# SUCCESSION OF CARABID COMMUNITIES IN DIFFERENT TYPES OF REED STANDS IN CENTRAL EUROPE

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**Abstract.** Carabid communities in reed stands were studied in six localities in southwestern Slovakia lowlands. Choice of the localities reflected different conditions, almost natural and anthropogenically influenced, in which these vegetation formation survives in this area. The communities split into two principal groups. One, in the frequently flooded stands, showed a high species diversity (about 40 species) and absolute, quantitative and qualitative predominance of characteristic hydrophilous species. The second, in rarely flooded stands with reduced area, was able to maintain occurrence of the characteristic species, but the community was influenced by species penetrating from adjacent ecosystems. All communities showed a considerable instability of composition, number of species and individuals. It resulted from long lasting flooding of some sites as well as from a fast, but to certain degree unpredictable re-colonization by Carabids. This instability reflects the cyclical (catastrophic) climax character of reed stand, but is to be carefully taken in account at ecosozological assessment and evaluation of pilot monitoring studies. A characteristic feature of communities of the second group was presence of huge numbers of larval and adult *Silpha obscura* representing a strong food competition and predatory pressure, as well as an intensive interference with adjacent agroecosystems.

**Keywords:** Carabidae, Silphidae, reed stands, communities, cyclical climax.

**Rezumat. Succesiunea cenozelor de carabide în câteva formaţiuni de stuf din Europa Centrală.** Cenozele carabidelor din diferite formaţiuni de stuf au fost studiate in şase localităţi din Slovacia de sud-vest. Localităţile au fost alese în aşa fel încât să reflecte condiţiile diferite, naturale şi antropogene, în care supravieţuiesc stufărişurile din această regiune. Cenozele studiate formează, în principiu, două grupuri. Primul grup, format din stufărişurile inundate adesea, este caracterizat de un număr mare de specii (cca. 40) şi preponderenţa absolută, cantitativă şi calitativă a speciilor hidrofile caracteristice. Al doilea grup, format din stufărişuri inundate rar, cu o suprafaţă redusă, a reuşit să menţină toate specii caracteristice, dar structura cenozelor a fost influenţată de pătrunderea speciilor din ecosistemele vecine. Toate cenozele au fost caracterizate de o instabilitate mare a spectrelor de specii, a numărului speciilor şi al indivizilor. Această instabilitate rezultă însă din inundarea îndelungată a unor localităţi şi din recolonizarea lor destul de nepredictibilă, de carabide. Instabilitatea cenozelor studiate reflectă o stare de climax ciclic (catastrofic) a stufărişurilor şi trebuie să fie luată în considerare cu marea grijă la evaluarea statutului ecosozologic sau la evaluarea rezultatelor de monitoring de scurtă durată. O caracteristică certă a cenozelor celui de al doilea grup a fost întâlnirea unui număr mare de larve şi adulţi de *Silpha obscura,* care reprezentă o presiune puternică de competiţie trofică şi de pradă, precum şi o interferenţă intensivă cu agroecosistemele vecine.

**Cuvinte cheie:** carabide, silphide, stufărişuri, cenoze, climax ciclic.

## INTRODUCTION

The Common reed (*Phragmites australis*) stands in Central Europe represent a wide scale of vegetation formations (Union *Phragmitetalia*) (MICHALKO, 1986; JAROLÍMEK & ŠIBÍK, 2008,) growing on shores of permanent water tables, in silting paleopotamal type water bodies, humid depressions, but also persisting in artificially dried places. Also physiognomy and composition of these stands varies considerably. There are extensive, dense, high, almost monospecific homogenous stands, but with decreasing moisture number of co-occurring plant species increases, the stands become lower, smaller and discontinuous or form just little isolated patches in other types of vegetation. Most of them are characterized by an impressive production of biomass and host many highly specialized animals, for example some birds (*Acrocephalus* spp., *Panurus biarmicus* LINNAEUS 1758). All reed stands in Central Europe are exposed to a strong anthropogenic pressure and their distribution was strongly reduced in 20$^{th}$ century.

Paradoxically, the Carabid communities were only little investigated in reed stands. The first pioneer and up to present the only large work was that of OBRTEL (1972) showing an extraordinary high species diversity of beetles in almost natural reed stands around the Nesyt fish-pond in South Moravia, founded between 1414 and 1418 in the dominium of the House of Liechtenstein. Shortly later beetle fauna of a small reed stand in Brno - Soběšice was studied by MERTA. His material, however, remained unpublished and was evaluated by ŠUSTEK (1984, 1987, 1992) in his studies on Central-European urban beetle fauna. Recently, the reed stand fauna, inclusively of Carabids, was studied, in regard to different management methods of reed stands, by SCHMIDT et al. (2005) in southern France, while VALKAMA et al. (2008) synthesized the results of different management methods on common reed stands and their fauna in entire Europe.

In order to fill the existing information gap and to obtain data for ecosozological assessment of reed stands in cultural landscape of southwestern Slovakia, investigations were undertaken in 1998 – 2001 in six localities. The aim of this paper is to characterize differentiation of Carabid communities in reed stands and to show their significance for survival of wetland fauna in cultural landscape.

## MATERIAL AND METHODS

The beetles were pitfall trapped. Ten traps (glass jars of 0.75 l with opening of 75 mm filled with formalin) were installed in distances of about 10 m in a line situated about 50 m from the margin of each reed stand (Fig. 1). In

three cases (Lozorno, Stupava Suchohrad) the trap line also crossed the adjacent field or forest in order to establish interference of communities in both ecosystems. However, samples from these traps were excluded from evaluation in this study. The traps were usually exposed from April until November and emptied monthly. However, in more cases the whole studied stand or its major part was flooded for a longer period by seeping ground water. Due to it, the traps might be exposed only for a much shorter time or a part of them was not functional. This aspect reduces comparability of the quantitative data, especially comparison of number of individuals or the biomass.

The localities were selected so to they characterize diversity of reed stands in lowlands of southwestern Slovakia. All of them are situated out of the protective dikes along the Danube and Morava rives. However, their hydrological regime was correlated by discharge in these rivers by fluctuating ground water table. The following six localities were chosen (Fig. 1).

