The resource role of flowering woody plants in increasing the insects biological diversity

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Abstract. The aim of the study was to assess the resource role of flowering woody plants in maintaining the biological diversity of insects. The studies were carried out in 2019–2020 in the northern forest-steppe of the Ob region during the flowering period of woody plants from the Oleaceae family of the genus *Syringa*: *S. josikaea* J. and *S. vulgaris* L. Insects were collected by mowing with an entomological net in the crowns and under-crown space. The flowering of plants attracted insects from more than 25 families from 7 orders. The largest number of insects belonged to the order Thysanoptera - 79.2%, followed by representatives of the orders Hemiptera (7.1%) and Diptera (6.4%). The entomological faunas of *S. josikaea* and *S. vulgaris* differed significantly in their taxonomic composition, insects abundance, and their association with flowering periods. Low coefficients of similarity and high power of the factor “plant species” influence on biological diversity and the insects number were revealed. *S. josikaea* played a more significant role in maintaining the biological diversity of insects. Research showed that insects are associated with a certain species of woody plant.

1 Introduction

The global scale of urbanization is leading to the rapid expansion of urban areas and the strengthening of human economic activity. Anthropogenic land use changes landscapes radically and sustainably, therefore urbanization can become the main cause of the biological diversity of flora and fauna decline and can lead to the health and functioning of ecosystems disruption [1,2].

Insects are one of the main components of phytocenoses. They play a large ecological role in ecosystems, since they are the leading pollinators of plants, a source of food for invertebrates and vertebrates at a higher trophic level, and indicators of ecological changes in territories. A decrease in the number and diversity of insects can lead to functional changes in other groups of living organisms [3].

Woody plants help to preserve and support insect communities in altered ecosystems [4], they are a favorable place for reproduction, larval development, wintering and the formation of new trophic links, thereby realizing fundamental ecological niches of insects [5,6]. Abundantly flowering plants play a special role in maintaining pollinating insects and other beneficial biota, because nectar and pollen become an additional food resource [7],

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which helps to increase insect immunity, reproductive ability and increase population size [8].

The purpose of the study: to assess the resource role of flowering woody plants in maintaining the biological diversity of insects.

2 Material and Methods

To assess the resource role of woody plants in maintaining the biological diversity of insects, two species from the Oleaceae family of the genus Syringa were selected: Syringa josikaea J. and Syringa vulgaris L. - highly decorative shrubs with abundant and long flowering [9]. The study was carried out in 2019-2020 on the territory of the arboretum of the Specially Protected Natural Territory - the Arboretum of regional significance (Novosibirsk).

Entomological screening was carried out during the flowering period of plants using the method of mowing with an entomological net in the crowns and undercrown space [10, 11]. Entomological records were supplemented with phenological observations of woody plants [12]. Observations were carried out during the growing season with an emphasis on the flowering period - the beginning of flowering, mass flowering and the end of flowering were recorded.

The weather conditions of the growing season during the research years differed in temperature indicators, but were similar in terms of the abundance of precipitation and were characterized as moderately humid: in 2019, GTC = 1.23 and in 2020, GTC = 1.25.

To assess the degree of biocenotic similarity and biological diversity of entomological complexes, the Jaccard, Menhinikh, and Margaleff coefficients were calculated [13]. Statistical data processing was carried out by methods of variance analysis using the software package SNEDECOR [14].

3 Results

The phenological rhythms of woody plants corresponded to the growing season of Novosibirsk region local species. In 2019, the growing season began in the third decade of April, and the flowering of S. josikaea and S. vulgaris - from May 17 and 10, respectively, and continued until the end of June. The meteorological data were close to the mean annual values. In 2020, the beginning and end of the growing season, as well as the flowering of plants, came two weeks earlier. It is possible that the shift in phenological rhythms of shrubs was influenced by the average monthly temperatures sum, which was 5.8°C higher than the norm.

As a result of two years of research, it was found that the flowering of S. vulgaris and S. josikaea attracted insects from more than 25 families from 7 orders. The largest number of insects belonged to the order Thysanoptera (79.2%), followed in descending order by the orders Hemiptera (7.1%), Diptera (6.4%), Hymenoptera (3.2%), Coleoptera (2.4%), Lepidoptera (1.7%), Neuroptera (0.1%). The ecological analysis of the data obtained showed that the entomological fauna of woody plants consisted of insects with different trophic specialization - phytophages, entomophages and pollinators.

Among the phytophages, the families Aphididae, Cicadellidae, Psyllidae, Pentatomidae, Miridae, and Lygaeidae of the order Hemiptera were identified; order Thysanoptera; families Chrysomelidae, Curculionidae, Mordellidae, Nitidulidae, Scarabaeidae of the order Coleoptera; family Pieridae of the order Lepidoptera.

Entomophages were represented by parasitoids of the order Hymenoptera and predators of the Anthocoridae family of the order Hemiptera, the family Coccinellidae of the order

Coleoptera; the Chrysopidae family of the Neuroptera order; by the family Syrphidae of the order Diptera. Pollinating insects from the families Apidae, Colletidae, and Halictidae of the order Hymenoptera were also found.

