

Ecological-faunistic Review of the Geometrid Moths (Lepidoptera, Geometridae) of Northern Tien-Shan Mountains

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Abstract: The present study was carried out between 2009 and 2014 in Northern Tien-Shan Mountains, with the aim of assessing the fauna of geometrid moths (Lepidoptera, Geometridae) and collecting data on the distribution and ecology of the species. New faunistic data are given on 129 species, out of which 56 species are new records for Northern Tien-Shan. Two species of the genera *Thera* and *Horisme* may be new for science. Larentiinae (57 species) were the most diverse subfamily, as it is typical for mountainous regions. The second most diverse were the Ennominae (35 species), followed by Sterrhinae (28 species) and Geometrinae (nine species). The vast majority of the recorded geometrids are mesophilic, followed by xerophilic and xero-mesophilic elements. A small number of species are ubiquitous.

Key words: Northern Tien-Shan, Geometridae, faunistic, ecological groups, new species, mesophilic, xerophilic, xero-mesophilic, ubiquitous

Introduction

Moths of the family Geometridae are one of the most diverse, eurytopic and worldwide distributed families of the order Lepidoptera. In terms of species richness, geometrids are the second, family of Lepidoptera in the world fauna, with more than 23,000 described species (SCOBLE, HAUSMANN 2007).

So far, the fauna of geometrid moths from Northern Tien-Shan Mountains is poorly studied due to the lack of comprehensive collection focused on that moth family. In the last 50 years, only fragmentary data have been published on Northern Tien-Shan geometrids (DYAKONOV 1952, VIIDALEPP, ISHKOV 1986, VIIDALEPP 1996, KAILA *et al.* 1996, NAZymbetova, 2014), not providing exact and comprehensive patterns of their species richness in Kazakhstan. In Northern Kazakhstan, some valuable studies were carried out by KENZHEKHANOV (1975). Among recent publications, the work on a new and rare species of moth of Kazakhstan should be also mentioned (VASSILENKO 1995, 2005, 2003,

2009, NUPPONEN, SIHVONEN 2013). NURMATOV (1971) and NURMATOV *et al.* (1987) compiled a list of pest geometrids on pasture plants in the south-eastern Kazakhstan desert zones. The aim of this article is to fill the knowledge gap for northern Tien-Shan geometrid fauna.

The study area

According to TAKHTADZHYAN (1978) Northern Tien-Shan is attributed to the Dzhungar-Tien-Shan Province, whilst KAMELIN (1973) includes it to a wider concept of the Dzhungar-Tien-Shan-Alai Province. Almost the whole Northern Tien-Shan is situated within the borders of Kazakhstan, including the mountain systems of Ketmen ridge, Kungey and Zaili Alatau, Kirghiz Alatau and others. Outside Kazakhstan, parts of Kirghiz Alatau and the south slopes of Kungei – Alatau belong to the same mountain system (VILESOV *et al.* 2009), but we restricted our investigations to the parts in Kazakhstan.

Northern Tien-Shan Mountains show a characteristic vertical arrangement of different ecological zones. These belts result from abiotic factors in correlation with orographic properties of the mountain ridges and their geographic position. Because of the diversity of biotic and abiotic factors and the characteristic features of each mountain ridge, not everywhere the corresponding vegetation zones are vertically situated at equal height.

In Northern Tien-Shan five levels of high-altitude belts can be distinguished. Starting from the very top (3600-4973 m), they include:

1. Eternal snow, glaciers, rocks. On stones rocks lichens settle and alpine plants grow in cracks of rocks.

2. The alpine belt is located at elevations from 2800 (3000) up to 3400 (3600) m a.s.l. In this belt *Kobresia capilliformis*, *Polygonum viviparum*, *Festuca kryloviana*, *Dichodon cerastoides*, *Pyrethrum karelinii*, *Oxygraphis glacialis*, *Lagotis integrifolia*, *Schultzia albiflora*, *Potentilla gelida*, *Thalictrum alpinum*, *Festuca valesiaca*, *Poa stepposa*, *Carex melanantha*, *Carex orbicularis*, *Eriophorum scheuchzeri*, *Saxifraga hirculus*, *Thylacospermum caespitosum*, *Oxytropis chionobia*, *Cerastium lithospermifolium*, *Saussurea coccinea*, *Saussurea glacialis*, *Waldheimia tridactylites*, *Rhodiola coccinea* and other species of plants are dominating.

3. The subalpine belt is extended at elevations from 2300 (2500) up to 2800 (3000) m a.s.l. Dominant here are *Juniperus pseudosabina*, different herbs and cereals, grassy meadow: *Alchemilla sibirica*, *Alchemilla cyrtopleura*, *Trollius dschimgaricus*, *Polygonum nitens*, *Potentilla gelida*, *Myosotis suaveolens*, *Allium atosanguineum*, *Aster alpinus*, *Alopecurus pratensis*, *Poa pratensis*, *Carex melanantha*, *Festuca valesiaca*, *Helictotrichon altaicum*, *Poa stepposa*, *Geranium collimom* and other species of plants.

