
Nymphidiinae (Riodinidae), 99
Nymphidiini (Riodinidae), 99
Nymphulinae (Pyralidae), 61
Nymphulini (Pyralidae), 61
Nystaleinae (Notodontidae), 120
Obeidiini (Geometridae), 93
Ochrognesiini (= Nemoriina), 93
Ochromolopinae (Epermeniidae), 48
OCHSENHEIMERIIDAE, 49
Ochyroticinae (Pterophoridae), 64
Oditinae (Lecithoceridae), 35
Oditini (Lecithoceridae), 35
Odontiinae (Pyralidae), 61
Odontiini (Pyralidae), 61
Odontodinae (= Stictopterinae), 125
Odontoperinae (= Odontoperini), 93
Odontoperini (= Ennomini), 93
Odontoperini (Geometridae), 93
Odopteridi (= Ennomini), 93
Odopterini (= Ennomini), 93
Oeciini (Oecophoridae), 34
OECOPHORIDAE, 34
Oecophorinae (Oecophoridae), 34
Oecophorini (Oecophoridae), 34
Oecophorina (Oecophoridae), 34
Oecophoroidea (= Gelechioidea), 34
Oecophyllembiinae (= Gracillariinae), 33
Oegoconiinae (= Oegoconiini), 34
Oegoconiini (Oecophoridae), 34
Oeneini (= Erebiina), 101
Oenochrominae (= Oenochromini), 93
Oenochrominae (Geometridae), 93
Oenochromini (Geometridae), 93
Oenophilidae [sic] (= Hieroxestinae), 25
Oenosandrinae (Notodontidae), 120
Oenosandrinina (Notodontidae), 120
Ogyrina (Lycaenidae), 98
Oiketicidae (= Oiketicinae), 27
Oiketicinae (Psychidae), 27
Oiketicini (Psychidae), 27
Oiketicoidinae (= Oiketicinae), 27
Oinophilidae (= Hieroxestinae), 25
Oinophilinae (= Hieroxestinae), 25
Oleriini (Nymphalidae), 101
Olethreutidae (= Olethreutinae), 84
Olethreutinae (Tortricidae), 84
Olethreutini (Tortricidae), 84
Onconemidini (Noctuidae), 125
Oncyrorini (Geometridae), 93
Operophterinae (= Operophterini), 93
Operophterini (Geometridae), 93
Operophterini [sic] (= Operophterini), 93
Ophideridae (= Ophiderini), 125
Ophiderinae (= Catocalinae), 125
Ophiderini (Noctuidae), 125
Ophiderini (= Ophiderina), 125
Ophiderina (Noctuidae), 125
Ophiustidae (= Ophiusina), 125
Ophiusini (= Ophiusina), 125
Ophiusina (Noctuidae), 125
Opogoninae (= Hieroxestinae), 25
Oporiniinae (= Operophterini), 93
Oporiniini (= Operophterini), 93
OPOSTEGIDAE, 16
Opoteaginae (Opotegidae), 16
Opotegoidinae (Opotegidae), 16
Oreanaiini (Pyralidae), 61
Oreopsychinae (= Oiketicinae), 27
Oreopsychini (Psychidae), 27
Oretinae (Drepanidae), 105
Orgyiidae (= Orgyiinae), 123
Orgyiinae (Lymantriidae), 123
Orgyiini (= Orgyiinae), 123
Orgyiinae [sic] (= Orgyiinae), 123
Orneoidea (= Alucitidae), 46
Ornichichinae [sic] (= Gracillariinae), 33
Ornichinae (= Gracillariinae), 33
Ornioidae (= Gracillariidae), 33
Orophinae (= Cryptolechini), 34
Orophini (= Chryptolechini), 34
Ortholithinae (= Xanthorhini), 93
Orthostiidae (= Eriopini), 125
Orthostixidae (= Orthostixinae), 93
Orthostixinae (Geometridae), 93
Orthostixini (= Orthostixinae), 93
Orthotaeliinae [sic] (= Orthoteliinae), 50
Orthotelidae (= Glyphipterigidae), 50
Orthotelinae (Glyphipterigidae), 50
Osminiini (Sesiidae), 66
Othreinae (= Ophiusina), 125
Ourapteryginae (= Ourapterygini), 93
Ourapterygini (Geometridae), 93
OXYCHIROTIDAE, 63
Oxydiidae (= Oxydiini), 93
Oxydiini (Geometridae), 93
Oxydina (Lycaenidae), 98
Oxyptilinae (= Pterophorinae), 64
OXYTENIDAE, 116
Oxytripiinae (= Eriopini), 125
Pachycnemidae (= Prosoplophini), 93
Pachycnemini (= Prosoplophini), 93
Pachycnemini (= Prosoplophini), 93
PALAEOSSETIDAE, 13
PALAEPHATIDAE, 18
PALAEPHATOIDEA, 18
Palimpsestidae (= Thyatiridae), 103
Palindidae (= Ophiderina), 125
Palparidae (= Crambinae), 61
Palumbinae (= Anacampsiini), 38
Palyadae (= Palyadini), 93
Palyadini (Geometridae), 93
Pamphilinae (= Hesperinae), 95
Panacelinae (Eupterotidae), 107
Pangaptini [sic] (= Pangraptina), 125
Pangraptina (Noctuidae), 125
Pantheinae (Noctuidae), 125
Pantheini (Noctuidae), 125
Pantheridae (= Abraxini), 93
Pantherini (= Abraxini), 93
PAPILIONIDAE, 96
Papilioniformes, 96
Papilioninae (Papilionidae), 96
Papilionini (Papilionidae), 96
PAPILIONOIDEA, 95
Paramesiinae (= Cnephasiini), 84
Parametriotinae (= Parametriotini), 42
Parametriotini (Agonoxenidae), 42
Paranthreninae (Sesiidae), 66
Paranthrenini (Sesiidae), 66
Parargina (Nymphalidae), 101
Pararginae (= Elymniini), 101
Parargini (= Parargina), 101
Parathyridae (= Arrhenophanidae), 28
Pardopsini (Nymphalidae), 101
Parnassiidae (= Parnassiinae), 96
Parnassiinae (Papilionidae), 96
Parnassiini (Papilionidae), 96
Pectinivalvinae (Nepticulidae), 15
Peleopodidae (= Peleopodini), 34
Peleopodinae (Oecophoridae), 34
Peleopodini (Oecophoridae), 34
Peloponnesini (Psychidae), 27
Penestoglossinae (= Penestoglossini), 27
Pennisetini (Sesiidae), 66
Penhinae (= Eucosmini), 84
Pentilini (Lycaenidae), 98
Peoriinae (= Peoriini), 61
Peoriini (Pyralidae), 61
Pericopinae (Arctiidae), 124
Pericopina (Arctiidae), 124
Pericymatini (= Polydesmina), 125
Perissomactini (Tineidae), 25
Perissomactinae (= Perissomactini), 25
Peritiinae (Elachistidae), 36
Peritiini (= Peritiinae), 36
Perizomini (Geometridae), 93
Peroneidae (= Tortricini), 84
Perophoridae (= Mimalloniidae), 110
Pexicopiinae (Gelechiidae), 38
Pexicopiini (Gelechiidae), 38
Phaenopterini (Arctiidae), 124
Phalacropterygini (Psychidae), 27
Phalerinae (Notodontidae), 120
Phaloniidae (= Cochylini), 84
Phaselinae (= Phaseliina), 93
Phaselini (= Phaseliina), 93
Phaseliina (Geometridae), 93
Phaselini [sic] (= Phaseliina), 93
Phaudinae (Zygaenidae), 70
Phiditinae (Apatelodidae), 108
Philampeliidae [sic] (= Philampelini), 119
Philampelinae (= Philampelini), 119
Philampelini (Sphingidae), 119
Philereminae (= Rheumapterini), 93
Phileremini (Geometridae), 93
Philobotidae (= Oecophoridae), 34
Philobotinae (= Philobotini), 34
Philobotini (Oecophoridae), 34
Phlogophorinae (= Euteliinae), 125
Phosphilini (Noctuidae), 125
Phricanthini (Tortricidae), 84
Phryganopterini (Arctiidae), 124
Phthoropoeinae (Tineidae), 25
Phycidae [sic] (= Phycitinae), 61
Phycidina (Nymphalidae), 101
Phycitidae (= Phycitinae), 61
Phycitinae (Pyralidae), 61
Phycitini (Pyralidae), 61
Phycitina (Pyralidae), 61
Phycodinae (Brachodidae), 65
Phyllorostidae (= Lyonetiidae), 55
Phyllocnistidae (= Phyllocnistinae), 33
Phyllocnistinae (Gracillariidae), 33
Phyllonorycteridae (= Gracillariidae), 33
Phyllonorycterinae (= Lithocolletinae), 33
Phylloporidae (= Incurvariidae), 19
Phyllorycteridae [sic] (= Gracillariidae), 33
Physoptilidae (= Physoptilinae), 38
Physoptilinae (Gelechiidae), 38
Phytometrinae (= Plusiinae), 125
PIERIDAE, 97
Pieridae (= Pieridae), 97
Pierinae (Pieridae), 97
Pierini (Pieridae), 97
Pigritini (Blastobasidae), 39
Pingasini unavail. (= Pseudoterpnina), 93
Placodomininae (= Taleporiinae), 27
Placodomini (Psychidae), 27
Plastistomidae [sic] (= Oecophoridae), 34
Platyhasmatinae (Notodontidae), 120
Platyoidae nom. nud. (= Tortricidae), 84
Platyptericidae (= Drepanidae), 105
Platyptiliinae (= Platyptiliini), 64
Platyptiliini (Pterophoridae), 64
Plebeinae (= Polyommataini), 98
Plebeini (= Polyommataina), 98
Plebejinae [sic] (= Polyommataini), 98
Plebejini [sic] (= Polyommataina), 98
Pleurotinae (= Pleurotini), 34
Pleurotini (Oecophoridae), 34
Plusiinae [sic] (= Plusiinae), 125
Plusiidae (= Plusiinae), 125
Plusiina (= Plusiina), 125
Plusiinae (Noctuidae), 125
Plusiini (Noctuidae), 125
Plusiina (Noctuidae), 125
PLUTELLIDAE, 51
Plutellinae (Plutellidae), 51
Plutelloidea (= Yponomeutoidea), 49
Plutodini (Geometridae), 93
Pococerinae (= Epipaschiinae), 61
Poecilocampinae (Lasiocampidae), 112
Poeciloptiliinae (= Gracillariinae), 33
Polydesmidae (= Polydesmina), 125
Polydesmini (= Polydesmina), 125
Polydesmina (Noctuidae), 125
Polyommatainae (Lycaenidae), 98
Polyommataini (Lycaenidae), 98
Polyommataina (Lycaenidae), 98
Polyorthini (Tortricidae), 84
Polyplocidae (= Polyplocinae), 103
Polyplocinae (Thyatiridae), 103
Polyplocini (Thyatiridae), 103

