

Urban ornamental plants for sustenance of wild bees (Hymenoptera, Apoidea)

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Abstract

The aim of our study was to assess the attraction and value of flowering plants at green areas in support and sustenance of wild bees (Hymenoptera, Apoidea) populations in Kyiv. Study objects were the most common flowering ornamental plants of the city and the wild bees visiting their inflorescence during the vegetation season to collect pollen and feed on nectar. The study was conducted at 16 areas of observation and material collection, which include urban parks, M.M. Gryshko National Botanical Garden, green spaces of residential areas, roadsides, etc. Insects were collected following the standard method of catching individual specimens during the spring and summer periods of 2012–2018. Based on the observations, we visualized trophic relations of bees with plants and calculated the biodiversity index of visiting insects for plants. The blossom periods were analyzed using phenological data. Examination of urban green areas revealed ornamental plants that were the most attractive for bees, including more than 35 taxa of 20 families of trees, shrubs, and grassy plants. Bees are superiorly attracted to plants of the genera *Rudbeckia*, *Sedum*, *Gypsophila*, *Cerasus*, *Tagetes*, *Spiraea*, *Lonicera*, and *Aesculus*. There is a succession of plant flowering during spring-summer season, which must be considered while planting of greenery. Certain plant species attract insects at each blossom period, for example, *Prunus*, *Rhododendron*, *Crataegus*, *Aesculus* in spring, most of Asteraceae – in summer. The diversity of blossoming plants is significantly lower at the end of summer and beginning of fall, coinciding with the decreasing flight activity of wild bees. Overall, the studied ornamental plants attract not only the most common species of wild bees but also highly specific and rare species such as *Bombus argillaceus* and *Xylocopa valga*, protected by the Red Data Book of Ukraine. We found that blossoming green areas made up of trees, shrubs, and herbs are essential for feeding many species of wild bees and sustaining their populations in urban conditions.

Keywords: ornamental plants, wild bees, urban conditions

Introduction

The urban environment becomes increasingly important to the sustenance of biodiversity, which is critically endangered by the combined effects of intensive agriculture, agrotechnical measures, and use of pesticides (Chiesura, 2004; Winfree et al., 2009; Dearborn & Kark, 2010; Sanderson & Huron, 2011). The humankind is now facing

the problem of extinction and rapid decline of pollinator populations (Potts et al., 2010), including the wild bees (Hymenoptera, Apoidea). Those insects are considered the best pollinators because they pollinate almost 80% of flowering plants (Klein et al., 2007; Smitley, 2018).

Botanical gardens, parks, and garden squares are especially significant for the preservation of biodiversity (Hammitt, 2002;

Mexia et al., 2018). For many plants, there are conditions to grow *ex situ* in botanical gardens and parks. The general composition of green areas of Kyiv, their protective and purifying functions, esthetic value and conservation significance were described in numerous publications (Cherevchenko et al., 1999; Cherevchenko & Kuznetsov, 2003; Rubtsova, 2006; Doyko, 2012; Klymenko, 2012; Hatalaska & Kryvenko, 2012; Rogovskiy, 2013; Pikhalo, 2014; Melezhyk, 2015; Matiashuk et al., 2015). Trees and shrubs are essential food sources for bees (Somme et al., 2016). The species composition of trees of urban plantations in Kyiv includes a lot of plants that are attractive to bees: 39.6% linden, 22.2% horse chestnut, 4.0% Norway maple, and nearly 2% black locust and rowan (Lesnik, 2015). However, their distribution is limited, and flowering is rather short-term. As for shrubs, only 20 of recorded species are decorative bloomers, representing only 6.7% of all shrub species in collections of the botanical gardens of Kyiv (Oleksiychenko & Breus, 2013).

The primary factors limiting the sustenance and persistence of wild bee populations are feeding and nesting resources. Places for bees to nest are more or less present in urban biotopes. Species that nest in the soil can use fragments of soil cover at roadsides, garden squares, urban parks; those that use plant material can nest in deadwood in parks and private plots; for those preferring hollows, there are walls of buildings and fences. However, the foraging resources (flowers) are often limited due to the impoverished composition of plants. This fact also negatively impacts the growth and reproduction of bee populations.

Overall, the trophic relations of wild bees have been studied extensively in cities of other countries. Many authors have pointed out the significance of decorative green areas (with blossoming trees, shrubs, and herbs) as foraging resources for bees (Gathmann & Tschantke, 2002; Acar et al., 2007; Hennig & Ghazoul, 2011; Garbuzov & Ratnieks, 2014; Hausmann et al., 2016; Garbuzov et al., 2017; Lowenstein et al., 2019; Sikora, 2019; Erickson et al., 2020). However, the attractiveness and value of decorative green areas with various plant species to wild bees have not been studied in urban conditions before.

Our work aimed to study the trophic relations of wild bees with flowering plants of the green areas of Kyiv.

Material and methods

Studies were conducted in Kyiv during the spring and summer seasons of 2012–2018. Model areas were located in the M.M. Gryshko National Botanical Garden of NAS of Ukraine (a significant hotbed of phytodiversity), and urban parks “Feofaniya”, “Nyvky”, “Peremoha”, “Partizans’koi slavy”. Also, the ornamental green plantations of residential areas “Teremky 1”, “Vynohradar”, as well as the avenues, roadsides, stops of civil transport, and road intersections were studied (Fig. 1).

Here, we consider the most common flowering ornamental plants (more than 35 taxa) of green areas and decorative plant compositions of the model territories, in relation to their attractiveness to bees. Bees were collected with an insect net while bees were visiting flowers (Pesenko, 1982). The visited plants and their botanical family membership were recorded. Individual specimens were caught, euthanized with ethyl acetate, and brought to the laboratory for species identification. We chose the most common bee species found in a city from our previously published check-lists of wild bee species (Honchar, 2017; Honchar & Gnatiuk, 2018; Radchenko & Honchar, 2019) to determine their trophic relations. In total, around 50 species of wild bees are considered here from the families Colletidae (two species of *Colletes* Latreille, 1802 and three of *Hylaeus* Fabricius, 1793), Andrenidae (seven species of *Andrena* Fabricius, 1775), Halictidae (one species of *Nomioides* Schenck, 1866, two of *Sphecodes* Latreille, 1804, two of *Seladonia* Robertson, 1918, two of *Lasioglossum* Curtis, 1833, three of *Halictus* Latreille, 1804, and six of *Evylaeus* Robertson, 1902), Megachilidae (one species of *Heriades* Spinola, 1808, two of *Osmia* Panzer, 1806, one of *Anthidium* Fabricius, 1804, one of *Anthidiellum* Cockerell, 1904, three of *Megachile* Latreille, 1802), Apidae (one of *Xylocopa* Latreille, 1802, one of *Eucera* Scopoli, 1770, one of *Tetralonia* Spinola, 1838, two of *Anthophora* Latreille, 1803, and eight of *Bombus* Latreille, 1802). In total, 1041 samples were collected (see Appendix).

