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ASSESSMENT OF FEEDING NICHE AND PHENOTYPIC VARIATION IN THE URALS POPULATIONS OF LEAF BEETLE *CHRYSOMELA LAPPONICA*

(ИЗУЧЕНИЕ ПИЩЕВОЙ НИШИ И ФЕНОТИПИЧЕСКОЙ ИЗМЕНЧИВОСТИ В УРАЛЬСКИХ ПОПУЛЯЦИЯХ ЛАПЛАНДСКОГО ЛИСТОЕДА)

The objective was to study feeding preferences of the populations of Lapland leaf beetle Chrysomela lapponica in connection to the peculiarities of their habitats. In the urban forests of Yekaterinburg we found colonies with low density, monomorphic in colouration and feeding only on one willow species – Salix caprea. In contrast, all the samples from the Konzhakovsky Kamen' mountains were abundant and variable in colouration. 5 willow species were indicated as host plants for the mountain population of Lapland leaf beetle with wooly willow (Salix lanata) as preferable host.

Целью работы было изучение пищевых предпочтений в популяциях лапландского листоеда (Chrysomela lapponica) в связи с особенностями их местообитаний. В лесопарках Екатеринбурга нами обнаружены колонии с низкой численностью, мономорфные по окраске и питающиеся только на одном виде ивы – иве козьей. Напротив, все выборки с горного массива Конжаковский Камень были многочисленными и изменчивыми по окраске. В качестве кормовых растений для горной популяции лапландского листоеда были отмечены 5 видов ив, среди которых ива мохнатая (Salix lanata) – наиболее предпочтительное кормовое растение.

Introduction

The subject of our research includes the Urals populations of the Lapland leaf beetle (*Chrysomela lapponica*), which is widespread in Eurasia but has arctic-alpine distribution pattern. This means that its distribution area is separated in two parts, one lays north of the Arctic circle (Northern group of populations) and the rest (Southern group of populations) are scattered southwards in the mountains on the elevations from 450 m to 2000 m above sea level (Mikhailov, 2001; Machkour-M'Rabet et al., 2008).

The populations from the Urals can be attributed to the Southern group, but this group is quite heterogeneous. Small isolated populations in the city limits of Yekaterinburg (Urban forest named after Foresters of Russia and Uktus urban forest) as well as very abundant populations in the North Ural Mountains were both found by us in Sverdlovk region.

Lapland leaf beetle in the last 20 years is an object of special interest of the foreign researchers, in Germany, Belgium, Finland (Zvereva et al., 2010), while in Russia, where the major part of its distribution is situated, this species has not been studied as bioindicator yet. This explains the relevance of our research.

The leaves of willows have high content of glucosides that make them unedible for leaf-eating animals. At the same time larvae of Lapland leaf beetle that feed on willow sequester salicyl glucosides (SGs), which are modified in their defensive glands to bioactive compounds. These secretions serve for defense against generalist enemies. However, some populations of *C. lapponica* have shifted to SG-poor hosts, and their secretions do not contain salicyl-aldehyde (Zvereva et al., 2010).

Therefore the host plants of Lapland leaf beetle influence the composition of chemical defense of their larvae, which helps them to overcome predatory attacks. The objective of our work was to study feeding preferences of the populations of Lapland leaf beetle in connection to the peculiarities of their habitats.

Materials and methods

The material was collected in June and July of 2012 and 2013 in the urban forests of Yekaterinburg and in July of 2013 in Konzhakovsky Kamen' massif.

We used the methods of evaluating of feeding niche breadth of *C. lapponica* offered E. Zvereva (Zvereva et al., 1995), who also gave us some advice how to use them in exact conditions. To evaluate the pattern of host-plant use, we recorded species and size of all willow bushes within the areas of 50 m^2 size and counted specimens of *Ch. lapponica* (larvae, pupae and beetles) on each bush. Surveys were conducted when most of the larvae reached the last instar. Willow bushes were ranked to one of five groups according to their approximate number of annual shoots. The mass of foliage was estimated by collecting 20 annual shoots from several bushes of each species. The leaves were dried at 80 ºC for 12 hours and then weighed.

