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Lepidoptera collected in S. W. Mongolia during expedition in Mongolian Altai in 2022 (Lepidoptera: Geometridae)

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Abstract

An annotated checklist of Geometridae collected in Southwest Mongolia is presented. In total 51 species are recorded. Eight species are recorded as new for the fauna of Mongolia, *Alcis depravata* (Staudinger, 1892), *Holoterpna diagrapharia* Püngeler, 1900, *Scotopteryx supproximaria* (Staudinger, 1892), *Cataclysme riguata* (Hübner, [1813]), *Rhodostrophia crypta* Viidalepp & Kostkuk, 2020, *Idaea ossiculata* (Lederer, 1870), *Scopula divisaria* (Christoph, 1893), and *Casilda consecraria* (Staudinger, 1871). Habitus and genitalia are illustrated for these species. Four of them were DNA-barcoded, as well as three other species. Results of DNA barcoding are discussed.
Kewwords: Lepidoptera, Geometridae, new records, Mongolian Altai, DNA barcoding, Mongolia.

Lepidoptera recolectados en el S. O. de Mongolia durante la expedición en el Altai Mongol en 2022 (Lepidoptera: Geometridae)

Resumen

Se presenta una lista anotada de los Geometridae recolectados en el suroeste de Mongolia. En total se registran 51 especies. Ocho especies son nuevas para la fauna de Mongolia, *Alcis depravata* (Staudinger, 1892), *Holoterpna diagrapharia* Püngeler, 1900, *Scotopteryx supproximaria* (Staudinger, 1892), *Cataclysme riguata* (Hübner, [1813]), *Rhodostrophia crypta* Viidalepp & Kostkuk, 2020, *Idaea ossiculata* (Lederer, 1870), *Scopula divisaria* (Christoph, 1893) y *Casilda consecraria* (Staudinger, 1871). Se ilustran el hábitat y la genitalia de estas especies. Cuatro de ellas han sido codificadas por ADN, al igual que otras tres especies. Se discuten los resultados de la codificación del ADN.
Palabras clave: Lepidoptera, Geometridae, nuevos registros, Altai mongol, código de barras de ADN, Mongolia.

Introduction

The Lepidoptera fauna of Mongolia is of considerable interest to zoologists. Entomologists from different countries (former Soviet Union, Hungary, Russia etc.) have been studying the insect fauna (including Lepidoptera) of Mongolia for many years. Some groups of Mongolian lepidopterans were studied relatively well, namely Papilionoidea (Tshikolovets et al. 2009; Yakovlev, 2012), Sphingidae (Derzhavets, 1977; Yakovlev et al. 2015), Zygaenidae (Efetov et al. 2012), Cossidae (Yakovlev, 2004, 2015), Notodontidae (Morozov et al. 2016; Schintlmeister, 2008) and Pterophoridae (Ustjuzhanin & Kovtunovich, 2008). Nevertheless, the knowledge about other taxonomic groups (e. g. Geometridae, Noctuidae, Alucitidae) remains insufficient. The recent publications illustrate this well (Knyazev et al. 2020; Ustjuzhanin et al. 2016).

Our research considers the west part of Mongolia, Mongolian Altai in particular, which is still poorly

known. The Mongolian Altai is a mountain system in Mongolia and China which stretches approximately 1000 km from the northwest to the southeast. The mountain system of the Mongolian Altai reaches uplands of the Altai Republic (Russia) in the north, borders with deserts and semi-deserts of Dzhungaria and Gobi towards the south and west, and semi-deserts of the Great Lakes Depression in the northeastern area of the system. Mongolian Altai reaches an altitude of 4362 m (Mountain Munkh-Khajrkhan-Ula) and consists of several parallel ridges. Southwestern slopes receive more precipitation than northeastern ones, and they consist of richer forest-meadow landscapes (with spruce and larch prevailing in forests), changing into steppes in lowlands and alpine meadows. Steppes and semi-deserts dominate on northeastern slopes, while semi-deserts prevail between the mountains (Kamelin, 2005; Yakovlev et al. 2015).

The Mongolian Altai is a significant frontier in the distribution of insects: a number of studies have shown that insect fauna of the southwestern (Dzhungarian) slopes of Mongolian Altai differs markedly from those of the northeastern slopes. This conclusion is based on the distribution of Orthoptera (Sergeev, 1986), Coleoptera (Kryzhanovskij, 2002), Lepidoptera (Yakovlev, 2011, 2012, 2015). The main ridge of the Mongolian Altai divides the biota of the Altai Mountain region into two biological provinces: Altai-Dzhungarian (western) and Western Mongolian (eastern) (Yakovlev, 2012).

In June 2022 the authors of this article made a trip to the south of Mongolian Altai (Figure 1). The main goals of this expedition were to study the Lepidoptera fauna in south-western (Dzhungarian) macroslope of Mongolian Altai and Dzhungarian Gobi, the less studied and rather rich in biodiversity southern parts of Khovd and Gov'-Altai Aimags (Yakovlev, 2012; Yakovlev & Dubatolov 2013a, b).

The present paper is devoted to Geometridae recorded by us during this travel. Although Mongolia is one of the largest countries, 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 fairly complete historical review of the study of geometrid moths in Mongolia was given by Enkhtur and co-authors (2020). Only a few works deal with the geometrid moths of the Mongolian Altai (Vasilenko, 2004, 2006).

Here we provide the list of Geometridae recorded in 11 localities of W Mongolia (Table 1), including the species new for Mongolia.

Table 1. List of collection sites (in alphabetical order).

Abbreviation	Locality	Coordinates	Date	Figure
G-AT	Gov'-Altai Aimag, Tonkhil Sum, 11 km W of Tonkhil village	46.2979918N, 93.7575660E	15-VI	2A, 2B
G-AS	Gov'-Altai Aimag, Sharga Sum, Sharga village vicinity, wet meadow	46.265184N, 95.275054E	17-VI	2C
KA	Khovd Aimag, Altai Sum, 22 km NNW of Altai, 1552 m.a.s.l.	46.006623N, 92.356425E	6-VI	3A
KB1	Khovd Aimag, Bulgan Sum, 19 km NE of Bulgan, dry steppe	46.2548970N, 91.2569036E	12-VI	3B, 3C
KB2	Khovd Aimag, Bulgan Sum, 27 km NNW of Burenkhairkhan	46.3372557N, 91.4698368E	10-VI	4A
KB3	Khovd Aimag, Bulgan Sum, 30 km NNE of Bulgan	46.4021527N, 91.1830443E	11-VI	4B
KB4	Khovd Aimag, Bulgan Sum, 36 km S of Bulgan, desert	45.7812698N, 91.1355541E	7-VI	4C
KD	Khovd Aimag, Darvi Sum, 14 km NWW of Darvi vill., dry hills	46.958009N, 93.435621E	17-VI	5A, 5B
KM1	Khovd Aimag, Must Sum, 16 km NWW of Must, 2280 m.a.s.l.	46.7274700N, 92.5920415E	13-VI	6A, 6B
KM2	Khovd Aimag, Must Sum, 16 km NWW of Must, dry hills	46.7274700N, 92.5920415E	5-VI	6C
KU	Khovd Aimag, Uyench Sum, 10 km NNE of Burenkhairkhan	46.1866290N, 91.6003534E	9-VI	5C

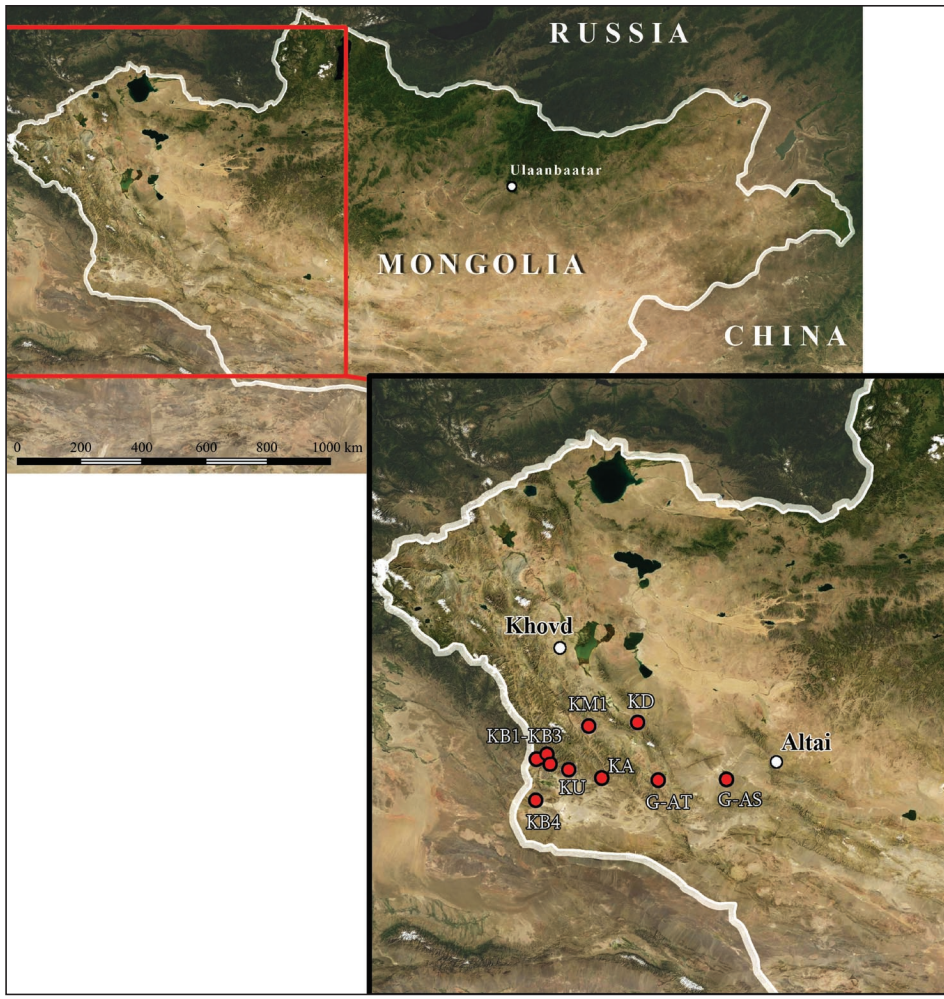

Figure 1. Map of collecting localities.