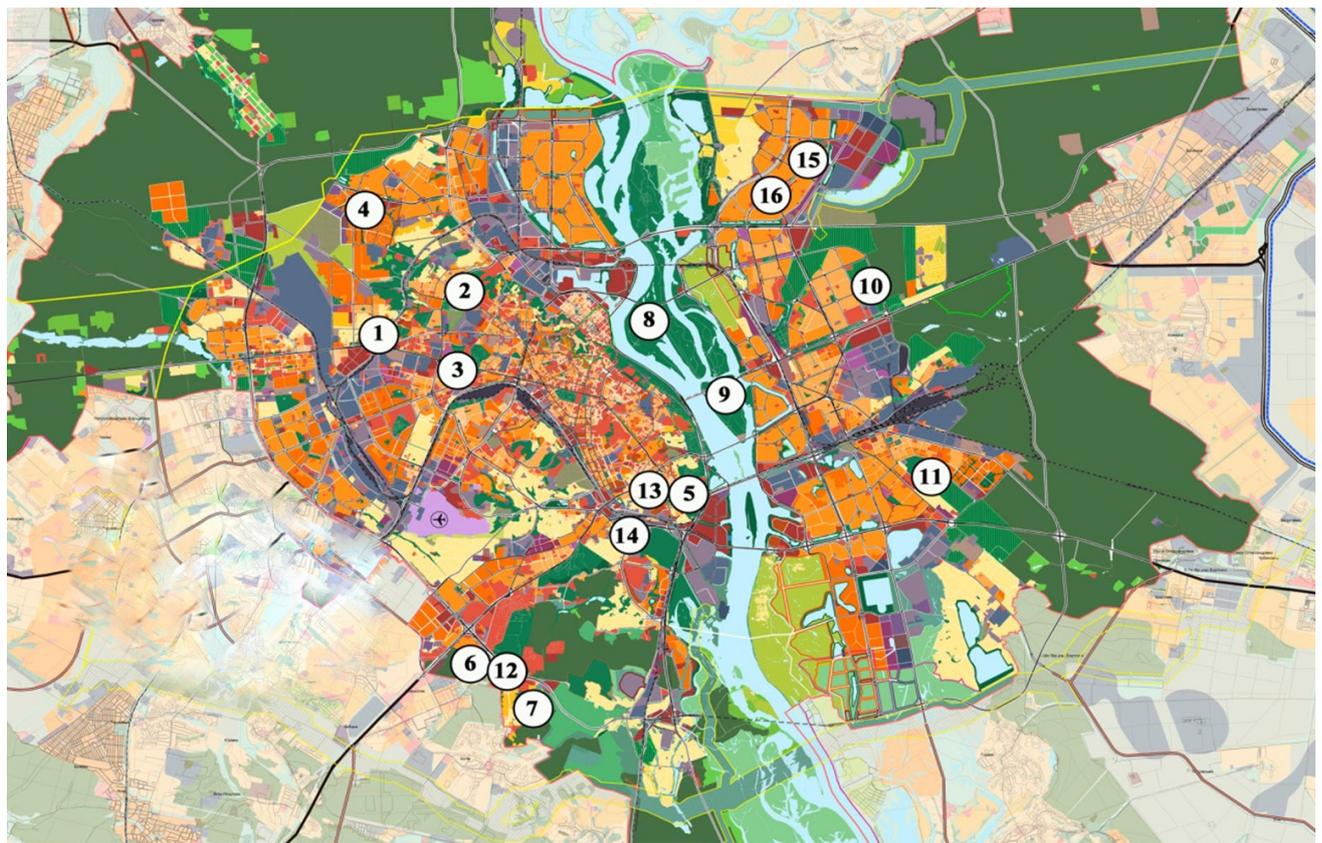


Figure 1. Model areas: 1 – “Babin Yar” park; 2 – “Nyvki” park; 3 – “KPI” park; 4 – “Vinogradar” residential area; 5 – M.M. Gryshko National Botanical Garden; 6 – “Teremki-1” residential area; 7 – “Feofaniya” park; 8 – Trukhaniv island; 9 – Hydropark island; 10 – “Peremoha” park; 11 – “Partizans’koi Slavy” park; 12 – Akademika Zabolotnoho str.; 13 – Druzhby Narodiv blvd.; 14 – Saperno-Slobidska str.; 15 – Zakrevskogo str.; 16 – Mayakovs’koho avn.

The trophic relations were visualized in R version 3.6.1 (R Core Team, 2014) using the “bipartite” package (Dormann, 2011, 2020). Trophic relations between bees and the respective plants are presented graphically. The width of relation on one side indicates the number of visits and diversity of visitors for plants, and on the other side for bees (Figs. 2 & 3).

We used the diversity index S for the bee visitors of flowers (Table 1). The index is based on Fisher’s α (Fisher et al., 1943; Magurran, 2013; Dormann, 2020).

Results

The bee species differed by periods of their flight activity and nesting specifics. Some of them build their nests in soil, other – in plant material, for example, members of the family Megachilidae or the genus *Hylaeus* prefer hollows. There were solitary bees, inquilines (*Sphecodes* spp.), and eusocial

species (*Bombus*). The main trophic relations that we have observed in the system “bee – angiosperm” are represented on Figs. 2 & 3.

The bipartite network (Fig. 2 & 3) constitutes weighted representations of the plant–pollinator interactions. We used the frequency of flower visits by bees as the interaction weight to construct the network. The number of relations and index of diversity for each plant are given in Table 1.

