Abstract: Geometrids are a species-rich group of moths that serve as reliable indicators for environmental changes. Little is known about the Mongolian moth fauna, and there is no comprehensive review of species richness, diversity, and distribution patterns of geometrid moths in the country. Our study aims to review the existing knowledge on geometrid moths in Mongolia. We compiled geometrid moth records from published scientific papers, our own research, and from the Global Biodiversity Information Facility (GBIF) to produce a checklist of geometrid moths of Mongolia. Additionally, we analyzed spatial patterns, species richness, and diversity of geometrid moths within 14 ecoregions of Mongolia and evaluated environmental variables for their distribution. In total, we compiled 1973-point records of 388 geometrid species. The most species-rich ecoregion in Mongolia was Daurian Forest Steppe with 142 species. Annual precipitation and maximum temperature of the warmest month were the most important environmental variables that correlated with NMDS axes in an analysis of geometrid assemblages of different ecoregions in Mongolia.

Keywords: beta diversity; ecoregions; environmental variables; location; NMDS; species checklist

1. Introduction

Regarded as disturbing pests or less charismatic than butterflies, moths are nevertheless creatures with an important role in the ecosystem and the potential to serve as environmental indicators [1–4]. Moths are globally distributed and it is estimated that more than 130,000 described species exist [5], far more than the more conspicuous and mostly diurnal butterflies with ca. 20,000 species. Many moths are pollinators, but due to their nocturnal activity they are not well studied [6]. In a recent review from the current literature, Hahn and Brühl reported that in Europe and North America there are 227 moth–plant interactions with 129 moth species involved [6]. Geometrid moths (Geometridae), constituting one of the biggest families of Lepidoptera, are a species-rich and easily recognizable family that have served as indicators for environmental changes in many previous studies [7–10]. These groups also appear to be effective at colonizing habitats after natural or anthropogenic disturbances [11]. There are approximately 24,000 described species of Geometridae worldwide [12]. Although Mongolia is one of the largest countries (rank 19th in size) on Earth, little is known about its moth fauna, and there is no comprehensive review of species richness, diversity, and distribution patterns of geometrid moths in the country. A few researchers attempted to summarize information to mainly confirm this lack of information [13].

Mongolia is a country that encompasses landscapes with a high variety of climatic and geographic features with forest in the north, high mountains in the west, desert in the south, and steppes in the
eastern and central parts of Mongolia [14,15]. Altogether, it comprises 16 ecoregions [16] (Figure 1). Ecosystems change along a latitudinal gradient from forest in the north, over steppe and semi-desert to desert in the south [17]. In most areas of the country, livestock herding is a dominant land-use practice, and due to overgrazing, some pasture lands have recently been degraded [18]. With recent discoveries of various mineral resources, mining has become not only the main economic sector, but also the major reason for environmental disturbance in Mongolia. Together with climate change, it is the major driver for habitat loss and environmental changes [14,19]. As a result of these anthropogenic changes, many species are disappearing, but there is little information about which species are at greatest risk of becoming extinct, especially for the less studied taxa.

In order to monitor diversity loss and gain, and to further study the influence of environmental disturbance and climate change on geometrid moths in Mongolia, we need an up-to-date dataset that mirrors the current state of knowledge and that includes all species already recorded. Given this knowledge gap, this study aims to review, summarize, and evaluate the existing knowledge on geometrid moths in Mongolia. It will provide a baseline for further studies, as well as define research priorities in the field. In this study, we aim to: (1) provide a checklist of geometrid moths of Mongolia, setting a baseline for future studies, (2) analyze distribution patterns and species richness and diversity of geometrid moths within ecoregions of Mongolia, and (3) analyze which environmental variables are most important in determining their distribution. We are aware that all results can only give a provisional status due to the data situation, especially the results for Objectives 2 and 3 can only be given with caution; however, our detailed review of the current data will help to define the needs for further research more efficiently.

Figure 1. Mongolian 14 ecoregions with distribution of 1557 geometrid moth records (211 of 1973 records are missing exact locations, 205 records were sampled at the same location, but at different time period). For two small ecoregions (marked in gray), there is no scientific knowledge of geometrid moths.
Study Review

Information on the species composition of Macrolepidoptera of Mongolia began to accumulate from the end of the nineteenth century, as a result of the works of collectors such as Fritz Dörries, Hauberhauer and Leder, and others. Otto Staudinger [20] published the first paper on the collection of Fritz Dörries, who made a trip in 1879 to Khentii Mountains to collect Lepidoptera. This resulted in data on the location of 75 species of geometrids in central and western parts of Mongolia [20]. Later, Staudinger published several papers and books on the fauna of Palaeartic Lepidoptera which included some geometrid species from Mongolia [21–23]. In 1964, a Mongolian–German expedition conducted a biological survey, as a result of the expedition 214 Lepidopteran exemplars were sampled. Burchard Alberti later published the results on Lepidoptera and nine geometrid species were listed in the paper [24]. Likewise, Joseph Moucha listed four geometrid species from a Mongolian–Czech entomological–botanical expedition, which was conducted around 1960 [25]. Grigory Grum-Grshimailo found three geometrid species from Selenge Aimag in the collection of M.I. Molleson [26]. Alexander Mikhailovich Djakonov [27,28] recorded a new occurrence of Horisme scosiata and described one new species Scotopteryx transbaicalica from the family of Geometridae based on old material of Staudinger. Other researchers such as Karl Dietze [29], Eugen Wehrli [30], and Fritz Heydemann [31] also described new species. In the fourth volume and its supplementary of “Die Gross-Schmetterlinge der Erde. Die Spanner des Palaearktischen Faunengebietes” series edited by Adalbert Seitz, 34 geometrid species were listed for Mongolia [32,33].

The most important contribution to the collection and study of Mongolian geometrid moths were made by Russian and Soviet expeditions led by Pyotr Kuzmich Kozlov and later by Soviet–Mongolian expeditions [34–36]. During the survey of Soviet–Mongolian expeditions, Jaan Viidalepp recorded a total of 201 geometrid species. Viidalepp later in 1999 compiled a checklist of geometric moths of the former U.S.S.R and in this monograph 210 species were included for Mongolia [37]. Particularly rich and diverse material on Lepidoptera (41,000 specimens) were collected by the Hungarian expeditions conducted by Zoltán Kaszab, who made six entomological collecting trips along latitudinal and longitudinal gradients in Mongolia, between 1963 and 1968. András Vojnits published several papers based on the Kaszab’s collections dedicated to subfamilies of Geometridae in the period between 1974 and 1979. He recorded 177 species from the whole collection, described 39 species new to the fauna of Mongolia and four species new to science [38–44]. Malcolm J. Scoble [45] presented 66 taxa from Mongolia.

Other researchers also contributed to the study of Mongolian geometric moths. For instance, Gantigmaa Ch. and coworkers recorded 90 species in the West Khentii of Northern Mongolia [46]. In the book “Biodiversity of Sokhondinsky Reserve”, 29 geometrid species from Mongolia have been included [47]. Beljaev and Vasilenko [48] noted 29 species of geometric moths in Mongolia. Vasilenko and colleagues [49–51] recorded eight species and described one new species Rhodostrophia ustuyzanini in Western Mongolia. In 2012 and 2013, we collected 70 geometrid species from central and northern parts of Mongolia [4]. Mironov and Glasworthy [52] reported 57 species with two species (Eupithecia ankini, Eupithecia munguata) new to science and 12 species new to the fauna of Mongolia. Erlacher et al., studied six geometric species from Mongolia and described one new species Charissa beljaevi [53–55]. In 2019, Makhov and Beljaev [56] studied the geometrid moths of the Baikal Region and recorded 14 species from Mongolia. In six volumes of “The Geometrid Moths of Europe”, 117 moth species are listed from Mongolia. We validated our species checklist with these volumes [57–62].

2. Materials and Methods

We compiled geometric moth records from published scientific papers, from our work [63] (all sample identifications were double checked by curator T. Enkhbayar, Department of Biology, National University of Mongolia), from the collections of the Siberian Zoological Museum (curator - S.V.Vasilenko) [64], and also from the Global Biodiversity Information Facility (GBIF) [65]. Lastly, we checked the “Revised, annotated systematic checklist of the Geometridae of Europe and adjacent
areas, Vols 1–6” [62]. From the Museum collections we could only get country-level information, not the exact location. From GBIF data, we included 380 records into our species list [65]. Fourteen specimens of six species were found in the public data of The Barcode of Life Data System (Bold System) [66].

We used Google Scholar to search the literature with following search strings:
- With all of the words: Mongol (in English Mongolia, in German Mongolei, thus it was better to use only Mongol);
- With at least one of the words: Geometrid OR Larentiinae OR Desmobathrinae OR Ennominae OR Archiearinae OR Geometrinae OR Oenochrominae OR Orthostixinae OR Sterrhinae;

As a result of the search, 184 literatures appeared, though many of them were about geometrid moths of Inner Mongolia. These we excluded from our list.
- Without the words: Inner Mongolia.

After excluding Inner Mongolia, 96 results remained and of these, 73 were relevant to our study. Totally, we compiled 1973-point records of 388 geometrid species (Table S1). Of these records, 87 species were missing information on exact locations, these 87 species are used to estimate species richness and listed in the species checklist but are excluded from other analysis. We georeferenced species locations from literature and generated coordinates of each location with Google Earth [67].

After that we cross-checked each species name in “The Global Lepidoptera Names Index” [68]. Moreover, experts on geometrid moths such as Axel Hausmann, Jaan Viidalepp, Gunnar Brehm, Sven Erlacher, and Pasi Sihvonen validated most species of our checklist and provided further literatures.