Material and methods

Material sampling

The moths were sampled with standard methods. Most geometrids were captured at night (usually since twilight coming to 4-5 am) using a Sylvania HSL-BW 250W E40 mercury vapor lamp powered from a FUBAG TI 1000 petrol generator, and a portable screen made of white cotton canvas. The small part of lepidopterans was caught at daytime by an entomological net. All collected Lepidoptera are deposited in the Zoological Institute of the Russian Academy of Sciences (Saint Petersburg, Russia).

Morphological analysis

Genitalia preparations were made using a standard technique; maceration was performed with a 15% solution of potassium hydroxide. Glycerol was used for temporary preparations. The photos of temporary genitalia preparations were performed using a Nikon SMZ25 stereoscopic microscope, Nikon DS-Ri2 camera and NIS-Elements BR software.

DNA barcoding and data analysis

For some moths we obtained DNA barcodes to verify our identifications. For DNA extraction we used the dry specimens; one to three legs of each specimen were used. The legs were crushed before lysis, and the lysis reaction proceeded overnight. DNA extraction was carried out using the DNeasy Blood & Tissue Kit (QIAGEN, Germany), according to the manufacturer's protocol. DNA elution was performed with 150 μL elution buffer. Amplification of a 658-bp-long COI fragment was performed using the primers HCO2198 (5'-TAAACTTCAGGGTGACCAAAAAATCA-3') (Folmer et al. 1994) and LCO1490 (5'-GGTCAACAAATCATAAAGATATTGG-3') (Folmer et al. 1994). The polymerase chain reaction (PCR) profile used for this marker was as follows: 95 ºC for 3 min, 95 ºC for 30 s, 50 ºC for 45 s, 72 ºC for 1 min (steps 2-4 cycled 34 times) and 72 ºC for 10 min. The samples were sequenced at Evrogen JSC (Moscow).

Obtained COI sequences were blasted against the complete sequence database of the Barcode of Life Data systems (BOLD) in order to infer the closest matches using the BOLD Identification Engine (http://www.boldsystems.org/index.php/IDS_OpenIdEngine). Moreover, a cross-check control of external morphology was also performed. Genetic distances were calculated using the Kimura 2-parameter (K2P) distance model (Kimura, 1980), using the analytical tools provided by the BOLD Systems v4 platform (Ratnasingham & Hebert, 2007). Genetic distances are given in % minimum pairwise distance. All sequences obtained were uploaded to GenBank; their accession numbers are provided in the annotated checklist (in the parentheses next to the corresponding specimens).

Results and discussion

In the species list below, we provide the data on the findings of Geometridae made in 2022. All moths were collected by the first author. The taxonomic order follows the one presented in Beljaev & Mironov (2019). Literature references are given for each species with the corresponding combination. In the section "Material" the data on the location (see Table 1 for details), the number of collected moths and their sex are given. In the section "Distribution" the countries in which this species occur are listed. The following sources were used to characterize the distribution (Beljaev & Mironov, 2019; Beljaev, 2016; Gorbunov, 2011; Hausmann, 1993, 2001; Mironov & Galsworthy, 2014; Mironov & Ratzel, 2012; Mironov, 2013; Mironov, 2017; Rajaei et al. 2023; Vasilenko & Belousov, 2021; Vasilenko & Mironov, 2021; Vasilenko, 2006; Vasilenko, 2019; Viidalepp, 1975-1979, 1988, 1996).The species new for Mongolia are marked with asterisk. Some notes on distribution, results of DNA-barcoding and additional information are given in the separate section.

Annotated checklist of species

GEOMETRIDAE
ENNOMINAE

Perconia strigillaria (Hübner, [1787])
Perconia strigillaria: Viidalepp, 1975, 488; 1979, 783; 1996, 78; Enkhtur et al. 2017, 672; 2020, 15
Perconai [sic!] *strigillaria*: Enkhtur et al. 2021b, 370
Material: KB3 - 3 ♂♂, 2 ♀♀, G-AT - 2 ♀♀, KB1 - 1 ♀.

Distribution: Europe, Balkans, Ireland, Turkey, Transcaucasia, Russia (European part to S. Yakutia), Mongolia.

Charissa difficilis (Alphéraky, 1883)
Gnophos difficilis: Staudinger, 1896, 275; Alberti, 1971, 374; Viidalepp, 1975, 485; 1979, 786
Dysgnophos difficilis: Vojnits, 1975, 194
Charissa difficilis: Enkhtur et al. 2020, 13; Knyazev et al. 2020, 193

Material: KA - 3 ♂♂, 6 ♀♀, KB4 - 1 ♂, 4 ♀♀, KB1 - 1♀, KB3 - 3 ♀♀, KB2 - 2 ♂♂, 10 ♀♀, KU - 1♂, 2 ♀♀, KM1 - 2 ♂♂, 1 ♀, G-AT - 2 ♂♂.

Distribution: Russia (Caucasus, S. Ural), Armenia, Kazakhstan, Kyrgyzstan, Mongolia, N. W. China.

Charissa turfosaria (Wehrli, 1922)
?Gnophos exilis Wehrli, 1922, 15: Viidalepp, 1975, 486; 1979, 786; 1996, 82
?Gnophos benepunctaria, nec Wehrli, 1922, 16: Viidalepp, 1975, 486
?Gnophos glaciata Wehrli, 1922, 14: Viidalepp, 1975, 485
?Gnophos glaciatus: Viidalepp, 1979, 786
?Dysgnophos benepunctarius (Wehrli, 1922): Vojnits, 1975, 193; 1977, 174
?Dysgnophos glaciatus: Vojnits, 1975, 194; Viidalepp, 1996, 82
Gnophos turfosaria: Smiles, 1979: 117
?Dysgnophos subsplendidaria: Smiles, 1979, 118; Enkhtur et al. 2021b, 370
?Charissa subsplendidaria (Wehrli, 1922): Enkhtur et al. 2020, 13
Charissa turfosaria: Enkhtur et al. 2020, 13

Material: KM1 - 1 ♂; KM2 - 1 ♂; G-AT - 1 ♂; KB3 - 1 ♀.

Distribution: Russia (N. and central Ural, Altai, mountains of S. Siberia, E. and S. Yakutia, northern part, and mountains of the Far East), Kazakhstan, Mongolia, Alaska, Canada.

Synopsia strictaria Lederer, 1853
Synopsia strictaria: Staudinger, 1892, 366; 1896, 273; Staudinger & Rebel, 1901, 339; Vojnits, 1975, 189; 1977, 173; Viidalepp, 1979, 784; 1996, 79; Mühlenberg et al. 2011, 202; Enkhtur et al. 2021b, 370
Megalycinia strictaria: Viidalepp, 1975, 482; Enkhtur et al. 2020, 14; 2021a, Supplementary material (Table S2)

Material: KB3 - 1 ♀.

Distribution: Russia (S. Ural, Altai, S. Siberia, Dauria, southern part of the Far East), Kazakhstan, Mongolia, N. and S. W. China, N Korea.

Dyscia fagaria (Thunberg, 1784)
Dyscia fagaria: Beljaev, 2016, 544

Material: KB4 - 1 ♂.

Distribution: N. W. and Central Europe, W. Ukraine, Russia (S. European part, Caucasus, S. Ural, Transbaikalia), Transcaucasia, Central Asia, Kazakhstan, Mongolia, China (N. and N. W.).

Jankowskia bituminaria (Lederer, 1853)
Boarmia bituminaria: Staudinger, 1896, 274; Staudinger & Rebel, 1901, 339
Cleora bituminaria: Viidalepp, 1975, 483
Pleogynopteryx bituminaria: Vojnits, 1975, 190; 1977, 173; Enkhtur et al. 2020, 15
Jankowskia bituminaria: Vasilenko, 2004, 68; Enkhtur et al. 2020, 14; Knyazev et al. 2020, 192
Jankowskia bituminaria raddensis Wehrli, 1941: Jiang et al. 2010, 10; Enkhtur et al. 2020, 14

Material: KA - 2 ♂♂, KB4 - 3 ♀♀, KU - 1 ♂.

Distribution: Russia (S. Siberia, Dauria, southern part of Far East), Mongolia, N. China, N. Korea.

Spartopteryx kindermannaria (Staudinger, 1871)
Synopsia kindermannaria: Staudinger, 1896, 274; Staudinger & Rebel, 1901, 338
Spartopteryx kindermannaria: Viidalepp, 1975, 482; Vojnits, 1975, 189; 1977, 173; Viidalepp, Solyanikov, 1977, 637; Mühlenberg et al. 2011, 202; Enkhtur et al. 2020, 15
Spartopteryx kindermanniaria [sic!]: Viidalepp, 1979, 789; 1996, 86

Material: KB3 - 1 ♂.

Distribution: Russia (S. Ural, Altai, S. Siberia, Dauria, southern part of the Far East), S. Kazakhstan (Tien Shan), Mongolia, China (N. and N. W.).

