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ECOLOGICAL FEATURES OF TERRESTRIAL INSECT FAUNA OF THE BOTANICAL GARDEN OF VASYL STEFANYK PRECARPATHIAN NATIONAL UNIVERSITY

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Abstract. In 2018, we conducted a study of the terrestrial insect fauna of the Botanical Garden. Research was conducted at six areas: three areas in the meadow-steppe biotope, one area near a pond, and two areas in the forest part of the botanical garden.

As a result, 54 species of terrestrial insects were found to be inhabited, among which beetles from two families – Ground beetle and Darkling beetle (Coleoptera). The basis of the fauna of the botanical garden is widespread species (cosmopolitan, trans- and western Palearctic, trans- and western Eurasian, Scythian) – 88%; in most cases, these are evrybiont species that are well adapted to life in agrocenoses and in urbanized areas. The terrestrial insect fauna of the botanical garden is dominated by steppe and polyzonal species (57%), as well as a large share of field, steppe-field and meadow-field species (29%).

Comparing the species composition of insects in different areas, it can be noted that in the meadow areas of the botanical garden (Areas 2, 3, 6) there are no virgin species such as *Amara pastica*, *Pterostichus macer*, *Taphoxenus gigas*, and in the areas near the lake (Area 1) and in the forest part of the botanical garden (Areas 4-5) there are no field species *Pterostichus punctulatus*, *Harpalus zabroides*, *Harpalus distinguendus*, *Silpha obscura*; thus, the fauna of the meadow areas of the Botanical Chad is closer to the virgin steppe than the fauna of Areas 1, 4, 5.

56% of terrestrial insect species in the botanical garden are species with one or another degree of phytophagy, zoophagy is characteristic of 40% of species; pure phytophages make up 32% of species, pure zoophages 24%. Predominance of phytophages is a characteristic of agrocenoses and disturbed ecosystems.

One trend is observed – a decrease in the biodiversity of entomofauna in August; this is explained by the drying of biotopes at the end of summer, especially in 2018. If we compare the indices by biotopes, then in June biodiversity is much higher in the meadow areas of the botanical garden, and in August these indicators are slightly higher in the areas near the pond and in the forest part of the botanical garden, which can also be explained by environmental factors and their influence on terrestrial insect organisms.

Keywords: insects, fauna, botanical garden, biodiversity indices, trophic specialization.

1. INTRODUCTION

As a result of anthropogenic load, the entomofauna undergoes significant changes. This is due to the strengthening of the transformation of nature, which led to a radical transformation of biogeocenoses. This influence was expressed in the change in the quantitative and species composition of insects, namely, many species die out or become rare, while some species gain advantages in access to food and an ecological niche and become massive. The degree and nature of changes in biocenoses are determined by the genus and the intensity of its economic use [3, 5].

According to the research of scientists, in the absolutely protected steppe, where both grazing and haymaking are prohibited, the species composition of insects has noticeably decreased and they are mainly represented by orthoptera and bugs [1, 2]. Currently, there is a huge anthropogenic impact on natural objects. This topic is becoming the most important for scientists all over the world, as our planet is losing its bright colors. Therefore, it is very important to know which species of terrestrial insects have managed to adapt to life in urbanized cities, and therefore this study is relevant [2, 5].

2. MATERIALS AND METHODS OF RESEARCH

The main purpose of the research we conducted in June-September 2018 was to study the features of the terrestrial entomofauna of the botanical garden of Vasyl Stefanyk Precarpathian National University, in areas with different anthropogenic loads. For this purpose, we chose three biotopes: the area near the pond (one sample plot), forest (two sample plots) and meadow-steppe ecosystems (three sample plots).

Experimental area 1 – site near the pond – 48°56'33.1"N 24°40'42.4"E;

Experimental area 2 – meadow-steppe ecosystem – 48°56'29.6"N 24°40'30.1"E;

Experimental area 3 – meadow-steppe ecosystem – 48°56'23.7"N 24°40'12.2"E;

Experimental area 4 – forest – 48°56'43.8"N 24°40'04.1"E;

Experimental area 5 – forest – 48°56'43.1"N 24°39'57.5"E;

Experimental area 6 – meadow-steppe ecosystem – 48°56'35.4"N 24°39'50.2"E (see on the map).

