Lepidoptera of black taiga in Transbaikalia, East Siberia

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Abstract. Based on the studies conducted in 2012-2020 on the key plots of mixed fir tree woodlands that grow within the Ulan-Burgasy Mountain range, the authors identified a special nemoral group of lepidopterans, that typically inhabit ocean coastline mixed and broad-leaved forests. Another peculiarity of this area is the presence of species atypical for the major part of the Transbaikal Region: Spialia orbifer Hbn., Leucodonta bicoloria Den. et Schiff., Furcula bifida Brahm (Sub-boreal group); Laothoe populi L. (Central Palearctic group); and Feralia sauberi Graes. (Palearchearctic group). The comparison of Lepidoptera faunas on the key plots and other forest and forest-steppe habitats in the Transbaikal Region revealed their high similarity (more than 80%) to the Ulan-Burgasy humid forests that grow near Baikal and mixed fir tree taiga forests of the Khamar-Daban Ridge.

1. Introduction
The nemoral relics of flora and fauna are essential for the understanding of biota genesis [1-3]. The major part of nemoral plants in Southern Siberia is associated with the linden island forests as well as dark-coniferous forests with dominating fir trees distributed in Kuznetsky Alatau, Kazakhstan Altai, Eastern Altai, and Krasnoyarsk [2, 6-7]. Black (‘chernevaya’) taiga of Southern Siberia occurs mostly in Altai and Kuznetsky Alatau and contains up to 180 plant species, with 57 relics of tertiary broad-leaved forests [1]. The eastern border of most nemoral plant species’ occurrence in dark-coniferous forests is located on the northern slope of the Khamar-Daban Ridge [1, 6, 8]. Habitats of these plants are characterized by abundant precipitation (> 1,000 mm/year) [9-10] and a relatively mild climate. It is known that a significant amount of precipitation (up to 1,000 mm/year and more) falls on the western macro-slope of the Ulan-Burgasy mountain range [11] due to the influence of Baikal and western transfer of the Atlantic oceanic air masses. The elements of nemoral flora were found in this area [12]. To date, a lot of data on nemoral and black taiga species of Siberia were accumulated [1, 2, 6, 7, 13-15], including the south Baikal region [6, 8, 10, 16-18].

There were fewer studies dedicated to the fauna of the Siberian nemoral forests and black taiga. However, there were found some Lepidopteran species (Insecta, Lepidoptera) that inhabit only such types of forests [3, 19-21]. In 2012, we found forests that looked similar to black taiga near the upper reaches of the Khara-Atsagat river and Cheremshanskaya river (south-western edge of the Ulan-Burgasy mountain range, 850-1,000 m a.s.l.) [22]. This work aimed to study Lepidoptera that occur in these fragments of black-taiga-like communities (further named “black taiga”).

2. Materials and Methods
Since 2012, several key plots have been established on the south-eastern end of the Ulan-Burgasy range to collect and observe Lepidopterans. Night species were attracted by UV lamps during nighttime, while daylight-flying and twilight-flying were counted on belt transects. The surveys were
conducted as follows: on May 16-17, 2017, June 30 – July 2, 2018, July 31 – August 1, 2017, July 8, 2018, August 26-27, 2018, May 22-23, 2019 in Khara-Atsagat; on May 29, 2018, June 19, 2018, in Cheremshanskaya. The ecological characteristics of species were compiled from [3, 19-21]. To compare Lepidoptera faunas, we used species lists from the ‘Catalogue of the Lepidoptera of Russia’ [23] and our unpublished data. The comparative analysis included the faunas of the following mountain range localities:

**Ulan-Burgasy.** Taiga: Khara-Atsagat (52°06′30″ N, 108°06′59″ E); Northern part of Ulan-Ude City, V. Beryozovka (52°55′52″ N, 107°42′04″ E); Near the Turka village, Turka (53°13′31″ N, 108°30′50″ E); Forest-steppe: North of the Onokhoy village, Onokhoy-Shibir (52°00′20″ N, 108°00′21″ E); Steppe: Near the Onokhoy village, Onokhoy (51°53′39″ N, 108°04′34″ E).

