DISTRIBUTION OF CARABID BEETLES (COLEOPTERA, CARABIDAE) ALONG A SEMINATURAL HEDGEROW IN SOUTH MORAVIA

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Abstract. *Changes in distribution of Carabids along a seminatural hedgerow connected directly with a large oak-hornbeam forest was studied in southern eastern slopes of the Pavlovské kopce hills in South Moravia in 1988 and 1989. Most forest species occurred in a reduced number on individuals along the whole 1.6 km long hedgerow, but their proportion declined toward the more remote parts but independently of the distance from the forest increased in wide part of the hedgerow. A similar, but not so expressive distribution pattern was also found in the eurytopic species. The open landscape species tended to predominate in more remote or narrower and lighter parts of the hedgerow. There has been shown that such type of hedgerow is able to serve simultaneously as a migration corridor for the forest species of Carabidae and as a refuge for the open landscape species during the time when the field ecosystem are disturbed by harvesting, ploughing. or other agrotechnical measures.*

Keywords: *Carabidae, distribution, hedgerows, agricultural landscape, Moravia.*

Rezumat. Distribuirea carabidelor (Coleoptera: Carabidae) de-a lungul unei perdele seminaturale în Moravia de Sud. *S-au studiat schimbările în distribuţia carabidelor de-a lungul unei perdele seminaturale de plante lemnoase conectate direct cu o pădure de stejari şi carpen de pe panta de sud-est a dealurilor Pavlovské kopce în Moravia de sud în anii 1988 şi 1989. Majoritatea speciilor de pădure se găsesc în număr redus de indivizi de-a lungul întregii perdele, in lungime de 1,6 km. Numărul lor scade spre capătul perdelei, dar, independent de distanţa faţa de pădure, creşte în părţile mai late ale perdelei. O tendinţă similară, dar nu aşa de puternică, s-a observat şi la speciile euritopice. Speciile caracteristice pentru agroecosisteme predominau în părţile mai distanţate faţă de pădure sau în părţile mai înguste ale acesteia. S-a arătat că acest tip de perdele de plante lemnoase servesc, pe de o parte, ca un coridor pentru migrarea carabidelor de pădure şi pe de altă parte, ca un refugiu pentru speciile din agroecosisteme în timpul recoltatului, aratului sau a celelalte măsuri agrotehnice.*

Cuvânte cheie: *Carabide, distribuţie, perdele de plante lemnoase, peisaj agrar, Moravia.*

INTRODUCTION

Line formations of woody vegetation play an important ecological role in agricultural landscape. They serve a biocorridors for forest species and increase connectivity of fragmented forest vegetation. At the same time they serve as a refuge for a plenty of species of different ecological character, especially during periods ploughing or harvesting the crop, which represent a periodical and very profound intervention into the life cycle of animals inhabiting arable land. The line formations of woody vegetation considerably contribute to biodiversity of intensively exploited cultural landscape and increase its ecological stability. In Czechoslovakia of, after a long period of land use homogenization resulting from collectivization of agriculture, efforts to re-establish such formations in the cultural landscape as a ”skeleton of the landscape ecological stability” started in late 1980´s. These efforts continue, in changed social conditions, up to the present and are officially included in the projects of land use planning and optimizing (BUČEK 2002, RUŽIČKOVÁ et al. 2000, SMITH & HELLMUND 1993). However, there appears a question of minimum ecological parameters enabling such formations to play their positive role. Of course, ecological requirements of individual animal groups are often contradictory and practically applicable parameters of biocorridors can be set only arbitrary as compromise of different views.

The Carabid beetles are one of the most frequently used animal groups to show the relationships between the properties of line formations and their function as refuges and migration corridors for animals (DESENDER 1982, DESENDER et al. 1981, FARKAŠ & FARKAČOVÁ 1990, PETIT 1994, ŠUSTEK 1992, 1994, 1998, 2002). The aim of this paper is to show, how carbide beetles are distributed along an old seminatural hedgerow connected directly with a large island of mature oak hornbeam forest.

MATERIAL AND METHODS

The Carabids were collected in a seminatural 1.6 km long hedgerow situated on the south-eastern slope of the Děvín hill in Pavlovské kopce hills, between the villages Klentnica and Pavlov, in South Moravia in 1988 and 1989 (Fig. 1). The geologic substrate is Jurassic limestone covered by powerful stratum of loess soil. The annual mean temperature moves around 9 °C in the last decades and the total annual precipitation does exceed 500 mm. This hedgerow is marked already in the military maps from late 19th century and represents a remnant of more variable landscape structure characterized by small patches of orchards, vineyards and small strips of fields.