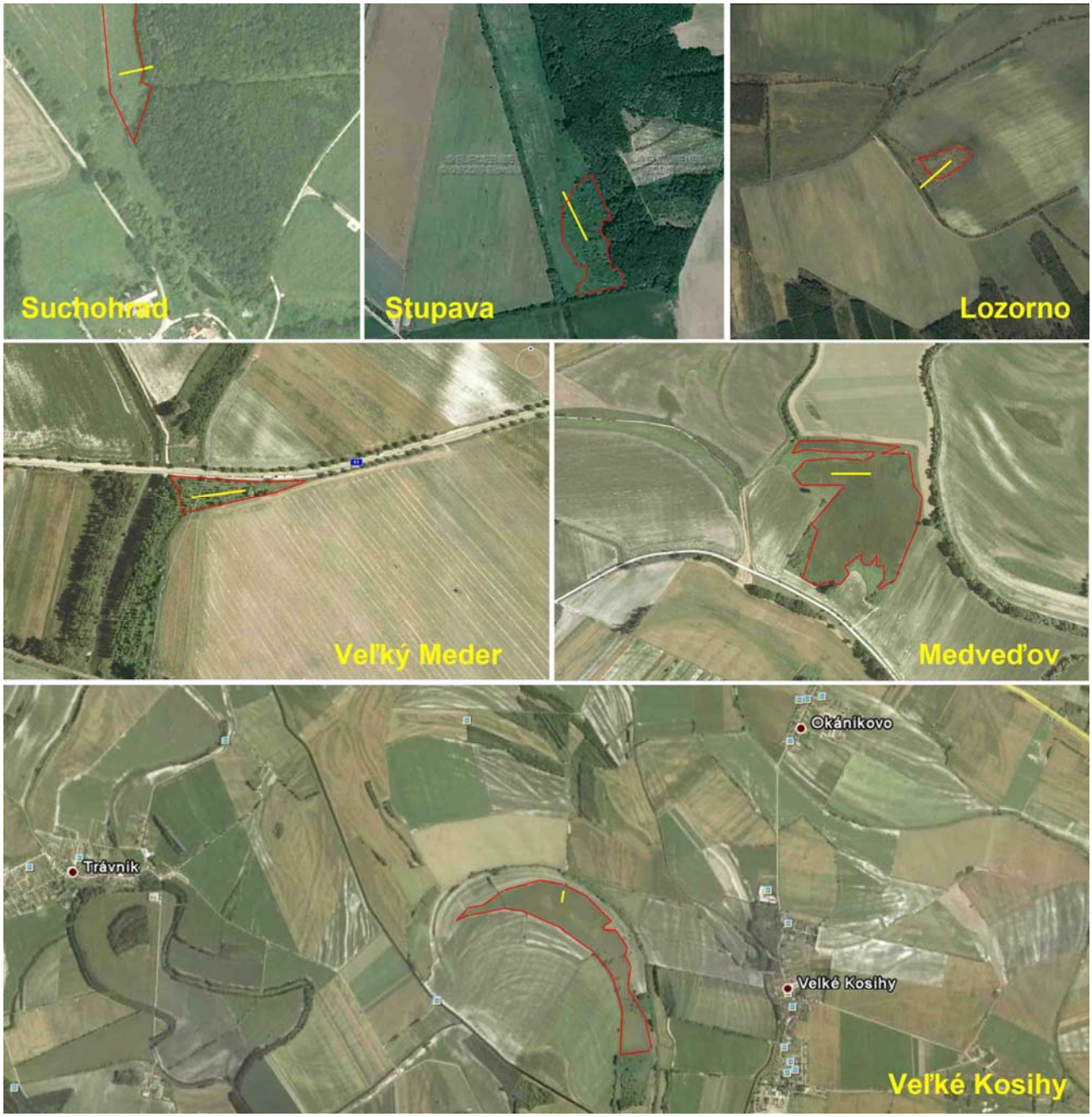


Figure 1. Six reed stands studied and their position in the surroundings (red lines - borders of reed stands, yellow line – position of 10 traps in the stand and in adjacent ecosystem).
Figura 1. Şase stufărişuri studiate şi poziţia lor în împrejurimi (linia roşie – graniţele stufărişurilor, linia galbenă – poziţia a 10 capcane în stufărişul respectiv şi în ecosistemul vecin).

1. Veľké Kosihy (47º 46' 08.25" N, 17º 51' 50.38" E, 107 m a. s. l.) – a large, 850 m long and, at widest place, 340 m wide, 3-4 m high, absolutely pure reed stand in an ancient silted oxbow of the Danube, frequently flooded by seeping ground water. Locality situated westerly of the village.
2. Medveďov (47º 48' 08.32" N, 17º 41' 23.03" E, 108 m a. s. l.), a continuous, 370 x 450 m large, almost rounded reed stand in a remnant of an ancient silting oxbow of the Danube, about 2 m high reed stand, with other admixed herbs. The stand was frequently flooded by seeping ground water. Locality situated easterly of the village
3. Veľký Meder (47º 51' 13.33" N, 17º 47 ' 46.66" E, 109 m a. s. l.) a drained remnant of a reed stand situated at a drainage canal in a shallow depression, about 100 m long and 40 m wide, drained, not flooded, locally with admixed willows and poplars. Locality situated easterly of the village.
4. Lozorno (48º 20' 13.72" N, 17º 04' 45.79" E, 207 m a. s. l.), an about 80 x 70 m large, about 1.5 m high stand with admixed nettles, situated in a wheat field, in a shallow moist depression on a north-western moderate slope of Little Carpathians. Locality situated northerly of the village.
5. Stupava (47º 14' 35.28" N, 17º 01' 16.47" E, 155m a .s l.), an about 243 long and 110 drained reed stand, about 1.5 m high, with abundantly admixed nettles and sparse poplars, from the east bordered by a locust tree forest with individually surviving alders, from the west and north bordered by a wheat field and a wet meadow, occasionally flooded by seeping ground water. Locality situated westerly of the village
6. Suchohrad (48°25' 21.00"N, 16°52'36.35"E, 118 m a. s. l.), a small reed stand along a remnant of an ancient oxbow of the Morava river. At present, completely separated from the river by protective dike and supplied exclusively by ground or rain water. The stand immediately neighbors with a drained remnant of floodplain forests of the group of geobiocoens *Ulmi-Fraxineta populnea* (RAUŠER & ZLATNÍK 1966). The stand was frequently flooded. The water table fluctuated according fluctuation of ground water and discharge in the Morava river. The stand was situated northerly of the farm Karlov Dvor.

Preference of species for humidity and vegetation cover is characterized by a semiquantitative scales proposed by ŠUSTEK (2004). This data were used for direct ordination of the communities. The scores of each community were calculated as average preference of all species weighted by their abundance. Unweight average linkage method and Whiteker´s index of similarity were used for hierarchical classification of the communities, while the Non-metric multidimensional scaling was used for indirect ordination of the communities. The community diversity is characterized by Shannon´s index. The calculations were made by the PASR and CAP 3.1 programs.

The nomenclature and systematic status of Carabids is adopted according to HŮRKA (1995), who accepted splitting of the species *Agonum moestum* (DUFTSCHMIDT 1812) into three disputable species, *Agonum afrum* (DUFTSCHMIDT 1812), *Agonum permoestum* (PUEL 1930) (also earlier not accepted by some authors, e. g. MAGISTRETTI (1979)) and *Agonum duftschmidti* SCHMIDT 1994 made by SCHMIDT (1994). Examination of the large material obtained in this study and in other localities in Slovakia and Moravia as well the literary data on distribution of *Agonum permoestum* (KULT 1947, FREUDE et al., 1976, HURKA 1995) indicates that there probably coexist only two species – *A. moestum* in its traditional concept (identical with SCHMIDT´s *A. duftschmidti*) as a species with a much larger distribution area and *A. permoestum* (probably also including *A. afrum*) as a submediterranean species with a smaller area, with its northern distribution border running through Slovakia and southern Moravia. Reliable identification of the species according to characters presented by SCHMIDT (1994) and HŮRKA (1995) is problematic. In spite of this, his concept was also accepted in this study and it is to be stressed, that it considerably influences evaluation of the results and makes difficult their comparison with earlier data.

## RESULTS AND DISCUSSIONS

In all six localities a remarkable set of 99 species was recorded (Table 1). However, in individual localities and years number of recorded species was much lower and did not exceed 14-49% of the total number. It was also subjected to considerable fluctuations (from 14 and 16 species in Stupava and Medveďov 1999 to 41 in Medveďov 1998, 43 in Veľké Kosihy 44 in Suchohrad or 46 in Lozorno). Cumulative number of individuals also fluctuated considerably (from 70 and 98 in Medveďov 1999 and Stupava 1999, respectively, to 1018 in Medveďov 1998). It was particularly strikingly manifested in Medveďov, where the between-year changes in number of individuals of the characteristic species *Agonum duftsmidti* ranged from 2 to 162. Similar profound fluctuations were observed in *Badister peltatus* (PANZER 1797) (2 versus 25) or *Bembidion biguttatum* (FABRICIUS 1779) (1 versus 309). These fluctuations resulted predominantly from long flooding (Veľké Kosihy, Medveďov) or from a relatively bad state of the locality (Stupava). Such fluctuations also occurred within a short time in one growing season as exemplified by a striking difference between two one-month samples from Velké Kosihy, one immediately after the flood finished in early June, second one month later (Fig. 2). The characteristic number of species value for this type of communities probably moves around 40. This number of species was higher than that recorded by OBRTEL (1972) and comparable with the richest Carabid communities in natural floodplain forests central Europe (ŠUSTEK, 2004) and was about twice higher than in most Central European mesohygrophilous forests in lowlands and uplands (ŠUSTEK, 1984). Similarly the cumulative numbers of Carabids in one-year samples moving around 1000 individuals correspond to the typical situation in these types of communities (ŠUSTEK, 2004a).