Hypomecis atomaria (Linnaeus, 1758)
Ematurga atomaria: Staudinger, 1892, 379; Staudinger & Rebel, 1901, 350; Alberti, 1957, 6; Viidalepp, 1975, 486; Viidalepp, Solyanikov, 1977, 639; Enkhtur et al. 2020, 13
Ematurga atomaria krassnojarscensis Fuchs, 1901: Vojnits, 1975, 197; 1977, 174; Viidalepp, 1979, 787; 1996, 85; Enkhtur et al. 2020, 13

Material: KB2 - 1 ♂.

Distribution: Europe, Turkey, Transcaucasia, Russia, Kyrgyzstan, E. and S. Kazakhstan, Mongolia, China.

* *Alcis depravata* (Staudinger, 1892)

Material: KB2 - 1 ♀ (GenBank ID: OQ720933).

Distribution: E. and S. Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Mongolia, N. W. China.

Note: The only collected female was a mosaic gynandromorphy (Figure 7A). However, its appearance corresponds to the features of *A. depravata*, previously unknown from Mongolia.

Phaselia serrularia (Eversmann,1847).
Phaselia serrularia: Enkhtur et al. 2020, 15

Material: KA - 1 ♂ (GenBank ID: OQ720935).

Distribution: Kazakhstan, Uzbekistan, Turkmenistan, Kyrgyzstan, Tajikistan, W. Mongolia, and Southern Fderal District of Russia.

Note: The DNA barcode obtained from our sample was found to be identical with several *COI* of *Phaselia* collected in Khovd Aimag (Mongolia) by Roman Yakovlev in 2005 and 2016. Four of them are identified as *Phaselia serrularia* (Eversmann, 1847) and only one as *P. narynaria*. Analysis of genitalia of our specimen (Figures 10A, 10B) shows that it is conspecific with *P. serrularia*.

Chiasmia saburraria (Eversmann, 1851)
Macaria intermaculata var. *kenteata* Staudinger, 1892, 375: Staudinger, 1896, 273
Phasiane zimmermanni Graeser, 1888 var. *kenteata*: Staudinger & Rebel, 1901, 353
Phasiane biparata Lederer, 1853: Staudinger & Rebel 1901, 353
Semiothisa saburraria kenteata Staudinger, 1892: Vojnits, 1974, 283; 1977, 172
Semiothisa saburraria: Viidalepp, 1975, 478; 1978, 760; 1996, 75
Chiasma [sic!] *saburraria*: Vasilenko, 2004, 68
Chiasmia saburraria: Enkhtur et al. 2020, 13; Knyazev et al. 2020, 193
Chiasmia saburraria kenteata: Enkhtur et al. 2020, 13

Material: KB4 -1 ♂.

Distribution: Russia (S. Ural to the southern part of the Far East), Mongolia, N. China.

GEOMETRINAE

* *Holoterpna diagrapharia* Püngeler, 1900

Material: KB2 - 4 ♂♂, 2 ♀♀ (Figures 7C, 7D).

Distribution: Iran, Turkmenistan, Uzbekistan, Kyrgyzstan, Kazakhstan, W. Mongolia.

Note: Rare turanian desert species (Gorbunov, 2011; Viidalepp, 1988), **new for Mongolia**. Apparently, the easternmost limits of the *H. diagrapharia* range lies in S. W. Mongolia.

Thetidia smaragdaria (Fabricius, 1787)
Phorodesma smaragdaria var. *prasinaria* (Eversamann, 1837): Staudinger, 1896, 271
Euchloris smaragdaria v. *mongolica*: Staudinger & Rebel 1901, 262
Euchloris anomica Prout, 1935: Vojnits, 1976, 169; 1977, 167
Euchloris volgaria mongolica: Vojnits, 1977, 168
Thetidia volgaria (Guenée, 1858): Viidalepp, 1975, 442; Enkhtur et al. 2020, 15
Thetidia smaragdaria mongolica: Viidalepp, 1976, 845; 1996, 63; Mühlenberg et al. 2011, 202
Thetidia volgaria mongolica: Enkhtur et al. 2020, 15
Thetidia smaragdaria: Knyazev et al. 2020, 192; Enkhtur et al. 2021, Supplementary material (Table S2)

Material: KB2 - 1 ♂, KB3 - 1 ♂.

Distribution: Europe, Russia, W. Turkey, ?Transcaucasia, ?N. Iran, Kyrgyzstan, Turkmenistan, Uzbekistan, Kazakhstan, Mongolia, China, Korea, Japan.

Dyschloropsis impararia (Guenée, 1858)
Eucrostis impararia: Staudinger, 1896, 272
Geometra impararia: Staudinger & Rebel 1901, 261
Holoterpna impararia: Vojnits, 1976, 170; 1977, 167
Dyschloropsis impararia: Alberti, 1971, 373; Viidalepp, 1975, 442; 1976, 845; 1996, 61; Vasilenko, 2004, 68; Knyazev et al. 2020, 192; Enkhtur et al. 2020, 15

Material: KA - 1 ♂; KD - 2 ♂♂; KU - 1 ♀; KB1 - 1 ♀.

Distribution: Russia (southern Ural to Dauria), Mongolia, Kazakhstan, Central Asia, N. China.

Phaiogramma etruscaria (Zeller, 1849)
Fhaiogramma [sic!] *etruscaria*: Vasilenko, 2006, 346

Material: KU - 2 ♂♂, 2 ♀♀; KB1 - 1 ♂.

Distribution: S. Europe, Morocco, Tunisia, Turkey, Levant, S. W. Russia, Caucasus, Transcaucasia, N. Iraq, Iran, Afghanistan, Turkmenistan, Tajikistan, Uzbekistan, Kyrgyzstan, Kazakhstan, W. Mongolia.

Microloxia herbaria (Hübner, [1813])
Microloxia herbaria advolata Eversmann, 1837: Vojnits, 1977, 168; Enkhtur et al. 2020, 15
Microloxia herbaria: Viidalepp, 1975, 443; 1976, 846; 1996, 62; Knyazev et al. 2020, 192; Enkhtur et al. 2020, 15

Material: KB1 - 12 ♂♂, 2 ♀♀, KU - 1 ♂.

Distribution: Europe, Russia (S. European part, S. Ural), Turkey, Levant, Caucasus, Transcaucasia, N. Iran, Afghanistan, N. Pakistan, Kazakhstan, Turkmenistan, Uzbekistan, Kyrgyzstan, Tajikistan, W. Mongolia.

LARENTIINAE

Aplocera plagiata (Linnaeus, 1758)
Aplocera plagiata roddi Vasilenko, 1995: Enkhtur et al. 2020, 16

Material: KB3 -1 ♀.

Distribution: Europe, European Russia, Turkey, Transcaucasia, Levant, N. Iran, Afghanistan, Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, Turkmenistan, Mongolia, N. America.

* *Scotopteryx supproximaria* (Staudinger, 1892)

Material: KB3 - 2 ♂♂, 7 ♀♀ (Figures 7E, 7F; genitalia: Figures 10C, 10D, 11I; GenBank ID: OQ720938).

Distribution: Kazakhstan, Uzbekistan, Kyrgyzstan, W. Mongolia.

Note: A **new species for the fauna of Mongolia**. Genetically *S. supproximaria* is close to *S. burgaria* (Eversmann, 1843): at minimum distances of 1.2%.

Euphyia unangulata (Haworth, 1809)
Euphyia unangulata: Viidalepp, 1975, 459; 1996, 17; Mühlenberg et al. 2011, 201; Enkhtur et al. 2020, 17; 2021a, Supplementary material (Table S2); 2021b, 371

Material: KA - 2 ♂♂.

Distribution: Europe, Russia, Mongolia, Central China, Korea, Japan, N. America.

Euphyia coangulata (Prout, 1914)
Cid[aria] unangulata var. *subangulata* Staudinger, 1896, 279
Larentia unangulata var. *subangulata*: Staudinger & Rebel, 1901, 303
Cidaria coangulata: Alberti, 1971, 373
Euphyia coangulata: Viidalepp, 1975, 459; 1977, 571; 1996, 17; Vojnits, 1979, 209; Knyazev et al. 2020, 193; Enkhtur et al. 2020, 17

Material: KB2 - 2 ♂♂; KB4 - 2 ♀♀.

Distribution: Russia (Altai, S. Siberia, Transbaikalia), Mongolia, W. China.

* *Cataclysme riguata* (Hübner, [1813])

Material: KB3 - 5 ♂♂ (Figure 7B).

Distribution: S. Europe, S. W. Russia (S. European part, Caucasus, S. Ural, Altai), Turkey, Transcaucasia (Georgia, Armenia, Azerbaijan), N. Iran, Afghanistan, Kazakhstan, S. Turkmenistan, Tajikistan, Kyrgyzstan.

Note: Not previously recorded from Mongolia. Earlier Viidalepp (1975, 462) noted that occurrence of this species in Mongolia is probable.

Catarhoe cuculata (Hufnagel, 1767)
Catarhoe cuculata undulosa (Warnecke, 1934): Viidalepp, 1996, 14
Catarhoe cuculata: Mühlenberg et al., 2011, 200; Enkhtur et al. 2020, 16; 2021b, 371

Material: KB3 - 1 ♀.

Distribution: Algeria, Europe, Russia, Turkey, Caucasus, Transcaucasia, Iran, Kazakhstan, Uzbekistan, Kyrgyzstan, Mongolia, Northeast China.

Kyrtolitha obstinata (Staudinger, 1892)
Kyrtolitha obstinata: Viidalepp, 1975, 451; 1977, 566; Enkhtur et al. 2020, 19

Material: KA - 2 ♂♂ (Figures 8A, 8B).

Distribution: E. and S. Kazakhstan (Dzhungarian (?) and Transili Alatau), Kyrgyzstan, Uzbekistan, Tajikistan, W. Mongolia, N. W. China.

