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SPECIES DIVERSITY AND HABITAT PREFERENCES OF ACULEATA (INSECTA: HYMENOPTERA) OF URBAN AND SUBURBAN GARDENS IN BRNO-CITY (CZECH REPUBLIC)

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Abstract

ŘÍHA MARTIN. 2017. Species Diversity and Habitat Preferences of Aculeata (Insecta: Hymenoptera) of Urban and Suburban Gardens in Brno-City (Czech Republic). *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis,* 65(1): 0171–0178.

I conducted a survey of aculeate Hymenoptera in urban and suburban gardens of Brno-city in August 2015. For my survey, I selected three individual gardens, and in each of them chose three type of microhabitats: tree, grass and patch. I used yellow pan traps for taxon sampling. Using this method, I recorded 382 specimens belonging to 76 species. Subsequently, the basic indices of species diversity in individual gardens were calculated, and statistical analyses of individual gardens and various microhabitats were created. I report large differences between the Aculeata taxa found in urban and suburban gardens. Habitat preferences of species between microhabitats were discovered as well. Furthermore, I report 14 species mentioned in the Red List of threatened species of the Czech Republic (Straka 2005a,b) (hereinafter referred to as Red List); as well as one invasive species *Isodontia mexicana* (Saussure, 1867) and one species *Pison atrum* Spinola, 1808 recently reported as new for the Czech Republic (reported after the publication of the Red List itself).

Keywords: Hymenoptera, Aculeata, Czech Republic, Brno-city, urban gardens, species diversity, habitat preferences.

INTRODUCTION

Rural and urban gardens are quite common biotopes in the Czech Republic. Despite their great heterogeneity and potential for assessment of biotope quality, they remain overlooked. Although aculeate Hymenoptera are considered to be a very useful group for assessing the quality of biotopes (e.g. Gayubo *et al.* 2005), previous surveys of aculeate Hymenoptera in gardens of central Europe reported chiefly only important pollinators of fruit trees. Usually (and understandably), it is mainly the honeybee (*Apis mellifera* Linnaeus, 1758) and common species of bumblebees (*Bombus* sp.) that appear in the surveys. Other groups of aculeate Hymenoptera are practically absent in publications, although they can be highly sensitive to pollution and rapidly responsive to changes in global climate and microclimate changes from the perspective of biotopes or localities. Reports that focus on these or just on individual families (eg. Owen *et al.* 1981) and/or other parts of Europe (eg. Archer 1990, 2013, Harvey 2001) or continents (eg. Fetridge *et al.* 2008, Frankie *et al.* 2009, Mazzeo and Torretta 2015) are notable exceptions to this rule. Almost every species shows rather well known (see e.g. Blösch 2000 or Michener 2007), well-defined environmental requirements. However, within gardens, their habitat preferences are largely unknown. The object of the present paper is therefore to fill this gap, albeit on a small scale.

MATERIALS AND METHODS

In August 2015, the survey of aculeate Hymenoptera was conducted in gardens in urban and suburban areas of the city of Brno (Czech

Republic). Three individual gardens in the following locations: Brno – Líšeň (LIS), Brno – Židenice (ZID) and Brno – Královo pole (KRP) were selected. The LIS is a suburban garden, situated in the garden colony consisting of 114 similar gardens with area ca. 100 m^2 (per individual garden). This colony is located in eastern side of the city, and it is opened to the surrounding landscape. It is bordered by forest from the north only. Locations ZID and KRP are urban type areas of ca. 140 m^2. These gardens are surrounded by family houses on all sides. Such architecture is prevalent in the entire region of Moravia. Both ZID and KRP are partly used as yard, and their total area is in principle identical.

For the insect sampling, I used yellow Moericke's pan traps with a diameter of 15 cm and a capacity of 500 ml. In each garden, three pan traps in a patch (-P), three in grass (-G) and further three among fruit trees (-T) were installed. The pan traps were checked at weekly intervals.