4. The forests in Northern Tien-Shan do not form a continuous belt: they are found in a combination with steppes and meadows. In ridges of Northern Tien-Shan they are located at medium elevation from 1500 (1600) up to 2300 (3000) m a.s.l. On the south slopes of the mountain chains the forest belt is absent; on the north and north-west slopes it is well expressed as fir, or deciduous forests. Meadows in this belt are dominated by different plants: *Stipa capillata*, *Stipa pennata*, *Phleum phleoides*, *Poa stepposa*, *Thalictrum minus*, *Campanula glomerata*, *Geranium collinum*, *Galium verum*, *Veronica spuria*, *Veronica spicata*, *Crepis sibirica*, *Dactylis glomerata*, *Alopecurus pratensis*, *Poa pratensis*, *Calamagrostis epigeios*, *Bromopsis inermis*, *Anthriscus aemula*, *Polygonum alpinum*, *Aconitum leucostomum*, *Thalictrum minus*, *Campanula glom-*

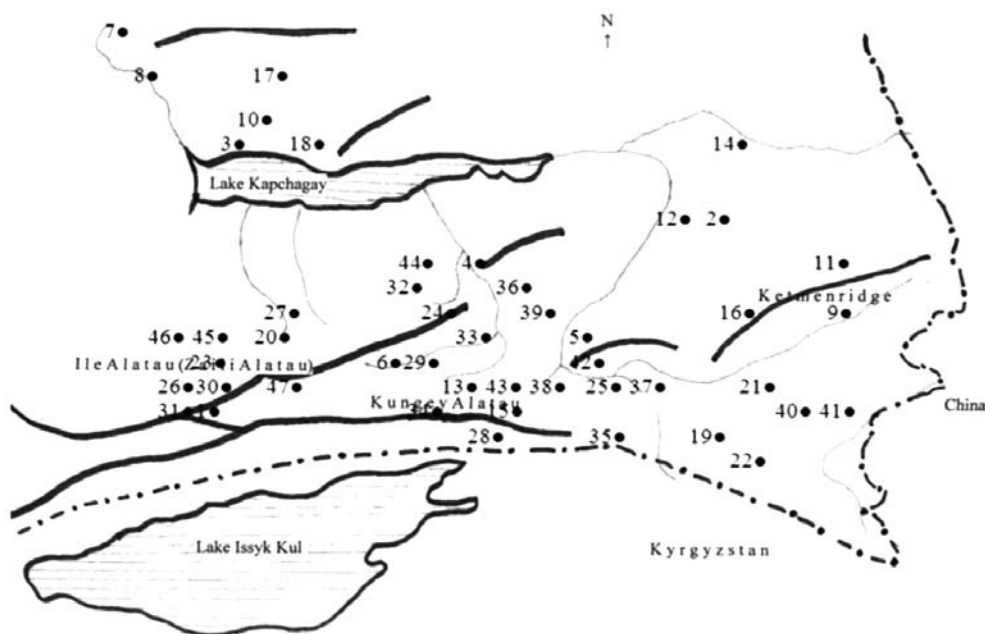


Fig. 1. Map of the Northern Tien-Shan with collecting sites for the present study: 1- B. Almatinka Lak, 2- Chingrlau, 3- Shengeldi, 4- Nurly, 5- Sharin, 6- Turgen, 7- Bakhanas vill, 8- Ily, 9- Ketmen, 10- Cholak, 11- Mynbulak, 12- Jsnevaj rosha, 13- Kolsai, 14- Hatutau, 15- Taldi, 16- Kyrgizsai 17- Arharli, 18- Kapchagay, 19- Sarizhaz, 20- Issik lake, 21- Tuiuk vill, 22- Zabrtau, 23- Almaty, 24- Malibay, 25- Aktam, 26- Butakovka, 27- riv. Talgar, 28- Kayndi, 29- Assa, 30- Medeo, 31- Peak Lake, 32- Tesken-su, 33- Bartogay, 34- Kurmeti, 35- Minzhilki, 36- 130 km from Almaty, Sugati, 37- Kegen, 38- Botamoinak, 39- Kokpek, 40- Tuzkol, 41- Saribastau, 42- Uzinbulak, 43- Zhalanash, 44- Shelek, 45- Talgar, 46- Tabagan, 47- Ulkenturgen

Table 1. Distribution of the Geometridae species identified in the study area and their habitats (numbers referring to dots on the map (Fig. 1))

