DIVERSITY OF CARABID ASSEMBLAGES IN URBAN AND SUBURBAN ECOSYSTEMS IN CENTRAL EUROPE

ŠUSTEK Zbyšek

Abstract. The study represents a synthesis of investigation of Carabid assemblages in 57 sites (13 alluvial sites, 18 mesohydrophilous forests and 25 urban parks, gardens and cemeteries) studied in two Central European cities (Bratislava and Brno) since 1978 up to 2006. In both cities, but especially in Bratislava, seminatural ecosystems penetrate deeply into the center. In addition, there also exist secondarily restored ecosystems that have reached, structurally and physiognomically, a considerable degree of naturalness. In all types of ecosystems 162 Carabid species were recorded. They represent about ¼ of the Central European Carabid fauna and about half of the lowland fauna in this area. However, the species richness in individual sites strongly varies. In the suburban zones, at city margins or in some restored sites with continuous tree vegetation even in the city center it is very similar to the corresponding ecosystems in free landscape (about 30 species in flood plain forests and 20-25 species in mesohygrophylous deciduous forests). But in general there is a strong tendency to declining of species number toward the city center. A special situation is in urban parks and gardens in residential quarters with discontinuous tree vegetation, where the Carabid assemblages predominantly consist of the species characteristic for the arable land, but their number is usually much lower. This number is much lower in spite of summer nocturnal migration waves of flying arable land Carabid species, which are attracted to the city center by extensive illuminations and make possible to colonize the patches of grassy vegetation in city center.

Keywords: Carabidae, urban ecosystems, Central Europe, community ecology, species diversity.

Rezumat. Diversitatea cenozelor de Carabide din ecosistemele urbane şi suburbane din Europa centrală. Acest studiu reprezintă o sinteză a cercetărilor cenozelor de Carabide din 56 localităţi (13 din aluvii, 18 din pădurile mesohidrofile şi 25 din parcuri, grădini şi cimitire) efectuate în două oraşe central europene (Bratislava şi Brno) din anul 1978 până în 2006. În ambele oraşe, dar în mod special în Bratislava, ecosistemele seminaturale pătrund adânc în centru. În afară de acestea, în oraşe există şi ecosisteme restituite secundar care au atins, structural şi fizionomic, un grad remarcabil al caracterului natural. În toate tipurile de ecosisteme, au fost înregistrate 162 de specii de Carabide care reprezintă aproximativ un sfert din numărul speciilor din fauna Carabidelor din Europa centrală şi o jumătate din fauna de câmpii. Însă, numărul speciilor din localităţile individuale este extrem de variabil. În zonele suburbane, pe lângă marginile oraşului sau în unele ecosisteme restituite cu vegetaţie continuă de arbori, chiar în centrul oraşului, numărul speciilor este foarte asemănător celui din ecosistemele analogice din peisajul natural (aproximativ 30 de specii în păduri de luncă, 20-25 de specii în păduri mesohidrofile). Dar, în general, există o tendinţă puternică de reducere a numărului speciilor în centrul oraşului. O situaţie deosebită există in parcuri şi grădini din cartiere rezidenţiale de vile , cu vegetaţie de arbori discontinuă, unde cenozele de Carabide constau din specii caracteristice pentru câmpuri, dar în general, numărul speciilor la o localitate concretă este mult mai scăzut. Numărul lor este mult mai mic, dimpotrivă ,in migraţiile nocturne de vară ale multor specii zburătoare, caracteristice pentru câmpuri, care sunt atrase de către iluminaţia enormă a unor locuri şi face posibilă colonizarea pajiştilor din centrul oraşului.

Cuvinte cheie: Carabidae, ecosisteme urbane, Europa Centrală, ecologia cenozelor, diversitatea speciilor.

INTRODUCTION

Urban ecosystems represent, in dependence on the city size, form of its territory and character of surrounding landscape, an enormously complex mosaic of ecosystems, in which almost natural habitats can neighbor with strongly influenced habitats, without continuously surviving populations of individual species (NIEMELA 2011; MĂGURA et al., 2008, 2018). Depending on the historical development of the city and the character of geographical relief, seminatural habitats can occur deep in city center and act as biocorridors. The intensive illumination attracts many insects into the city center (ŠUSTEK 1999a; OWENS 2019), where they can colonize the suitable habitats, especially in grassy plots and parks and cemeteries with sparse wooden vegetation.

Carabid assemblages in urban ecosystems were a focus of many authors. In Europe they were studied in Kiel (TOPP, 1972), Leipzig (KLAUSNITZER & RICHTER, 1980; KLAUSNITZER et al., 1980), Warsaw (CZECHOWSKI, 1980a; 1980b; 1981a; 1981b; 1982), Moscow (DUSHENKOV, 1983), Brno (ŠUSTEK, 1979; 1983; ŠUSTEK & VAŠÁTKO 1984a; 1984b), Nitra (MAJZLAN & FRANTZOVÁ, 1995), Birmigham (SMALL et al., 2003), Helsinki (ALARUIKKA et al., 2002; VENN et al., 2003), Berlin (DEICHSEL, 2006) and Debrecen (MĂGURA et al., 2008; 2018), while in West Mediterranean in Madrid (ŠUSTEK, 2012), in East Asia in Pyongyang (ŠUSTEK, 2011) and in USA in Central Minnesota (GANDHI et al., 2011). Recently, urban carabid communities were studied in Lvov, Kijev, Charkow, Donetsk and Dneprov (NIKOLENKO, 2018; PUTCHKOV et al., 2019). In Bratislava the carabids were studied by ŠUSTEK (1984a), but among his results only various more general analyses of community structure (ŠUSTEK, 1980; 1987) or species behaviour were published (ŠUSTEK 1999a, 1999b), while the list of species found in each locality has remained unpublished because of the large extent of the tables. A synthesis of many papers on urban fauna and urban ecology in general was recently compiled by NIEMELÄ et al. (2011). The carabid fauna of Devínska Kobyla was also studied by KORBEL et al. (1997), MAJZLAN & BAŤALÍK (1997), ŠUSTEK (2004a) and MAJZLAN et al. (2005).

The aim of this paper is to synthesize the results of samplings carried out in Brno and Bratislava in the period 1978 – 2006 in 57 localities (11 localities in Brno, 46 in Bratislava - eight of them were studied repeatedly) representing an ecological gradient ranging from seminatural oak-hornbeam or floodplain forests on the city margin to gardens in residential quarter and parks or abandoned places in the very city interior.

MATERIAL AND METHODS

The beetles were pitfall-trapped. The number of traps varied according to size and character of the studied plots and possibility to hide them before the public. In seminatural, less frequented sites, five traps were installed in a line in distances of 10 m. In the city center number of traps was limited to 1-2. The traps were exposed each year from early April until late October, in 2005/2006, including the whole winter. They were emptied approximately once a month. The samples from Devínska Kobyla, Dúbravská Hlavica, Horský park, Mlynská Dolina, Briežky and Koliba were collected by Milada Holecová, those from Brno Ráječek and Soběšice by Aleš Merta, while those from Kraví Hora by Jaroslav Vašátko. All beetles were identified by the author using the keys by KULT (1947) and HŮRKA (1996). The nomenclature is taken from HŮRKA (1996) and the complete specific names are alphabetically ordered in Annex 1.

The carabids were characterized by their preference for humidity and shadowing using two semiquantitative scales (1 – xerophilous to 8 polyhydrophilous; 1 – open landscape species to 4 – species requiring complete shadowing by tree vegetation) proposed by ŠUSTEK (2004b) (Annex 1). The characteristics of ecological requirements were taken from BURMEISTER (1939), LARSSON (1939), LINDROTH (1949), THIELE (1977) and HŮRKA (1996), and précised by results of numerous zoocoenological studies made in Central Europe. On this basis, the shadowing and humidity index of community was calculated for each year as arithmetical average of all species weighted by number of each species. The obtained values were used for the direct ordination of the communities (POOLE, 1974).

The dominance is characterized by the following scale: > 10% eudominant, 5–10% dominant, 2–5% subdominant,1–2% recedent, < 1% subrecedent (SCHWERDTFEGER, 1975).

The hierarchical classification was made by the UPGMA method and the indirect ordinations were made by the principle coordinate method. In both cases, the Horn index reflecting the proportional similarity was used. For the canonical correlation analysis, three factors characterizing the individual sites were chosen: altitude, surface and coverage of the layers F0 – F3. The equitability calculated on the base of Shannon Wiener's index was used as a diversity measure. All calculations were executed by the Program Past, version 2012 (HAMMER, 2012).

STUDY PLOTS

Here a general characteristic of study plots is presented. For the quantitative characteristiocs and abbreviations of locality names see Annex 2.

Bratislava – suburbs

- Devínska Kobyla and Dúbravská hlavica – four plots in mature oak-hornbeam forests in the State Nature Reserve Devínska Kobyla
- Horský park – a forest park founded in the late 19th century on the west slopes of foothills of the Little Carpathians, surrounded by residential quarter with family houses, four different plots
- Kalvária: a mature oak-horn beam stand isolated between the proper city center and residential part with family houses surrounded by gardens, arisen secondarily on the place of former pastures in mid 19th century
- Koliba and Briežky – oak-hornbeam forests on southern slopes of Little Carpathians, immediately at the margins of residential quarter with family houses and gardens
- Mlynská dolina – a mature oak-hornbeam stand with admixed locust trees on a steep western slope in western part of Bratislava
- Sitina: a mature oak-horn beam stand with admixed locust trees and cherries, arisen secondarily on the place of former vineyards in mid 19th century
- Vrakuňa forest – a profoundly altered remnant of a former floodplain forest at the Little Danube, locust trees predominate
- Vrakuňa oxbow – reed and nettle stand around the Little Danube dead arm
- Vrakuňa ruderal – a dump of construction wastes in vicinity of the Little Danube dead arm, discontinuous ruderal herbage vegetation
- Vrakuňa wheat field – a field in the eastern part of the city, adjacent to the Vrakuňa forest locality
- Vydrica sanatory – alluvium of the Vydrica creek, high tree vegetation, Little Carpathians
- Vydrica ZOO - alluvium of the Vydrica creek, sparse tree and shrubby vegetation on the creek bank
- Vydrica Slovák – a small remnant of floodplain forest along the Vydrica creek
- Vydrica crossing – a narrow strip of shrubs and tree vegetation the along the Vydrica creek at Botanical garden
- Železná studnička – natural oak-hornbeam forest in the valley of the Vydrica creek, in Little Carpathians

Bratislava - city center

- Americké námestie square - urban park, grassy plots and sparse trees and shrubs
- Bajkalská street – a large meadow-like abandoned area at the crossing of the Bajkalská and Ružinovská streets
- Hlavné námestie square – urban park in the very historical center, grassy plots sparse trees and shrubs, in late 1990-ies all vegetation removed
- Hradný vrch – southern slope of the Bratislava castle hill, secondary shrub vegetation
- Kollárovo námestie square – urban park, grassy plots and sparse trees and shrubs
- Líštiny, grassy plot in surrounding of buildings of the Slovak Academy of Sciences within the garden area in the western part of Bratislava
- Líštiny, vineyard – an abandoned vineyard in the garden area in the western part of Bratislava
- Medická záhrada - park, grassy plots and sparse trees and shrubs
- Notre Dam – a small plot with high trees and shrubs at the Notre Dam church
- Ondrejský cintorín – cemetery founded in 1784, used until 1950-ies, now transformed into a park, most monuments removed, grassy and sparse shrub vegetation under dense high trees
- Prior, small and large plots – two plots densely covered by thujas, at the Prior store in the Kamenné námestie square, now turned into grassy plots
- Petržalka – poplar stand – a remnant mature floodplain forest on the Danube right bank
- Sad Janka Kráľa – urban park founded in late 18th in the Danube alluvium, grassy plots and sparse shrubs under dense tree vegetation
- Šafárikovo námestie square - urban park, grassy plots and sparse trees and shrubs
- Uršulínska street– a small grassy plot along the City hall

Brno

- Břenkova street – a garden in the residential quarter founded in late 1920-ies, sparse fruit trees
- Čertova rokle and Hakenova streets– secondary tree (pines and oaks) and shrub vegetation on slopes of deep erosion rills, until early 1960-ies a military exercise area, since late 1968 a modern housing estate
- Kraví hora – a grassy plot in the extensive "Schrebergarten" colony
- Líšeňská – an apricot and apple orchard in the eastern part of the city
- Lužánky – park founded in 1780ies in the alluvium of the Ponávka creek, grassy plots and sparse shrubs and trees
- Námestí 28. října – an urban park founded in 1890-ies in the alluvium of the Ponávka creek, grassy plots and sparse shrubs and trees
- Ráječek – a remnant of a floodplain forest along the Svitava river
- Soběšice – a reed stand on shores of a small fish pound in northern part of Brno
- Špilberk southern slope –park with secondary, predominantly shrubby vegetation around the medieval fortres, up to 19th century deforested
- Špilberk northern slope - park with secondary high tree vegetation around the medieval fortres, up to 19th century deforested

RESULTS

Structure of assemblages

In all localities 162 species were recorded. They represent approximately 25 % of the species recorded in Moravia or Slovakia (HŮRKA, 1996) and most of all species known to occur in forest and non-forest ecosystems at the altitudes of 130 – 380 m or in the oak to oak-beech vegetation tier (RAUŠER & ZLATNÍK, 1966; ZLATNÍK, 1976, ŠUSTEK, 2000).