Terrestrial insects were caught in the experimental areas. The species composition of the entomofauna was determined with the help of identifiers and scientific articles in the zoological museum of the department biology and ecology.

The results of catches using various traps were used to determine the number of insect populations. For the quantitative assessment of biological diversity, a large number of indices of varying degrees of complexity are used, which allow an objective assessment of the state of communities and ecosystems. We calculated four indices characterizing biodiversity: Shannon, Menkhinik, Simpson and Berger-Parker [4, 6, 7].

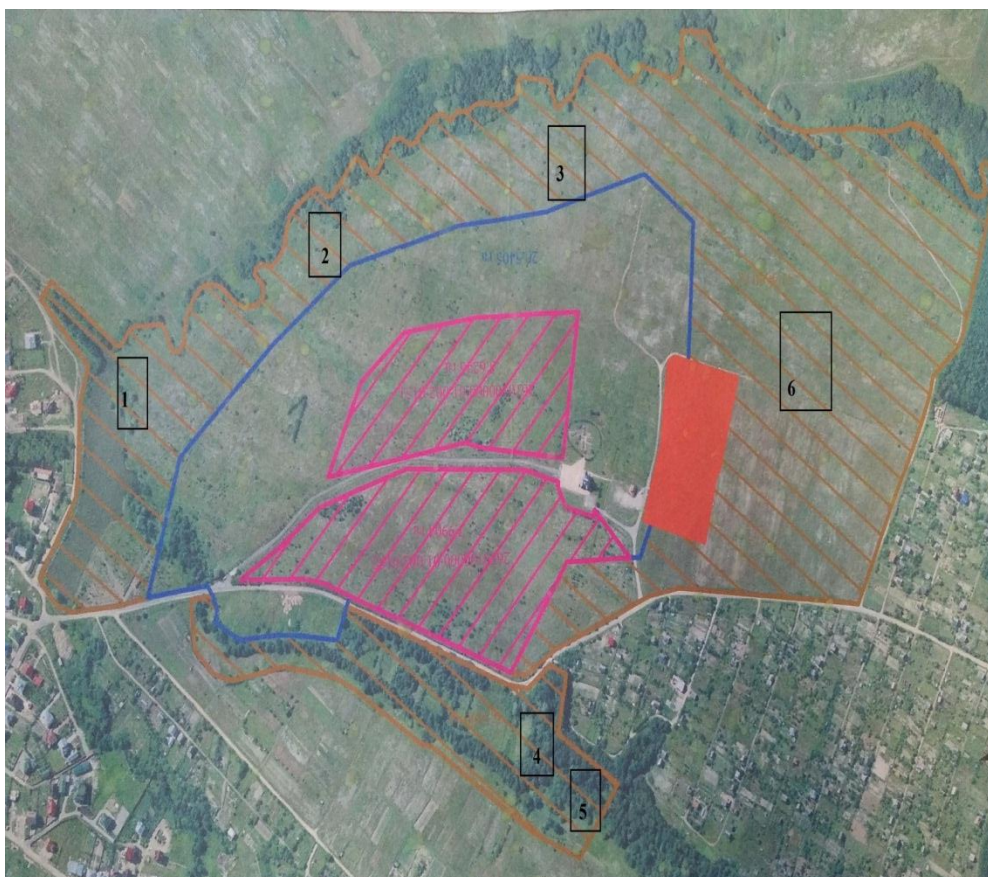


Fig. 1. Map of the botanical garden of Vasyl Stefanyk Precarpathian National University

3. RESEARCH RESULTS AND THEIR DISCUSSION

We discovered 54 species of insects during the research in June-September 2018 (Table 1). The analysis of the species composition showed that the terrestrial insect fauna in the botanical garden is mainly represented by beetles from two families – Ground beetle (Carabidae Latreille, 1802) and Darkling beetle (Tenebrionidae Latreille, 1802).