№	Name of subfamily and species	Locality	Habitat
1	<i>Thetidia smaragdaria volgaria</i> (Guenée, 1858)	2, 5, 44, 3, 25	<i>Achillea</i> –steppe, fallows, grassland
2	<i>Thetidia fulminaria</i> (Lederer, 1871)	2, 1, 45, 4	Steppe desert landscape
3.	* <i>Thetidia correspondens</i> (Alphéraky, 1883)	4, 2, 46	Desert landscape
4	<i>Thalera fimbrialis</i> (Scopoli, 1763)	4, 2, 43	<i>Achillea millefolium</i> , <i>Rumex</i> , <i>Senecio</i> – steppe
5	* <i>Hemistola chrysoprasaria lissas</i> (Prout, 1912)	20, 18	<i>Clematis vitalba</i> , <i>Pulsatilla pratensis</i> – riverside vegetation, meso- to hygrophilous deciduous and mixed forests
6	<i>Chlorissa viridata</i> (Linnaeus, 1758)	13	<i>Calluna</i> , <i>Betula</i> – aisles, forest fringe, grassland.
7	* <i>Dyschloropsis impararia</i> (Guenée, 1858)	3, 25, 47, 7	<i>Spiraea</i> , <i>Prunus</i> – steppe
8	* <i>Phaiogramma etruscaria</i> (Zeller, 1849)	10, 18, 16, 9	<i>Ferula communis</i> , <i>Paliurus</i> , <i>Rubus caesius</i> –steppe, mountain–steppe belt, grassland
9	<i>Microloxia herbaria advolata</i> (Eversmann, 1837)	7, 8, 18	Steppe
10	<i>Idaea sericeata</i> (Hübner, 1813)	5, 18, 7, 8	Larva on dry plant debris – steppe, semi-deserts
11	<i>Idaea ossiculata</i> (Lederer, 1871)	18	Larva on dry plant debris – steppe, semi-deserts
12	<i>Idaea lucellata</i> (Püngeler, 1902)	18	Larva on dry plant debris – steppe, semi-deserts
13	<i>Idaea rufaria</i> (Hübner, 1799)	5, 12	Larva on dry plant debris – steppe and in areas requiring irrigation.
14	* <i>Idaea bundeli</i> (Viidalepp, 1988)	8, 5, 7, 10	Larva on dry plant debris – steppe and desert areas
15	<i>Idaea inquinata</i> (Scopoli, 1763)	23	Larva on dry plant debris – steppe, mixed forests
16	* <i>Idaea degeneraria</i> (Hübner, 1799)	16, 9	Larva on dry plant debris – steppe, grassy meadow-steppe
17	<i>Scopula ornata</i> (Scopoli, 1763)	13, 38, 34, 28	<i>Achillea</i> , <i>Mentha</i> , <i>Rumex</i> , <i>Thymus</i> , <i>Veronica</i> – steppe, river plains, foothills, deciduous and mixed forests
18	<i>Scopula cumulata</i> (Alphéraky, 1883)	3, 30	Scrubland, mixed forests
19	<i>Scopula grisescens</i> (Staudinger, 1892)	32	Steppe
20	<i>Scopula marginepunctata</i> (Goeze, 1781)	9, 16	<i>Gypsophila struthium</i> , <i>Galium</i> , <i>Achillea</i> <i>millefolium</i> , <i>Artemisia vulgaris</i> – Steppe, grassy meadow-steppe
21	* <i>Scopula decorata</i> (Denis & Schiffmüller, 1775)	17	<i>Thymus serpyllum</i> – mountain-steppe
22	<i>Scopula rubiginata</i> (Hufnagel, 1767)	5, 12	<i>Convolvulus</i> , <i>Thymus</i> – dry meadows, steppe
23	* <i>Scopula halimodendrata</i> (Erschov, 1874)	4, 5	Steppe and areas, requiring irrigation.
24	<i>Scopula beckeraria</i> (Lederer, 1853)	4, 5, 12	<i>Taraxacum officinale</i> , <i>Galium</i> – steppe and areas, requiring irrigation. Brushwood of bushes
25	* <i>Scopula ansulata characteristica</i> (Alphéraky, 1882)	9, 16, 2	Steppe, grassy meadow- steppe
26	<i>Scopula latelineata</i> (Graeser, 1892)	2, 9, 18	Mountain-forest
27	* <i>Scopula albidaria</i> (Staudinger, 1901)	7, 8	Steppe and desert areas
28	<i>Scopula arenosaria</i> (Staudinger, 1879)	9, 21, 7	Mountain-forest and steppe
29	<i>Cinglis humifusaria</i> (Eversmann, 1837)	7, 18, 8, 14	<i>Artemisia absinthium</i> – steppe, brushwood of bushes
30	<i>Stigma kuldshaensis</i> (Alphéraky, 1883)	27	Scrubland, mixed forests
31	* <i>Rhodostrophia staudingeri</i> (Alphéraky, 1883)	9, 16	Steppe, grassy meadow- steppe
32	* <i>Rhodostrophia vibicaria strigata</i> (Staudinger, 1871)	19	Steppe, grassy meadow- steppe
33	* <i>Rhodostrophia adauctata</i> (Staudinger, 1892)	29	Steppe
34	* <i>Timandra comae</i> (A. Schmidt, 1931)	15, 13, 23, 38	<i>Rumex</i> , <i>Atriplex</i> , <i>Polygonum</i> – steppe, river plains, foothills, deciduous and mixed forests