Most communities studied had a very similar diversity (Table 1) expressed by the Shannon´s index (around 2.1-2.5) and equitability as the community studied by OBRTEL (1972) and corresponded to the diversity of similar communities studied in 1970-s and early 1980-s (ŠUSTEK, 1983). A much higher diversity (3.04) was recorded only in Suchohrad in 2000 due to immigration of species from adjacent forests (Table 1).

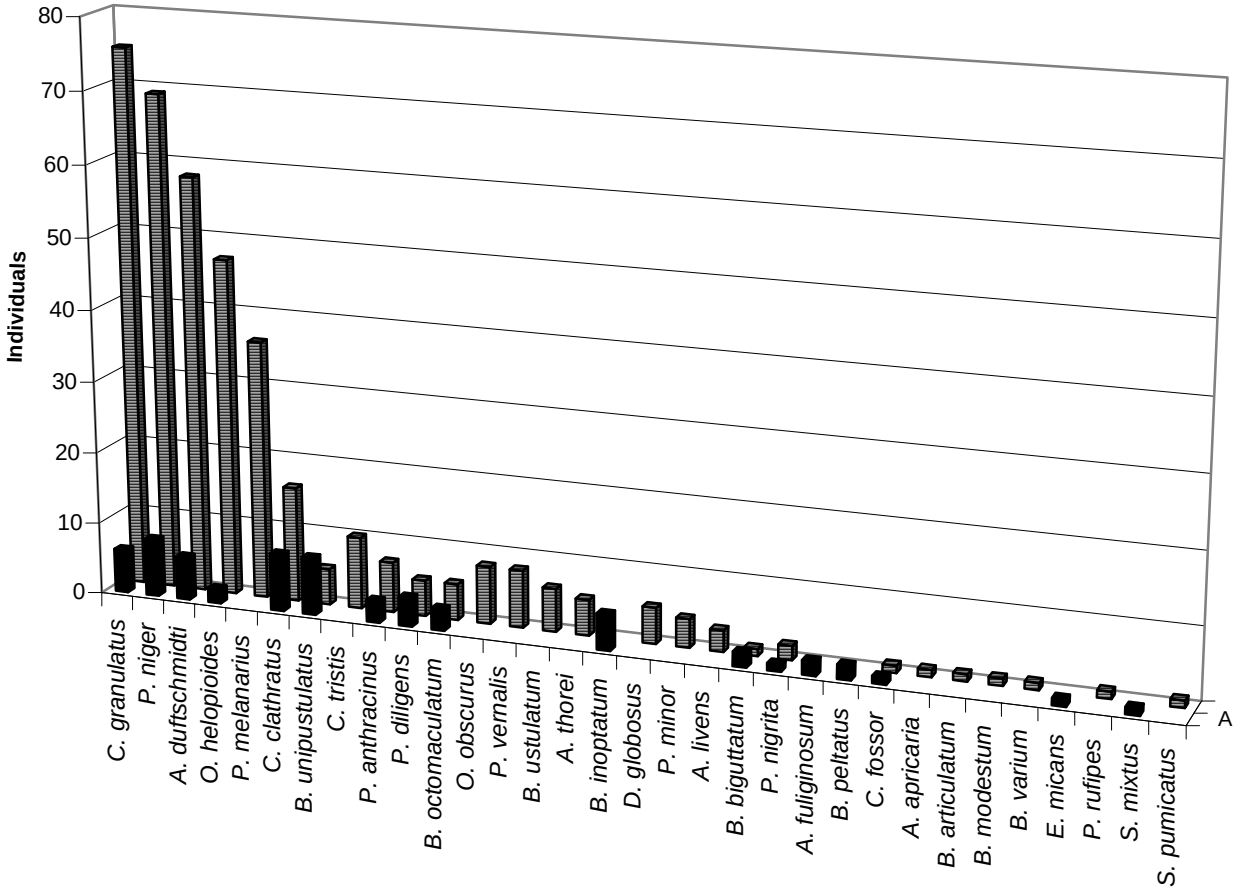


Figure 2. Changes in presence and abundance of Carabids in the natural reed stand in Veľké Kosihy in 1998 immediately one month after the flooding finished in early June and one month later (A: 13 June – 15 July, B: 15 July – 12 August).
Figura 2. Schimbările în prezența şi abundența carabidelor în stufărişul natural din Veľké Kosihy în 1998, la o lună după inundarea din primele zile ale lunii iunie şi o lună mai târziu (A: 13 Junie – 15 Julie, B: 15 Julie – 12 August).

Among the total of 99 species, 19 species represented 83,4% of the total catch (Fig. 3) being eudominant, dominat or subdominant in most communities. Almost one third of the species recorded (31) occurred euconstantly (75-100%) or constantly (50-75%) in the communities (Fig. 4), however, six of them were xenocenous species penetrating into the studied communites from surroundings. Ten characteristic hydrophious species, *Agonum afrum, Agonum duftschmidti, Carabus granulatus* LINNAEUS 1758*, Bembidion guttula* (FABRICIUS 1792)*, Europhilus micans* (NICOLAI 1822)*, Oxypselaphus obscurus* (HERBST1784)*, Oodes helopioides* (FABRICIUS 1792)*, Pterostichus antracinus* (ILLIGER 1798)*, Pterostichus streuus* (PANZER 1797)*, Pterostichus niger* (SCHALLER 1783) and *Pterostichus melanarius* (ILLIGER 1799) showed simultaneously a high dominance and presence (Figs. 3 and 4, Table 1). They constituted the major part of the communities and proportion of their quantitative representation was most responsible of the analyses presented bellow.

The species identified here as *Agonum afrum* and *Agonum duftschmidti* seem to exclude each other (Table 1). If their specific status is valid, it can reflect a slight shift in their ecological requirements. In this case *Agonum duftschmidti* prefers more humid sites and seem to be more indifferent to shadowing of the habitat by woody vegetation. In contrast *Agonum afrum* seem to prefer less humid and not shadowed habitats. If *Agonum afrum* is really identical with *Agonum permoestum*, it might corresponds with its geographical distribution having its center in southern Europe and marginally reaching to Central Europe. However, the observed variability of shape of subgenital plate of males representing the only more or less reliable distinguishing morphologic character of these three species and especially the very different degree of their sclerotizing in males examined suggest that this character might reflect just their age. Thus the earlier concept of the original *Agonum moestum* (s. l.) is possibly not excluded.

From the faunistic point of view, the species assemblages consisted only of two really rare and specialized species – *Carabus clathratus* LINNAEUS 1762 in Velké Kosihy and *Oodes gracilis* A. VILLS et J. B. VILLS, 1833 in

Veľké Kosihy and Medveďov. Remarkable was also occurrence of *Diachromus germanus* (LINNAEUS 1758)*, Platynus krynickyi* (SPARK 1835) and *Agonum thorei* (DEJEAN 1828) (Table 1). After several decades of a strong retreat or even disappearance of *Carabus cancellatus* (ILLIGER 1798) in major part of Slovakia and Moravia, its reappearance in Stupava, not only directly in the reed stand (Table 1), but especially in the adjacent meadow (even 365 individuals not presented here) is significant from the viewpoint of biodiversity preservation. Other species occur frequently in various wetland ecosystems or floodplain forests.

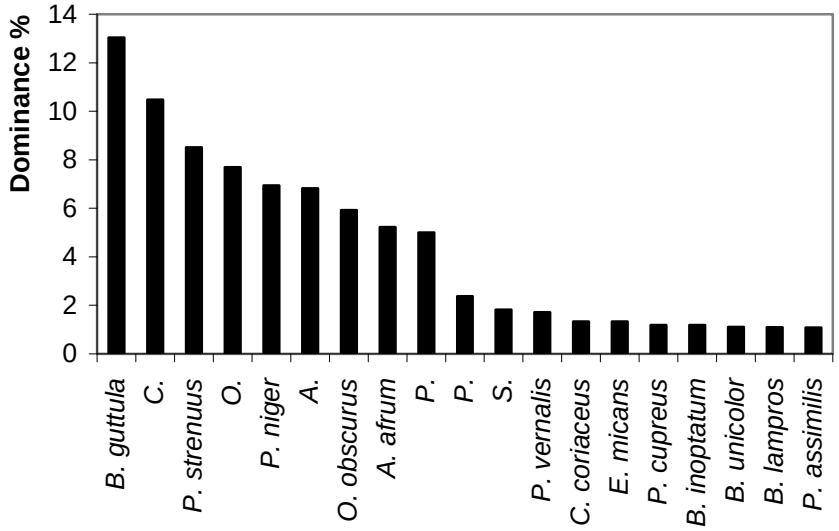


Figure 3. Dominance of 14 most abundant species representing 83.4% of the material studied.
Figura 3. Dominanţa celor mai abundente 14 specii care reprezintă 83,4% din materialul studiat.