In the next step we used the sampled data in order to estimate true species richness, to evaluate the distribution of species within Mongolia, and to identify regions that have been undersampled so far by species rarefaction. For these reasons, we transformed all species locations into 2° × 2° grid cells, resulting in 51 grid cells inhabited by 301 species. Of 301 species, 121 were unique species occurring only once within 51 grids. To estimate species richness we applied Good Turing Theory, which uses unique species for estimation [69]. We used the application SuperDuplicates (https://chao.shinyapps.io/SuperDuplicates/) for the estimation with the following setting: Data type: incidence data; Number of observed species (SOBs): 388; Number of uniques (Q1): 208 (we combined the 121 unique species with the former mentioned 87 species without locations).

Further we calculated rarefaction curves for single ecoregions to assess collection quality in different areas of Mongolia. Four ecoregions (Altai Alpine Meadow and Tundra, Dzungarian Basin Semi-Desert, Khangai Mountains Alpine Meadow and Sayan Alpine Meadows, and Tundra) were strongly under sampled, having species richness below 15, thus we excluded them from the analysis to avoid misleading interpretation.

To estimate the rarefaction curve across grid cells and ecoregions, we calculated interpolation and extrapolation of species richness using the ‘iNEXT’ package: Interpolation and extrapolation for species richness in R [70,71] with 0.95 confidence interval and prepared the rarefaction plots with ‘devtools’ package [72] and ggiNEXT function of ‘ggplot2’ package [73].

We performed Non-Metric Multidimensional Scaling Analysis (NMDS) to check the dissimilarity of geometrid species composition between ecoregions based on the zero-adjusted Bray–Curtis dissimilarity measure using ‘phytomosaic/ecole’ and ‘vegan’ package [74–76]. For estimation of pairwise similarities between ecoregions, we calculated the estimated abundance based Soerensen Index by abundance data using online program SpadeR [77]. We preferred Soerensen Index over Jaccard Index, while the result was a little bit higher than Jaccard. This estimated abundance based index can detect unseen shared species and is appropriate to evaluate beta diversity of samples under sampling bias [78].

We used 19 Bioclim data with 30 arc seconds resolution as climatic variables for the region [79]. We extracted these variables for the fourteen ecoregions. Ecoregion GIS data for Mongolia were downloaded from The Nature Conservancy (TNC) [80]. In two ecoregions no geometrid moths were found, namely, Khangai Mountains Conifer Forests and Sayan Intermontane Steppe (Figure 1). We thus excluded these ecoregions from the further analysis. To check for strong linear dependencies
among explanatory variables we computed the variance inflation factor (VIF) for each variable in R package ‘vegan’. We excluded variables with VIF values higher than 10 [81] (Table 1). We chose the most significant environmental variables with forward selection method by using vegan’s ‘ordistep’ function [81]. Variables selected by forward selection method were fitted into the ordination plot using vegan’s ‘entfit’ function.

All analysis were performed in R [82] and most graphs were made with package ‘ggplot2’ [73].

Table 1. List of the environmental [79] variables* for the fourteen ecoregions used in this study. All variables have been entered into forward selection method for selecting most important variables. The selected variables were later fitted in the Non-Metric Multidimensional Scaling Analysis (NMDS). Colors refer to the map in Figure 1.

| Ecoregions                          | Bio1 | Bio2 | Bio5 | Bio6 | Bio7 | Bio10 | Bio11 | Bio12 | Biome [83]                          |
|------------------------------------|------|------|------|------|------|-------|-------|-------|-------------------------------------|
| Alashan Plateau                    | 5.1  | 14.1 | 28.6 | −20.3| 49   | 20.6  | −11.7 | 85    | Deserts and Xeric Shrublands        |
| Semi-Desert                        | −4.5 | 12.3 | 17.1 | −28.1| 45.2 | 10.3  | −20.3 | 199   | Montane Grasslands and Shrublands   |
| Altai Alpine Meadow and Tundra     | −1.8 | 13.1 | 20.5 | −26.8| 47.3 | 13.4  | −18.5 | 148   | Temperate Conifer Forests           |
| Montane Forest and Forest Steppe   | 3.9  | 14   | 27.4 | −23  | 50.4 | 19.6  | −13.9 | 91    | Deserts and Xeric Shrublands        |
| Dzungarian Basin                   | −1.5 | 13.9 | 23.7 | −29.1| 52.9 | 16    | −21   | 306   | Temperate Grasslands, Savannas and Shrublands |
| Semi-Desert                        |      |      |      |      |      |       |       |                                  |
| Daurian Forest Steppe              | 3.3  | 13.4 | 27.6 | −22.5| 50.1 | 19.8  | −14.7 | 130   | Deserts and Xeric Shrublands        |
| Eastern Gobi Desert Steppe         | 0.7  | 14.6 | 23.8 | −24.3| 48.1 | 15.9  | −15.5 | 141   | Deserts and Xeric Shrublands        |
| Gobi Lakes Valley Desert Steppe    | −1.6 | 13.5 | 24.2 | −31.7| 55.9 | 16.6  | −23.1 | 147   | Deserts and Xeric Shrublands        |
| Great Lakes Basin Desert Steppe    | −5.6 | 14.3 | 17.3 | −30.5| 47.8 | 9.7   | −22.1 | 261   | Montane Grasslands and Shrublands   |
| Khangai Mountains Alpine Meadow    | 0.3  | 13.6 | 25.4 | −26.4| 51.8 | 17.6  | −18.7 | 224   | Temperate Grasslands, Savannas and Shrublands |
| Mongolian-Manchurian Grassland     | −8.4 | 13.6 | 16.3 | −34.9| 51.2 | 8.5   | −27.3 | 355   | Montane Grasslands and Shrublands   |
| Sayan Alpine Meadows and Tundra    | −5.1 | 13.7 | 19.2 | −31.3| 50.4 | 11.4  | −23.5 | 381   | Temperate Conifer Forests           |
| Sayan Montane Coniferous Forests   | −3.2 | 14.3 | 20.6 | −29.7| 50.3 | 12.9  | −21.4 | 277   | Temperate Grasslands, Savannas and Shrublands |
| Selenge-Orkhon Forest Steppe       | −3.3 | 13.4 | 22.1 | −31.1| 53.2 | 14.6  | −23.3 | 366   | Boreal Forests/Taiga                |

* Environmental variables with VIF under 10. Bio1—Annual Mean Temperature [°C]; Bio2—Mean Diurnal Range [°C]; Bio5—Max Temperature °C; Bio6—Min Temperature °C; Bio7—Temperature Annual Range [°C]; Bio10—Mean Temperature of Warmest Quarter [°C]; Bio11—Mean Temperature of Coldest Quarter [°C]; Bio12—Annual precipitation [mm].

3. Results

Altogether, we recorded 388 geometrid species of six subfamilies: Archiearinae, Desmobathrinae, Ennominae, Geometrinae, Larentiinae, and Sterrhinae (Appendix A Table A1). The most species-rich subfamily was Larentiinae with 203 species, while we recorded only one species in the subfamily Desmobathrinae. For 301 species with exact location data (Table S1), we recorded species richness within 2° × 2° grid cells in whole Mongolia (Figure 2).
Results

Altogether, we recorded 388 geometrid species of six subfamilies: Archiearinae, Desmobathrinae, Ennominae, Geometrinae, Larentiinae, and Sterrhinae (Appendix Table 1). The most species-rich subfamily was Larentiinae with 203 species, while we recorded only one species in the subfamily Desmobathrinae. For 301 species with exact location data (Table S1), we recorded species richness within 2° × 2° grid cells in whole Mongolia (Figure 2).

Species richness was highest in the northern central part of the country, with 133 species recorded near Darkhan-Uul Aimag and the capital Ulaanbaatar. Four most frequently recorded species were Rhodostrophia jacularia (in n = 32 grids), Scopula beckeraria (n = 18) Scopula albiceraria (n = 17), and Horisme aquata (n = 17).

As a result of the Good–Turing theory, estimated species richness for whole Mongolia was 663.19 with 0.95 confidence interval (606.80–734.12), which is nearly double the observed species richness (Q2.est = 78.51; se = 32.31; Undetected # species = 275.19; Undetected percentage (%) = 41.49). Also, we constructed a sample-based interpolation and extrapolation curve of 301 species with exact reported location within 51 grids. The interpolated and extrapolated estimators of species richness show similar results (Figure 3), the curve was not asymptotic, indicating under-sampling of the communities.

In the next step we used the fourteen Mongolian ecoregions (Figure 1) to investigate the distribution of the sampled geometrid species in more detail. The most species-rich ecoregion was Daurian Forest.
Steppe with 142 species, while Khangai Mountains Alpine Meadow was the lowest in species richness with only three species of geometrid moths (Figure 4). One species (*Rhodostrophia jacularia*) occurred in 10 ecoregions, there were five further generalist species (*Euphyia unangulata*, *Eupithecia nephelata*, *Scopula albiceraria*, *Scopula beckeraria*) that occurred in eight to nine ecoregions. In contrast, 126 species were recorded only in one ecoregion. Four ecoregions were clearly under-sampled (Altai Alpine Meadow and Tundra, Dzungarian Basin Semi-Desert, Khangai Mountains Alpine Meadow, Sayan Alpine Meadows and Tundra) thus to avoid misleading interpretation, we excluded those ecoregions from further analysis.

