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**SPOLOČENSTVÁ BYSTRUŠKOVITÝCH (COL. CARABIDAE) DEGRADAČNÝCH ŠTÁDIÍ  
DRIEŇOVÝCH DÚBRAV (*CORNI QUERCETA* DEG.) V DUBOVOM VEGETAČNOM STUPNI**

**CARABID COMMUNITIES (COL. CARABIDAE) IN DEGRADATION STAGES OF PUBESCENT  
OAK FORESTS (*CORNI QUERCETA* DEG.) IN OAK VEGETATION TIER**

Zbyšek Šustek

*Institute of zoology, Slovak Academy of Sciences, Dúbravská cesta 9, 845 06 Bratislava, Slovakia*

**Abstrakt**

Spoločenstvá bystruškovitých v degradačných štádiách drieňových dúbav (lesostepí) vytvárajú medzi spoločenstvami v ostatných typoch prirodzených geobiocenóz v strednej Európe osobitý celok. Vyznačujú sa výskytom malého počtu silne termoxerofilných druhov (*Carabus hungaricus*, *Dyschirius rufipes*, *Zabrus spinipes*, *Licinus cassideus*, *Cymindis angularis*, *Masoreus wetterhali*) zastúpených spravidla veľmi malým počtom jedincov. Výnimkou je len početná populácia *C. hungaricus* na jednej lokalite na Pavlovských kopcoch. Tieto druhy sú sprevádzané dvoma skupinami druhov. Prvou skupinou sú lesné druhy, ktoré obývajú okolité plne zapojené porasty a ktoré do drieňových lesostepí imigrujú v daždivejších alebo chladnejších obdobiach, pričom sa sústreďujú v miestach s ostrovčekmi drevinnej vegetácie. Druhou skupinou sú dobre lietajúce druhy migrujúce zo vzdialenejších miest, najmä počas teplých nocí pred prechodom frontálnych systémov. Avšak aj imigrujúce druhy sú zastúpené malým a navyše veľmi kolísajúcim počtom jedincov. Druhy charakteristické pre tzv. kultúrnu step sú napriek fyziogonomickej podobnosti oboch ekosystémov zastúpené málo. Časovo sa výskyt bystruškovitých sústreďuje do jarých a najmä jesenných mesiacov. Tým sa sezónna dynamika výskytu bystruškovitých v týchto geobiocenózach ostro odlišuje od ostatných geobiocenóz v strednej Európe, no približuje sa sezónnej dynamike výskytu bystruškovitých v aridných oblastiach mediteránu.

**Abstract**

Carabid communities in degradation stages of pubescent oak forests (forest steppes) form a special entity among Carabid communities in other type of natural geobiocoenoses in Central Europe. They consist of a small number of strongly termoxerophilous species (*Carabus hungaricus*, *Dyschirius rufipes*, *Zabrus spinipes*, *Licinus cassideus*, *Cymindis angularis*, *Masoreus wetterhali*) which are, however, represented by a very small number of individuals. An exception is a rich population of *C. hungaricus* in one locality in Pavlovské kopce hills. These species are accompanied by two groups of species. The first group includes forests species that inhabit surrounding closed stands and into pubescent oak forest steppes immigrate during rainy or colder periods and concentrate around small islands of woody plant vegetation. The second group consists of well flying species migrating from remote places, especially in warm nights before passing of frontal systems. The immigrating species are also represented by low number of individuals. Most species characteristic for the s.c. cultural steppe are little represented in spite of physiognomical similarity of both ecosystems. Occurrence of Carabids concentrates in spring and especially in autumn months. This feature of seasonal dynamics of occurrence of Carabids in these geobiocoenoses strongly differs from other geobiocoenoses in Central Europe, but is similar seasonal dynamics of Carabids in arid areas of the Mediterranean.

**Introduction**

The degradation stages of pubescent oak forest represent small islands of extrazonal forest-steppe-like ecosystems inhabited with many termo xerothermophilous plant and animal species and situated on southern slopes in areas with low annual precipitation (550 – 700 mm) and high average temperature (8–10° C) (Randuška et al, 1986). The Carabid communities in this type of geobiocoenoses are still little known. Only the data on published by Šustek (1976, 1984, 2000) show these communities to strongly differ from other Carabid communities in Central Europe.