In two shore and 13 floodplain sites 9,631 individuals belonging to 113 species were caught (Annex 3). The species number in individual sites ranges from 11 to 28 (mean 24.27, s.d. 12.12, while the numbers of individuals in one-year samples move from 77 to 1962 (mean 646.07, s.d. 498.87). There are 17 species (in decreasing order of presence: *P. assimilis, P. atrorufus, P. niger, P. strenuus, C. granulatus, P. anthracinus, P. melanarius, P. nigrita, A. parallelopipedus, L. caerulescens, N. brevicollis, O. obscurus, A. moestum, A. dorsalis, B. bullatus, E. micans, P. oblongopunctatus* and *S. pumicatus*) occurring in 40.0-86.7% of sites and representing even 80,9% of all individuals. These species were eudominant or subdominant in most of sites studied. Besides it, several strongly hydrophilous species like *O. helopioides, B. biguttatum, D. globosus* or *B. peltatus* occurred abundantly at least in one site (Annex 3).

In some sites, an interference with neighboring mesohygrophilous forests or non-forest habitats exists. In all sites along the Vydrica creek it is shown first of all by the occurrence of the mesohygrophilous *A. paralelopipedus* and *P. oblongopunctatus*, while in the sites Vrakuňa oxbow and Vrakuňa forest by the open landscape species *A. dorsalis, P. rufipes* and *T. quadristriatus* (Annex 5). Other xenocoenous species occurred in shore and floodplain habitats only rarely.

In the mesohydrophilous forests 7,480 individuals belonging to 74 species were trapped (Annex 4). The species number in individual sites ranges from 5 to 27 (mean 13.8, s.d. 5.6), while numbers of individuals in one-year samples move from 21 to 1492 (mean 299.2, s.d. 303.93). 12 species (in decreasing order of presence *A. parallelopipedus, C. coriaceus, C. nemoralis, H. atratus, A. parallelus, C. hortensis, C. glabratus, C. intricatus, P. rufipes, P. diligens, C. convexus* and *C.*

ullrichi) occurred in 40-100% of sites and represented 81.2% of individuals (Annex 4). Among them, the expansive open landscape species *P. rufipes* was xenocenous in the forest-like habitats, but it was represented in them by 22 individuals only. Further strongly represented xenocoenous species were *H. tardus* and *A. saphyrea* and *A. familiaris* in Bratislava Klavária. Otherwise, open landscape species (*Harpalus* ssp. *Ophonus* spp. and *Amara* spp.) were little represented in the forest or forest-like habitats. A remarkable occurrence was seen of *A. bombarda* in Devínska Kobyla and Dúbravská hlavica because of local occurrence in Slovakia. The interference with the massive of Little Carpathians was manifested by occurrence of *P. burmeisteri, T. pilisensis, T. pulchellus, C. glabratus, C. violaceus* and *C. attenuatus* in the site at northern margin of Bratislava (Koliba, Briežky, Železná studnička).

In 25 localities without continuous tree vegetation, 1,924 individuals were recorded belonging to 80 species (Annex 5). The species number in individual sites ranged from 3 to 29 (mean 9.89, s.d. 6.40), while number of individuals from 4 to 332 (mean 75.61, s.d. 95.08). The species were very unequally represented in individual sites. Only two species (*Anchomenus dorsalis* and *Pseudoophonus rufipes*) were present in 56% of sites, next four species (*Bembidion lampros, Harpalus affinis Pterostichus melanarius, Amara aenea*) in 40-48% of sites. These six species represented altogether 58.23% of individuals (Annex 5). 12 species occurred in 20-32% of sites and represented 19.58 of individuals. In contrast, 29 species were recorded in only one site, 16 species in two localities and 12 in three localities (Annex 5). The abundance of species varied extremely, from 1 individual to several tens of individuals. This variability is best indicated by the variance coefficients ranging mostly from 1.79 to 5.0.

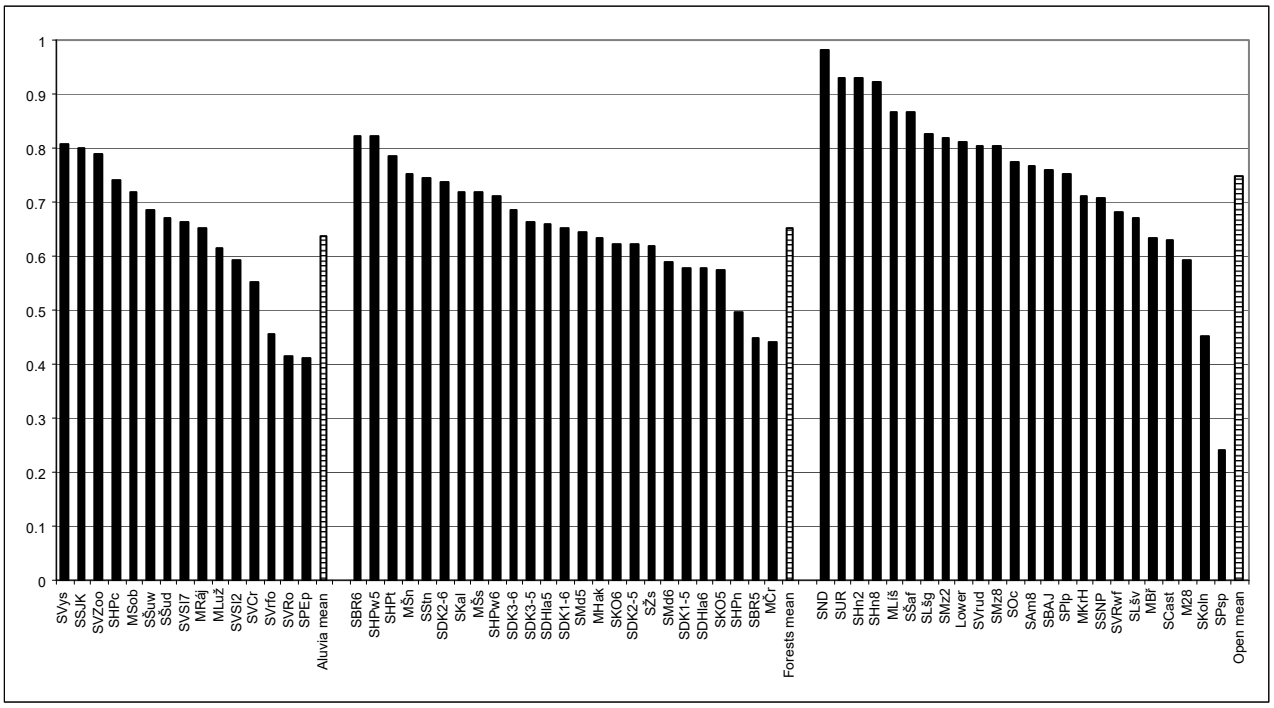

Figure. 1. Equitability of Carabit assemblages in three types of habitats in urban and suburban landscape in Bratislava and Brno (abbreviations of locality names see Annex 2).

The equitability of assemblages in all three basic habitat types differs considerably (Fig. 1), but in all types there are assemblages with balanced representation of competing species of similar ecological requirements or they represent ecotonal assemblages with more or less balanced representation of species of different ecological requirements. In particular it is visible in habitats with sparse tree vegetation or without it in the city center, where a small number of different species temporarily meets in one site. From this reason the equitability in assemblages from the city center is in general higher. However, in all three types of habitats there are assemblages with 1-2 eudominant species that successfully survive in disturbed habitats. The equitability of such assemblages is low. Examples of such assemblages are Poplar stand in Bratislava-Petržalka with eudominant *P. assimilis*, Bratislava Briežky with enormously dominant *P. diligens* Prior, small plot with increased abundance of *B. lampros.*

Classification and ordination of the assemblages

The studied assemblages form three large clusters at the similarity level 0.10, They correspond to three basic habitats type – alluvial and riparian habitats dominated by the polyhrophilous species *P. assimilis* or *A. moestum*, mesohygrophilous oak-hornbeam forests with dominance of *A. parallelopipedus* and the habitats with no or sparse tree vegetation (Fig. 2) with predominance of the expansive *P. rufipes*. The cluster of assemblages from alluvial habitats is structured according to alternative predominance of three polyhygrophious species *P. anthracinus, P. nigrita, P. atrorufus* or two less hygrophilous species *N. brevicollis* or *A. parallelus*. The assemblages from mesohygrophilous forests form smaller clusters according to

predominance of *P. diligens*, species combination of *C. hortensis, C. convexus* and *A. bombarda* or combination of *C. coriaceus* and *C. nemoralis* or by exclusively predominant *A. parallelopipedus.*

The assemblages from habitats without shadowing are furthermore differentiated according to higher representation of more or less heliophilous species *B. lampros, A. dorsalis, O. signaticornis, H. affinis, H. distginguendus* and the combination of *P. griseus* and *A. dorsalis* or in places with sparse tree or shrubby vegetation by the more eurytopic species *L. ferrugineus* or *T. quadristriatus*. The southern slope of the Bratislava castle hill and two plots from Líštiny take an isolated position due to exclusive occurrence of *O. subsinuatus* and increased dominance of more eurytopic *C. fuscipes*. The clustering pattern (Fig. 2) shows that the assemblages without shadowing have much more unstable composition that those from alluvial or forest habitats.

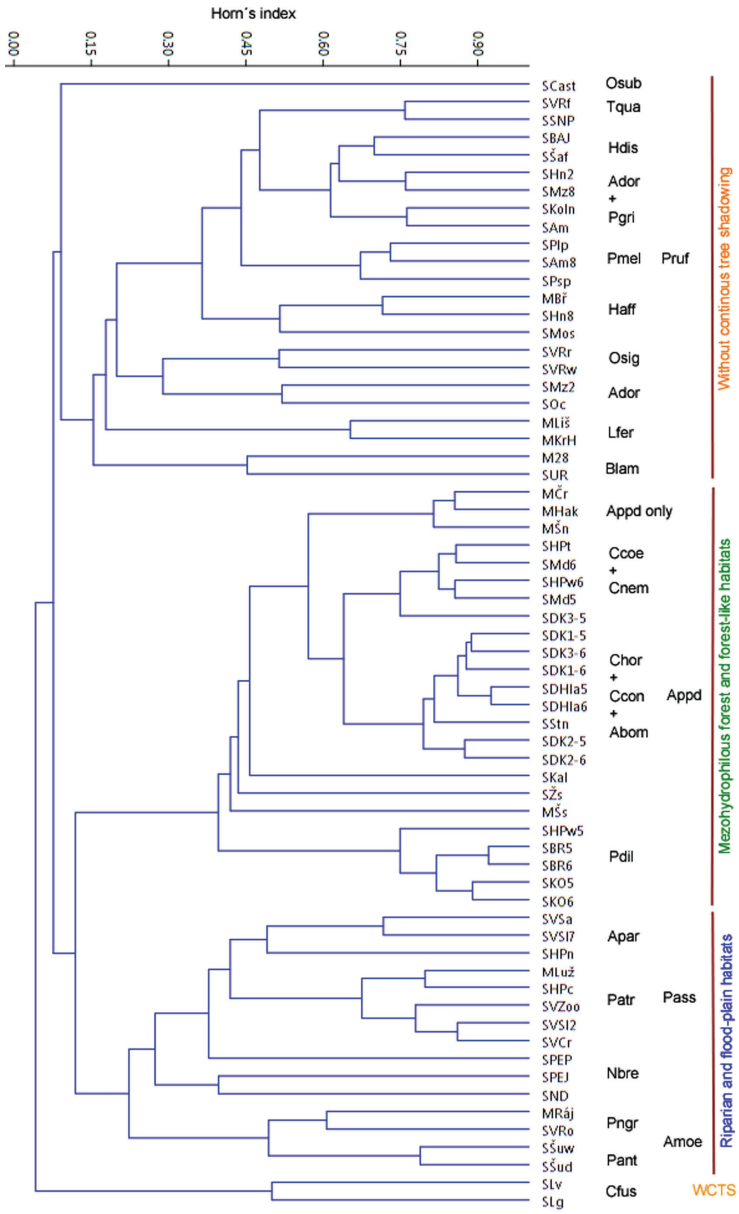

Figure 2. Hierarchical classification of Carabid assemblages in Bratislava and Brno (for abbreviation of species names see Annex 1 and for the locality names see Annex 2).