- Roeslerstammiidae* (= Amphitheridae), 29
Rosemini (Notodontidae), 120
Rumiinae (= Epionini), 93
Rumini (= Epionini), 93
Ruralinae (= Lycaenidae), 98
Sabaliidae (= Sabaliinae), 114
Sabaliinae (Lemoniidae), 114
Sabatincinae (Micropterigidae), 1
Salassinae (Saturniidae), 118
Saridoscelinae (Yponomeutidae), 53
Sarotini (= Helicopini), 99
Sarrothripidae (= Sarrothripinae), 125
Sarrothripinae (Noctuidae), 125
Sarothripini (Noctuidae), 125
SATURNIIDAE, 118
Saturniiformes, 113
Saturniinae (Saturniidae), 118
Saturniini (Saturniidae), 118
Saturnioidea (= Saturniiformes), 113
Satyridae (= Satyriinae), 101
Satyriinae (Nymphalidae), 101
Satyriini (Nymphalidae), 101
Satyriina (Nymphalidae), 101
Satyrioidae (= Satyriinae), 101
Scaesophidae (= Cosmopterigidae), 43
Scardaminae (= Scardamiini), 93
Scardamiini (Geometridae), 93
Scardiidae (= Scardiinae), 25
Scardiinae (Tineidae), 25
Schistomitriinae (Epicopeiidae), 88
Schistoneoeini (Oecophoridae), 34
Schoenobiidae (= Schoenobiinae), 61
Schoenobiinae (Pyralidae), 61
Schoenotenidae (= Schoenotenini), 84
Schoenotenini (Tortricidae), 84
SCHRECKENSTEINIIDAE, 30
Sciaphilidae (= Cnephasiini), 84
Sciaphilinae (= Cnephasiini), 84
Scirpophagidae (= Schoenobiidae), 61
Scoliopteryginae (= Ophirerina), 125
Scoliopterygini (= Ophiderini), 125
Scolitantidini (= Scolitantidina), 98
Scolitantidina (Lycaenidae), 98
Scopariidae (= Scopariinae), 61
Scopariinae (Pyralidae), 61
Scopariini (Pyralidae), 61
Scopulini (Geometridae), 93
Scoriodytinae (= Psychinae), 27
Scoriodytini (Psychidae), 27
Scranciini (Notodontidae), 120
Scythridae [sic] (= Scythrididae), 44
SCYTHRIDIDAE, 44
Scythropiinae (Plutellidae), 51
Scythropodini (Lecithoceridae), 35
Seleniini (= Ennomini), 93
Selidosemidae (= Boarmiini), 93
Selidoseminae (= Boarmiini), 93
Semanophorae [sic] (= Macroglossinae), 119
Semanophorinae (= Macroglossinae), 119
SEMATURIDAE, 90
Semioscopidae (= Oecophoridae), 34
Semioscopinae (= Depressariinae), 34
Semioscopinae [sic] (= Depressariinae), 34
Semiothisinae (= Semiothisini), 93
Semiothisini (Geometridae), 93
Semniinae (= Chrysauginae), 61
Sericorididae [sic] (= Eucosmini), 84
Sericorinae [sic] (= Eucosmini), 84
SESIIDAE, 66
SESIINA, 65
Sesiinae (Sesiidae), 66
Sesiini (Sesiidae), 66
SESIIOIDEA, 65
Setomorphinae (Tineidae), 25
Siculidae (= Siculodidae), 60
Siculodinae (Thyrididae), 60
Siculodini (Thyrididae), 60
Siginae (= Pyraustinae), 61
Siloscinae (Tineidae), 25
Simaethidae (= Choreutidae), 68
Simaethistinae (Thyrididae), 60
Similipepsini (Sesiidae), 66
Sionidae (= Boarmiini), 93
Sionini (= Gnophina), 93
Smerinthinae (= Smerinthini), 119
Smerinthini (Sphingidae), 119
Solenobiidae (= Taleporiinae), 27
Solenobiinae (= Taleporiinae), 27
Solitaneini nom. nud. (= Operophterini), 93
Solitaneini (Geometridae), 93
Somabrachyidae [sic] (= Somabrachyidae), 73
SOMABRACHYIDAE, 73
Spalgini (Lycaenidae), 98
Sparganothidae (= Sparganothini), 84
Sparganothinae (= Sparganothini), 84
Sparganothini (Tortricidae), 84
Sphacelodini (Geometridae), 93
Sphingicampinae (= Ceratocampinae), 118
SPHINGIDAE, 119
Sphinginae (Sphingidae), 119
Sphingini (Sphingidae), 119
SPHINGOIDEA, 119
Spilomelidae (= Spilomelini), 61
Spilomelinae (= Pyraustinae), 61
Spilomelini (Pyralidae), 61
Spilonotinae (= Eucosmini), 84
Spilosominae (= Arctiinae), 124
Stalachtini (Riodinidae), 99
Stamnodini (Geometridae), 93
Stathmopodidae (= Stathmopodini), 34
Stathmopodinae (= Stathmopodini), 34
Stathmopodini (Oecophoridae), 34
Stathmopolitinae (= Tineidae), 25
Stauropini (Notodontidae), 120
Steniidae (= Pyraustinae), 61
Steninae (= Pyraustinae), 61
Stenomatidae (= Stenomatinae), 34
Stenomatinae (Oecophoridae), 34
Stenomatidae [sic] (= Stenomatinae), 34
Stenopterygidae (= Pyraustinae), 61
Stenoptiliinae (= Pterophorinae), 64
Stephensiini (Elachistidae), 36
Sterrhinae (Geometridae), 93
Sterrhini (Geometridae), 93
Stichobasinae (= Psychinae), 27
Stichobasini (Psychidae), 27
Stictopterinae (Noctuidae), 125
Stigmellidae (= Nepticulidae), 15
Stigmellinae (= Nepticulidae), 15
Stimonotidae (= Eucosmini), 84
Stimonotinae (= Eucosmini), 84
Stilbiidae (= Apameini), 125
Stirinae (Noctuidae), 125
Stiriini (Noctuidae), 125
Stomopteryginae (= Anacampsiini), 38
Strepsimanidae (= Hypenodinae), 125
Strepsimanini (Noctuidae), 125
Striglininae (Thyrididae), 60
Striphnopterygidae (= Eupterotidae), 107
Strymoninae (= Theclini), 98
Strymonini (= Theclini), 98
Styginae (Riodinidae), 99
Syleptinae (= Pyraustinae), 61
Symmachiini (Riodinidae), 99
Symmocidae (= Symmocini), 34
Symmocinae (Autostichinae), 34
Symmocini (Oecophoridae), 34
Synanthedoninae (= Synanthedonini), 66
Synanthedonini (Sesiidae), 66
Synchlorini (= Synchronina), 93
Synchlorina (Geometridae), 93
Synedini (= Drasteriina), 125
Synemoninae (Castniidae), 83
Syntomidae (= Syntomini), 124
Syntominae (Arctiidae), 124
Syntomini (Arctiidae), 124
Syricorinae (= Eucosmini), 84
Syricorinae (= Eucosmini), 84
Syringopainae (= Syringopaini), 34
Syringopaini (Oecophoridae), 34
Syssphingina (= Ceratocampinae), 118
Syssphinginae (= Ceratocampinae), 118
Talaeporiinae [sic] (= Taleporiinae), 27
Talaeporiinae [sic] (= Taleporiinae), 27
Taleporiidae (= Taleporiinae), 27
Taleporiinae (Psychidae), 27
Taleporiini (Psychidae), 27
Tarakina (Lycaenidae), 98
Teichobiidae (= Teichobiinae), 25
Teichobiinae (Tineidae), 25
Teinopalpidae (= Teinopalpini), 96
Teinopalpini (Papilionidae), 96
Telechrysidini (= Telechrysidina), 34
Telechrysidina (Oecophoridae), 34
Teleiodini (= Gelechiini), 38
Tellervinae (Nymphalidae), 101
Teragridae (= Metarbelidae), 77
Terpnini (= Pseudoterpnina), 93
Terpnini (= Pseudoterpnina), 93
Tetheini (Thyatiridae), 103
Thaidinae (Papilionidae), 96
Thaiainae (Papilionidae), 96
Thalamarchellidae (= Oecophoridae), 34
Thalamarchidae (= Oecophoridae), 34
Thalassodini (= Hemiteina), 93
Thalerini (= Hemiteina), 93
Thamnospheciini (= Synanthedonini), 66
Thaumetopoeinae (Notodontidae), 120
Thaumetopoeinina (Notodontidae), 120
Theclinae (Lycaenidae), 98
Theclini (Lycaenidae), 98
Theclina (Lycaenidae), 98
Thecopina (Riodinidae), 99
Therini (Geometridae), 93
Therini (= Cidarini), 93
Thestorinae (= Tomarina), 98
Thinopterygini (Geometridae), 93
THYATIRIDAE, 103
Thyatirinae (Thyatiridae), 103
Thyatirini (Thyatiridae), 103
Thymelicinae (= Hesperinae), 95
THYRETIDAE, 122
Thyretini (= Thyretidae), 122
Thyridae [sic] (= Thyrididae), 60
THYRIDIDAE, 60
Thyridinae (Thyrididae), 60
Thyroidea (= Thyrididae), 60
Thysanini (= Thysanina), 125
Thysanina (Noctuidae), 125
Tichobiidae [sic] (= Teichobiini), 25
Timandridi (= Timandrinini), 93
Timandrinini (Geometridae), 93
Timandromorphini (= Timandromorphina), 93
Timandromorphina (Geometridae), 93
Timyridae (= Lecithoceridae), 35
Tinaegeriidae (= Stathmopodini), 34
TINEIDAE, 25
Tineiformes, 24
TINEINA, 24
Tineinae (Tineidae), 25
TINEODIDAE, 62
TINEOIDEA, 24
Tinissinae (= Scardiinae), 25
Tinthiinae (Sesiidae), 66
Tinthiini (Sesiidae), 66
Tirathabini (Pyralidae), 61
TISCHERIIDAE, 17
TISCHERIOIDEA, 17
Tissangini (Pterothysanidae), 86
Titiini (= Odontiini), 61
Tithoreini (Nymphalidae), 101
Tolteophorini (= Coleophorinae), 40
Tomarina (Lycaenidae), 98
Torodorinae (Lecithoceridae), 35
TORTRICIDAE, 84
Tortricinae (Tortricidae), 84
Tortricini (Tortricidae), 84
Tortricodidae (= Cnephasiini), 84
TORTRICOIDEA, 84
Toxocampidae (= Toxocampina), 125
Toxocampini (= Toxocampina), 125
Toxocampina (Noctuidae), 125
Trapezitinae (Hesperidae), 95
Trichophoridae unavail. (= Tortricidae), 84
Trichopterygini (Geometridae), 93
Trifurculinae (= Trifurculini), 15
Trifurculini (Nepticulidae), 15
Triocnemidini (Noctuidae), 125
Trochilidae (= Sesiidae), 66
Troidini (Papilionidae), 96
Troidina (Papilionidae), 96
Trosiinae (Megalopygidae), 74
Trypaninae (= Cossinae), 75
Typhoniinae (Psychidae), 27
Typhoniini (Psychidae), 27
Tytini (= Tytina), 125
Tytina (Noctuidae), 125
Udeini (= Pyraustini), 61
Ufeinae (= Ufeini), 125
Ufeini (Noctuidae), 125
URANIIDAE, 91
Uraniinae (Uraniidae), 91
URANIOIDEA, 88
Urapteridae (= Ouraptrygini), 93
URODIDAE, 67
Urodinae (Urodidae), 67
Urotini (Saturniidae), 118
Utetheisini (Arctiidae), 124
Uzuchidae (= Xyloryctinae), 34
Vanessidae (= Nymphalidae), 101
Varneriini (= Phycitini), 61
Vestermanniinae [sic] (= Westermanniini), 125
Walshiidae (= Cosmopterigidae), 43
Walshiinae (= Chrysopleiinae), 43
Westermanniinae (= Westermanniini), 125
Westermanniini (Noctuidae), 125
Whalleyaninae (Thyrididae), 60
Whitebreadini (= Perittini), 36
Wilemaniina (Geometridae), 93
Wilemanini [sic] (= Wilemaniina), 93
Wurthiinae (Pyralidae), 61
Xanthiinae (= Acronictinae), 125
Xanthopastinae (= Glottulini), 125
Xanthorhoinae (= Xanthorhoini), 93
Xanthorhoini (Geometridae), 93
Xylenini (Noctuidae), 125
Xylenina (Noctuidae), 125
Xyliniidae (= Xylenini), 125
Xyloryctidae (= Xyloryctinae), 34
Xyloryctinae (Oecophoridae), 34
Xysmatodomininae (= Taleporiinae), 27
YPONOMEUTIDAE, 53
Yponomeutinae (Yponomeutidae), 53
Yponomeutini (Yponomeutidae), 53
YPONOMEUTOIDEA, 49
Ypsolophidae (= Plutellidae), 51
Ypsolophinae (Plutellidae), 51
Ypthimini (Nymphalidae), 101
Zanolidae (= Apatelodidae), 108
Zaretini (Nymphalidae), 101
Zelleriinae (= Yponomeutinae), 53
Zenobiinae (= Amphipyriinae), 125
Zenodoxinae (= Tinthiinae), 66
Zenodoxini (= Tinthiini), 66
Zephyrinae (= Theclinae), 98
Zerenidae (= Abraxini), 93
Zerenini (= Abraxini), 93
Zerynthiinae (= Zerynthiini), 96
Zerynthiini (Papilionidae), 96
Zesiini (Lycaenidae), 98
ZEUGLOPTERA, 1
Zeuzeridae (= Cossidae), 75
Zeuzerinae (Cossidae), 75
Zizeerini (= Zizeerina), 98
Zizeerina (Lycaenidae), 98
Zizerini [sic] (= Zizeerina), 98
Zonosomatidi (= Cosymbiini), 93
Zonosomini (= Cosymbiini), 93
ZYGAENIDAE, 70
Zygaeninae (Zygaenidae), 70
ZYGAENOIDEA, 69

DISTRIBUTION NOTES ON TAIWAN MOTHS,

2. *MIMICIA PSEUDOLIBATRIX*

(LEPIDOPTERA: PYRALIDAE: PYRALINAE)

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ABSTRACT.— The Chinese pyraline species, *Mimicia pseudolibatrix* (Caradja), is newly recorded from Taiwan and named as a new subspecies, as *M. p. taiwana* n. subsp., with distribution records from the Taiwan Lepidoptera Survey. Notes also give specimen records from China and Japan.

KEYWORDS: Asia, Catocalinae, China, East Asia, Fujian, Guangdong, Höne Collection, Japan, *Mimicia pseudolibatrix taiwana* n. subsp., Noctuidae, Oriental, Pyralinae, *Scoliopteryx*, taxonomy.

This second report on Taiwan moths from the Taiwan Lepidoptera Survey (Heppner, 2003), begun in 1981, treats the large species, *Mimicia pseudolibatrix* (Caradja), subfamily Pyralinae, newly recorded herein for Taiwan. The species was originally described in the genus *Hybolomia* by Caradja (1925), based on a single male from the Höne Collection, collected at Lianping (formerly Lienping), Guangdong Province, southern China, from Höne's collecting in the Guangdong region during 1920-23. Höne was in China from 1917-46 and made collections over most areas of the country east of the Tibetan plateau (Niethammer, 1963). His vast collections of Lepidoptera from China, mostly moths, are now in museums in Germany (mostly in Bonn and Karlsruhe), other than what Caradja received from him and which is now preserved in the natural history museum in Bucharest, Romania.

Meyrick (1934) later named a new genus, *Mellia*, for this unusual pyralid species. Strand (1935) then coined a new name for the genus (*Meltalia*) because of some nomenclatural point, but his name is now listed as a synonym of the Meyrick name, with both names being junior to *Mimicia* Caradja (1925) (first named as a subgenus of *Hybolomia*) (Inoue, 1988; Sugi, 2000).

In subsequent notes about material from China, Caradja (1934) noted that among H. Höne (1883-1963) specimens collected in China, as well as in other collections by R. E. Mell (1878-1970) made in the years 1908-21, there were further specimens from Lianping, China, specifically at a nearby mountain pass called "Tsatmicku-gao", 18 km south of Lianping, at 900m elevation. The added specimens totaled 35 more collected at light from the same site in China, dated 11 Jul, 26 Sep, and 7 Oct (no year indicated), presumably collected by Mell. Caradja (1934) also mentioned two specimens from a location called "Kwanshien" (in Sichuan Prov., near Chengdu) in his German text, but this may be in error since this was in reference to the type "pair", but Caradja (1925) described the species from only a single male stated to be from Lianping. The variety "*obscura*" (Caradja, 1935) was also described from Guangdong Province but is merely a melanic form.

Since Caradja's (1925) original description of this interesting moth, few if any additional specimens have been taken in China, as far as is known (Luh and Kuan, 1953), and only recently has a survey in Fujian Province, at Wuyishan Nature Reserve, obtained the species again and extended its known range to another province of China (Wang *et al.*, 2003). The Fujian data involves only a single female, collected 1 Sep 1981 (Wang *et al.*, 2003).



Fig. 1. Paratype forewing of *Mimicia pseudolibatrix taiwana* ♀, from Taiwan.

In 1988, the species was reported for the first time from Japan by Inoue (1988), for two specimens collected at Kiune, Niimi City, Okayama Prefecture: a male on 15 Sep 1986 and a female on 9 Aug 1987 (S. Yano coll.). In 2003, an additional female was found in Niigata Prefecture, Japan, on 25 Aug 2003 (Sakurai, 2003). Evidently, this species is very rare in Japan, since Japan is among the best surveyed of any nation for Lepidoptera yet only 3 specimens have been found there in the last 160 years, unless the species has somehow recently gotten to Japan and Taiwan.

In 1996 and again in 2005, the species was found in mid-elevation mountains in northern Taiwan, at about 1500m elevation in mid-July, in the Tamanshan range south of Taipei, near forest at the mountain resort town called Upper Palin, Taoyuan County (J. B. Heppner, collector). Both females were taken at blacklight in July. Another female was found in 1996 only about 20km northeast from there at the mountain area of Mingchih (1250m), while in mid-July 2005 another female was taken at Litonshan, Hsinchu Co. (1450m).

In the original description, Caradja (1925) noted the resemblance of the species to the noctuid, *Scoliopteryx libatrix* (Linnaeus), a European species of the subfamily Catocalinae that also occurs in East Asia, including Taiwan. The resemblance, of course, prompted Caradja (1925) to name the new pyralid after the noctuid. Although even a cursory examination clearly shows that *M. pseudolibatrix* belongs in Pyralidae, collections of unsorted noctuid moths should still be checked for any possible specimens of this pyralid inadvertently left there due to this superficial resemblance to *Scoliopteryx libatrix*.

The collection data from Japan and Taiwan, as well as China, indicate the species is active during several months from July to October, perhaps with two generations. However, nothing is otherwise known of its life cycle or what the larvae may feed on.

¹ Contribution No. 995, Entomology Section, Bur. Ent. Nema. Plant Path., Div. Plant Industry, Florida Dept. Agric. & Consumer Serv., Gainesville, Florida.

Given that only a single specimen has turned up in Taiwan in the last 25 years of intensive collecting in Taiwan with the Taiwan Lepidoptera Survey, besides the extensive collecting activities by the Japanese in Taiwan already since 1895 by both professional and amateur lepidopterists, *M. pseudolibatrix* would seem to be as rare in Taiwan as it is in Japan. However, at the right time and in the right place the species can be found in numbers, as was noted by Caradja (1934) for the 35 additional specimens taken at one locality in Guangdong, China, up to that time.

In Taiwan, the habitat of *M. pseudolibatrix* is typical Chinese subtropical montane forest, mostly hardwoods mixed with some tropical species, as well as cedars and other trees from higher elevations, and with numerous understory plants. The forests are, thus, similar to original forest in mountains of Guangdong and Fujian, where the moths have been found in mainland China.

The following new name is provided for the Taiwan population of *M. pseudolibatrix*:

Mimicia pseudolibatrix taiwana Heppner, n. subsp.

Adult similar in size (female 38mm wingspan) to mainland Chinese specimens, with similar wing maculation: forewing coloration reddish-brown (with orange highlights), with short white costal margin mark angled as in the nominate subspecies but more uniform in thickness (not narrowed at middle as in mainland China population); more basal central angular white mark also thicker than in nominate subspecies; postmedian curved white fascia with costal widening angled mesally (not angled slightly distal as in mainland China populations); hindwing uniformly gray but for slight brown tinge near margins. Males not known for Taiwan but in China they are much smaller (28mm) than the females.

Holotype female: TAIWAN.—Taoyuan Co.: Upper Palin (1500m), 11-18 Jul 1996, J.B. Heppner. Deposited with the National Taiwan Museum, Taipei, Taiwan (on indefinite loan to the Florida State Collection of Arthropods, Gainesville, Florida).

Paratypes (3 ♀): Hsinchu Co.: Litonshan (1450m), 13 Jul 2005 (1 ♀), J. B. Heppner. Taoyuan Co.: Upper Palin (1350m), 4-5 Jul 2005 (1 ♀), Mingchih For. Res. Area (1250m), 9-10 Jul 1996 (1 ♀), J. B. Heppner & H.-Y. Wang.

Etymology.—Named after the island of Taiwan.

Distribution.—China (Fujian and Guangdong), Japan, and Taiwan.

Notes.—The mainland China population of *M. pseudolibatrix* is darker brown than those of *M. p. taiwana* in Taiwan, as also in Japan. Adults have been figured by Wang *et al.* (2003) from Fujian, and by Inoue (1988) and Sakurai (2003) from Japan. The biology of the species remains to be studied more, but Yoshimatsu (1991) reported on the immature stages reared on artificial diet in Japan.

The Taiwan catalog update (Heppner, 2005) will list over 140 other new species records for Taiwan from the Taiwan Lepidoptera Survey, all added since publication of the original Taiwan catalog (Heppner and Inoue, 1992), but *M. pseudolibatrix* can already be added below as follows (with appropriate catalog number for insertion into the 1992 catalog):

MIMICIA Caradja, 1925

Mellia Meyrick, 1934

Melitalia Strand, 1935

- 394.1 *pseudolibatrix* (Caradja, 1925) (*Hybolomia*) China (Guangdong)
var. *obscura* (Caradja, 1935) (*Mellia*) China (Guangdong)
a) *taiwana* Heppner, n. subsp. Taiwan

ACKNOWLEDGMENTS

The Taiwan Lepidoptera Survey project began in 1980 with organizational meetings at the National Taiwan Museum (then called the Taiwan Provincial Museum), in Taipei, by J. F. G. Clarke (Smithso-

nian Institution, Washington, DC), and the first survey trip was by Dr. Don R. Davis, Smithsonian Institution, Washington, DC, in 1981. All subsequent trips were by the author, since 1982, and were primarily funded by two National Science Foundation grants (INT-8119539 and INT-8721716), plus survey grants from the Smithsonian Institution and added support from the Florida State Collection of Arthropods, Division of Plant Industry, Florida Dept. of Agriculture and Consumer Services, Gainesville, Florida. In Taiwan, project support has been primarily from the National Taiwan Museum, Taipei, and the Taiwan Forestry Research Institute, Taipei, and their entomology staffs, as well as a publication grant from the Pacific Cultural Foundation, Taipei. Special thanks to H.-Y. Wang, National Taiwan Museum, for facilitating all field trips in Taiwan since 1982. Principal housing of survey specimens is with the Florida State Collection of Arthropods, Gainesville, Florida, for the study of the collections, plus samples at the Smithsonian Institution and the National Taiwan Museum, Taipei.

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DISTRIBUTION NOTES ON TAIWAN MOTHS, 3. *PYRAUSTA MYSTICA* (LEPIDOPTERA: PYRALIDAE: PYRAUSTINAE)

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ABSTRACT.— Notes are provided on specimens from Taiwan of the Chinese (Sichuan) pyralid species *Pyrausta mystica* Caradja, including the first Taiwan records. The taxon *Pyrausta mystica taitungensis* n. subsp. is described as a new subspecies from Taiwan.

KEYWORDS: Asia, China, East Asia, Oriental, *Pyrausta mystica taitungensis* n. subsp., Pyraustinae, Sichuan, taxonomy.