![Figure 4. Geometrid moth species richness of 14 ecoregions of Mongolia. Under-sampled ecoregions are Altai Alp, Dzungarian, Khangai, and Sayan Alp. Colors refer to the map in Figure 1. Ecoregion abbreviations: Alashan: Alashan Plateau Semi-Desert, Altai Alp: Altai Alpine Meadow and Tundra, Altai Mont: Altai Montane Forest and Forest Steppe, Dzungarian: Dzungarian Basin Semi-Desert, Daurian: Daurian Forest Steppe, Eastern: Eastern Gobi Desert Steppe, Gobi: Gobi Lakes Valley Desert Steppe, Great: Great Lakes Basin Desert Steppe, Khangai: Khangai Mountains Alpine Meadow, Mongolian: Mongolian-Manchurian Grassland, Sayan Alp: Sayan Alpine Meadows and Tundra, Sayan Mont: Sayan Montane Coniferous Forests, Selenge: Selenge-Orkhon Forest Steppe, Trans: Trans-Baikal Coniferous Forests.](image)

Interpolation and extrapolation curves of particular ecoregions differ in their shapes, thus indicating different “sample quality”. Curves of Alashan Plateau Semi-Desert, Altai Montane Forest and Forest Steppe, Eastern Gobi Desert Steppe, Gobi Lakes Valley Desert Steppe, and Great Lakes Basin Desert Steppe are not asymptotic, only half of the estimated maximum species richness is sampled; while curves of Daurian Forest Steppe, Mongolian-Manchurian Grassland, Selenge-Orkhon Forest Steppe and Trans-Baikal Coniferous Forests are half asymptotic, thus tending to increase, while the curve of Sayan Montane Coniferous Forests is flattening, thus pointing to complete sampling of the moth community (Figure 5).
Figure 5. Sampling unit-based interpolation and extrapolation curves of ecoregions with 0.95 confidence interval. Axes X and Y axes represent the number of records and species richness, respectively. Ecoregions are jointly drawn on plots according to their grouping in the NMDS graph (Figure 6). Colors refer to the map in Figure 1. Ecoregion abbreviations as in Figure 4.

Figure 6. Non-metric multidimensional scaling (NMDS) ordination of 10 ecoregions of Mongolia according to their dissimilarity in geometrid moth species assemblage (zero-adjusted Bray-Curtis dissimilarity index for presence-absence data; stress 0.05). Significant variables are drawn in blue arrows. Temp: Maximum temperature of warmest month, Precip: Precipitation, Records: Number of records of geometrid moths. Colors refer to the map in Figure 1. Ecoregion abbreviations as in Figure 4.
For assessment of beta-diversity, we calculated estimates of the abundance-based Sorensen Index between ecoregions (Table 2). We excluded ecoregions with fewer than 20 species to avoid sampling bias in similarity analysis. The highest pairwise estimated Sorensen Similarity Index was between Eastern Gobi Desert Steppe and Gobi Lakes Valley Desert Steppe ($\beta_s = 0.942$), while the lowest were between Trans-Baikal Coniferous Forests and both of Gobi Lakes Valley Desert Steppe, Great Lakes Basin Desert Steppe ($\beta_s = 0.076$).

Table 2. Pairwise estimates of similarity between ecoregions with online tool Spade [69]. Shown is the estimated abundance-based Sorensen Index. Colors refer to the map in Figure 1. Ecoregion abbreviations as in Figure 4. Highest and lowest values in bold.

| C_{ij} | Alashan | Altai | Daurian | Eastern | Gobi | Great | Mongol | Sayan | Selenge | Trans |
|-------|---------|-------|---------|---------|------|-------|--------|-------|---------|-------|
| Alashan | 1 0.504 0.184 0.595 0.716 0.446 0.433 0.097 0.206 0.244 |
| Altai | 1 0.451 0.64 0.742 0.702 0.523 0.311 0.594 0.445 |
| Daurian | 1 0.188 0.324 0.267 0.669 0.499 0.769 0.685 |
| Eastern | 1 0.942 0.644 0.533 0.127 0.424 0.141 |
| Gobi | 1 0.8 0.679 0.14 0.371 0.076 |
| Great | 1 0.497 0.301 0.544 0.139 |
| Mongol | 1 0.417 0.719 0.522 |
| Sayan | 1 0.631 0.447 |
| Selenge | 1 0.606 |
| Trans | 1 |

An NMDS ordination biplot (stress = 0.05) shows two separate groups of geometrid species communities within ecoregions (Figure 6). Altai Montane Forest and Forest Steppe, Alashan Plateau Semi-Desert, Eastern Gobi Desert Steppe, Gobi Lakes Valley Desert Steppe, and Great Lakes Basin Desert Steppe are clustered in the first group, Sayan Montane Coniferous Forests, Mongolian-Manchurian Grassland, Daurian Forest Steppe, Selenge-Orkhon Forest Steppe, and Trans-Baikal Coniferous Forests are grouped in the second group. Precipitation was positively correlated with NMDS1, while temperature was positively correlated with NMDS2, both correlations were highly significant ($p < 0.01$). Number of records was positively correlated with both axes but was not significant (Table 3).

Table 3. NMDS vector fitted values. Temp: Max temperature of warmest month, Precipitation: Annual precipitation, Records: Number of records of geometrid moths.

| Variable | NMDS1 | NMDS2 | $r^2$ | Pr ($> 0$) |
|----------|-------|-------|-------|-------------|
| Temperature | -0.32277 | 0.94648 | 0.7473 | 0.009 |
| Precipitation | 0.97252 | -0.23281 | 0.9183 | 0.001 |
| Records | 0.73924 | 0.67344 | 0.5096 | 0.095 |

4. Discussion

In this study, we compiled a geometrid species checklist for Mongolia, examined species richness and diversity of geometrid communities among ecoregions. In addition, we investigated which environmental variables impact the distribution of geometrid moths. Compiling a species checklist on geometrid moths from a variety of sources published since 1892 was quite challenging, as names of species and locations were changing over the years, while sample efforts in different studies and areas differed considerably. Despite all our efforts we may not have included all species recorded in Mongolia in our list.
In total, we found 1973 records of 388 geometrid species of six subfamilies, but these records were not evenly sampled. The sample-based interpolation and extrapolation curve of gridded sample was not asymptotic, indicating that our records do not represent the whole potential geometrid fauna in Mongolia (Figure 3). Species richness for whole Mongolia was estimated as 663.19 species with Good–Turing theory and this estimated species richness was nearly double the observed species richness. These results confirm the rarefaction analysis and show that our inventory of geometrid moths in Mongolia is still incomplete, with less than 60% of the estimated species being recorded. The fact that countrywide diversity was highest in the grid cell of the capital draws further attention towards an obvious sampling bias with undersampling for the rest of the country. Moreover, we expect to find species of two other subfamilies, Orthostixinae and Alsophilinae in Mongolia. Species of these subfamilies were recorded in adjacent areas, such as in Kazakhstan and in China [37]. However, according to Müller et al. Alsophilinae is transferred to Ennominae, while the subfamily status of Orthostixinae is still not clear [62].

Given the huge size of Mongolia the estimated richness of 663 geometrid species for the whole country seems to be not high. But we wanted to compare the species richness of Mongolia with species richness of other countries similar in size. Norway + Sweden + Finland (1,173,940 km²) together are similar in size to Mongolia (1,564,000 km²). Altogether, for these countries, 341 geometrid species are recorded [84]. If we compare observed species richness (388) of Mongolia with the richness of those countries, it is almost similar; if we compare estimated species richness (663), it is almost double. However, Scandinavia is an area at high latitudes, with harsh climate, not really suited for an ectotherm group like moths. Further south, Iberian Peninsula and Balearic Islands together, have 589 geometrid species (According to a personal information of Javier Gastón, one of the authors of the paper, due to scientific efforts the total number of Geometridae recorded on Iberian Peninsula and the Balearic Islands is now 605 species.) [85] and their areas (596,740 km² + 4564 km²) are almost three times smaller than the landlocked area of Mongolia, which is situated at higher latitude. Comparisons between distant countries are always somewhat lacking, but no figures on geometrid species richness are available for the countries in Inner Asia (e.g., Kazakhstan).

The most frequently recorded species, which occurred in 10 ecoregions of Mongolia, was *Rhodostrophia jacularia*, an inhabitant of steppe and semi-desert [34,86]. Sihvonen and Nupponen [87] studied female wing shape of this species, but we could not find other studies related to the biology of this species.

Most records were found in Daurian Forest Steppe, Selenge-Orkhon Forest Steppe, and Mongolian-Manchurian Grassland. For many ecoregions, rarefaction curves were not asymptotic, thus revealing that sampling there was incomplete. Two ecoregions have no geometrid moth records at all and were thus excluded from analysis, namely Khangai Mountains Conifer Forests and Sayan Intermontane Steppe. The less studied areas comprise higher altitude areas from central Mongolia, as well as border regions. Sampling in these ecoregions, many of them with high habitat heterogeneity, will certainly expand our checklist.

To assess beta diversity among these unevenly sampled groups we used an estimator for Soerenson similarity that includes unseen species in the calculation [70]. The results, on the one hand, reflect the high habitat heterogeneity of Mongolia, with steep ecological north-south gradient and the diverse biomes of the country that promote high beta diversity (Table 1). On the other hand, it proved that ecoregions that include similar biomes have higher similarity of moth communities, a result corroborated by NMDS. The most similar ecoregions were Eastern Gobi Desert Steppe and Gobi Lakes Valley Desert Steppe that adjoin each other ($\beta_s = 0.942$).