The aim of this paper is to synthesize the quantitative data on Carabid communities in these type of geobiocoenoses obtained in last 20 years, characterize variability of their composition, compare them with non-forest Carabid communities in similar abiotic conditions, and contribute in this way to the knowledge of animal component of geobiocoenoses of the oak vegetation tier according the concept of prof. A. Zlatník (Raušer & Zlatník 1966).

## Material and methods

The material was pitfall-trapped in three segments of degradations stages of pubescent oak forests (*Corni Querceta* deg) on the southeastern Slope of the Děvín hill (48° 52' 20" N, 16° 39' 40" E, leg. Šustek 1971 and 1981) near the Pavlov village, on the top plateau of the Děvín hill (48° 52' 00" N, 16° 39' 00" E, lgt. Chytil, det. Z. Šustek 1995 and 1996) and on the southwestern slope of the Devínska Kobyla hill, above the Devín settlement at western margin of Bratislava (48° 10' 16" N, 16° 59' 55" E, leg. Šustek 1988). For comparison, a material sampled on an abandoned field in initial stage of secondary succession on the southwestern slope of Dunajovské kopce hills near Dolné Dunajovice in South Moravia (48° 53' 00" N, 16° 33' 30" E, leg. Šustek 1986) where degradations stages of pubescent oak forests can be supposed to be potential vegetation was also included in this study. For comparison, Carabid community from a wheat field near the Dlhá village (48° 16' 10" N, 17° 23' 5" E, leg. Šustek 1997) in southwestern Slovakia was chosen because of similar microclimatic conditions of this locality.

In Pavlovské kopce and Devínska kobyla, 10 pitfall traps were installed, while in Dunajovské kopce and Dlhá 6 traps. The traps filled with 4% formaldehyd were emptied each 4-6 weeks.

The species ecology is characterized by a 8-degree scale of humidity preference and a 5-degree scale of vegetation cover preference (Šustek, in press). The preference indices of communities is calculated as average of preferences of all species in the community weighted by their abundance.

## Results

All three communities in Děvín and Devínska kobyla (Tab. 1) are characterized by a very low number of species (8-12) and individuals (22 – 144). This numbers represent about 30% of species number usually constituting natural or semi-natural Carabid communities in other forest or non forest ecosystems and about 5-10% of number of individuals in one year catch from such communities. These communities consist of four groups of species:

1. strongly xerothermophilous species (humidity preference 1-2, Tab. 1) preferring grassy or herbage vegetation cover (*Carabus hungaricus*, *Dyschirius rufipes*, *Harpalus picipennis*, *Harpalus pumilus*, *Masoreus wetterhalli*, *Licinus cassideus*, *Cymindis angularis*, *Zabrus spinipes*). These species, however, occur very irregularly and individually. The only exception is *Carabus hungaricus* on the top plateau of the Děvín hill, which occurred in several tens of individuals (Tab. 1). Presence of these species can be considered, irrespectively of very low quantitative representation, as the most characteristic feature of these communities and, at the same time, as of the trophical row D. In the community in Devínska kobyla, these strongly xerothermophilous species were represented only by *Zabrus spinipes* (Tab. 1).
2. species like *Calathus fuscipes*, *Calathus cinctus*, *Calathus melanocephalus*, *Poecilus cupreus*, *Dromius linearis*, *Cicindela campestris*, *Microlestes maurus* which are less xerothermophilous (humidity preference 2-4, Tab. 1), but have a clear preference for open, non-forest ecosystems. In Devínska kobyla, these species formed the major part of community. One of these species, *Calathus fuscipes* (humidity preference 4), was even eudominant (74.05%), but due to its higher humidity preference (4) concentrated around small groups of trees and shrubs (Tab. 2, traps 1, 2 4 and 9). Other of these species occurred more or less sporadically, though in other non-forest ecosystems they often reach a high absolute and relative abundance.
3. forest species like *Carabus coriaceus*, *Carabus hortensis*, *Pterostichus oblongopunctatus* and *Abax ater* (humidity preference 4-5, tab. 1), which immigrate in degradation stages of pubescent oak geobiocoenoses from surrounding closed forest stands. Their immigration occurs in only in rainy periods or in late autumn, when the humidity and temperature gradient between the forest and adjacent "forest steppe" is not so strong. This situation is fairly illustrated by example of southeastern slope in Děvín, where these species almost absented in 1971, but co-occurred (particularly *C. coriaceus*) in 1981 (Tab. 1). Due to such immigrations, the composition of communities in these geobiocoenoses can be strongly variable and unstable.
4. Immigrants from remote places of different ecological character. The strongly hygrophilous species *Bembidion biguttatum* and *Pterostichus anthracinus* having humidity preference 8, tab. 1) come to the southeastern slope of the Děvín hill obviously from the Dyja river floodplains at foots of the Pavlovské kopce hills. These species are completely xenocoenous in this geobiocoenosis, but their immigration can occur at any time in summer, as these species have an enormous dispersal power and fly over large distances particularly in warm nights immediately before passing of frontal systems (Kádár & Szentkirályi 1992) and, at such occasions, penetrate even into centers of large cities (Šustek 1999). Irrespectively of this, presence of hygrophilous species is a surprising and paradoxical feature of insect communities of deserts (Crawford 1981). The s.c. field species like *Anchomenus dorsalis* or *Poecilus cupreus* also belong to this group of immigrants.