The continuous transitions between assemblages from habitats with complete shadowing to those without shadowing in mesohygrophilous sites and between alluvial habitats are clearly shown by ordination diagrams. (Figs. 3 - 5). The principal coordinate analyses (Fig. 3) shows a stronger interference between the assemblages from the mesohygrophilous habitats with and without shadowing, whereas the direct ordination according the humidity and vegetation cover preference shows a stronger interference between the assemblages from the mezohygrophilous an alluvias habitats with shadowing (Fig. 4). In this case, four groups of assemblages can be distinguished. A very compact group of assemblages from mesohygrophilous forest or forest-like habitats is formed in the right lower corner. Two assemblages from forest habitats are shifted to left – that from southern slope of Špilberk in Brno and from Kalvária in

Bratislava. In Špilberk this shift is caused by balanced representation of two forest species *A. paralellopipedus* and *H. atratus* accompanied by several open landscape species. In Kalvária a still stronger shift is caused by high abundance of *H. tardus* and *A. saphyrea*. In the central lower part, a group of assemblages from sites with partial shadowing with trees or shrubs, where eurytopic species (*C. fuscipes, L. ferrugineus, P. melanarius*) or preferably forest species (*H. atratus, P. niger*, *C. intricatus*) are represented. In the left lower part, assemblages from the sites in the very city center or from sites with absence of wooden vegetation are concentrated (Fig. 4).

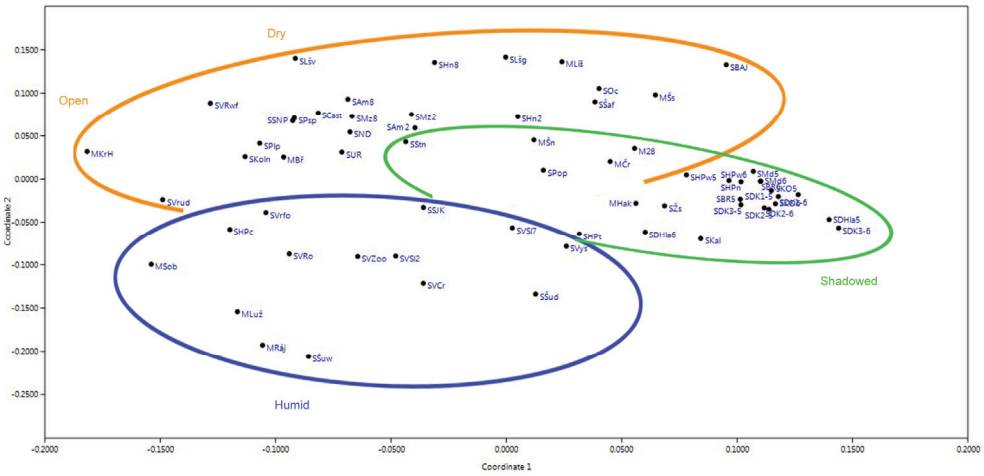

Figure 3. Principal coordinate ordination of Carabid assemblages in Bratislava and Brno according to humidity and vegetation cover preference (for abbreviation of species names see Annex 1 and for the locality names see Annex 2).

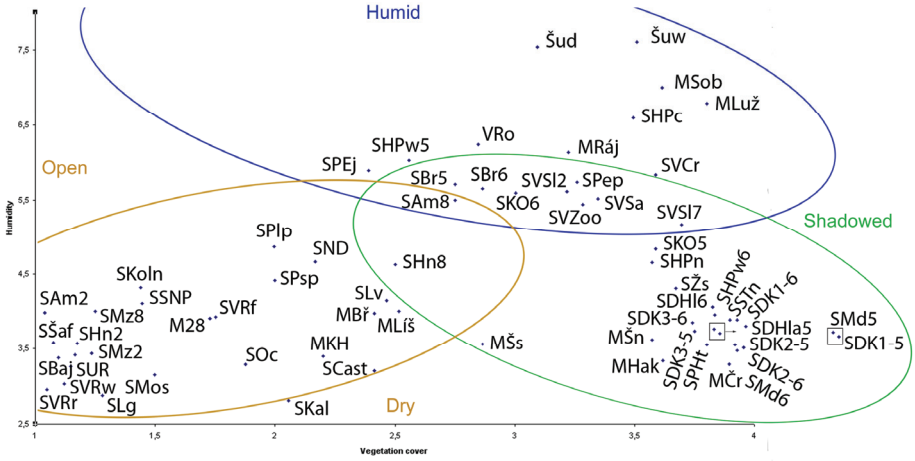

Figure 4. Direct ordination of Carabid assemblages in Bratislava and Brno according to humidity and vegetation cover preference (for abbreviation of species names see Annex 1 and for the locality names see Annex 2).

In the diagram of canonical correlation (Fig. 5) the assemblages from all three habitat types are separated in own quadrants and those from mesohygrophilous and floodplain forests are associated with coverage and to a limited degree also study plot size and altitude. However, the gradient between assemblages from floodplain and mesohygrophilous forest is more fluent.

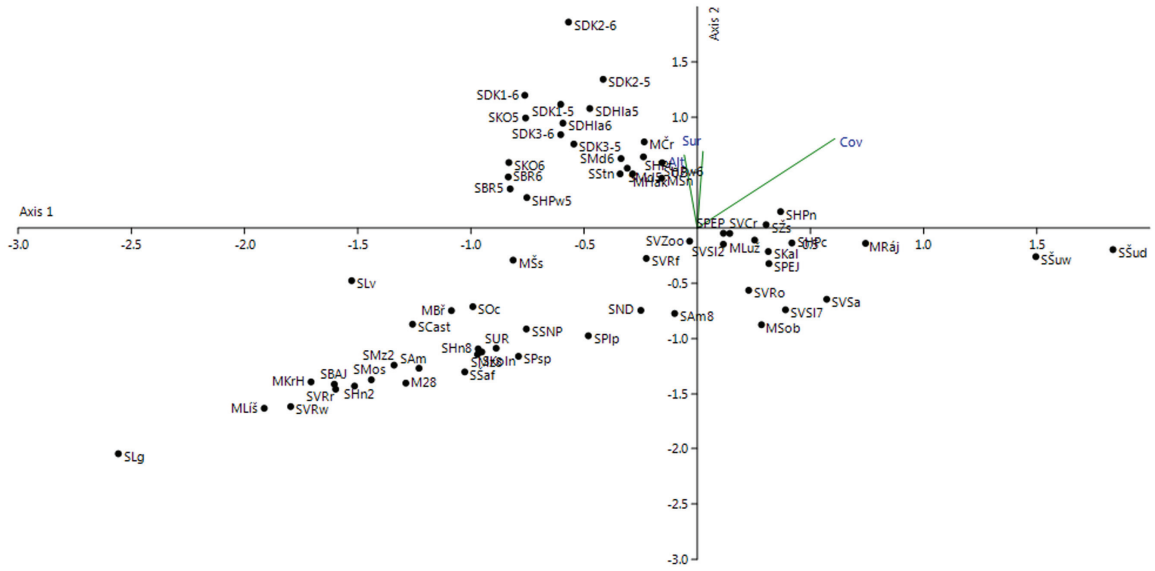

Figure 5. Canonical correlation of Carabid assemblages in Bratislava and Brno (Ar – surface of study plot, Alt – altitude, Cov – tree vegetation coverage, for abbreviation of the locality names see Annex 2).

In all ordination diagrams the dispersion of assemblages from the habitats without or with partial shadowing is larger and cluster analysis indicates a greater heterogeneity and randomness of representation of different species with similar ecological requirements.

DISCUSSION AND CONCLUSIONS

The forest stands preserving their integrity, independently on the composition of tree species and the often considerable representation of locust trees and other xenocoenous trees, offer suitable conditions for survival of most mesohygrophilous or hygrophilous forest species. These species are able to preserve or re-establish assemblages showing at least some basic features of the assemblages in natural or seminatural forest ecosystems in free landscape in Central Europe (ŠUSTEK, 1984a; 1984b, 2000). The tolerance of individuals of forest carabids is highly proportional to their quantitative representation in the natural ecosystems in corresponding conditions in free landscape in Central Europe (ŠUSTEK, 1976; 1983). Among the mesohygrophilous species the most tolerant is *A. parallelopipedus* followed by C. *coriaceus, C. hortensis, C. nemoralis* and *M. piceus,* while among the hygrophilous species in alluvia the most tolerant are *Agonum moestum, Patrobus atrorufus* and *Nebria brevicollis.*

The ability of some species of genus *Carabus* to survive in Bratislava was much higher (11 species) than in Brno (2 species), but in both cities it was much lower than in some big cities in Ukraine (PUTCHKOV et al., 2019), where even 21 species were recorded. In contrast, only two species were recorded in Berlin (DEICHSEL, 2006), one of which abundantly (*C. nemoralis*) A special case is occurrence of *C. intricatus* in both cities. It is made possible by the admirable ability of this species to overcome the vertical obstacles (ŠUSTEK, 1999b).

The composition of Carabid assemblages in the city center is predominantly regulated by several factors: absence or low density of tree or dense shrub vegetation on non built-up areas, isolation from the free landscape by different constructions, a limited area that does not allow establishment of independent prospering populations, strong dependence on spreading ability of species or more precisely ability to fly. Due to it, the Carabid assemblages in the city centers consist predominantly of the species inhabiting the arable land in city surrounding, but in some sites there is also considerably increased proportion of hygrophilous species characteristic of floodplain forests or riparian habitats. Similarly as in the forest-type urban ecosystem, the composition of the Carabid assemblages reflects the quantitative representation of individual species in the arable land. Thus the most frequent and abundant species in most parks and gardens in the city interior is *P. rufipes* showing an enormous expansivity, especially in warm evenings by turn of July and August (LINDROTH 1949; ŠUSTEK 1999a, 2014). It is followed by *A. dorsalis* and *B. lampros* or *B. properans.* However, unlike the forest type urban ecosystems, the composition of Carabid assemblages in very city center is much more variable and, due to certain degree, occasional (MAGURA et al., 2018). This variability (randomness) results from a large number of species of the genera *Ophonus* (in Central Europe 19 species, in the studied material 10 species), *Harpalus* (42/13 species) and *Amara* (52/12 species) with similar ecological requirements, but except for few almost anywhere abundant species (*O. brevicollis, H. latus, H. tardus, A. aenea, A. familiaris*) occurring locally and mostly in subdominant or subrecedent position (ŠUSTEK, 1994). For this reason, their chance to invade a site in the city centre depends on the momentary situation and local conditions. An example of their relatively high abundance is visible in just one site (Annex 5) *A. bifrons* in ruderal site at Vrakuňa, *H. rubripes* in grassy plot in Líštiny, *O. subsinuatus* in the Bratislava castle, but otherwise by a very dispersed occurrence of 1-2 individuals in all localities.

In spite of the fact that most Carabid species recorded in the very city center originate from the arable land in the city surrounding, some of such species, which reach high abundances in arable land, are rare in the city center. This is mainly valid for *P. cupreus* and *D. halensis* that are especially frequent in the fields. Similarly, the typical field species *C. auropunctatum*, recorded in more big cities in Ukraine (PUTCHKOV et al., 2019), was also found in Bratislava just in one meadow-like plot in the Bajkalská street. In general, the structure of the Carabid assemblages in center of Brno and Bratislava was most similar to that published recently by NIKOLENKO (2018) from Kharkov. In contrast, there was a considerable similiratity between the assemblages from alluvial sites in Bratislava and Brno and those from Berlin (DEICHSEL, 2006), which were also collected in habitates close to rivers.

A completely unique case was two small plots in the Kamenné námestie square in Bratislava at the Prior supermarket (now Tesco), where a surprisingly high number of *P. melanarius* and *P. niger* occurred under a dense stand of thuja. Both species are known to inhabit the floodplain forests and to change there suddenly their density according to momentary changing humidity conditions (ŠUSTEK, 1993). *P. niger* also quickly colonizes the reed stands shortly after longtermed flooding, where it co-occurs with so prominently hydrophilous species like *C. clathratus* (ŠUSTEK, 2010).