In NMDS, ecoregions were grouped in two big groups. The first group included Alashan Plateau Semi-Desert, Eastern Gobi Desert Steppe, Gobi Lakes Valley Desert Steppe, Great Lakes Basin Desert Steppe and Altai Montane Forest and Forest Steppe, while in the second group there were Daurian Forest Steppe, Mongolian-Manchurian Grassland, Sayan Montane Coniferous Forests, Selenge-Orkhon Forest Steppe, and Trans-Baikal Coniferous Forests. The geographically nearest ecoregions were
grouped together, and also the ecoregions included in the same group belonged to mostly same biome type (Table 1). The first group comprised mostly Deserts and Xeric Shrublands except Altai Montane Forest and Forest Steppe, while three ecoregions of the second group belonged to Temperate Grasslands, Savannas and Shrublands.

Environmental variables that shaped species distribution were nominated by forward selection in NMDs and included annual precipitation and maximum temperature of warmest quarter. Number of records was also selected as variable, but only temperature and precipitation were significant in NMDs, thus corroborating the general robustness of our analysis, which was less influenced by sample effort. The aforementioned groups of ecoregions in NMDs differ along the precipitation gradient and within groups in temperature, e.g., the montane forests regions of both groups have lower values of NMDs2.

In a study on Borneo, geometrid moths showed a similar relationship with precipitation and temperature [88]. Temperature has also been a major impact on geometrid species distribution in the Andes [89]. Moreover, habitat disturbance played a big role in shaping the geometrid moth ensemble in northern Borneo [90]. Similarly, grazing proved to be a factor influencing community pattern in Mongolian moths [4]. Temperature, rainfall and habitat disturbance are impacted by climate change and anthropogenic influence, so we expect future changes within the Mongolian geometrid communities. The species list we present here can be a tool helping to monitor these changes.

Finally, we have to admit that our study has a few weaknesses. We compiled records only from literature (we apologize if we missed any) due to limited time and funding. A total of 87 of the 388 species in our checklist are still missing an exact location. This information may be available in the museum collections pinned to the respective specimens. A detailed research in museums would have certainly brought more records and species. In addition, all our records were not systematically collected, which might affect the statistical analysis. The mere fact that data were sampled over a long period of time in different research projects, with different ways of sampling certainly impacts the value of a statistical analysis. For example, in our field study [4], we used UV light, but in other studies normal light bulbs were used, sometimes even moths have even been collected during day time. Together with the general problem of undersampling, these points hamper a more detailed analysis of the Mongolian geometrid communities at the present time.

Nevertheless, due to our study, future directions of research on Mongolian Geometridae have become more clear: geometrid moths are really under-studied in Mongolia. We found two unsampled and four extremely under-sampled ecoregions and for all ecoregions expected species numbers were higher than recorded ones. So, we expect to find many more amazing moth species in future collections in the respective regions.

5. Conclusions

In total, 1973 records of 388 species were recorded, but we also expect that many more species will be recorded in the future in more elaborated sampling designs, especially from locations of southern, eastern and western Mongolia. Despite the fact that our compiled data is not good enough to analyze the distribution and diversity pattern in full detail, our study could reveal the knowledge gaps and undersampled areas, provide a first estimate of the approximate species number in whole Mongolia (n = 663), visualize the currently recorded distribution and diversity pattern of geometrid moths of Mongolia and evaluate the main environmental factors that shape the communities.

Supplementary Materials: The following are available online at http://www.mdpi.com/1424-2818/12/5/186/s1, Table S1: Occurrence data of geometrid moths compiled from Mongolia.

Author Contributions: K.E., B.B. and M.P . designed research. K.E. performed research, analyzed data and wrote the paper with inputs from M.P . and B.B. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Checklist of geometrid moths in Mongolia. Note that we conducted all analysis at species level. Here subspecies are listed to show compiled data in more detail. The listed references include in most cases articles with location information.

| Subfamily       | Species                  | Author      | Year  | Reference                           |
|-----------------|--------------------------|-------------|-------|-------------------------------------|
| Archiearinae    | Archiearis notha         | Hübner      | 1802  | [34]                               |
| Archiearinae    | Archiearis parthenias    | Linnaeus    | 1761  | [34]                               |
| Archiearinae    | Archiearis parthenias sajana | Prout     | 1912  | [46]                               |
| Archiearinae    | Leucoserephos middenforst | Ménetriès   | 1858  | [41]                               |
| Desmobathrinae  | Gypsocrhoa renitidata    | Hübner      | 1817  | [57]                               |
| Ennominae       | Abraxas grossulariata    | Linnaeus    | 1758  | [21,34,46,63,65]                   |
| Ennominae       | Abraxas grossulariata dsungarica | Wehrli | 1939  | [38]                               |
| Ennominae       | Alcis deversata          | Staudinger  | 1892  | [34,39,46,63,65]                   |
| Ennominae       | Alcis extinctaria        | Eversmann   | 1851  | [23,34,36,39,65,91]                |
| Ennominae       | Alcis jubata             | Thunberg    | 1788  | [37]                               |
| Ennominae       | Alcis repandata          | Linnaeus    | 1758  | [65]                               |
| Ennominae       | Allopachra conjungens    | Alphéraky   | 1892  | [33]                               |
| Ennominae       | Anuraica superans       | Butler      | 1878  | [33]                               |
| Ennominae       | Angeron prunaria         | Linnaeus    | 1758  | [24,34,46,63,65]                   |
| Ennominae       | Angeron prunaria kentaria | Staudinger | 1892  | [39]                               |
| Ennominae       | Angeron prunaria mongolgena | Bryk      | 1949  | [62]                               |
| Ennominae       | Apetra syringaria        | Linnaeus    | 1758  | [63]                               |
| Ennominae       | Apocheina haidarida      | Denis & Schiffermüller | 1775 | [34]                               |
| Ennominae       | Apocoloits almatensis    | Djakonov    | 1952  | [39]                               |
| Ennominae       | Apocoloits smirnowi      | Romanoff    | 1885  | [39]                               |
| Ennominae       | Arichanna barteli       | Prout       | 1915  | [32,45]                            |
| Ennominae       | Arichanna melanaria      | Linnaeus    | 1758  | [34,46,65,91]                      |
| Ennominae       | Arichanna melanaria decolorata | Staudinger | 1892  | [45]                               |
| Ennominae       | Arichanna melanaria praeolivina | Wehrli | 1933  | [39]                               |
| Ennominae       | Aspitates conspersaria   | Staudinger  | 1901  | [23,45]                            |
| Ennominae       | Aspitates curvaria       | Eversmann   | 1852  | [1,5,14]                           |
| Ennominae       | Aspitates forbesi        | Munroe      | 1963  | [65]                               |
| Ennominae       | Aspitates gilvaria       | Denis & Schiffermüller | 1775 | [23,24,34,36,63,91]                |
| Ennominae       | Aspitates gilvaria minimes | Vojnits    | 1975  | [39]                               |
| Ennominae       | Aspitates insignis       | Alphéraky   | 1883  | [36,39]                            |
| Ennominae       | Aspitates kozhantchikovi | Munroe      | 1963  | [36,65]                            |
| Ennominae       | Aspitates mongolicus     | Vojnits     | 1975  | [39,65]                            |
| Ennominae       | Aspitates mundataria     | Stoll       | 1782  | [34,46,63,65]                      |
| Subfamily | Species | Author     | Year | Reference |
|-----------|---------|------------|------|-----------|
| Ennominae | Aspitates mundataria uncinataria | Vojnits | 1975 | [39] |
| Ennominae | Aspitates obscurata | Wehrli | 1953 | [33,34,39] |
| Ennominae | Aspitates staudingeri | Vojnits | 1975 | [39] |
| Ennominae | Aspitates tayloriae sibirica | Djakonov | 1955 | [36,65] |
| Ennominae | Aspitates tristrigaria | Bremer & Grey | 1853 | [34,37] |
| Ennominae | Astegetia honesta | Prout | 1908 | [34] |
| Ennominae | Biston betularia | Linnaeus | 1758 | [34,46,63,91] |
| Ennominae | Biston betularia sibiricus | Fuchs | 1899 | [37] |
| Ennominae | Cabera exanthemata | Scopoli | 1763 | [23,34,46,65] |
| Ennominae | Cabera exanthemata lamica | Wehrli | 1939 | [39] |
| Ennominae | Cabera pusaria | Linnaeus | 1758 | [34,39,63] |
| Ennominae | Calcaritis pallida | Hedemann | 1881 | [47] |
| Ennominae | Charissa atropunctata | Eversmann | 1837 | [37] |
| Ennominae | Charissa aurata | Staudinger | 1897 | [55] |
| Ennominae | Charissa ambiguata | Duponchel | 1830 | [34,36,46,65] |
| Ennominae | Charissa ambiguata ophthalmicata | Lederer | 1853 | [39] |
| Ennominae | Charissa beljaevi | Erlacher et al., 2017 | 2017 | [55] |
| Ennominae | Charissa bidentatus | Schetkin & Vidalepp | 1980 | [46] |
| Ennominae | Charissa creperaria | Erschhoff | 1877 | [34,55,65] |
| Ennominae | Charissa difficilis | Alphéraky | 1883 | [21,24,34,39,65] |
| Ennominae | Charissa gozmanyi | Vojnits | 1975 | [14] |
| Ennominae | Charissa macquifini | Smiles | 1979 | [65] |
| Ennominae | Charissa ochrofasciata | Staudinger | 1895 | [21,30,34,39,55,65] |
| Ennominae | Charissa remni | Viidalepp | 1988 | [56,63] |
| Ennominae | Charissa sibirata | Guenée | 1858 | [21,24,30,34,66] |
| Ennominae | Charissa subsplendidaria | Wehrli | 1922 | [63,92] |
| Ennominae | Charissa turfolaria | Wehrli | 1922 | [30,34,39,65,62] |
| Ennominae | Charissa vastaria | Staudinger | 1892 | [30,34] |
| Ennominae | Chiasmia aestimaria | Hübner | 1809 | [65] |
| Ennominae | Chiasmia aestimaria kalaschana | Wehrli | 1940 | [39] |
| Ennominae | Chiasmia clathrata | Linnaeus | 1758 | [23,24,26,34,36,39,56,91] |
| Ennominae | Chiasmia clathrata djakonovi | Kardakoff | 1928 | [38,39] |
| Ennominae | Chiasmia saburraria | Eversmann | 1851 | [21,34,65] |
| Ennominae | Chiasmia saburraria kenteata | Staudinger | 1892 | [38] |
| Ennominae | Cleora cinctaria | Denis & Schiffermüller | 1775 | [34,46,63] |
| Ennominae | Colotois pennaria | Linnaeus | 1760 | [46] |
| Ennominae | Deileptenia ribeata | Clerck | 1759 | [63] |
| Ennominae | Dogrammia rippingaria | Duponchel | 1830 | [34] |
| Ennominae | Ectropis crepuscularia | Denis & Schiffermüller | 1775 | [34,46] |
| Ennominae | Eilicrinia orias | Wehrli | 1933 | [45] |
| Ennominae | Elopheis banghaesi | Wehrli | 1922 | [30,34,45] |
| Ennominae | Ematurga atomaria | Linnaeus | 1758 | [23,24,34,36,46,65] |
| Ennominae | Ematurga atomaria krasnojarscensis | Fuchs | 1899 | [39] |
| Ennominae | Ennomos autumnaria | Werneburg | 1859 | [46] |
| Ennominae | Epione repandaria | Hufnagel | 1767 | [34] |
Table A1. Cont.