Speaces, families	June-July		August-September	
	Areas 1, 4, 5	Areas 2, 3, 6	Areas 1, 4, 5	Areas 2, 3, 6
Ground beetle Total:	68	148	330	237
Including:				
<i>Amara aulica</i> Panzer, 1797	16	10	26	-
<i>Amara bifrons</i> Gyllenhal, 1810	4	38	6	7
<i>Amara deserta</i> Krynicky, 1832	-	6	2	-
<i>Amara pastica</i> Dejean, 1831	-	4	-	-
<i>Amara ingenua</i> Duftschmid, 1812	2	-	-	-
<i>Amara convexuscula</i> Marsham, 1802	-	2	-	-
<i>Amara equestris</i> Duftschmid, 1812	-	10	-	-
<i>Ophonus rufipes</i> DeGeer, 1774	12	40	28	8
<i>Ophonus azureus</i> Fabricius, 1775	2	-	-	-
<i>Pterostichus sericeus</i> Fischer von Waldheim, 1824	6	10	-	2
<i>Pterostichus macer</i> Marsham, 1802	-	4	-	2

<i>Pterostichus punctulatus</i> Schaller, 1783	2	-	2	-
<i>Calathus ambiguus</i> Paykull, 1790	-	16	106	152
<i>Calathus erratus</i> C.R. Sahlberg, 1827	-	-	141	55
<i>Taphoxema gigas</i> Fischer von Waldheim, 1823	-	2	-	7
<i>Harpalus smaragdinus</i> Duftschmid, 1812	4	2	2	-
<i>Harpalus zabroides</i> Dejean, 1829	2	-	-	-
<i>Harpalus distinguendus</i> Duftschmid, 1812	4	-	-	-
<i>Harpalus rubripes</i> Duftschmid, 1812	6	-	-	-
<i>Harpalus amplucalis</i> Schrank, 1781	-	-	-	2
<i>Cymindus variolosa</i> Fabricius, 1794	-	2	4	-
<i>Cymindus scapularis</i> Schaum, 1857	-	-	4	2
<i>Cymindus angularis</i> Gyllenhal, 1810	-	-	4	-
<i>Notiophilus palustris</i> Duftschmid, 1812	-	-	5	-
<i>Syntonus</i> sp.	2	-	-	-
<i>Microlestes</i> sp.	2	-	-	-
<i>Calosoma auropunctatum</i> Herbst, 1784	2	2	-	-
Larvae	2	-	-	-
Darkling beetle Total: Including:	92	86	2	29
<i>Blaps halophila</i> Fischer von Waldheim, 1832	20	38	-	17
<i>Blaps lethifera</i> Marsham, 1802	4	10	-	-
<i>Opatrum sabulosum</i> Linnaeus, 1761	16	22	-	2
<i>Odoscelis polita</i> Sturm, 1807	52	14	2	10
<i>Crypticus quisquilius</i> Linnaeus, 1761	-	2	-	-
<i>Pedinus femoralis</i> Linnaeus, 1767	-	2	-	-
Other bugs Total: Including:	224	108	14	30
<i>Otiorhynchus velutinus</i> Germar, 1823	146	32	2	10
<i>Otiorhynchus ovatus</i> Linnaeus, 1758	-	-	-	2
<i>Otiorhynchus ligustici</i> Linnaeus, 1758	-	2	-	-
<i>Eusomus ovulum</i> Germar, 1824	-	4	-	-
<i>Psalidium maxillosum</i> Fabricius, 1792	6	2	-	-
<i>Cleonis pigra</i> Scopoli, 1763	34	4	-	-
<i>Sitona</i> sp.	2	-	-	-
<i>Pseudocleonus cinereus</i> Schrank, 1781	-	2	-	-
<i>Tanymecus palliatus</i> Fabricius, 1787	-	2	-	-