Table 1. Continued

№	Name of subfamily and species	Locality	Habitat
35	* <i>Casilda consecraria</i> (Staudinger, 1871)	7, 14, 8	<i>Limonium sinuatum</i> – steppe, desert areas, halophilous
36	<i>Ochodontia adustaria</i> (Fischer v. Waldheim, 1840)	7, 9, 21	<i>Atraphaxis</i> , <i>Euonymus europaeus</i> – steppe, mountain steppe
37	<i>Lythria purpuraria</i> (Linnaeus, 1758)	41	<i>Rumex</i> – mountain-steppe.
38	<i>Scotopteryx chenopodiata</i> (Linnaeus, 1758)	23	<i>Vicia</i> , <i>Trifolium</i> – steppe, mixed forests
39	* <i>Scotopteryx sartata</i> (Alphéraky, 1883)	3, 19	Mountain-steppe
40	* <i>Scotopteryx kashghara</i> (Moore, 1878)	1	Mountain-forest, mountain-steppe
41	<i>Xanthorhoe asiatica</i> (Staudinger, 1882)	23	Steppe, mixed forests
42	* <i>Xanthorhoe tianschanica</i> (Alphéraky, 1882)	40, 19	Mountain-steppe, brushwood of bushes
43	<i>Xanthorhoe fidonaria</i> (Staudinger, 1892)	1, 27, 31	Mountain-forest and mountain-steppe
44	<i>Xanthorhoe alexandraria</i> (Staudinger, 1892)	1, 31	Mountain-forest and mountain-steppe
45	<i>Catarhoe rubidata</i> (Denis & Schiffermüller, 1775)	27	Steppe, mixed forests
46	<i>Costaconvexa polygrammata</i> (Borkhausen, 1794)	3, 2, 4, 5	<i>Galium</i> – steppe
47	<i>Epirrhoe pupillata orientalis</i> (Osthelder, 1909)	1, 19, 39	<i>Galium verum</i> – mountain-forest, mountain-steppe
48	<i>Epirrhoe alternata dubiosata</i> (Alphéraky, 1883)	1, 32, 27, 23	<i>Galium verum</i> – steppe, mixed forest
49	* <i>Pelurga comitata</i> (Linnaeus, 1758)	15, 13, 28, 38	<i>Chenopodium</i> , <i>Atriplex</i> – steppe, river plains, foothills, deciduous and mixed forests
50	<i>Larentia clavaria saisanica</i> (Prout, 1937)	6, 29, 27, 33	<i>Althaea officinalis</i> , <i>Malva</i> , <i>Prunus padus</i> – steppe, mountain-steppe
51	<i>Thera variata</i> (Denis & Schiffermüller, 1775)	27	<i>Picea</i> , <i>Abies sibirica</i> – steppe, mixed and coniferous forests
52	* <i>Thera</i> species	13, 38, 34, 15	Steppe, river plains, foothills, deciduous and mixed forests
53	<i>Cidaria distinctata</i> (Staudinger, 1892)	9, 19, 16, 1	Mountain-steppe
54	<i>Cosmorhoe ocellata</i> (Linnaeus, 1758)	3, 4, 5, 23	<i>Galium</i> – steppe, river plains, mixed forests
55	<i>Eulithis ledereri</i> Bremer, 1864	1	Mountain-forest, mountain-steppe
56	<i>Ecliptopera fastigiata</i> (Püngeler, 1909)	3, 1	Mountain-forest, mountain-steppe
57	<i>Chloroclysta miata</i> (Linnaeus, 1758)	27	<i>Betula</i> , <i>Salix</i> , <i>Populus tremula</i> , <i>Sorbus</i> , <i>Padus</i> – steppe, mixed forests
58	* <i>Pasiphila chloerata</i> (Mabille, 1870)	32	Rosaceae – steppe, scrubland
59	<i>Nebula neogamata</i> (Püngeler, 1909)	30	Scrubland, mixed forest, grassland
60	<i>Minoa murinata</i> (Scopoli, 1763)	27	Steppe zones, mixed forests
61	* <i>Hydria incertata</i> (Staudinger, 1882)	3, 4, 17	Steppe, mountain-steppe, areas, requiring irrigation.
62	<i>Horisme vitalbata</i> (Denis & Schiffermüller, 1775)	9, 16, 7, 8	<i>Pulsatilla</i> , <i>Clematis</i> – mountain-steppe
63	* <i>Horisme</i> species	13, 38, 34, 28, 15	Steppe areas, river plains, foothills, deciduous and mixed forests
64	* <i>Horisme stratata</i> (Wileman, 1911)	7, 21	Steppe, mountain steppe, desert and mountain-deserts
65	<i>Aplocera plagiata</i> (Linnaeus, 1758)	9, 16	<i>Hypericum</i> – mountain-steppe
66	* <i>Lithostege coassata</i> (Hübner, 1817)	3, 7, 8, 11	Steppe, mountain-steppe, areas, requiring irrigation.
67	* <i>Lithostege staudingeri</i> (Erschov, 1872)	16, 9	Mountain-steppe
68	* <i>Lithostege griseata</i> (Denis & Schiffermüller, 1775)	23	Brassicaceae, <i>Sisymbrium officinale</i> – steppe, mixed forests
69	* <i>Lithostege infuscata</i> (Eversmann, 1837)	7	Steppe and desert areas
70	<i>Kuldscha staudingeri</i> (Alphéraky, 1883)	1	Mountain-forest, mountain-steppe
71	<i>Photoscotia palaeartica</i> (Staudinger, 1882)	3, 19, 1, 27	Mountain-forest, mountain-steppe
72	* <i>Eupithecia biornata</i> (Christoph, 1867)	1, 7, 38, 15, 38	<i>Artemisia</i> – mountain-forest, mountain-steppe
73	* <i>Eupithecia mima</i> (Mironov, 1989)	2, 5, 6, 17	Brushwood of bushes, dry meadow-steppes