Among many new moths recorded for Taiwan from the Taiwan Lepidoptera Project, this third note reports on a rare species of the pyralid subfamily Pyraustinae described from Sichuan, China, and now recorded for the first time from Taiwan. This is another of many to be added to the 1992 catalog (Heppner and Inoue, 1992), as will be noted in the additions to the catalog (Hepper, 2005).

Much of the Taiwan lepidopteran fauna is a disjunct remnant from the Himalaya Mountains of Nepal and western China, possibly isolated now in the higher mountains of Taiwan since the last Ice Age regression of habitats that once were continual from the Himalayas to Taiwan. Taiwan has the highest mountain area east of the Himalayas, other than for the isolated peak of Kinabalu in northern Borneo, so cooler habitats in Taiwan mountains have allowed these remnant lepidopterans to survive there. Likewise, many species from western Sichuan also have disjunct remnant populations in Taiwan. On the highest Taiwan mountains one also finds plants and Lepidoptera typical of Japan and even of northern Eurasian species.

The Himalayan and Sichuan lepidopteran faunas in Taiwan are sometimes at various elevations, depending on the species, and not necessarily all above 2000m elevation, where most of the Himalayan fauna begins in Taiwan in earnest. Such is the case with the small blackish pyralid moth found in Taiwan at only 720m elevation near the southeast region of Taiwan, in Taitung County. A similar moth was described from a single male from Sichuan, China, by A. Caradja (1932). He appropriately named it *Pyrausta mystica* Caradja, since he was unsure of its generic placement and had not seen anything similar from China or from the European fauna of his native Romania. The unique holotype of the species is in the natural history museum in Bucharest, Romania, along with the rest of the large Caradja Collection of Lepidoptera, much of it being Chinese moths.

The current Lepidoptera curator of the Muzeul National de Istoria Naturala 'Grigore Antipa', Bucharest, Romania, Dr. Mihai Stanescu, kindly helped reconfirm the label data and physical aspects of Caradja's type. The holotype male of *P. mystica*, type no. 177636 (Museum Bucharest, MGAB), has the following label data: Omei-shan (2300m), Sichuan, China, 20 Jul 1931, G. Franck. The rather worn male specimen has a wingspan of 19mm, and appears as illustrated in Fig. 1.

On earlier visits of mine to Romania and the Bucharest museum to study types there, in 1980 and again in 1984, I had already photographed the type specimen of *P. mystica*, along with many

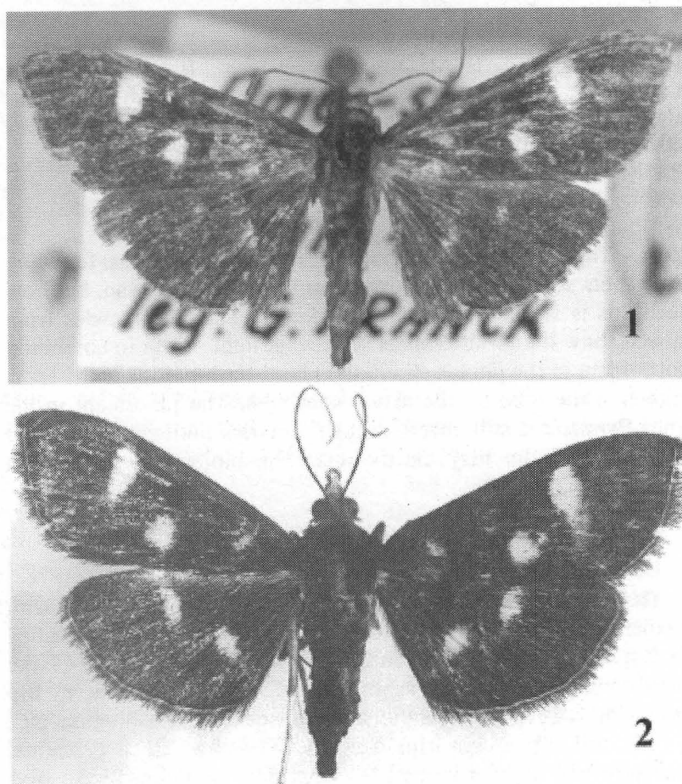


Fig. 1-2. Adults of *Pyrausta mystica*: 1) holotype male, *P. m. mystica*, Omeishan, Sichuan, China (MGAB). 2) holotype female, *P. m. taitungensis*, Bishan Hot Springs, Taitung Co., Taiwan (FSCA).

others, but did not have time or need then to dissect it for genitalic examination. After sorting of the many collections obtained in Taiwan since 1981 from the Taiwan Lepidoptera Project, specimens of a small pyralid were found that could not be readily placed to any known species until the photograph of the Caradja type of *P. mystica* was checked to verify that the specimens unquestionably are the same species. Unfortunately, all the Taiwan specimens thus far are females, so no genitalic confirmation is as yet possible.

The Caradja collection has only the single male holotype of *P. mystica* and no other specimens of the species are known of in any other collection thus far, other than the 3 females from Taiwan. None of the more recent Chinese works on pyralid moths include the species and it was not even included in the last Chinese catalog

¹ Contribution No. 996, Entomology Section, Bur. Ent. Nema. Plant Path., Div. Plant Industry, Florida Dept. Agric. & Consumer Serv., Gainesville, Florida.

of Lepidoptera, by Wu (1938), although finally listed in the catalog update for Pyralidae by Luh and Kuan (1953). Thus, it is likely that no other specimens of the species have been collected in China.

The following new name is provided for the Taiwan population of *P. mystica*:

***Pyrausta mystica taitungensis* Heppner, n. subsp.**

Adult similar in size (female 19-20mm wingspan) to mainland Chinese specimen, with similar wing maculation: body and forewing coloration brown-black, with 2 white (slight cream color) oval spots past mid-wing (more elongate than in nominate subspecies), angled from the end of cell equidistantly from termen border, the radial spot being somewhat larger than the cubital spot; also a much smaller white spot near the base; hindwing dark like forewing and white spots near midwing as in forewing except somewhat more elongated or oval than in forewing (males have these reduced and the inner spot elongated diffusely toward anal angle of wing margin); overall the wings and body have a bluish sheen in fresh specimens. Males not known for Taiwan but in China they are similar to females except for the hindwing spot pattern, where in the male the white marks are elongated instead of rounded as in the female.

Holotype female: TAIWAN.—Taitung Co.: Bishan Hot Springs (720m), 26-29 Oct 1984, J.B. Heppner & H.-Y. Wang. Deposited with the National Taiwan Museum, Taipei, Taiwan (on indefinite loan to the Florida State Collection of Arthropods, Gainesville, Florida).

Paratypes (2 ♀): same data as holotype (FSCA).

Etymology.—Named after the county of Taitung of the type locality.

Distribution.—China (Sichuan) and Taiwan.

Notes.—The Sichuan, China, population of *P. mystica* has forewing white spots somewhat more oval than those from Taiwan, but how much this is sexual variation is not known yet. The females from Taiwan show the "white" spots somewhat light-cream in coloration (not evident in the photos where the photo-flash has made the spots brighter white than on the actual specimen. The placement in the genus *Pyrausta* is still uncertain for *P. mystica* until examination of the male genitalia may clarify this. The biology of *P. mystica* remains unknown.

ACKNOWLEDGMENTS

The Taiwan Lepidoptera Survey project began in 1980 with organizational meetings at the National Taiwan Museum (then called the Taiwan Provincial Museum), in Taipei, by J. F. G. Clarke (Smithsonian Institution, Washington, DC), and the first survey trip was by Dr. Don R. Davis, Smithsonian Institution, Washington, DC, in 1981. All subsequent trips were by the author, since 1982, and were primarily funded by two National Science Foundation grants (INT-8119539 and INT-8721716), plus survey grants from the Smithsonian Institution and added support from the Florida State Collection of Arthropods, Division of Plant Industry, Florida Dept. of Agriculture and Consumer Services, Gainesville, Florida. In Taiwan, project support has been primarily from the National Taiwan Museum, Taipei, and the Taiwan Forestry Research Institute, Taipei, and their entomology staffs, as well as a publication grant from the Pacific Cultural Foundation, Taipei. Special thanks to H.-Y. Wang, National Taiwan Museum, for facilitating all field trips in Taiwan since 1982. Principal housing of survey specimens is with the Florida State Collection of Arthropods, Gainesville, Florida, for the study of the collections, plus samples at the Smithsonian Institution and the National Taiwan Museum, Taipei.

My thanks also to Dr. Mihai Stănescu, Muzeul National de Istoria Naturală 'Grigore Antipa', Bucharest, Romania, for his kind help in checking the Caradja holotype for me. Likewise, the former curator, the late Dr. Aurelian Popescu-Gorj, was very helpful during

my visits to Romania in 1980 and 1984, both at the museum in Bucharest and on field trips around the country. In Romania, my travel and research was supported in 1980 by the National Geographic Society, Washington, DC (grant 2136), the American Philosophical Society, Philadelphia, PA, and the Smithsonian Institution, Washington, DC. In 1984, a grant for study in Romania was received from the National Academy of Sciences, Washington, DC (scientific exchange program, Romania).

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DISTRIBUTION NOTES ON TAIWAN MOTHS, 4. GENERA *LIXA* AND *TAMRACA* (LEPIDOPTERA: PYRALIDAE: PYRALINAE)

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ABSTRACT.— Notes are provided on specimens from Taiwan in the Asian pyralid genera *Lixa* Walker and *Tamraca* Moore, including new Taiwan records, and description of the subspecies, *Lixa productalis taiwana* n. subsp. and *Tamraca torridalis taiwana* n. subsp. from Taiwan.

KEYWORDS: Asia, Borneo, China, East Asia, Japan, *Lixa productalis taiwana* n. subsp., Malaysia, Oriental, Pyralinae, Sarawak, Sulawesi, *Tamraca torridalis taiwana* n. subsp., taxonomy.

Among many new moths recorded for Taiwan from the Taiwan Lepidoptera Project, this note reports on some species in the pyralid genera *Lixa* Walker and *Tamraca* Moore, both in the subfamily Pyralinae. While *Lixa* has 6 known species in Asia, *Tamraca* includes only two species. The new Taiwan records below are added to the Taiwan catalog of 1992 (Heppner and Inoue, 1992), and are further listed in the catalog updates (Heppner, 2005).

All specimens reported on below are from the Taiwan Lepidoptera Survey, currently housed at the Florida State Collection of Arthropods (FSCA), Gainesville, Florida.

LIXA Walker

The genus *Lixa* Walker ([1866]) presently contains 6 known species, all from Southeast Asia (Robinson *et al.*, 1994). The type species of the genus, *Lixa productalis* Walker, originally described from Sarawak, Borneo (Walker, [1866]), has until now remained known only from Borneo (thus far Sarawak and Brunei). Specimens from the Taiwan Lepidoptera Survey include 34 specimens of this species, which can now be reported for Taiwan for the first time, named herein as a new subspecies for Taiwan.

Lixa productalis taiwana Heppner, n. subsp.

Adults similar in size (male 20-25mm wingspan; female 27-28mm) to Bornean specimens, with similar wing maculation: body and forewing coloration reddish orange-brown, with HW more orange; FW with 1 fuscous line at 1/3 from base and a subterminal line angled near tornus, and costa with tan edge; HW with 2 curved fuscous lines (Taiwan specimens with HW more orange than from Borneo). Female similar to male.

Holotype male: TAIWAN.— Taoyuan Co.: Upper Palin (1500m), 11-18 Jul 1996, J.B. Heppner. Deposited with the National Taiwan Museum, Taipei, Taiwan (on indefinite loan to the Florida State Collection of Arthropods, Gainesville, Florida).

Paratypes (32 ♂, 3 ♀): TAIWAN.— Chiayi Co.: Fennchihwu (1450m), 2-4 Jul 1985, J. B. Heppner & H.-Y. Wang (1 ♂). Hsinchu Co.: Litonshan (1450m), 13 Jul 2005, J. B. Heppner (2 ♂). Ilan Co.: Fushan Bot. Sta. (650m), 20-24 Jul 1996, J. B. Heppner (1 ♂, 1 ♀). Tuchen [Chilan For. Sta.] (480m), 1-2 Jul 1982, J. B. Heppner (1 ♂). Nantou Co.: Lo Farm, 8 km E. Puli (750m), 10-11 Jul 2005, J. B. Heppner (2 ♂). Taichung Co.: Kukuan (700m), 6 Jul 1985, J. B. Heppner & H.-Y. Wang (1 ♂). Taipei Co.: Wulai (200m), 17-19 Jun 1985, J. B. Heppner & H.-Y. Wang (4 ♂). Taoyuan Co.: Upper Palin (1350m), 7-9 Jul 1986, J. B. Heppner & H.-Y. Wang (1 ♂). Upper Palin (1500m), 11-18 Jul 1996, J. B. Heppner (19 ♂, 2 ♀). All FSCA. Etymology.— Named after the island of Taiwan.

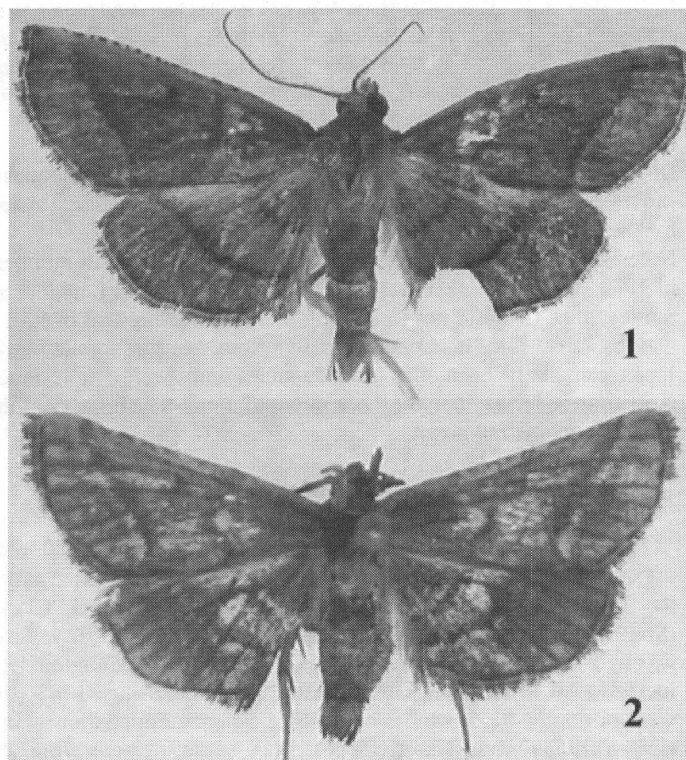


Fig. 1-2. Adults: 1) *Lixa productalis taiwana*, holotype male. 2) *Tamraca torridalis taiwana*, holotype male.

Distribution.— Borneo (Sarawak, East Malaysia) and Taiwan.

Notes.— The Taiwan population has the hindwings much more orange-brown than those from Borneo, which are more red-brown. The biology of the species remains unknown.

TAMRACA Moore

The genus *Tamraca* Moore (1887) was described for an unusual pyralid already described earlier from Sri Lanka, *Asopia torridalis* Lederer (1863). Walker (1965) described the same species again from northern India as *Varnia incerta* Walker. Since then the species, as *T. torridalis*, has been known from the Indian region and other parts of Southeast Asia (east at least to Sulawesi), as well as southern China (Hampson, 1896; Wang *et al.*, 2003). Later, it was

1. Contribution No. 997, Entomology Section, Bur. Ent. Nema. Plant Path., Div. Plant Industry, Florida Dept. Agric. & Consumer Serv., Gainesville, Florida.

reported from Japan (Inoue *et al.*, 1982) and Taiwan (Heppner and Inoue, 1992).

The following subspecies is described for the Taiwan populations:

***Tamraca torridalis taiwana* Heppner, n. subsp.**

Adults similar (male 20-22mm wingspan; female 20-34), with similar wing maculation to those from Southeast Asia: body and forewing coloration mostly fuscous on FW costa and radius, plus similar small spot at mid-wing (near costa) and on subterminal line, with remainder of wing red-brown intermixed with yellow, plus some fuscous along anal margin. HW mostly fuscous, with central light tan area surrounded with yellow and red-brown between 2 curved fuscous lines angled to anal margin and base.

Holotype male: TAIWAN.—Nantou Co.: Lienhuachih For. Sta. (700m), nr. Puli, 7-12 Sep 1983, J.B. Heppner. Deposited with the National Taiwan Museum, Taipei, Taiwan (on indefinite loan to the Florida State Collection of Arthropods, Gainesville, Florida).

Paratypes (25 ♂, 16 ♀): TAIWAN.—*Ilan Co.*: 5 km. N. Nanao (100m), 11-13 Oct 1984, J. B. Heppner & H.-Y. Wang (3 ♂). Tuchia [Chilan For. Sta.] (480m), 1-2 Jul 1982, J. B. Heppner (1 ♂, 1 ♀). *Hualien Co.*: Kuyuan (750m), Taroko Gorge, 6-7 Jul 2005, J. B. Heppner (1 ♀). *Nantou Co.*: Lienhuachih For. Sta. (700m), 7-12 Sep 1983, J. B. Heppner (21 ♂, 14 ♀). All FSCA.

Etymology.—Named after the island of Taiwan.

Distribution.—Sri Lanka and India/Nepal to Malayasia and Indonesia (Sulawesi), and China to Japan for the nominate subspecies; Taiwan for the Taiwan subspecies.

Notes.—Although the species was collected in Taiwan in numbers in 1983 (two were taken earlier in 1982), the Taiwan Lepidoptera Survey since then did not find many more, indicating that overall it may be fairly rare. It is unclear at this time, but the population in Japan can likely be named as a Japanese subspecies: it is much more orange-brown than the Taiwan populations. The biology of the species remains unknown.