<i>Dermestes lanarius</i> Illiger, 1801	16	14	-	2
<i>Coccinella septempunctata</i> Linnaeus, 1758	-	-	-	2
<i>Silpha obscura</i> Linnaeus, 1758	4	-	-	-
<i>Chrysomela limbata</i> Fabricius, 1775	-	8	4	2
<i>Chrysomela sanguinolenta</i> Linnaeus, 1758	-	2	-	-
<i>Agriotes sputator</i> Linnaeus, 1758	10	24	-	-
Alticini	-	-	2	2
<i>Dorcadion carinatum</i> Pallas, 1771	2	2	-	2
Cassida	2	-	-	-
<i>Byrrhus pilula</i> Linnaeus, 1758	-	6	-	4
Staphylinus sp.	-	-	4	2
<i>Onthophagusemicornis</i> Panzer, 1798	2	-	-	2
<i>Maladera holosericea</i> Scopoli, 1772	-	4	2	-
Hemiptera Total: Including:	14	8	61	0
<i>Emblethis verbasci</i> Fabricius, 1803	14	2	40	-
<i>Emblethis griseus</i> Wolff, 1802	-	-	8	-
<i>Emblethis denticollis</i> Horváth, 1878	-	-	4	-
<i>Dicranomerus agilis</i> Scopoli, 1763	-	2	-	-
<i>Megalonotus chiragra</i> Fabricius, 1794	-	-	7	-
<i>Cydnus aterrimus</i> Forster, 1771	-	2	2	-
Myodochoideae	-	2	-	-
Orthoptera Total: Including:	0	2	35	26
<i>Decticus verrucivorus</i> Linnaeus, 1758	-	2	4	-
<i>Gryllulus desertus</i> Pallas, 1771	-	-	4	-
<i>Calliptamus italicus</i> Linnaeus, 1758	-	-	-	-
<i>Oedipoda caerulea</i> Linnaeus, 1758	-	-	17	5
<i>Chorthippus biguttulus</i> Linnaeus, 1758	-	-	5	10
<i>Chorthippus macrocerus</i> Fischer de Waldheim, 1846	-	-	5	-
Locust larvae	-	-	-	9
<i>Ovocestus haemorrhoidalis</i> Charpentier, 1825	-	-	-	2

Tab.1. The relative abundance of terrestrial insects in the botanical garden of Vasył Stefanyk Precarpathian National University (2018, insects/100m²)

On the site near the pond and two experimental areas in forest, 68 insects/100m² of Ground beetle were found in June-July, in August-September the number of Ground beetles increased sharply – up to 330 insects/100m². 148 insects/100m² were found in the meadow-steppe plots (3 research areas) in June-July, and 237 insects/100m² in August-September. The increase in number of Ground beetle in the experimental territories in August-September can be explained by their mass reproduction and activation of their physiological processes.

The following species of Ground beetle were most abundant in the area near the pond and in two forest areas: *Amara aulica*, *Ophonus rufipes*, *Calathus ambiguus* and *Calathus erratus*. The following species of Ground beetle were not found at all in these research areas: *Harpalus amplucalis*, *Taphoxema gigas*, *Pterostichus macer*, *Amara equestris*, *Amara convexiuscula* and *Amara pastica*.

The following species of Ground beetle were the most common in the meadow-steppe areas: *Amara aulica*, *Amara bifrons*, *Amara equestris*, *Ophonus rufipes*, *Calathus ambiguus* and *Calathus erratus*. The following species of Ground beetle were not found at all in these research areas: *Amara ingenua*, *Ophonus azureus*, *Pterostichus punctulatus*, *Harpalus zabroides*, *Harpalus distinguendus*, *Harpalus rubripes*, *Cymindus angularis*, *Notiophilus palustris*, *Syntonus* sp., *Microlestes* sp. and larvae.

In the experimental plots, the number of Ground beetle, mostly of all species, was quite low, only in August-September, a mass appearance of *Calathus ambiguus*, *Calathus erratus* was observed in all experimental areas.

In the area near the pond and two experimental plots in forest, 92 insects/100m² Darkling beetle were found in June-July, in August-September the number of Darkling beetle decreased sharply – to 2 insects/100m². 86 insects/100m² were found in the meadow-steppe area (three research areas) in June-July, and 29 insects/100m² in August-September. The decrease in the number of Darkling beetle in the experimental areas in August-September can be explained by their mass destruction due to their ability to damage field plantings, because the country estate is located next to the botanical garden. The country estate and human settlements are located closer to experimental plots 1, 4 and 5, therefore, in these areas too, we observe a mass death of Darkling beetle in August-September.

