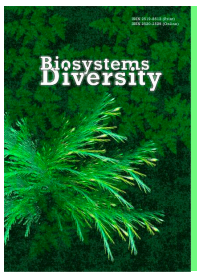

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Ecological and faunistic survey of the true bugs of the infraorder Pentatomomorpha (Hemiptera) in the urban cenoses of Kharkiv City (Ukraine)

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A total of 63 species of true bugs in 53 genera and 11 families of the infraorder Pentatomomorpha was recorded from the city of Kharkiv. For one species, *Carpocoris purpureipennis* (Pentatomidae), we obtained the first record from Left-Bank Ukraine. Formerly, this species was known from Western and Central Ukraine only. Four species of the family Lygaeidae (*Nysius ericae*, *Perithrechus geniculatus*, *P. gracilicornis*, *Taphropeltus contractus*) are new to Kharkiv Region. The families Lygaeidae (23 species of 19 genera, 38.3% of the total collected bugs), Pentatomidae (16 species of 14 genera, 26.7%), Rhopalidae (7 species of 5 genera, 11.7%), and Coreidae (6 species of 6 genera, about 3%) were the most rich in species and individual numbers. The families of Berytidae, Cydnidae and Scutelleridae were represented by two species each (3.3% out of the total collected bugs). Six species (*Myrmus miriformis*, *Lygaeus equestris*, *Scolopostethus pictus*, *Aelia acuminata*, *Graphosoma lineatum*, and *Pyrrhocoris apterus*) were abundant, eight species common, 14 species rare, and 32 species belonged to occasional elements of the urban cenoses. The true bug species composition and individual abundance were the highest in the suburban meadows and large city parks (44 and 27 species, respectively). By contrast, only seven species were registered in the green areas of the city centre (lawns, public gardens). Faunal similarity (Jaccard / Chekanovsky-Sørensen indices) of the true bug assemblages was the lowest when comparing public gardens of the city centre with the habitats of the suburbs and city parks (0.04–0.06 / 0.07–0.12), and the highest between the meadows and urban parks with glades and grassy vegetation under low recreational pressure (0.52 / 0.68). Jaccard similarity indices for the other six pairs of compared urban cenoses were low (0.1–0.42). The average Pentatomomorpha similarity in different urban cenoses was also low (Jaccard index 0.27, Chekanovsky-Sørensen index 0.39). The essential faunal differences can be explained by both the low number of most Pentatomomorpha species and their ecological peculiarities. The proportions of various ecological groups of bugs in different urban cenoses were analyzed and discussed. Major differences were observed in the species habitat distributions while the lesser differences concerned trophic groups and hygropreferences of most species. Hortobiont and herpetohortobiont polyphytophagous species dominated all the habitats.

Keywords: terrestrial bugs; species composition; faunal similarity; ecological groups; city parks; Kharkiv; Ukraine

Introduction

Hemipterans or true bugs (Hemiptera) account for about 40,000 described species in the world fauna (Schuh & Slater, 1995). One of the largest groups, the infraorder Pentatomomorpha, is represented by seven superfamilies. In the Palearctic, there are about 3,500 species in 750 genera and 23 families of this infraorder (Catalogue of the Heteroptera, 2001, 2004). In Ukraine, this group of true bugs is represented by 15 families, which include 350 species (Zhuravel, 2016; Putshkov & Putshkov, 1996). All the representatives of Pentatomomorpha lead a terrestrial way of life being an integral part of ecosystems of all types. Most species are typical phytophages, many of them are of practical importance as pests of various plants. On the other hand, a number of species have bioindication significance and can be used in the assessment of the state of ecosystems. Some representatives (species of the subfamily Asopinae, and/or the genus *Geocoris*) are predators, including those feeding on pests of many field crops. A significant number of papers has been devoted to the study of Pentatomomorpha, addressing a variety of questions, their morphology, faunistics, ecology, taxonomy and phylogeny (Dolling, 1981; Aldrich, 1988; Henry, 1997; Catalogue of the Heteroptera, 2001, 2006; Li et al., 2005; Musolin, 2007; Grazia et al., 2008; Hua et al., 2008; Park et al., 2011; Yao et al., 2012; Putchkov, 2013; Tembe et al., 2014; Ghahari et al., 2014; Kuzhuget, 2017).

In Ukraine, this group of insects in general has been studied quite well, which is reflected in a number of issues of "Fauna of Ukraine" (Putshkov, 1961, 1962, 1969, 1974). At the same time, in these (and other similar) works, ecological and faunal information on bugs is given exclusively for natural habitats of large geographic regions or various protected areas while only occasionally is fragmentary information (Brygadyrenko, 2016; Faly et al., 2016) devoted to transformed ecosystems (more often, agrocenoses). In conditions of megalopolises, very few such studies (unlike those for some other insects, for example beetles) have been carried out not only in Ukraine, but also in other countries of Europe and Asia. Each large city consists not only of high-rise areas and industrial enterprises, but also of green zones (parks, lawns, public gardens) and wastelands, which have characteristic features and differ from other transformed lands. Megalopolises have a green zone that hosts a peculiar and relatively rich entomofauna, where true bugs (including Pentatomomorpha) undoubtedly can be one of the most widespread groups of insects. However, even the taxonomic structure of bugs in urban habitats remains poorly known while the information on species autecology is absent at all. Only fragmentary information about the three species of Pentaomomorpha bugs collected in the parks of Kharkiv is available in some rather poorly informative papers (Dekhtyaryova, 2002).