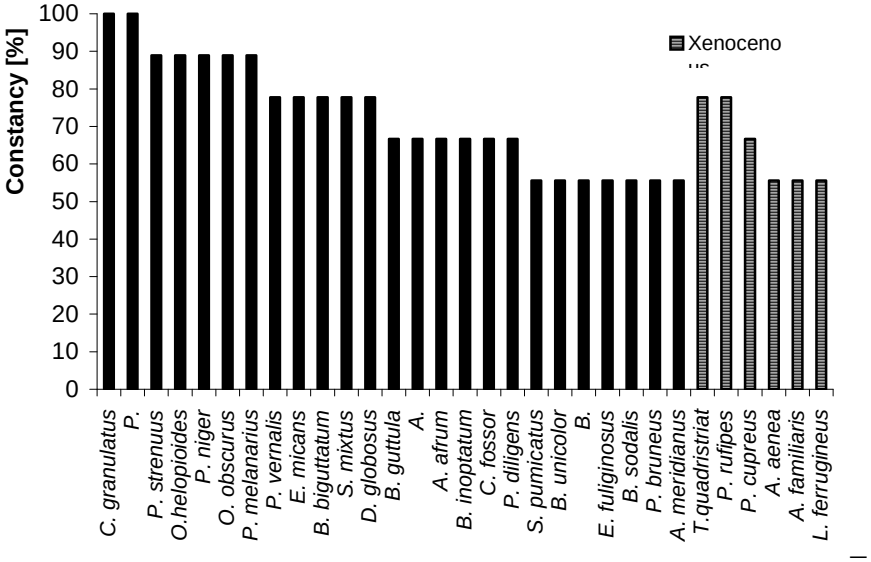


Figure 4. Constancy of 31 euconstant or constant species of Carabids in reed stands in southwestenrn Slovakia
Figura 4. Constanţa a 31 specii euconstante şi constante ale carabidelor din stufărişurile Slovaciei de sud-vest.

Contamination of the community by the xenocenous Carabids species from adjacent ecosystems (Table 1, Fig. 5) was most visible in the isolated communities in Lozorno (*Bembidion lampros* (HERBST 1784)*, Poecilus cupreus* (LINNAEUS 1759)) and in the dried stand in Stupava, where more typical field species occurred and in Suchohrad, where also several species prefering mesohygrophilous forests penetrated (*Carabus coriaceus* LINNAEUS 1758*, Carabus nemoralis* C. F. MÜLLER 1764*, Carabus hortensis* LINNAEUS 1758). This contamination was more visible in qualitative representation of the xenocenous species (Fig. 5) than in their quantitative representation (Fig 6). Other contamination factor is occurrence of enormous number of adults and larvae of the carrion beetle *Silpha obscura* LINNAEUS 1758. It occurred especially in Veľký Meder, Stupava and Lozorno, in other localities it absented or occurred negligibly (Fig. 7). Its high abundance coincided with occurrence of the open landscape carabids and represented a manifestation of interference with fauna of adjacent fields, where this species often predominates (NOVÁK, 1966; PETRUŠKA, 1964). At the same time it represented a serious food competition pressure for other carnivorous beetles or a significant predatory pressure on all invertebrates.

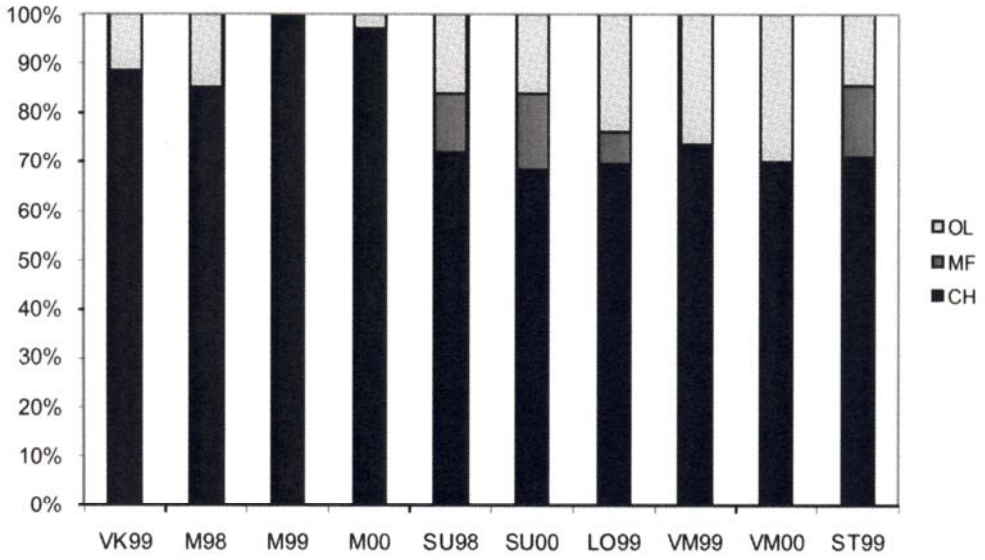


Figure 5. Proportion of xenocenous species in Carabid communities in reed stands in southwestenrn Slovakia (CH – characteristic species, MF – mesohydrophilous forests species, OL – open landscape species; VK – Veľké Kosihy, M98 – M00 Medveďov in 1998 – 2000, SU 98 and SU00 – Suchohrad in 1998 and 2000, LO99 – Lozorno, VM99 and VM00 – Veľký Meder 1999 and 2000, ST99 – Stupava 1999).

Figura 5. Proporţia speciilor xenocene în cenozele carabidelor din stufărişurile Slovaciei de sud-vest (CH – specii caracteristice, MF – specii mezohidrofile de pădure, OL – specii de ecosisteme non-forestiere; VK – Veľké Kosihy, M98 – M00 Medveďov în 1998 – 2000, SU 98 şi SU00 – Suchohrad în 1998 şi 2000, LO99 – Lozorno, VM99 şi VM00 – Veľký Meder 1999 şi 2000, ST99 – Stupava 1999).

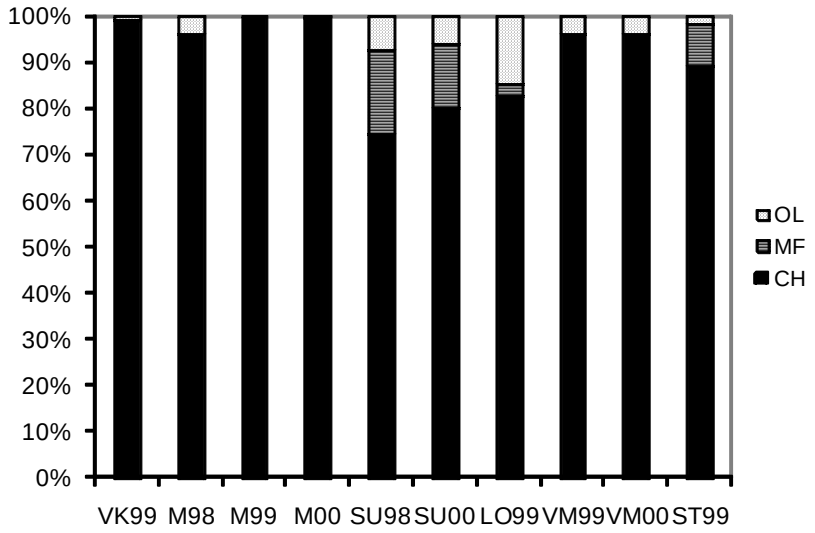


Figure 6. Proportion of individuals of xenocenous species in Carabid communities in reed stands in southern Slovakia (abbreviations as in Fig. 1).