| Subfamily     | Species                        | Author         | Year    | Reference          |
|---------------|--------------------------------|----------------|---------|--------------------|
| Ennominae     | Epione vespertaria             | Linnaeus       | 1767    | [34,39]            |
| Ennominae     | Epirranthis diversata          | Denis & Schiffermüller | 1775 | [63]                |
| Ennominae     | Enania jacobsoni               | Djakonov       | 1926    | [34,46,65]         |
| Ennominae     | Gnophosodos ravistriolaria     | Wehrli         | 1922    | [36]                |
| Ennominae     | Gnophosodos ravistriolaria ravistriolaria | Wehrli       | 1922    | [55]                |
| Ennominae     | Gnophosodos sternmataria       | Eversmann      | 1848    | [39]                |
| Ennominae     | Gnophosodos thaleraria         | Püngeler       | 1901    | [50]                |
| Ennominae     | Gnophos bipartitus             | Vojnits        | 1975    | [39]                |
| Ennominae     | Gnophos rubacaria              | Püngeler       | 1902    | [37]                |
| Ennominae     | Heliomata glarearia            | Denis & Schiffermüller | 1775 | [46]                |
| Ennominae     | Hypomecis punctalis            | Scopoli        | 1763    | [46]                |
| Ennominae     | Hypomecis roboraria            | Denis & Schiffermüller | 1775 | [23,34,39,63]     |
| Ennominae     | Hypoxystis pluviaria           | Fabricius      | 1787    | [34,46,63]         |
| Ennominae     | Isturgia altaica               | Vojnits        | 1978    | [43]                |
| Ennominae     | Isturgia arenacaria            | Denis & Schiffermüller | 1775 | [63,91]            |
| Ennominae     | Isturgia arenacaria mongolica  | Vojnits        | 1974    | [38]                |
| Ennominae     | Isturgia falsaria              | Alphéraky      | 1892    | [34]                |
| Ennominae     | Isturgia halitutaria           | Guenée         | 1858    | [48]                |
| Ennominae     | Isturgia kaszabi               | Vojnits        | 1974    | [38]                |
| Ennominae     | Isturgia murinaria             | Denis & Schiffermüller | 1775 | [34,36]            |
| Ennominae     | Isturgia murinaria uralica     | Wehrli         | 1937    | [63]                |
| Ennominae     | Jankowska bituminaria          | Lederer        | 1853    | [65]                |
| Ennominae     | Jankowska bituminaria raddensis| Wehrli        | 1941    | [93]                |
| Ennominae     | Lomaspilis marginata           | Linnaeus       | 1758    | [23,34,46,65]     |
| Ennominae     | Lomaspilis opis amuresensis    | Hedemann       | 1881    | [38]                |
| Ennominae     | Lomographa buraceta            | Staudinger     | 1892    | [34]                |
| Ennominae     | Lomographa temperata           | Denis & Schiffermüller | 1775 | [46]                |
| Ennominae     | Lycia hirtaria                 | Clerck         | 1759    | [63]                |
| Ennominae     | Lycia lapponaria               | Boisduval      | 1840    | [37]                |
| Ennominae     | Macaria alternata              | Denis & Schiffermüller | 1775 | [34,46,91]        |
| Ennominae     | Macaria artesaria              | Denis & Schiffermüller | 1775 | [54,38]            |
| Ennominae     | Macaria brunneaeta             | Thunberg       | 1784    | [36,38,91]         |
| Ennominae     | Macaria circumflexaria         | Eversmann      | 1848    | [38,46,63,91]      |
| Ennominae     | Macaria costmaculata           | Graeser        | 1888    | [34]                |
| Ennominae     | Macaria latefasciata           | Staudinger     | 1896    | [21,34]            |
| Ennominae     | Macaria liturata               | Clerck         | 1759    | [65]                |
| Ennominae     | Macaria liturata pressaria     | Christoph      | 1893    | [37]                |
| Ennominae     | Macaria loricaria              | Eversmann      | 1837    | [36]                |
| Ennominae     | Macaria notata                 | Linnaeus       | 1758    | [34,63]            |
| Ennominae     | Macaria notata kirina          | Wehrli         | 1940    | [38]                |
| Ennominae     | Macaria serenaria              | Staudinger     | 1896    | [21,34]            |
| Ennominae     | Macaria signaria               | Hubner         | 1809    | [38,46]            |
| Ennominae     | Macaria wuauria                | Linnaeus       | 1758    | [34,36]            |
| Ennominae     | Megalychnia strictaria         | Lederer        | 1853    | [21,34,39,46,63]  |
| Ennominae     | Meganetopon piperatum          | Alphéraky      | 1892    | [34,39,65]         |
| Subfamily       | Species               | Author       | Year | Reference                  |
|-----------------|-----------------------|--------------|------|----------------------------|
| Ennominae       | Narraga fasciolaria   | Hufnagel     | 1767 | [34, 63]                   |
| Ennominae       | Odontopera bidentata  | Clerck       | 1759 | [21, 35, 40, 47, 66]       |
| Ennominae       | Odontopera bidentata exsul | Tchetrerikov | 1905 | [36, 39]                   |
| Ennominae       | Ourapteryx persica    | Ménétrisés   | 1832 | [34]                       |
| Ennominae       | Ourapteryx sambucaria | Linnaeus     | 1758 | [63, 65]                   |
| Ennominae       | Perconia strigillaria | Hübner       | 1787 | [46, 63]                   |
| Ennominae       | Petrophora kaszabi   | Vojnits      | 1978 | [43]                       |
| Ennominae       | Phaselia narynaria    | Oberrhür     | 1913 | [49]                       |
| Ennominae       | Phaselia serrularia   | Eversmann    | 1847 | [65]                       |
| Ennominae       | Phthonandria emaria   | Bremer       | 1864 | [39]                       |
| Ennominae       | Plagodis dolabaria    | Linnaeus     | 1767 | [34]                       |
| Ennominae       | Plagodis pulvaria     | Linnaeus     | 1758 | [21, 34, 65]               |
| Ennominae       | Selenia dentaria      | Fabricius    | 1775 | [39]                       |
| Ennominae       | Selenia dentaria alpestris | Wehrli   | 1940 | [37]                       |
| Ennominae       | Selenia ononica       | Kostjkuk     | 1991 | [37]                       |
| Ennominae       | Selenia sordidaria    | Lecch        | 1897 | [39]                       |
| Ennominae       | Selenia tetralunaria  | Hufnagel     | 1767 | [34, 36, 46, 63]           |
| Ennominae       | Siona lineata         | Scopoli      | 1763 | [23, 26, 34, 36, 39, 46, 63, 65] |
| Ennominae       | Spartopteryx kindermannaria | Staudinger | 1871 | [36, 39, 46]               |
| Ennominae       | Xandrames dholaria    | Moore        | 1868 | [33]                       |
| Ennominae       | Yeozgnosphos vittaria | Thanberg     | 1792 | [65]                       |
| Geometrinae     | Chlorissa virulata   | Linnaeus     | 1758 | [34]                       |
| Geometrinae     | Dyacheloropsis impararia | Guenée    | 1858 | [21, 24, 34, 40, 41, 65]   |
| Geometrinae     | Geometra papilionaria | Linnaeus     | 1758 | [40, 46, 63]               |
| Geometrinae     | Geometra papilionaria herbaceaaria | Ménétrisés | 1859 | [41, 65]                   |
| Geometrinae     | Hemistola chrysoprasaria | Esper      | 1794 | [46, 63]                   |
| Geometrinae     | Hemistola chrysoprasaria lissas | Prout    | 1912 | [40]                       |
| Geometrinae     | Hemistola zimmermanni | Hedemann     | 1879 | [34, 40, 41]               |
| Geometrinae     | Hemitha aesticaria    | Hübner       | 1799 | [16]                       |
| Geometrinae     | Jodis lactaria       | Linnaeus     | 1758 | [37]                       |
| Geometrinae     | Microloxia herbaria  | Hübner       | 1813 | [34, 65]                   |
| Geometrinae     | Microloxia herbaria adrolata | Eversmann  | 1837 | [41]                       |
| Geometrinae     | Thaleria chlorosaria | Graeser      | 1890 | [34, 40, 41, 91]           |
| Geometrinae     | Thaleria finbrialis  | Scopoli      | 1763 | [63]                       |
| Geometrinae     | Thetidia atyche     | Prout        | 1935 | [40, 41]                   |
| Geometrinae     | Thetidia chlorophyllaria | Hedemann    | 1879 | [37]                       |
| Geometrinae     | Thetidia correspondens | Alpheraky   | 1883 | [49]                       |
| Geometrinae     | Thetidia vulgaria    | Guenée       | 1858 | [21, 34, 40, 46, 65]       |
| Larentiinae     | Acasis appensata     | Eversmann    | 1842 | [46, 65]                   |
| Larentiinae     | Anticlea bafiata     | Denis & Schimmermüller | 1775 | [54, 63]                   |
### Table A1. Cont.