Table 1. Continued

№	Name of subfamily and species	Locality	Habitat
74	* <i>Eupithecia extensaria</i> (Freyer, 1844)	17, 2	<i>Artemisia</i> – brushwood of bushes, dry meadow-steppes
75	<i>Eupithecia subpulchrata</i> (Alphéraky, 1883)	14, 8	Semi-deserts, brushwood of bushes
76	* <i>Eupithecia pallescens</i> (Dietze, 1913)	1	Mountain-forest, mountain-steppe
77	* <i>Eupithecia remmi</i> (Viidalepp, 1988)	14	Semi-deserts (desert-steppe) and deserts
78	* <i>Eupithecia ochridata</i> (Schütze & Pinker, 1968)	7, 8	Steppe and deserts
79	* <i>Eupithecia gratiosata</i> (Herrich-Schäffer, 1861)	10, 14	<i>Ferulago, Heracleum, Anethum, Pastinaca</i> – semi-deserts (desert-steppe) and deserts
80	* <i>Eupithecia opistographata</i> (Dietze, 1906)	7, 8, 18	<i>Tamarix</i> – steppe and deserts
81	<i>Eupithecia parallelaria</i> (Bohatsch, 1893)	7, 8, 3	Steppe and deserts
82	* <i>Eupithecia usbeca</i> (Viidalepp, 1992)	7, 8, 18	Steppe and deserts
83	<i>Eupithecia succenturiata exalbidata</i> (Staudinger, 1901)	1	<i>Solidago, Senecio</i> – mountain-forest and mountain-steppe
84	* <i>Eupithecia rebeli</i> (Bohatsch, 1893)	1	Mountain-forest and mountain-steppe
85	<i>Eupithecia rubellata</i> (Dietze, 1904)	1	Mountain-forest and mountain-steppe
86	<i>Eupithecia absinthiata</i> (Clerck, 1759)	1	<i>Solidago, Achillea, Aster, Tanacetum, Artemisia, Matricaria, Cirsium</i> – mountain-forest and mountain-steppe
87	<i>Eupithecia centaureata</i> (Denis & Schiffermüller, 1775)	1	<i>Centaurea cyanus, Solidago, Senecio</i> – mountain-forest and mountain-steppe
88	<i>Eupithecia satyrata</i> (Hübner, 1813)	23	<i>Achillea millefolium, Solidago, Senecio</i> – steppe, mixed forests
89	<i>Eupithecia assimilata</i> (Doubleday, 1856)	23	<i>Humulus, Ribes</i> – steppe, mixed forests
90	<i>Eupithecia denotata</i> (Hübner, 1813)	30	<i>Campanula</i> – grassland, mountainous deciduous and mixed forests
91	<i>Eupithecia subfuscata</i> (Haworth, 1809)	23	<i>Centaurea cyanus, Galium, Achillea millefolium</i> – steppe, mixed forests
92	<i>Stannodes danilovi</i> (Erschov, 1877)	31	Mountain-steppe
93	<i>Stannodes pauperaria</i> (Eversmann, 1848)	35	Mountain-steppe, brushwood of bushes.
94	* <i>Operophtera brumata</i> (Linnaeus, 1758)	23	Polyphagous, e.g. <i>Carpinus betulus, Betula, Malus, Pyrus, Prunus</i> – scrubland, mixed forests
95	<i>Stegania dalmataria arenaria</i> (Staudinger, 1892)	7, 8, 23	Steppe and desert areas, scattered dry forest
96	<i>Ligdia coctata</i> (Guenée, 1858)	30	Scrubland, mixed forests, forest fringe, brushwood of bushes, grassland
97	* <i>Heliomata glarearia</i> (Denis & Schiffermüller, 1775)	27, 3, 12, 23	Grassland, steppe
98	* <i>Isturgia arenacearia</i> (Denis & Schiffermüller, 1775)	3	<i>Coronilla varia</i> – steppe
99	* <i>Isturgia kaszabi</i> (Vojnits, 1974)	12	Steppe and desert areas
100	* <i>Macaria alternata</i> (Denis & Schiffermüller, 1775)	7	Steppe and desert areas
101	<i>Narraga fasciolaria</i> (Hufnagel, 1767)	1	<i>Artemisia absinthium</i> – mountain-forest and mountain-steppe
102	* <i>Digrammia rippertaria</i> (Duponchel, 1830)	3	Steppe
103	* <i>Digrammia tancrearia</i> (Staudinger, 1892)	12	Steppe and desert areas
104	* <i>Gnopharmia cocandaria</i> (Erschov, 1874)	7, 8	Steppe and desert areas
105	* <i>Phaselia narynaria</i> (Oberthür, 1913)	25, 18	Steppe and mountain-steppe, oasis areas, requiring irrigation.
106	* <i>Phaselia serrularia</i> (Eversmann, 1847)	2	<i>Ephedra equisetina</i> – steppe
107	<i>Siona lineata</i> (Scopoli, 1763)	18, 7	Meadows, meadow-steppes
108	* <i>Dyscia malatyana</i> (Wehrli, 1934)	7, 8, 17	<i>Artemisia, Seriphidium</i> – steppe and desert areas
109	* <i>Synopsis sociaria unitaria</i> (Prout, 1915)	18, 7, 4, 39	Steppe
110	<i>Aspitates acuminaria</i> (Eversmann, 1851)	23, 15, 38, 19, 13, 28, 34	Steppe, river plains, foothills, deciduous and mixed forests
111	<i>Eilicrinia subcordaria</i> (Herrich-Schäffer, 1852)	9, 5, 7, 21	Steppe