ACKNOWLEDGMENTS

The Taiwan Lepidoptera Survey project began in 1980 with organizational meetings at the National Taiwan Museum (then called the Taiwan Provincial Museum), in Taipei, by J. F. G. Clarke (Smithsonian Institution, Washington, DC), and the first survey trip was by Dr. Don R. Davis, Smithsonian Institution, Washington, DC, in 1981. All subsequent trips were by the author, since 1982, and were primarily funded by two National Science Foundation grants (INT-8119539 and INT-8721716), plus survey grants from the Smithsonian Institution and added support from the Florida State Collection of Arthropods, Division of Plant Industry, Florida Dept. of Agriculture and Consumer Services, Gainesville, Florida. In Taiwan, project support has been primarily from the National Taiwan Museum, Taipei, and the Taiwan Forestry Research Institute, Taipei, and their entomology staffs, as well as a publication grant from the Pacific Cultural Foundation, Taipei. Special thanks to H.-Y. Wang, National Taiwan Museum, for facilitating all field trips in Taiwan since 1982. Principal housing of survey specimens is with the Florida State Collection of Arthropods, Gainesville, Florida, for the study of the collections, plus samples at the Smithsonian Institution and the National Taiwan Museum, Taipei.

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DISTRIBUTION NOTES ON TAIWAN MOTHS, 5. *UDEA STIGMATALIS* (LEPIDOPTERA: PYRALIDAE: PYRAUSTINAE)

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ABSTRACT.— Notes are provided on specimens newly recorded from Taiwan of the Japanese species, *Udea stigmatalis* (Wileman). A Taiwan subspecies is described: *Udea stigmatalis tayulingensis* n. subsp.

KEYWORDS: Asia, China, East Asia, Japan, Oriental, *Udea stigmatalis tayulingensis* n. subsp., taxonomy.

The genus *Udea* includes many species from around the world. For Taiwan, the Taiwan catalog of 1992 (Heppner and Inoue, 1992) listed 5 species then known for the island. Some nomenclatural changes will be noted for some of the species in the catalog update (Heppner, 2005). Herein, collection records from the Taiwan Lepidoptera Survey are recorded for another *Udea* species new for Taiwan, being a high altitude example of the Japanese faunal influence in Taiwan, *Udea stigmatalis* (Wileman, 1911), originally described from Japan. Thus far, all specimens in Taiwan have only been taken at 2000-2570m elevation. Inoue *et al.* (1982) illustrate the species from Japan. The species has until now not been recorded outside of Japan.

All specimens reported on below are from the Taiwan Lepidoptera Survey, currently housed at the Florida State Collection of Arthropods (FSCA), Gainesville, Florida. A new Taiwan subspecies is described for the Taiwan populations of *U. stigmatalis*.

Udea stigmatalis tayulingensis Heppner, n. subsp.

Adult similar in size (male 22-24mm wingspan, female 22-26mm) to Japanese specimens, with similar wing maculation: body and forewing coloration fuscous (abdomen paler) with pale irrorations on FW, with basal suffusion of rust-brown to mid-costal region, with 2 irregular fuscous spots about midwing on radius. HW pale translucent white with apical gray area and small subterminal line, plus a small fuscous spot midwing. Female similar but FW spots somewhat larger than in male.

Holotype male: TAIWAN.— Nantou Co.: Tayuling (2570m), 5-9 Jun 1982, J.B. Heppner. Deposited with the National Taiwan Museum, Taipei, Taiwan (on indefinite loan to the Florida State Collection of Arthropods, Gainesville, Florida).

Paratypes (33 ♂, 30 ♀): TAIWAN.— Hsinchu Co.: Kuangwu For. Sta. (2000m), 18-25 Aug 1988 (1 ♂), J. B. Heppner & H.-Y. Wang. Kaohsiung Co.: Tienchih (2210m), 24 Oct 1984 (7 ♂, 2 ♀), J. B. Heppner & H.-Y. Wang. Nantou Co.: Tayuling (2570m), 5-9 Jun 1982 (9 ♂, 7 ♀); 10-14 Jun 1982 (6 ♂, 12 ♀); 15-18 Jun 1982 (9 ♂, 8 ♀), J. B. Heppner. Meifung Hort. Sta. (2100m), 6-10 Sep 1988 (1 ♂, 1 ♀), J. B. Heppner & H.-Y. Wang. Etymology.— Named after the town of Tayuling, Taiwan. Distribution.— Japan and Taiwan.

Notes.— The species *U. stigmatalis* seems related to two European species that have some resemblance to it, *Udea prunalis* ([Denis & Schiffermüller]) and *U. inquinatalis* (Lienig & Zeller). Males of the European *U. olivalis* ([Denis & Schiffermüller]) also have some resemblance to *U. stigmatalis*. In all these cases, the European species have some markings that are similar but nonetheless are all gray in general coloration, while *U. stigmatalis* in Japan and Taiwan

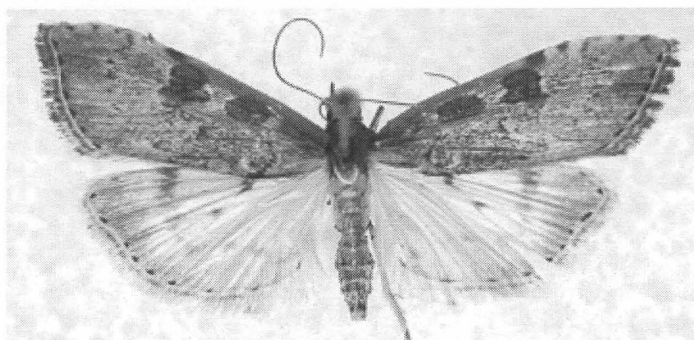


Fig. 1. Paratype female of *Udea stigmatalis tayulingensis*.

have shades of brown on the forewings. In Japan, the species is generally somewhat larger than in Taiwan and more brownish overall. The biology of the *U. stigmatalis* remains unknown. *Udea* species in general are known to be leaf-feeders on herbaceous plants, and some species also feed on various hardwood trees.

ACKNOWLEDGMENTS

The Taiwan Lepidoptera Survey project began in 1980 with organizational meetings at the National Taiwan Museum (then called the Taiwan Provincial Museum), in Taipei, by J. F. G. Clarke (Smithsonian Institution, Washington, DC), and the first survey trip was by Dr. Don R. Davis, Smithsonian Institution, Washington, DC, in 1981. All subsequent trips were by the author, since 1982, and were primarily funded by two National Science Foundation grants (INT-8119539 and INT-8721716), plus survey grants from the Smithsonian Institution and added support from the Florida State Collection of Arthropods, Division of Plant Industry, Florida Dept. of Agriculture and Consumer Services, Gainesville, Florida. In Taiwan, project support has been primarily from the National Taiwan Museum, Taipei, and the Taiwan Forestry Research Institute, Taipei, and their entomology staffs, as well as a publication grant from the Pacific Cultural Foundation, Taipei. Special thanks to H.-Y. Wang, National Taiwan Museum, for facilitating all field trips in Taiwan since 1982. Principal housing of survey specimens is with the Florida State Collection of Arthropods, Gainesville, Florida, for the study of the collections, plus samples at the Smithsonian Institution and the National Taiwan Museum, Taipei.

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Trop. Lepid. 215+80pp (76 pl.).

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PRIMITIVE SEDGE MOTHS FROM NEW ZEALAND AND TASMANIA: TRANSFER OF *PRODITRIX* AND RELATIVES TO ORTHOTELIINAE (LEPIDOPTERA: GLYPHIPTERIGIDAE)

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ABSTRACT.— The New Zealand genera, *Charixena* Meyrick, *Doxophytis* Meyrick, *Proditrix* Dugdale, *Protosynaema* Meyrick, and *Titanomis* Meyrick, in the past thought to be in Plutellidae or other families, are transferred to subfamily Orthoteliinae of the family Glyphipterigidae as the first non-European Orthoteliinae, a highly significant finding for elucidating the evolution of Glyphipterigidae and the superfamily Yponomeutoidea. *Orthotelia*, previously the only known member of primitive sedge moths (subfamily Orthoteliinae), shows many adult and larval characters that align it with the New Zealand *Proditrix* complex of genera and species. The Southern Hemisphere contingent of Orthoteliinae is seen as a relictual group within Glyphipterigidae, present thus far only in the ancient refugium of New Zealand, with one species in Tasmania. Adults are diurnal or crepuscular. Larvae of Orthoteliinae are borers in monocot hostplants (except for the single species in Tasmania feeding on a lower dicot plant), while most species in the subfamily Glyphipteriginae that are known biologically (95% of species in the family remain unknown biologically) are borers or leafminers, mostly also in monocot hostplants such as sedges and grasses.

KEY WORDS: *Abrenthia*, Acrolophidae, Asia, Australia, biology, Brachodidae, *Carmentina*, *Caunaca*, *Charixena*, China, Choreutidae, cocoon, Colombia, Costa Rica, *Cotaena*, Cyperaceae, *Diploschizia*, *Doxophytis*, *Drymoana*, Epacridaceae, Ericales, Europe, Japan, Glyphipteriginae, *Glyphipterix*, Gramineae, *Hierodoris*, hostplants, Immidae, Immoidea, Japan, Lacturidae, larvae, *Lepidotarphius*, morphology, *Neomachlotica*, Neotropical, Noctuidae, Noctuoidea, *Ochsenheimeria*, *Ochsenheimeriidae*, Oecophoridae, Oriental, *Orthotelia*, Pandanaceae, Palearctic, *Plutella*, Plutellidae, Praydinae, *Prays*, *Proditrix*, *Protosynaema*, Psychidae, pupae, *Sericostola*, Sesiioidea, Taiwan, Tasmania, taxonomy, Tineidae, Tineoidea, *Titanomis*, USA, Urodidae, Yponomeutidae, Yponomeutoidea, Ypsolophinae, Zygaenidae, Zygaenoidea.

When the family Glyphipterigidae was first delineated to modern taxonomic standards (Heppner, 1977, 1982a), a number of genera incongruously named or organized within the family by E. Meyrick (1914) were transferred to other families (Heppner, 1982b). Types and descriptions of 272 supposed or historically associated Glyphipterigidae genera were previously studied (Heppner, 1982b), and then transferred to 25 different families as diverse as Psychidae (Tineoidea) and Zygaenidae (Zygaenoidea), even small Noctuidae (Noctuoidea), plus large contingents to Choreutidae and Brachodidae (Sesiioidea), and many tropical genera to such families as Attevidae (Yponomeutoidea), Immidae (Immoidea), Lacturidae (Zygaenoidea), and Urodidae (Sesiioidea) (Heppner, 1981a, 1982b, 1982c, 1995, 1996; Kyrki, 1988, 1990). Genera remaining in Glyphipterigidae were a fairly homogeneous group that have retained their status (Heppner, 1982a), with the most speciose and worldwide genus being *Glyphipterix* (often misspelled as *Glyphipteryx* in older literature).

It was not until Kyrki (1984) began his studies of Yponomeutidae that this further grouping of unrelated genera was found needing re-study, and where he also had to transfer various genera to other families, although some went to what now can be considered subfamilies of Yponomeutidae, or Plutellidae (e.g., Ypsolophinae). Later, Kyrki and Itämes (1986) discovered in their study of the biology and morphology of the unusual misplaced and monobasic European genus *Orthotelia* Stephens (often misspelled as *Orthotaelia*), that this represented the most primitive sedge moth, and transferred the genus as a new glyphipterigid subfamily, Orthoteliinae. Meyrick's (1895) summary of British Lepidoptera had *Orthotelia* as a genus of Plutellidae, although his concept of this family was equivalent to half of what now are considered part of the superfamily Yponomeutoidea, plus the genera that now are in Choreutidae. Spuler (1910) already had the genus in its own subfamily, Orthoteli-

nae, but within Plutellidae. Older works, as summarized by Kyrki and Itämes (1986), had *Orthotelia* placed among other groups since Stephens first named the genus in 1829 (the single species was first described in 1794), even as disparate as Gelechiidae and Tineidae, and sometimes in its own monobasic family. None of these works, including later works by Meyrick (1895) and Spuler (1910), made any significant phylogenetic comments about the genus or offered much of a solution as to its affinities, other than a generalized phylogenetic schematic by Meyrick (1895) showing *Orthotelia* basal to lineages to what now are Yponomeutidae and Plutellidae. In his world catalog for the yponomeutid complex, Meyrick (1914) still retained the genus in Plutellidae. *Orthotelia* are larger and different in appearance from typical sedge moths of the subfamily Glyphipteriginae, but conform to the fundamental morphology of the family, as the subfamily Orthoteliinae.

In my earlier paper on generic transfers out of the older concept of Glyphipterigidae (Heppner, 1977), two Meyrick genera from New Zealand, *Charixena* and *Protosynaema*, appeared to belong best in Plutellidae and were retained or transferred to that family based on adult characters. Meyrick had described *Protosynaema* in 1886 (named in 1885) and placed it tentatively in Plutellidae (Meyrick, 1914). *Doxophytis* Meyrick (1914) was also described as Plutellidae, but Meyrick stated he thought it was related to Glyphipterigidae. It was not until a paper by Dugdale (1987a), on a new complex of strange New Zealand moths which he named in the new genus *Proditrix* and which he grouped together with some other unusual New Zealand species of related genera described by Meyrick — *Charixena*, *Doxophytis*, and *Protosynaema* — that it became evident to me that this group of New Zealand taxa actually represented the first non-European Orthoteliinae.

On adult characters, it could be possible to maintain *Proditrix* and relatives as Plutellidae, as Dugdale (1987a) thought (he used Plutellinae as a subfamily of Yponomeutidae), since to some extent the often plesiomorphic characters partially overlap in the families

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we are discussing, but the larval and pupal morphology, and their biologies, clearly are unknown for Plutellidae. Kyrki (1990) made further studies on possible evolutionary lineages in Yponomeutoidea, based on a cladification of the groups involved, later reviewed by Dugdale *et al.* (1999). All four of these New Zealand genera are borers in the leaf crowns of monocot hostplants (Dugdale, 1987a; Hudson, 1928), something unknown for Plutellidae, which typically are leaf skeletonizers on dicot plants (a small group are flower borers). Although it is not unusual to find strange tropical species that require us to alter the concept of Lepidoptera families, which were originally based mostly on European species, a study of the morphology of these New Zealand species demonstrates that they conform to Orthoteliinae and need a transfer to Glyphipterigidae to join *Orthotelia* as the most primitive of the sedge moths. Table 1 notes the main characters demonstrating the new assignments to Glyphipterigidae for the New Zealand species. Clearly, they represent evolutionary elements that are basal to much of the Yponomeutoidea.

Dugdale (1987a) noted a fauna of 12 species in New Zealand in the *Proditrix* group of genera, plus an undescribed species from Tasmania that he thought was possibly related to *Doxophyrtis*. Together with species Dugdale (1987a) transferred to his new genus, *Proditrix*, the check list below includes all species now transferred to Orthoteliinae, plus the one from Tasmania recently described as another species of *Proditrix* (McQuillan, 2003). Dugdale (1987a) included the New Zealand species, "*Hierodoris*" *stellata* Philpott, as the 12th member of this group; this species needs further study to confirm its generic placement. The genus *Hierodoris* Meyrick otherwise belongs in Oecophoridae (Dugdale, 1988; Heppner, 1977).

The species *Proditrix tetragona* (Hudson), was originally described in the genus *Titanomis* Meyrick and thought to belong in Tineidae, but Dugdale (1987a) verified this as belonging in his new genus *Proditrix*. The only actual known *Titanomis* species, *Titanomis sisyrota* Meyrick, previously left unclassified (Dugdale, 1988), is also a very rare species from the highlands of New Zealand. This species in the past was referred to Psychidae or even Cossioidea, due to its combination of primitive characters. The original description by Meyrick (1888) tentatively placed the genus in his concept of Anaphoridae (now Acrolophidae), and was maintained there by Dalla Torre and Strand (1929) in their catalog of Psychidae but which then included Anaphorinae. Further notes by Hudson (1928), and the known characters of *T. sisyrota*, lend credence to it also being in Orthoteliinae, and is hereby transferred to the *Proditrix* group. Dugdale (1987a) noted that *Titanomis* has 4-segmented maxillary palpi and lacks ocelli, among other characters now seen as close to *Orthotelia*. The biology and larvae are not known but the noted habitat is similar to that of the other New Zealand Orthoteliinae, namely montane wet grasslands (Hudson, 1928). It is even slightly larger than *P. tetragona* and also appears similar in wing maculation (illustrated by Hudson, 1928).

Whereas the type-species of the genera were examined for adult characters for my generic study of Glyphipterigidae (Heppner, 1977), other species were not all examined. Thus, it remains uncertain if some odd species, like *Protosynaema steropucha* Meyrick (Fig. 9) belong in the genus and in Glyphipterigidae, since the greatly thickened antennae are anomalous for the family. However, based on Dugdale's (1987a) analysis, these species are all placed correctly to genus, and can thus herein be transferred to Orthoteliinae, but perhaps individually needing further study. However, the undescribed species from Tasmania mentioned by Dugdale (1987a) as possibly related to *Doxophyrtis* from New Zealand, and now named as *Proditrix nielsenii* McQuillan (2003), feeds on an ericaceous-group tree (family Epacridaceae) and not a

monocot, so odd species sometimes do not conform to previous views. Although a few other sedge moths around the world are also known to feed on dicot plants, such as Piperaceae and Urticaceae (Diakonoff, 1986; Heppner, 1982a, in prep. a), most feed on monocots.

Most species in the family are not known biologically, so while the Holarctic and south temperate Glyphipterigidae have so far mainly been recorded on sedges, rushes and grasses, the tropical species that we know biologically thus far feed on more diverse plants, as just noted, but most species remain unknown biologically and detailed larval descriptions are even more scarce. At least for New Zealand Orthoteliinae, most appear to inhabit higher elevations with wet grasslands. The new species from Tasmania likewise occurs in a montane south temperate rainforest habitat (McQuillan, 2003).