The highest diversity of bee visitors, seen at Figs. 2 & 3, is indicated for the genera *Spiraea* L. (mostly for *S. japonica* L.f., *S. media* Schmidt, *S. vanhouttei* (Briot) Zabel.), *Malva* L., *Prunus* L. (*Cerasus* L.), *L.*, *Rhododendron* L., *Rudbeckia* L., *Tagetes* L., *Dahlia* L. Representatives of the genus *Bombus* (*B. lapidarius* (Linnaeus, 1758), *B. lucorum* (Linnaeus, 1761), *B. terrestris* (Linnaeus, 1758), *B. pascuorum* Scopoli, 1763, and of *Hylaeus communis* Nylander, 1852, *Anthophora plumipes* (Pallas, 1772) and a few other taxa were the most frequent visitors of decorative plants in our study (Figs. 2 & 3).

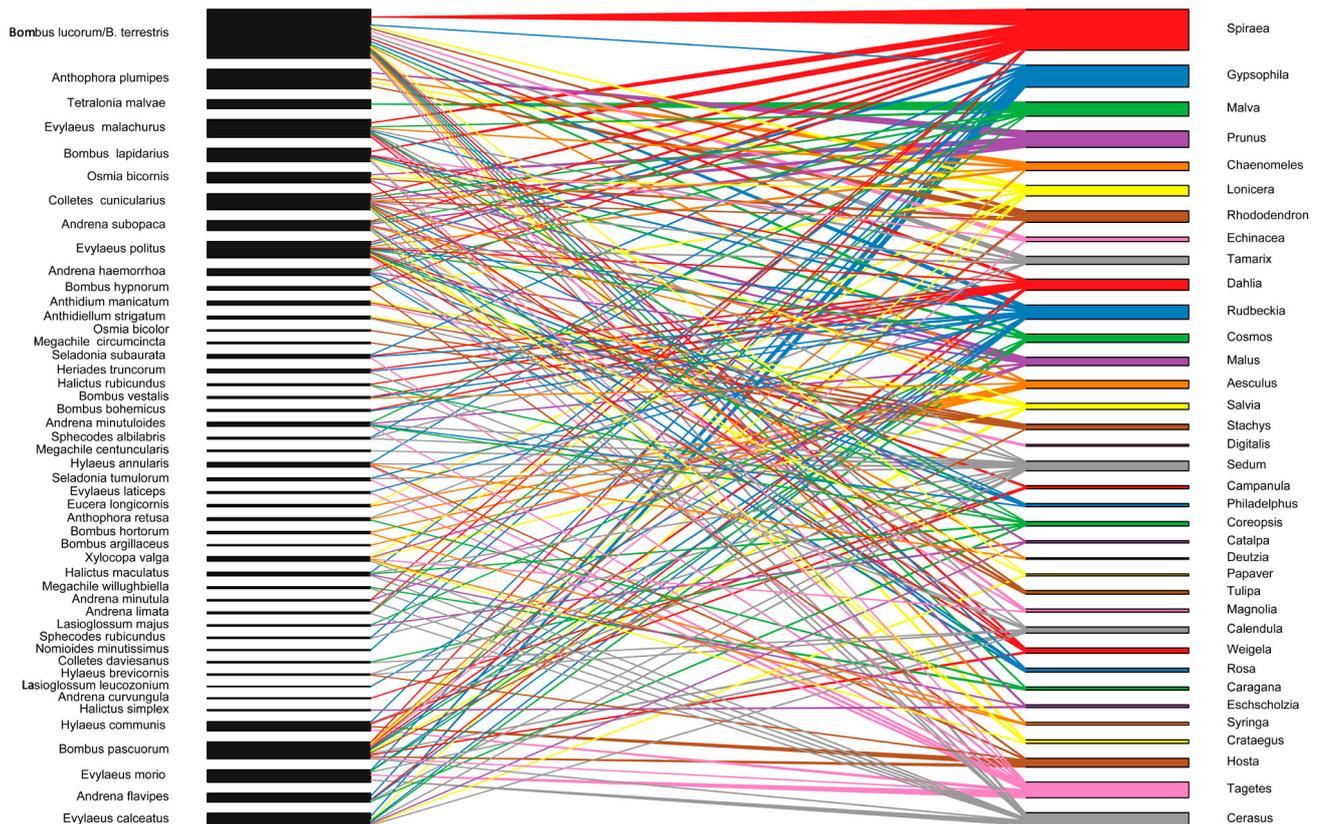


Figure 2. General view of the trophic relations of wild bees with ornamental plants of the urban green areas. The size of boxes is proportional to the total number of visits recorded per species. The thickness of the interaction lines represents the frequency categories of the interactions.

As can be seen from Table 1 and Figs. 2 & 3, there are plant species that attract more than 10 wild bee species. However, there are plants such as *Spiraea*, which mostly attract the most common bumblebee species and abundant species of the genus *Evylaeus*, less so other wild bees. Similarly, flowers of *Gypsophila paniculata*, *Dahlia*, and *Tagetes* attract a significant number of these insect species. However, the visitor diversity index is 3 to 6 in these cases because of the domination of certain species. Some plant species, such as *Calendula*, *Coreopsis*, *Rudbeckia*, *Sedum* L., *Prunus*, attract pollinators more evenly. In general, the bee species with higher ecological plasticity dominate in the urban environment, though specific oligolectic pollinators of certain species also are represented (Banaszak-Cibicka & Źmihorski, 2012; da Rocha-Filho, 2018). Those bees are attracted to plants of the genus *Malva* (specifically, *Tetralonia malvae* (Rossi, 1790), bees eat pollen from these flowers), *Campanula* (to which *Andrena curvungula* Thomson, 1870 is specialized), *Stachys*

and *Digitalis* are pollinated by *Anthidium manicatum* (Linnaeus, 1758) and *Osmia bicolor* (Schrank, 1781).

Aesculus hippocastanum L. attracts eight of the most common wild bee species, including two protected by the Red Data Book of Ukraine (Radchenko, 2009; Radchenko et al., 2009), *Bombus argillaceus* (Scopoli, 1763) and *Xylocopa valga* Gerstaecker, 1872. Bees of the latter species have a lot of various trophic relations on the studied territory. Fruiting trees of the family Rosaceae that are planted in green areas are also essential for bees in early spring throughout the season, especially in herb-free urban biotopes.