Table 1. Continued

№	Name of subfamily and species	Locality	Habitat
112	* <i>Megaspilates mundataria</i> (Stoll, 1782)	32	<i>Artemisia absinthium</i> , <i>Achillea millefolium</i> – steppe and desert areas
113	<i>Alcis subrepandata</i> (Staudinger, 1897)	19, 27, 30	Grassland, mountain deciduous and mixed forests
114	* <i>Alcis jubata</i> (Thunberg, 1788)	1	Mountain-forest
115	<i>Alcis depravata</i> (Staudinger, 1892)	1, 15, 38, 13, 27, 32, 30	Grassland, mountain deciduous and mixed forests
116	<i>Alcis songarica</i> (Alphéraky, 1883)	30	Grassland, mountain deciduous and mixed forests
117	<i>Alcis maculata</i> (Moore, 1868)	23	Steppe, mixed forests
118	<i>Afriberina nobilitaria</i> (Staudinger, 1892)	23	<i>Juniperus</i> – steppe, mixed forests
119	<i>Biston betularia</i> (Linnaeus, 1758)	1	<i>Betula</i> , <i>Populus</i> , <i>Quercus</i> , <i>Tilia</i> , <i>Fraxinus excelsior</i> , <i>Acacia</i> , <i>Artemisia</i> , <i>Genista</i> , <i>Atriplex</i> – mountain-forest and mountain-steppe
120	* <i>Lycia hirtaria</i> (Clerck, 1759)	3, 17	<i>Betula</i> – scrubland and mixed forests, forest fringe, brushwood of bushes, grassland
121	<i>Phthorarcha primigena</i> (Staudinger, 1895)	36	Steppe
122	<i>Selenia lunularia</i> (Denis & Schiffmüller, 1775)	7, 8	Steppe and desert areas
123	<i>Odontopera muscularia</i> (Staudinger, 1892)	27, 19, 9	Steppe, mixed forests
124	* <i>Opisthograptis emaculata</i> (Graeser, 1892)	9, 15	Steppe and desert areas, river plains, mixed forests
125	<i>Opisthograptis luteolata</i> (Linnaeus, 1758)	23, 15, 38	<i>Betula</i> , <i>Salix</i> , <i>Alnus</i> , <i>Sorbus aucuparia</i> , <i>Prunus</i> , <i>Lonicera tatarica</i> – iscrubland, mixed forests, forest fringe, brushwood of bushes, grassland
126	* <i>Ourapteryx purissima</i> (Thierry-Mieg, 1905)	9, 19, 15, 38	Steppe and desert areas, river plains, mixed forests
127	<i>Apocolotois almatensis</i> (Djakonov, 1952)	6, 29, 24	Steppe, mixed forests
128	* <i>Spartopteryx kindermannaria</i> (Staudinger, 1871)	14, 5	Steppe and desert areas
129	* <i>Angerona prunaria</i> (Linnaeus, 1758)	26	Scrubland, mixed forests, forest fringe, brushwood of bushes, grassland

erata, *Geranium collinum*, *Geranium sibiricum* and others. Dominating bushes: *Rosa platyacantha*, *Spiraea hypericifolia*, *Cotoneaster multiflorus*, *Berberis sphaerocarpa*. Fir forests are often accompanied at the top part by *Picea schrenkiana tianschanica* and *Abies sibirica* with undergrowing *Polypodium vulgare*, *Dryopteris filix-mas*, *Thalictrum minus*, *Brachypodium pinnatum*, *Poa nemoralis*, *Juniperus sibirica*, *Lonicera karelinii*, *Rosa alberti*, *Rubus idaeus*, *Rubus saxatilis*, *Ribes meyeri*, *Grossularia acicularis*. Accompanying deciduous trees are *Betula tianschanica*, *Betula pendula*, *Sorbus tianschanica*, *Malus sieversii*, *Populus tremula* and many others.

5. The lowest belt includes intermontane plains and foot-hills from approximately 450 (800) up to 1500 (1600) m a.s.l. These territories are characterised by desert, semi-desert, and steppe vegetation. Steppes are dominated by *Artemisia sublessingiana*, *Artemisia heptapotamica*, *Kochia prostrata*, *Stipa sareptana*, *Stipa capillata* and others, with bushes

like *Caragana leucophloea*, *Salsola arbusculiformis*, *Salsola orientalis*, *Ceratoides latens*, *Nanophyton erinaceum* and others (Abdullina 1984).