Material and methods

The purpose of our research was to study the species composition, spatial (layer) distribution and ecological structure of all terrestrial bugs of the city of Kharkiv. This paper presents a preliminary analysis of the infraorder Pentatomomorpha while the data on other groups (mainly the

infraorder Cimicomorpha) is under laboratory processing. The material was collected with the use of a standard entomological net, Barber pitfall traps (0.2 liter plastic cups filled with 10% acetic acid solution), and hand collecting in the detritus (soil litter). At each study plot, at least 150 swipes with the net were taken and 10–20 traps were set. In addition, bugs were collected during excursions throughout the city by examining individual plants and trees. Insects were sampled at intervals of 10–15 days in May–October 2017 at the following plots: Peremoha Park, the gully "Sarzhin Yar", Kharkiv Forest Park (part of a large forest located in the city agglomeration), lawns, public gardens of the city centre (Pushkinskaya Street, the territory of H. N. Vysotsky Forestry and Agroforestry Research Institute) and peripheral districts of the city (territory of H. S. Skovoroda Kharkiv National Pedagogical University, Saltivka residential complex, and Zhuravlivskyi Hydropark).

To assess similarity of the bug species composition of the study plots, the Jaccard similarity index and in addition (for comparison) the Chekanovsky-Sørensen index were used. According to the abundance level (out of 1,800 collected individuals), four groups of species were distinguished: abundant (more than 5% out of the total number of bugs), common (1–5%), rare (0.2–1%) and single (from one to three individuals).

Classification of the infraorder follows the catalogues of bugs of the Palearctic (Catalogue of the Heteroptera, 2001, 2004). Characteristics of the ecological structure (by imago) and species distributions within Ukraine is based on literature data (Putshkov, 1961, 1962, 1969, 1974; Putshkov & Putshkov, 1996). It should be mentioned that the data obtained during our study is preliminary and will be extended in the course of further research.

The "Peremoha Park" (45 hectares) is located in the eastern part of Kharkiv (Moscow District). It was founded in 1985 on the land of former collective gardens. The dendroflora is represented by 30 species with a predominance of Rosaceae. The park-forming species are *Populus bolleana* Lauche, *Cornus sanguinea* L., *Malus sylvestris* (L.) Mill., *Rosa canina* L., and *Pyrus communis* L. There are also species from the family Pinaceae (*Picea pungens* Engelm., *P. abies* (L.) H. Karst., *P. orientalis* (L.) Link.). Asteraceae (*Ambrosia artemisiifolia* L., *Artemisia austriaca* Jacq., *Achillea millefolium* L.) prevail in the herbaceous layer; Poaceae are presented by numerous *Dactylis glomerata* L., *Anisantha tectorum* (L.) Nevski, and *Elymus repens* (L.) Gould.

"Sarzhin Yar", a gully 12 km in length with gentle slopes, is a Monument of Nature of Local Importance. It is located in the Shevchenko district of Kharkiv being a favourite place of active recreation of the townspeople. The main park-forming tree species are *Tilia*, *Pinus*, *Morus nigra*, *Fraxinus excelsior* and others.

Kharkiv Forest Park (about 2,000 hectares) is located in the northwest of the city. It is mostly covered by a thickened natural oak forest cut by ravines, small glades and clearcuttings. The most common tree species is *Quercus robur*, with *Acer platanoides*, *Pinus sylvestris*, *Picea abies*, *Tilia cordata* as the second-rank components. The undergrowth is sparse, and the grassy vegetation is heavily impoverished.

A study plot in the city center is a botanical Monument of Nature of Local Importance «Instytutskyi» (Pushkinska st., the territory of H. N. Vysotsky Forestry and Agroforestry Research Institute). It is a decorative lawn with shrubs and trees. A number of alien species are planted here: *Picea abies* (L.) H. Karst., *Picea pungens* Engelm., *Abies concolor* (Gordon) Lindley ex Hildebrand, *Pseudotsuga menziesii* (Mirb.) Franco, (Pinaceae), *Juniperus virginiana* L. (Cupressaceae), *Juglans ailantifolia* Carr. (Juglandaceae), *Corylus colurna* L. (Betulaceae), *Eucommia ulmoides* Oliv. (Eucommiaceae). The herbaceous layer is represented by early spring flowering plants like *Ficaria verna* Huds. (Ranunculaceae), some species from the genera *Viola* and *Soridalis*.