We have found that bees are more attracted to plants from the following 20 families. Families Asteraceae and Rosaceae were exceptionally diverse by the number of plant taxa visited by bees (Table 1; Fig. 4). At the same time, several families which were presented by only one or two genera (such as Tamaricaceae and Sapindaceae) are significant for feeding of wild bees of various species.

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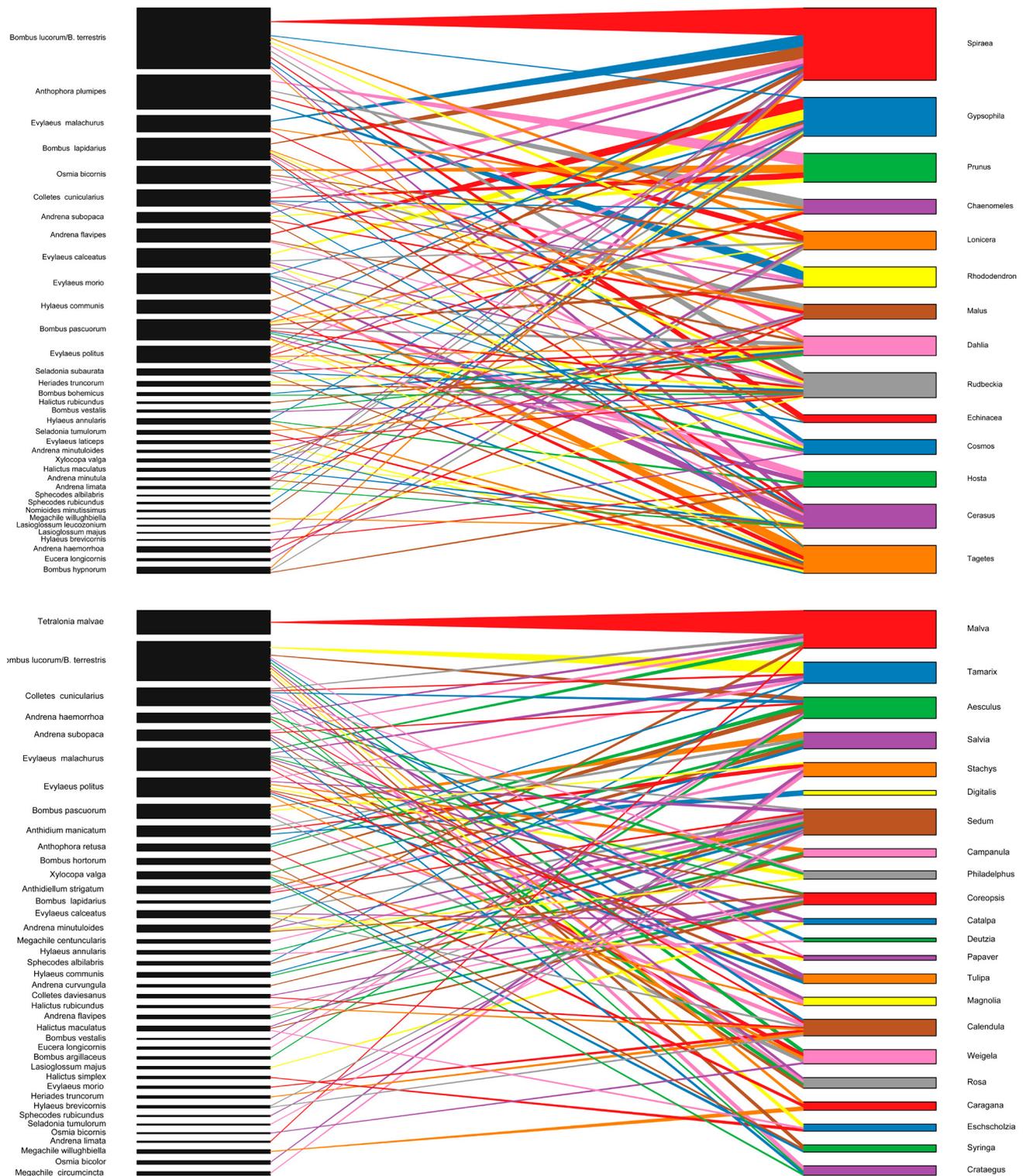


Figure 3. Detailed view of the trophic relations of wild bees with ornamental plants of the urban green areas. The size of boxes is proportional to the total number of visits recorded per species. The thickness of the interaction lines represents the frequency categories of the interactions.

There are seasonal fluctuations in the species diversity of wild bees. Overall, wild bees begin their flight activity in the middle of March though that is notably dependent on weather conditions. The highest level of bee diversity is observed in May and June, then

again in early July, and declines in August. During the large-scale distribution and reproduction of bees, the presence of pollen and nectar reserves is critical, affecting the nutritive qualities of feeding resources, and most importantly, the collection of a provision

Table 1. Diversity of relations of certain decorative plants with bees.