The climate of the study area shows a strong vertical zonation. From the lowest foothill plains up to the snow-covered summits the climate gradually changes from hot and very dry to sharply continental, damp and very cold conditions. The climate of the study area is connected and characterised by high amplitudes of temperature fluctuations, relatively cold winter (average temperature in January -11-13°C), hot summer (average temperature in July +24-28°C).

The 47 sampling localities in Northern Tien-Shan are presented in Fig. 1.

Materials and Methods

The present study is based on material collected at light by the authors between 2009 and 2014 from Northern Tien-Shan Mountains. Additional material

from the study area was collected in 1993-1995 by S. Murzin and A. Saldaitis. The Lepidoptera collection of the Bavarian State Collection of Zoology (ZSM, Germany) and literature data were studied as well. Material was collected at 47 localities. Information for eight of the sites (19, 30, 27, 23, 36, 31, 32, and 36) is from the literature (VIIDALEPP 1988), while for three of the sites (1, 25, 21) S. Murzin and A. Saldaitis collected the samples.

For collecting at light, 500 W bulbs were used. Collecting of diurnal species was done with nets. Species identification was based on reference collections (ZSM) and literature, e.g. HAUSMANN, VIIDALEPP (2012), HAUSMANN (2001, 2004), VIIDALEPP (1988), MIKKOLA *et al.* (1989), XUE, ZHU (1999); SAVCHUK (2013), SEGERER, HAUSMANN (2011). Regarding taxonomy and nomenclature, we follow the list of European Geometridae (HAUSMANN, VIIDALEPP 2012; HAUSMANN 2001, 2004, MIRONOV 2003, MÜLLER 1996), the checklist of geometrids of the former USSR (VIIDALEPP 1996) and the catalogue of Russian Lepidoptera (MIRONOV *et al.* 2008).

Due to the lack of data, it is very difficult to determine the ecotypes of geometrids from Northern Tien-Shan. In this paper we make the first attempt, mainly based on the ecological conditions of the localities, where they have been collected, in combination with data on larval host-plants and habitats, as they were available for certain species in HAUSMANN (2001, 2004), HAUSMANN, VIIDALEPP (2012).

Results and Discussion

The combination of newly collected material with literature data reveals that the geometrid fauna of Northern Tien-Shan Mountains consists of 129 spe-

cies belonging to four subfamilies and 68 genera (Table 1). Two species may be new for science: *Thera* sp. and *Horisme* sp. New for the Northern Tien-Shan Mountains are 56 species marked with one asterisk (*) in the following list.

In a generalised, rough approximation, Northern Tien-Shan geometrids can be attributed to the following four ecotypes: xerophilous, mesophilous, xero-mesophilic species and ubiquist species.

Mesophilous species (52 species) inhabit mesophilous grasslands, gardens, scrubland and mixed forests, forest fringe, brushwood of shrubs, river plains.

Xerophilous species (49 species) inhabit dry, open grassland, characteristic of steppes and semi-deserts.

Xero-mesophilic species (24 species) are ecologically intermediate between the first two groups; in mountainous areas they are found both on dry southern slopes, and on more damp meadow-vegetation, but mainly in open, sunny places.

Ubiquist species are usually polyphagous with a high ecological valence, occurring in a broad range of habitats.

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References

- ABDULLINA S.A. 1984. Oxytropis Northern Tien-Shan (composition, botanical and geographical connections). Thesis abstract of candidate of biological sciences. Alma-Ata. (Nauka), 23 p. (In Russian).
- DYAKONOV A.M. 1952. New geometrids (Lepidoptera, Geometridae) from Kazakhstan and the southern Primorye. – *Entomologicheskoe Obozrenie*, **32**: 268-269. (In Russian).
- HAUSMANN A. 2001. The Geometrid Moths of Europe. Vol. 1. Introduction, Archiariae, Orthostixinae, Desmobaethrinae, Alsophilinae, Geometrinae. Stenstrup (Apollo Books), 282 p.
- HAUSMANN A. 2004. The Geometrid Moths of Europe. Vol. 2. Sterrhinae. Stenstrup (Apollo Books), 600 p.
- HAUSMANN A., J. VIIDALEPP 2012. The Geometrid Moths of Europe. Larentiinae Vol. 3. Stenstrup (Apollo Books), 743 p.
- KAMELIN R.V. 1973. Florogenetic analysis of the natural flora of the Mountain Central Asia. Leningrad (Nauka), 354 p. (In Russian).
- KENZHEKHANOV T.M. 1975. Ecological-faunistic review of moths (Geometridae) of the western part of Northern Kazakhstan. Alma-Ata, Institute of Zoology of the Kazakh SSR. 26. (manuscript Dep. at VINITI 1975. № 1133-75 Dep.). (In Russian).
- KAILA L., J. VIIDALEPP, K. MIKKOLA, V. MIRONOV 1996. Geometridae (Lepidoptera) from the Tian-Shan Mountains in Kazakhstan and Kyrgyzstan, with descriptions of three new species and one new subspecies. – *Acta Zoologica Fennica*, **200** (2): 57-82.
- NUPPONEN K., P. SIHVONEN. 2013. *Dorsispina furcicornaria*, a new geometrid species and new genus from Kazakhstan (Lepidoptera: Geometridae: Ennominae). – *Nota Lepidopterologica*, **36** (2): 179-187.
- MIKKOLA K., I. JALAS, O. PELTONEN 1989. Suomen perhoset, mitarit 2. [Lepidoptera of Finland, Geometridae 2, in Finnish]. Hangan Kirjapaino (Hanko), 280 p.