| Subfamily | Species | Author | Year | Reference |
|-----------|---------|--------|------|-----------|
| Larentiinae | Anticlea derivata | Denis & Schiffermüller | 1775 | [24,34,46,63] |
| Larentiinae | Aplocera plagia roddi | Vasilenko | 1995 | [59] |
| Larentiinae | Baptria tribiae | Esper | 1804 | [34,42] |
| Larentiinae | Camptogramma bilineata | Linnaeus | 1758 | [46] |
| Larentiinae | Carsia sororita | Hübner | 1813 | [23,34,36] |
| Larentiinae | Catarhoe cuculata | Hufnagel | 1767 | [37,46,59,63] |
| Larentiinae | Catarhoe rubidata | Denis & Schiffermüller | 1775 | [46] |
| Larentiinae | Chlorocraspa miata | Linnaeus | 1758 | [36] |
| Larentiinae | Cidaria distinctata | Staudinger | 1892 | [37] |
| Larentiinae | Cidaria fulvata | Forster | 1771 | [34,44,63,65] |
| Larentiinae | Coenocalpe lapidata | Hübner | 1809 | [21,23,34,36,46,65] |
| Larentiinae | Coenotephria korschunovi | Viidalepp | 1976 | [34] |
| Larentiinae | Colostygia ocellata | Linnaeus | 1758 | [37] |
| Larentiinae | Dysstroma autocrypta | Heydemann | 1929 | [34,44,63,65] |
| Larentiinae | Dysstroma citrata septentrionalis | Heydemann | 1929 | [31,34,44] |
| Larentiinae | Dysstroma truncata | Hufnagel | 1767 | [23,31,34,44,65,91] |
| Larentiinae | Dysstroma truncata transbaicalensis | Heydemann | 1929 | [36] |
| Larentiinae | Ecliptopera capitata | Herrich-Schäffer | 1839 | [63] |
| Larentiinae | Ecliptopera domita | Prout | 1938 | [37] |
| Larentiinae | Ecliptopera umbrosaria | Motschulsky | 1861 | [34] |
| Larentiinae | Ecliptopera oblongata | Guenée | 1858 | [44] |
| Larentiinae | Electrophaes chimakalepia | Oberthür | 1893 | [44] |
| Larentiinae | Electrophaes corylata | Thunberg | 1792 | [46,65] |
| Larentiinae | Entephrina caesiata | Denis & Schiffermüller | 1775 | [34,36,44] |
| Larentiinae | Entephrina kuznetzovi | Viidalepp | 1976 | [34,45] |
| Larentiinae | Entephrina tzigankovoi | Wehrli | 1929 | [36] |
| Larentiinae | Epirhoe atteraria | Müller | 1764 | [23,34,36] |
| Larentiinae | Epirhoe hastulata | Hübner | 1790 | [34,36,44,46] |
| Larentiinae | Epirhoe hastulata reducta | Džakonov | 1929 | [48] |
| Larentiinae | Epirhoe papillata | Thunberg | 1788 | [23,34,36,44,66,65,91] |
| Larentiinae | Epirhoe tristata | Linnaeus | 1758 | [23,34,46] |
| Larentiinae | Epirrita autumnata | Borkhausen | 1794 | [21,34,34] |
| Larentiinae | Epirrita autumnata smetanini | Beljaev & Vasilenko | 2002 | [48] |
| Larentiinae | Epirrita autumnata tucuana | Bang-Haas | 1910 | [36] |
| Larentiinae | Eukipteryx volitans | Butler | 1878 | [44] |
| Larentiinae | Eulithis mellinata | Fabricius | 1787 | [34] |
| Larentiinae | Eulithis populata | Linnaeus | 1758 | [36,44,63,91] |
| Larentiinae | Eulithis prunata | Linnaeus | 1758 | [34,44,46] |
| Larentiinae | Eulithis pyralata | Denis & Schiffermüller | 1775 | [23,34,44,6,63,65] |
| Larentiinae | Eulithis pyropata | Hübner | 1809 | [91] |
| Subfamily | Species | Author | Year | Reference |
|-----------|---------|--------|------|-----------|
| Larentiinae | Eulithis testata | Linnaeus | 1761 | [23,34,44,46,63] |
| Larentiinae | Euphyia coangulata | Prout | 1914 | [21,23,24,36,44,65] |
| Larentiinae | Euphyia intersecta | Staudinger | 1882 | [21,23,34] |
| Larentiinae | Euphyia unangulata | Haworth | 1809 | [34,46,65] |
| Larentiinae | Euphyia selinata | Herrich-Schäffer | 1861 | [34] |
| Larentiinae | Eupithecia absinthiata | Clerck | 1759 | [95] |
| Larentiinae | Eupithecia actaeata | Walderdorff | 1869 | [37] |
| Larentiinae | Eupithecia addictata | Dietze | 1908 | [37] |
| Larentiinae | Eupithecia aggregata | Guenée | 1858 | [37] |
| Larentiinae | Eupithecia amplexata | Christoph | 1881 | [34,65] |
| Larentiinae | Eupithecia anikini | Mironov & Galsworthy | 2014 | [52] |
| Larentiinae | Eupithecia aporia | Vojnits | 1975 | [41,45] |
| Larentiinae | Eupithecia assimilata | Doubleday | 1856 | [52] |
| Larentiinae | Eupithecia bastebergeri | Dietze | 1910 | [52] |
| Larentiinae | Eupithecia biornata | Christoph | 1867 | [34,65] |
| Larentiinae | Eupithecia bohatschi | Staudinger | 1897 | [25,34,65] |
| Larentiinae | Eupithecia carpophilata | Staudinger | 1897 | [34,65] |
| Larentiinae | Eupithecia catharinana | Vojnits | 1969 | [65] |
| Larentiinae | Eupithecia centaurata | Denis & Schiffermüller | 1775 | [34,63,65] |
| Larentiinae | Eupithecia chingana | Wehrli | 1926 | [45] |
| Larentiinae | Eupithecia corborata | Dietze | 1908 | [36] |
| Larentiinae | Eupithecia denotata | Hubner | 1813 | [34] |
| Larentiinae | Eupithecia despectaria | Lederer | 1853 | [54,37] |
| Larentiinae | Eupithecia dissertata | Püngeler | 1905 | [34,36,65] |
| Larentiinae | Eupithecia djakonovi | Shchetkin | 1956 | [37] |
| Larentiinae | Eupithecia dolosa | Vojnits | 1977 | [45] |
| Larentiinae | Eupithecia ericata | Rambur | 1833 | [52,65] |
| Larentiinae | Eupithecia extensaria | Freyer | 1844 | [36,65] |
| Larentiinae | Eupithecia fennoscandica | Knaben | 1949 | [36,96] |
| Larentiinae | Eupithecia fuscoostata | Christoph | 1887 | [65] |
| Larentiinae | Eupithecia graciliata | Dietze | 1906 | [34] |
| Larentiinae | Eupithecia hannemannii | Vojnits & De Laever | 1973 | [65] |
| Larentiinae | Eupithecia holti | Viidalepp | 1973 | [34,65,97] |
| Larentiinae | Eupithecia illaborata | Dietze | 1904 | [52] |
| Larentiinae | Eupithecia impolita | Vojnits | 1980 | [52] |
| Larentiinae | Eupithecia incula | Vojnits | 1975 | [65] |
| Larentiinae | Eupithecia indigata | Hubner | 1813 | [63] |
| Larentiinae | Eupithecia innatata | Hufnagel | 1767 | [21,34,65] |
| Larentiinae | Eupithecia intricata | Zetterstedt | 1839 | [34] |
| Larentiinae | Eupithecia inveterata | Vojnits | 1987 | [65] |
| Larentiinae | Eupithecia irriguata | Hubner | 1813 | [65] |
| Larentiinae | Eupithecia kazlovii | Viidalepp | 1973 | [34,97] |
| Larentiinae | Eupithecia kulschaensis | Staudinger | 1892 | [34,65] |
| Larentiinae | Eupithecia laboriosa | Vojnits | 1977 | [65] |
| Larentiinae | Eupithecia lariciata | Freyer | 1841 | [34,36,65] |
| Larentiinae | Eupithecia leptogrammata | Staudinger | 1882 | [65] |
| Subfamily | Species            | Author               | Year  | Reference |
|-----------|--------------------|----------------------|-------|-----------|
| Larentiinae | Eupithecia linariata | Denis & Schiffermüller | 1775  | [65]      |
| Larentiinae | Eupithecia mima      | Mironov              | 1989  | [65]      |
| Larentiinae | Eupithecia minusculata | Alphéraky          | 1883  | [34,65]  |
| Larentiinae | Eupithecia mongolica | Vojnits              | 1974  | [65]      |
| Larentiinae | Eupithecia morosa    | Vojnits              | 1976  | [65]      |
| Larentiinae | Eupithecia musgusta  | Mironov & Galsworthy | 2014  | [52]      |
| Larentiinae | Eupithecia necessaria | Vojnits             | 1977  | [41,45]  |
| Larentiinae | Eupithecia nephelata | Staudinger           | 1897  | [21,23,34,65] |
| Larentiinae | Eupithecia nobilitata | Staudinger          | 1882  | [36,65]  |
| Larentiinae | Eupithecia olgae     | Mironov              | 1986  | [52]      |
| Larentiinae | Eupithecia opisthographata | Dietze            | 1906  | [34]      |
| Larentiinae | Eupithecia perpuscata | Vojnits             | 1975  | [65]      |
| Larentiinae | Eupithecia pernotata | Gueneé              | 1858  | [48]      |
| Larentiinae | Eupithecia pimpinellata | Hubner             | 1813  | [34,65]  |
| Larentiinae | Eupithecia propria   | Vojnits              | 1977  | [65]      |
| Larentiinae | Eupithecia pusililata | Denis & Schiffermüller | 1775  | [52]      |
| Larentiinae | Eupithecia pygmaeata  | Hubner               | 1799  | [65]      |
| Larentiinae | Eupithecia recens    | Dietze               | 1904  | [34,36]  |
| Larentiinae | Eupithecia relaxata  | Dietze               | 1904  | [65]      |
| Larentiinae | Eupithecia repentina | Vojnits & De Laever  | 1978  | [52]      |
| Larentiinae | Eupithecia rabeilata | Dietze               | 1904  | [41,45]  |
| Larentiinae | Eupithecia saisanaria | Staudinger          | 1882  | [52]      |
| Larentiinae | Eupithecia satyrata  | Hubner               | 1813  | [36]      |
| Larentiinae | Eupithecia selinata  | Herrich-Schäffer    | 1861  | [95]      |
| Larentiinae | Eupithecia simpliata | Haworth              | 1809  | [52]      |
| Larentiinae | Eupithecia sinuosaria | Eversmann           | 1848  | [23,34,36] |
| Larentiinae | Eupithecia subbrunnnea | Dietze             | 1904  | [52]      |
| Larentiinae | Eupithecia subexiguata | Vojnits            | 1974  | [65]      |
| Larentiinae | Eupithecia subfuscata | Haworth             | 1809  | [34]      |
| Larentiinae | Eupithecia suboxydata | Staudinger         | 1897  | [65,98]  |
| Larentiinae | Eupithecia subtacincta | Hampson           | 1895  | [37]      |
| Larentiinae | Eupithecia subumbrita | Denis & Schiffermüller | 1775  | [23,34,65] |
| Larentiinae | Eupithecia succenturiata | Linnaeus           | 1758  | [95]      |
| Larentiinae | Eupithecia satliata  | Christoph            | 1877  | [65]      |
| Larentiinae | Eupithecia thalicrata | Püngeler            | 1902  | [52]      |
| Larentiinae | Eupithecia undata    | Freyer              | 1840  | [65]      |
| Larentiinae | Eupithecia veratraria | Herrich-Schäffer   | 1848  | [95]      |
| Larentiinae | Eupithecia vicina    | Mironov             | 1989  | [65]      |
| Larentiinae | Eupithecia virgaureata | Doubleday          | 1861  | [21,23,34,65] |
| Larentiinae | Eupithecia vulgata   | Haworth             | 1809  | [21,23,34] |
| Larentiinae | Eupithecia vulgaris   | Staudinger          | 1882  | [37]      |
| Larentiinae | Eupithecia unedonata  | Mabille             | 1868  | [33]      |
| Larentiinae | Eustroma reticulatum obsolenta | Djakonov | 1929  | [48]      |
| Larentiinae | Gagitodes sagittata   | Fabricius           | 1787  | [44,46,63] |
| Larentiinae | Gagitodes sagittata albiflora  | Prout          | 1939  | [48]      |
| Larentiinae | Horismus aemulata    | Hübner              | 1813  | [25,34,46,65] |
Table A1. Cont.