A significant feature was the recording of rare species in higly altered habitats, like *A. gracilipes* in Bratislava Americké námestie or *D. dentata* in the waste dump in Bratislava Vrakuňa (Annex 5), or *C. vaporariorum* and *C. cingulata* and specialized *C. clathratus* in seminatural forests and in the suburban zone (Annex 3 and 4).

In general it can be stated that even the intensively exploited and disturbed urban landscape is still able to preserve conditions for the long-term or at least temporary survival of a rich Carabid fauna.

ACKNOWLEDGEMENTS

.

The paper was prepared due to the financial support of the projects VEGA 1/0370/18.

REFERENCES

ALARUIKKA D., KOTZE D. J., MATVEINEN K., NIEMELÄ J. 2002. Carabid beetle and spider assemblages along a forested urban-rural gradient in southern Finland. *Journal of Insect Conservation*. Edit. Springer. New York. **6**: 195-206.

BURMEISTER F. 1939. *Biologie, Ökologie und Verbreitung der europäischen Käfer auf systematischer Grundlage. I. Band; Adephaga I, Familiengruppe: Caraboidea*. Hans Goecke Verlag. Krefeld. 307 pp.

CZECHOWSKI W. 1980a. Influence of the manner of managing park areas and their situation on the formation of the communities of carabid beetles (Coleoptera, Carabidae). *Fragmenta faunistica*. Edit. Państwowe Wydawnictwo Naukowe. Warszawa. **25**: 199-219.

CZECHOWSKI W. 1980b: Carabids (Coleoptera, Carabidae) of the Wistula escarpments in Warszaw. *Fragmenta faunistica*. Edit. Państwowe Wydawnictwo Naukowe. Warszawa. **25**: 293-316.

CZECHOWSKI W. 1981a. Carabids (Carabidae, Coleoptera) of Warszaw and Mazowia. *Memorabilia zoological* Edit. Ossolineum. Wrocław – Warszawa- Kraków – Łódż. **34**: 119-144.

CZECHOWSKI W. 1981b. Influence of environment urbanisation on seasonal dynamics of carabids (Coleoptera, Carabidae) (in Polish). *Przegląd zoologiczny*. Edit. Państwowe Wydawnictwo Naukowe. Warszawa. **26**: 68-74.

CZECHOWSKI W. 1982. Occurrence of carabids (Coleoptera, Carabidae) in the urban greenery of Warsaw according to the land utilization and cultivation. *Memorabilia zoological*. Edit. Ossolineum. Wrocław – Warszawa-Kraków – Łódż. **39**: 1-108.

DEICHSEL R. 2006. Species change in urban setting - ground and rove beetles (Coleoptera: Carabidae and Staphylinidae) in Berlin. *Urban Ecosystems*. Edit. Springer. New York. **9**: 161-178.

DUSHENKOV V. M. 1983. On carabid fauna of Moscow (in Russian). *Fauna i ekologija pochvennykh bespozvonochnykh*. Edit. Nauka. Moskva: 111-112.

GANDHI K. J. K., EPSTEIN M. E., KOEHLE J. J., PURRINGTON F. F. 2011. A quarter of a century succession of epigaeic beetle assemblages in remnant habitats in an urbanized matrix (Coleoptera, Carabidae). *ZooKeys*. Edit. Pensoft. Sofia. **147**: 337-689.

HAMMER Ø. 2012. PAST: *Paleontological Statistics, Version 2,16 Reference manual*. Natural history museum, University of Oslo. Oslo. 227 pp.

HŮRKA K. 1996. *Carabidae of the Czech and Slovak Republic*. Edit. Kabourek. Zlín. 565 pp.

KLAUSNITZER B. & RICHTER K. 1980. Qualitative und quantitative Aspekte der Carabidenfauna der Stadt Leipzig. *Wissenschaftliche Zeitschrift der Universität Leipzig, Mathematisch-naturwissenschaftliche Reihe*. Edit. Univesität Leipzig. Leipzig. **29**: 567-573.

KLAUSNITZER B., RICHTER K., KÖBERLEIN C., KÖBERLEIN F. 1980. Faunistische Untersuchungen der Bodenarthropodes zweier Leipziger Stadtparks unter besonderer Berücksichtigung der Carabiden und Staphyliniden. *Wissenschaftliche Zeitschrift der Universität Leipzig, Mathematisch-naturwissenschaftliche Reihe*. Univesität Leipzig. Leipzig. **29**: 583-597.

KORBEL L., RYCHLÍK I., MAJZLAN O. 1997. Epigaeic beetles (Coleoptera) of the Devínska Kobyla hill (the Malé Karpaty mountains, SW Slovakia). *Biologia, Bratislava*. Edit. Veda. Bratislava. **52**: 263-272.

KULT K. 1947. *Klíč k určování brouků čeledi Carabidae Československé republiky*. Edit. Československá společnost entomologická. Praha. 200 pp.

LARSSON S. G. 1939. Entwicklungstypen und Entwicklungszeiten der dänischen Carabidae. *Entomologisk Meddeeleser*. Edit. Entomologisk forening. København. **20**: 277-560.

LINDROTH C. H. 1949. *Die Fennoskandischen Carabidae I. Spezieller Teil*. Wettergren & Kerbers Förlag. Göteborg. 710 pp.

MĂGURA T., TÓTHMÉRÉSZ B. & MOLNÁR T. 2008. A species-level comparison of occurrence patterns in carabids along an urbanisation gradient. *Landscape and Urban Planning*. Edit. Elsevier. Amsterdam. **86**: 134-140.

MĂGURA T., LŐVEI G., TÓTHMÉRÉSZ B. 2018. Conversion from environmental filtering to randomness as assembly rule of ground beetles assemblages along an urbanisation gradient. *Scientific reports*. Edit. Springer. New York. 2018(8) **16692**: 1-9.

MAJZLAN O. & BAŤALÍK P. 1997. Taxocoenoses of carabids (Coleoptera, Carabidae) as a part of epigeon of the Devínska Kobyla National Nature Reserve (in Slovak). *Folia faunistica Slovaca*. Edit. Faunima. Bratislava. **2**: 57-60.

MAJZLAN O. & FRANTZOVÁ E., 1995. Structure and dynamics of Carabids (Coleoptera, Carabidae) in epigeon of the Nitra town interior (in Slovak). *Rosalia*. Edit. CHKO Ponitrie. Nitra, **10**: 107-118.

MAJZLAN O., RYCHLÍK I., KORBEL L. 2005. Beetles (Coleoptera) (in Slovak). In MAJZLAN (Ed.), Fauna Devínskej Kobyly. *Asociácia priemyslu a ochrany prírody* (edícia APOP). Bratislava. 87-117.

NIEMELÄ J., BREUSTE J. H., GUNTENSPERGEN G., MCINTYRE N. E., ELMQVIST T. J. P. 2011. *Urban Ecology Patterns, Processes and Applications.* Oxford University Press. Oxford. 388 pp.

NIKOLENKO N. J. 2018. Ekologo-faunystytchnyj ogljad karabidofauny (Coleoptera, Carabidae) urbotsenozyv m. Kharkova. *Ekologja ta biologja*. V. N. Karazin Kharkiv National University. Kharkiv. **20**: 58-53.

OWENS A. C. S., COCHARD P., DURANT B., FARMWORTH J., PERKIN E. K., SEMORE B. 2019. Light pollution is a driver of insect declines. *Bioconservation*. http://dx.doi.org/10.2139/ssrn.3378835 (accessed February 2019).

POOLE R. W. 1974. *An introduction to quantitative ecology*. McGraw-Hill. New York. 532 pp.

RAUŠER J. & ZLATNÍK A. 1966. *Biogeography I. National atlas of Czechoslovakia, folio 21*, offprint (in Czech).

PUTCHKOV A. V., BRYGADYRENKO V. V., MARKINA T. V. 2019. Ground beetles of the tribe Carabini (Coleoptera, Carabidae). *Vestnik zoologii*. Schmalhausen Institute of Zoology National Academy of Sciences of Ukraine. Kiev. **53**: 3-12.

SMALL E., SADLER J. P., TELFER, M. 2003. Carabid beetle assemblages on urban derelict sites in Birmingham, UK. *Journal of Insect Conservation*. Springer International Publishing. New York**. 6**: 233-246.

SCHWERDTFEGER F. 1945. *Ökologie der Tiere. Synökologie*. Verlag Paul Parey. Hamburg - Berlin. 452 pp.

ŠUSTEK Z. 1976. *Role of carabids and staphylinids in forest geobiocoenoses* (thesis, in Czech). Edit. Vysoká škola zemědělská, Fakulta lesnická. Brno. 64 pp.

ŠUSTEK Z. 1979. Geoecology of the parks of Brno city: a case study of carabids and staphylinids in the Lužánky park (in Czech). *Zprávy Geografického ústavu ČSAV Brno*. Edit. Geografický ústav SAV. Brno. **16**: 156-174.

ŠUSTEK Z. 1980. Some connections of geographic distribution of carabids (Col. Carabidae) and their ability to colonize urbanized landscape ecosystems (in Czech). *Zprávy Geografického ústavu ČSAV Brno.* Edit. Geografický ústav SAV. Brno. **18**: 30-40.

ŠUSTEK Z. 1983. The comparison of the Carabidae and Staphylinidae (Ins., Col.) in the selected geobiocoenoses of Pavlovské kopce hills during the years 1971–1981. *Biológia (Bratislava).* Edit. Veda. Bratislava. **38**: 105-115.

ŠUSTEK Z. 1984a. *Bioindication ability of carabids and staphylinids (Coleoptera, Carabidae et Staphylinidae) of big central European cities* (PhD thesis, in Slovak). Institute of Experimental Biology and Ecology of the Centre of Biological and Ecological Sciences of the Slovak Academy of Sciences. Bratislava. 366 pp.

ŠUSTEK Z. 1984b: Carabidae and Staphylinidae of two forest reservations and their reactions on surrounding human activity. *Biológia (Bratislava)*. Edit. Veda. Bratislava. **39**: 137-162.

ŠUSTEK Z. 1987. Changes in body size structure of Carabid communities (Coleoptera, Carabidae) along an urbanisation gradient. *Biológia (Bratislava).* Edit. Veda. Bratislava. **42**: 145-156.

ŠUSTEK Z. 1993. Fluctuations of populations of *Pterostichus melanarius* and *Pterostichus niger* and their interpretation. In: LISICKÝ (Ed.): *Výsledky a skúsenosti z monitoringu bioty územia ovplyvneného vodným dielom Gabčíkovo*. Edit. Ústav zoológie a ekosozológie SAV. Bratislava. 1-450.

ŠUSTEK Z. 1994. Impact of pollution by nickel leachibng rest on Carabidae, Silphidae and Staphylinidae in the surrounding of the nickel smelting plant at Sereď (Slocakia, Central Europe. *Biologia, Bratislava*. Edit. Veda. Bratislava. **40**: 709-721.

ŠUSTEK Z. 1999a. Light attraction of carabid beetles and their survival in the city centre. *Biologia (Bratislava).* Edit. Veda. Bratislava. **54**: 539-551.

ŠUSTEK Z. 1999b. A curious case of wall climbing in *Carabus intricatus*: do the carabids orient by odour trails? *Entomofauna carpathica*. Slovenská entomologická spoločnosť pri SAV. Bratislava. **11**: 58-62.

ŠUSTEK Z. 2000. Carabid communities (Coleoptera, Carabidae) and their use as supplementary characteristics of geobiocoenologic units: problems and state of knowledge (in Slovak). In: ŠTYKAR. & ČERMÁK (Eds),

Geobiocenologická typizace krajiny a její aplikace. *Geobiocenologické spisy.* Mendelova Universita. Brno. **5**: 18-30.

ŠUSTEK Z. 2004a. Carabid communities (Col. Carabidae) in degradation stages of pubescent oak forests (Corni-Querceta deg.) in oak vegetation tier. In: POLEHLA. (Ed.), Hodnocení stavu a vývoje lesních geobiocenóz. Sborník příspěvků z mezinárodní konference 15.-16. 10. 2004 v Brně. *Geobiocenologické spisy*. Mendelova Universita. Brno. **9**: 203-209.

ŠUSTEK Z. 2004b. Characteristics of humidity requirements and relations to vegetation cover of selected Central-European carabids (Col., Carabidae). In: Polehla (Ed.), Hodnocení stavu a vývoje lesních geobiocenóz. Sborník příspěvků z mezinárodní konference 15.-16. 10. 2004 v Brně. *Geobiocenologické spisy*. Mendelova Universita. Brno. **9**: 210-214.