Nebula mongoliata (Staudinger, 1896)
Cid[aria] ibericata ?var. *mongoliata* Staudinger, 1896, 278
Larentia mongoliata: Staudinger & Rebel, 1901, 300
Coenotephria mongoliata: Viidalepp, 1975, 458; Vojnits, 1979, 209
Nebula mongoliata: Viidalepp, 1996, 27; Vasilenko, 2004, 66; Enkhtur et al. 2020, 19

Material: KB2 - 1 ♂ (GenBank ID: OQ720940), KB3 - 2 ♂♂ (GenBank ID: OQ720939), KB4 - 5 ♂♂ (GenBank ID: OQ720941, OQ720942, OQ720943, OQ720944)

Distribution: Russia (S. E. Altai, Tyva, Irkutskaya Oblast, Buryatia, Zabaikalsky Kray), Mongolia.

Note: The studied specimens are genetically homogeneous, and their barcodes differ from ones of S. Siberian *N. mongoliata* (Irkutskaya Oblast, Buryatia) by 4 substitutions.

Eupithecia centaureata ([Denis & Schiffermüller], 1775)
Eupithecia centaureata: Viidalepp, 1975, 463; Vasilenko, 2004, 67; Mironov, Galsworthy, 2014, 114; Enkhtur et al. 2020, 17; 2021a, Supplementary material (Table S2); 2021b, 371; Knyazev et al. 2020, 193
Eupithecia centaureata centralisata Staudinger, 1892: Viidalepp, 1978, 753; 1996, 41

Material: KB4 - 1 ♂, KB2 - 1 ♂, KB3 - 1 ♂, 2 ♀♀, KU - 1 ♂, 1 ♀.

Distribution: Europe, Russia (European part to Amur region), N. Africa (Morocco, Algeria, Tunisia); Turkey, Transcaucasia, Lebanon, Israel, Jordan, Syria, Iran, Afghanistan, Kazakhstan, Uzbekistan, Turkmenistan, Kyrgyzstan, Tajikistan, Mongolia, China, Taiwan, Korea, India.

Eupithecia vulgata (Haworth, 1809)
Tephroclystia vulgata: Staudinger & Rebel, 1901, 312
Eupithecia vulgata: Staudinger, 1896, 283; Viidalepp, 1975, 463; Mironov & Galsworthy, 2014, 118; Enkhtur et al. 2020, 18
Eupithecia vulgata lepsaria Staudinger, 1882: Viidalepp, 1996: 42; Enkhtur et al. 2020, 18.

Material: KA - 2 ♂♂.

Distribution: N. Africa, Europe, Russia (European part to Amur region), Morocco, Lebanon, Turkey, Transcaucasia, N. Iran, Tajikistan, Afghanistan, Kazakhstan, Uzbekistan, Kyrgyzstan, Mongolia, N. W. China, Korea.

Eupithecia holti Viidalepp, 1973
Eupithecia holti Viidalepp, 1973, 397; 1975, 468; 1996, 36; Mironovm & Galsworthy, 2014, 105; Enkhtur et al. 2020, 17; Knyazev et al. 2020, 193

Material: KA - 1 ♂, 1♀, KB4 - 1 ♂.

Distribution: Russia (Altai Mountains, Tyva, S. Buryatia), Mongolia.

Eupithecia vicariata Dietze, 1904
Eupithecia vicariata: Mironov, Galsworthy, 2014, 113; Knyazev et al. 2020, 193

Material: KB3 - 2 ♀♀, KU - 1 ♂.

Distribution: Turkmenistan, Kyrgyzstan, Tajikistan, S. W. Kazakhstan, Mongolia, W. China.

Eupithecia exactata Staudinger, 1882
Eupithecia exactata: Viidalepp, 1978, 752; Mironov & Galsworthy, 2014, 120; Knyazev et al. 2020, 193.

Material: KD - 2 ♂♂, G-AT - 1 ♂, 1 ♀.

Distribution: N. Iran, S. E. Kazakhstan, Kyrgyzstan, Tajikistan, N. E. Afghanistan, Russia (Altai Mountains), Kyrgyzstan, Mongolia, China, India, Pakistan.

Eupithecia innotata (Hufnagel, 1767)
Eupithecia innotata: Enkhtur et al. 2020, 17

Material: KB3 - 2 ♂♂.

Distribution: Europe (except Iceland, Scandinavia and the south of the Balkans), W. Russia,

Morocco, Algeria, Tunisia, Turkey, Transcaucasia, Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Afghanistan, Pakistan, Mongolia, China (Xinjiang Uygur Autonomous Region, Qinghai).

Eupithecia lariciata (Freyer, 1842)
Eupithecia lariciata: Viidalepp, 1975, 468; Viidalepp & Solyanikov, 1977, 634; Viidalepp, 1996, 37; Mironov & Galsworthy, 2014, 108; Enkhtur et al. 2020, 17; 2021, Supplementary material (Table S2)

Material: KD - 1 ♂.

Distribution: Europe, Russia, Mongolia, Central China, N. Korea, Japan (Hokkaido, Honshu), N. America.

Eupithecia subbrunneata Dietze, 1904
Catarina carissima (Vojnits & de Laever, 1973): Viidalepp, 1978, 756
Eupithecia carissima: Viidalepp, 1996, 40; Vasilenko, 2004, 66
Eupithecia subbrunneata: Mironov & Galsworthy, 2014, 110; Enkhtur et al. 2020, 18

Material: KU - 3 ♂♂.

Distribution: Russia (S. Ural to Primorye), S. E. Kazakhstan, Mongolia, China, Korea.

Eupithecia dissertata (Püngeler, 1905)
Eupithecia dissertata: Viidalepp, 1975. 462; Viidalepp & Solyanikov, 1977, 631; Viidalepp, 1978, 753; Viidalepp, 1996, 36; Mironov & Galsworthy, 2014, 107; Enkhtur et al. 2020, 17

Material: KU - 2 ♂♂.

Distribution: Central and E. Europe (in mountains), Russia (Altai Mountains, Sayan, Baikal region, Amur region, Magadanskaya Oblast), S. E. Kazakhstan, N. and W. Mongolia, China.

Eupithecia illaborata Dietze, 1904
Eupithecia illaborata: Mironov & Galsworthy, 2014, 102; Enkhtur et al. 2020, 17

Material: KB3 - 1 ♀.

Distribution: S. E. Kazakhstan, Tajikistan, Kyrgyzstan (Tien Shan Mountains), Mongolia, N. China (Xinjiang and Inner Mongolia).

Eupithecia kozlovi Viidalepp, 1973
Eupithecia kozlovi Viidalepp, 1973, 398; 1975, 470; 1996, 37; Mironov & Galsworthy, 2014, 108; Enkhtur et al. 2020, 17; Knyazev et al. 2020, 193.

Material: KU - 1 ♂, 2 ♀♀, KB1 - 1 ♂, KB2 - 1 ♂, 1 ♀, KB4 - 1 ♂.

Distribution: China (Inner Mongolia, Qinghai, Gansu), Tajikistan, Kyrgyzstan, S. E. Kazakhstan, Russia (Altai Mountains), Mongolia.

Eupithecia despectaria Lederer, 1853
Eupithecia despectaria: Viidalepp, 1975, 462; 1978, 752; Vasilenko, 2004, 67; Mironov & Galsworthy, 2014, 115; Enkhtur et al. 2020, 17

Material: KU - 5 ♂♂, KB3 - 1 ♂.

Distribution: Turkey, Russia (Altai Mountains, Sayan, Tyva), S. and E. Kazakhstan, Mongolia, N. W. China (Kuldja), Kirghizstan, Tajikistan, Uzbekistan, N. W. Pakistan.

Eupithecia parallelaria Bohatsch, 1893
Eupithecia parallelaria: Viidalepp, 1975, 466; 1978, 755; 1996, 39; Mironov & Galsworthy, 2014, 112

Material: KU - 5 ♂♂, 2 ♀♀, KA - 2 ♂♂, 4 ♀♀, KB2 - 2 ♀♀, KB3 - 1 ♂, 2 ♀♀, KM2 - 1 ♀, KB1 - 2 ♀♀.

Distribution: Iran, Turkmenistan, Uzbekistan, Tajikistan, S. E Kazakhstan, Kyrgyzstan, Afghanistan, Pakistan, N. W. China, Mongolia.

Horisme intersecta (Staudinger, 1882)
Cid[aria] intersecta: Staudinger, 1896, 280
Larentia intersecta: Staudinger & Rebel, 1901, 301
Horisme intersecta: Viidalepp, 1975, 474
Euphyia intersecta: Enkhtur et al. 2020, 17
Material: KA - 1 ♂, 1 ♀, KB2 - 2 ♂♂, KB3 -5 ♂♂, 2 ♀♀.
Distribution: N. Iran, Kazakhstan, Kyrgyzstan, ?N. W. China, Mongolia.

STERRHINAE

Rhodostrophia vibicaria (Clerck, 1759)
Rhodostrophia vibicaria: Viidalepp, 1975, 450; 1976, 850; 1996, 57; Mühlenberg et al. 2011, 201; Enkhtur et al. 2020, 21; 2021a, Supplementary material (Table S2); 2021b, 371
Material: KB3 - 2 ♂♂, KB1 - 1 ♂.
Distribution: Europe, Morocco, Algeria, Turkey, Transcaucasia, N. Iran, W. Russia, Kazakhstan, Central Asia, Central Mongolia.