| Subfamily | Species                  | Author            | Year  | Reference                  |
|-----------|--------------------------|-------------------|-------|---------------------------|
| Larentiinae | *Horisme aquata*         | Hübner            | 1813  | [23,34,36,46,65,91]       |
| Larentiinae | *Horisme falcata*        | Bang-Haas         | 1907  | [25,27,34,36,63,65]       |
| Larentiinae | *Horisme incurvaria*     | Erschoff          | 1877  | [34,36,65]                |
| Larentiinae | *Horisme lucillata*      | Guenée            | 1858  | [23,34]                   |
| Larentiinae | *Horisme parcata*        | Püngeler          | 1909  | [65]                      |
| Larentiinae | *Horisme scotosiata*     | Guenée            | 1858  | [21,23,34,63,65]          |
| Larentiinae | *Horisme tersata*        | Denis & Schiffermüller | 1775 | [34,65]                   |
| Larentiinae | *Horisme tersata tetricata* |                |       |                           |
| Larentiinae | *Hydrelia flammeolaria*  | Hufnagel          | 1767  | [44,46]                   |
| Larentiinae | *Hydria cervinalis*      | Scopoli           | 1763  | [34]                      |
| Larentiinae | *Hydria undulata*        | Linnaeus          | 1758  | [34,65]                   |
| Larentiinae | *Hydriomena furcata*     | Thunberg          | 1784  | [21,23,34,36,44]          |
| Larentiinae | *Hydriomena impluviata*  | Denis & Schiffermüller | 1775 | [21,34,36]               |
| Larentiinae | *Hydriomena impluviata djakonovii* | Beljaev & Vasilenko | 2002  | [48]                      |
| Larentiinae | *Hydriomena ruberata*    | Freyer            | 1831  | [65]                      |
| Larentiinae | *Juxtephria consentaria* | Freyer            | 1846  | [36,44,65]                |
| Larentiinae | *Klytoliia obstinata*    | Staudinger        | 1892  | [34]                      |
| Larentiinae | *Laciniodes denigrata abiens* | Prout        | 1938  | [33]                      |
| Larentiinae | *Lampropteryx albigerata* | Kollar           | 1848  | [65]                      |
| Larentiinae | *Lampropteryx jameza*    | Butler            | 1898  | [37]                      |
| Larentiinae | *Lampropteryx minna*     | Butler            | 1881  | [44,45,65]                |
| Larentiinae | *Lampropteryx suffumata* | Denis & Schiffermüller | 1775 | [63]                      |
| Larentiinae | *Leptostege tenatera*    | Christoph         | 1881  | [99]                      |
| Larentiinae | *Lithosege coassata mongolica* | Vojnits      | 1978  | [42]                      |
| Larentiinae | *Lithosege coassata ochraceata* | Staudinger   | 1897  | [42,65]                   |
| Larentiinae | *Lithosege mesolecata*   | Püngeler          | 1899  | [34,42]                   |
| Larentiinae | *Lithosege pallescens*   | Staudinger        | 1897  | [21,34]                   |
| Larentiinae | *Labophora halterata*    | Hufnagel          | 1767  | [44,46]                   |
| Larentiinae | *Martania taeniata*      | Stephens          | 1831  | [44]                      |
| Larentiinae | *Mesoleuca albicillata*  | Linnaeus          | 1758  | [34,37,44,46]             |
| Larentiinae | *Mesotype verbata*       | Scopoli           | 1763  | [44]                      |
| Larentiinae | *Nebula lamata*          | Staudinger        | 1897  | [21,34]                   |
| Larentiinae | *Nebula mongolata*       | Staudinger        | 1897  | [21,34,44,65]             |
| Larentiinae | *Odezia atrata*          | Linnaeus          | 1758  | [23,34]                   |
| Larentiinae | *Orthonana obstipata*    | Fabricius         | 1794  | [34]                      |
| Larentiinae | *Pelurga comitata*       | Linnaeus          | 1758  | [34,44,63,65]             |
| Larentiinae | *Pelurga taczanowskii*   | Oberthür         | 1880  | [63,91]                   |
| Larentiinae | *Perizoma alchemillata*  | Linnaeus          | 1758  | [34,36,44]                |
| Larentiinae | *Perizoma bifaciata*     | Haworth           | 1809  | [65]                      |
| Larentiinae | *Perizoma blandiata*     | Denis & Schiffermüller | 1775 | [23,34]                   |
| Larentiinae | *Perizoma hydrata*       | Treitschke        | 1829  | [36,44,65]                |
| Larentiinae | *Perizoma minorata*      | Treitschke        | 1828  | [46]                      |
| Larentiinae | *Phibalapteryx virgata*  | Hufnagel          | 1767  | [34,36,42,91]             |
| Larentiinae | *Photoscotosia palanaeartica* | Staudinger   | 1882  | [23,34]                   |
| Larentiinae | *Plemyria rubiginata*    | Denis & Schiffermüller | 1775 | [34,44,65]                |
| Subfamily      | Species                        | Author          | Year | Reference       |
|---------------|--------------------------------|-----------------|------|-----------------|
| Larentiinae   | Plesioscotosia pulchrata       | Alphéraky       | 1883 | [23,34]         |
| Larentiinae   | Povilasiia kasghara            | Moore           | 1878 | [51]            |
| Larentiinae   | Pseudentephria remni           | Viidalepp       | 1976 | [35]            |
| Larentiinae   | Pseudobaptria corpudaria       | Graeser         | 1889 | [34]            |
| Larentiinae   | Rheumaptera hastata            | Linnaeus        | 1758 | [34,36,44,46,65]|
| Larentiinae   | Rheumaptera subhastata         | Nolcken         | 1870 | [36]            |
| Larentiinae   | Rheumaptera subhastata commixta| Matsumura       | 1925 | [48]            |
| Larentiinae   | Rhisostosteae subhilaria       | Hübner          | 1799 | [23,34,36,42,65]|
| Larentiinae   | Scotopteryx chenopodata        | Linnaeus        | 1758 | [23,34,46,63,65]|
| Larentiinae   | Scotopteryx golovuschkini      | Kostjuk         | 1991 | [65]            |
| Larentiinae   | Scotopteryx sinensis           | Alphéraky       | 1883 | [23,34]         |
| Larentiinae   | Scotopteryx transcaaticula     | Djakonov        | 1955 | [28,34,36]      |
| Larentiinae   | Spargania lactuata             | Denis & Schiffermüller | 1775 | [23,34,44,46,65]|
| Larentiinae   | Stamnodes danilovi             | Erschoff        | 1877 | [21,23,34,46,65]|
| Larentiinae   | Stamnodes danilevi djakonovi   | Alphéraky       | 1916 | [33]            |
| Larentiinae   | Stamnodes pauperaria           | Eversmann       | 1848 | [65]            |
| Larentiinae   | Theria obeliscata              | Hübner          | 1787 | [34,91]         |
| Larentiinae   | Theria variata                 | Denis & Schiffermüller | 1775 | [23,34]         |
| Larentiinae   | Trichopterigia consobrinaria   | Leech           | 1891 | [44]            |
| Larentiinae   | Trichopterix carpinita         | Borkhausen      | 1794 | [65]            |
| Larentiinae   | Xanthorhoe abrasaria           | Herrich-Schäffer | 1855 | [36,44,65]     |
| Larentiinae   | Xanthorhoe deflurata           | Erschoff        | 1877 | [23,34,44,65]   |
| Larentiinae   | Xanthorhoe montanata           | Denis & Schiffermüller | 1775 | [34,36,46]     |
| Larentiinae   | Xanthorhoe quadrifasiata tannuensis | Prout            | 1924 | [45,63]         |
| Larentiinae   | Xanthorhoe sajanaria           | Prout           | 1914 | [36,44]         |
| Larentiinae   | Xanthorhoe sajanaria djakonovi | Vasilenko       | 1995 | [100]           |
| Larentiinae   | Xanthorhoe spadiccaria         | Denis & Schiffermüller | 1775 | [44,46]       |
| Larentiinae   | Xanthorhoe stupida aridela     | Prout           | 1937 | [37]            |
| Larentiinae   | Zola lerranea                  | Butler          | 1879 | [34]            |
| Sterrhinae    | Cleta jacutica (Axel Hausmann: probably only one Cleta species occurring in Mongolia) | Viidalepp | 1976 | [36] |
| Sterrhinae    | Cleta perpusillaria            | Eversmann       | 1847 | [65]            |
| Sterrhinae    | Cyclophora albiplunctata       | Hufnagel        | 1767 | [46]            |
| Sterrhinae    | Cyclophora pendularia          | Clerck          | 1759 | [46]            |
| Sterrhinae    | Glossotrophia rufotinctata     | Prout           | 1913 | [49]            |
| Sterrhinae    | Holarctias rufinaria           | Staudinger      | 1861 | [58]            |
| Sterrhinae    | Idea aureolaria                | Denis & Schiffermüller | 1775 | [23,34,46]      |
| Sterrhinae    | Idea biselata extincta         | Staudinger      | 1897 | [101]           |
| Sterrhinae    | Idea muricata                  | Hufnagel        | 1967 | [34]            |
| Sterrhinae    | Idea muricata minor            | Sterneck         | 1727 | [40]            |
| Sterrhinae    | Idea nitidata                  | Herrich-Schäffer | 1861 | [37]            |
| Sterrhinae    | Idea nudaria                   | Christoph       | 1881 | [37]            |
| Sterrhinae    | Idea pallidata                 | Denis & Schiffermüller | 1775 | [34,40]      |
| Sterrhinae    | Idea rufaria                   | Hübner          | 1799 | [65]            |
### Table A1. Cont.