ŠUSTEK, Z. 2010. Succession of Carabid communities in different types of reed stands in Central Europe. *Oltenia, Studii şi comunicări, Ştiinţele Naturii.* Muzeul Olteniei Craiova. **26**: 127-138.

ŠUSTEK, Z. 2011. Changes in carabid communities along the urbanization gradient in Pyongyang (North Korea). *Oltenia, Studii şi comunicări, Ştiinţele Naturii.* Muzeul Olteniei Craiova. **27**: 87-96.

ŠUSTEK Z. 2012. Changes in carabid communities (Insecta, Coleoptera) along urbanization gradient in Madrid (Spain). Oltenia, *Studii şi comunicări, Ştiinţele Naturii.* Muzeul Olteniei Craiova. **28**: 73-92.

ŠUSTEK Z. 2014. Survival length and strategies of the light attracted Carabids in the center of a large city. Oltenia, Studii şi comunicări, *Ştiinţele Naturii.* Muzeul Olteniei Craiova. **30**: 108-121.

ŠUSTEK Z. & VAŠÁTKO J. 1984a. Model groups of invertebrates in a big city (in Czech). *Živa*. Academia. Praha. **31**: 142-145.

ŠUSTEK Z. & VAŠÁTKO J. 1984b. Coleoptera and Mollusca (Gastropoda) of the Brno agglomeration (in Czech). In: BÍNA. & FOLK. (eds): Geoekologie brněnské aglomerace. *Studia Geographica*. Geografický ústav ČSAV. Brno, **83**: 116-123.

THIELE H. U. 1977. *Carabid beetles in their environments*. Springer-Verlag, Berlin-Heidelberg-New York. 369 pp.

TOPP W. 1972. Die Besiedlung eines Stadtparks durch Käfer. *Pedobiologia*. Edit. VEB Gustaf Fischer Verlag. Jena.**12**: 336-346.

VENN S. J., KOTZE D. J., NIEMELÄ J. 2003. Urbanization effects on carabid diversity in boreal forests. *European Journal of Entomology*. Academia. Praha. **100**: 73-80.

ZLATNÍK A. 1976. Survey of groups of geobiocoens of original forest and shrub communities in Czechoslovakia (preliminary communication) (in Czech). *Zprávy Geografického ústavu ČSAV v Brně*. Geografický ústav ČSAV. Brno. **13**: 53-64.

Zbyšek Šustek
Institute of Zoology, Slovak Academy of Sciences, Dúbravská cesta 9, 845 06 Bratislava, Slovakia.
E-mail: zbysek.sustek@savba

Received: March 31, 2019
Accepted: September 01, 2019

Annex 1. Complete names of species, their abbreviations (A) and characteristics preference for humidity (H – 1 xerophilous, 8 – hygrophilous) and vegetation cover (V - 1 open landscape, 4 forests with continuous tree canopy).

Species	A	H	V	Species	A	H	V
Abax parallelopipedus (Paller et Mitterpacher, 1783)	*Appd*	3	4	*Europhilus piceus* (Linnaeus, 1758)	*Epic*	8	4
Abax parallelus (Duftschmidt, 1812)	*Apar*	4	4	*Harpalus affinis* (Schrank, 1781)	*Haff*	3	1
Acupalpus flavicollis (Sturm, 1825)	*Afla*	6	1	*Harpalus atratus* Latreille, 1804	*Hatr*	4	4
Acupalpus interstitialis Reitter, 1884	*Aint*	6	1	*Harpalus distinguendus* (Duftschmidt, 1812)	*Hdis*	3	1
Acupalpus meridianus (Linnaeus, 1767)	*Amer*	6	1	*Harpalus honestus* (Duftschmidt, 1812)	*Dhon*	4	1
Acupalpus mixtus (Herbst, 1784)	*Amix*	6	1	*Harpalus latus* (Linnaeus, 1758)	*Hlat*	4	1
Agonum gracilipes (Duftschmidt, 1812)	*Agra*	3	2	*Harpalus luteicornis* (Duftschmidt, 1812)	*Hlut*	5	1
Agonum moestum (Duftschmidt, 1812)	*Amoe*	8	4	*Harpalus picipennis* (Duftschmidt, 1812)	*Hpic*	3	1
Agonum muelleri (Herbst, 1784)	*Amue*	7	2	*Harpalus quadripunctatus* Dejean, 1812)	*Hqua*	5	4
Amara aenea (De Geer, 1774)	*Aaen*	3	1	*Harpalus rubripes* (Duftschmidt, 1812)	*Hrub*	2	1
Amara apricaria (Paykull, 1790)	*Apr*	3	1	*Harpalus serripes* (Quensel in Schönherr, 1806)	*Hser*	2	1
Amara aulica (Panzer, 1797)	*Aaul*	3	1	*Harpalus smaragdinus* (Duftschmidt, 1812)	*Hsma*	4	1
Amara bifrons (Gyllenhal, 1810)	*Abif*	3	1	*Harpalus tardus* (Panzer,1797)	*Htar*	2	1
Amara communis (Panzer, 1797)	*Acom*	3	1	*Harpalus vernalis* (Fabricius, 1801)	*Hver*	2	1
Amara consularis (Duftschmidt, 1812)	*Acon*	3	1	*Chlaenius nigricornis* (Fabricius, 1787)	*Chni*	8	5
Amara convexiuscula (Marsham, 1802)	*Acnv*	3	1	*Chlaenius vestitus* (Paykull, 1790)	*Chve*	8	8
Amara cursitans (Zimmermann, 1831)	*Acur*	3	1	*Laemosthenus terricolla* (Herbst, 1784)	*Lter*	4	2
Amara erratica (Duftschmidt, 1812	*Aerr*	3	1	*Lasiotrechus discus* (Fabricius, 1792)	*Ldis*	6	5
Amara familiaris (Duftschmidt, 1812)	*Afam*	3	1	*Leistus ferrugineus* (Linnaeus, 1758)	*Lfer*	4	3
Amara ovata (Fabricius, 1792)	*Aova*	3	1	*Leistus piceus* Fröhlich, 1799	*Lpic*	6	4
Amara saphyrea Dejean, 1828	*Asap*	3	1	*Leistus rufomarginatus* (Duftschmidt, 1812)	*Lruf*	5	4
Anchomenus dorsalis (Pontoppidan, 1763)	*Ador*	3	1	*Licinus cassideus* (Fabricius, 1792)	*Lcas*	1	1
Anisodactylus binotatus (Fabricius, 1792)	*Abin*	6	1	*Licinus depressus* (Paykull, 1790)	*Ldep*	2	1
Anisodactylus signatus (Panzer, 1797)	*Asig*	5	1	*Lorocera caerulescens* (Fabricius, 1775)	*Lcae*	4	2
Aptinus bombarda (Illiger, 1800)	*Abom*	3	4	*Microlestes maurus* (Sturm, 1827)	*Mmau*	2	1
Asaphidion flavipes (Linnaeus. 1758)	*Aflv*	6	4	*Microlestes plagiatus* (Duftschmidt, 1812)	*Mpla*	2	1
Badister bullatus (Schrank, 1798)	*Bbul*	5	2	*Molops elatus* (Fabricius, 1801)	*Mela*	5	4
Badister meridionalis (Puel,1925)	*Bmer*	6	2	*Molops piceus* (Panzer, 1793)	*Mpic*	4	4
Badister peltatus (Panzer, 1797)	*Bpel*	8	2	*Nebria brevicollis* (Fabricius, 1792)	*Nbre*	6	2
Badister sodalis (Duftschmidt, 1812)	*Bsod*	7	2	*Notiophilus biguttatus* (Fabricius, 1799	*Nbig*	4	2
Badister unipustulatus (Bonelli, 1813)	*Buni*	7	2	*Notiophilus palustris* (Duftschmidt, 1812)	*Npal*	4	2
Bembidion articulatum (Panzer, 1796)	*Bart*	8	5	*Notiophilus rufipes* Curtis, 1829	*Nruf*	4	2
Bembidion biguttatum (Fabricius, 1779)	*Bbig*	8	4	*Oodes gracilis* A. et G. B. Villa, 1833)	*Ogra*	8	2
Bembidion dentellum (Thunberg, 1787)	*Bden*	8	5	*Oodes helopioides* (Fabricius, 1792)	*Ohel*	8	2
Bembidion inoptatum (Schaum, 1857)	*Bino*	8	1	*Ophonus azureus* (Fabricius,1775)	*Oazu*	2	1
Bembidion lampros (Herbst, 1784)	*Blam*	3	1	*Ophonus brevicollis* Audinet-Serville, 1821	*Obre*	3	1
Bembidion minimum (Fabricius, 1792)	*Bmin*	8	5	*Ophonus cordatus* (Duftschmidt,1812)	*Ocor*	3	1
Bembidion nitidulum (Marsham, 1822)	*Bnit*	8	5	*Ophonus gammeli* Schauberger, 1832)	*Ogam*	3	1
Bembidion properans (Stephens, 1828)	*Bpro*	3	1	*Ophonus punctatulus* (Duftschmidt,1812)	*Opun*	2	1
Bembidion punctulatum Drapez, 1821	*Bpun*	8	5	*Ophonus puncticollis* (Paykull, 1793)	*Opcp*	2	1
Bembidion tetracolum (Say, 1823)	*Btet*	5	5	*Ophonus rupicola* Sturm, 1818	*Opcl*	2	1
Bembidion ustulatum (Linnaeus, 1758)	*Btet*	8	5	*Ophonus seladon* Schauberger, 1928	*Osel*	2	1
Bembidion varium (Olivier, 1795)	*Bvar*	8	5	*Ophonus signaticornis* (Duftschmidt,1812)	*Osig*	2	1
Bradycellus collaris (Paykull, 1798)	*Bcol*	3	1	*Ophonus subsinuatus* Rey 1886	*Osub*	2	1
Brachynus crepitans (Linnaeus, 1758)	*Bcre*	3	1	*Oxypselaphus obscurus* (Herbst, 1784)	*Oobs*	7	4
Brachynus explodens Duftschmidt, 1812	*Bexp*	3	1	*Panageus bipustulatus* (Fabricius, 1775)	*Pbip*	6	1
Broscus cephalotes (Linnaeus, 1758)	*Bcep*	3	1	*Paranchus alpipes* (Fabricius, 1796)	*Palb*	8	5
C.arabus clathratus Linnaeus, 1761)	*Ccla*	8	2	*Patrobus atrorufus* (Stroem, 1768)	*Patr*	7	4
Carabus.convexus Fabricius, 1775	*Ccon*	4	4	*Platyderus rufus* (Duftschmidt, 1812)	*Pruf*	3	4
Carabus coriaceus Linnaeus, 1758	*Ccor*	5	4	*Platynus assimilis* (Paykull, 1790)	*Pass*	7	4
Carabus glabratus Paykull, 1790	*Cgla*	5	4	*Platynus krynickyi* (Sperk, 1835)	*Pkry*	8	4
Carabus granulatus Linnaeus. 1758	*Cgra*	7	2	*Platynus livens* (Gyllenhal, 1810)	*Pliv*	8	4
Carabus hortensis Linnaeus, 1758	*Chor*	4	4	*Poecilus cupreus* (Linnaeus, 1758)	*Pcup*	4	1
Carabus intricatus Linnaeus, 1761	*Cint*	4	4	*Poecilus punctulatus* (Schaller, 1783)	*Punc*	2	1
Carabus nemoralis O. F. Mueller, 1764	*Cnem*	4	4	*Poecilus serriceus* (Fischer, 1824)	*Pser*	2	1
Carabus scheidleri Letzner, 1850	*Csch*	5	4	*Pseudoophonus griseus* (Panzer, 1797)	*Pgri*	3	1
Carabus ullrichi Germar, 1824	*Cull*	4	4	*Pseudoophonus rufipes* (De Geer, 1774)	*Pruf*	4	1
C.arabus violaceus Linnaeus, 1758	*Cvio*	5	4	*Pterostichus anthracinus* (Illiger, 1798)	*Pant*	8	4
Calathus erratus (C. R. Sahlberg, 1827)	*Cerr*	4	2	*Pterostichus burmeisteri* Heer, 1838)	*Pbur*	5	4
Calathus fuscipes (Goeze, 1777)	*Cfus*	4	2	*Pterostichus diligens* (Sturm, 1824)	*Pdil*	7	2
Calathus melanocephalus (Linnaeus, 1758)	*Cmel*	4	2	*Pterostichus macer* (Marsham, 1802)	*Pmac*	4	1
*Calosoma auropunctatu*m (Herbst, 1784)	*Caur*	4	4	*Pterostichus melanarius* (Illiger, 1798)	*Pmel*	5	2