The following Darkling beetle species were most abundant in the area near the pond and in two forest areas: *Blaps halophila*, *Opatrum sabulosum* and *Oodoscelis polita*. The following species of Darkling beetle: *Crypticus quisquilius*, *Pedinus femoralis* were not found at all in these research areas.

The most common species in the meadow-steppe areas were all species of Darkling beetle, which are common in the study area, except for *Crypticus quisquilius* and *Pedinus femoralis*.

In the experimental areas, the number of Darkling beetle, mostly of all species, was quite high in June-July, except for *Crypticus quisquilius* and *Pedinus femoralis*, which were observed only in the meadow-steppe areas of the botanical garden, and in August-September, a decrease in the number of Darkling beetle was observed in the experimental areas near the pond and in the plots in the forest, and in the meadow-steppe research plots of the botanical garden were quite common.

On the area near the pond and two experimental sites in forest, no one individual of the order Orthoptera was not found in June-July, in August-September their number was 35 insects/100m². In the meadow-steppe area (three research areas) 2 insects/100m² were found in June-July, and 26 insects/100m² in August-September. The increase in the number of representatives of the order Orthoptera can be explained by their massive reproduction and development during this period.

The following species order Orthoptera were most abundant in the area near the pond and in two forest areas: *Oedipoda caerulescens*, *Chorthippus biguttulus*, *Chorthippus macrocerus*. The following orthopteran species: *Calliptamus italicus*, locust larvae, and *Ovocestus haemorrhoidalis* were not found at all in these research areas.

The following species of Orthoptera were most abundant in the meadow-steppe areas: *Oedipoda caerulescens*, *Chorthippus biguttulus* and locust larvae. *Gryllulus desertus*, *Calliptamus italicus* and *Chorthippus macrocerus* were not found at all in the experimental areas.

In June-July, 14 insects/100m² of Hemiptera were found in the area near the pond and two experimental plots in forest, in August-September their number was 61 insects/100m². In the meadow-steppe area (three research areas) 8 insects/100m² were found in June-July, and in August-September

no bugs were found at all. This situation with the number of Hemiptera can be explained by the lack of fodder for young and adults in the meadow-steppe research areas.

The following species of Hemiptera were most abundant in the area near the pond and in two forest areas: *Emblethis verbasci*, *Emblethis griseus* and *Megalonotus chiragra*. *Dicranomerus agilis*, *Myodochidae* were not found at all in the experimental areas.

Emblethis verbasci was the most widespread in the meadow-steppe areas. The following species of Hemiptera: *Emblethis griseus*, *Emblethis denticollis* and *Megalonotus chiragra* were not found at all in these research areas.

The basis of the fauna of the botanical garden is widespread species (cosmopolitan, trans- and western Palearctic, trans- and western Eurasian, Scythian) – 88%.

In most cases, these are evrybiont species that are well adapted to life in agrocenoses and in urbanized areas; thus, the terrestrial insect fauna of the botanical garden has an appearance characteristic of human-disturbed areas. It has practically no species characteristic of virgin steppes.

The terrestrial insect fauna of the botanical garden is dominated by steppe and polyzonal species (57%), as well as a large share of field, steppe-field and meadow-field species (29%). The analysis of the abundance of field (evrybiont) and virgin species showed that quantitatively the basis of the fauna is field species.

The analysis of the trophic specialization of the insect fauna of the botanical garden showed that it contains representatives of 7 trophic groups:

- 1 – Phytosaprophages: *Blaps halophila*; *Opatrum sabulosum*;
- 2 – Phytophages: *Otiorhynchus ligustici*; *Eusomus ovulum* ;
- 3 – Phytophages: *Onthophagus semicornis*;
- 4 – Zoophages: *Cymindus angularis*; *Taphoxenus gigas*;
- 5 – Necrosaprophages: *Silpha obscura*;
- 6 – Zoosaprophages: *Taphoxenus gigas*;
- 7 – Zoophytophages: *Harpalus zabroides*; *Ophonus rufipes*.

56% of species are species with one or another degree of phytophagy, zoophagy is characteristic of 40% of species; pure phytophages make up 32% of species, pure zoophages 24%.