Plant taxa	Number of visiting bee species	Fisher's α index of diversity	Plant taxa	Number of visiting bee species	Fisher's α index of diversity
Asteraceae Bercht. & J. Presl			Magnoliaceae Juss.		
<i>Calendula</i> L.	8	8.85	<i>Magnolia</i> L.	3	1.98
<i>Dahlia</i> Cav.	10	6.17	Malvaceae Juss.		
<i>Coreopsis</i> L.	7	10.36	<i>Malva</i> L.	7	2.76
<i>Rudbeckia</i> L.	15	11.00	Oleaceae Hoffmanns. & Link		
<i>Tagetes</i> L.	11	5.40	<i>Syringa</i> L.	3	2.38
<i>Cosmos sulphureus</i> Cav.	7	4.00	Papaveraceae Juss.		
<i>Echinacea purpurea</i> (L.) Moench	3	1.45	<i>Eschscholzia californica</i> Cham.	3	2.38
Campanulaceae Juss.			<i>Papaver orientale</i> L.	3	5.45
<i>Campanula</i> L.	3	1.98	Plantaginaceae Juss.		
Caprifoliaceae Juss.			<i>Digitalis purpurea</i> L.	1	0.427
<i>Lonicera tatarica</i> L.	8	4.20	Rosaceae Juss.		
<i>Weigela floribunda</i> (Sieb. et Zucc.) C. Koch.	5	3.21	<i>Cerasus erythrocarpa</i> Nevski.	12	7.18
Caryophyllaceae Juss.			<i>Chaenomeles japonica</i> (Thunb.) Lindl. ex Spach	5	2.21
<i>Gypsophila paniculata</i> L.	12	5.00	<i>Crataegus</i> Tourn. ex L.	4	3.18
Crassulaceae J. St.-Hil.			<i>Malus</i> P. Mill.	7	4.00
<i>Sedum acre</i> L.	14	16.57	<i>Prunus</i> L.	4	1.13
Ericaceae Juss.			<i>Rosa</i> L.	4	2.75
<i>Rhododendron dauricum</i> L.	5	1.84	<i>Spiraea</i> L.	11	3.24
Fabaceae Lindl.			Sapindaceae Juss.		
<i>Caragana arborescens</i> Lam.	3	1.98	<i>Aesculus hippocastanum</i> L.	8	5.51
Hydrangeaceae Dumort.			Tamaricaceae Link		
<i>Deutzia scabra</i> Thunb.	2	2.62	<i>Tamarix ramosissima</i> Ldb.	6	3.15
<i>Philadelphus coronarius</i> L.	4	3.87	Asparagaceae Juss.		
Lamiaceae Martinov			<i>Hosta</i> Tratt.	5	2.13
<i>Stachys byzantina</i> K. Koch	5	3.21	Bignoniaceae Juss.		
<i>Salvia</i> L.	5	2.78	<i>Catalpa</i> Scop.	3	3.16
Liliaceae Juss.					
<i>Tulipa</i> L.	3	1.74			

intended for broods. Thus, a continuance of blossom is needed from March to September. According to our data, it is not found in a number of parks, and less so at roadsides, in flowerbeds and garden squares. Therefore, the assortment of angiosperms does not provide the succession of flowering plants to sustain wild bees. Some plant species

bloom only in early spring, others only in summer. Only by combining plants with varying periods of flowering, it is possible to sustain wild bees with good-quality nutrition resources. In Kyiv, the most common and attractive for bees ornamental plants flower from the end of April till the middle of August (Fig. 5). This fact indicates the incompleteness

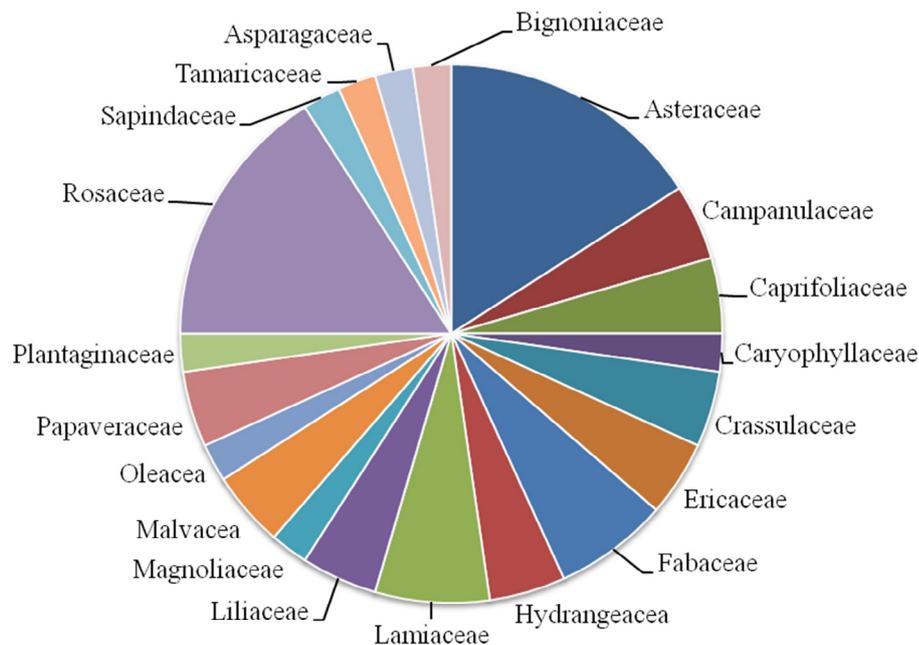


Figure 4. The relative share of most common ornamental plant families in the diet of wild bees in urban areas.

of feeding resources for bees in early spring and autumn.

Discussion

Urban ornamental plants are usually introduced species. The nectar they produce may contain metabolites, which are unattractive, unusable, and even poisonous to bees due to the narrow ranges of feeding preferences of the latter (Novotny & Basset, 2005; Dyer et al., 2007). An example of such a plant is *Tilia tomentosa* Moench, with nectar that can cause mass mortality of bumblebees (Koch et al., 2017; Jacquemart et al., 2018). We would like to note that this plant is rarely used in green areas of Kyiv, only sometimes in residential areas and collections of botanical gardens and arboretums.

Double-flowered plants are widely used for ornamentation of green areas and present another problem for the foraging bees. Such plants are less attractive for pollinators due to lower production of nectar and accessibility of flowers (Comba et al., 1999; Corbet et al., 2001). According to our data, double-flowered cultivars of the genera *Dahlia*, *Tagetes*, *Paeonia* L., and *Rosa* were indeed less attractive for bees compared to the cultivars with simple flowers. Among other ornamental and widely

used plants, cultivars of *Petunia* Juss. had low value for bees. Their flowers produce nectar and pollen in low quantities, and their deep and narrow corollas limit the access to the flower in general. Varieties and cultivars of *Ageratum* L., *Hydrangea* L., *Viola × wittrockiana*, and *Begonia* L. are also unattractive for bees.