The peripheral territory of Kharkiv includes public gardens and lawns in various districts. They are characterized by a combination of both ornamental and cultivated (fruit) plants. These are *Prunus armeniaca* L., *P. domestica* L., *P. spinosa* L., *Cerasus vulgaris* Mill., *Pyrus communis* L., *Rosa canina* L., *Padus avium* Mill., *Spiraea media* F. Schmidt, *Cotoneaster melanocarpus* Fisch. ex Blytt. However, ornamental plants dominate in the vegetation structure.

Meadow plots were located in the Zhuravlivskyi Hydropark (189 hectares), between Shevchenko and Akademika Barabashova streets in the northeastern part of Kharkiv (Kiev District) in the floodplain of the Kharkiv River. On the river banks, there are weeping willows, scattered planted groups of birches, pines and larch. Most of the territory is occupied by floodplain meadows. In the park, there is a section of pine forest of anthropogenic origin, in which the numerous *Pinus sylvestris* L. form the first tree layer while single specimens of *Robinia pseudoacacia* L., *Prunus armeniaca* L., *Pyrus communis* L., *Acer negundo* L. occur in the undergrowth. There are a few shrubs such as *Rubus idaeus* L. and *Rosa canina* L. The out-of-layer vegetation is represented by *Humulus lupulus* L. Xerophilous species of Asteraceae (*Achillea millefolium* L., *Tanacetum vulgare* L., *Ambrosia artemisiifolia* L., *Artemisia austriaca* Jacq., *Hieracium umbellatum* L., *Erigeron canadensis* L.) predominate in the herbaceous layer. The other dominants of the herbaceous layer belong to four families. The Brassicaceae are represented by *Berteroa incana* (L.) DC., the Fabaceae by *Medicago falcata* L., the Polygonaceae by *Polygonum aviculare* L., and the Poaceae by *Pennisetum setaceum* (Forssk.) Chiov., *Elymus repens* (L.) Gould. There are Asteraceae species at low abundance such as *Hieracium pilosella* L., *Artemisia absinthium* L., *Cichorium intybus* L., Caryophyllaceae (*Silene latifolia* Poir.), Convolvulaceae (*Convolvulus arvensis* L.), Plantaginaceae (*Linaria vulgaris* Mill., *Plantago major* L). Such species as *Solidago canadensis* L., *Taraxacum officinale* (L.) Weber ex FH Wigg, *Helichrysum arenarium* (L.) Moench (Asteraceae), *Solanum nigrum* L. (Solanaceae), *Hypericum perforatum* L. (Hypericaceae), *Echium vulgare* L. (Boraginaceae), *Falcaria vulgaris* Bernh. (Apiaceae) were recorded as singletons.

The territory of H. S. Skovoroda Kharkiv National Pedagogical University (KhNPU) is located on alluvial sands. Here, ornamental plants are cultivated on the plots with natural vegetation. At the studied plots, there are single young specimens of woody plants like *Prunus armeniaca* L. (Rosaceae), *Acer negundo* L. (Sapindaceae), *Pinus nigra pallasiana* (Lamb.) Holmboe and *Picea abies* (L.) H. Karst. (Pinaceae). The herbaceous layer is dominated by *Achillea millefolium* L., *Hieracium umbellatum* L., *Ambrosia artemisiifolia* L., *Tanacetum vulgare* L., *Artemisia austriaca* Jacq. (Asteraceae), *Berteroa incana* (L.) DC. (Brassicaceae), *Medicago falcata* L. (Fabaceae), *Pennisetum setaceum* (Forssk.) Chiov., and *Elymus repens* (L.) Gould (Poaceae). To a lesser extent, this layer is formed by *Achillea nobilis* L., *Hieracium pilosella* L., *Cichorium intybus* L., *Artemisia absinthium* L., *Artemisia marschalliana* Spreng., *Solidago canadensis* L., *Taraxacum officinale* (L.) Weber ex F. H. Wigg (Asteraceae), *Falcaria vulgaris* Bernh. (Apiaceae), *Echium vulgare* L. (Boraginaceae), *Convolvulus arvensis* L. (Convolvulaceae), *Saponaria officinalis* L. (Caryophyllaceae), *Trifolium arvense* L. (Fabaceae) and *Cynodon dactylon* (L.) Pers. (Poaceae).

Results and discussion

In the course of our research, 60 true bug species of 50 genera and 9 families of the infraorder Pentatomomorpha were registered in the urban cenoses of Kharkiv. Together with some species recorded previously in Kharkiv (Dekhtyaryova, 2002; Putchkov, 2013), the total number of taxa is 63 species of 53 genera and 11 families (Table 1). According to the preliminary assessment, this amounts to about 60% of the total hemipterofauna of the urban cenoses of Kharkiv at the species level.

Carpocoris purpureipennis (family Pentatomidae) was recorded for the first time for Left-bank Ukraine. Formerly, it had been mainly known from Western Ukraine, and from some regions of central Right-Bank Ukraine (Cherkassy Region) (Putshkov & Putshkov, 1996). Four species of the family Lygaeidae (*Nysius ericae*, *Perithrechus geniculatus*, *P. gracilicornis*, and *Taphropeltus contractus*) turned out to be new to Kharkiv Region. In Ukraine, they are widely distributed while in the areas neighboring Kharkiv they were recorded only from Poltava, Donetsk and Lugansk regions.