Its starting point at an oak hornbeam forest has coordinates 48° 51’ 37” N and 16° 38’ 59” E, while the end point 48° 51’ 53” N and 16° 40’ 12” E. The hedgerow width varied between 6 and 35 m. The vegetation consisted of autochtonous trees and shrubs (mostly *Acer campestre, Acer pseudoplatanus, Prunus spinosa, Rosa canina, Sambucus nigra, Ligustrum vulgare*, rarely *Fraxinus excelsior, Ulmus campestre* and *Quercus robur*) with individually admixed fruit trees (*Amygdalus communis, Prunus domestica, Juglans regia*). At margins or in the undergrowth it consisted of dense growth of grasses, locally also of *Urtica dioica*. The woody vegetation was almost continuous, only locally broken by grassy stretches (Fig. 1). The height of shrubs or trees varied from about 4-5 m to 18 m. In the adjacent fields, wheat and barley was cultivated, rarely also maize. Some parameters of the hedgerow are given in the Tab. 1. Humidity and temperature were measured by a classical psychrometer, near the ground surface about the traps. Density of the stand was expressed as light intensity on the ground surface in close vicinity of the traps. The light intensity was measured by the luxmeter PU 150 produced by Metra Blansko. All the abiotic parameters were measured in the sunny day on 29 June 1988, when a maximum difference between the forest or hedge interior and surrounding open landscape was expected.

Fig. 1. A seminatural hedgerow in southeastern slope of the Děvín hill, its surrounding and position of individual traps.
Fig. 1. O perdea seminaturală de pe panta de sud-est a dealului Děvín, împrejurimile ei şi poziția capcanelor.

The beetles were pitfall trapped. The traps (glass jars of 0.75 l with an opening pf 75 mm filled with formalin) were installed in variable distances allowing characterizing the expected ecological gradients (Fig. 1). The traps were functional from Mid April to late October and were emptied once a month. The traps 1 – 3 were situated in the forest, the trap 4 immediately at the border between the forest and hedgerow while the traps 5 – 20 were in the hedgerow, in its center or on at its southeastern margin, which was easily accessible. The trap 3 was in a terrain depression functioning during strongly rainy periods as river bad of a temporary creek. However, in the majority of vegetation season it was dry.

In this paper, the material from the whole vegetation season was pooled. Unweight average linkage method was used for hierarchical classifications of the communities and the canonical correspondence analysis for their ordination. The Horn´s index was used for similarity measure. This index expresses the proportional similarity of the communities. All calculations were carried out by the programs Past and CAP 3.1. Preference of species for vegetation cover was characterized by a semiquantitative scale proposed by ŠUSTEK (2004).

RESULTS AND DISCUSSIONS

In 1988, the material consisted of 2984 individuals belonging to 58 species, while in 1989 of 4239 individuals belonging to 64 species. The total number of species in both years was 73. The between-year difference in number of individuals is due to *Anchomenus dorsalis* (PONTOPIDAN, 1763), which occurred in much higher number of individuals in 1989. The abundant typical mesohygrophilous forest species *Abax parallelopipedus* (PILLER ET MITTENBACHER. 1783), *Abax parallelus* (DUFTSCHMIDT, 1812), *Carabus coriaceus* LINNAEUS, 1758, *Carabus nemoralis* O. F. MÜLLER, 1764, *Carabus hortensis* LINNAEUS, 1758 (Tab. 1 and 2) were distributed along the whole hedgerow. Number of their individuals and species tended to decrease toward the hedgerow end, but at the same time their number increased in wider parts of the hedgerow, independently of the distance from the forests. The most sensitive among them was *Abax parallelus* (DUFTSCHMIDT, 1812). In 1988 it emigrated from the forest only up to the traps 5 and 6 laying within the distance of 127 m from the forest margin and situated in shadowed places. In 1989 it appeared also in a wider stretch of the hedgerow at the trap 15, in the distance of 1052 from the forest margin. A similar sensitivity was also observed in *Pterostichus oblongopunctatus* (FABRICIUS, 1787).

In contrast to the general tendency of distribution of forest species along this hedgerow, Carabus coriaceus LINNAEUS, 1758 occurred abundantly in both years also in the traps 9 and 10 laying in the very narrow and insolated stretch of the hedgerow in the distance of 300-400 m from the forest margin, whereas number of its individuals dropped in the less distant traps 6 and 7. However, this drop was obviously caused by competition with the eurytopic congener, *Carabus cancellatus* ILLIGER, 1798, which reached in this stretch of the hedgerow a local maximum of its distribution.

Three more hygrophilous forest species, *Platynus assimilis* (PAYKUL, 1790), *Patrobus atrorufus* (STROEM, 1768) and *Asaphidion flavipes* (LINNAEUS, 1761), did not leave the forest at all and concentrated there in both years only around the trap 3, which was situated in a humid depression serving as a river bed of a temporary creek. The strongly hydrophilous paludicolous species *Agonum moestum* (DUFTSCHMIDT, 1812) was found only in the remote traps 18 and 19, but its finding in these traps is to be interpreted rather as manifestation of long distance migration and influence of large flood plain of the Dyja river, situated about 2.5 km northerly of the hedgerow studied.