Tab.1:

Species	Ecology	Vegetation cover preference	Locality						
			Děvín SE slope	Děvín SE slope	Děvín top	Děvín top	Devínska Kobyla	Dunajovické kopce	Dlhá
			1971	1981	1995	1996	1988	1986	1997
<i>Carabus hungaricus</i> Fabricius, 1792	1	1			73	126			
<i>Dyschirius rufipes</i> (Dejean, 1825)	1	1	1	1					
<i>Harpalus picipennis</i> (Duftschmidt, 1812)	1	1	2	2				33	
<i>Harpalus pumilus</i> Sturm, 1818	1	1			1	3			
<i>Masoreus wetterhali</i> (Gyllenhal, 1813)	1	1	1						
<i>Licinus cassideus</i> (Fabricius, 1792)	1	1	2	1	1	1		1	
<i>Ophonus sabulicola</i> (Panzer, 1796)	1	1						14	
<i>Zabrus spinipes</i> Fabricius, 1798	1	1					4	2	
<i>Cymindis angularis</i> Gyllenhal, 1810	2	1	1		1			10	
<i>Dromius linearis</i> (Olivier, 1795)	2	1				1	1		
<i>Harpalus signaticornis</i> (Duftschmidt, 1812)	2	1			1	2			
<i>Harpalus tardus</i> (Panzer, 1797)	2	1	3					3	
<i>Licinus depressus</i> (Paykull, 1790)	2	1				1			
<i>Microlestes maurus</i> (Sturm, 1827)	2	1					1	5	
<i>Ophonus azureus</i> (Fabricius, 1775)	2	1						1	8
<i>Ophonus puncticollis</i> (Paykull, 1798)	2	1						29	
<i>Poecilus sericeus</i> Fischer von Waldheim, 1823	2	1						1	
<i>Microlestes plagiatus</i> (Duftschmidt, 1812)	2	1						1	
<i>Amara aenea</i> (De Geer, 1774)	3	1		1				3	1
<i>Amara apricaria</i> (Paykull, 1790)	3	1						4	4
<i>Amara aulica</i> (Panzer, 1797)	3	1						1	
<i>Amara caudoiri incognita</i> Fassati, 1946	3	1							2
<i>Amara consularis</i> (Duftschmidt, 1812)	3	1						3	
<i>Amara cursitans</i> Zimmermann, 1832	3	1		1				3	
<i>Amara ovata</i> (Fabricius, 1792)	3	1							1
<i>Amara saphyrea</i> Dejean, 1828	3	1							1
<i>Amara majuscula</i> Chaudoir, 1850	3	1				1			
<i>Amara similata</i> (Gyllenhal, 1810)	3	1	1						
<i>Bembidion lampros</i> (Herbst, 1784)	3	1							18
<i>Brachynus crepitans</i> (Linnaeus, 1758)	3	1						361	29
<i>Brachynus explodes</i> (Duftschmidt, 1812)	3	1						329	219
<i>Calathus ambiguus</i> (Paykull, 1790)	3	1						4	1
<i>Calathus cinctus</i> Motschulsky, 1850	3	1					4		
<i>Calosoma auropunctatum</i> (Herbst, 1784)	3	1							7
<i>Harpalus affinis</i> (Schrank, 1781)	3	1							1
<i>Harpalus distinguendus</i> (Duftschmidt, 1812)	3	1						2	4
<i>Anchomenus dorsalis</i> (Pontoppidan, 1763)	3	1					1	367	684
<i>Ophonus schauermegerianus</i> Puel, 1937	3	1						1	
<i>Abax ater</i> (Villers, 1789)	3	4	1	1					
<i>Brachinus gangelbaueri advena</i> Schaubberger, 1921	4	1							84