Predominance of phytophages is characteristic of agrocenoses and disturbed ecosystems.

We used four indexes for the assessment of the biodiversity of the insect fauna of the botanical garden: Shannon, Simpson, Menhinick and Berger-Parker. The following values were obtained, which are presented in Table 2.

Indexes	Biotopes			
	Areas 1, 4, 5		Areas 2, 3, 6	
	June	August	June	August
Shannon	2,4	2,2	3,5	1,9
Simpson	5,8	5,7	17,6	4,0
Menhinick	1,5	1,3	2,2	1,4
Berger-Parker	2,7	3,1	9,1	2,1

Tab.2. Biodiversity indices of entomofauna of the Botanical Garden of Vasyl Stefanyk Precarpathian National University

One trend can be clearly observed when analyzing the data – a decrease in the biodiversity of entomofauna in August; this is explained by the drying of biotopes at the end of summer, especially in 2018. If we compare the indices by biotopes, then in June biodiversity is much higher in the meadow areas of the botanical garden, and in August these indicators are slightly higher in the areas near the lake and in the forest part of the botanical garden, which can also be explained by environmental factors and their influence on terrestrial insect organisms.

4. CONCLUSIONS

The terrestrial entomofauna of the Botanical Garden is a highly degraded variant of the steppe entomofauna with a pronounced anthropogenic character.

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Микитин Тетяна, Долинко Неля, Белова Наталія, Кузенко Василь. Екологічні особливості фауни наземних комах ботанічного саду Прикарпатського національного університету імені Василя Стефаника. *Журнал Прикарпатського університету імені Василя Стефаника*, 8 (4) (2021), 52–60.

У 2018 році нами проведено дослідження фауни наземних комах Ботанічного саду Прикарпатського національного університету імені Василя Стефаника. Дослідження проводилися на шістьох дослідних ділянках: 3 пробні ділянки на території лучно-степового біотопу, 1 ділянка біля ставка та 2 ділянки на території лісової частини ботанічного саду.

В результаті встановлено проживання 54 видів наземних комах, серед яких переважають жуки з двох родин – Туруни і Чорнотілки ряду Твердокрилі або Жуки.

Основу фауни ботанічного саду становлять широко поширені види (космополіти, транс- і західнопалеарктичні, транс- і західноєвразійські, скіфські) – 88%; в більшості випадків це еврибіонтні види, які добре пристосовуються до життя в агроценозах і на урбанізованих територіях. У фауні наземних комах ботанічного саду переважають степові і полізональні види (57%), також велика частка польових, степово-польових і лучно-польових видів (29%).

Порівнюючи видовий склад комах на різних ділянках, можна відзначити, що на лучних територіях ботанічного саду (Ділянки 2, 3, 6) немає таких цілинних видів, як *Amara pastica*, *Pterostichus masei*, *Tarphoxenus gigas*, а на ділянках поблизу озера (Ділянка 1) і в лісовій частині ботанічного саду (Ділянки 4-5) немає польових видів *Pterostichus punctulatus*, *Harpalus zabroides*, *Harpalus distinguendus*, *Silpha obscura*; таким чином фауна лучних територій ботанічного саду ближча до цілинної степової, ніж фауна Ділянок 1, 4, 5.

56 % видів наземних комах ботанічного саду становлять види з тим або іншим ступенем фітофагії, зоофагія властива 40 % видів; чисті фітофаги становлять 32% видів, чисті зоофаги 24%. Переважання фітофагів характерно для агроценозів і порушених екосистем.

Простежується одна тенденція – зниження біорізноманіття ентомофауни в серпні; це пояснюється висушування біотопів в кінці літа, особливо в 2018 році. Якщо порівнювати індекси по біотопах, то в червні біорізноманіття значно вище на лучних територіях ботанічного саду, а в серпні ці показники трохи вищі на ділянках поблизу ставка і в лісовій частині ботанічного саду, що можна також пояснити екологічними факторами та їх впливом на організми наземних комах.

Ключові слова: комахи, фауна, ботанічний сад, індекси біорізноманіття, трофічна спеціалізація.