Annex 1. Continuation

Species	A	H	V	Species	A	H	V
Calosoma inquisitor Linnaeus, 1758	*Cinq*	4	4	*Pterostichus minor* (Gyllenhal, 1827)	*Pmiin*	8	5
Cicindela germanica Linnaeus, 1758	*Cger*	3	1	*Pterostichus niger* (Schaller, 1783)	*Pnig*	6	4
Clivina collaris (Herbst, 1784)	*Ccol*	6	2	*Pterostichus nigrita* (Fabricius, 1792)	*Pngr*	8	2
Clivina fossor (Linnaeus, 1758)	*Cfos*	6	4	*Pterostichus oblongopunctatus* (Fabricius, 1787)	*Pobl*	5	4
Cychrus attenuatus (Fabricius, 1792)	*Catt*	5	4	*Pterostichus ovoideus* (Sturm, 1824)	*Povo*	4	2
Cymindis axillaris (Fabricius, 1794)	*Caxi*	2	1	*Pterostichus pumilio* (Dejean, 1828)	*Ppum*	5	4
Cymindis cingulata (Dejean, 1825)	*Ccin*	2	1	*Pterostichus strenuus* (Panzer, 1797)	*Pstr*	7	2
Cymindis humeralis (Fourcroy, 1785)	*Chum*	3	4	*Pterostichus vernalis* (Panzer, 1796)	*Pver*	8	5
Cymindis vaporariorum (Linnaeus, 1758)	*Cvap*	2	1	*Stomis pumicatus* (Panzer, 1796)	*Spum*	6	2
Demetrias monostigma (Samuelle, 1819)	*Dmon*	8	1	*Syntomus pallipes* (Dejean, 1825)	*Spal*	5	1
Dolichus halensis (Schaller, 1783)	*Dhal*	4	1	*Syntomus truncatellus* (Linnaeus, 1761)	*Stru*	4	1
Dromius linearis (Olivier, 1795)	*Dlin*	4	1	*Synuchus vivalis* (Illiger, 1798)	*Sviv*	4	2
Dromius quadrimaculatus (Linnaeus, 1758)	*Dqua*	4	1	*Trechoblemus micros* Herbst, 1784)	*Tmic*	4	2
Drypta dentata (Rossi, 1790)	*Dden*	8	5	*Trechus pilisensis* Csiki, 1918	*Tpil*	5	4
Dyschirius globosus (Herbst, 1783)	*Dglo*	8	5	*Trechus pulchelus* Putzeys, 1846	*Tpul*	5	4
Elaphrus cupreus Duftschmidt, 1812	*Ecup*	8	2	*Trechus quadristriatus* (Schrank, 1781)	*Tqua*	4	1
Elaphrus uliginosus (Fabricius, 1792)	*Euli*	8	5	*Trichocellus placidus* (Gyllenhal, 1827)	*Tpla*	7	4
Europhilus fuliginosus (Panzer, 1809)	*Eful*	8	4	*Trichotichnus laevicollis* (Duftschmidt, 1812)	*Tlae*	5	4
Europhilus micans (Nicolaj, 1822)	*Emic*	7	4	*Zabrus tenebrionides* (Goeze, 1777)	*Zten*	3	1

Annex 2. Names, abbreviations and basic characteristics of the study plots in Bratislava (S) and Brno (M) (Ar – area in hectars, Alt – altitude in m, D – density of trre cover in %, V – vegetation type [R – riparian, A – flodplain forests, G – garden, O – plots without wooden plamt, P – urban parks], S – slope in º, E/S - exposition or shadowing by close high buildings [E – East, S – South, W – west, N – North], end year of collecting.

Locality	Abbrev.	Coordinates	Ar	Alt	D	V	S	E/S	Years
M Soběšice	MSob	N 49°14.272' E 16°36.394'	4,41	282	70	R	15	S	1973
S Vrakuňa oxbow	SVRo	N 48°09.605' E 17°13.257'	0,00	131	0	R	20	W	1982
M Lužánky	MLuž	N 49°12.342' E 16°36.594'	20,95	207	75	A	2	S	1977
M Ráječek	MRáj	N 49°09.898' E 16°38.764'	15,01	194	100	A	1	S	1973
S Jurský Šúr dry	SŠud	N 48°13.920' E 17°12.757'	1,20	130	100	A	1	E	1988
S Jurský Šúr wet	SŠuw	N 48°14.003' E 17°12.833'	0,80	130	100	A	1	E	1988
S Vydrica sanatory	SVSa	N 48°12.201' E 17°05.775'	0,60	258	100	A	5	S	1982
S Vydrica ZOO	SVZoo	N 48°09.512' E 17°04.541'	0,09	160	40	A	5	S	1982
S Vydrica Slovák	SVSl	N 48°09.259' E 17°04.539'	0,08	150	90	A	5	S	1982, 1987
S Vydrica crossing	SVCr	N 48°08.861' E 17°04.539'	0,06	142	30	A	5	S	1982
S Horský park creek	SHPc	N 48°09.594' E 17°05.296'	1,50	196	100	A	5	W	1982
S Vrakuňa forest	SVRf	N 48°09.617' E 17°13.303'	13,50	132	80	A	1	N	1982
S Petržalka SJK park	SPEJ	N 48°08.131' E 17°06.575'	20,61	137	60	A	1	E	1982
S Petržalka poplar stand	SPEP	N 48°08.176' E 17°07.195'	5,51	136	90	A	1	E	1982
M Čertova rokľa	MČr	N 49°13.652' E 16°37.536'	3,16	268	90	F	10	S	1978
M Hakenova	MHak	N 49°13.776' E 16°37.506'	4,20	273	90	F	10	S	1978
S Horský park top	SHPt	N 48°09.367' E 17°05.555'	23,80	255	100	F	20	S	1982
S Horský park north	SHPn	N 48°09.444' E 17°05.568'	23,80	220	100	F	20	N	1982
S Horský park west	SHPw	N 48°09.600´ E 17°05.217´	23,80	212	100	F	15	SE	1982
S Mlynská dolina	SMd	N 48°09.650´ E17°04.683´	4,12	190	100	F	45	W	2005, 2006
S Briežky	SBr	N 48°10.967´ E 17°06.666	7,50	340	100	F	10	SE	2005, 2006
S Koliba	SKO	N 48°10.550´ E 17°05.0833	6,09	380	100	F	2	SW	2005, 2006
S Devínska Kobyla 1	SDK1	N 48°11.083´ E 16°59.833´	69,00	340	100	F	15	S	2005, 2006
S Devínska Kobyla 2	SDK2	N 48°11.933´ E 16°59.583´	69,00	300	100	F	10	N	2005, 2006
S Devínska Kobyla 2	SDK3	N 48°11.233´ E 16°59.555´	69,00	452	100	F	2	S	2005, 2006
S Dúbravská Hlavica	SDHla	N 48°11.100´ E 17°00.750´	17,90	350	100	F	5	E	2005, 2006
S Kalvária	SKal	N 48°09.667' E 17°05.967'	4,98	225	100	F	40	S	1982
S Železná studnička	SŽs	N 48°11.754´ E 17°05.863´	3,50	199	100	F	35	E	1982
S Sitina	SStn	N 48°09.667' E 17°05.967'	5,03	244	95	F	5	E	1982
M Břenkova	MBř	N 49°12.763' E 16°37.281'	0,70	242	20	G	0	N	1980
M Líšeňská	MLíš	N 49°11.741' E 16°39.443'	1,30	255	20	G	5	N	1980
M Kraví Hora	MKrH	N 49°12.207' E 16°35.018'	3,70	292	20	G	2	S	1980
S Vrakuňa ruderal	SVRr	N 48°09.681' E 17°13.282'	0,03	132	0	O	5	S	1982
S Vrakuňa wheat field	SVRw	N 48°09.545' E 17°13.347'	0,50	132	0	O	1	N	1982

S Bajkalská str.	SBAJ	N 48°09.351' E 17°08.839'	2,78	135	0	O	1	W	1982
S Líštiny vineyeard	SLv	N 48°09.794' E 17°03.915'	0,39	227	15	O	1	E	1988
S Líštiny grassy plot	SLg	N 48°09.776' E 17°03.952'	0,11	224	0	O	1	E	1988
M Námestie 28. října sqr.	M28	N 49°12.155' E 16°36.779'	2,07	208	10	P	0	E	1978
M Špilberk south	MŠs	N 49°11.599' E 16°36.006'	1,53	271	15	P	35	S	1978
M Špilberk north	MŠn	N 49°11.734' E 16°36.006'	1,08	255	40	P	50	N	1978
S Castle	SCast	N 48°08.480' E 17°06.202'	0,25	148	30	P	40	S	1982
S Hlavné námestie sqr.	SHn	N 48°08.608' E 17°06.512'	0,16	140	10	P	1	N	1982, 1988
S Uršulínska str.	SUR	N 48°08.700' E 17°06.544'	0,03	140	5	P	1	NE	1982
S Notre Dam	SND	N 48°08.502' E 17°06.625'	0,04	139	20	P	1	NW	1982
S Nám. SNP sqr.	SSNP	N 48°08.760' E 17°06.569'	0,29	142	15	P	5	E	1982
S Kollárovo námestie sqr.	SKoln	N 48°08.983' E 17°06.763'	0,95	145	15	P	3	E	1982
S Prior large plot	SPlp	N 48°08.677' E 17°06.818'	0,00	139	60	P	1	NW	1982
S Prior small plot	SPs	N 48°08.689' E 17°06.815'	0,00	139	50	P	1	NW	1982
S Americké námestie sqr.	SAm	N 48°09.089' E 17°07.103'	0,23	140	20	P	1	S	1982, 1988
S Medická záhrada park	SMz	N 48°08.966' E 17°07.126'	3,27	140	20	P	1	N	1982, 1988
S Šafárikovo námestie sqr.	SŠaf	N 48°08.501' E 17°06.965'	0,20	138	10	P	1	S	1982
S Ondrejský cintorín cemetery	SOc	N 48°08.892' E 17°07.334'	6,58	139	40	P	1	N	1988
S Moskovská str.	SMos	N 48°09.122' E 17°07.227'	0,10	139	15	P	1	S	1988

Annex 3. Survey of species (arranged descendently according to presence) recorded in riparian and floodplain forest habitats in Brno and Bratislava (for site abreviations see tab. 1. P – presence in %. – sum of individuals. D – dominance in %.F – frequency. S.D. – standard deviation of number of individuals. V – coeficient of variance of number of individuals).

	MSob	**SVox**	**MLuž**	**MRáj**	**SŠuw**	**SŠud**	**SVys**	**SVyzo**	**SVySl2**	**SVySl7**	**SVyCr**	**SHPc**	**SVRf**	**SPEj**	**SPEp**	**P**	**S**	**D**	**F**	**S. D.**	**V**
P. assimilis		1	952	79	32	1	85	51	40	17	205	294		6	30	86.7	1793	18.6	119.5	466.5	3.9
P. atrorufus	27	113	689	378	67	14	84	67	14	1	79	381				80.0	1914	19.9	127.6	537.8	4.2
P. niger	141	5	15	20	27	13	14	22	10		18	10	1			80.0	296	3.1	19.7	82.0	4.2
P. strenuus	2	32	12	25	19	14			1	2		5	6	1	5	80.0	124	1.3	8.3	38.4	4.6
C. granulatus	13	2	3	14	173	315		3				3	1	1		66.7	528	5.5	35.2	177.9	5.1
P. anthracinus	1	57	4	8	122	113	24			1		11				60.0	341	3.5	22.7	108.3	4.8
P. melanarius		2	112	5			12	104	15		43	6	12			60.0	311	3.2	20.7	93.6	4.5
P. nigrita	22	38	27	32	44	13	86		4			27				60.0	293	3.0	19.5	90.7	4.6
A. parallelopipedus			12				11	35	33	12	93	6	76			53.3	278	2.9	18.5	78.9	4.3
L. caerulescens		2	11	18	6				3		2		1	2		53.3	45	0.5	3.0	20.3	6.8
N. brevicollis			1				6	25	24	4	53	162		113		53.3	388	4.0	25.9	113.8	4.4
O. obscurus		1	8	1	16	10					5	2			4	53.3	47	0.5	3.1	19.6	6.3
A. moestum	71	86		139	399	143	3						2			46.7	843	8.8	56.2	296.3	5.3
A. dorsalis		39	3							4	5		28	5	2	46.7	86	0.9	5.7	28.6	5.0
B. bullatus		8				1		1	1	2		1	33			46.7	47	0.5	3.1	19.7	6.3
E. micans		2		43	4	10	3		1					1		46.7	64	0.7	4.3	23.1	5.4
P. oblongopunctatus			1		1		257	6		71	18	13				46.7	367	3.8	24.5	126.2	5.2
S. pumicatus					2	2	3		4			2	9			40.0	22	0.2	1.5	12.5	8.5
A. flavipes		4	5										2	20	7	33.3	38	0.4	2.5	15.2	6.0
B. lampros		7	7		1								16	1		33.3	32	0.3	2.1	14.5	6.8
L. ferrugineus		2	17	1	1								3			33.3	24	0.2	1.6	13.8	8.6
P. ovoideus		1	7	4					1				1			33.3	14	0.1	0.9	12.9	13.8
S. pallipes		8	1										31	2	1	33.3	43	0.4	2.9	18.1	6.3
A. parallelus	1						5					10			4	26.7	20	0.2	1.3	9.6	7.2
B. sodalis		3		4	8	5										26.7	20	0.2	1.3	10.1	7.6
B. biguttatum		3	3	2	83											26.7	91	0.9	6.1	42.0	6.9
C. coriaceus								2			7	10			5	26.7	24	0.2	1.6	9.8	6.2
D. globosus		1		10	9	5										26.7	25	0.3	1.7	11.1	6.6
H. tardus							2					10	8		1	26.7	21	0.2	1.4	9.7	6.9
O. helopioides	12	3			14	51										26.7	80	0.8	5.3	30.0	5.6
O. brevicollis		8	1										19		2	26.7	30	0.3	2.0	12.9	6.4
P. rufipes		2	4										63		5	26.7	74	0.8	4.9	31.5	6.4
P. pumilio		3									1		27	3		26.7	34	0.4	2.3	14.5	6.4
T. quadristriatus		40		3								19	123			26.7	185	1.9	12.3	74.5	6.0
A. binotatus											1	1	1			20.0	3	0.0	0.2	7.1	35.3
B. peltatus					4	18				1						20.0	23	0.2	1.5	9.8	6.4
B. dentellum		9		1										4		20.0	14	0.1	0.9	8.2	8.8