Almost all eurytopic species were relatively homogenously distributed along the hedgerow, but almost did not penetrate into the forest (Tab. 1 and 2). Only *C. cancellatus* obviously preferred the less distant stretch of the hedgerow (up to 400 m from the forest margin). Some more or less hydrophilous and, at the same time eurytopic species like *Pterostichus melanarius* (ILLIGER, 1798), *Pterostichus niger* (SCHALLER, 1783), *Pterostichus nigrita* (PAYKULL, 1790), *Pterostichus anthracinus* (ILLIGER, 1798), *Pterostichus strenuus* (PANZER, 1797) and *Carabus granulatus* LINNAEUS, 1758 were concentrated around the trap 3 in the humid depression in the forest. Although they were and together with the hygropilous forest species formed there a floodplain forest community sui generis.

The open landscape ("field") species began to be more abundant in the hedgerow only in traps 9 – 10, in distance of 300-400 m from the forest margin and in less shadowed places (about 2000 lux) and predominated in the more remote part of the hedgerow. In both years the most abundant species were *A. dorsalis* and *Brachynus explodens* DUFTSCHMIDT, 1812. Their number reached in some traps even several hundred individuals. Other typical "field" species like *Pseudoophonus rufipes* (DE GEER, 1774), *Brachinus crepitans* (LINNAEUS, 1758) or *Poecilus cupreus* (LINNAEUS, 1758) did not exceed several tens of individuals (Tab. 1 and 2). Such proportion of quantitative representation of "field" species is typical of cereals as the predominant crop in surrounding fields. The remaining "field" species were represented only individually, but they also occurred exclusively in more remote parts of the hedgerow. All "field" carabid species, especially the most abundant ones, were distributed very unequally, but in both years they tended to escape the wider and a little more shadowed parts of the hedgerow (bellow 1500 lux).

Among a large number of species, there were individually found *Carabus hungaricus* FABRICIUS. 1792 and *Carabus scabriusculus* OLIVIER, 1795 – both rare thermophilous species. *C. hungaricus* has a strong extrazonal population on the top of the Děvín hill and sporadically emigrates to the foots of the hill. Together with relatively frequent *Platyderus rufus* (DUFTSCHMIDT 1812) they indicate thermophious character of this locality. Similarity of the Carabid communities in individual parts of the hedgerow is shown by hierarchical classification (Fig. 2 and 3). In both years, most samples from the traps 9–20 form a clear cluster at the similarity level of 0.60 and 0.68 respectively. In 1988 the samples from the forest (1–4) and beginning of the hedge (5–11) form two separate clusters at similarity level of about 0.73. At the same time the samples from the traps 5–11 joint with the samples from more remote parts of the hedge. In 1989 the samples from the forests (1–4) and beginning of the hedge (5–11) form a common cluster at similarity level 0.58. In both years some samples from more remote parts of the hedge tend to samples from its beginning. In 1988 it was the sample from the trap 13 due to increased number of *A. paralelopipedus* and *H. atratus* and strongly reduced number of *A. dorsalis*. In 1989 it were, from the same reason the samples 13, 15 and 19.

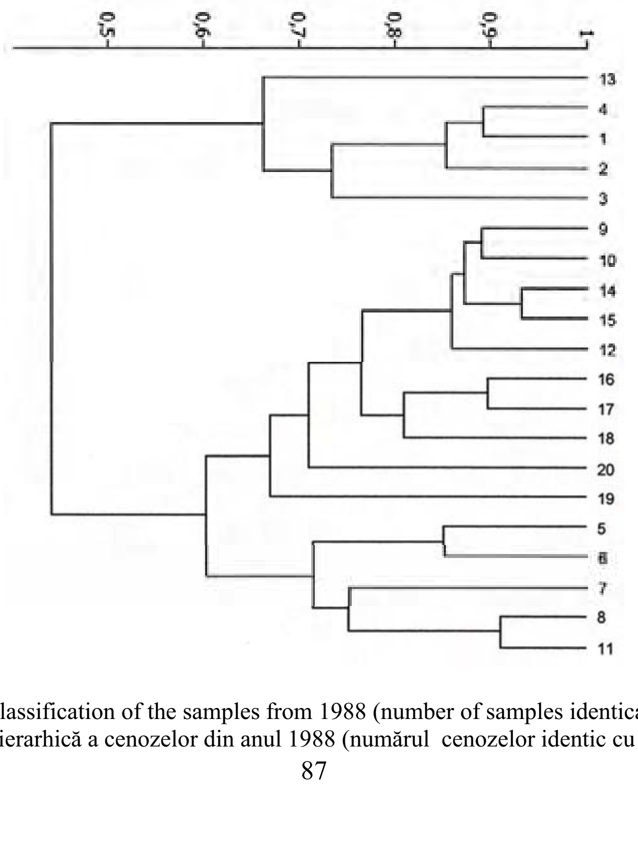

Fig. 2. Hierarchical classification of the samples from 1988 (number of samples identical with tab. 1 and 2).
Fig. 2. Clasificarea ierarhică a cenozelor din anul 1988 (numărul cenozelor identic cu cel din tab. 1 şi 2).