**Khamar-Daban.** Taiga: Near the Vydrino village, Vydrino (51°28′13″ N, 109°14′51″ E); Forest-steppe: the Jugal river valley, Jugal (50°23′39″ N, 108°57′52″ E).

**Khentei-Dauria Upland.** Taiga: the Atsa river valley, V. Atsa (50°09′11″ N, 109°14′51″ E); Forest-steppe: the Jugal river valley, Jugal (50°23′39″ N, 108°57′52″ E).

**Tunkinsky (East Sayan Mountains).** Taiga: North of the Mondy village, Mondy Mt. (51°41′32″ N, 101°02′34″ E); Forest-steppe: near the Mondy village, Mondy (51°40′34″ N, 101°02′11″ E).

The dendrograms of fauna similarity were obtained in BIODIV software, using Unweighted Pair Group Average as an amalgamation rule and Jaccard Index (Kj) as a distance measure.

### 3. Results and Discussion

Below is the list of Lepidoptera species that were found only or widely met only in the black taiga of the Ulan-Burgasy range and were not found in a major part of the Transbaikalian Region (figure 1). The following abbreviations are used: m – male; f – female; specimen/ha – number of individuals per hectare.

1. **Spialia orbifer** (Hübner, 1823). Eurasian sub-boreal species. Adults are active from the end of May to the beginning of July. In the Transbaikalia, it was not known to the east of the Ulan-Burgasy mountain range. In 2000-2021, in the lower part of the Uda river valley, this species seldom occurred (> 0.5 specimen/ha) in the forest-steppe belt of Ulan-Burgasy and was common (> 1 specimen/ha) in black taiga.

2. **Aporia hippia** (Bremer, 1861). East Asian nemoral species. Flight: mid-June to July. Earlier it was considered as common [22]. Our surveys revealed a high density of the species (up to 25 specimens/ha). In Western Transbaikalia, the range of *A. hippia* was not large. As a rule, adults concentrated nearby the only feeding plant i.e. saplings of *Berberis sibirica*. Single specimens were found below 900 m a.s.l.

3. **Ahlbergia frivaldszkyi** (Lederer, 1853). Asian sub-boreal species. Adults are active in May. The belt census method performed in 2017-2019 confirmed a high density of the species (up to 64 specimens/ha) in the black taiga and a low density or absence in other types of forests.

4. **Brenthis daphne** (Bergsträsser, 1780). Eurasian sub-boreal species. Flight: mid-June to August. In Western Transbaikalia, it occurs syntopically with nemoral species (*Niphanda fusca* Brem. et Grey, *Damora sagana* Dblld., etc.) [24]. It was observed on the key plot in Khara-Atsagat in 2018.

5. **Erebia jeniseiensis** Trybom, 1877. Asian boreal species. Flight: mid-June to mid-July. It is most widespread in Siberian pine, larch, and fir trees forests at the upper forest line [25, 26]. Earlier, this species was not observed to the east of the Khamar-Daban Ridge. It is common in the taiga belt of the Eastern Sayan and the western part of Khamar-Daban. In 2005 and 2007, the population density of the species there was up to 10-20 specimens/ha in the mixed fir tree woodland, and spruce forests of the lower part of the taiga belt. In the upper taiga belt mixed fir tree, Siberian pine, and spruce forests 39 specimens/ha have been registered. In the Ulan-Burgasy, two specimens were collected on June 21, 2011, one was on the slopes forested by small-leaved trees, Siberian pine, and larch in the upper reaches of the Kurba river basin (52°54′26″ N, 109°53′22″ E), and another one (the male specimen) was found in the area of Khara-Atsagat on July 1, 2018, in the forests composed by small-leaved trees, Siberian pine, fir tree, and spruce.