B. ustulatum			50							2		12				20.0	64	0.7	4.3	23.8	5.6
B. explodens		2											54		1	20.0	57	0.6	3.8	26.0	6.8
C. hortensis							2	48			1					20.0	51	0.5	3.4	22.3	6.5
C. collaris		6							8			1				20.0	15	0.2	1.0	7.9	7.9
C. fossor		10								2			1			20.0	13	0.1	0.9	8.0	9.2
E. fuliginosus	37				2	7										20.0	46	0.5	3.1	17.3	5.6
H. luteicornis		1					1					1				20.0	3	0.0	0.2	7.6	37.9
P. bipustulatus		3											10		3	20.0	16	0.2	1.1	7.8	7.3
P. krynickyi		1			24	82										20.0	107	1.1	7.1	43.3	6.1
P. cupreus		1					3						2			20.0	6	0.1	0.4	7.2	18.1
P. minor		2		1		13										20.0	16	0.2	1.1	8.2	7.7
A. meridianus						1							1			13.3	2	0.0	0.1	5.0	37.4
A. mixtus		1			1											13.3	2	0.0	0.1	5.4	40.8
A. muelleri			1	1												13.3	2	0.0	0.1	6.0	45.3
A. aulica		44											8			13.3	52	0.5	3.5	20.7	6.0
A. familiaris									1			3				13.3	4	0.0	0.3	4.8	18.0
B. meridionalis					1	2										13.3	3	0.0	0.2	4.9	24.3
B. unipustulatus		1				12										13.3	13	0.1	0.9	6.2	7.2
B. articulatum		1	1													13.3	2	0.0	0.1	6.0	45.3
B. inoptatum				1								2				13.3	3	0.0	0.2	5.3	26.3

Annex 3. Continuation.

	MSob	**SVox**	**MLuž**	**MRáj**	**SŠuw**	**SŠud**	**SVys**	**SVyzo**	**SVySl2**	**SVySl7**	**SVyCr**	**SHPc**	**SVRf**	**SPEj**	**SPEp**	**P**	**S**	**D**	**F**	**S. D.**	**V**
B. nitidulum												5	2			13.3	7	0.1	0.5	4.7	10.1
B. crepitans		1											3			13.3	4	0.0	0.3	5.1	19.2
C. nemoralis							10	8								13.3	18	0.2	1.2	6.5	5.4
C. violaceus											2				2	13.3	4	0.0	0.3	4.8	17.8
C. fuscipes											4		45			13.3	49	0.5	3.3	21.8	6.7
C. melanocephalus		2											2			13.3	4	0.0	0.3	5.2	19.5
D. monostigma		1											1			13.3	2	0.0	0.1	5.4	40.8
E. cupreus				126			57									13.3	183	1.9	12.2	75.4	6.2
E. uliginosus					16	9										13.3	25	0.3	1.7	8.9	5.4
H. atratus											1		1			13.3	2	0.0	0.1	5.0	37.4
Ch. nigricornis		1											2			13.3	3	0.0	0.2	5.3	26.3
L. discus		4	1													13.3	5	0.1	0.3	5.8	17.3
N. biguttatus													1	1		13.3	2	0.0	0.1	5.0	37.4
N. rufipes														1	1	13.3	2	0.0	0.1	5.0	37.4
O. gracilis		2				1										13.3	3	0.0	0.2	5.4	26.9
P. albipes			3			2										13.3	5	0.1	0.3	5.2	15.6
P. livens					1	47										13.3	48	0.5	3.2	22.4	7.0
P. punctulatus		1											1			13.3	2	0.0	0.1	5.4	40.8
P. diligens	17					5										13.3	22	0.2	1.5	8.8	6.0
P. vernalis					8	15										13.3	23	0.2	1.5	8.3	5.4
A. interstitialis												3				6.7	3	0.0	0.2	2.5	12.5
A. aenea										3						6.7	3	0.0	0.2	2.5	12.5
A. apricaria													1			6.7	1	0.0	0.1	2.7	40.0
A.convexiuscula													1			6.7	1	0.0	0.1	2.7	40.0
A. saphyrea												2				6.7	2	0.0	0.1	2.5	19.0
B. minimum					1											6.7	1	0.0	0.1	2.7	40.0
B. properans													15			6.7	15	0.2	1.0	7.0	7.0
B. punctulatum					1											6.7	1	0.0	0.1	2.7	40.0
B. tetracolum					3											6.7	3	0.0	0.2	2.5	12.5
B. collaris													1			6.7	1	0.0	0.1	2.7	40.0
C. clathratus					14											6.7	14	0.1	0.9	6.5	7.0
C. ullrichi													1			6.7	1	0.0	0.1	2.7	40.0
C. erratus													2			6.7	2	0.0	0.1	2.5	19.0
C. attenuatus							1									6.7	1	0.0	0.1	2.7	40.0
C. axillaris							2									6.7	2	0.0	0.1	2.5	19.0
D. linearis		1														6.7	1	0.0	0.1	3.0	45.3

D. quadrimaculatus			4												6.7	4	0.0	0.3	2.9	11.0
E. piceus				1											6.7	1	0.0	0.1	3.0	45.3
H. honestus												1			6.7	1	0.0	0.1	2.7	40.0
H. latus												1			6.7	1	0.0	0.1	2.7	40.0
H. serripes		1													6.7	1	0.0	0.1	3.0	45.3
Ch. vestitus		3													6.7	3	0.0	0.2	2.9	14.4
L. terricolla												5			6.7	5	0.1	0.3	2.8	8.3
L. piceus							1								6.7	1	0.0	0.1	2.7	40.0
L. rufomarginatus											1				6.7	1	0.0	0.1	2.7	40.0
L. depressus												2			6.7	2	0.0	0.1	2.5	19.0
M. maurus													1		6.7	1	0.0	0.1	2.7	40.0
N. palustris					2										6.7	2	0.0	0.1	2.5	19.0
O. azureus												1			6.7	1	0.0	0.1	2.7	40.0
O. punctatulus			6												6.7	6	0.1	0.4	3.3	8.2
O. rupicola				1											6.7	1	0.0	0.1	3.0	45.3
O. seladon			1												6.7	1	0.0	0.1	3.0	45.3
P. rufus														4	6.7	4	0.0	0.3	2.6	9.7
P. burmeisteri							45								6.7	45	0.5	3.0	22.8	7.6
S. vivalis							1								6.7	1	0.0	0.1	2.7	40.0
T. pillisensis												25			6.7	25	0.3	1.7	12.2	7.3
Species	11	50	30	25	32	28	24	12	15	13	17	29	47	15	16		123				
Individuals	344	572	1962	918	1106	924	718	372	160	122	538	1028	628	162	77		9631				

Annex 4. Survey of species (arranged desccendently according to presence) recorded in the mesohygrophilous forest-like habitats in Brno and Bratislava (for site abbreviations see tab. 1, P – presence in %, – sum of individuals, D – dominance in %, F – frequency, S.D. – standard deviation of number of individuals, V – coefficient of variance of number of individuals).

	MČr	MHak	SHPt	SHPn	SHPw5	SHPw6	SMd5	SMd6	SBR5	SBR6	SKO5	SKO6	SDK1-5	SDK1-6	SDK2-5	SDK2-6	SDK3-5	SDK3-6	SDHla5	SDHla6	SKal	SŽs	SStn	MŠpn	MŠps	P	S	D	F	S. D.	V
A. parallelopipedus	120	67	104	9	10	12	20	63	25	38	9	6	87	61	183	200	51	54	107	118	135	45	392	15	20	100	1951	26.1	78.0	85.3	1.1
C. coriaceus			16	2	9	10	3	11	1	10	7	7	5	5	10	4	5	7	11	10	8	2	73			84	216	2.9	8.6	14.1	1.6
C. nemoralis			26	3	10	11	24	8	5	3	13	18	13	12	35	19	37	12	37	15	43	63	130			84	537	7.2	21.5	27.6	1.3
H. atratus		1	11	1	1	3	16	19	4	1	2	1	1	7	2	4	48	14			2	4	125		24	84	291	3.9	11.6	26.0	2.2
A. parallelus	33	4	9	37		1				1			1	1	36	21			19	15		40	8			56	226	3.0	9.0	13.7	1.5
C. hortensis									17	172	56	83	71	163	35	155	28	82	116	199		5	449			56	1631	21.8	65.2	102.6	1.6
C. glabratus									1	4	36	33	4	10	10	6			12	19		39	1			48	175	2.3	7.0	12.0	1.7
C. intricatus								3		2		6	2	2	4	2		3	1		3		9	1		48	38	0.5	1.5	2.2	1.5
P. rufipes	1		4			1				1			2	1	3	1	2	1				2	3			48	22	0.3	0.9	1.2	1.3
P. diligens					86		1		88	297	32	162	5			3	4	9	3	38						48	728	9.7	29.1	68.0	2.3
C. convexus								1					11	11	24	15	2	3	7	1			1			40	76	1.0	3.0	6.0	2.0
C. ullrichi													8	8	8	18	5	4	23	26		45	40			40	185	2.5	7.4	12.9	1.7
C. inquisitor					4		1			1		5	7		4		6		5				3			36	36	0.5	1.4	2.3	1.6
M. piceus		1			1	2	2	3				1	1		1							14				36	26	0.3	1.0	2.8	2.7
H. tardus				3	1		1						1			2	5	5			227					32	245	3.3	9.8	45.3	4.6
N. rufipes				2	1	2	2	3				1		1												28	12	0.2	0.5	0.9	1.8
A. aenea					1		1														9	23	11		2	24	47	0.6	1.9	5.2	2.8
A. ovata										1			1	1				2	1						5	24	11	0.1	0.4	1.1	2.5
A. bombarda														2	20	110	1		8	3						24	144	1.9	5.8	22.1	3.8
C. violaceus												1	4	21								3	3			20	32	0.4	1.3	4.3	3.3
O. brevicollis		1		1																	2	2	14			20	20	0.3	0.8	2.8	3.5
O. gammeli														4	1	8	5	2								20	20	0.3	0.8	2.0	2.5
P. burmeisteri										3		6				2			2			175				20	188	2.5	7.5	34.9	4.6
P. oblongopunctatus				20																	6	29	201	1		20	257	3.4	10.3	40.3	3.9
S. pumicatus	2	5																			1	2		3		20	13	0.2	0.5	1.2	2.4
T. quadristriatus		1		5																			1	1	1	20	9	0.1	0.4	1.0	2.9
C. granulatus										7		1						1	1							16	10	0.1	0.4	1.4	3.5
P. pumilio			1	2																	4		5			16	12	0.2	0.5	1.3	2.7
S. vivalis																1		1			6		4			16	12	0.2	0.5	1.4	3.0
A. familiaris																					26	5			10	12	41	0.5	1.6	5.5	3.4
A. saphyrea																	1				103	5				12	109	1.5	4.4	20.6	4.7
C. scheidleri																			7	4		6				12	17	0.2	0.7	1.9	2.8
N. brevicollis			5	7																		1				12	13	0.2	0.5	1.7	3.2
O. azureus													2		1		1									12	4	0.1	0.2	0.5	3.0
A. dorsalis																							1		1	8	2	0.0	0.1	0.3	3.5
B. lampros				1																	1					8	2	0.0	0.1	0.3	3.5
C. fuscipes													1		1											8	2	0.0	0.1	0.3	3.5
H. distinguendus		1												1												8	2	0.0	0.1	0.3	3.5
H. smaragdinus	2																								2	8	4	0.1	0.2	0.6	3.5
L. terricolla																			1	1						8	2	0.0	0.1	0.3	3.5
N. biguttatus		4																				3				8	7	0.1	0.3	1.0	3.5

Annex 4. Continuation.