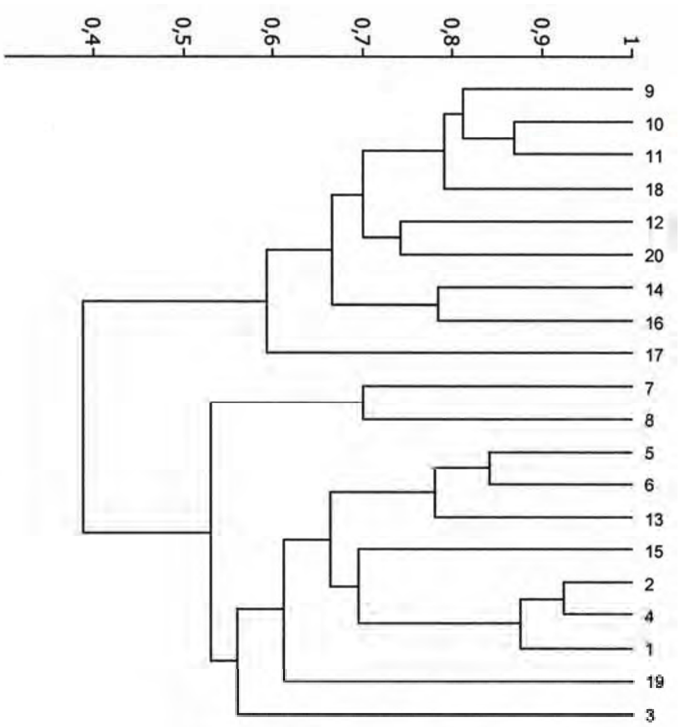

Fig. 3. Hierarchical classification of the samples from 1988 (number of samples identical with tab. 1 and 2).
Fig. 3. Clasificarea ierarhică a cenozelor din anul 1988 (numărul cenozelor identic cu cel din tab. 1 şi 2).

Changes in distribution of the carabids along hedgerow are also illustrated by canonical correspondence analysis (Fig. 4 and 5). In both years the gradient between the forest and remote part of the hedgerow is associated with the first axis. The samples and species from the forest and wider parts of the hedgerow are placed in the right part of the ordination diagram, while the samples and species from the narrower and more remote stretches in left part of the ordination diagram. The samples and hygrophilous species from the trap 3 take an isolated position in both diagrams.