| Subfamily | Species               | Author                  | Year  | Reference |
|-----------|-----------------------|-------------------------|-------|-----------|
| Sterrhinae | Idaea rusticata       | Denis & Schiffermüller | 1775  | [40,63]   |
| Sterrhinae | Idaea serpentina      | Hufnagel                | 1767  | [23,34,36,41,63] |
| Sterrhinae | Idaea straminata      | Borkhausen              | 1794  | [34,91]   |
| Sterrhinae | Idaea straminata sibirica | Djakonov                | 1926  | [40]      |
| Sterrhinae | Ochodontia adustaria  | Fischer de Waldheim     | 1840  | [23,34,65] |
| Sterrhinae | Rhodometra sacaria    | Linnaeus                | 1767  | [34]      |
| Sterrhinae | Rhodostrophia jaculata | Hübner                  | 1813  | [21,23,34,36,40,41,63,65] |
| Sterrhinae | Rhodostrophia tyugui  | Vasilenko               | 1998  | [64]      |
| Sterrhinae | Rhodostrophia ustuzhanini | Vasilenko              | 2006  | [49]      |
| Sterrhinae | Rhodostrophia vibicaria | Clerck                | 1759  | [34,46,63] |
| Sterrhinae | Scopula aesquifasciata | Christoph              | 1881  | [47]      |
| Sterrhinae | Scopula albicernaria  | Herrich-Schäffer       | 1847  | [21,25,34,65] |
| Sterrhinae | Scopula albilascata   | Eversmann              | 1851  | [40,41]   |
| Sterrhinae | Scopula beckeraria    | Lederer                | 1853  | [34,40,41,63,65] |
| Sterrhinae | Scopula beckeraria amata | Wehrli              | 1927  | [36,40,65] |
| Sterrhinae | Scopula cajanderi     | Herz                   | 1903  | [41,46]   |
| Sterrhinae | Scopula caricaria     | Reutti                 | 1853  | [46]      |
| Sterrhinae | Scopula contramutata  | Prout                  | 1920  | [34]      |
| Sterrhinae | Scopula cumulata      | Alpheraky              | 1883  | [65]      |
| Sterrhinae | Scopula decorata      | Denis & Schiffermüller | 1775  | [21,23,34,41,63,65] |
| Sterrhinae | Scopula decorata przewalskii | Vidalpepp       | 1975  | [36,40,65] |
| Sterrhinae | Scopula dignata       | Guenée                 | 1858  | [34]      |
| Sterrhinae | Scopula floslactata   | Haworth                | 1809  | [37]      |
| Sterrhinae | Scopula frigidaria    | Moschler               | 1860  | [47]      |
| Sterrhinae | Scopula immorata      | Linnaeus               | 1758  | [23,34,36,40,46,63,65] |
| Sterrhinae | Scopula immutata contramutata | Prout           | 1913  | [58]      |
| Sterrhinae | Scopula impersonata   | Walker                 | 1861  | [34]      |
| Sterrhinae | Scopula impersonata macescens | Butler        | 1879  | [40,41]   |
| Sterrhinae | Scopula incanata      | Linnaeus               | 1758  | [34,41,65] |
| Sterrhinae | Scopula latelinata    | Graeser                | 1892  | [49]      |
| Sterrhinae | Scopula marginpunctata | Goeeze              | 1781  | [23,34,63] |
| Sterrhinae | Scopula nigropunctata | Hufnagel               | 1767  | [34]      |
| Sterrhinae | Scopula nigropunctata subcandidata | Walker         | 1863  | [37]      |
| Sterrhinae | Scopula ornata        | Scopoli                | 1763  | [34,41,46] |
| Sterrhinae | Scopula permutilata   | Staudinger             | 1897  | [34,39,65] |
| Sterrhinae | Scopula rubiginata    | Hufnagel               | 1767  | [34,40,41,63,65,91] |
| Sterrhinae | Scopula ternata       | Schrank                | 1802  | [25,34,36,46] |
| Sterrhinae | Scopula tessellaria   | Boisduval              | 1840  | [65]      |
| Sterrhinae | Scopula umbelaria     | Hübner                 | 1813  | [34,46,63] |
| Sterrhinae | Scopula umbelaria graeseri | Prout           | 1935  | [41,65]   |
| Sterrhinae | Scopula virgulata     | Denis & Schiffermüller | 1775  | [23,34,40,41,46,63,65,91] |
| Sterrhinae | Scopula virgulata substrigaria | Staudinger   | 1900  | [36]      |
| Sterrhinae | Timandra griseata     | Petersen               | 1902  | [46]      |
| Sterrhinae | Timandra paralis      | Prout                  | 1935  | [34,40]   |
| Sterrhinae | Timandra recompta     | Prout                  | 1930  | [40,63]   |
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