On the other hand, there are such widely grown, aggressive introduced species as *Robinia pseudoacacia* L., *Amorpha fruticosa* L., *Solidago canadensis* L., *S. gigantea* Aiton and *Asclepias syriaca* L. They are considered to be quality honey plants, rich with nectar and pollen, with long periods of flowering and at times presenting the only foraging resource for bees. However, their ability to displace other plants has negative effect on the ecosystem as a whole (Salisbury et al., 2015; Baker & Potter, 2018; Jachuła et al., 2020). Therefore, using species of the natural flora of Ukraine to maintain green areas is preferable, because that would also sustain the populations of rare and specialized species of wild bees (Gnatiuk & Gaponenko, 2018). We think that using species of the genera *Tamarix* and *Rhododendron* (in particular, *R. dauricum*) would be advantageous in the maintenance of urban green areas because these plants are of high ornamental value and produce nectar and pollen for many wild bee

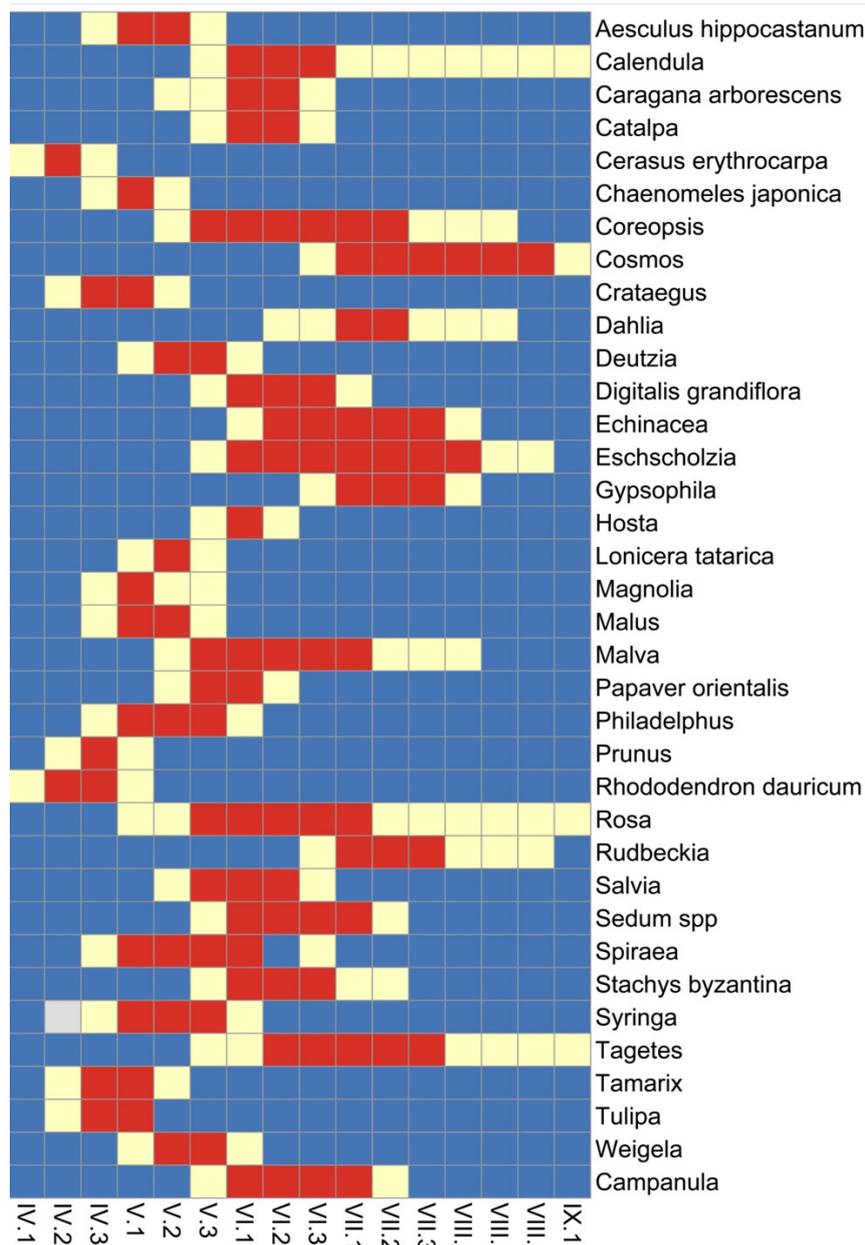


Figure 5. Periods of the blossom of ornamental plants, which are most common and attractive for bees in Kyiv: ■ - no flowering; □ - beginning and ending of anthesis; ■ - the main period of anthesis (IV–IX – months; 1–3 – first, second and third 10-day periods).

species in spring. Similar recommendations concerning the species mentioned above and species of the genus *Lonicera* and to a lesser degree, *Deutzia*, have been made for the maintenance of green areas in other European cities (Bagatska & Romanenko, 2011; Jachuła et al., 2019; Masierowska, 2006).

Conclusions

Parks, botanical gardens, garden squares, and other green areas sustain the biological

diversity in cities. For pollinators, whose populations face a worldwide decline, the flowering plants of green areas are especially important. We examined more than 35 species of plants of 20 families and observed the highest bee diversity on plants of the families Asteraceae, Rosaceae, and Lamiaceae. The most attractive plant species under study belong to the genera *Aesculus*, *Rhododendron*, *Rudbeckia*, *Sedum*, *Gypsophila*, *Prunus*, *Malus*, *Tagetes*, *Spiraea*, *Lonicera*, and *Tamarix*. Certain plant species, for example, from the genera *Malva*, *Campanula*, *Stachys*, and

Digitalis attract specialized bee species. Ornamental angiosperms also provide pollen and nectar to species listed in the Red Data Book of Ukraine, *Bombus argillaceus* and *Xylocopa valga*.

In our opinion, the plants used in urban green areas should not have decorative value only but also provide pollen and nectar to the wild bees of urban landscapes. To ensure the excellent nutritive resources for bees, the assortment of flowering plants should be continuous, and cultivars and varieties with simple flowers should be a preference for the green areas. Of particular interest are early-flowering species and plants which bloom in autumn. Using plant species with low-productive flowers which are inaccessible for insects should be limited. Introduced plants, which are tolerant of urban conditions and actively produce seeds and self-propagate, should be avoided.

It should be noted that the assortment of ornamental plants used in urban green areas is continuously growing. Thus the studies of trophic relations between the wild bees (and insects in general) have to be continued. That would provide scientific recommendations for the selection of species and cultivars of esthetically pleasing plants that ensure the survival of many groups of insects in urban conditions.