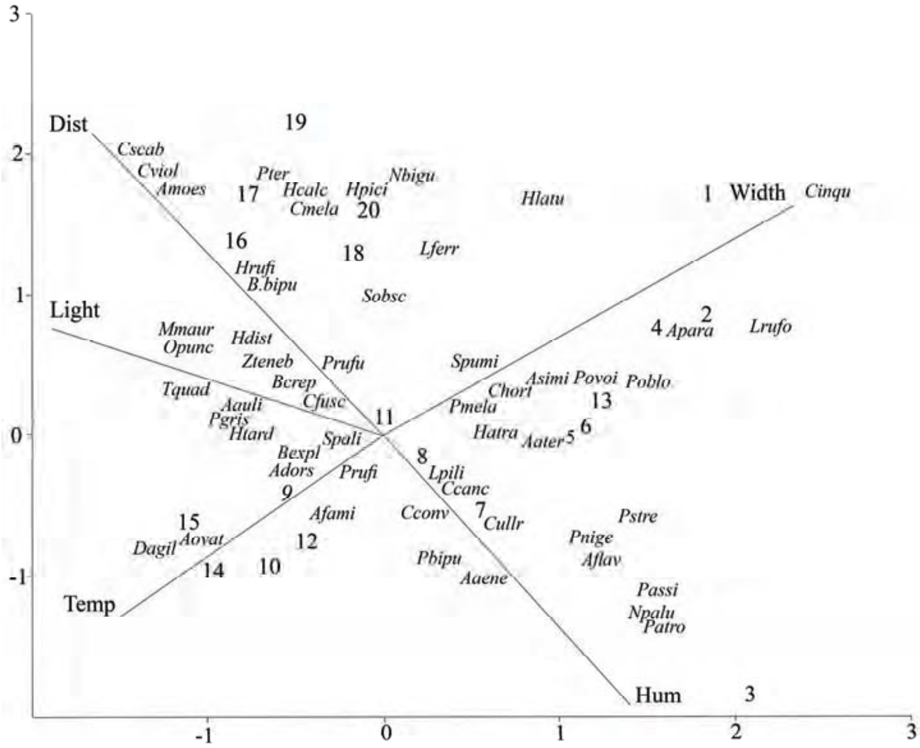

Fig. 4. Canonical correspondence analysis of the samples from 1988 (number of samples identical with tab. 1 and 2; abbreviations of species names: first letter – generic name, next four letters – first four letter of the species name).
Fig. 4. Analiza de corespondenţă canonică a cenozelor din anul 1988 (numărul cenozelor identic cu cel din tab. 1 şi 2, abrevieri ale numelor speciilor: prima literă – numele genului, următoarele patru litere – primele patru litere ale numelui speciei).

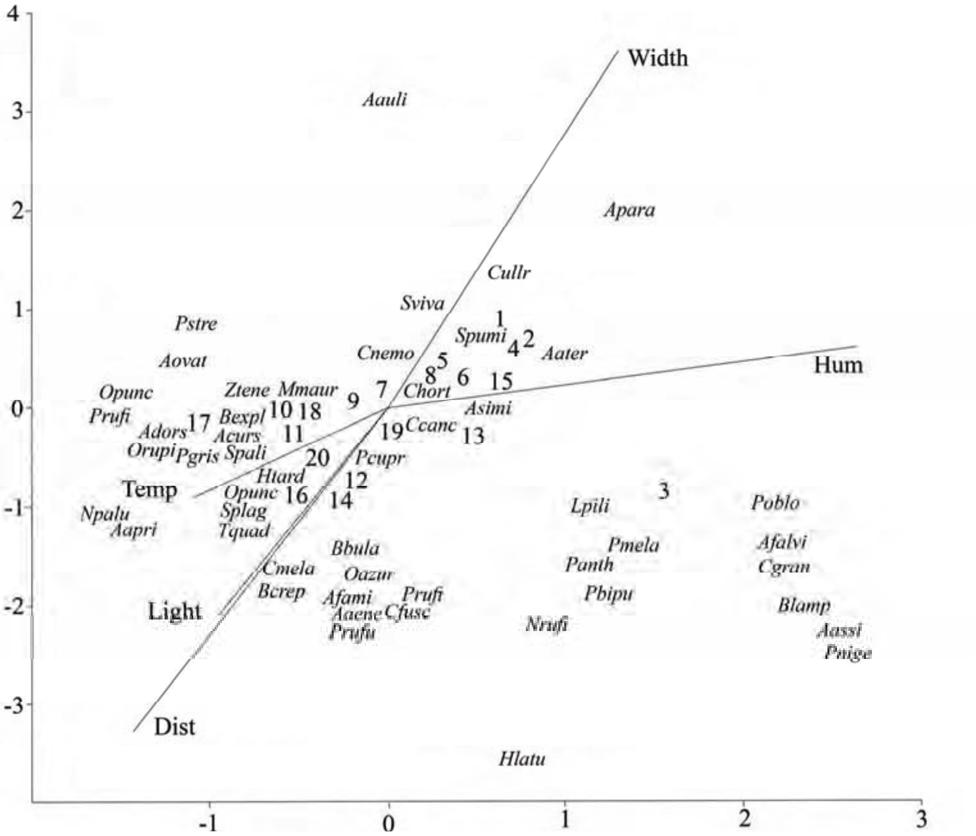

Fig. 5. Canonical correspondence analysis of the samples from 1988 (number of samples identical with tab. 1 and 2; abbreviations of species names: first letter – generic name, next four letters – first four letter of the specific name).
Fig. 5. Analiza de corespondenţă canonică a cenozelor din anul 1989 (numărul cenozelor identic cu cel din tab. 1 şi 2, abrevieri ale numelor speciilor: prima literă – numele genului, următoarele patru litere – primele patru litere ale numelui speciei).

The relationship of individual ecological groups of carabids to length and width of the hedgerow is illustrated by values of correlation coefficient. Correlation of forest species with hedgerow width ranges between 0.66 and 0.72, that of eurytopic species between 0.03 and 0.25 while that of field species between – 0.67 and – 0.42. Correlation of forests species with distance from the forests moves from – 0.65 to 0.36, that of eurytopic species from – 0.31 to – 0.44 while that of field species from 0.60 to 0.72. Correlation of forests species with light in the stand moves from – 0.74 to 0.41, that of eurytopic species fluctuates around – 0.30 and that of field species from 0.45 to 0.79.

The changes in mutual proportion of all forest, eurytopic and field species along the hedgerow are shown in figs. 6 – 7. In spite of large fluctuations between individual traps and both years, there is a clear tendency of decline in number of species and individuals of forest species toward the more distant places. Influence of increasing distance is partly compensated by locally increased width of the hedgerow. The eurytopic species show a less expressive declining trend toward the more distant part of the hedgerow. The field species start to predominate, qualitatively and qualitatively, above the eurytopic and forest species in the distance of about 300 m from the forest margin.