As adults, most sedge moths are diurnally active (Heppner, 1981b, 1982a, 1985a, 2004, in prep. a). *Orthotelia* adults fly at dusk according to Kyrki and Itämes (1986). Dugdale (1987a) mentions some of the *Proditrix* species being collected at lights and also in flight traps, but it is likely most of these moths are crepuscular in adult activity. Typical Glyphipteriginae adults can be taken at lights as well, if one is near one of their resting sites at night, even though they are otherwise diurnal in activity. Hudson (1928) also notes species of what now are in the *Proditrix* complex as being taken at lights, but his text is often unclear whether any are also found during the day or at dusk. He notes diurnal activity, however, for the *Protosynaema* species. For *Doxophyrtis*, Hudson (1928) notes adults resting on hostplants during the day but is unclear if they otherwise are active diurnally or only at dusk. His notes on *Charixena* are very detailed about the larval life history, as well as the cocoon, but has no clear notes on adult activity. In Tasmania, McQuillan (2003) found the adults of the new *Proditrix* species there to be unwilling fliers, very sluggish and behaviorally adapted to death feints when disturbed among the leaves of their hostplant, and thus far not taken at lights, but no normal flight activity was recorded for this species.

One reason many of the *Proditrix* complex species seem to be rare may well be that they are active during the day or are crepuscular and are often in remote mountains, and thus not often taken at lights. Most moth collectors in general do not actively search for day-flying or crepuscular moths, if at all.

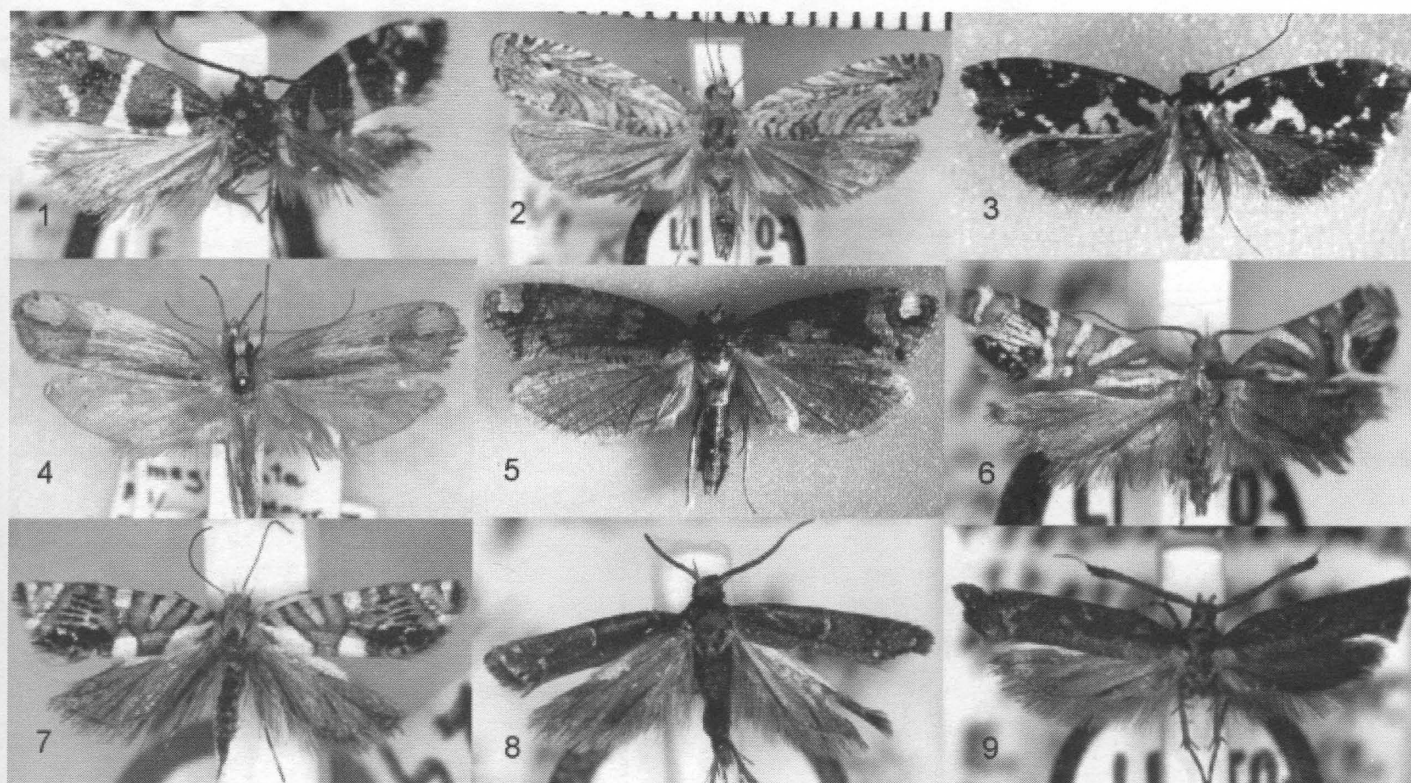


Fig. 1-9. Adults of New Zealand Orthoteliinae: 1. *Charixena iridoxa* (Meyrick), lectotype female (BMNH) (ca. 17mm). 2. *Doxophyrtis hydrocosma* Meyrick, lectotype male (BMNH) (ca. 20mm). 3. "*Hierodoris*" *stellata* Philpott, holotype male (NMNZ) (ca. 20mm). 4. *Proditrix megalynta* (Meyrick), holotype male (BMNH) (ca. 35mm). 5. *Proditrix tetragona* (Hudson), holotype female (NMNZ) (ca. 55mm). 6. *Protosynaema eratopis* Meyrick, lectotype male (BMNH) (ca. 16mm). 7. *Protosynaema hymenopis* Meyrick, holotype female (BMNH) (ca. 11mm). 8. *Protosynaema quaestuosa* Meyrick, lectotype male (BMNH) (ca. 16mm). 9. *Protosynaema steropucha* Meyrick, lectotype male (BMNH) (ca. 17mm).

ORTHOTELIINAE

ORTHOTELIA Stephens, 1829

TS: *Depressaria venosa* Haworth, 1811

Orthotelia Stephens, 1829, redesc.

Orthotaelia Stephens, 1834, emend.

Agonipteryx Treitschke, 1835

TS: *Haemylis sparganiella* Treitschke, 1832

Caulobius Duponchel, 1838

TS: *Haemylis sparganiella* Treitschke, 1832

sparganella (Thunberg, 1788) (*Tinea*) Sweden

sparganella (Thunberg, 1794) (*Tinea*), redesc. Sweden

venosa (Haworth, 1811) (*Depressaria*) England

tostella (Hübner, [1824]) (*Tinea*) Germany

sparganiella (Treitschke, 1832) (*Haemylis*) ?Hungary

TITANOMIS Meyrick, 1888

Titanomis Dalla Torre & Strand, 1929, missp.

TS: *Titanomis sisyrota* Meyrick, 1888

sisyrota Meyrick, 1888 New Zealand

PRODITRIX Dugdale, 1987

TS: *Plutella megalynta* Meyrick, 1915

chionochloae Dugdale, 1987 New Zealand

gahniae Dugdale, 1987 New Zealand

megalynta (Meyrick, 1915) (*Plutella*) New Zealand

nielsenii McQuillan, 2003 Tasmania

tetragona (Hudson, 1918) (*Titanomis*) New Zealand

tetragma Dugdale, 1999, missp.

DOXOPHYRTIS Meyrick, 1914

TS: *Doxophyrtis hydrocosma* Meyrick, 1914

Doxophyrtis Meyrick, 1914, nom. nud.

hydrocosma Meyrick 1914 New Zealand

hydrocosma Meyrick, 1914, nom. nud.

[New genus]

Hierodoris auct.

stellata (Philpott, 1918) (*Hierodoris*) New Zealand

CHARIXENA Meyrick, 1920

TS: *Philpottia iridoxa* Meyrick, 1916

Philpottia Meyrick, 1916, preocc.

Charixena Meyrick, 1921, redesc.

Charizena [sic] Neave, 1939, missp.

iridoxa (Meyrick, 1916) (*Philpottia*) New Zealand

PROTOSYNAEMA Meyrick, 1885

Protosynaema Meyrick, 1886

TS: *Protosynaema eratopis* Meyrick, 1886

eratopis Meyrick, 1886 New Zealand

hymenopis Meyrick, 1935 New Zealand

matutina Philpott, 1928 New Zealand

quaestuosa Meyrick, 1924 New Zealand

steropucha Meyrick, 1886 New Zealand

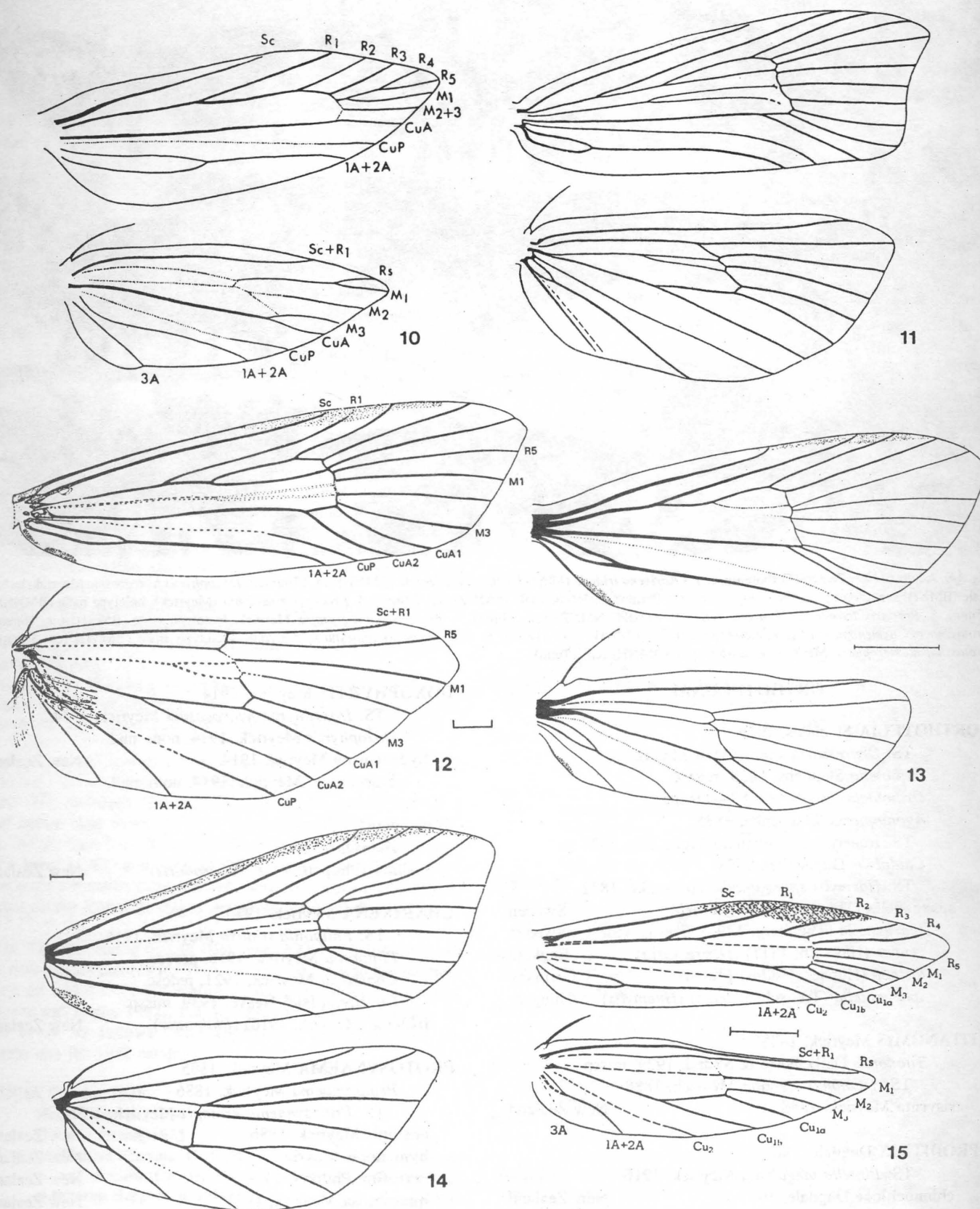


Fig. 10-15. Wing venations (Glyphipterigidae: Orthoteliinae and others as noted): 10) *Ochseneimeria vacculella* Fischer von Röslerstamm (Ochseneimeriidae), Europe (after Davis, 1975). 11) *Orthotelia spraganella*, Europe (after Spuler, 1910). 12) *Proditrix megalynta*, New Zealand (after Dugdale, 1987a). 13) *Glyphipterix quadragintapunctata* Dyar (Glyphipteriginae), USA (after Heppner, 1985). 14) *Sericostola rhodanopa* Meyrick (Glyphipteriginae), Colombia (after Heppner, 1990). 15) *Plutella xylostella* (Linnaeus) (Plutellidae), Eurasia (after Moriuti, 1977). Lines equate to 1mm for those figures with a line shown (others to various scales).

TABLE 1. Characters of Orthoteliinae in relation to Ochsenheimeriidae, Glyphipteriginae, and Plutellidae.

	Ocelli	Maxillary Palpi	Pupal Spines	Larval L-Group	Larval anal shield	Larval Prolegs	Larval Crochets	Larval A8 Spiracle	Larval Feeding	R1 spur vein
<i>Ochsenheimeria</i>	+	2	-	3	+	S	U/T1	N	B	--
<i>Orthotelia</i>	-	4	-	2	+	S	U/T2	L	B	--
<i>Titanomis</i>	-	4	?	?	?	?	?	?	?	+
<i>Proditrix</i>	+	3	-	3	+	S	U/P (C)	L	B	+
<i>Glyphipterix</i>	+	2-4	-	2(3)	+	S	U/P	L	B/LM	--
<i>Plutella</i>	+	4	-	3(2)	R	L	U/C	N	LS(FB)	--

Codes

Ocelli: present (+) or absent (-).

Maxillary palpi: number of segments.

Pupal spines: dorsal spination (some dorsal, lateral and ventral ridges may be present in some groups, like *Orthotelia* and *Proditrix*).

Larval L-group (prothoracic): number of setae.

Larval anal shield: dorsal shield present (+) or reduced (R).

Larval prolegs: short (S) or long (L).

Crochets: uniserial (U); transverse bands (T2) or in single row (T1); penellipse (P); circles (C).

A8 spiracle: normal (N) or enlarged (L).

Larval feeding: borers (B) or flower borers (FB); leafminers (LM); leaf skeletonizers (LS).

Characters distinguishing the New Zealand genera from Plutellidae while demonstrating cohesiveness with Orthoteliinae, in Glyphipterigidae, are summarized in Table 1. The table treats *Orthotelia*, *Titanomis* (adult characters only), and *Proditrix* in Orthoteliinae, *Glyphipterix* in Glyphipteriginae, plus the outgroups, *Ochsenheimeria* (Ochsenheimeriidae) and *Plutella* (Plutellidae). Information on Ochsenheimeriidae is taken mostly from Davis (1975) and Karsholt and Nielsen (1984); and notes on *Orthotelia* are from Kyrki and Itämes (1986), plus characters noted by Spuler (1910). Notes about Glyphipterigidae are taken from my works (Heppner, 1981b, 1982a, 1985a, 1990, 1998, 2004, in prep.), and from Arita and Heppner (1992) and Diakonoff (1986). Notes on Plutellidae are from Heppner (1998, 2004, in prep. a) and Dugdale *et al.* (1999). Biological data are from these references, as well as from Dugdale (1987a,b), Heppner (1987), Hudson (1928), and McQuillan (2003).

ORTHOTELIINAE

Adult: small to large (11-65mm wingspan); usually winged (rarely with slight female brachyptery). **Head:** vestiture somewhat rough-scaled; ocelli present or absent; chaetosema absent; eyes normal proportion; antenna filiform, sometimes thickened (rarely greatly thickened with scaling); labial palpi generally upcurved, with 2nd segment often tufted and apical segment smoother-scaled and upright; maxillary palpi 3- to 4-segmented and relatively prominent; haustellum present, naked. **Forewing:** elongated with typically oblique termen and tornal angle relatively abrupt; apex acute to rounded; costal margin with pterostigma or vestigial; venation complete and mostly evenly spaced veins, chorda developed and large; discal cell with forked median vein usually evident; venation with R1-R3 to costal margin, R4 to costa or at termen angle, and R5 to termen; median veins unbranched and M3 separate from CuA1, although may be very close at end of discal cell; cubital veins separate; CuP present at wing margin; anal veins present as A1+2 and A3; fringes moderate along termen. **Hindwing:** elongated with relatively acute apex, or somewhat blunted, and rounded tornal angle; venation similar to FW, with all veins present are rather evenly separated; discal cell with weak forked median vein evident; R5 to near apex or at apex, and usually straight from discal cell (rarely offset with R1 midwing spur

connection to Sc); median veins separate; M3 separate from CuA1; cubital veins distant at discal cell; CuP present at wing margin; anal veins as A1+2 and A3; fringes moderate but sometimes somewhat longer in some genera. **Abdomen:** dorsal spining absent; normal shape, without prominent sexual scaling or prominent choremata except small tufts at male pleural lobes; genitalia with male having pleural lobes configured with termen of abdomen, and female normal.