<i>Cicindela campestris</i> Linnaeus, 1758	4	1				2		
<i>Harpalus latus</i> (Linnaeus, 1758)	4	1				1	2	
<i>Poecilus cupreus</i> (Linnaeus, 1758)	4	1	4	2		2	108	1931
<i>Pterostichus macer</i> (Marsham, 1802)	4	1						7
<i>Pseudoophonus rufipes</i> De Geer, 1774)	4	1				2	104	239
<i>Trechus quadristriatus</i> (Schränk, 1781)	4	1						26
<i>Calathus fuscipes</i> (Goeze, 1777)	4	2			2	4	56	83
<i>Synuchus vivalis</i> (Illiger, 1798)	4	2						1
<i>Pterostichus ovoideus</i> (Sturm, 1824)	4	2		1				
<i>Leistus ferrugineus</i> (Linnaeus, 1758)	4	3					3	
<i>Carabus hortensis</i> Linnaeus, 1758	4	4		5				
<i>Calosoma inquisitor</i> (Linnaeus, 1758)	4	4				2		
<i>Carabus hortensis</i> Linnaeus, 1758	4	4			1			
<i>Harpalus atratus</i> Latreille, 1804	4	4		1		1		
<i>Pterostichus melanarius</i> (Illiger, 1798)	5	2						65
<i>Syntomus foveatus</i> Fourcroy, 1785	5	2					2	
<i>Syntomus obscuriguttatus</i> Duftschmidt, 1812	5	2				4		3
<i>Carabus coriaceus</i> Linnaeus, 1758	5	4	3	49				
<i>Pterostichus oblongopunctatus</i> (Fabricius, 1787)	5	4		1				
<i>Carabus scheidleri</i> Panzer, 1799	5	4						2
<i>Carabus violaceus</i> Linnaeus, 1758	5	4						2
<i>Carabus coriaceus</i> Linnaeus, 1758	5	4	4		3	2	1	
<i>Badister lacertosus</i> (Sturm, 1815)	6	2					1	
<i>Stomis pumicatus</i> (Panzer, 1796)	6	2					2	1
<i>Clivina fossor</i> (Linnaeus, 1758)	6	4						1
<i>Carabus granulatus</i> Linnaeus, 1758	7	2						1
<i>Bembidion biguttatum</i> (Fabricius, 1779)	8	4	1					
<i>Pterostichus anthracinus</i> (Illiger, 1798)	8	4	2					
Number of species			11	12	8	11	11	31
Number of individuals			22	66	83	144	78	1484
Index of humidity			3,6	4,5	1,3	1,2	3,8	3,1
Index of vegetation cover			2,5	3,6	1,2	1,1	2,6	1,1

Explanations:

Scale of humidity preference: 1 - 8 (1 - strongly xerophilous, 4-5 - mezohygrophilous, 8 - strongly hygrophilous)

Scale of vegetation cover preference: 1 - herbage cover without any tree or shrub (fields, meadows, ruderals)  
 2 - indifferent to vegetation cover (eurytopic in the large sense)  
 3 - herbage cover with dispersed group of trees or shrubs  
 4 - continuous forest stands

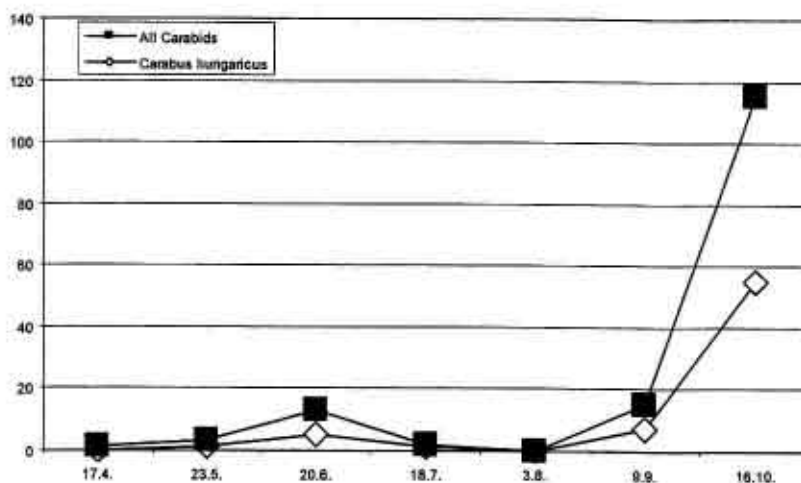
A very characteristic feature of Carabid communities in degradation stages of pubescent oak forests is the seasonal dynamics of occurrence (Fig. 1 and 2), which shows a clear tendency of concentration of Carabid occurrence into autumnal month, September and October. This concentration is especially well visible in the immigrants from the neighbouring forests and in *Carabus coriaceus* and *Carabus hortensis* is also connected with their autumn-type reproduction. This type of seasonal dynamics does not occur in other type of Central European carabid communities, but is very typical of Carabid communities in arid or semiarid ecosystems of Mediterranean area, where active of Carabids often culminates in winter, while in summer the Carabids aestivate.