Rhodostrophia jacularia (Hübner, [1813])
Eusarca jacularia: Staudinger, 1896, 276
Rhodostrophia jacularia: Viidalepp, 1975, 450; 1976, 850; Viidalepp & Solyanikov, 1977, 626; Viidalepp, 1996, 57; Vojnits, 1976, 171; 1977, 169; Vasilenko, 2004, 67; Enkhtur et al. 2020, 21; 2021a, Supplementary material (Table S2); 2021b, 371; Knyazev et al. 2020, 193
Rhodostrophia tyugui Vasilenko, 1998, 1138; Vasilenko, 2004, 67; Enkhtur et al. 2020, 21
Rhodostrophia ustyuzhanini Vasilenko, 2006, 345; Enkhtur et al. 2020, 21
Material: KB4 - 1 ♂, KD - 3 ♂♂, KM1 - 10 ♂♂, G-AT - 2 ♂♂.
Distribution: Turkey, Russia (Volga region, Altai, S. Siberia, Dauria), N. Kazakhstan, Mongolia, N. W. China.

* *Rhodostrophia crypta* Viidalepp & Kostjuk, 2020
Material: KA - 1 ♂ (Figure 8D).
Distribution: E. Kazakhstan, W. Mongolia.
Note: *R. crypta* was described only 3 years ago. The authors of this taxon showed that it reliably differs from its closely related *R. vastaria* Christoph, 1877 described from Turkmenistan. According to the Viidalepp and Kostjuk (2020), *R. vastaria* inhabits the Turkmen shore of the Caspian Sea (Turkmenbashi), the Ustjurt plateau (W. Kazakhstan) and the southern Urals. The genitalia structure of our specimen (Figures 10E-10G) corresponds precisely to those in *R. crypta* which is **new for Mongolia**.

Idaea straminata (Borkhausen, 1794)
Sterrha sibirica: Djakonov, 1926; Vojnits, 1976, 174
Sterrha inornata (Haworth, 1809): Viidalepp, 1975, 444
Idaea straminata: Korsun et al. 2012, 22; Enkhtur et al. 2020, 21; 2021a, Supplementary material (Table S2); Knyazev et al. 2020, 193
Idaea straminata sibirica: Viidalepp, 1996, 52; Enkhtur et al. 2020, 21
Material: KB4 - 1 ♂.

Distribution: N. Africa, Europe, Lebanon, Turkey, Caucasus, Transcaucasia, Russia, N. Iran, Afghanistan, W. Tajikistan, Turkmenistan, Kyrgyzstan, Kazakhstan, Uzbekistan, Mongolia, N. E. China, N. Korea.

* *Idaea ossiculata* (Lederer, 1870)

Material: KB3 - 1 ♂ (Figure 8E; genitalia: Figures 10H, 10I).

Distribution: Europe, Russia (S. European part, Caucasus, S. Ural), Transcaucasia (Armenia, Azerbaijan), Turkey, Iran, Kazakhstan, Uzbekistan, Turkmenistan, Kyrgyzstan, Tajikistan, W. Mongolia.

Note: This species is easily confused with *I. sylvestraria* (Hübner, [1799]). *I. ossiculata* is a **new representative of the genus for the Mongolian fauna**.

Idaea descitaria (Christoph, 1893)

Material: KB2 - 2 ♂♂, KB1 - 1 ♂ (Figure 8F), KB3 - 1 ♂.

Distribution: E. Europe, Russia (S. European part, S. Ural, S. Siberia, Altai, Transbaikalia), Caucasus, Turkey, Iran, Kazakhstan, Uzbekistan, Turkmenistan, Kyrgyzstan, Tajikistan, N. W. China, Mongolia.

Note: In the studied publications on Mongolian geometrids this species is absent. Mongolia is listed for the range of *I. descitaria* in Vasilenko (2019, p. 352). According to the author (personal communication) the specimens of *I. descitaria* from Mongolia are kept in collection of Institute of Systematics and Ecology of Animals of Siberian Branch of Russian Academy of Sciences (Novosibirsk).

Scopula cumulata (Alphéraky, 1883)

Scopula cumulata: Vasilenko, 2006, 344; Enkhtur et al. 2020, 21

Material: KA – 1♂, KB3 – 2♂ 2♀.

Distribution: Russia (S. E. Altai), S. Kazakhstan, Uzbekistan, Tajikistan, Kyrgyzstan, N. W. China, W. Mongolia.

Scopula beckeraria (Lederer, 1853)

Scopula beckeraria: Vojnits, 1976, 172; 1977, 170; Viidalepp, 1975, 449; Vasilenko, 2004, 67; Enkhtur et al. 2020, 21; Knyazev et al. 2020, 194

Scopula beckeraria amataria Wehrli, 1926: Viidalepp & Solyanikov, 1977, 625; Viidalepp, 1976, 849; 1996, 56; Enkhtur et al. 2020, 21

Material: KD - 1 ♀, KB4 - 6 ♂♂, 1 ♀, KA - 1 ♂, KB2 - 2 ♂♂, 1 ♀, KB1 - 3 ♀♀, KB3 - 2 ♀♀.

Distribution: S. E. Europe (Macedonia, N. Greece, Bulgaria, W. Romania), Caucasus, Transcaucasia, Central Asia, E. Mediterranean, Turkey, Levant, Russia (southern part: Volga region to Transbaikalia), Kazakhstan, Uzbekistan, Turkmenistan, Kyrgyzstan, Tajikistan, Mongolia, N. India, N. Iran, N. Afghanistan, N. China.

Scopula marginepunctata (Goeze, 1781)

Acidalia marginepunctata: Staudinger & Rebel, 1901, 273

Scopula marginepunctata: Viidalepp, 1975, 448; Enkhtur et al. 2020, 21; 2021b, 371

Material: KB4 - 1 ♂, KB2 - 5 ♂♂, 1 ♀, KB3 - 2 ♂♂, 9 ♀♀, KB1 - 1 ♀.

Distribution: Europe, S. W. Russia, Morocco, Tunisia, Levant, Caucasus, Turkey, Iran, Kazakhstan, Uzbekistan, Turkmenistan, Kyrgyzstan, Tajikistan, Afghanistan, N. W. China, Mongolia.

Scopula rufotinctata (Prout, 1913)

Glossotrophia rufotinctata: Vasilenko, 2006, 345; Enkhtur et al., 2020, 20

Material: KA - 2 ♂♂ (GenBank ID: OQ720937) 1 ♀ (Figures 9A, 9B; genitalia: Figures 11A-11C).

Distribution: Turkmenistan, Tajikistan, Uzbekistan, Kyrgyzstan, Mongolia, N. W. China, India.

Note: The barcode obtained by us significantly differs from COI sequences of *S. rufotinctata* available in BOLD (minimum distance 4.3%); however, it is almost conspecific to several *Scopula sp.* (‘*sacrariaNP01Ir*’) from N. Iran (Golestan). Perhaps there is misidentification and / or several differentiated haplogroups occur in populations of *S. rufotinctata*.

* *Scopula divisaria* (Christoph, 1893)

? *Scopula latelineata* (Graeser, 1892): Vasilenko, 2006, 345; Enkhtur et al. 2020, 21

Material: KA - 1 ♂ (GenBank ID: OQ720936).

Distribution: Russia (S. Ural), Kazakhstan, W. Mongolia.

Note: Some authors (Enkhtur et al. 2020; Vasilenko, 2006) recorded a sister species *Scopula latelineata* (Graeser, 1892) for Mongolia. We studied the original description of *S. latelineata*, and also a photo of syntype of *Acidalia latelineata* in Hausmann (2004, Pl. 19, Fig. 155f). The appearance (Figure 9E) and genitalia structure (Figure 11D-11F) of the male collected in our trip correspond to that in *S. divisaria*. It has not hitherto been recorded from Mongolia.

Lythria purpuraria (Linnaeus, 1758)

Material: G-AS - 1 ♂.

Distribution: Europe, Transcaucasia, Russia (from the western borders to Transbaikalia), Turkey, Iran, Kazakhstan, Uzbekistan, Turkmenistan, Kyrgyzstan, Tajikistan, Afghanistan, W. Mongolia, N. W. China.

Note: In the studied publications on Mongolian geometrids this species is absent. Mongolia is listed for the range of *L. purpuraria* in Vasilenko (2019, p. 353). According to the author (personal communication) the specimens of *L. purpuraria* from Mongolia are kept in collection of Institute of Systematics and Ecology of Animals of Siberian Branch of Russian Academy of Sciences (Novosibirsk).

* *Casilda consecraria* (Staudinger, 1871)

Material: KB4 - 2 ♂♂ (Figure 9C; genitalia: Figures 11G, 11H; GenBank ID: OQ720934) 1 ♀ (Figure 9D).

Distribution: S. Europe (S. France, Spain, Corsica, Sardinia, S. Sicily), Morocco, Israel, Egypt, S. Cyprus, Levant, Arabian Peninsula, Iran, Turkmenistan, S. W. Kazakhstan, Uzbekistan.

Note: Not hitherto **recorded from Mongolia**.

Thus, we collected 51 species of moths, of which 8 were new to Mongolia. This ratio suggests that the inventory of the Geometridae fauna of the Mongolian Altai, as well as Mongolia as a whole, is still far from completion.

Some species new for Mongolia have turanian and central Asian ranges (4 species), and one - Tien Shan range. Presumably, in S. W. Mongolia they are located on the eastern border of their areas being elements of the Dzhungarian fauna.

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Figure 2. Habitats of the travel. Gov'-Altai Aimag. **A, B.** Tonkhil Sum, 11 km W of Tonkhil vill. **C.** Sharga Sum, Sharga village vicinity.

