Postfire changes in chortobiont insects community at experimental plots in Southern Transbaikalia (Daursky Nature Reserve)

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Abstract. The purpose of the research is to study the features of the abundance of the chortobiont insect community in the burnt and unburned plots of the plain grasslands of the Torey depression in Southern Transbaikalia. In a number of cases, the diversity in the burned-out plots turned out to be significantly lower. This tendency remains throughout June and July, suggesting the importance of dry, dead grass, which serves as a shelter for invertebrates, providing better protection from predators and high temperatures. However, the species Trigonotylus longitarsus (Hemiptera, Miridae), on the contrary, showed an increase in abundance in the burnt plots.

1. Introduction
Spring landscape fires in the south of Transbaikalia are one of the important factors that can affect the structure of phytocenoses [1, 2]. In this case, litter and perennial parts of plants burn out, and the temperature regime of the burnt plot changes [3]. The degree of damage caused by fires to communities of invertebrate animals in open spaces is assessed in different ways. In the example of European steppes, it has been shown that arthropods, the inhabitants of the litter and grass stand, suffer the most from fires. At the same time, the restoration of the number of such species proceeds slowly over several years [4, 5]. On the other hand, other studies have shown a rapid recovery of species diversity and abundance using the example of coleopteran chortobionts in a meadow community [6].

Some studies have shown examples of the rapid increase in the number of certain groups of invertebrates in unburnt plots. Sometimes, the number of individual representatives in the burnt plots could exceed that of the unburnt ones. A detailed review of such examples is given in the work of K Reed [7]. Differences in the responses of insects to the burning of vegetation can be explained both by the ecological peculiarities of individual taxa and the specificity of climate, soil, and other conditions of the biotopes themselves. Accordingly, these factors can determine the dynamics of the structure and number of invertebrate communities inhabiting phytocenoses in the post-fire period.

The purpose of this work is to reveal the features of the abundance of the community of key groups of chortobiont insects in the burnt and unburnt plots of the plain steppes of the Torey depression in South Transbaikalia.
2. Materials and methods

The studies were conducted out in 2014 on the Daursky State Natural Biosphere Reserve territory in the area between lakes Zun-Torey and Barun-Torey (Utochi Research Station). Preliminarily, five burnt plots with dimensions of 10 × 10 m and the same number of control plots that were not burnt out were prepared. In this case, the burnt and unburnt plots were located in pairs at a distance of approximately 10 m from each other. The totality of these plots represented a transect, the various elements of which differed in the degree of the drought resistance of its components. Plot 1 was the driest version of the steppes in the study area, plot 5 – a dry meadow formed at the bottom of the dried-up lake, Barun-Torey (table 1).

The collection of material was carried out by mowing with an entomological net (for each plot – 100 sweeps of the net), followed by soaking the collected insects. The following groups were taken into account: Orthoptera, Hemiptera, Coleoptera, Hymenoptera, Neuroptera. The selection criteria for these groups were determined by the degree of convenience in collecting entomological material through the above method. For each sample, both the number of specimens and the number of species caught in the net were counted. In total, 895 samples of insects belonging to 49 species (Orthoptera – 2, Hemiptera – 17, Coleoptera – 23, Hymenoptera – 6, Neuroptera – 1) were taken into account during the work. During the 2014 season, the counts at each plot were carried out in three replications – on June 23, July 20, and August 22. The collection results are presented in table 1.

The data presented in table 1 and figures 1 and 2 demonstrate noticeable differences between the samples of chortobionts both in the number of species and in the total number of recorded insects. To characterize the diversity in the burnt and unburnt plots, the values of the Shannon diversity index ($H$) were calculated (table 2); to assess the relative distribution of individuals among species – the values of Pielou’s evenness index ($J$).