Larva: typically elongated and slender, with short prolegs; head usually somewhat prognathous; head setae with A1 close to A2, with A3 distant; P1 and P2 about subequal in separation as are A1 and A3; ocelli normal; prothorax with shield developed, L-group setae usually 2-segmented but some are 3-segmented, and SV setae on same pinaculum; abdomen with prolegs reduced or very short, crochets uniserial in transverse bands or small penellipse (rarely somewhat circular), SD1 setae above spiracle, SD2 usually very small, L1 and L2 setae separate and usually more distant from L3, spiracles enlarged on segment A8 and somewhat higher than remainder of spiracle line along abdomen, D1 setae usually somewhat closer together than D2 or about equidistant. Anal end of abdomen with prominent dorsal shield, often with strongly armed spurs or spines, and A8 with D1 setae more separated than D2 setae, and L1 distant from L2.

Pupa: head often with raspy process or horn-like structures; appendages all evident; spiracles usually somewhat protruded or on small cones; abdomen often roughened but not spined, but sometimes with prominent ridges (both dorsally and ventrally); cremaster with strong spines. Pupa not generally protruded from cocoon at eclosion but sometimes somewhat projected part-way from cocoon (*Orthotelia*).

Cocoon: flattened silken case with ends slit for emergence, or simple tubular silken structure within host stem and with pre-constructed emergence hole.

ADULT CHARACTERS

Among the genera treated, the head includes useful characters like the ocelli and maxillary palpi. All groups in Table 1 have ocelli present except *Orthotelia* and *Titanomis*. For maxillary palpi, the Glyphipterigidae have a range of 2-4 segments, while Ochsenheimeriidae have 2-segmented maxillary palpi and Plutellidae have 4 segments. As in archaic moths, the greater number of maxillary palpal segments is considered to be the primitive state, even though some otherwise ancestral groups can have developed reductions, as has Ochsenheimeriidae (2 segments) among the Yponomeutoidea.

In Glyphipterigidae, the genera vary in the number of segments

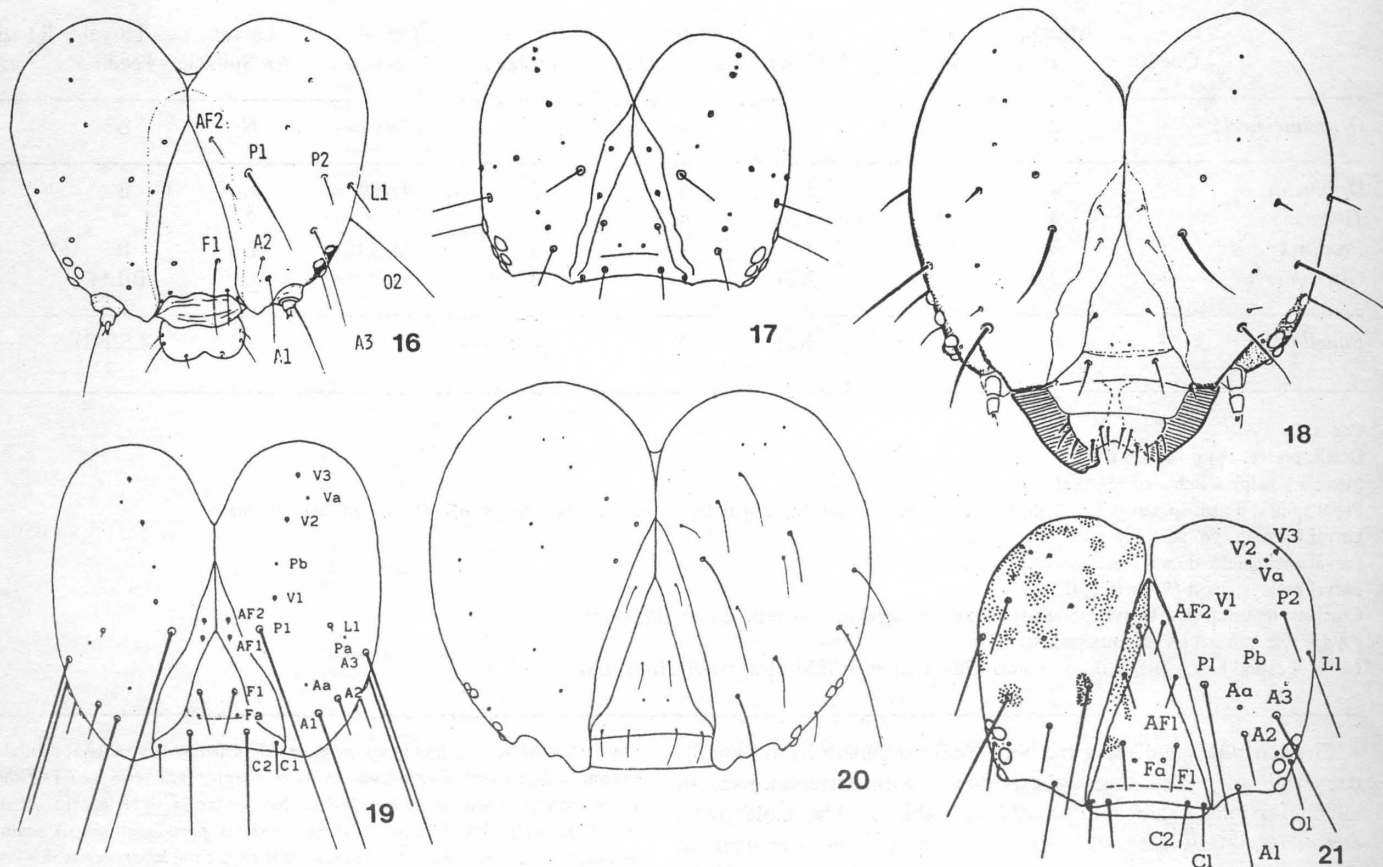


Fig. 16-21. Larval head chaetotaxy (Glyphipterigidae except as noted): 16) *Ochsenheimeria* (Ochsenheimeriidae), Europe (after Davis, 1975). 17) *Orthotelia* (Orthoteliinae), Europe (after Kyrki and Itämes, 1986). 18) *Proditrix megalynta* (Orthoteliinae), New Zealand (after Dugdale, 1987a). 19) *Glyphipterix scirpi* Arita (Glyphipteriginae), Thailand (after Arita, 1995). 20) *Glyphipterix semiflaviana* Issiki (Glyphipteriginae), Japan (after Moriuti, 1960). 21) *Plutella xylostella* (Plutellidae), Europe (after Moriuti, 1977). Fig. 19 and 21 with stylized setae as drawn.

in the maxillary palpi from 2 to 4 segments: for example, *Orthotelia* (4), *Titanomis* (4), *Proditrix* (3), *Abrenthia* (3), *Neomachlotica* (3), *Drymoana* (4), *Lepidotarphius* (2), *Carmentina* (2, vestigial), *Sericostola* (2), *Glyphipterix* (2-4), and *Diploschizia* (2). The genus *Orthotelia* is European, *Lepidotarphius* is East Asian (northern China and Japan), *Carmentina* is tropical Oriental, *Proditrix* and relatives are from New Zealand and Tasmania, and *Sericostola* is from Colombia and Costa Rica, while the remainder are Nearctic except for the worldwide genus *Glyphipterix* (Diakonoff, 1986; Heppner, 1981b, 1982a, 1985a, 1990, 1998, 2003, in prep. a,b; Spuler, 1910).

Wing venation of the *Proditrix* group (Dugdale, 1987a) conforms very well with the venation found in *Orthotelia* (Spuler, 1910). The only significant difference is that in *Proditrix* the hindwing Rs (or R5) vein is offset mid-wing by an R1 spur connection (Fig. 12), which is a straight vein in *Orthotelia* (Fig. 11). The radial veins are the same in both wings, while in *Plutella* in the hindwing the first 2 radial veins are typically fused as M1+M2 at the discal cell and split near the termen (Fig. 15); both being separate in Orthoteliinae. The wing venation among Glyphipteriginae genera is more and more specialized in the smaller or more narrow-winged species, while the larger species are less so (Fig. 13-14). Females of *Proditrix megalynta* (Meyrick) are somewhat brachypterous, with shortened and pointed wings (Dugdale, 1987a), which is not evident elsewhere in the Glyphipterigidae.

The R1 hindwing spur vein connection to Sc is a very primitive character in Lepidoptera. Evidently, an ancient character that has been modified in most lepidopterans. One finds this still among some homoneurous archaic moths and also in various isolated genera among higher lepidopterans, as in Tineidae (*Ardiosteres* from Australia), Psychidae (*Homera* from Australia, *Thyridopteryx* from the New World, *Pseudarbela* from Southeast Asia, and many others), many Pyralidae, Urodidae (*Urodus* from the New World), many Zygaenidae, Ratardidae (*Ratarda* from Southeast Asia), and Lasiocampidae (*Heteropacha* from the USA). Otherwise, besides those groups with reduced venation, instead of a mid-wing R1 spur vein some other lepidopterans have retained a basal connection or part of the radius is merged with the Sc vein, as in Prodoxidae (*Tegeticula* from North America), Cecidosidae (*Cecidoses* from Argentina), Oecophoridae (*Thyrocopa* from Hawaii), many Gelechiidae, Attevidae (*Atteva* from the New World), Thyrididae (*Thyris* from Europe), many Pyralidae, Somabrachyidae (*Somabrachys* from North Africa), Megalopygidae (*Megalopyge* from the New World), many Tortricidae, many Geometridae, many Papilionidae, many Drepanidae, Bombycidae (*Bombyx* from Asia), and other Bombycoidea, as well as most Noctuoidea.

Genitalia characters of the *Proditrix* complex are not distinctive in being either Plutellidae or Glyphipterigidae, and certainly can be included in Orthoteliinae without any problem based on genitalia. Even the so-called pleural lobes in males, thought to be an apomor-

phic character for Yponomeutoidea (Kyrki, 1984), are also found in some Pyralidae (Heppner, 1998), although it remains unknown whether these are independently derived in the latter family.

Among Glyphipterigidae in general, the European *Orthotelia sparganella* (Thunberg) is a large species (18-28mm in wingspan) and is very different in appearance from most sedge moths (Kyrki and Itämies, 1986). However, the very large New Zealand species, *Proditrix megalynta* (29-38mm), is rather similar in superficial appearance to *Orthotelia*. The genus *Sericostola* (ca. 34mm), with two species from Colombia and Costa Rica, includes the largest known sedge moths from the New World in the subfamily Glyphipteriginae (Heppner, 1990), although the Neotropical genus *Cotaena* has very heavy-bodied, colorful species that average about 26mm in wingspan (in prep. c), and an undescribed sedge moth (genus uncertain) from Venezuela is about 22mm in wingspan. The largest species in Europe is *Glyphipterix loricatella* (Treitschke), with a wing expanse of 17-21 mm (Diakonoff, 1986; Kun and Szabóky, 2000). *Lepidotarphius perornatella* (Walker), an exceedingly colorful orange and green species from China and Japan (probably introduced to Taiwan with its garden hostplant), averages 13-19mm, and is the largest sedge moth from East Asia (Arita and Heppner, 1992; Diakonoff, 1986; Kodama, 1961).

The newly transferred New Zealand species in Orthoteliinae now are among the largest of all sedge moths, with *Proditrix* species being among the largest known: *P. megalynta* at 29-38mm in wingspan and *P. tetragona* (Hudson) at 44-55mm wingspan (Dugdale, 1987a). The latter species was described by Hudson (1918) and is one of the largest microlepidopterans in New Zealand outside of the Hepialidae. Its long-thought sister species, *Titanomis sisyrota*, is likewise a rare higher altitude (ca. 1000m) moth, known only by a few specimens, and the females are up to 65mm in wingspan, making it the largest known glyphipterigid. The new species from Tasmania, *Proditrix nielsenii*, is about the same size, at about 64mm in wingspan (McQuillan, 2003).

Most typical sedge moths, mainly in the genus *Glyphipterix*, average only about 8-10mm in wingspan (Diakonoff, 1986; Heppner, 1982a, 1985a, in prep.). Among the smallest species are *Diploschizia minimella* Heppner, from Florida (ca. 4.5-6mm) (Heppner, 1981b, 1985a), and the Taiwan species *Glyphipterix tona* Arita & Heppner (ca. 5-6mm) (Arita and Heppner, 1992).

LARVAL CHARACTERS

The primitive condition in the larvae appears to be 3 lateral (L-group) setae on the prothorax, as in Ochsenheimeriidae: this is 2 in *Orthotelia*, 3 in *Proditrix*, and 2 in other Glyphipterigidae where larvae are known. One New Zealand species of *Glyphipterix*, however, also has 3 L-group prothoracic setae, according to Dugdale (1987b). Plutellidae have 3 lateral prothoracic setae, but a few have only 2 (Praydinae). The bisetose L-group configuration has been thought typical for Glyphipterigidae, but the New Zealand species noted by Dugdale (1987b) as having a vestigial 3rd seta is a key indication that more species in the family may have this character state. We know at most 5% of the species of Glyphipterigidae biologically, and far fewer where the larvae have been described, and most of these are from the Holarctic region, not the tropics where more of the stranger species occur, like *Sericostola* in South America. Thus, having 3 prothoracic L-group setae is likely the ancestral larval state, as evidenced also in the *Proditrix* complex of Orthoteliinae from New Zealand. Unfortunately, as is often the case hindering phylogenetic analyses among the more obscure lepidopter-

ans in the world, the larvae of *Titanomis* remain unknown. Previously, we only had detailed larval chaetotaxy for *Orthotelia* and some Glyphipteriginae (Heppner, 1981b, 1985a, 1987; Kodama, 1961; Kyrki and Itämies, 1986; Moriuti, 1977; Werner, 1958).

Head chaetotaxy among the New Zealand species conform well to *Orthotelia* (Fig. 17-18), while *Glyphipterix* have the setae more varied (Fig. 19-20). However, few species have the larvae known or described, so overall generalities for the family still remain speculative to some extent.

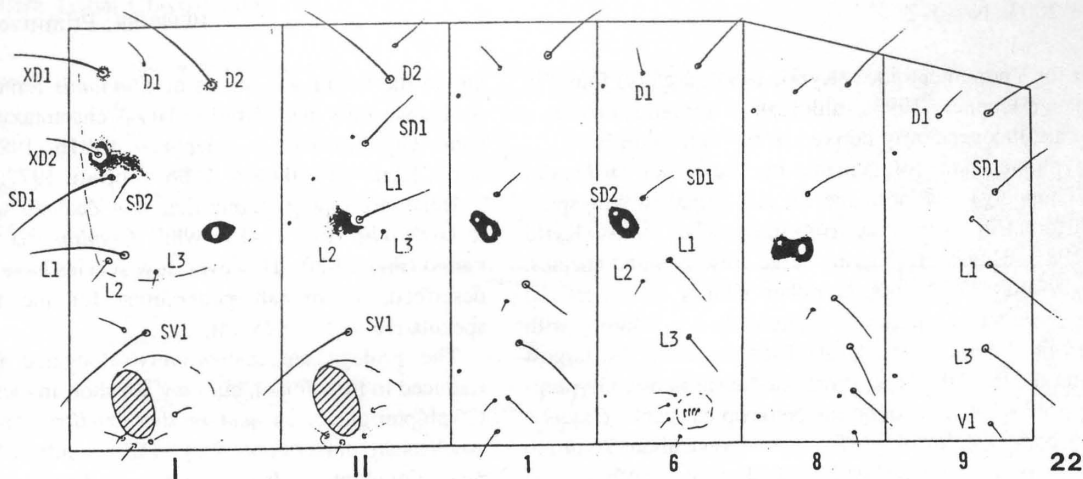
The prolegs are distinctively elongated in most Plutellidae (reduced in Praydinae), but they are short in Ochsenheimeriidae and Glyphipterigidae, as also in the *Proditrix* group of genera. The crochets are uniserial but vary in their configuration: a penellipse in most Glyphipterigidae, likewise in *Proditrix* but slightly more circular in some species, yet transverse bands in *Orthotelia*. Ochsenheimeriidae also have transverse bands but a reduced form with a single row of crochets. Plutellidae have crochets in uniserial circles.

Spiracles on abdominal segment 8 are normal (subequal in size) in Ochsenheimeriidae (Fig. 22) and Plutellidae (Fig. 26). Spiracles are distinctly enlarged in Glyphipterigidae (sometimes only slightly enlarged in some Glyphipterigidae but often very much so and protruded), and the segment 8 spiracles are also shifted somewhat dorso-laterally compared to where the other abdominal segment spiracles are on each abdominal segment (Fig. 23-25) (common to many lepidopteran larvae but more pronounced in Glyphipterigidae). The *Proditrix* group of genera likewise have these apomorphic larval characters. It should be noted that enlarged A8 spiracles are found in various other families of Lepidoptera. However, at least among Yponomeutoidea, this feature is more typical of Glyphipterigidae than for the other yponomeutoid families.