- MIRONOV V. 2003. Larentiinae II (Perizomini and Eupitheciini), Eds. Hausmann A. The Geometrid Moths of Europe, Vol. 4. Stenstrup (Apollo Books), 463 p.
- MIRONOV V., U. RATZEL 2012. *Eupithecia* Curtis, 1825 of Afghanistan (Geometridae: Larentiinae). – *Nota Lepidopterologica*, **35** (2): 197-231.
- MIRONOV, V.G., E.A. BELYAEV, S.V. VASILENKO 2008. Geometridae. – In: SINEV S.Y. (Ed.): Catalogue of Lepidoptera of Russia. St. Petersburg – Moscow. (Fellow. Scien. KMC editions). 190-226 p. (In Russian).
- MÜLLER B. 1996. Geometridae. – In: KARSHOLT, O., J. RAZOWSKI (Eds.). The Lepidoptera of Europe. A distributional checklist. Stenstrup (Apollo Books), 218-249 p.
- NAZYMBOVA G.Sh., B.K. YELIKBAYEV, B.T. TARANOV 2015. New data about Larentiinae (Geometridae, Lepidoptera) of the Kolsai Koldery State National Natural Park and its adjacent areas. – *Biosciences Biotechnology Research Asia*, **12** (1): 599-604.
- NURMATOV T.N. 1971. Insects – pests haloxylon: thesis abstract of candidate of biological sciences. Almaty. (Nauka), 32 p. (In Russian).
- NURMATOV T.N., V.G. LINSKY, B.T. TARANOV 1987. The species composition of insects on pasture vegetation desert south-eastern Kazakhstan. – Insect forage crops and pasture plants, Alma-Ata (Nauka) 13-38. (In Russian).
- SEGERER A.H., A. HAUSMANN 2011. Die Großschmetterlinge Deutschlands. The Macrolepidoptera of Germany. – Budapest (Heterocera Press), 308 p.
- SAVCHUK V.V. 2013. Atlas of moths and caterpillars of Crimea. Simferopol. (Business Inform), 296 p. (In Russian).
- SCOBLE M. J., A. HAUSMANN 2007. Online list of valid and available names of the Geometridae of the World, http://www.lepbarcoding.org/geometridae/species_checklists. Page visited 19 March 2015.
- TAKHTADZHIAN, A.L. 1978. Floristic regions of the Earth. Leningrad (Nauka), 247 p. (In Russian).
- VILESOV E.N., A.A. NAUMENKO, L.K. VESELOV, B.J. AUBEKEROV 2009. Physical Geography of Kazakhstan (ed. A.A. NAUMENKO) Proc. benefits. – Almaty. (Kazakh National University), 362 p. (In Russian).
- VII DALEPP J. 1988. The fauna of Geometrid Moths of the mountains of Central Asia. Moscow (Nauka). 240 p. (In Russian).
- VII DALEPP J. 1996. Checklist of the Geometridae (Lepidoptera) of the former USSR. Stenstrup (Apollo Books). 131 p.
- VII DALEPP J., E.V. ISHKOV 1986. A contribution to the geometrids of the Aksu-Dzhabagly Nature Reserve (Kazakh SSR). – *Trudy Vsesojuznogo Entomologicheskogo Obshchestva*, **67**: 100-111. (In Russian).
- VASILENKO S.V. 2003. A new species and interesting findings of geometer-moths (Lepidoptera, Geometridae) from Kyrgyzstan and Kazakhstan. – *Zoologicheskii Zhurnal*, **82** (6): 748-751.
- VASILENKO S.V. 1995. Neue arten der *Aplocera plagiata* (Linnaeus, 1758) gruppe aus den gebirgen Mittelasiens. (Lepidoptera: Geometridae). – *Atalanta*, **26** (1/2): 303-310.
- VASILENKO S.V. 2005. A new genus and two new species of geometer moths (Lepidoptera, Geometridae) from Northeastern Kazakhstan. – *Zoologicheskii Zhurnal*, **84** (3): 362-366.
- VASILENKO S. V. 2009. *Lythria venustata* (Lepidoptera, Geometridae), a Rare Species from Kazakhstan. – *Zoologicheskii Zhurnal*, **88** (4): 508-510.
- XUE D., ZHU H. 1999. Lepidoptera, Geometridae, Larentiinae. – Fauna Sinica, Beijing (Science Press), 1090 p.

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