Significant differences were revealed in qualitative and quantitative characteristics of the true bug families which depended on the type of urban cenoses. Besides, it is worth mentioning, that comparison of individual species abundance when the data were obtained by different sampling methods is quite complicated. Therefore, the classification of families and species according to their occurrence (abundance) presen-

ted in this paper is relative, since it is based on the averaged data on all hemipterans collected by various sampling methods.

In terms of taxonomic composition, the family Lygaeidae was the richest (23 species of 19 genera). On the level of individual abundance, it made up 38.3% of all collected Pentatomomorpha (Table 1). Of these, only two species (*Scolopostethus pictus* and *Lygaeus equestris*) were numerous; they dominated in the public gardens and city lawns (7.77–8.99% of the total number of bugs). Such habitats (high insolation, sparse vegetation, periodic irrigation) largely correspond to the ecological characteristics of these species (Putshkov, 1969). There were five relatively common species (1–5%) in almost all study plots (except for the Forest Park and wastelands) (Table 1), but their occurrence at each separate plot was still low.

The shield-bugs (Pentatomidae) proved to be well represented in both species and numbers. A total of 16 species of 14 genera was recorded, which amounted to 26.7% of the Pentatomomorpha abundance (Table 1). In most city parks and public gardens (but not in the city centre), there were only two numerous generalist polyphagous species, *Aelia acuminata* and *Graphosoma lineatum* (7.33–13.45%). Other common shield-bug species (6–7) were recorded from most of the parks, public gardens of the urban outskirts, as well as on the meadows along the Kharkiv River, but they were absent or rarely found in the city centre and in the Forest Park (except for the habitat generalist *Dolycoris baccarum*).

The family of rhopalid bugs (Rhopalidae) is represented by seven species of five genera (11.7% of the abundance). Only *Myrmus miriformis* was abundant in the forb grass vegetation of Peremoha Park and common in some public gardens and wastelands (Table 1). The other species (except for a single record of *Corizus hyoscyami*) were rare (0.2–1.0% of the total abundance) in most urban cenoses (except for the city centre).

Among the leaf-footed bugs (Coreidae), six species of six genera (10% of the total bag abundance) were registered; *Bathysolen nubilus* (public gardens and lawns on the outskirts) and *Coreus marginatus* (almost all urban ecosystems, except the Forest Park) were classified as common. There was an interesting record of the North American invasive species *Leptoglossus occidentalis* in the Kharkiv Botanical Garden, a pest of conifers (Putchkov, 2013). Its abundance was low, but it was constantly sampled in this locality.

The Berytidae and Scutelleridae families were represented by two species each (up to 3.30%) rarely found in individual urban cenoses (Table 1). A synanthropic species *Pyrrhocoris apterus* (Pyrrocoridae) was classified as abundant. Despite the fact that its mean ratio in the general collection reached only 5.07%, it was registered as a single dominant at various study plots throughout the city. Sporadically common (in some cenoses) were the species *Tritomegas sexmaculatus* (Cydnidae) and *Alydus calcaratus* (Alydidae), whose total abundance reached 0.94–3.58%. *Coptosoma scutellatum* (Plataspidae) and *Thyreocoris scarabaeoides* (Thyreocoridae) previously recorded from Kharkiv parks (Dekhtyaryova, 2002), were not found in our collection of 2017. However, a preliminary analysis of the collection of 2018 showed that these species were common inhabitants of most urban cenoses.

The ecological structure of the hemipterofauna of Kharkiv is also specific due to variable conditions of the urban cenoses (tree and shrub associations, lawns, public gardens, meadows, etc.).

In terms of habitat preferences (Table 1), most Hemiptera species are represented by the meadow group in the broad sense (inhabitants not only of typical meadowsbut of steppe-like or sparse meadow-shrub plots as well). In total, about 20 species of this group are registered, among which half are common at some plots. The typical representatives of this group are *Alydus calcaratus*, *Nysius ericae*, *Neottiglossa leporina*, *Myrmus miriformis*, and most species of the genus *Stictopleurus*. Generalist species (eurybionts and/or inhabitants of fields and weed vegetation) registered in most urban cenoses are also numerous in other transformed ecosystems and many natural habitats as well; but in general they prefer open habitats. In total, 14 species of this group were recorded, with the prevalence of Pentatomidae, Rhopalidae; *Coreus marginatus* and *Pyrrhocoris apterus* (Table 1). The forest group (with the subgroups of forest-meadow and forest-steppe elements) is represented by 19 species. Among them, five species (*Tritomegas sexmaculatus*, *Kleidocerys resedae*, *Perithrechus geniculatus*, *Rhyparochromus vulgaris*, *Pentatoma rufipes*) were found to be common or abundant in some tree plantations. The representatives of the steppe (*Eurygaster integriceps*, some Rhopalidae) and floodplain (*Eurygaster testudinarius*) groups were rare or single (Myrkasimova, 2017).