	MČr	MHak	SHPt	SHPn	SHPw5	SHPw6	SMd5	SMd6	SBR5	SBR6	SKO5	SKO6	SDK1-5	SDK1-6	SDK2-5	SDK2-6	SDK3-5	SDK3-6	SDHla5	SDHla6	SKal	SŽs	SStn	MŠpn	MŠps	P	S	D	F	S. D.	V
O. punctatulus			4																				16			8	20	0.3	0.8	3.3	4.1
P. strenuus			1	1																						8	2	0.0	0.1	0.3	3.5
A. flavicollis																					1					4	1	0.0	0.0	0.2	5.0
A. interstitialis																					1					4	1	0.0	0.0	0.2	5.0
A. mixtus																					2					4	2	0.0	0.1	0.4	5.0
A. communis																						15				4	15	0.2	0.6	3.0	5.0
B. bullatus																									7	4	7	0.1	0.3	1.4	5.0
B. ustulatum				2																						4	2	0.0	0.1	0.4	5.0
B. varium																					1					4	1	0.0	0.0	0.2	5.0
C. erratus		2																								4	2	0.0	0.1	0.4	5.0
C. melanocephalus		1																								4	1	0.0	0.0	0.2	5.0
C. cingulata																							1			4	1	0.0	0.0	0.2	5.0
C. humeralis														1												4	1	0.0	0.0	0.2	5.0
C. vaporariorum													1													4	1	0.0	0.0	0.2	5.0
D. linearis																									1	4	1	0.0	0.0	0.2	5.0
H. latus												1														4	1	0.0	0.0	0.2	5.0
H. quadripunctatus																						1				4	1	0.0	0.0	0.2	5.0
H. vernalis																									1	4	1	0.0	0.0	0.2	5.0
L. ferrugineus		1																								4	1	0.0	0.0	0.2	5.0
L. caerulescens																									1	4	1	0.0	0.0	0.2	5.0
M. elatus																						1				4	1	0.0	0.0	0.2	5.0
O. subsinuatus																						2				4	2	0.0	0.1	0.4	5.0
P. bipustulatus								1																		4	1	0.0	0.0	0.2	5.0
P. rufus					1																					4	1	0.0	0.0	0.2	5.0
P. assimilis				8																						4	8	0.1	0.3	1.6	5.0
P. cupreus																						1				4	1	0.0	0.0	0.2	5.0
P. serriceus																							1			4	1	0.0	0.0	0.2	5.0
P. melanarius	2																									4	2	0.0	0.1	0.4	5.0
P. nigrita				2																						4	2	0.0	0.1	0.4	5.0
T. pilisensis				16																						4	16	0.2	0.6	3.2	5.0
T. pulchelus																					1					4	1	0.0	0.0	0.2	5.0
T. placidus																					1					4	1	0.0	0.0	0.2	5.0
T. laevicollis																						5				4	5	0.1	0.2	1.0	5.0
Species	6	12	10	18	11	8	10	9	7	14	7	15	20	18	17	17	15	15	17	12	21	27	23	5	12		55				
Individuals	160	89	181	122	125	42	71	112	141	541	155	332	228	312	378	571	201	200	361	449	583	538	1492	21	75		7480				

Annex 5. Survey of species (arranged descendently according to presence) recorded in Brno and Bratislava in habitats without continuous tree canopy (for site abbreviations see tab. 1. P – presence in %. S – sum of individuals. D – dominance in %. F – frequency. S.D. – standard deviation of number of individuals. V – coefficient of variance of number of individuals).

	MBř	MLiš	MKrH	SVrud	SVRw	SBAJ	SLšv	SLšg	M28	SCast	SHN2	SHN8	SUrš	SND	SSNP	SKoln	SPlp	SPsp	SAm2	SAm8	SMz2	SMz8	SŠaf	SOc	SMos	P	S	D	F	S. D.	V.
A.dorsalis		4	1	72	1			2			6			1	1	1	1		6		19	1		3		56.0	119	6.2	4.8	14.6	3.1
P. rufipes	30	8				140					38	3			2	14	54	23	197	1	8	6	20			56.0	544	28.3	21.8	47.1	2.2
B. lampros	3			50		16			7		1		4		1	2	2	43	1				1			48.0	131	6.8	5.2	12.9	2.5
H. affinis	22					13				1	43	1					1		4		7	1	3		5	44.0	101	5.2	4.0	9.6	2.4
P. melanarius	1	13		2							3			3	1		158	17		1		3	4			44.0	206	10.7	8.2	31.5	3.8
A. aenea		1		1		2		1			1		2				1		3		1		6			40.0	19	1.0	0.8	1.4	1.8
A. flavipes	9			1							5	1		3		2	4	5								32.0	30	1.6	1.2	2.3	1.9
A.f amiliaris				1		4			2	1				1									9		1	28.0	19	1.0	0.8	1.9	2.6
H. distinguendus		1		1		46					2		2								2		6			28.0	60	3.1	2.4	9.2	3.8
T. quadristriatus	3	7				1									1	1	1						1			28.0	15	0.8	0.6	1.5	2.5
B. properans				19	3	33					2				1						1					24.0	59	3.1	2.4	7.4	3.1
C. collaris													1	1		1	2	4	2							24.0	11	0.6	0.4	1.0	2.2
O. brevicollis		1				1		1						1								1	2			24.0	7	0.4	0.3	0.5	1.9
S. pallipes	2			3	1	2		1													1					24.0	10	0.5	0.4	0.8	2.0
C. fuscipes				2		7	14	16													10					20.0	49	2.5	2.0	4.6	2.3
C. melanocephalus						1		2									2	2			1					20.0	8	0.4	0.3	0.7	2.2
H. atratus	50									6		1												1	1	20.0	59	3.1	2.4	10.0	4.2
P. niger		2										2					21	24		1						20.0	50	2.6	2.0	6.2	3.1
B. bullatus	5			1	2					2																16.0	10	0.5	0.4	1.1	2.8
C. intricatus	4	3	1							14																16.0	22	1.1	0.9	2.9	3.3
H. latus	2					1	1	1																		16.0	5	0.3	0.2	0.5	2.5
M. maurus		4		5		7																	1			16.0	17	0.9	0.7	1.8	2.7
P. griseus																1	2	1	3							16.0	7	0.4	0.3	0.7	2.6
A. binotatus															1	1							1			12.0	3	0.2	0.1	0.3	2.8
B. nitidulum				1	1													1								12.0	3	0.2	0.1	0.3	2.8
C. erratus		2	1														1									12.0	4	0.2	0.2	0.5	3.0
D. halensis		2															2		2							12.0	6	0.3	0.2	0.7	2.8
H. tardus				5		5								1												12.0	11	0.6	0.4	1.4	3.2
L. caerulescens	6																				1				1	12.0	8	0.4	0.3	1.2	3.8
N. brevicollis														1			2		1							12.0	4	0.2	0.2	0.5	3.0
N. rufipes										1			1											1		12.0	3	0.2	0.1	0.3	2.8
O. signaticornis				22	22	11																				12.0	55	2.9	2.2	6.4	2.9
P. bipustulatus				1	5			1																		12.0	7	0.4	0.3	1.0	3.6
P. punctulatus				19	10	20																				12.0	49	2.5	2.0	5.6	2.9
S. truncatellus				1	1	8																				12.0	10	0.5	0.4	1.6	4.0
A. aulica		3		1																						8.0	4	0.2	0.2	0.6	3.9
A. cursitans							4	5																		8.0	9	0.5	0.4	1.3	3.5
A. saphyrea				1		1																				8.0	2	0.1	0.1	0.3	3.5
B. biguttatum																1			1							8.0	2	0.1	0.1	0.3	3.5
B. explodens											2		1													8.0	3	0.2	0.1	0.4	3.7
B. cephalotes				4	2																					8.0	6	0.3	0.2	0.9	3.7
C. violaceus		11					8																			8.0	19	1.0	0.8	2.7	3.5

Annex 5. Continuation.

	MBř	MLíš	MKrH	SVrud	SVRw	SBAJ	SLšv	SLšg	M28	SCast	SHN2	SHN8	SUrš	SND	SSNP	SKoln	SPlp	SPsp	SAm2	SAm8	SMz	SMz	SŠaf	SOc	SMos	P	S	D	F	S. D.	V.
C. germanica				2	11																					8.0	13	0.7	0.5	2.2	4.3
D. linearis										1			1													8.0	2	0.1	0.1	0.3	3.5
E. micans																			1	1						8.0	2	0.1	0.1	0.3	3.5
L. ferrugineus		88	1																							8.0	89	4.6	3.6	17.6	4.9
L. depressus		4	1																							8.0	5	0.3	0.2	0.8	4.1
O. azureus				1				3																		8.0	4	0.2	0.2	0.6	3.9
P. cupreus				7	20																					8.0	27	1.4	1.1	4.2	3.9
P. serriceus				1	4																					8.0	5	0.3	0.2	0.8	4.1
P. pumilio										4					1											8.0	5	0.3	0.2	0.8	4.1
A. parallelopipedus					1																					4.0	1	0.1	0.0	0.2	5.0
A. gracilipes																			1							4.0	1	0.1	0.0	0.2	5.0
A. apricaria		2																								4.0	2	0.1	0.1	0.4	5.0
A. bifrons				14																						4.0	14	0.7	0.6	2.8	5.0
A. consularis											1															4.0	1	0.1	0.0	0.2	5.0
A. erratica	4																									4.0	4	0.2	0.2	0.8	5.0
A. ovata								1																		4.0	1	0.1	0.0	0.2	5.0
A. signatus				4																						4.0	4	0.2	0.2	0.8	5.0
B. articulatum									2																	4.0	2	0.1	0.1	0.4	5.0
B. dentellum																	2									4.0	2	0.1	0.1	0.4	5.0
B. ustulatum																		2								4.0	2	0.1	0.1	0.4	5.0
B. crepitans				8																						4.0	8	0.4	0.3	1.6	5.0
C. hortensis							1																			4.0	1	0.1	0.0	0.2	5.0
C. auropunctatum						8																				4.0	8	0.4	0.3	1.6	5.0
C. fossor																	1									4.0	1	0.1	0.0	0.2	5.0
H. picipennis								1																		4.0	1	0.1	0.0	0.2	5.0
H. rubripes								29																		4.0	29	1.5	1.2	5.8	5.0
H. smaragdinus				1																						4.0	1	0.1	0.0	0.2	5.0
L. discus																	1									4.0	1	0.1	0.0	0.2	5.0
N. biguttatus		2																								4.0	2	0.1	0.1	0.4	5.0
O. cordatus	1																									4.0	1	0.1	0.0	0.2	5.0
O. puncticollis						1																				4.0	1	0.1	0.0	0.2	5.0
O. subsinuatus										23																4.0	23	1.2	0.9	4.6	5.0
O. obscurus																	1									4.0	1	0.1	0.0	0.2	5.0
P. macer																			1							4.0	1	0.1	0.0	0.2	5.0
S. pumicatus					4																					4.0	4	0.2	0.2	0.8	5.0
S. vivalis		3																								4.0	3	0.2	0.1	0.6	5.0
T. micros																1										4.0	1	0.1	0.0	0.2	5.0
Z.tenebrionides						4																				4.0	4	0.2	0.2	0.8	5.0
Species	14	19	5	29	15	21	5	13	3	9	11	5	7	8	8	10	19	10	12	4	10	5	11	3	4		80				
Individuals	142	161	5	251	88	332	28	64	11	53	104	8	12	12	9	25	259	122	222	4	51	12	54	5	8		1924				