Figura. 6. Proporţia indivizilor speciilor xenocene în cenozele carabidelor din stufărişurile Slovaciei de sud-vest (abrevieri ca în Fig. 1).

According to the Whiteker´s similarity index the communities split into two groups (Fig. 8). One includes the more natural communities from Veľké Kosihy, Medveďov and Suchohrad. This group further differentiates into two clusters, the first one including the communities from Medveďov from 1999 and 2000, and the second one the communities from Suchohrad and from Velké Kosihy and Medveďov from 1998. The second group includes the partly dried communities from Velký Meder and Stupava as well as the isolated community in Lozorno. Within this group the community from Veľký Meder forms a separate subcluster. This pattern of clustering results first of all from absence or low representation of *Agonum duftschmidti, Oxypselaphus obscurus, Oodes helopioides, Pterostichus anthracinus* and *Pterostichus niger* in the communities from the moister localities and from high representation *Bembidion guttula, Agonum afrum, Patrobus atrorufus* (STURM 1768) and *Prerostichus strenuus* (PANZER 1797) in the drier localities (Table 1). This clustering pattern is also supported by occurrence of a larger number of mezohydrophilous open landscape species (*Amara* spp., *Poecilus cupreus*) in the drier localities. The pattern described above is also strongly influenced by splitting of *Agonm moestum* into three different species (see methods). In this case the individuals

identified here as *Agonum afrum* and recorded especially in Lozorno, Veľký Meder, Stupava and also found in Medveďov (Table 1) seem to show a preference for open vegetation formations, unlike the floodplain forest preferring *Agonum duftschmidti.* This difference in ecological requirements might coincide by the hypothesis that *Agonum afrum* can be identical with *Agonum permoestum* distributed primarily in southern Europe and with possible shifts in ecological requirements between more eurytopic *Agonum duftschmidti* and more stenotopic *Agonum permoestum*.

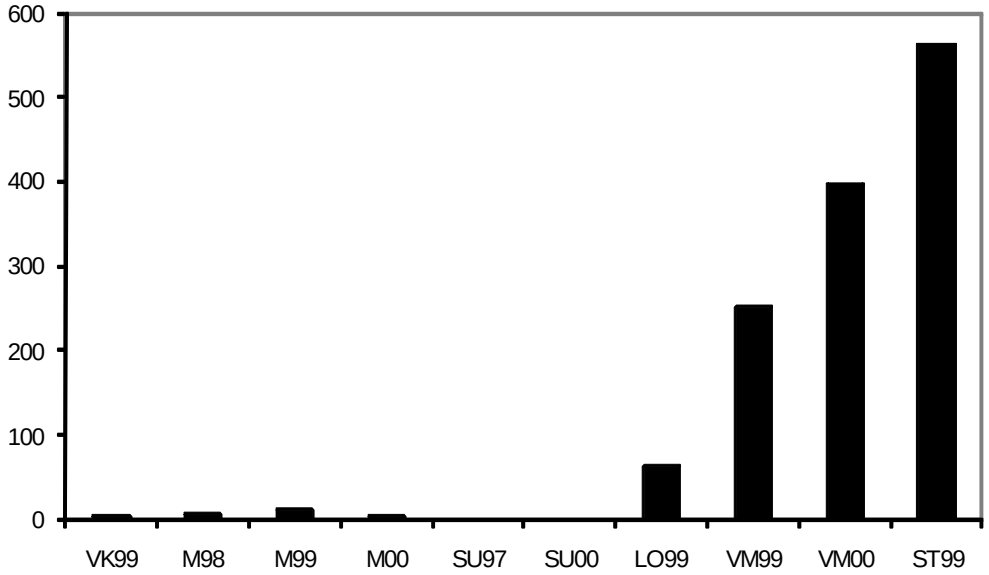


Figure 7. Number of individuals of *Silpha obscura* in reed stands in southern Slovakia (locality abbreviations as in Fig. 1).
Figura 7. Numărul indivizilor de *Silpha obscura* din stufărişurile Slovaciei de sud-vest (abrevieri ca în Fig. 1).

Internal differentiation of the communities (Fig. 8) from moister localities results from low representation of *Oxypselaphus obscurus* and *Europhilus micans* in Medveďov in 1999 and 2000 and from low representation of *Oodes helopioides* and penetration of *Carabus coriaceus* into the reed stand in Suchohrad from the adjacent floodplain forests.

Internal differentiation of the communities (Fig. 8) from drier or deteriorated localities results especially from proportion of *Agonum afrum* and *Carabus granulatus* (more in Lozorno and Stupava), *Bembidion guttula, Stomis pumicatus* (PANZER 1796) (extreme abundance in Veľký Meder in 1999) and increased representation of *Pterostichus vernalis* (PANZER 1796) in Veľký Meder 1999 (Table 1).

This differentiation is also confirmed by the MDS ordination (Fig. 9), where the two major clusters described above are confirmed by separation of the communities along the first axis, which is clearly interpretable as moisture gradient (left the communities from moister localities, right those from drier localities) The second axis is interpretable as vegetation cover gradient (preference for decreasing shadowing from down to up). This interpretation is supported especially by position of the community from Suchohrad penetrated by the typical forest species from the adjacent floodplain forests.

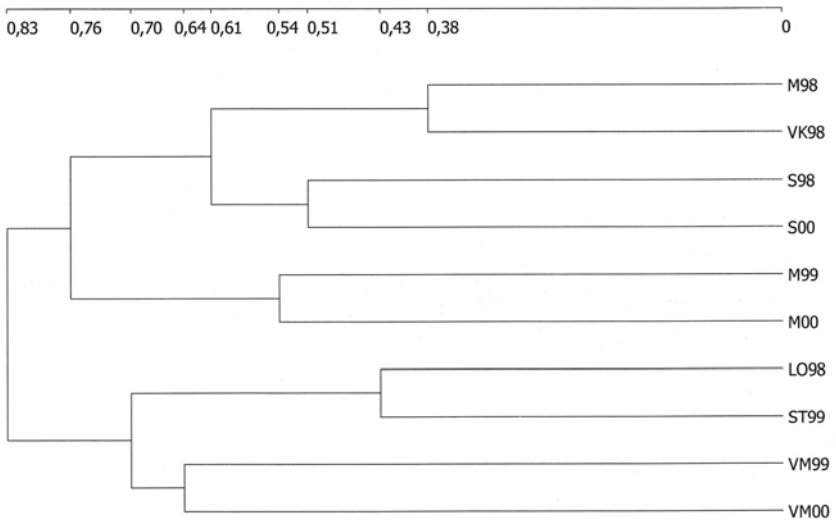


Figure 8. Hierarchical classification of Carabid communities from reed stands in southern Slovakia (locality abbreviations as in Fig. 1).
Figura 8. Clasificarea ierarhică a cenozelor de carabide din stufărişurile Slovaciei de sud-vest (abrevieri ca în Fig. 1).

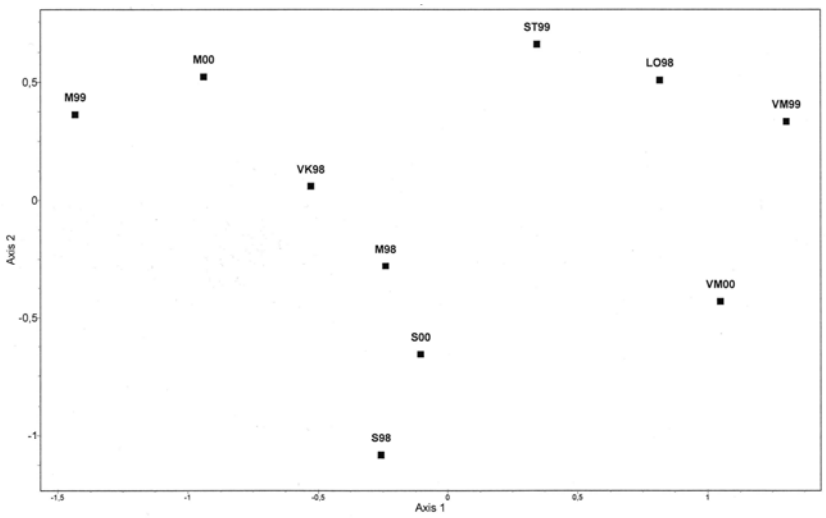


Figure 9. MDS ordination of Carabid communities from reed stands in southern Slovakia (locality abbreviations as in Fig. 1).
Figura 9. Ordonarea MDS a cenozelor de carabide din stufărişurile Slovaciei de sud-vest (abrevierea localităților ca în Fig. 1).