An analysis of the hemipterofauna based on the species hygropreference (Table 1) showed prevalence of the broad mesophiles in the urban cenoses of Kharkiv. They are represented by 36 species, half of which are classified as dominants or subdominants, which made up almost 90% of the abundance of the entire group. Relative mesoxerophiles include 22 mostly rare species. Among them, only four species (*Alydus calcaratus*, *Bathysolen nubilus*, *Nysius ericae*, *Stictopleurus abutilon*) were sporadically common at some plots. There were two mesohygrophiles (*Scolopostethus affinis*, *Eurygaster testudinarius*) found as singletons.

According to the trophic preference, all Pentatomomorpha species belong to phytophages of different specializations. The collected true bug species were conventionally divided into two large groups – polyphytophages and oligophytophages. Thirty-nine species are polyphytophages (of these, 6 were abundant and 5 common) while 22 species (including one abundant and two common) are to oligophytophages (Table 1). Only one monophage was found, *Heterogaster urticae*, which feeds on nettles.

According to preferred habitat layer, the collected true bugs were referred to four main groups and several transitional subgroups (Table 1). The hortobionts, 25 species (Coreidae, Lygaeidae, Rhopalidae, Scutelleridae, and most Pentatomidae) and herpetohortobionts, 23 species (most of Berytidae, Lygaeidae, some Coreidae and Cydnidae) dominated in both taxonomic composition and abundance. Two collected species belonged to geobionts (*Legnotus limbosus*, rare, and *Thyreocoris scarabaeoides*, common) and one species (*Sciocoris cursistans*) to herpetobionts. The typical dendrobionts were represented by two species rare in the urban ecosystems (*Kleidocerys resedae* and *Rhaphigaster nebulosa*). The transitional groups included *Lygaeus equestris* (hortotamnobiont dominating most cenoses) and *Pyrrhocoris apterus* (herpetodendrobiont). *Alydus calcaratus*, *Palomena prasina* (horotamnobionts), and *Dolycoris baccarum* (hortodendrobiont) were sporadically common in some habitats. The herpetotamnobiont *Rhyparochromus vulgaris* was rare while the tamnodendrobiont *Gonocerus acuteangulatus* is considered as occasional. An analysis based on above-mentioned qualitative, quantitative and ecological characteristics of the Pentatomomorph bugs made it possible to identify certain differences in the structure of hemipterofauna of various urbanized plots.

The largest number of species (44, of these 16 were dominants and subdominants) was recorded from the green zone of the city outskirts. Such a high diversity (about 90% of the total hemipterofauna), apparently, is explained by the larger number of examined plots (public gardens, lawns, isolated wastelands and sparse woody biotopes with low disturbance level), especially in the territory of KhNPU (areas of the botanical garden). Generalist and meadow (in the broad sense) hortobiont mesophiles mainly from the families Pentatomidae and Rhopalidae (about 10 species) were dominants. In addition, the largest number of representatives of the Lygaeidae family was recorded here (but only two were numerous, *Scolopostethus pictus* and *Lygaeus equestris*).

In the parks adjacent to large residential areas and industrial enterprises, which are subject to significant recreational pressure, true bug species diversity is lower. In the Peremoha Park and the "Sarzhin Yar", 27 species were registered (41.2%), nine of them dominated. Most species belonged to the shield-bugs (Pentatomidae) and only a few to the families Alydidae (*A. calcaratus*), Coreidae (*C. marginatus*), Pyrrhocoridae (*P. apterus*), and Rhopalidae (*M. miriformis*). Most of them were represented by generalist hortobiont mesophiles, although hortodendro- and hortotamnobionts (*Dolycoris baccarum*, *Palomena prasina*), forest dendrotamnobiont (*Pentatoma rufipes*), and herpetohortobiont-dendrobionts (some lygaeids of genera *Rhyparochromus*, and *Kleidocerys resedae*) were also found. Typical meadow and meadow-steppe species were less common there while forest-meadow and shrub-meadow species appeared (*Piezodorus lineatus*, *Stictopleurus punctatonervosus*, and many lygaeids).

Table 1
The taxonomic structure, ecological and quantitative characteristics of the Pentatomomorpha bugs of the main urban areas of Kharkiv City