When compared with the windbreaks founded artificially in the postwar period and consisting often of different introduced shrubs or cultivars of poplars (ŠUSTEK 1998, 2002) or with the hedges in s.c. bocage in Normandy in France (PETIT 1994), the seminatural hedgerows function much better. The differences between the individual part of hedgerows and adjacent forests are much larger in late spring and summer than in late autumn, when the gradient of climatic factors between the hedgerow interior and surrounding are not so sharp (ŠUSTEK 2002).

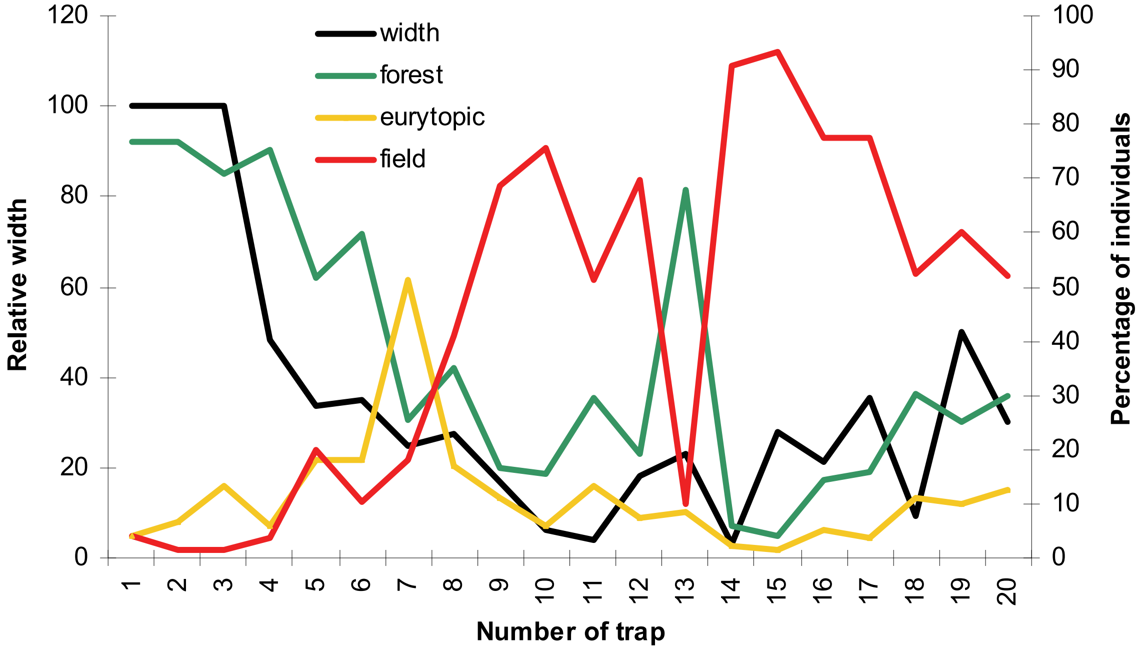

Fig. 6. Changes in relative abundance of the forest, eurytopic and open landscape species along the seminatural hedgerow in Pavlovksé kopce hills in 1988.
Fig. 6. Schimbările în abundența relativă a speciilor de pădure, speciilor euritopice şi a celor de peisaj deschis de-a lungul unei perdele seminaturale în dealurile Pavlovské kopce în anul 1988.