Position of communities in MDS ordination along the ordination axes interpreted in the above way differs to certain degree from results of their direct ordination after preference for humidity and vegetation cover (Fig. 10). The general trend is preserved, but the communities from Suchohrad appears as the most xerophilous community, while in relation to vegetation cover takes an intermediary position among other communities. These differences result first of all from the fact that the ecological requirements were predefined in the direct ordination, while in the MDS ordination alternating of several ecologically identical or similar species can lead to strong differentiation of the classified communities. This difference, however, cannot be taken as a disadvantage of one of these methods, but as manifestation of their mutual complementarity.

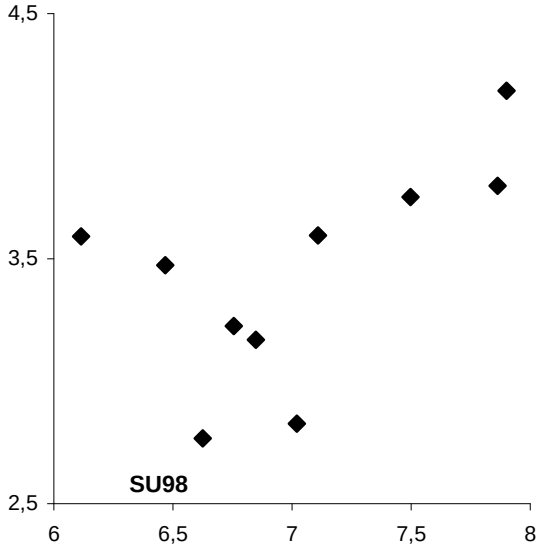


Figure 10. Direct ordination of Carabid communities from reed stands in southern Slovakia according to their preference for humidity and vegetation cover (locality abbreviations as in Fig. 1).
Figura 10. Ordonarea directă a cenozelor de carabide din stufărişurile Slovaciei de sud-vest, după preferența lor pentru umiditate şi stratul vegetal (abrevieri ca în Fig. 1).

All analyses and classifications show, that in spite of mostly constant number of species, the structure of Carabid communities in reed stand suffer from a considerable temporal, within- and between-season, instability. This instability also results from properties of some very common and moderately hydrophilous species, especially of *Pterostichus niger* and *Pterostichus melanarius*, which are able very quickly and, as a rile, unexpectedly colonize the habitats after floods in huge numbers of individuals. On the contrary, they very quickly left from such habitats. The case of the community in Medveďov in 1999, where the xenocoenous species absented after the long-termed flooding in 1999 show, that these species colonize the habitats after retreated flooding later than the characteristic wetland species. This ability was observed also in floodplain forests (ŠUSTEK, 1995). Due to it the instability considerably influences momentary community structure and results of any evaluation methods. The observed within- and between-season instability cannot be taken as instability of the community as such and as a feature indicating a bad state of the communities, but as manifestation of very wide amplitude of oscillations characteristic of this group of communities

and for their cyclical (catastrophic) climax nature. However, this instability is to be very carefully taken in consideration at evaluating results of different pilot monitoring studies and their use for ecosozological assessment of ecosystems. Their misinterpretation and mistaken application may have serious consequences in landscape planning or in nature protection measures.

The obtained results show that the reed stands represent, in spite of their relative instability, significant refugees for the wetland fauna in cultural landscape. Even in reduced surfaces they are able to maintain a major part of species spectrum of Carabid characteristic for the most natural and preserved reed stands. This fact shows necessity of protection of reed stand in cultural landscape, irrespectively of their seemingly negligible surface.

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## REFERENCES

JAROLÍMEK I. & ŠIBÍK J. 2008. *Vegetation of Slovakia. Diagnostic, constant and dominant species of the higher vegetation units of Slovakia.* Veda. Bratislava: 329 pp.

FREUDE H., HARDE K. H., LOHSE G. A. 1976. *Die Käfer Mitteleuropa. **2**(Adephaga 1).* Goecke & Evers. Krefeld: 302 pp.

HŮRKA K. 1995. *Carabids of the Czech and Slovak Republics*. Kabourek. Zlín: 565 pp.

KULT K. 1947. *Klíč k určvání brouků čeledi Carabidae Československé republiky, československá společnost entomologická*. Praha: 199 pp.

MAGISTRETTI M. 1979. *Fauna d'Italia**, Coleoptera, Cicindelidae, Carabidae*.** Edizioni. Calderini Bologna: 512 pp.

MICHALKO J. (ED.). 1986. *Geobotanická mapa ČSSR, Slovenská socialistická republika*. Veda. Bratislava: 162 pp., 12 maps.

NOVÁK B. 1966. *Dynamika populace brouků ze skupiny Silphini*. Acta Universitais Palackianae Olomucensis. Facultas Rerum Naturalium. **22**: 147-158.

OBRTEL, R. 1972. *Soil surface coleoptera in a reed swamp.* Acta scientiarum naturalium Academiae scientiarum bohemoslovacae. Brno. **6**: 1-35.

PETRUŠKA F. 1964. *Příspěvek k poznání pohyblivosti několika druhů brouků nalétávajících na mršiny (Col. Silphidae et Histeridae).* Acta Universitais Palackianae Olomucensis. Facultas Rerum Naturalium. **16**: 159-190.

RAUŠER J. & ZLATNÍK A. 1966. Biogeografie I. Národní atlas ČSSR. List 21.

SCHMIDT J. 1994. *Revision der mit Agonum (s. str.) viduum (Panzer, 1797) verwandten Arten (Coleoptera, Carabidae*). Beiträge zurEntomolologie. **44**: 3-51.

SCHMIDT M H., LEFEBRE G., POULIN B., TSCHARNTKE T. 2005. *Reed cutting affects arthropod communities , potentially reducing food for passerine birds*. Biological Conservation. **121**: 157-166.

ŠUSTEK Z. 1983. *Zeitkorrelierte Veränderungen der Alpha-Diversitäz der Carabidenzönosen in Mitteleuropa*. Biologia (Bratislava). **38**: 858-970.

ŠUSTEK Z. 1984. *Bioindikačné vlastnosti bystruškovitých a drobčíkovitých (Coleoptera, Carabodae et Staphylinidae) stredoeurópskeho veľkomesta*. PhD tesis, Institute of Experimental Biology and Ecolofy, Slovak Academy of Sciences. Bratislava: 360 pp.

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

ŠUSTEK Z. 1992. *Changes in the representation of Carabid life forms along an urbanisation gradient (Coleoptera, Carabidae).* Biológia (Bratislava). 47: 417-430.

ŠUSTEK Z. 1995. *Fluktuácie populácií druhov Pterostichus melanarius a Pterostichus niger (Col. Carabidae) a ich interpretácia.* In. SVOBODOVÁ, A. et LISICKÝ, M. J. (eds). Výsledky a skúsenosti z monitorovania bioty územia ovplyvneného vodným dielom Gabčíkovo. Ústav zoológie a ekosozológie SAV. Bratislava: 314-318.

ŠUSTEK Z. 2004. *Estimate of the ground beetles (Coleoptera, Carabidae) community parameters for evaluation of optimization measures in floodplains affected by the Gabčíkovo barrage system*. X$^{th}$ International Poster Day Transport of Water, Chemicals and Energy in the System Soil-Crop-Canopy-Apmosphere. Bratislava 28. 11. 2002: 426-437.