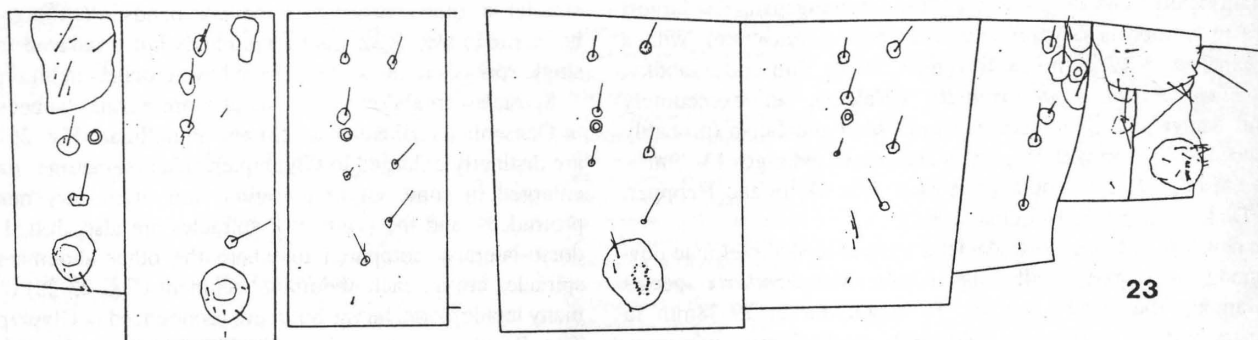
The anal dorsal shield of the larvae is usually well-developed and distinctively shaped in all groups mentioned (Fig. 28-33), while reduced in Plutellidae (Fig. 34). Another useful character for distinguishing Glyphipterigidae from Plutellidae, and one that likewise places the *Proditrix*-complex in Glyphipterigidae, is on the 9th abdominal segment, where in Plutellidae (Fig. 34) the D1 and D2 setae are close together and on merged pinacula, whereas in Glyphipterigidae (Fig. 28-33) they are more separate and on distinct pinacula. Spatulate setae, as in *Proditrix* on the 9th abdominal segment (Fig. 24, 29-30) are also known in larvae of the glyphipterigine genus *Lepidotarphius* (Fig. 25) and likely other genera once more of them are known biologically. In the Tasmanian species, *P. nielsenii*, these spatulate setae are missing, however.

Larval feeding is typically as leaf skeletonizers in Plutellidae, as in the well-known diamondback moth, *Plutella xylostella* (Linnaeus), but most Glyphipterigidae are stem borers or borers in seeds, sometimes as leafminers. The *Proditrix* group of genera all are stem borers as far as is known, as are also *Orthotelia* and Ochsenheimeriidae (start as leafminers and then become stem borers). The Tasmanian *P. nielsenii* has somewhat modified feeding, in preferring the crown area of leaf buds and then into the leaf axils of the giant leaves of the pandanus-like host it uses. The feeding behavior of stem boring, and the concomitant larval modifications, are particularly striking in not being known in Plutellidae, where the few borers that are known feed only in flower heads (Praydinae). Some works erroneously place Praydinae in Yponomeutidae, instead of Plutellidae (Heppner, 1998, in prep.).

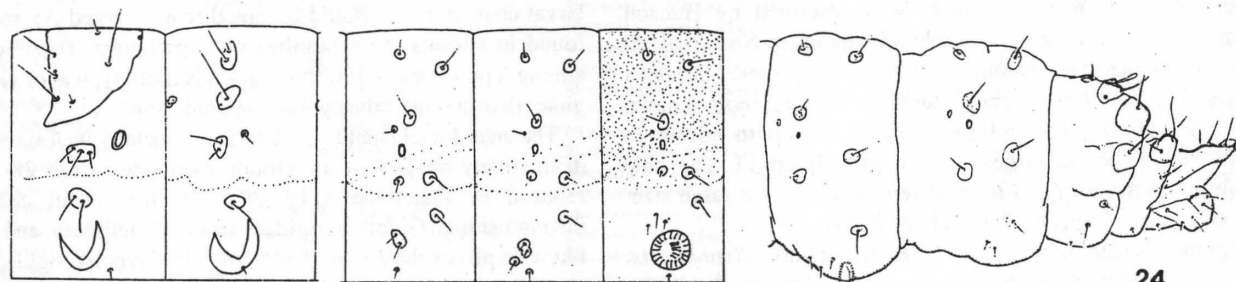
The *Proditrix* complex of species feed on tussock grasses (*Chionochloa* spp.; Gramineae) in New Zealand (Dugdale, 1987a), or other plants with water-holding leaves (the sedges *Carex* sp. and *Gahnia*



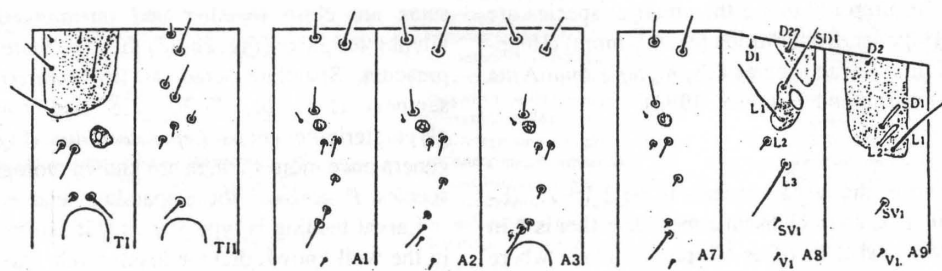
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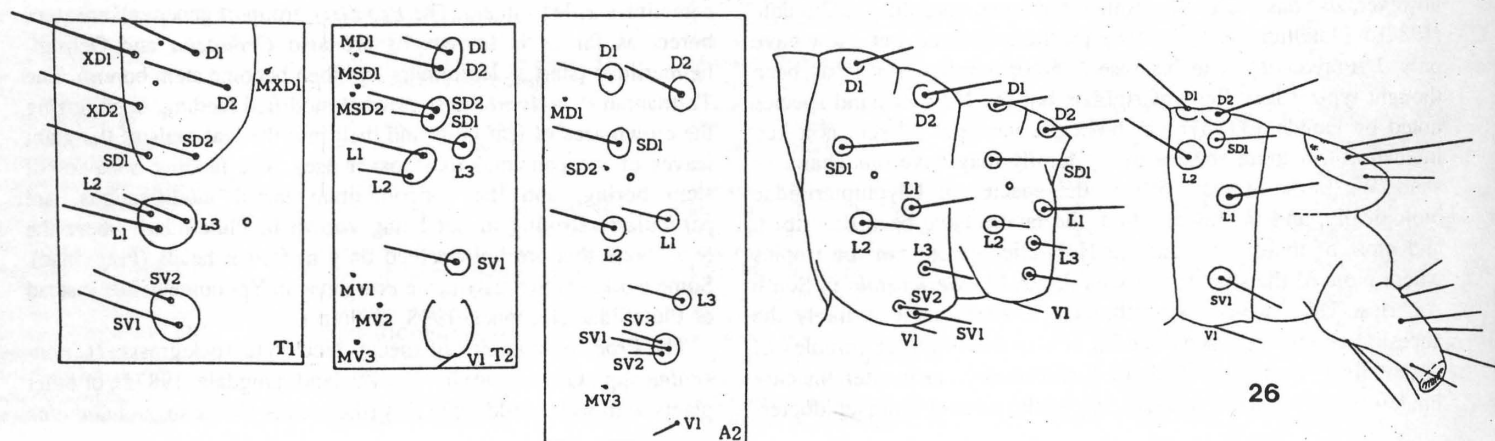
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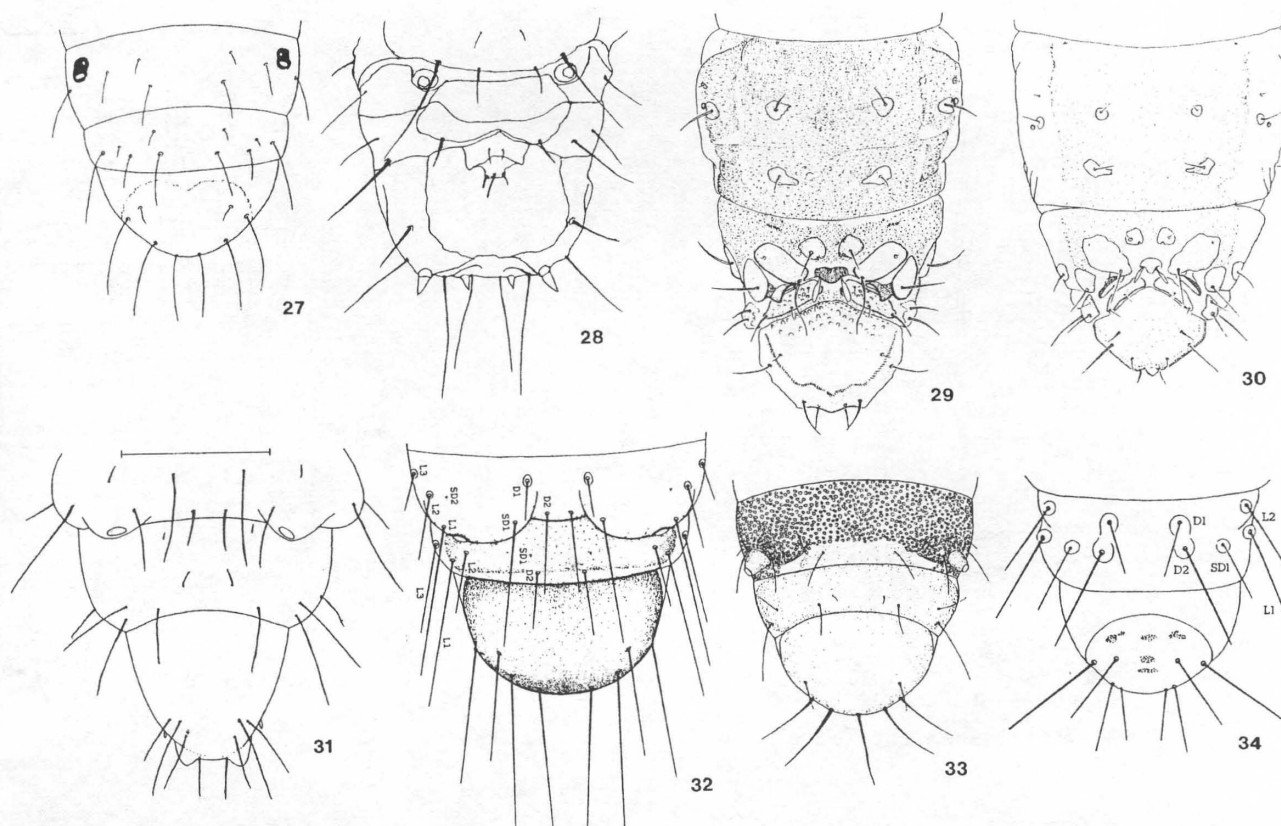


Fig. 27-34. Posterior ends of larvae, segments 8-10 (dorsal view) (Glyphipterigidae except as noted): 27) *Ochsenheimeria* (Ochsenheimeriidae), Europe (after Davis, 1975). 28) *Orthotelia* (Orthoteliinae), Europe (drawn after Kyrki and Itämes, 1986). 29) *Proditrix tetragona* (Orthoteliinae), New Zealand (after Dugdale, 1987a). 30) *Proditrix megalynta* (Orthoteliinae), New Zealand (after Dugdale, 1987a). 31) *Glyphipterix semiflavana* (Glyphipteriginae), Japan (after Moriuti, 1960). 32) *Glyphipterix scirpi* (Glyphipteriginae), Thailand (after Arita, 1995). 33) *Diploschizia habecki* Heppner (Glyphipteriginae), USA (after Heppner, 1981). 34) *Plutella xylostella* (Plutellidae), Europe (after Moriuti, 1977). Fig. 32 and 34 with stylized setae as drawn; Fig. 27 and 31-34 with stylized segmental forms as drawn.

setifolia, in Cyperaceae, the lilies *Astelia cockaynei* and *Collospermum hastatum* in Liliaceae, and *Freycinetia banksii* in Pandanaceae). The Tasmanian species feeds on foliage of a small pandanus-like tree, *Richea pandanifolia* (Epacridaceae), which is an ericaceous-related (Ericales) dicot plant (Dugdale, 1987a; McQuillan, 2003). Some other glyphipterigids around the world also feed on various dicot plants, although most are on sedges and rushes, or grasses. The use of mostly tussock grasses, or other monocots, as hostplants, however, conforms to the hosts of typical New Zealand glyphipterigid moths (genus *Glyphipterix*), which in New Zealand are called tussock moths, or cocksfoot moths, rather than sedge moths. At least some of the species do enough feeding on pasture and range grasses in New Zealand to be considered pests (White, 2002). Hudson (1928) presented most of the known biologies for the species, later elaborated on by Dugdale (1987a) for some of them.

PUPAL CHARACTERS

All genera discussed lack dorsal pupal spines, as is typical for Yponomeutoidea. The large pupae of *Orthotelia* and *Proditrix* do have some abdominal ridges (Fig. 35-36), both dorsally and laterally and even ventrally, but not spines as in Tortricidae and other primitive Microlepidoptera. However, all have the spiracles raised out from the pupal body, even in Plutellidae, but they are reduced in Orthoteliinae and Ochsenheimeriidae (Fig. 35-41). Some Ypono-

meutidae have this feature of the spiracles even more pronounced.

The few Glyphipteriginae pupae known show advanced characters, such as having the labial palpi exposed away from the labrum (Fig. 37-39), while in Orthoteliinae (Fig. 35) as also in Plutellidae (Fig. 40-41), the labial palpi touch the labrum, but the configuration among the more primitive Glyphipteriginae (e.g., the genera *Carmentina* and *Cotaena*, among others) is not known.

The cocoons in Glyphipterigidae and Plutellidae have rather distinctive filigreed or mesh-work form in an elongated shape. These cocoons are rather delicate silken construction in most sedge moths, but in some genera, like the Neotropical *Cotaena*, the large cocoons are very strongly constructed, yet with an open mesh-work form nonetheless. The only other families that also have such cocoons among the Microlepidoptera are Urodidae, in Sesiioidea, and Lacturidae, in Zygaenoidea (some Saturniidae, for example, make unusual filigreed cocoons, among the macro moths). There also are some similar cocoon examples among Acrolepiidae and in the tineoid family Schreckensteiniidae. In Ochsenheimeriidae, the cocoon is a simple silken case but few of the species are known biologically. In the New Zealand *Proditrix* complex, the cocoon is a flattened silken case, open at both ends as small slits in the webbing. The cocoon of *Orthotelia* is a simple form within the host stem, with an external silken flap over a pre-constructed emergence hole.

Fig. 22-26. Larval chaetotaxy (Glyphipterigidae except as noted): 22) *Ochsenheimeria* (Ochsenheimeriidae), Europe (after Davis, 1975). 23) *Orthotelia* (Orthoteliinae), Europe (after Kyrki and Itämes, 1986). 24) *Proditrix tetragona* (Orthoteliinae), New Zealand (after Dugdale, 1987a). 25) *Lepidotarphius perornatella* (Walker) (Glyphipteriginae), Japan (after Kodama, 1961). 26) *Plutella xylostella* (Plutellidae), Europe (after Moriuti, 1977). Fig. 26 with stylized setae as drawn.

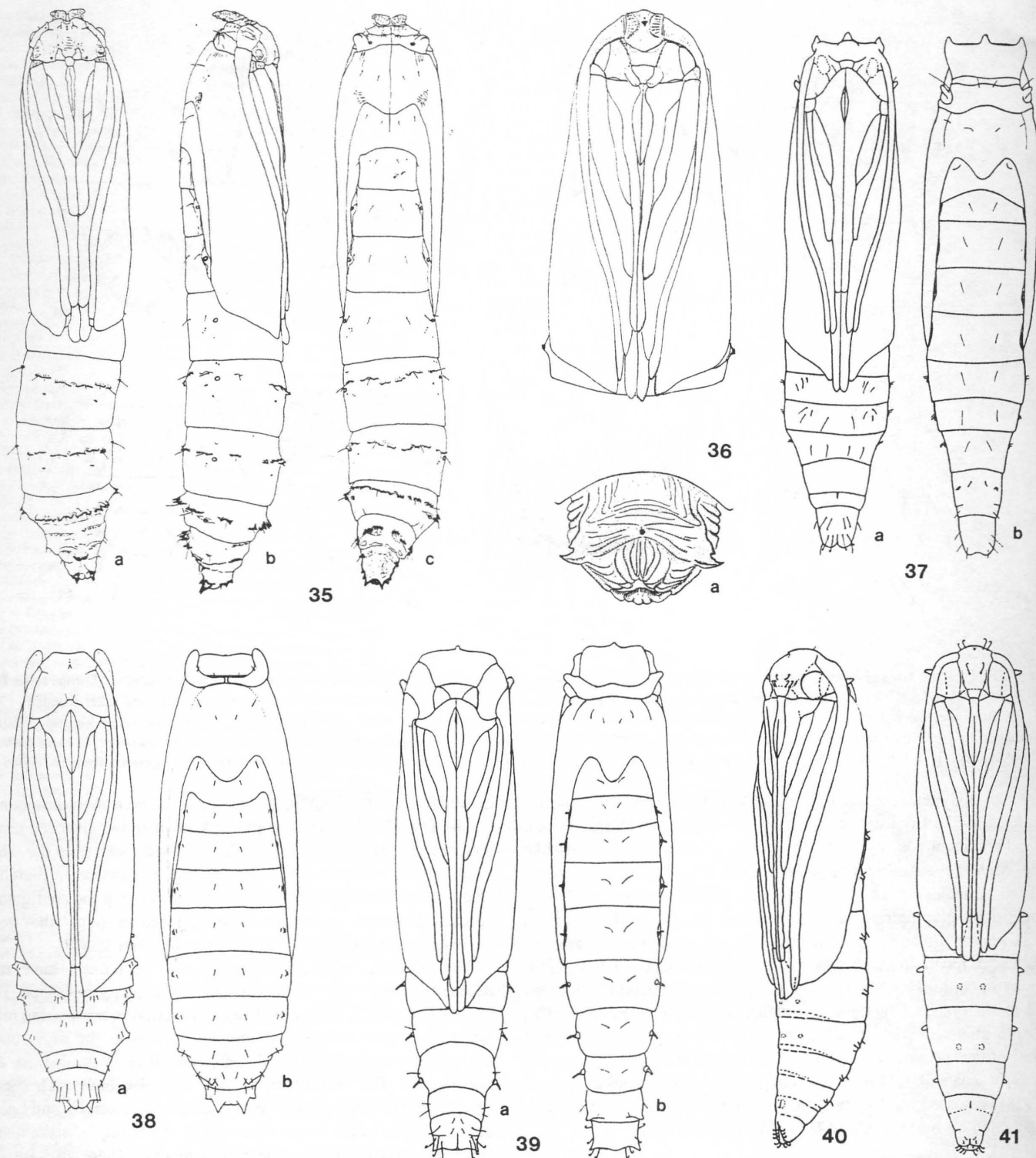


Fig. 35-41. Pupae (Glyphipterigidae except as noted): 35) *Orthotelia* (Orthoteliinae), Europe (after Kyrki and Itäemies, 1986) (a, ventral view; b, lateral; c, dorsal). 36) *Proditrix gahniae* (Orthoteliinae), New Zealand (after Dugdale, 1987a) (a, cremaster detail). 37) *Glyphipterix semiflavana* (Glyphipteriginae), Japan (after Moriuti, 1960) (a, ventral; b, dorsal). 38) *Glyphipterix scirpi* (Glyphipteriginae), Thailand (after Arita, 1995) (a, ventral; b, dorsal). 39) *Diploschizia habecki* (Glyphipteriginae), USA (after Heppner, 1981) (a, ventral; b, dorsal). 40) *Plutella xylostella* (Plutellidae), Europe (after Moriuti, 1977) (ventro-lateral view). 41) *Caunaca sera* (Meyrick) (Plutellidae), New Zealand (after Moriuti, 1977) (ventral view).