Families, genera, species		Ecological and quantitative characteristics			Occurrence in urban cenoses (in points)				
		Habitat preference / Trophic guild	Habitat layer / Hygropreference	Relative abundance, %	City parks	Public gardens and lawns of suburbs	Public gardens and lawns of the city centre	Kharkiv Forest Park	Meadows along the Kharkiv River
Alydidae	*Alydus calcaratus* (Linnaeus, 1758)	MD-SP/OPH	HTB/MX	3.58	3	2	–	1	2
Berytidae	*Berytinus clavipes* (Fabricius, 1775)	MD-FS/OPH	HCB/MX	0.17	–	2	–	–	–
	Neides tipularius (Linnaeus, 1758)	MD-FS/OPH	HCB/MX	0.06	–	1	–	–	–
Coreidae	*Bathysolen nubilus* (Fallén, 1807)	MD/OPH	HCB/MX	0.39	–	2	–	–	–
	Ceraleptus gracilicornis (Herrich-Schäffer, 1835)	F/OPH	CHB/MPH	0.06	–	1	–	–	–
	Coreus marginatus (Linnaeus, 1758)	PT/PPH	CHB/MPH	2.26	3	1	–	1	2
	Coriomeris denticulatus (Scopoli, 1763)	FS-MD/OPH	CHB/MPH	0.06	–	1	–	–	–
	Gonocerus acuteangulatus (Goeze, 1778)	FS/PPH	TDB/MX	0.06	–	–	–	1	–
	Leptoglossus occidentalis Heidemann, 1910*	FS/PPH	DB/MPH	Marked as invasive species (Putchkov. 2013)					
	Syromastus rhombeus (Linnaeus, 1767)	PT-SP/PPH	HCB/MX	0.06	–	1	–	–	–
Cydnidae	*Legnotus limbosus* (Geoffroy, 1785)	FS-MD/OPH	HB/MX	0.17	2	–	–	–	–
	Tritomegas sexmaculatus (Rambur, 1839)	FS-MD/OPH	HCB/MPH	0.94	2	2	–	2	2
Lygaeidae	*Beosus maritimus* (Scopoli, 1763)	FS-MD/PPH	HCB/MPH	0.11	–	1	–	–	–
	Drymus sylvaticus (Fabricius, 1775)	FS-MD/PPH	HCB/MPH	0.11	–	–	1	–	–
	Emblethis griseus (Wolff, 1800)	FS-MD/PPH	HCB/MX	0.11	–	–	–	1	–
	Ischnodemus sabuleti (Fallen, 1826)	FS-MD/PPH	CHB/MPH	0.11	–	–	–	1	–
	Heterogaster urticae (Fabricius, 1775)	FS-MD/OPH	HCB/MPH	0.06	–	–	–	1	–
	Kleidocerys resedae (Panzer, 1797)	FS/OPH	DB/MPH	0.44	1	1	2	–	–
	Lygaeus equestris (Linnaeus, 1758)	PT/PPH	HTB/MPH	8.99	1	4	–	–	1
	Megalonotus chiragra (Fabricius, 1794)	MD-SP/PPH	HCB/MX	0.22	–	1	2	–	–
	Nysius ericae (Schilling, 1829)	PT/PPH	HCB/MPH	5.13	–	4	–	–	–
	N. helveticus (Herrich-Schäffer, 1850)	MD-SP/PPH	HCB/MX	0.17	1	1	–	–	–
	Ortholomus punctipennis (Herrich-Schäffer, 1838)	MD-SP/PPH	HCB/MX	0.17	–	2	–	–	–
	Oxycarenus pallens (Herrich-Schäffer, 1850)	MD-CT/PPH	HCB/MX	0.06	–	1	–	–	–
	Perithrechus geniculatus (Hahn, 1832)	FS-MD/PPH	HCB/MX	0.22	–	1	–	1	–
	P. gracilicornis Puton, 1877	SP/OPH	HCB/MX	0.11	–	1	–	1	–
	Platyplax salviae (Schilling, 1829)	FS-SP/OPH	CHB/MPH	0.17	–	2	–	–	–
	Pterotmetus staphyliniformis (Schilling, 1829)	MD/OPH	HCB/MX	0.06	–	1	–	–	–
	Raglius alboacuminatus (Goeze, 1778)	MD-FS/PPH	HCB/MPH	0.11	–	–	1	1	–
	Rhyparochromus pini (Linnaeus, 1758)	FS-MD/PPH	HCB/MPH	0.17	1	1	–	–	1
	Rh. vulgaris (Schilling, 1829)	FS/PPH	HTB/MPH	0.44	1	1	–	1	1
	Scolopostethus affinis (Schilling, 1829)	MD/PPH	HCB/MG	0.17	–	–	2	–	–
	S. pictus (Schilling, 1829)	MD/PPH	HCB/MPH	7.77	–	2	4	1	–
	Taphropeltus contractus (Herrich-Schäffer, 1835)	FS-MD/PPH	HCB/MPH	0.66	–	1	–	–	–
	Xanthochilus quadratus (Fabricius & J. C., 1798)	SP/PPH	HCB/MX	0.11	–	–	–	–	1
Pentatomidae	*Aelia acuminata* (Linnaeus, 1758)	PT/PPH	CHB/MPH	7.33	3	3	–	2	2
	Ae. rostrata Boheman, 1852	SP/OPH	CHB/MX	0.06	–	1	–	–	–
	Carpocoris purpureipennis (De Geer, 1773)	MD/PPH	CHB/MPH	3.64	4	3	–	1	3
	Dolycoris baccarum (Linnaeus, 1758)	PT/PPH	CHDB/MPH	1.93	2	1	–	2	2
	Eurydema oleracea (Linnaeus, 1758)	PT/OPH	CHB/MPH	1.05	2	1	–	–	2
	Eu. ornata (Linnaeus, 1758)	PT/OPH	CHB/MX	0.39	2	–	–	–	–
	Eysarcoris aeneus (Scopoli, 1763)	PT/PPH	CHB/MPH	0.06	–	1	–	–	–
	Graphosoma lineatum (Linnaeus, 1758)	PT/OPH	CHB/MPH	13.45	4	1	–	1	3
	Neottiglossa leporina (Herrich-Schäffer, 1830)	MD-SP/PPH	CHB/MPH	3.97	3	3	–	1	2
	Palomena prasina (Linnaeus, 1761)	PT/PPH	CHTB/MPH	0.88	2	2	1	–	1
	Pentatoma rufipes (Linnaeus, 1758)	FS/PPH	DTB/MPH	0.06	–	1	–	–	–
	Piezodorus lituratus (Fabricius, 1794)	KC-MD/PPH	CHB/MPH	0.77	–	2	–	2	–
	Peribalus strictus (Fabricius, 1803)	FS/PPH	CHB/MPH	0.17	1	–	–	1	–
	Rhaphigaster nebulosa (Poda 1761)	FS/OPH	DB/MPH	0.50	1	–	–	2	–
	Rubiconia intermedia (Wolff, 1811)	MD/PPH	CHB/MPH	0.06	1	–	–	–	–
	Sciocoris cursitans (Fabricius, 1794)	FS-SP/PPH	GB/MX	0.06	1	–	–	–	–
Plataspidae	*Coptosoma scutellatum* (Geoffroy, 1785)*	FS-MD/PPH	CHB/MPH	Recorded from some Kharkiv parks (Dekhtyaryova. 2002)					
Pyrrhocoridae	*Pyrrhocoris apterus* (Linnaeus, 1758)	PT/PPH	HDB/MPH	5.07	2	1	–	2	1
Rhopalidae	*Brachycarenus tigrinus* (Schilling, 1829)	PT/PPH	CHB/MPH	0.83	–	2	–	1	–
	Corizus hyoscyami (Linnaeus, 1758)	PT/PPH	CHB/MPH	0.06	–	–	–	1	–
	Myrmus miriformis (Fallén, 1807)	MD-SP/PPH	CHB/MPH	22.33	4	3	–	2	3
	Rhopalus parumpunctatus Schilling, 1829	SP/-MD/PPH	CHB/MPH	0.44	1	1	–	2	–
	Stictopleurus abutilon (Rossi, 1790)	SP/-MD/OPH	CHB/MX	0.28	1	2	–	–	–
	S. crassicornis (Linnaeus, 1758)	MD/PPH	CHB/MPH	0.94	–	1	–	2	–
	S. punctatonervosus (Goeze, 1778)	KC-MD/PPH	CHB/MX	2.76	1	2	–	2	3
Scutelleridae	*Eurygaster integriceps* Puton, 1881	SP/OPH	CHB/MX	0.06	–	–	–	1	–
	E. testudinarius (Geoffroy, 1785)	F-MD/OPH	CHB/MG	0.11	1	1	–	–	–
Thyreocoridae	*Thyreocoris scarabaeoides* (Linnaeus, 1758)*	FS-SP/OPH	CHB/MPH	Recorded from Kharkiv parks (Dekhtyaryova. 2002) , which was proved by our findings in 2018.					
Total number of families/species					8/27	9/44	2/7	8/28	7/16