In spite of physiognomic similarity of degradation stages of pubescent oak forests (forest steppe) and s.c. cultural steppe, they are almost not invaded by some of a large number of s.c. field species (potentially about 100-120 species), which usually very quickly and intensively colonize deforested or clear-cut areas (Šustek 1984a, b) or presence of such species is negligible (e. g. *Anchomenus dorsalis*, *Harpalus tardus*, *Harpalus latus*, *Calathus melanocephalus*, *Calathus cinctus*, *Poecilus cupreus*, tab. 1 and 2).

**Tab. 2.** Distribution of number of individuals of Carabid beetles along a 250 m long transect of 10 traps on southwestern slope of Devínska Kobyla

Species	Trap number										Summ
	1	2	3	4	5	6	7	8	9	10	
<i>Calathus fuscipes</i>	7	9	1	9	1	1	4	1	23	1	57
<i>Calathus mollis</i>	2			1		1					4
<i>Syntomus obscuroguttatus</i>				4							4
<i>Zabrus blapoides</i>	1	2					1				4
<i>Calosoma iquisitor</i>			1	1							2
<i>Pterostichus cupreus</i>		1			1						2
<i>Calathus melanocephalus</i>				1							1
<i>Harpalus latus</i>									1		1
<i>Anchomenus dorsalis</i>			1								1
<i>Microlestes maurus</i>					1						1
Number of individuals	10	12	3	16	3	2	5	1	24	1	77
Number of species	3	3	3	5	3	2	2	1	2	1	10

**Fig. 1.** Seasonal dynamics of *Carabus hungaricus* and of all carabids on top of the Děvín hill in 1995



**Fig. 2:** Seasonal dynamics of *Carabus hungaricus* and of all carabids on top of the Děvín hill in 1996 and January 1997

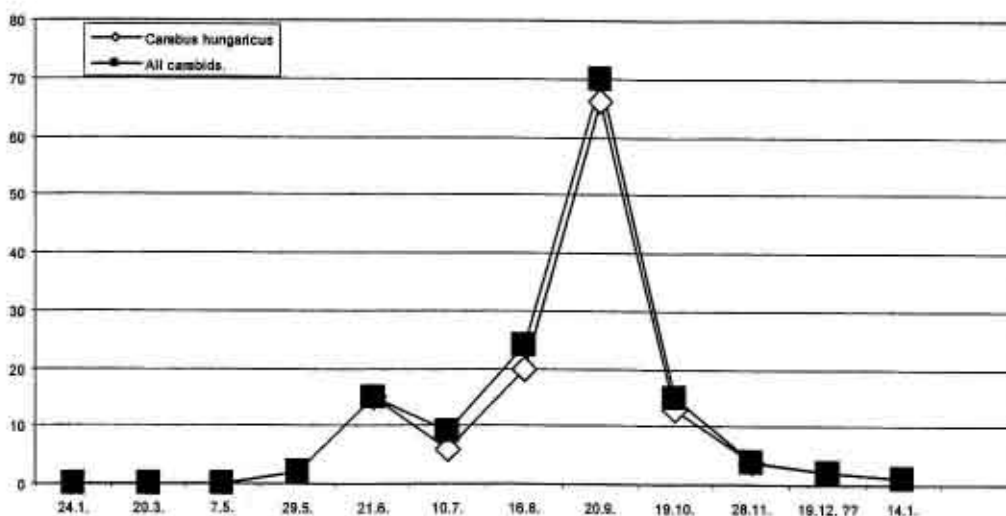


Fig. 3.: Seasonal dynamics of *Calathus fuscipes* and of all carabids on southwestern slope of Devínska kobyla in 1988