CONCLUSIONS

As noted above, the range of characters demonstrates that the New Zealand group of genera that Dugdale (1987a) thought to be very odd Plutellidae (or Yponomeutidae), are in fact primitive Glyphipterigidae and conform well to the European subfamily

Orthoteliinae, previously a monobasic group with a single odd genus. The south temperate genera related to *Proditrix*, as noted earlier, could be placed in Plutellidae on adult characters, since superficially they look like odd and very large plutellids, but the wealth of characters of the immature stages and the feeding habits clearly show the relationships to orthoteliine Glyphipterigidae. Thus,

they represent the first Southern Hemisphere members of this unusual subfamily, rather than being odd Plutellidae as noted by Dugdale (1987a).

The addition of so many New Zealand species to Orthoteliinae, plus one from Tasmania, is highly significant for the world phylogeny of Glyphipterigidae and Yponomeutoidea, demonstrating that there was a larger ancient fauna of this progenitor group than first thought, and with possibly their last remnants are most prevalent in the isolated faunal refugium that is New Zealand, as also Tasmania, rather than in Europe. The plate showing adults (Fig. 1-9) illustrates most of the New Zealand *Proditrix* complex of species; others are illustrated in Dugdale (1987a) and Hudson (1928).

No species related to the *Proditrix* complex are thus far known for Australia, other than the single species from Tasmania (Dugdale (1987a; McQuillan, 2003), but more may be found in such places as New Caledonia, or even in the high mountains of New Guinea. One can speculate that perhaps more Orthoteliinae also await discovery in remote regions of the Himalayas, in Nepal or southwestern China. None are known from the Himalayan-originating fauna of the high mountains of Taiwan. Survey studies over the past 25 years, as in Nepal and Borneo, have all concentrated on macro-moths, so the Microlepidoptera are still relatively unknown for these areas. Thus far, none have been discovered in austral South America (Heppner, in prep. b). The status of some of the other New Zealand Plutellidae need to be re-examined to be certain they are all true Plutellidae, or possibly also members of Orthoteliinae in Glyphipterigidae, or even Glyphipteriginae.

Other Glyphipterigidae may also still remain hidden among the conglomeration of genera and odd species already described in Yponomeutidae and Plutellidae today in most regions of the world. One need only look among the genera and species illustrated by Clarke (1955) of Meyrick types at the Natural History Museum (BMNH), London, to see what appear to be misplaced genera and species, and with some belonging in such families as Lacturidae and Urodidae, but a few even likely candidates for Gelechioidea, and still a few that may also belong in Glyphipterigidae. As noted earlier, my original generic study of what Meyrick had placed in Glyphipterigidae (Heppner, 1977) only treated genera and what species they then included. Thus, Plutellidae and Yponomeutidae were not systematically studied at that time to find odd species or genera that should be in Glyphipterigidae or other families. Even so, since then a few others have been identified and culled out of Yponomeutidae, as for example my placement of *Sericostola* to Glyphipterigidae (Heppner, 1990) and the transfer of the genus *Telosphrantis* to Choreutidae (Heppner, 1985b). Suffice it to say, that all Yponomeutidae and Plutellidae taxa throughout the world require re-checking to verify their family placement, other than those, of course, that are clearly typical for the families such as the type-genera for each family. The significant finding that the odd *Proditrix*-complex, thought to be Plutellidae, is actually part of orthoteliine Glyphipterigidae, demonstrates what may be hidden among all the other odd tropical genera of Yponomeutidae and Plutellidae, and which have important implications on the evolution of the group that should spur on such searches by other interested researchers.

New Zealand harbors an exceedingly rich fauna of Glyphipterigidae, given the size of its landmass, with some 47 species now identified in the family, although most are in the worldwide genus *Glyphipterix* (33 sp. in New Zealand). Likewise, Tasmania has about

7 endemic *Glyphipterix* species (Heppner, 1982a) for its small size, plus the single species of *Proditrix*. Both of these south temperate regions could reasonably have even more species of Glyphipterigidae, once more intensively investigated for the less-collected day-flying moths. This compares with Taiwan, which is more tropical yet has a sedge moth fauna of only 29 species (Arita and Heppner, 1992). Austral South America, previously without any recorded species of Glyphipterigidae, has about 16 species awaiting description (Heppner, in prep. b), the species about equally divided between Chile and Argentina: these are all typical sedge moths in Glyphipteriginae, and no Orthoteliinae have thus far been discovered. The entire continental region of North America, north of Mexico, has only 44 species (Heppner, 1981, 1985a, 1997a,b). All regions of the world need to be investigated more to determine if any further Orthoteliinae are hidden among odd Plutellidae that have not been studied much, as already noted, particularly in Africa, Asia, and possibly even in South America (especially austral South America and in the Andes).

With the presence of at least one New Zealand species in the main glyphipterigid genus *Glyphipterix* having 3 lateral prothoracic setae in the larvae (Dugdale, 1987b), and this being the character state in the *Proditrix* complex, one can see that New Zealand harbors an ancient refugium for the family where many Orthoteliinae are present as a relictual group from the lineage to Glyphipteriginae. Elsewhere, only the single European species of *Orthotelia* remains of this ancient group of species. The isolated southern land of New Zealand is well known as a Gondwanaland distribution refugium for other ancient groups of plants and animals, as are Tasmania, Australia, South Africa, and Chile, all likely places to search for more Orthoteliinae species, possibly hidden among unstudied Plutellidae genera there, or awaiting discovery.

My view is that there is an evolutionary relationship from ancestral Ochsenheimeriidae to the primitive Glyphipterigidae, which is now more evident in this enlarged Orthoteliinae subfamily, as evident in the larval and other characters outlined above. Plutellidae are likely developments from Orthoteliinae ancestors, as are the Glyphipteriginae. One would say that Ochsenheimeriidae and Glyphipterigidae are sister groups in cladistic terms, possibly with this combination being a sister group to Plutellidae and higher Yponomeutoidea. Cladologists may find this paraphyletic, but in a phylogenetic classification (rather than a cladification) this can occur.

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ADDITIONS TO THE BIBLIOGRAPHY OF BUTTERFLIES, IN THE ATLAS OF NEOTROPICAL LEPIDOPTERA No. VI. COMPRISING MOSTLY WORKS PUBLISHED IN 2001

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The fifth set of *Additions* to the annotated *Bibliography of Butterflies* (Lamas, Robbins, and Field, 1995) in the series *Atlas of Neotropical Lepidoptera*, Vol. 124, was published recently (Lamas, 2002, *Lepidoptera News* 2002(1/2): 49-64). The 316 additional references included herein comprise mostly works published in 2001, such as were recorded until December 31st, 2002.

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NEUROBATHRA LEAFMINER RECORDS ON *JATROPHA* NEW TO FLORIDA (LEPIDOPTERA: GRACILLARIIDAE)

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The leafminer moth, *Neurobathra curcassi* Busck, was originally described from Cuba (Busck, [1934]) from specimens reared on leaves of psychic nut, *Jatropha curcas* (Euphorbiaceae), a somewhat medicinal plant from Mexico and northern South America, and grown throughout the Caribbean. For a number of years (records are from as early as 1975), and possibly longer, a leafminer has been known on *Jatropha* in southern Florida (tentatively noted as "*Caloptilia* sp.") but had not been identified with certainty. Recent studies of available specimens, plus the fact that the Cuban species also mines the leaves of *Jatropha* plants, indicated that the Florida species could be *N. curcassi*. Don Davis (pers. comm.) (Smithsonian Institution, Washington, DC), who is revising the Gracillariidae for North America, notes that two new species of the genus are now known for southern Florida, one of which was reared from *Jatropha* plants, but that *N. curcassi* has not yet been confirmed to be among these new records.

The genus *Neurobathra* contains 3 described species, with two previously being found in the USA, and one of these also in Florida: *N. strigifinitella* (Clemens), a leafminer on oaks. Additionally, we have the two new species already mentioned above. It should be noted that it is conceivable that some of the records below may refer to another species (or that part of the records are mixed), since *N. curcassi* could also be in southernmost Florida, but thus far it has not been confirmed. Thus, the records below most likely are for the new species on *Jatropha* in Florida being described by Davis. While these records cannot be absolutely confirmed as the new species, it may be of interest to note the available DPI records for the leafminer on *Jatropha*. Most of these records refer only to the leafmine, and available specimens of adults lack abdomens, so species confirmation cannot be obtained for these records. Appearances of the adults are similar to *N. curcassi* but genitalic examination is required to determine the exact species.

The exact date of appearance for the species in Florida is not known but likely it is a native species. Rearings from two *Jatropha* species in 1983 were from Pompano Beach (Broward Co.) and Hialeah (Dade Co.); and the earliest records available are from North Miami (1975), Ft. Myers (1976), and Naples (1977, 1979). Inasmuch as these Florida records are so widespread (Miami to Ft. Myers), it is likely that the moth has been in Florida for many years previous to 1975 and is not a recent import from the Caribbean. However, all *Jatropha* species in Florida are naturalized from tropical America. There are about 180 species of *Jatropha* known in tropical America, and three of these occur as far north as southern and western Texas, and may also host *Neurobathra* species as leafminers. The *jatropha* leafminer from Cuba, *N. curcassi*, has been recorded on 4 or 5 species of *Jatropha*; thus, it may even feed on a number of additional species of the plant genus.

The Florida records are from along both coasts of Florida, from Key Largo to Ft. Pierce (St. Lucie Co.) on the Atlantic Coast, and to Palmetto (Manatee Co.) on the Gulf Coast. This distribution is typical of other moths and tropical plants of the Caribbean that can survive along the Florida coasts as far north to where occasional winter frosts are too se-

vere (the latitude of Tampa Bay) for them to survive, although some tropical species in Florida can go further north on the Atlantic coast as far as Cape Canaveral.

Records of the Florida *jatropha* leafminer include the following (DPI = Division of Plant Industry records; FSCA = Florida State Collection of Arthropods); all are larval records (DPI), except the FSCA records (from Pompano Beach):

Broward Co.

Ft. Lauderdale, 21 Nov 1991, ex *Jatropha* sp., L. Ooms (DPI)
Plantation, 2 Aug 1994, ex *Jatropha integerrima*, K. Vanyo (DPI)
Pompano Beach, 30 Sep 1983, ex *Jatropha curcas*, D. Leone (DPI/FSCA)

Collier Co.

Naples, 8 Jun 1979, ex *Jatropha* sp., K. Delate (DPI)
11 Aug 1993, ex *Jatropha integerrima*, M. Brodie & R. Buchholz (DPI)
18 Nov 1977, ex *Jatropha multifida*, G. Gwin (DPI)

Dade Co.

Hialeah, 8 Mar 1984, ex *Jatropha integerrima*, L. Chang & L. Davis (DPI)
19 Aug 1983, ex *Jatropha curcas*, M. Thurmond (DPI)
Miami, 14 Mar 1988, ex *Jatropha integerrima*, D. Storch (DPI)
23 Mar 1984, ex *Jatropha* sp., P. Perun (DPI)
24 Oct 1985, ex *Jatropha curcas*, R. Burns & A. Hamon (DPI)
North Miami, 9 Jan 1975, ex *Jatropha hastata*, D. E. Sager (DPI)
North Miami Beach, 23 Sep 1983, ex *Jatropha* sp., P. Perun (DPI)

Lee Co.

Ft. Myers, 23 Jul 1976, ex *Jatropha* sp., W. T. Walsh (DPI)
26 Aug 1987, ex *Jatropha integerrima*, D. L. Warkentin (DPI)

Manatee Co.

Palmetto, 6 Jul 1995, ex *Jatropha curcas*, J. gossypifolia, M. Runnals (DPI)

Monroe Co.

Key Largo, 17 May 1978, ex *Jatropha multifida*, P. Chobrd & W. E. Wyles (DPI)

Palm Beach Co.

Boynton Beach, 27 May 1994, ex *Jatropha integerrima*, S. Cook (DPI)
Palm Beach Gardens, 6 Jan 1983, ex *Jatropha integerrima*, P. Wright-Koll (DPI)

St. Lucie Co.

Ft. Pierce, 17 Sep 1983, ex *Jatropha* sp., K. Hibbard (DPI)
Ft. Pierce, 1 Dec 1983, ex *Jatropha* sp., K. Hibbard (DPI)

Sarasota Co.

Sarasota, 11 Apr 1980, ex *Jatropha hastata*, J. McFarlin (DPI)

Biology.—Recorded hosts above include *Jatropha* sp., *J. curcas*, *J. gossypifolia*, *J. integerrima*, *J. multifida* (Euphorbiaceae) (*J. hastata* = *J. integerrima*). Larvae mine the leaves.

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¹ Contribution No. 924, Entomology Section, Bur. Ent. Nema. Plant Path., Div. Plant Industry, Florida Dept. Agric. & Consumer Serv., Gainesville, FL.

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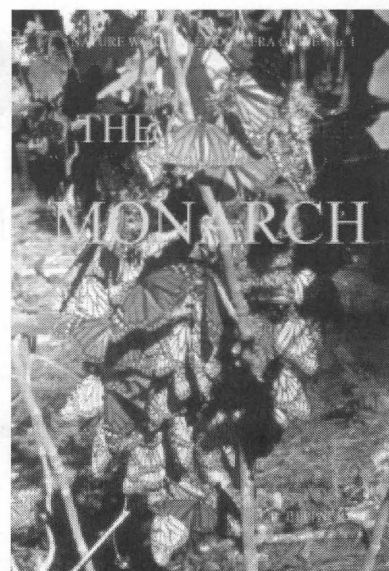
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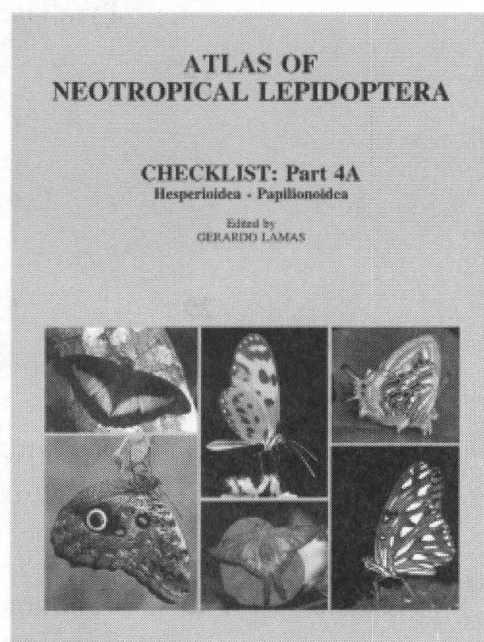
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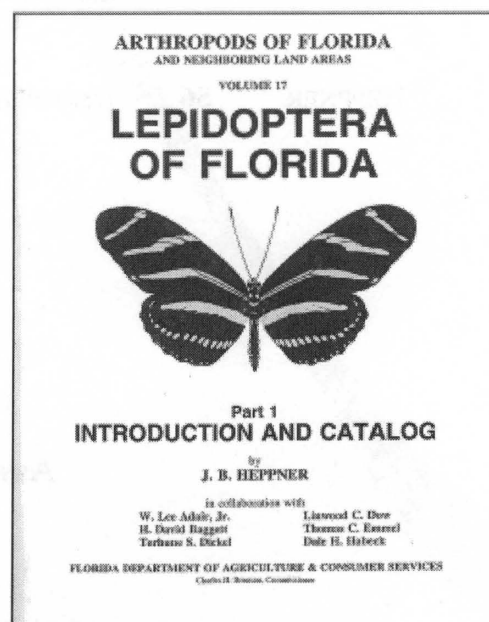
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- 25 3. *Pyrausta mystica* (Pyralidae: Pyraustinae)
- 27 4. Genera *Lixa* and *Tamraca* (Pyralidae: Pyralinae)
- 29 5. *Udea stigmatalis* (Pyralidae: Pyraustinae)
- HEPPNER 31 Primitive Sedge Moths from New Zealand and Tasmania: Transfer of *Proditrix* and Relatives to Orthoteliinae (Glyphipterigidae)
- LAMAS 43 Additions to the *Bibliography of Butterflies*, in the *Atlas of Neotropical Lepidoptera*. VI. Comprising mostly Works Published in 2001
- HEPPNER 56 *Neurobathra* leafminer records on *Jatropha* new to Florida (Gracillariidae)

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