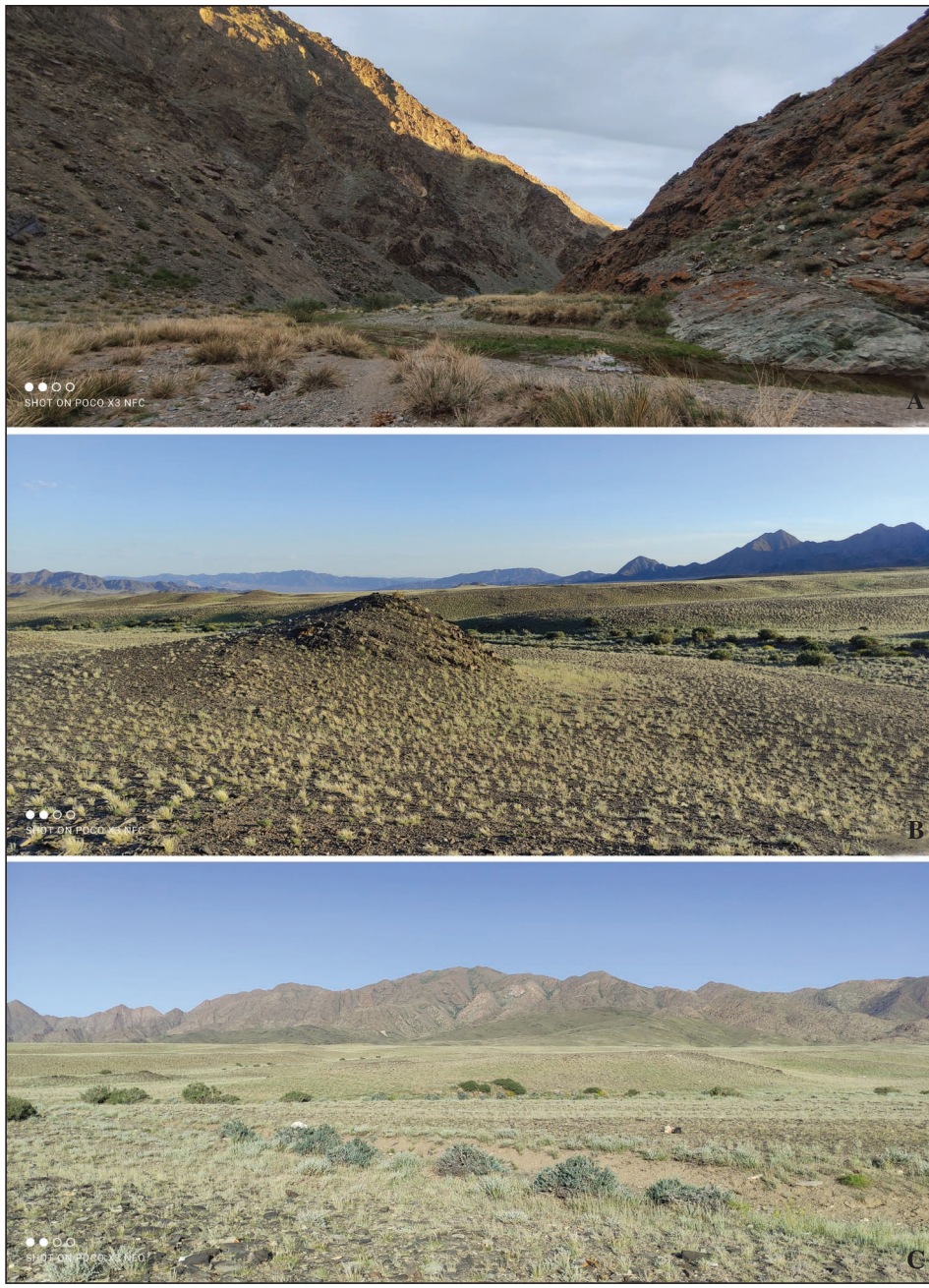

Figure 3. Habitats of the travel. Khovd Aimag. **A.** Altai Sum, 22 km NNW of Altai. **B, C.** Bulgan Sum, 19 km NE of Bulgan.

Figure 4. Habitats of the travel. Khovd Aimag. **A.** Bulgan Sum, 27 km NNW of Burenkhairkhan. **B.** Bulgan Sum, 30 km NNE of Bulgan; C. Bulgan Sum, 36 km S of Bulgan.

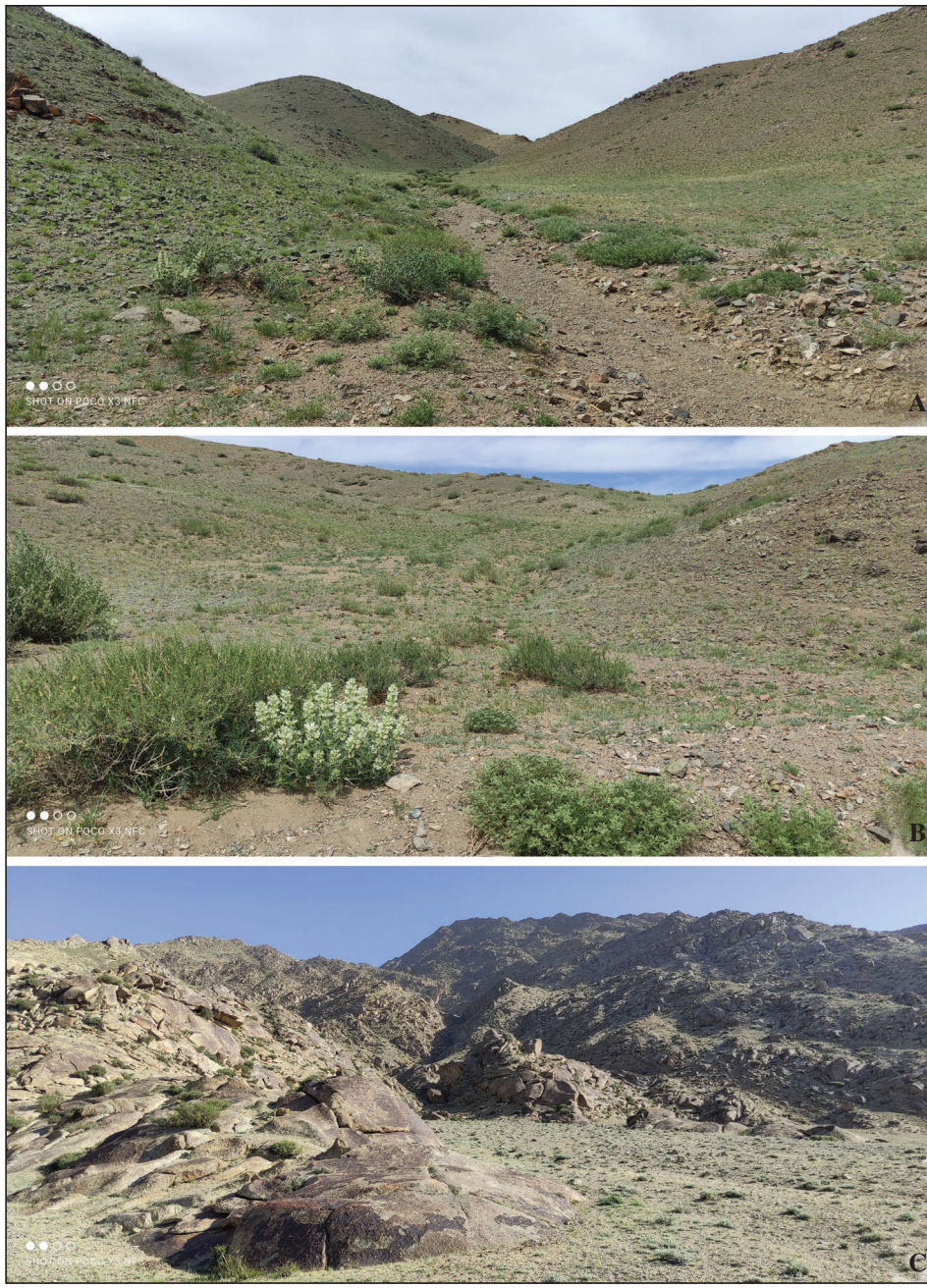

Figure 5. Habitats of the travel, Khovd Aimag. **A, B.** Darvi Sum, 14 km NWW of Darvi vill. **C.** Uyench Sum, 10 km NNE of Burenkhairkhan.