The quantitative assessment made it possible to compare the role of the studied plant species in maintaining the biological diversity of insects (Table 1).

Table 1. Indices of insect species richness on genus *Syringa* woody plant.

Species	Year	Margaleff index	Menhinikh index
S. vulgaris	2019	4,18	1,79
	2020	1,94	0,97
S. josikaea	2019	4,71	1,38
	2020	5,63	1,25

The indices, presented in the table, showed that *S. josikaea* played a more significant role in maintaining the insects biological diversity. The difference in Margaleff coefficients between *S. josikaea* and *S. josikaea* reached 2.9 times in 2020, the maximum difference between Menhinik's coefficients in favor of *S. josikaea* was 1.3 times.

In the course of the research, it was revealed that the entomological fauna of *S. vulgaris* and *S. josikaea* differed among themselves in taxonomic groups and the number of insects.

For example, phytophagous insects of the family Aphididae and Cicadellidae of the order Hemiptera were completely absent in the entomological complex of *S. vulgaris* in 2020, and insects of the family Psyllidae of the order Hemiptera were completely absent during the flowering period of *S. josikaea* in 2019. Species *Kleidocerys resedae* (P.) (Hemiptera: Lygaeidae) was found in the *S. vulgaris* entomological complex in 2019, and in the *S. josikaea* entomological complex - in 2020. The green tree bush *Palomena prasina* (L.) (Hemiptera: Pentatomidae) was attracted by the blooming of *S. vulgaris* and *S. josikaea* in 2020. Insects from other families were, as a rule, confined to the flowering of one of the two studied species of woody plants, although exceptions were identified.

Thus, in 2019, the common hoverfly *Syrphus ribesii* (L.) was found in the entomological complexes both *S. vulgaris* and *S. josikaea*, in 2020 the flowering of *S. vulgaris* attracted the sirphid of the genus *Platycheirus* sp., and the flowering of *S. josikaea* - the sirphid *Mallota eurasiatica* S. (Diptera: Syrphidae). The black garden ant *Lasius niger* L. (Hymenoptera: Formicidae) was found in the *S. vulgaris* entomological complex only in 2019, and in the *S. josikaea* one - in 2020. In 2020, the bloom of both *S. vulgaris* and *S. josikaea* attracted pollinating insects of the Apidae family.

A quantitative assessment of the common taxonomic composition of insects (Jaccard coefficient) in 2019 showed a low degree of similarity between the entomological fauna of *S. vulgaris* and *S. josikaea* crown (0.25), a similar indicator (0.22) was obtained in 2020.

Entomological complex of the genus *Syringa* woody plants differed in taxonomic composition and flowering phases (Table 2).

In 2019 the largest number of taxonomic groups were attracted by the flowering of *S. josikaea* in the phase of mass flowering, the smallest number of taxonomic groups was found at the end of *S. vulgaris* flowering. In 2020 the entomological fauna of *S. josikaea* at the end of flowering consisted of the largest number of taxonomic groups, while the

entomological complex of *S. vulgaris* at the same flowering phase consisted of the smallest number of taxonomic groups.

Table 2. The number of insects species by phases of genus *Syringa* woody plants flowering

Species	Year	The beginning of flowering	The mass flowering	The end of flowering
S. vulgaris	2019	10	11	7
	2020	4	6	5
S. josikaea	2019	17	15	10
	2020	15	18	27

According to the analysis of variance, the strength of the factor "plant species" influence on the biological diversity of insects was 35%. This indicates, that insects have close ecological ties with certain species of woody plants.

The entomological fauna of *S. vulgaris* and *S. josikaea* also differed in the abundance of insects in the phases of flowering (Table 3).

Table 3. The number of insects collected in different phases of genus *Syringa* plants flowering, 100 entomological net swings

Species	Year	The beginning of flowering	The mass flowering	The end of flowering
S. vulgaris	2019	28	53	70
	2020	18	11	76
S. josikaea	2019	169	159	146
	2020	330	228	465

In both years of research, most insects were attracted by the flowering of *S. josikaea*, moreover, in 2019 - in the phase of mass flowering, and in 2020 – in the phase of flowering end.

The strength of the factor “plant species” influence, according to the two-factors variance analysis, was 71.7%, which indicates that the insects abundance is confined to a certain species of genus *Syringa* woody plants.

4 Discussion

The flowering of genus Syringa woody plants - S. josikaea and S. vulgaris - attracted a rather diverse entomological complex of 7 orders and more than 25 families during the years of research. The order of Thysanoptera was distinguished by the greatest number of insects; representatives of the orders Hemiptera and Diptera also made a significant contribution to the formation of the entomological fauna. In terms of biological diversity,

the studied plant species are close to the main herbaceous entomophilous plants in the study region [15]. The entomological fauna of S. josikaea and S. vulgaris significantly differed in the taxonomic composition and abundance of insects, as evidenced by the low coefficients of entomological fauna similarity and the high influence of the factor “plant species” on the diversity and abundance of entomological complexes. Studies have shown that insect complexes are largely adapted to a specific arboreal species from the genus Syringa, and to maintain the biological diversity of invertebrates, the presence of both studied species in the urban and agricultural landscapes is necessary, since they complement each other.

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