Notes: habitat preferences: PT – polytopic, FS – forest, MD – meadow, SP – steppe, F-MD – floodplain meadow, FS-MD – forest-meadow, FS-SP – forest-steppe, MD-FS – meadow-forest, MD-SP – meadow-steppe, SP-MD – steppe-meadow, SHB-MD – shrub-meadow; habitat layers: PB – polybiont, HB – herpetobiont, DB – dendrobiont, CHB – hortobiont, HTB – hortotamnobiont, GB – geobiont, HCHB – herpetohortobiont; HDB – herpetodendrobiont; HTB – herpetotamnobiont, DTB – dendrotamnobiont, TDB – tamnodendrobiont; trophic guilds: OPH – oligophytophage, PPH – polyphytophage; hygropreference: MPH – mesophiles, MX – mesoxerophiles, MG – mesohygrophiles; relative abundance in points: 4 – abundant, 3 – common, 2 – rare, 1 – single; for the point gradation, see Material and methods; * – literature-derived records.

Table 2
Similarity of the Hemiptera species composition of the urban areas of Kharkiv (Jaccard / Chekanovsky-Sørensen indices)

Urban cenoses	City parks	Public gardens and lawns of the outskirts	Public gardens and lawns of the city centre	Kharkiv Forest Park	Meadows along the Kharkiv River
City parks	–	0.42	0.06	0.41	0.52
Public gardens and lawns of the outskirts	0.59	–	0.09	0.38	0.33
Public gardens and lawns of the city centre	0.12	0.16	–	0.07	0.04
Kharkiv Forest Park	0.58	0.55	0.13	–	0.36
Meadows along the Kharkiv River	0.68	0.50	0.07	0.53	–
Average value = 0.27 / 0.39					
Coefficient of variation C_v = 64% / 58%					

In Kharkiv Forest Park, 25 species were recorded, but only five of them were classified as abundant and/or common (Table 1). The generalist broad mesophilous elements predominated (mainly the herpetodendrobiont *Pyrrhocoris apterus* and the hortobionts of the families Pentatomidae and Rhopalidae). This fact may indicate unfavourable conditions (deep shade, extremely sparse herbaceous vegetation, trophic factors) for species with lower ecological flexibility.