The captured specimens were mounted and identified according to the following sources: Chrysididae: Balthasar (1954), Kunz (1994) and Linsenmeier (1997); Pompilidae: Oehlke & Wolf (1987); Vespidae: Schmid-Egger (1994); Apoidea: Spheciformes: Bitsch & Leclercq (1993), Bitsch *et al.* (1997, 2001) and Dollfuss (1991); Apoidea: Apiformes: Colletidae: Dathe (1980); Andrenidae: Schmid-Egger & Scheuchl (1997); Halictidae: Ebmer (1969, 1970, 1971); Megachilidae: Scheuchl (1996); Apidae: Scheuchl (1995) and Pavelka & Smetana (2003). The species were compared against the Red List of threatened species of the Czech Republic (Straka 2005a,b).

To calculate the indices of the species variability the formulas of Krebs (1999) were strictly applied.

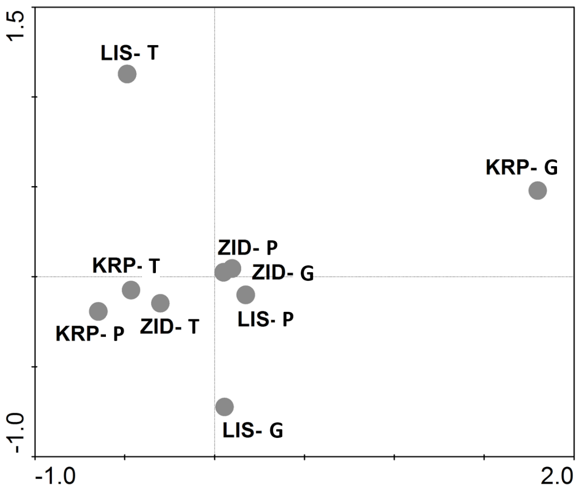
The influence of environmental variables (type of microhabitat) on aculeate Hymenoptera assemblages was tested using canonical correspondence analysis (CCA) and the Monte Carlo permutation test (999 permutations) in CANOCO. Data were log(y+1) transformed and, prior to CCA analysis, de-trended correspondence analysis (DCA) was undertaken to check for unimodal distribution of the data (ter Braak & Šmilauer 2002; Lepš & Šmilauer 2003). The length of the longest gradient was between 3 and 4. Thus, CCA was considered suitable for this dataset. Following Blanchet *et al.* (2008), I subsequently ran a global CCA with the set of all explanatory variables to model the response variable for each matrix. The global test was significant for a given set of variables ($F = 1.76$; $p < 0.001$). To eliminate the effect of stand, (locality – LIS x KRP x ZID) was used it as a co-variable in order to reveal the influence of microhabitat type (tree x grass x patch).