Preference experiments to find out the food preference of beetles were conducted with leaf disks of four willow species, arranged on moistened filter paper in a Petri dish. Beetles were allowed to feed for 24 hours and the proportion of the consumed area was recorded.

The niche breadth (NB) was calculated from the obtained data using the following equation (Zvereva et al., 1995):

$$NB = \sum \sqrt{\rho_j \alpha_j},$$

where p_j is the proportion of specimens of exact leaf beetle species collected on the willow species j, or the proportion of the biomass consumed in preference experiments; and a_j is the proportion of dry mass of the species j in the total resource available, which is either the field abundance of the species or their equal abundances for preference trials.

Results

In the urban forests of Yekaterinburg we found colonies with low density and unusual colouration (only entirely blue beetles). In addition to this they feed only on one willow species – *Salix caprea*. This is the only willow species under forest canopy. Several others can be found on the open places and near lakes, but the leaf beetles never feed on them. In contrast to them all the samples from the Konzhakovsky Kamen' mountains are abundant and variable in colouration (Fig. 1).

As a host plant *Salix caprea* has very low content of salicyl glucosides (SGs), that is why urban populations of the Lapland leaf beetle have low efficiency of defensive secretion and low larval growth rate (Zvereva et al., 2010). Preference tests in the lab showed that among four willow species (*Salix caprea*, *S. cinerea*, *S. triandra* and *S. myrsinifolia*) beetles chose SG-poor species and avoided SG-rich ones.

In the mountains of North Urals 8 study areas were established in different altitudes (from 1100 to 1250 m), biotopes and slope expositions. We found out 5 willow species to be host plants for the Lapland leaf beetles. From 3 most abundant willow species the beetles prefer wooly willow (*Salix lanata*). In the mountains wooly willow (*Salix lanata*) is the optimum host plant of this species, while *Salix cinerea* and *S. uralicola* are suboptimal. Among the stone debris large proportion of beetles occur on *Salix cinerea*, and on the alpine plateau – on the *S. uralicola* (Fig. 2).

On the study plots the niche segregation with competitor species was found. This was another arctic-alpine leaf beetle *Gonioctena arctica*. This species was the most abundant in the lower part of vertical distribution of Lapland leaf beetle (h = 1100–1150 m) and the niche breadth of *Ch. lapponica* was 0,90–0,96, while niche breadth of *G. arctica* – 0,85–0,97. On the alpine plateau, where only Lapland leaf beetle occurs its niche breadth is maximal (0,98–1,0).

Figure 1. Newly emerged beetles of *Chrysomela lapponica* on *Salix lanata* in the mountains of Noth Urals

It is known from the investigations in Finland (Zvereva et al., 1995), that the niche breadth (NB) of the Lapland leaf beetle usually goes narrower with the higher pollution. This is due to lower survival of larvae on suboptimal host plants. In the mountains of North Urals we found three suboptimal species of host plants that are useful for the purposes of bioindication.

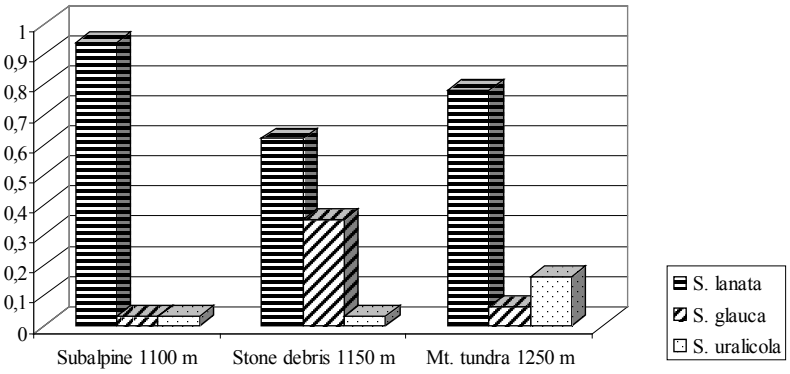

Figure 2. Preference of host plants in the mountain population of North Urals of *Chrysomela lapponica* (proportion of collected specimens on different host plants).

Literature

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