The hemipterofauna of certain urban cenoses in the city centre was the most impoverished. In total, there were seven species registered and only two of them can be termed as dominants. *Pyrrhocoris apterus* was found quite often in many areas (streets, public gardens, side streets) while *Scolopostethus pictus* was concentrated only in a small, relatively wet area of the Research Institute for Forestry and Agroforestry in the shade of tree crowns.

Differences in the qualitative and quantitative characteristics of the true bug species composition at the study plots resulted in significant differences in their faunal similarities (Table 2). Thus, the Jaccard / Chekanovsky-Sørensen indices ranged from 0.04 / 0.07 to 0.52 / 0.68 (with an average value of only 0.27 / 0.39). The smallest similarity is observed between public gardens and lawns of the city centre and meadows along the Kharkiv River (0.04 / 0.07) and city parks (0.06 / 0.12). The maximum similarity indices were obtained when comparing hemipterofauna of the inessentially transformed territories like meadows and city parks (0.52 / 0.68). Interesting is the middle level of similarity (0.33 / 0.50) between the meadows along the Kharkiv River and the public gardens and lawns of the center, despite the fact that they are largely different in tree species composition and in the characteristics of surrounding plots. For the six pairs of other plots, the Jaccard index turned out to be quite low (from 0.09 to 0.42). At the same time, the average value of Jaccard index variation (64%) can indicate significant differences in the composition of hemipterofauna of the examined plots. All the above may mean a weak association of particular bug species with certain urban biotopes.

Conclusions

During our primary researches, 60 species of true bugs of 50 genera and 9 families of the Pentatomomorpha infraorder were registered in the urban cenoses of Kharkiv City. Together with the literature records, the total number of taxa currently accounts for 63 species of 47 genera and 11 families.

The families Lygaeidae and Pentatomidae were the most species-rich (23 species from 19 genera (38.3%) and 16 species from 14 genera (26.7%), respectively). The family Rhopalidae included seven species of five genera (11.7%). The true bug species composition and abundance were higher in the peripheral districts of the city (territory of H. S. Skovoroda Kharkiv National Pedagogical University and the residential area), where 44 species were registered. In the large recreational parks (Peremoha, "Sarzhin Yar"), 27 species were recorded; in the Forest Park, there were 25 species found. In the other territories, the number of species did not exceed 20.

Based on the total number of captured individuals, only six species can be classified as abundant (but only in individual urban cenoses): *Myrmus miriformis*, *Lygaeus equestris*, *Scolopostethus pictus*, *Aelia acuminata*, *Graphosoma lineatum*, *Pyrrhocoris apterus*. Eight species were common, 14 rare, and 32 single. The occurrence of dominant and subdominant species in various urban cenoses resulted from both differences in the food plant bases and microclimatic conditions corresponding to the ecological characteristics of a certain taxon.

The faunal similarity on average was low (0.27 by the Jaccard index and 0.39 by the Chekanovsky-Sørensen index). The indices turned out to be slightly higher (0.33 / 0.50 – 0.52 / 0.68) for inessentially transformed territories (meadows along the Kharkiv River and city parks), but very low for typical public gardens and lawns of the city centre (0.04 / 0.07 – 0.09 / 0.16) when compared with parklands.

Each park was dominated by generalist species (14), followed by the forest-meadow (10 species), meadow-steppe, forest, and the meadow species (7 species each). Steppe (4), steppe-meadow, shrub-meadow (2 species each) and the only floodplain-meadow species were relatively rare. Almost all of them were represented by broad mesophiles.

In terms of trophic specialization, 39 species were to polyphytophages (18 of the family Lygaeidae and 11 of the Pentatomidae) and 21 species oligophytophages.

According to their distribution in habitat layers, the collected bugs were referred to four main groups, hortobionts (25 species) and herpehochortobionts (23 species) dominating in taxonomic composition and abundance. Ten species were dominants and/or subdominants. Most geobionts, dendrobionts (2 species), and herpetobionts (1) were classified as rare (sometimes common) species. Some representatives of the transitional groups were subdominants in certain biotopes (*Lygaeus equestris* and *Palomena prasina*, hortotamionbionts; *Pyrrhocoris apterus*, herpetodenendrobiont; *Dolycoris baccarum*, hortodendrobiont).

The presented ecological and faunistic study of the true bugs of the urbanized areas of Kharkiv is preliminary in nature. Later, these studies will be continued and expanded. We are planning to provide a comprehensive assessment of the heteropterofauna, analyze the specificity of its formation and clarify the nature of seasonal changes in the dominant species abundance in transformed cenoses.

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