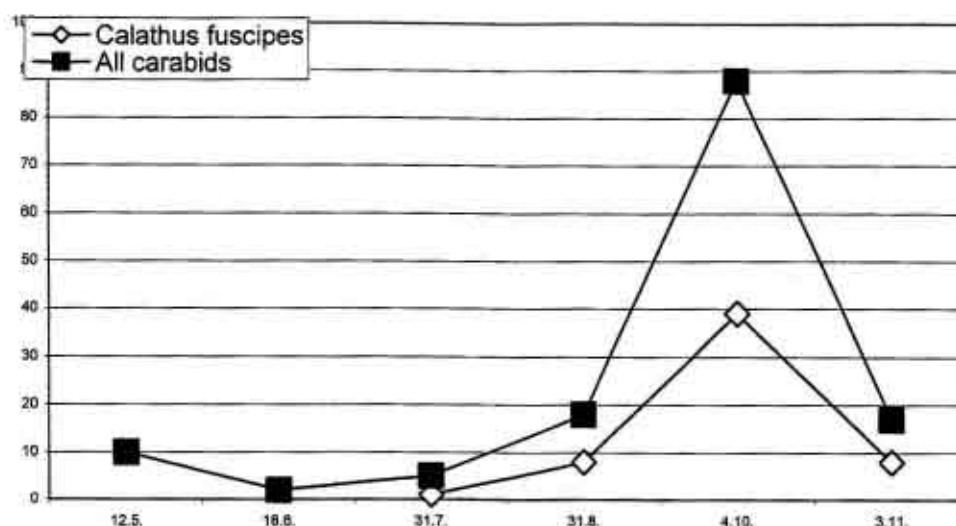
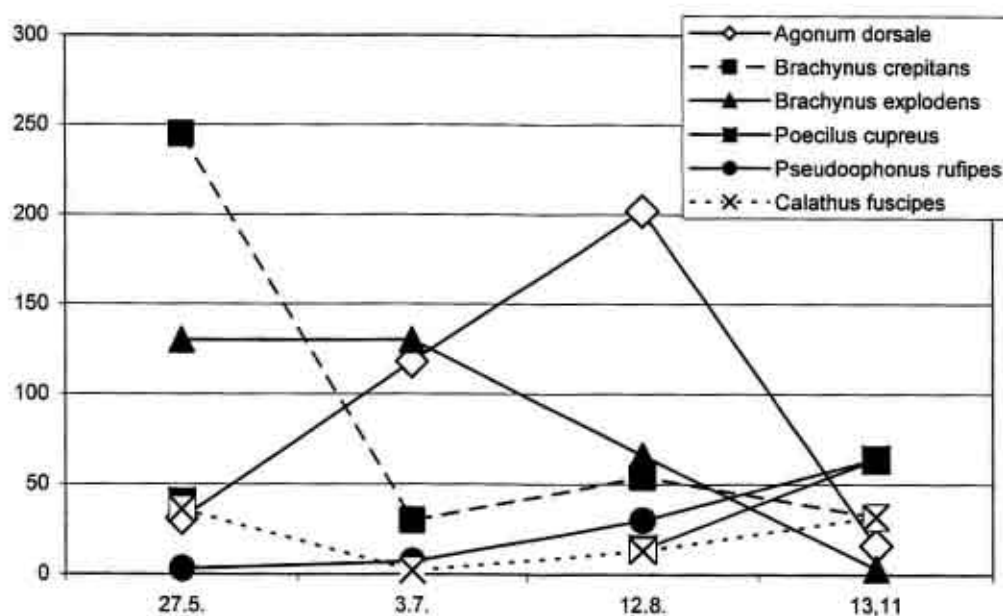


Fig. 4: Seasonal dynamics of six dominant carabid species in an abandoned field in advanced stage of secondary succession in Dunajovské kopce hills in 1986



Composition of Carabid communities in the natural or almost natural degradation stages of pubescent oak forests strongly differs from communities in several years abandoned field (originally vineyard) located on slopes of the Dunajovské kopce hills, where degradation stage of a pubescent oak forest can represent the potential natural vegetation. Here, the Carabid community exhibited the typical features of the field communities as exemplified in Tab. 1 by the community from the wheat field near Dlhá village:

1. a considerably high species richness (above 30 species) and cumulative abundance of individual species (almost 1500 ind.) and co-dominance of the species like *Anchomenus dorsalis*, *Brachynus crepitans*, *Brachynus explodens*, *Poecilus cupreus*, *Pterostichus melanarius* and *Pseudoophonus rufipes* (open landscape or eurytopic species, humidity preference 3-5), but unlike other fields some rare and strongly xerothermophilous species started to appear (*Harpalus picipennis*, *Licinus cassideus*, *Ophonus sabulicola*, *Zabrus spinipes*, *Cymidius angularis*) and *Harpalus picipennis* reached even a subdominant position (0.99%, Tab. 1). These species usually do not occur in the intensively cultivated fields and are characteristic of the communities in the natural degradation stages of the pubescent oak forests described above. These species indicated beginning certain approximation of this Carabid community in to the natural degradation stages of the pubescent oak forests.

2. The seasonal dynamics of occurrence of individual species (Fig. 4) has the same character as in other forest or field Carabid communities, hence occurrence of individual species culminated in spring or in summer, according to reproduction type of each species. No strong culmination of occurrence of some species in autumn months was observed.

## Conclusions

The Carabid communities in degradation stages of pubescent oak forests (*Corni Querceta* deg.) represent a very specific group among Central European Carabid communities. They are always characterized by presence of some mostly sporadically occurring more or less xerothermophilous species and of immigrants of different ecological nature. The immigrating forest species, however, can temporarily, especially in rain or colder periods predominate in the community. Due it, composition of these communities can be very variable, as also shown by indices of humidity and vegetation cover preference (Tab. 1).

These communities consist of a much lower number of species and individuals is much lower than other natural or semi-natural Carabid communities in Central Europe. Their poorness results from their extrazonal character and large distance from complexes of ecologically analogous communities in Mediterranean, South Russia and Ukraine and Dobrogea, which are inhabited by a well adapted fauna and which could serve as an immigration source.

The basic geological substrate in the geobiocoenoses of the trophical row D can favorite presence of termo- and xerophilous species, but unlike of other forest geobiocoenoses, it is unable to increase influence species diversity and secondary production.

The occurrence of Carabids in these communities culminates in autumn. Thus, their seasonal dynamics is similar to Carabid communities in arid Mediterranean-type ecosystems.

The zoocoenological relationships of these communities with Carabid communities in arable land is free. However, succession on abandoned arable land in the oak vegetation tier tends to converges to community structure of the Carabid communities in the natural degradation stages of pubescent oak forests

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## Literature

- Crawford, C. S., 1981: Biology of Desert Invertebrates. Berli – Heidelberg – New York.
- Kádár, F., & Szentkirályi, F., 1992: Influence of weather frontd on the flight activity of ground beetles (Coleoptera, Carabidae). pp. 500-503. In: Zombori, L., & Peregovits, L. (eds.) Proc. 4. ECE/XIII. SIEEC, 1-6. Sept. 1991, Gödöllő.
- Randuška, D., Vorel, J. & Plíva, K., 1986. Fytocenol'gia a lesnícka typológia. Bratislava.
- Raušer, J. & Zlatník, A., 1966: Biogeografie I. Mapa skupin přírodních biogeocenóz ve vegetačních stupních. Národní atlas ČSSR, List 21.
- 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), 38: 105-115.
- Šustek, Z., 1984 a: Carabidae and Staphylinidae of two forest reservations and their relations on surrounding human activity. Biológia (Bratislava), 39: 137-162.
- Šustek, Z., 1984 b: Influence of clear cutting on ground beetles (Coleoptera, Carabidae) in a pine forest. Communicationes Instituti Forestalis Czechoslovakiae, 12: 243-254.
- Šustek, Z., 1997: Light attraction of carabid beetles and their survival in the city centre. Biologia, Bratislava, 54: 639-551.
- Šustek, Z., 2000: Spoločenstvá bystruškovitých (Coleoptera, Carabidae) a ich využitie ako doplnkovej charakteristiky geobiocenologických jednotiek: problémy a stav poznania. p. 18 – 30. In: J. Štykar & P. Čermák (eds.): Geobiocenologická typizace krajiny a její aplikace. Geobiocenologické spisy, svazek č. 5., Brno, p. 136.
- Šustek, Z., in press: Charakteristika vlhkostných nárokov a vz'ahu k vegetačnému krytu vybraných druhov stredoeurópskych bystruškovitých (Col. Carabidae), Geobiocenologické spisy Brno.