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Appendix. Observed bees visiting plants in some model areas.

Taxa	"Babin Yar" park	"Nyvki" park	"KPI" park	"Vinogradar" residential area	M.M. Gryshko National Botanical Garden	"Tremki-1" residential area	"Feofaniya" park	Trukhaniv island	Hydropark island	"Perehoha" park	"Partizans'koi Slavy" part	Akademiika Zabolotnoho str.	Druzhby Narodiv blvd.	Saperno-Slobidska str	Zakrevskogo str.	Mayakovs'koho avn.	Total
Family Colletidae Lepeletier, 1841																	
Genus <i>Colletes</i> Latreille, 1802																	
<i>C. cunicularius</i> (Linnaeus, 1761)	3	3	1	0	5	2	7	7	6	2	1	0	0	0	0	0	37
<i>C. daviesanus</i> Smith, 1846	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	3
Genus <i>Hylaeus</i> Fabricius, 1793																	
<i>H. annularis</i> (Kirby, 1802)	2	1	0	0	2	0	3	0	1	1	3	0	0	0	0	0	13
<i>H. brevicornis</i> Nylander, 1852	0	0	0	0	5	0	3	0	0	0	4	0	0	0	0	0	12
<i>H. communis</i> Nylander, 1852	2	2	1	0	3	0	4	0	0	0	9	0	0	0	0	0	21
Family Andrenidae Latreiller, 1802																	
Genus <i>Andrena</i> Fabricius, 1775																	
<i>A. curvungula</i> Thomson, 1870	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	2
<i>A. flavipes</i> Panzer, 1799	2	4	1	0	4	1	4	2	2	1	1	0	0	0	0	0	22
<i>A. haemorrhhoa</i> (Fabricius, 1781)	1	2	1	0	3	0	3	0	1	2	2	0	0	0	0	0	15
<i>A. minutula</i> Kirby, 1802	0	0	4	0	8	0	7	0	0	5	3	0	0	0	0	0	27
<i>A. minutuloides</i> Perkins, 1914	2	4	0	0	8	0	5	1	0	4	0	0	0	0	0	0	24
<i>A. subopaca</i> Nylander, 1848	2	3	1	0	5	0	4	1	2	3	8	0	0	0	0	0	29
<i>A. limata</i> Smith, 1853	0	1	0	0	1	0	1	0	0	1	0	0	0	0	0	0	4
Family Halictidae Thomson, 1869																	
Genus <i>Sphecodes</i> Latreille, 1804																	
<i>S. albilabris</i> (Fabricius, 1793)	0	1	0	0	2	0	1	0	0	0	0	0	0	0	0	0	4
<i>S. rubicundus</i> von Hagens, 1875	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	3

Appendix. Continued.

Taxa	"Babin Yar" park	"Nyvki" park	"KPI" park	"Vinogradar" residential area	M.M. Gryshko National Botanical Garden	"Tremki-1" residential area	"Eofaniya" park	Trukhaniv island	Hydropark island	"Perehoha" park	"Partizans'koi Slavy" part	Akademika Zabolotnoho str.	Druhby Narodiv blvd.	Saperno-Slobidska str	Zakrevskogo str.	Mayakovs'koho avn.	Total
Family Halictidae Thomson, 1869																	
Genus <i>Halictus</i> Latreille, 1804																	
<i>H. maculatus</i> Smith, 1848	0	2	0	0	2	0	3	0	0	1	0	0	0	0	0	0	8
<i>H. rubicundus</i> (Christ, 1791)	0	1	0	0	1	0	1	0	1	1	0	0	0	0	0	0	5
<i>H. simplex</i> Blüthgen, 1923	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2
Genus <i>Seladonia</i> Robertson, 1918																	
<i>S. subaurata</i> (Rossi, 1792)	0	2	0	0	2	0	2	0	0	2	2	0	0	0	0	0	10
<i>S. tumulorum</i> (Linnaeus, 1758)	0	0	0	0	9	0	7	0	0	3	5	0	0	0	0	0	24
Genus <i>Lasioglossum</i> Curtis, 1833																	
<i>L. majus</i> (Nylander, 1852)	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	3
<i>L. leucozonium</i> (Schrank, 1781)	0	0	0	0	0	0	0	4	0	1	0	0	0	0	0	0	5
Genus <i>Evyllaes</i> Robertson, 1902																	
<i>E. calceatus</i> (Scopoli, 1763)	2	3	0	0	4	0	5	2	2	5	7	0	0	0	0	0	30
<i>E. laticeps</i> (Schenck, 1870)	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	4
<i>E. malachurus</i> Kirby, 1802	3	3	0	0	4	0	5	2	2	8	7	0	2	0	3	1	40
<i>E. morio</i> (Fabricius, 1793)	3	9	0	2	5	1	5	0	0	5	1	2	0	0	0	0	33
<i>E. politus</i> (Schenck, 1853)	5	5	6	3	1	3	0	0	0	0	0	6	3	3	5	2	42
Genus <i>Nomioides</i> Schenck, 1866																	
<i>N. minutissimus</i> (Rossi, 1790)	0	0	0	0	4	0	2	0	0	0	0	0	0	0	0	0	6

Appendix. Continued.