6. **Rheumaptera neocervinalis** Inoue, 1982. Palearchearctic species. Flight: May. It has been only found in one particular location in Transbaikalia. In 2017, it was common on the key plot of Khara-Atsagat.
Figure 1. Adults and genitalia of nemoral lepidopterans.
7. *Amurilla subpurpurea* (Butler, 1881). East Asian nemoral species. Flight: July. It was found here earlier [22]. We recorded it regularly.

8. *Laothoe populi* (Linnaeus, 1758) Central Palearctic boreal species. Flight: June to July. It is not observed to the east of the Ulan-Burgasy mountain range and is still not recorded in the Khamar-Daban mountain range [22, 27]. Rare in Buryatia. On the key plot of Khara-Atsagat, it was considered common in 2012-2019 [22].

9. *Leucodonta bicoloria* ([Denis & Schiffermüller], 1775). Eurasian sub-boreal species. Flight: mid-June to mid-July. It is absent in the major part of the Transbaikalia. It occurs on the Khamar-Daban mountain range [27]. In Eastern Transbaikalia, the only specimen was found in the mixed forests composed by small-leaved trees and Scots pine in the Daursky Nature Reserve [28]. The only male specimen (ab. *unicolor* Men.) was collected by the authors on the key plot with a UV lamp on July 1-2, 2018.

10. *Furcula bifida* (Brahm, 1787). Eurasian species. Flight: late May to mid-July. Before it was not observed to the east of the Transbaikal Region. Currently, it has been actively expanding to the east [29]. It is common in the Baikal reserve [27] and the east of Eastern Transbaikalia [30]. On the major part of the Transbaikal Region, this species was not observed. The only specimen (male) was found on the key plot on July 1-2, 2018.

11. *Feralia sauberi* (Graeser, 1892) Eastern Palearctic species. Flight: May. Trophically, it depends on larch woods and is observed in mountainous mixed dark-coniferous taiga forests [31]. In Eastern Transbaikalia, the highest density (>10 specimens/hour attracted by UV lamp) was observed in the mixed stands of small-leaved trees and larch in the lower part of the Argun river. In 1999-2020, no more than 1-5 specimens were caught per hour in the lower forest belt on the southeast edge of Ulan-Burgasy. In 2017-2019, on the key plot of Khara-Atsagat, this species was observed as dominant and codominant (15-20 specimens and more per hour, 200 specimens/night).

12. *Cryphia fraudatricula* (Hubner, 1803). Eurasian sub-boreal species. Flight: July. It was found here earlier [22]. In July 2018, 6 male specimens were caught per night in the Khara-Atsagat area.

Figure 2. The dendrogram of similarity of Lepidoptera faunas in different sites of the mountain ridges in the Baikal region.
4. Conclusions
Our studies confirmed the regular presence of *Ahlbergia frivaldszkyi*, *Aporia hippia*, *Amurilla subpurpurea*, and *Cryphia fraudatricula* (nemoral group) on the key plot of Kharra-Atsagat. The first two species and *C. fraudatricula* were common. *Rheumaptera neocervinalis* being common on the key plot was first found in the Transbaikalian Region. Besides, there were found some rare sub-boreal species that are common in the west and east parts of the Transbaikalia and not known throughout most of this region (*Spialia orbifer*, *Leucodonta bicoloria*, *Furcula bifida*). As for *Laothoe populi*, it can be concluded that this species with Euro-Siberian and Central Asian range type (Central Palearctic group) is common in Europe and Western Siberia in various types of forests. In the region, the species concentrates on the eastern border of dark-coniferous forests, in the upper parts of the mountain ranges adjacent to Baikal. This hawk moth was regularly observed only in the black taiga of Ulan-Burgasy. The same biotopic confinement was characteristic of *Feralia sauberi* (Palearchearctic group), which is found in all the mixed forests of the Upper Amur and Western Transbaikalia. This species was common only on the key plots of Ulan-Burgasy. As expected, the fauna of the key plot was the closest (more than 80%) to the wet biotopes nearby Baikal on the Ulan-Burgasy mountain range and mixed fir tree dark-coniferous forests of Khamar-Daban (figure 2).

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