Table 1. The number of species and individuals of chortobionts at the survey plots.

| No. | Plant communities                  | 23.06.2014 |          | 20.07.2014 |          | 22.08.2014 |          |
|-----|------------------------------------|------------|----------|------------|----------|------------|----------|
|     |                                    | Burnt plot | Unburnt plot | Burnt plot | Unburnt plot | Burnt plot | Unburnt plot |
| 1   | Onion-feather grass steppe         | 4/10       | 12/60    | 5/10       | 8/21     | 7/13       | 5/14     |
| 2   | Forb-wormwood-feather grass steppe | 4/4        | 14/27    | 4/32       | 13/28    | 8/20       | 8/45     |
| 3   | Herb-cereal steppe                 | 3/5        | 5/8      | 7/41       | 12/48    | 5/29       | 11/14    |
| 4   | Herb-cereal steppe                 | 4/6        | 14/56    | 4/39       | 11/60    | 3/49       | 7/20     |
| 5   | Forb-cereal dry solonchak meadow   | 7/52       | 10/59    | 7/58       | 8/39     | 4/16       | 7/22     |

3. Results and discussions

Some of the pairwise comparisons (burnt versus unburnt plots) were significant (p < 0.05). Differing samples are shown in bold in table 2. In most cases, the variety on burnt plots is significantly lower. The differences were more pronounced in June and July, which can be explained by less comfortable conditions that arose at the beginning of summer as a result of a controlled burn. The key factor of this unsuitability is the absence of dry litter on the unburnt plots, which plays the role of shelters for invertebrates, protecting them from predators and high temperatures.

Table 2. Shannon diversity ($H$) values for burnt and unburnt plots.

| No. | 23.06.14 |          | 20.07.14 |          | 22.08.14 |          |
|-----|----------|----------|----------|----------|----------|----------|
|     | Burnt plot | Unburnt plot | Burnt plot | Unburnt plot | Burnt plot | Unburnt plot |
| 1   | 1.280    | 1.744    | 1.359    | 1.889    | 1.517    | 1.438    |
| 2   | 1.386    | 2.433    | 0.985    | 2.253    | 1.692    | 1.409    |
| 3   | 0.950    | 1.494    | 1.036    | 2.084    | 1.186    | 1.562    |
| 4   | 1.243    | 2.030    | 0.853    | 2.006    | 0.329    | 1.752    |
| 5   | 1.470    | 1.893    | 0.960    | 1.708    | 0.822    | 1.617    |
Figure 1. The number of chortobiont species at the plots.
1-5 – numbering of plots; 06, 07, 08 – numbering of months.

Figure 2. The number of individuals of chortobionts at the plots.
1-5 – numbering of plots; 06, 07, 08 – numbering of months.

The small size of the experimental plots determines free opportunities for insects to move between burnt and unburnt plots, so we suppose that the absence of litter resulting from burning can be considered the most important factor that can affect the intensity of post-pyrogenic restoration of entomofauna. The significance of this factor can be especially high in the dry steppe conditions of South Transbaikalia. This region is characterized not only by a small amount of precipitation (less than 300 mm per year) [8] but also by its extremely uneven distribution throughout the year. Moreover, spring and early summer are characterized by low rainfall, insufficient for active vegetation growth. The consequence is that many plant species show only a slight increase in number at the
beginning of the season, and the total projective cover due to fresh vegetation increases slowly. The soil cover remains devoid of vegetation for a long time. A large number of clear sunny days with the maximum wind speed per year are characteristic for the region. Along with a slowdown in vegetation development, these factors contribute to the rapid spread of fires when they occur [1]. The postfire soil of the dark colour due to combustion products, devoid of litter and shade, heats up more and loses moisture more rapidly.

This trend continues until at least the second half of July. July and August are the wettest months of the year (about half of the annual rainfall). Active vegetation growth during this period makes it possible to compensate for differences in projective cover between burnt and unburnt plots. The data obtained in August demonstrates a smoothing of the differences in the number of chortobiont species between the plots for the two most dry steppe plots.