RESULTS

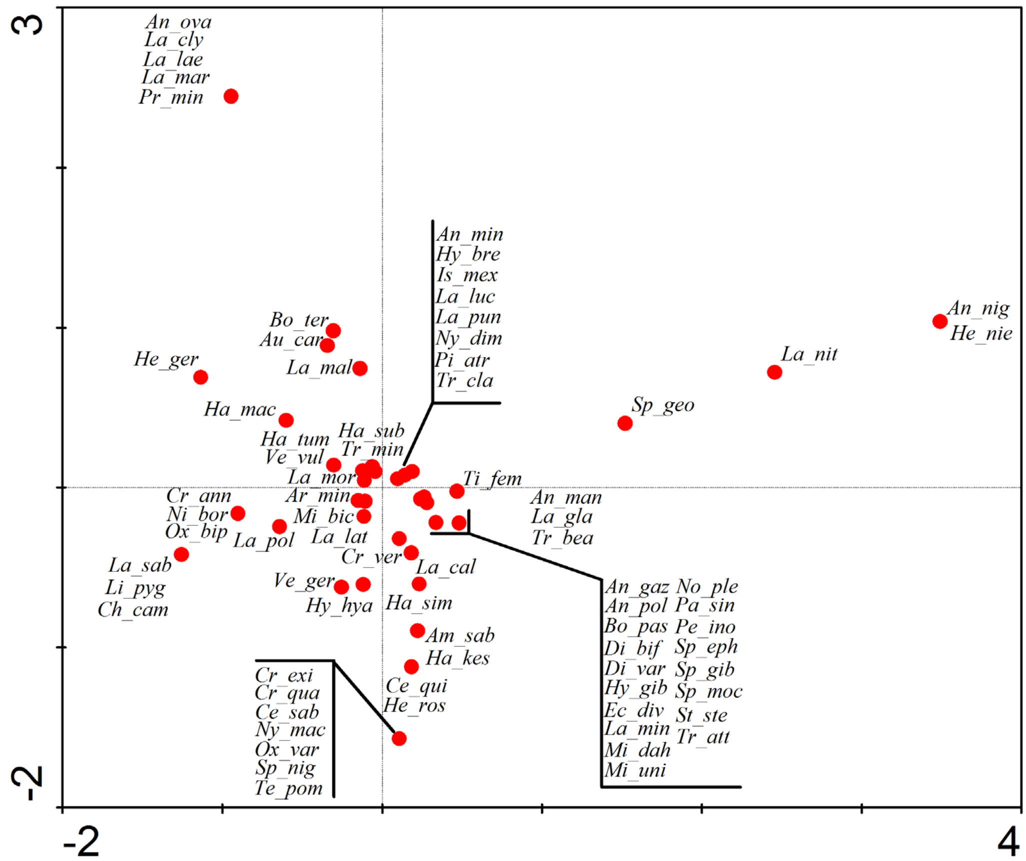
The highest number of species and specimens was reported from LIS. In the same area, a higher value for the Simpon's and Shannon-Weiner's index of species diversity was observed. The lowest species diversity was observed from the KRP, while in the ZID, the diversity indices were the lowest (Tab. II).

Microhabitat preferences of aculeate Hymenoptera were tested using CCA. Firstly, I verified whether there were statistically significant differences between the three monitored areas (LIS x KRP x ZID). CCA analysis revealed that communities of Hymenoptera in these regions differ significantly ($F = 2.52$; $p < 0.001$). This model explained 10.9 % (Axis1) or rather 20.3 % (Axis2) variability in the species data (Fig. 1). To reveal the microhabitat preferences, I therefore used Hymenoptera areas (sites) as the explanatory variables (co-variables), to eliminate their influence on the analysis of microhabitat preferences. Subsequent CCA analysis showed that Hymenoptera communities between different microhabitats significantly vary ($P = 1.42$; $p < 0.001$) and individual species are distributed according to the relation for the given station (Fig. 2). This model explained 8.8 % (Axis1) or rather 15.8 % (Axis2) variability of the species data.

Because of their occurrence in the individual categories in the Red List (Straka 2005a,b) the following 14 species are worth mentioning: *Dipogon variegatus* (Linnaeus, 1758) in the category – critically endangered; *Lasioglossum marginatum* (Brullé, 1832), *Nomada pleurosticta* Herrich-Schäffer, 1839, *Priocnemis minuta* (Vander Linden, 1827), *Spilomena mocsaryi* Kohl, 1898 and *Trypoxylon beaumonti* Antropov, 1991 in the category – endangered; and *Andrena polita* Smith, 1847, *Halictus kessleri* Bramson, 1879, *Lasioglossum clypeare* (Schenck, 1853), *Lasioglossum glabriusculum* (F. Morawitz, 1872), *Lindenius pygmaeus armatus* (Vander Linden, 1829), *Miscophus bicolor* Jurine, 1807, *Nysson maculosus* (Gmelin, 1790) and *Oxybelus variegatus* Wesmael, 1852 in the category – vulnerable. Another recorded species, so far reported only from ZID is *Isodontia mexicana* (Saussure, 1867) is an invasive North American taxon. Its geographical expansion is reviewed by Ćetković *et al.* (2012) and its records from the Czech Republic were reported by Rindoš & Říha (2014) and Straka *et al.* (2015). After the publication of the Red List, another noteworthy species, *Pison atrum* Spinola, 1808 was reported as new for the territory of Czech Republic. Originally a Mediterranean element, this species is currently spreading to the north. Its first records from the Czech Republic were published by Bogusch *et al.* (2007).