ŠUSTEK Z. 2004a. *Characteristic of humidity requirements and relation to vegetation cover of selected central European Carabids (Col. Carabidae)* in. Hodnocení stavu a vývoje lesních geobiocenóz. Geobiocenologické spisy 9. Lesnická a dřevařská fakulta MZLU v Brně. Brno: 210-214.

VALKAMA E., LYYTINEN S., KORICHEVA J. 2008. *The impact of reed management on wildlife: A meta-analytical review of European studies*. Biological Conservation. **141**: 364-374.

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Table 1. Alphabetic survey of species, their preference for humidity and vegetation cover and abundance in reed stand in seven localities of southwestern Slovakia (H – preference for humidity: 2 – moderately xerophilous species – 8 strongly hydrophilous species; V – preference for vegetation cover: 1 – open landscape species, 2 eurytopis species, 3 – species preferring dispersed shrubby and tree vegetation, 4 – forests species, 5 – ripicolous species). / Tabel. 1. Lista alfabetică a speciilor, preferința lor pentru umiditate şi stratul vegetal, şi abundența lor în stufărişurile din şase localități din Slovacia de sud-vest (H – preferința pentru umiditate: 2 – specii moderat xerofile – 8 specii extrem hidrofile; V – preferință pentru stratul vegetal: 1 – specii non-forestiere, 2 specii euritopice, 3 – specii care preferă vegetația discontinuă de arbuşti şi copaci, 4 – specii de pădure, 5 – specii ripicole).