Taxa	"Babin Yar" park	"Nyvki" park	"KPI" park	"Vinogradar" residential area	M.M. Gryshko National Botanical Garden	"Teremki-1" residential area	"Feofaniya" park	Trukhaniv island	Hydropark island	"Peremoha" park	"Partizans'koi Slavy" parl	Akademika Zabolotnoho str.	Druzhby Narodiv blvd.	Saperno-Slobidska str	Zakrevskogo str.	Mayakovs'koho avn.	Total
Family Megachilidae Latreille, 1802																	
Genus <i>Heriades</i> Spinola, 1808																	
<i>H. truncorum</i> (Linnaeus, 1758)	0	2	0	0	0	0	0	2	2	0	3	0	0	0	0	0	9
Genus <i>Osmia</i> Panzer, 1806																	
<i>O. bicolor</i> (Schrank, 1781)	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	3
<i>O. bicornis</i> (Linnaeus, 1758)	3	3	0	3	9	0	5	0	0	0	0	0	0	0	0	0	23
Genus <i>Anthidium</i> Fabricius, 1804																	
<i>A. manicatum</i> (Linnaeus, 1758)	0	2	0	0	5	0	0	2	4	0	0	0	0	0	0	0	13
Genus <i>Anthidiellum</i> Cockerell 1904																	
<i>A. strigatum</i> (Panzer, 1805)	0	0	0	0	1	0	3	0	0	2	2	0	0	0	0	0	8
Genus <i>Megachile</i> Latreille, 1802																	
<i>M. centuncularis</i> (Linnaeus, 1758)	0	4	0	0	0	0	0	0	0	2	0	0	0	0	0	0	6
<i>M. circumcincta</i> (Kirby, 1802)	0	0	0	0	4	0	0	3	0	0	0	0	0	0	0	0	7
<i>M. willughbiella</i> (Kirby, 1802)	3	0	0	0	4	0	0	0	0	3	0	0	0	0	0	0	10
Family Apidae Latreille, 1802																	
Genus <i>Xylocopa</i> Latreille, 1802																	
<i>X. valga</i> Gerstaecker, 1872	0	2	0	0	5	0	3	0	0	0	0	0	0	0	0	0	10
Genus <i>Eucera</i> Scopoli, 1770																	
<i>E. longicornis</i> (Linnaeus, 1758)	0	2	0	0	3	0	0	0	0	0	0	0	0	0	0	0	5
Genus <i>Tetralonia</i> Spinola, 1838																	
<i>T. malvae</i> (Rossi, 1790)	0	2	0	3	9	3	3	0	0	0	0	0	0	0	0	0	20

Appendix. Continued.

Taxa	"Babin Yar" park	"Nyvki" park	"KPI" park	"Vinogradar" residential area	M.M. Gryshko National Botanical Garden	"Teremki-1" residential area	"Eofaniya" park	Trukhaniv island	Hydropark island	"Peremoha" park	"Partizans'koi Slavy" part	Akademika Zabolotnoho str.	Druzhby Narodiv blvd.	Saperno-Slobidska str	Zakrevskogo str.	Mayakovs'koho avn.	Total
Family Apidae Latreille, 1802																	
Genus <i>Anthophora</i> Latreille, 1803																	
<i>A. retusa</i> (Linnaeus, 1758)	0	0	0	0	3	0	0	0	0	3	0	0	0	0	0	0	6
<i>A. plumipes</i> (Pallas, 1772)	3	9	0	4	16	4	5	0	0	0	3	0	0	0	0	0	44
Genus <i>Bombus</i> Latreille, 1802																	
<i>B. vestalis</i> (Geoffroy, 1785)	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	4
<i>B. bohemicus</i> (Seidl, 1837)	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	4
<i>B. hortorum</i> (Linnaeus, 1761)	0	0	0	0	6	0	9	0	0	0	0	0	0	0	0	0	15
<i>B. hypnorum</i> (Linnaeus, 1758)	0	4	0	0	7	10	5	0	0	0	4	0	0	0	0	0	30
<i>B. lapidarius</i> (Linnaeus, 1758)	13	0	3	14	25	9	25	0	0	0	0	0	4	5	4	3	105
<i>B. lucorum</i> (Linnaeus, 1761) / <i>B. terrestris</i> (Linnaeus, 1758)	10	19	3	18	34	5	15	5	4	7	7	3	5	6	5	17	163
<i>B. pascuorum</i> (Scopoli, 1763)	5	13	9	12	9	4	31	9	11	13	9	0	0	0	0	0	125
<i>B. argillaceus</i> (Scopoli, 1763)	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3
Total	64	111	30	59	229	42	186	40	41	77	83	11	14	14	17	23	1041

Роль зелених насаджень міста у збереженні диких бджіл (Hymenoptera, Apoidea)

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Метою нашого дослідження було визначення привабливості та ролі зелених квітучих насаджень міста Києва для підтримки та збереження популяцій диких бджіл (Hymenoptera, Apoidea). Об'єктом дослідження були найпоширеніші квітучі насадження міста та дикі бджоли, які відвідували їхні квітки протягом сезону квітання для збору пилку та харчування нектаром. Територія дослідження охоплювала міські парки, НБС ім. М.М. Гришка, зелені насадження житлових кварталів, узбіч, тощо (загалом 16 пунктів спостереження та відбору). Відбір комах здійснювався за загальноприйнятою методикою – індивідуальним відловом на квітках протягом весняно-літнього сезону 2012–2018 років. На основі цих спостережень будували графічне зображення трофічних зв'язків бджіл із відповідними рослинами, а також обраховували індекс різноманіття відвідувачів для рослин. На основі фенологічних даних будували графік періоду квітання основних рослин. У результаті обстеження зелених насаджень міста виявлено найбільш привабливі для бджіл декоративні насадження із деревних, чагарникових та трав'янистих видів рослин, що складається з понад 35 таксонів та близько 20 родин. Серед найбільш привабливих для комах виділено такі роди рослин як *Rudbeckia*, *Sedum*, *Gypsophila*, *Cerasus*, *Tagetes*, *Spiraea*, *Lonicera*, *Aesculus*, та деякі інші. Протягом весняно-літнього сезону відбувається зміна квітучих рослин, що необхідно враховувати при озелененні. У кожен період квітання певні види є привабливими для комах, так упродовж весняного періоду – *Prunus*, *Rhododendron*, *Crataegus*, *Aesculus*, у літній – більшість представників родини Asteraceae, на кінець літа та початок осені залишається незначне різноманіття рослин, але у цей період основна льотна активність більшості диких бджіл вже завершується. Загалом, досліджені декоративні рослини приваблюють не тільки найбільш поширені види диких бджіл, але і спеціалізовані та рідкісні види, наприклад *Bombus argillaceus* та *Xylocopa valga*, що внесені до Червоної Книги України. Нами встановлено, що квітучі зелені насадження, які складаються із декоративних деревних, чагарникових та трав'янистих форм відіграють значну роль у живленні багатьох видів диких бджіл, що сприяє збереженню та підтримці популяцій цих комах у міських умовах.

Ключові слова: декоративні рослини, дикі бджоли, міські умови