1: *Results of CCA: diagram showing areas (LIS, KRP, ZID) and microhabitats (G – grass, T – tree, P – patch) as environmental variables.*



2: *Results of CCA: diagram showing microhabitat preferences of aculeate Hymenoptera. Their position is related to microhabitats treated (Fig. 1). Species abbreviations were created based on the following rule: the first two letters for the given genus name and first three letters for the given species name (Tab. I).*

I: *Number of specimens of individual species in individual areas (including abbreviations of each species used in analyses).*

SPECIES	ABBREVIATION	GARDENS			RED LIST
		LIS	ZID	KRP	
Ammophila sabulosa	Am_sab	2			
Ancistrocerus gazella	An_gaz	1			
Andrena minutuloides	An_min		1		
Andrena ovatula	An_ova	1			
Andrena polita	An_pol	2			VU
Anoplius nigerrimus	An_nig			1	
Anthidium manicatum	An_man	1	1		
Arachnospila minutula	Ar_min	8	1		
Auplopus carbonarius	Au_car	6			
Bombus pascuorum	Bo_pas	2			
Bombus terrestris	Bo_ter	1	2		
Cerceris quinquefasciata	Ce_qui	3			
Cerceris sabulosa	Ce_sab	2			
Crossocerus annulipes	Cr_ann			1	
Crossocerus exiguus	Cr_exi	1			
Crossocerus quadrimaculatus	Cr_qua	1			
Cryptocheilus versicolor	Cr_ver	10			
Dipogon bifasciatus	Di_bif	1			
Dipogon variegatus	Di_var	1			CR
Ectemnius dives	Ec_div	2			
Halictus kessleri	Ha_kes	2			VU
Halictus maculatus	Ha_mac	4		2	
Halictus simplex	Ha_sim	16	2		
Halictus subauratus	Ha_sub	2	24	15	
Halictus tumulorum	Ha_tum	6	13	4	
Hedychridium roseum	He_ros	2			
Hedychrum gerstaeckeri	He_ger	1		2	
Hedychrum niemelai	He_nie			1	
Hylaeus brevicornis	Hy_bre		1		
Hylaeus gibbus	Hy_gib	1			
Hylaeus hyalinatus	Hy_hya	3		1	
Chelostoma campanularum	Ch_cam			1	
Isodontia mexicana	Is_mex		2		
Lasioglossum calceatum	La_cal	2	2		
Lasioglossum clypeare	La_cly	2			VU
Lasioglossum glabriusculum	La_gla	2	1		VU
Lasioglossum laevigatum	La_lae	1			
Lasioglossum laticeps	La_lat	10	7	3	
Lasioglossum lucidulum	La_luc		4		
Lasioglossum malachurum	La_mal	12	1		
Lasioglossum marginatum	La_mar	1			EN