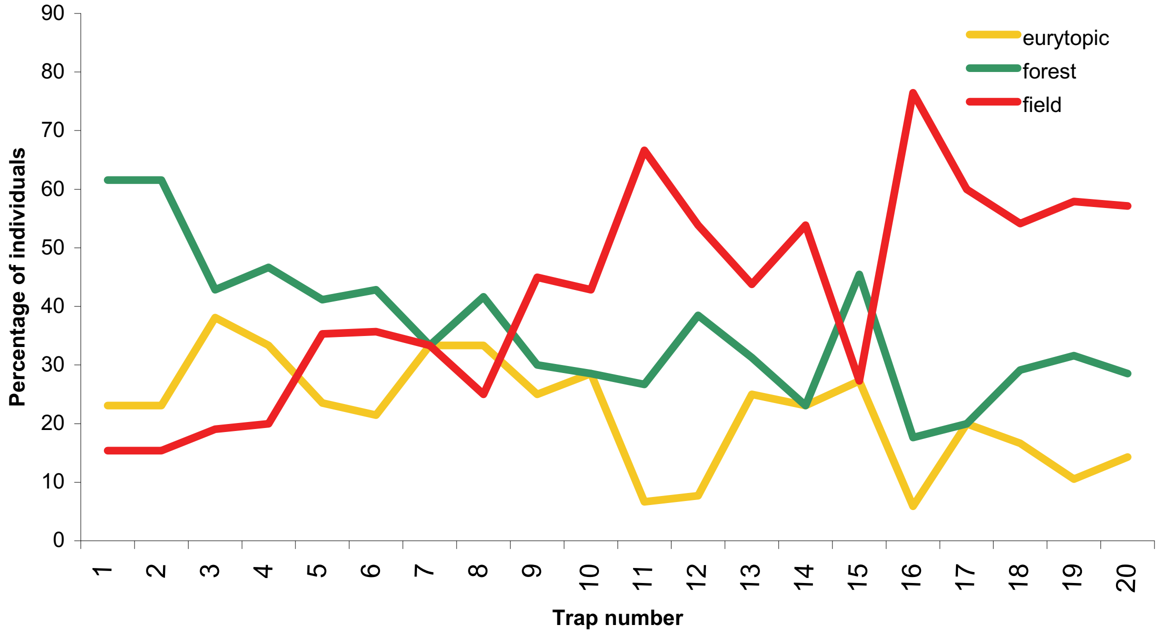

Fig. 7. Changes in relative abundance of the forest, eurytopic and open landscape species along the seminatural hedgerow in Pavlovksé kopce hills in 1989.
Fig. 7. Schimbările în abundența relativă a speciilor de pădure, speciilor euritopice şi a celor de peisaj deschis de-a lungul unei perdele seminaturale in dealurile Pavlovské kopce în anul 1989.

CONCLUSIONS

The results show that a seminatural hedgerow consisting of autochtonous trees and shrubs is able to function as an effective biocorridor for majority of abundant forests species of Carabids. Its length is effectively compensated by locally increased width of the hedgerow. Occurrence of forests species strongly decreases in the places, where light intensity at the ground surface increases in a summer sunny day above 1000 lux and where width of the hedgerow decreases under 10 m. Distribution of eurytopic Carabids is much less dependent on length and width of the hedgerow than in the forest species, but there is a slight indication of a similar trend as in the forest species. The seminatural hedgerow of this type is also able to offer a refuge for a large number of individual of field Carabids. They prefer drier and warmer stretches of the hedgerow, where light intensity at the ground surface exceed in a summer sunny day 2000 lux.

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Tab. 1. Some ecologic parameters of the hedgerow on southseastern slopes of the Pavlovské kopce hills between the Klentnica and Pavlov villages in South Moravia.

Ecologic parameter	Trap number																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Light at groung surface [lux]	350	450	500	420	720	850	1100	1200	2000	2200	1500	1800	900	3000	5000	4000	2500	3000	5000	900
Relative humidity [%]	53.7	52,7	58,8	46	39	44	47	49	43	39	41	46	53	48	45	39	35	36	34	39
Temperature [C]	21,5	21,9	22,4	23	27	27	29	25	26	39	30	28	25	26	36	27	29	28	26	25
Distance from forest martgin [m]	-	-	-	0	82	127	190	265	305	424	558	654	761	892	1052	1229	1322	1484	1550	1620
Hedgerow width [m]	-	-	-	40	20	19	12	11	6	8	13	11	35	15	18	14	17	11	16	10

Tab. 2. Survey of species and their abundance along a seminatural hedgerow on the southeastern slope of the Pavlovké kopce hills in 1988 (VC – vegetation cover, e – eurytopic species, f – forests species, o – open landscape species).

Species	VC	Trap number																				Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Abax paralelopipedus (PILLER ET MITTERPACHER, 1783)	f	46	85	135	41	81	83	5	21	12	11	10	31	99	8	6	6	15	26	8	13	742
Carabus coriaceus LINNAEUS, 1758	f	35	27	24	16	13	16	9	42	14	32	10	4	2	6	8	11	15	16	11	8	319
Harpalus atratus LATREILLE, 1804	f	13	3	1	17	5	1	4	2	1		3	15	67	6	5	1	2	2	13	2	163
Carabus nemoralis O. F. MÜLLER, 1764	f	3	4	2	2	13	8	2	2	2	4	3		8	2	6	1	3	8	6	9	88
Platynus assimilis (PAYKULL, 1790)	f	2	2	62	3	2																71
Carabus hortensis LINNAEUS, 1758	f	12	2	1	7		1	4	3	2	5	1		3	2	4	1		5	1		54
Abax parallelus (DUFTSCHMIDT, 1812)	f	18	12	4	7	11																52
Ophonus nitidulus STEPHENS, 1828	f						7		1	1	3	2	4	2	4	3		2			12	41
Pterostichus oblongopunctatus (FABRICIUS, 1787)	f	7	7	8						1				1	1			1	1	1		28
Asaphidion flavipes (LINNAEUS, 1761)	f			14	1					1					3			1			1	21
Platyderus rufus (DUFTSCHMIDT, 1812)	f								1	2	2				1	1		2	3		1	13
Leistus rufomarginatus (DUFTSCHMIDT, 1812)	f	2		1																		3
Agonum moestum (DUFTSCHMIDT, 1812)	f																		1	1		2
Carabus convexus FABRICIUS, 1775	f										1			1								2
Calosoma inquisitor (LINNAEUS, 1758)	f	1																				1
Carabus violaceus LINNAEUS, 1758	f																			1		1
Patrobus atrorufus (STROEM, 1768)	f			1																		1
Carabus cancellatus ILLIGER, 1798	e		3	7		25	25	34	22	12	10	9	8	2		3			6	3	1	170
Pterostichus melanarius (ILLIGER, 1798)	e	2	1	14	3	4				1			4	4		2		2	5	3	7	52