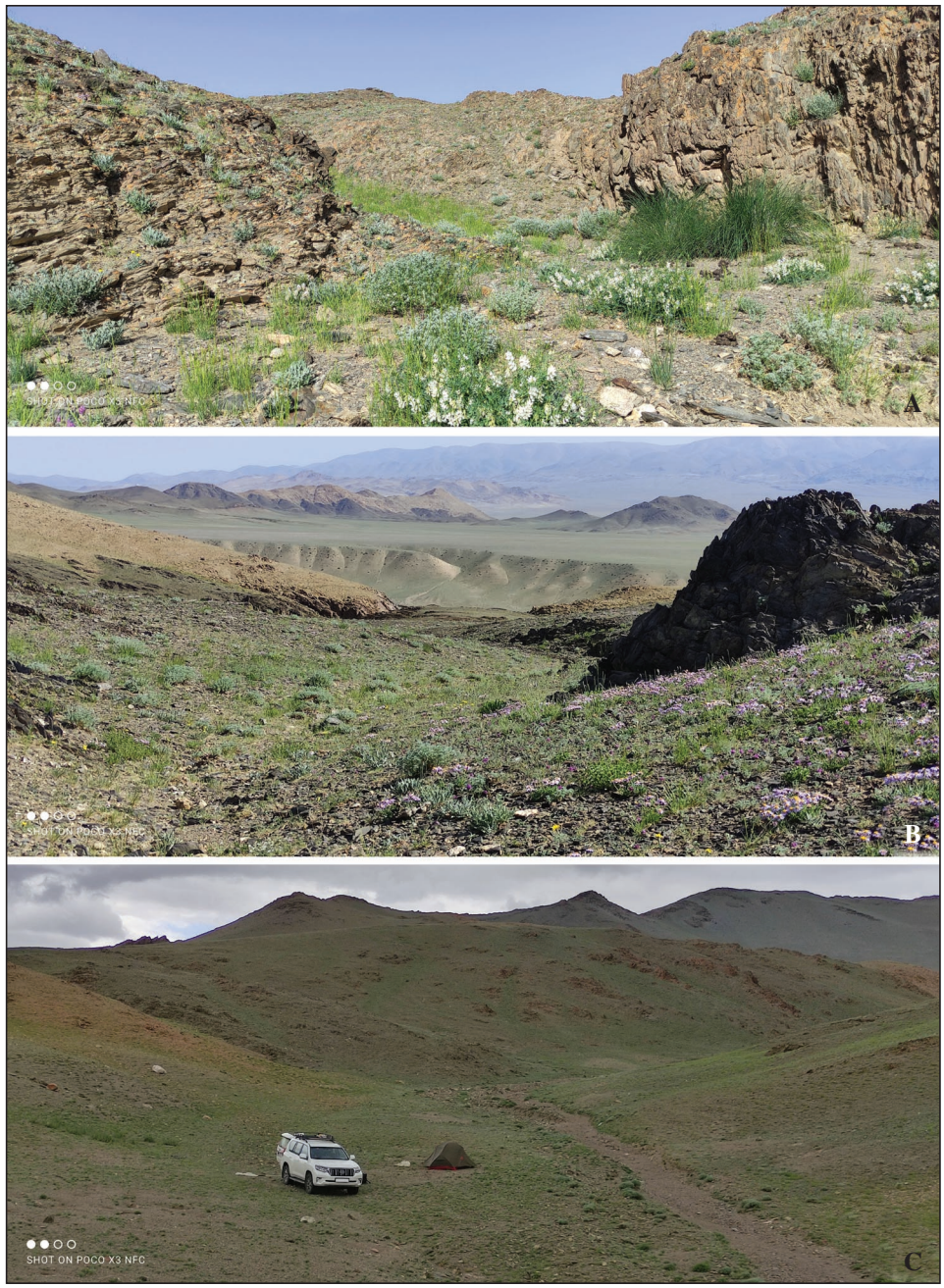

Figure 6. Habitats of the travel. Khovd Aimag. **A, B.** Must Sum, 16 km NWW of Must. **C.** Must Sum, 16 km NWW of Must.

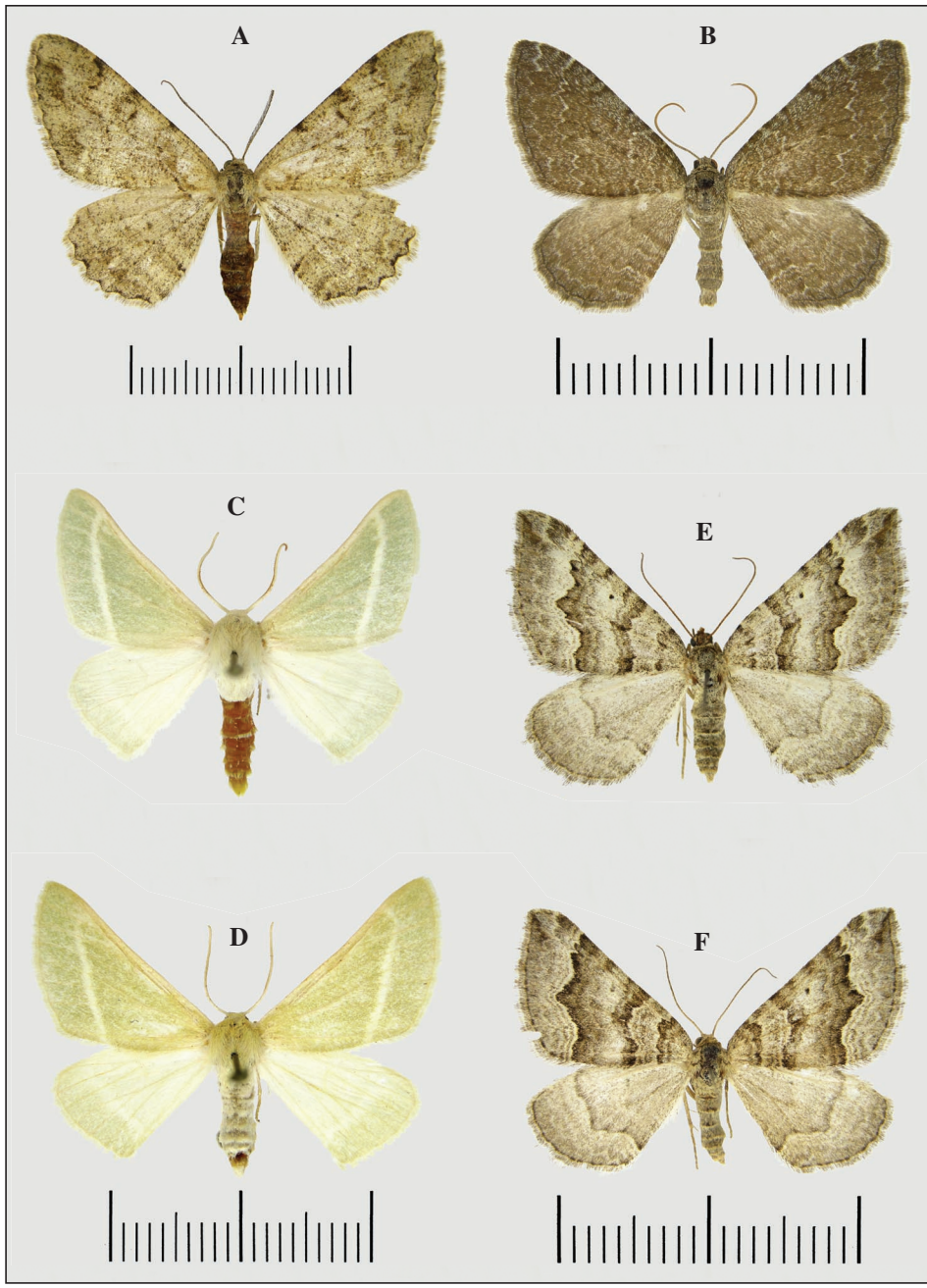

Figure 7. Adults of Mongolian Geometridae. **A.** *Alcis depravata*, female. **B.** *Cataclysme riguata*. **C.** *Holoterpna diagrapharia*, male. **D.** ditto, female. **E, F.** *Scotopteryx supproximaria*, females.

Figure 8. Adults of Mongolian Geometridae. **A, B.** *Kyrtolitha obstinata*, males. **C.** *Nebula mongoliata*, male. **D.** *Rhodostrophia crypta*, male. **E.** *Idaea ossiculata*, male. **F.** *Idaea descitaria*, male.

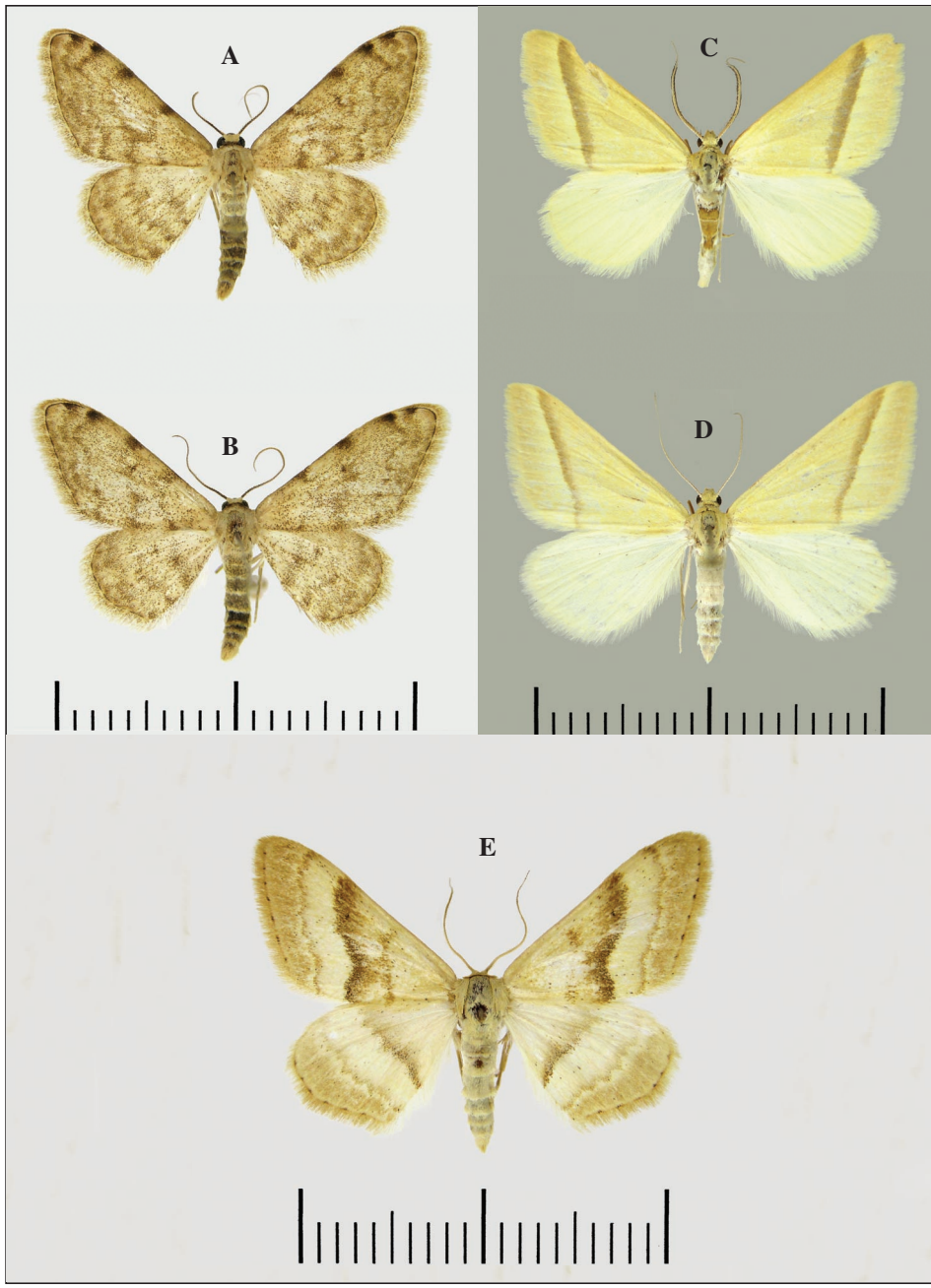

Figure 9. Adults of Mongolian Geometridae. **A, B.** *Scopula rufotinctata*, males. **C.** *Casilda consecraria*, male. **D.** ditto, female. **E.** *Scopula divisaria*, male.