SPECIES	ABBREVIATION	GARDENS			RED LIST
		LIS	ZID	KRP	
Lasioglossum minutulum	La_min	2			
Lasioglossum morio	La_mor	15	15	7	
Lasioglossum nitidulum	La_nit			5	
Lasioglossum politum	La_pol		4	3	
Lasioglossum punctatissimum	La_pun		1		
Lasioglossum sabulosum	La_sab			3	
Lindenius pygmaeus armatus	Li_pyg			1	VU
Mimumesa dahlbomi	Mi_dah	1			
Mimumesa unicolor	Mi_uni	1			
Miscophus bicolor	Mi_bic	1	3	1	VU
Nitela borealis	Ni_bor			1	
Nomada pleurosticta	No_ple	1			EN
Nysson dimidiatus	Ny_dim		1		
Nysson maculosus	Ny_mac	1			VU
Oxybelus bipunctatus	Ox_bip			1	
Oxybelus variegatus	Ox_var	1			VU
Passaloecus singularis	Pa_sin	2			
Pemphredon inornata	Pe_ino	1			
Pison atrum	Pi_atr		1		DD
Priocnemis minuta	Pr_min	1			EN
Sphecodes ephippius	Sp_eph	1			
Sphecodes geoffrellus	Sp_geo	1	2	2	
Sphecodes gibbus	Sp_gib	1			
Sphecodes niger	Sp_nig	1			
Spilomena moscaryi	Sp_moc	1			EN
Stenodynerus steckianus	St_ste	1			
Tachysphex pompiliformis	Te_pom	2			
Tiphia femorata	Ti_fem	2		11	
Trypoxylon attenuatum	Tr_att	7	1	2	
Trypoxylon beaumonti	Tr_bea	2	2		EN
Trypoxylon clavicerum	Tr_cla		1		
Trypoxylon minus	Tr_min	16	23	3	
Vespula germanica	Ve_ger	3	3	1	
Vespula vulgaris	Ve_vul	7	5	2	

II: *Numbers of species and specimens, and the basic indices of the diversity in the individual areas.*

	GARDEN		
NUMBER	**LÍŠEŇ**	**ŽIDENICE**	**KRÁLOVO POLE**
specimens	184	124	74
species	57	27	24
INDEX			
Simpson			
D	0,043	0,108	0,092
1-D	0,957	0,892	0,908
1/D	23,256	9,259	10,869
Shannon-Wiener			
H (2 logs)	5,107	3,813	3,981
N	34,464	14,055	15,791

DISCUSSION

A suburban garden (LIS) opened to the surrounding area is rather different from the other two urban gardens (ZID and KRP), which are situated in the complex, closed and isolated space. They differ in the number of recorded species and specimens as well as in different indices of diversity. This is certainly due the aforementioned different closeness (and openness), but probably also the size of the buildings, which cast shadows, and species composition of plants. In the gardening colony, where there are usually simple bungalows only, there are more sunlit areas, and the garden-open area as well. In urban conditions, on the contrary, there are more built-up areas, houses are often multi-storey and the sunlit areas are therefore situated primarily to the northern edge of the garden complex. Likewise, the internal order allotments, which do not permit (with some exceptions) to raise high grown shading trees may be of important influence.

Most species diversity of aculeate Hymenoptera was observed in grass and patch microhabitats of all three surveyed gardens. In patches, species using places without vegetation for nesting prevailed.

On the contrary, urban gardens can have specific temperature conditions just because of their closeness (e.g. generally higher temperature in city, less cooling wind, larger surface of perpendicular profiles in the wall, less evaporation in southern parts etc.). These facts would explain the occurrence of species such as *Pison atrum* or *Spilomena mocsaryi*. In their natural environment, such taxa are usually found on rocky steppes or on the rocks where they nest. For several species, it would be appropriate to evaluate their inclusion in the individual categories of the Red List. This applies to the following: *Lasioglossum marginatum* and *Trypoxylon beaumonti* (from the category endangered to the vulnerable). As for the species *Halictus kessleri*, *Lindenius pygmaeus armatus* and *Miscophus bicolor* it would be perhaps appropriate to remove them from Red List altogether. These species are in fact much more common than originally thought, and in southern Moravia they occur quite commonly even on anthropogenic sites. Based on the above-mentioned facts, I advocate the continuation of gardens surveys mainly due to our incomplete knowledge of the preferences of individual species and the lack of comparative studies.

CONCLUSION

My research demonstrated the differences between associations of aculeate Hymenoptera among the specified locations. The microhabitat preferences of individual species varies similarly. The biome of suburban garden is undoubtedly significantly richer (species-wise) and therefore more interesting than the urban gardens. Biotope preferences vary widely according to individual species as well. My study reports fourteen species listed in Red List; I herewith advocate it to be appropriate to alter their categorization for a five of these.

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