The values of the alignment indices (table 3) for the pairwise compared samples differ depending on the date of collection of the material. The evenness in the burnt plots turned out to be lower for all the materials in July. Analysis of the collected material shows that the key factor influencing this parameter is the abundance of the bug *Trigonotylus longitarsus* Golub, 1989 (*Hemiptera, Miridae*) in the samples.

**Table 3.** Pielou’s evenness index ($J$) values for burnt and unburnt plots.

| No.  | 23.06.14 Burnt plot | 23.06.14 Unburnt plot | 20.07.14 Burnt plot | 20.07.14 Unburnt plot | 22.08.14 Burnt plot | 22.08.14 Unburnt plot |
|------|---------------------|-----------------------|--------------------|----------------------|-------------------|---------------------|
| 1    | 0.899               | 0.477                 | 0.779              | 0.826                | 0.651             | 0.842               |
| 2    | 1.000               | 0.814                 | 0.670              | 0.732                | 0.680             | 0.511               |
| 3    | 0.862               | 0.891                 | 0.403              | 0.670                | 0.655             | 0.434               |
| 4    | 0.866               | 0.544                 | 0.587              | 0.676                | 0.463             | 0.824               |
| 5    | 0.622               | 0.664                 | 0.373              | 0.690                | 0.569             | 0.720               |

This species of bugs in the described territory is trophically related to such a species as the Chinese rye grass (*Leymus chinensis*) (Poaceae), which is the dominant species of herb-grass communities (plots 3–5). For plots 1 and 2, where *L. chinensis* was absent or played an insignificant role and feather grass predominated in the composition of grasses, the abundance of *T. longitarsus* was insignificant. In all samples at plots 3–5 (except for the June mowing at plots 4), *T. longitarsus* is characterized by a high abundance at pyrogenic plots (table 4). At the same time, on unburnt plots, the abundance of this species was noticeably lower, or it was completely absent. In total, the share of *T. longitarsus* was 50.0% of all insects collected from burnt plots and 9.6% from unburnt plots. An increase in the number in the burn areas was previously noted for some species or other taxa of various orders of insects (Orthoptera, Hemiptera, Coleoptera, Hymenoptera, etc.) [7].

**Table 4.** Share of bugs *Trigonotylus longitarsus* (%) in samples from burnt and unburnt plots.

| No.  | 23.06.14 Burnt plot | 23.06.14 Unburnt plot | 20.07.14 Burnt plot | 20.07.14 Unburnt plot | 22.08.14 Burnt plot | 22.08.14 Unburnt plot |
|------|---------------------|-----------------------|--------------------|----------------------|-------------------|---------------------|
| 1    | 30.0                | 0                     | 0                  | 0                    | 0                 | 0                   |
| 2    | 0                   | 3.7                   | 3.1                | 0                    | 5.0               | 0                   |
| 3    | 60.0                | 37.5                  | 70.7               | 29.2                 | 48.3              | 4.4                 |
| 4    | 0                   | 17.9                  | 61.5               | 0                    | 91.8              | 0                   |
| 5    | 40.4                | 25.4                  | 67.2               | 0                    | 75.0              | 27.3                |
4. Conclusions
Thus, in small, geographically close areas within the dry steppe territories of Southern Transbaikalia, differences in abundance and species diversity were revealed using the example of five key orders of chortobiont insects. The number and diversity in some of the burnt plots turned out to be significantly less than in the unburnt ones. Such differences are associated with the absence of dry litter on the unburnt plots, creating less favourable conditions for chortobionts. Differences in the diversity of the chortobiont fauna between the burnt and unburnt plots persisted throughout the summer months, although in July and August, they were less than in June. This suggests that the recovery of insect communities in dry steppes can proceed slower than in more humid meadow cenoses [6].

In contrast, the common phytophagous species *Trigonotylus longitarsus*, which feeds on *Leymus chinensis*, noticeably increased in abundance in burnt communities. The ratio of *T. longitarsus* in burnt communities with the dominance of this Poaceae species in July and August (plots 3–5) ranges from 48.3 to 91.8%, which is significantly higher than the incidence of this species in unburnt plots.

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