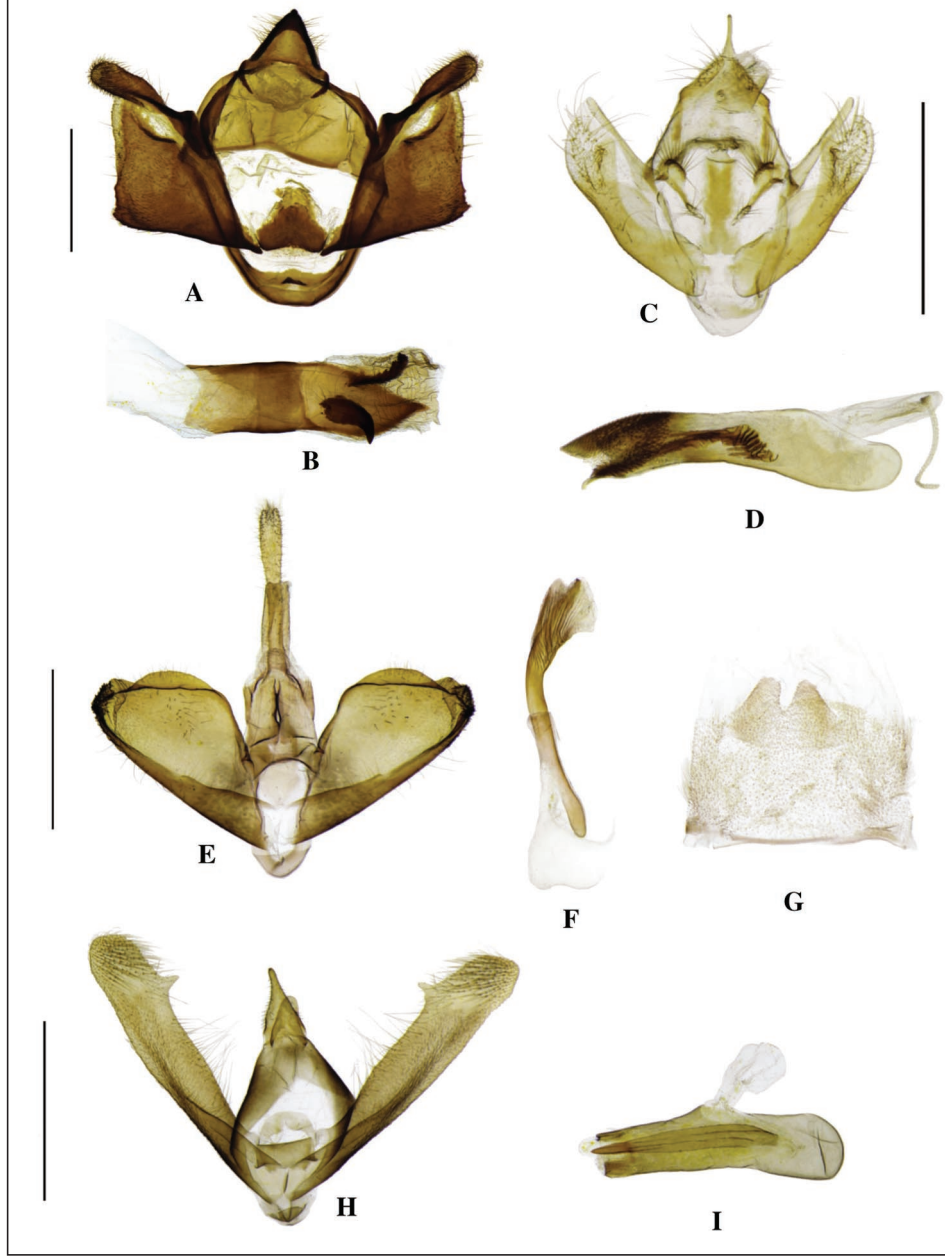

Figure 10. Male genitalia of Mongolian Geometridae. **A, B.** *Phaselia serrularia.* **C, D.** *Scotopteryx supproximaria.* **E-G.** *Rhodostrophia crypta.* **H, I.** *Idaea ossiculata.* **A, C, E, H.** genital segment. **B, D, F, I.** phallos. **G.** abdominal sternite VIII.

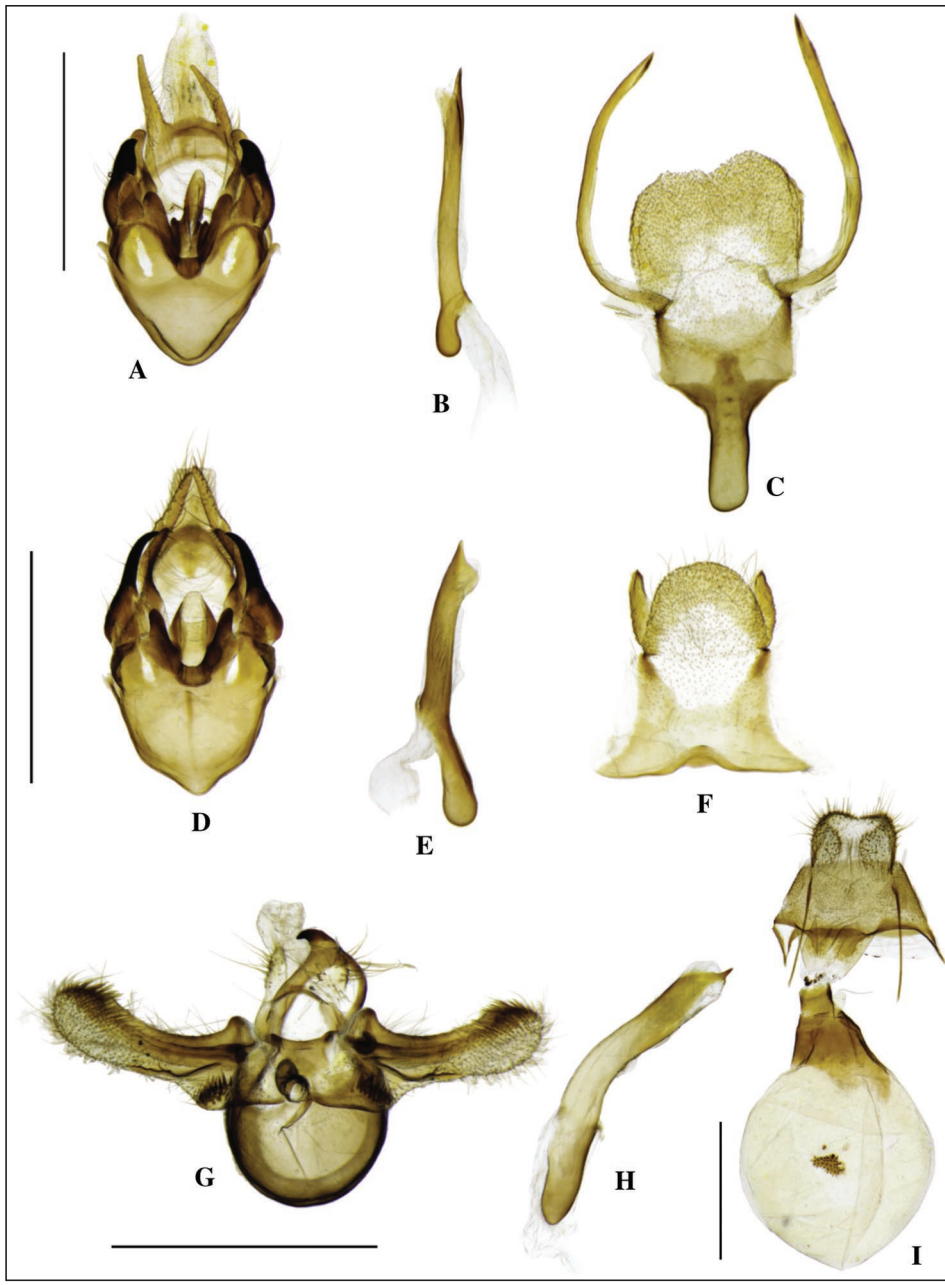

Figure 11. Male and female genitalia of Mongolian Geometridae. **A-C.** *Scopula rufotinctata*. **D-F.** *Scopula divisaria.* **G, H.** *Casilda consecraria.* **I.** *Scotopteryx supproximaria*. **A, D, G.** genital segment. **B, E, H.** phallos. **C, F.** abdominal sternite VIII. **I.** bursa copulatrix.