| | Species | H | V | V. Kosihy | Medveď'ov | Medveď'ov | Medveď'ov | Suchohrad | Suchohrad | Lozorno | V. Meder | V. Meder | Stupava |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1998 | 1998 | 1999 | 2000 | 1998 | 2000 | 1999 | 1999 | 2000 | 1999 |
| 1 | *Abax parallelopipedus* (PILLER et MITTERPACHER 1783) | 3 | 4 | | | | | | | 3 | | | 1 |
| 2 | *Acupalpus meridianus* (LINNAEUS 1767) | 6 | 1 | | 1 | | 1 | 1 | 2 | 3 | | | |
| 3 | *Agonum afrum* (DUFTSCHMIDT 1812) | 8 | 3 | | 3 | | 8 | | | 240 | 15 | 7 | 14 |
| 4 | *Agonum duftschmidti* SCHMIDT 1994 | 8 | 4 | 117 | 85 | 2 | 162 | | 6 | | 2 | | |
| 5 | *Agonum fuliginosum* (PANZER 1809) | 8 | 4 | 2 | 2 | 19 | 1 | 3 | | | | | |
| 6 | *Agonum livens* (GYLLENHAL 1810) | 8 | 4 | 30 | 2 | | | | | | | | |
| 7 | *Agonum lugens* (DUFTSCHMIDT 1812) | 8 | 4 | 28 | | | 4 | | | 1 | | | |
| 8 | *Agonum sexpunctatum* (LINNAEUS 1758) | 5 | 1 | | | | | | | 2 | | | |
| 9 | *Agonum thorei* (DEJEAN 1828) | 8 | 5 | 6 | | 5 | 7 | | | | | | |
| 10 | *Amara aenea* (DE GEER 1774) | 3 | 1 | | 3 | | | | | 21 | 8 | 1 | 1 |
| 11 | *Amara apricaria* (PAYKULL 1790) | 3 | 1 | 1 | | | | | | | | | |
| 12 | *Amara aulica* (PANZER 1797) | 3 | 1 | | | | | | | | | 2 | |
| 13 | *Amara familiaris* (DUFTSCHMIDT 1812) | 3 | 1 | | | | | | 1 | 4 | 4 | 2 | 1 |
| 14 | *Amara ovata* (FABRICIUS 1792) | 3 | 1 | | 1 | | | | | | | 1 | |
| 15 | *Amara similata* (GYLLENHALL 1810) | 3 | 1 | | 1 | | | | | | | | |
| 16 | *Anchomenus dorsalis* (PONTOPIDAN 1763) | 3 | 1 | | | | | | | 2 | | | |
| 17 | *Anisodactylus binotatus* (FABRICIUS 1787) | 6 | 1 | 1 | | | | | | | 2 | | |
| 18 | *Anisodactylus signatus* (PANZER 1797) | 5 | 1 | | 3 | | | | 1 | 1 | | 1 | |
| 19 | *Asaphidion flavipes* (LINNAEUS 1762) | 6 | 4 | | | | | | 1 | 1 | 1 | | |
| 20 | *Badister bulatus* (Schrank 1798) | 5 | 2 | | | | | | | | | 1 | |
| 21 | *Badister dilatatus* CHAUDOIR 1837 | 8 | 2 | | | | | | | | 1 | | |
| 22 | *Badister lacertosus* (STURM 1815 | 6 | 2 | | | | 1 | | 1 | 7 | 6 | | |
| 23 | *Badister peltatus* (PANZER 1797) | 8 | 2 | 2 | 2 | | 25 | | | | | | |
| 24 | *Badister sodalis* (DUFTSCHMIDT 1812) | 7 | 2 | | 5 | | 1 | | | 4 | 8 | 4 | |
| 25 | *Badister unipustulatus* BONELLI 1813) | 7 | 2 | 15 | 2 | 1 | 6 | | 3 | | | | |
| 26 | *Bembidion articulatum* (PANZER 1796) | 8 | 5 | 1 | | | | | | | | | |
| 27 | *Bembidion biguttatum* (FABRICIUS 1779) | 8 | 4 | 3 | 5 | 1 | 30 | 1 | 7 | 1 | | | |
| 28 | *Bembidion gilvipes* STURM 1825 | 8 | 5 | | 1 | | | | 8 | | | | |
| 29 | *Bembidion guttula* (FABRICIUS 1792) | 8 | 5 | | 1 | | | | 1 | 155 | 528 | 8 | 22 |
| 30 | *Bembidion inoptatum* SCHAUM 1857 | 8 | 1 | 5 | 14 | 3 | 37 | | | 1 | | 5 | |
| 31 | *Bembidion lampros* (HERBST 1784) | 3 | 1 | | | | | | | 60 | | | |
| 32 | *Bembidion lunulatum* (FOURCROY 1785) | 8 | 5 | 1 | | | 4 | | | 1 | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | *Bembidion minimum* (FABRICIUS 1792) | 8 | 5 | | 1 | | | | | | | | |
| 34 | *Bembidion modestum* (FABRICIUS 1801) | 8 | 5 | 1 | | | | | | | | | |
| 35 | *Bembidion octomaculatum* (GOEZE 1777) | 8 | 5 | 8 | | 6 | 1 | | | | | | |
| 36 | *Bembidion properans* STEPHENS 1828 | 3 | 1 | | | | | | | 1 | | | |
| 37 | *Bembidion quadripustulatum* AUDINET-SERVILLE 1821 | 7 | 5 | | | | 1 | | | 1 | | | |
| 38 | *Bembidion tetracolum* SAY 1823 | 8 | 5 | 6 | | | | | | | | | |
| 39 | *Bembidion unicolor* CHAUDOIR 1850 | 8 | 4 | 1 | | | | | 2 | 1 | 6 | 51 | |
| 40 | *Bembidion varium* (OLIVIER 1795) | 8 | 5 | 2 | | | 1 | | | | | | |
| 41 | *Bradycellus caucasicus* CHAUDOIR 1864 | 3 | 1 | | 2 | | | | | 1 | 1 | | |
| 42 | *Brachynus explodens* DUFTSCHMIDT 1812 | 3 | 1 | | | | | | | | 1 | | |
| 43 | *Calathus fuscipes* (GOEZE 1777) | 4 | 1 | | | | | | | | | 1 | |
| 44 | *Carabus cancellatus* ILLIGER 1798 | 4 | 2 | | | | | | | | | | 8 |
| 45 | *Carabus clathratus* LINNAEUS 1762 | 8 | 2 | 36 | | | | | | | | | |
| 46 | *Carabus coriaceus* LINNAEUS 1758 | 5 | 4 | | | | | 35 | 37 | 1 | | | |
| 47 | *Carabus granulatus* LINNAEUS 1758 | 7 | 2 | 126 | 193 | | 50 | 1 | 20 | 147 | 7 | 12 | 19 |
| 48 | *Carabus hortensis* LINNAEUS 1758 | 4 | 4 | | | | | 2 | | | | | |
| 49 | *Carabus nemoralis* C. F. MÜLLER 1764 | 4 | 4 | | | | | 1 | 6 | | | | |
| 50 | *Carabus scheidleri* PANZER 1799 | 5 | 4 | | | | | | 1 | | | | |
| 51 | *Carabus ullrichi* GERMAR 1824 | 4 | 4 | | | | | | 3 | 20 | | | |
| 52 | *Carabus violaceus* LINNAEUS 1758 | 4 | 5 | | | | | | 1 | | | | |
| 53 | *Clivina fossor* (LINNAEUS 1758) | 6 | 4 | 4 | 7 | | | | 1 | 22 | 12 | | 2 |
| 54 | *Diachromus germanus* (LINNAEUS 1758) | 7 | 1 | | 1 | | | | | | | | |
| 55 | *Dolichus halensis* (SCHALLER 1783) | 4 | 1 | | | | | | | 1 | | | |
| 56 | *Dromius longiceps* DEJEAN 1826 | 2 | 1 | 1 | | | | | 2 | | | | |
| 57 | *Dyschirius globosus* (HERBSTS 1784) | 8 | 5 | 6 | 6 | | 3 | | 3 | 3 | 1 | 1 | |
| 58 | *Epaphius secalis* (PAYKULL 1790) | 6 | 4 | | | | | 4 | | | | | |
| 59 | *Europhilus micans* (NICOLAI 1822) | 7 | 4 | 3 | 17 | | 5 | 12 | 15 | | 18 | | 3 |
| 60 | *Europhilus piceus* (LINNAEUS 1758) | 8 | 4 | 1 | | | | | | | | | |
| 61 | *Harpalus atratus* LATREILLE 1804 | 4 | 4 | | | | | | 1 | | | | |
| 62 | *Harpalus latus* (LINNAEUS 1758) | 4 | 1 | | | | | | 7 | 6 | | | |
| 63 | *Harpalus progrediens* SCHAUMBERGER 1922 | 5 | 2 | | 1 | | | | | | 2 | | |
| 64 | *Chlaenius nigricornis* (FABRICIUS 1787) | 8 | 5 | | | | 1 | | | | | | |
| 65 | *Chlaenius tristis* (SCHALLER 1783) | 8 | 5 | 11 | | | 6 | | | | | | |
| 66 | *Lasiotrechus discus* (FABRICIUS 1792) | 6 | 5 | 2 | | | | | | | | | |
| 67 | *Leistus ferrugineus* (LINNAEUS 1758) | 4 | 3 | 3 | | | | 2 | 1 | 1 | 1 | | |
| 68 | *Leistus rufomarginatus* (DUFTSCHMIDT 1812) | 5 | 4 | | | | | | 1 | | | | |
| 69 | *Lorocera pillicornis* (FABRICIUS 1775) | 4 | 2 | | | | | | 2 | | | | |
| 70 | *Microlestes minutulus* GOEZE 1777) | 2 | 1 | | | | | | | | 1 | | |
| 71 | *Nebria brevicollis* (FABRICIUS 1792) | 6 | 2 | | | | | | | 9 | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 72 | *Notiophilus palustris* (DUFTSCHMIDT 1812) | 4 | 2 | | | | | 1 | 2 | 2 | | | 1 |
| 73 | *Oodes gracilis* A. VILLS ET J. B. VILLS 1833 | 8 | 5 | 7 | 4 | 1 | 5 | | | | | | |
| 74 | *Oodes helopioides* (FABRICIUS 1792) | 8 | 5 | 131 | 72 | 22 | 179 | 2 | 7 | 2 | | | 7 |
| 75 | *Oxypselaphus obscurus* (HERBST 1784) | 7 | 4 | 42 | 168 | 1 | 3 | 52 | 50 | 5 | 4 | | |
| 76 | *Panageus bipustulatus* (FABRICIUS 1775) | 4 | 1 | | | | | | | | 1 | | |
| 77 | *Panageus cruxmajor* (LINNAEUS 1758) | 6 | 2 | | | | | | | | 2 | | |
| 78 | *Patrobus atrorufus* (STURM 1768) | 7 | 4 | | | 1 | | | 13 | 6 | 10 | | |
| 79 | *Platynus assimilis* (PAYKULL 1790) | 7 | 4 | | 1 | | 1 | | 56 | 1 | | | |
| 80 | *Platynus krynickyi* (SPARK 1835) | 8 | 4 | | 26 | | 6 | 1 | | | | | |
| 81 | *Poecilus cupreus* (LINNAEUS 1759) | 4 | 1 | | 6 | | 2 | 1 | 1 | 45 | 10 | | |
| 82 | *Pseudophonus rufipes* (DE GEER 1774) | 4 | 1 | 3 | 11 | | | 3 | 5 | 1 | 9 | 2 | |
| 83 | *Pterostichus anthracinus* (ILLIGER, 1798) | 8 | 4 | 16 | 28 | 2 | 58 | 1 | 19 | 2 | 1 | | 3 |
| 84 | *Pterostichus bruneus* (STURM 1824) | 8 | 5 | 4 | 4 | | 7 | 1 | | 1 | | | |
| 85 | *Pterostichus diligens* (STURM 1824) | 7 | 2 | 10 | 21 | 3 | 7 | 2 | 2 | | | | |
| 86 | *Pterostichus melanarius* (ILLIGER 1799) | 5 | 2 | 73 | 98 | | | 3 | 11 | 61 | 2 | 11 | 15 |
| 87 | *Pterostichus niger* (SCHALLER 1783) | 6 | 4 | 173 | 105 | | 1 | 59 | 24 | 4 | 2 | 13 | |
| 88 | *Pterostichus nigrita* (FABRICIUS 1792) | 8 | 5 | 8 | | | 2 | | | 7 | | | |
| 89 | *Pterostichus oblongopunctatus* (FABRICIUS 1787) | 5 | 4 | | | | | | 3 | | | | |
| 90 | *Pterostichus strenuus* (PANZER 1797) | 7 | 2 | 1 | 49 | 1 | | 7 | 18 | 100 | 220 | 71 | |
| 91 | *Pterostichus vernalis* (PANZER 1796) | 8 | 5 | 16 | 33 | 1 | | | 2 | | 34 | 7 | 1 |
| 92 | *Stenolophus mixtus* (HERBST 1784) | 8 | 1 | 4 | 8 | 1 | 12 | 4 | 3 | | 1 | | |
| 93 | *Stenolophus teutonus* (SCHRANK 1781) | 8 | 1 | | | | 1 | | | 1 | | | |
| 94 | *Stomis pumicatus* (PANZER1796) | 8 | 2 | 2 | 5 | | | 1 | 5 | | 87 | | |
| 95 | *Syntomus obscuroguttatus* (DUFTSCHMIDT 1812) | 5 | 2 | | | | | | 1 | 1 | | | |
| 96 | *Trechus quadristriatus* (SCHRANK 1781) | 4 | 1 | 1 | 20 | | | 10 | 5 | 1 | 5 | 1 | |
| Numer of individuals | | | | 914 | 1018 | 70 | 639 | 210 | 361 | 961 | 1013 | 202 | 98 |
| Numer of species | | | | 43 | 41 | 16 | 34 | 25 | 44 | 46 | 34 | 20 | 14 |
| Shannon´s index H´ | | | | 2.67 | 2.68 | 2.08 | 2.30 | 2.19 | 3.04 | 2.43 | 1.70 | 2.07 | 2.14 |
| Equitability | | | | 0.71 | 0.72 | 0.75 | 0.65 | 0.68 | 0.80 | 0.64 | 0.48 | 0.69 | 0,81 |