Species	VC	Trap number																				Total
Syntomus palipes DEJEAN, 1825	e							2	2	4	5	1	1	1	7	3	1	2	5	0		34
Stomis pumicatus (PANZER, 1796)	e	3	2	1		1	2	1	2	2	1		2		1				1	1	5	25
Carabus ullrichi GERMAR, 1824	e		1	3		1					2			10		1						18
Synuchus vivalis (ILLIGER, 1798)	e				2			2					1		3		1	2			2	13
Pterostichus niger (SCHALLER, 1783)	e			9		2														1		12
Badister bullatus (SCHRANK, 1798)	e									1		1					3		1	3		9
Pterostichus ovoideus (STURM, 1824)	e	1	1			3		1														6
Lorocera pilicornis (FABRICIUS, 1775)	e			2					1				1				1		1			6
Pterostichus strenuus (PANZER, 1797)	e		1	2			1															4
Syntomus obscuroguttatus (DUFTSCHMIDT, 1812)	e													1				2				3
Notiophilus rufipes CURTIS, 1829	e				1		1													1		3
Panageus bipustulatus (FABRICIUS, 1775)	e								2		1											3
Carabus granulatus LINNAEUS, 1758	e													1						1		2
Leistus ferrugineus (LINNAEUS, 1758)	e		1																	1		2
Notiophilus biguttatus (FABRICIUS, 1779)	e																				1	1
Notiophilus palustris (DUFTSCHMIDT, 1812)	e			1																		1
Pterostichus nigrita (PAYKULL, 1790)	e			1																		1
Anchomenus dorsalis (PONTOPIDAN, 1763)e	o			2	1	35	8	3	33	87	217	22	146	14	346	452	50	86	40	20	32	1594
Brachynus explodens DUFTSCHMIDT, 1812	o					1	3	3	24	18	6	7	6	2	26	60	6	12	11	9	9	203
Ophonus rufibarbis (FABRICIUS, 1792)	o						1			2			2			13	21	43	11	11	4	108
Brachynus crepitans (LINNAEUS, 1798)	o		1						1	6	1	1	6	3	13	27	2	14	11	6	7	99
Pseudoophonus rufipes (DE GEER, 1774)	o	1			2		1	3	1	2	4	1	3	1	18	10	3	1		3		54
Harpalus tardus (PANZER, 1797)	o					1		1	2	7	2	4		1	4	13	1	4	1	7		48
Poecilus cupreus (LINNAEUS, 1758)	o	2			1	2	2	1	6	1		3			3	4	2			7	2	36
Ophonus puncticollis (PAYKULL, 1798)	o							1								15	1	1	7	10		35
Bembidion lampros (HERBST, 1784)	o			2			2	1	2		1	2			2			1	2	1	7	23
Amara similata (GYLLENHAL, 1810)	o	2	1								1	1		1	1							7
Calathus fuscipes (GOEZE, 1777)	o							1							4				2			7
Microlestes maurus (STURM, 1827)	o															3		2		2		7
Amara ovata (FABRICIUS, 1792)	o										1					5						6
Pseudoophonus griseus (PANZER, 1797)	o										1				2	1	1			1		6
Trechus quadristriatus(SCHRANK, 1781)	o														1	2	1		1	1		6
Harpalus picipennis (DUFTSCHMIDT, 1812)	o																		1		4	5
Zabrus tenebrioides (GOEZE, 1777)	o														3					2		5
Harpalus distinguendus (DUFTSCHMIDT, 1812)	o														1	1		1		1		4

Species	VC	Trap number																				Total
Amara familiaris (DUFTSCHMIDT, 1812)	o										2				1							3
Calathus melanocephalus (LINNAEUS, 1758)	o																	1	1		1	3
Ophonus azureus (FABRICIUS, 1775)	o					1						1								1		3
Amara aulica (PANZER, 1797)	o										1						1					2
Harpalus latus (LINNAEUS, 1798)	o	1																	1			2
Laemosthenus terricola (HERBST, 1784)	o																			1	1	2
Amara aenea (DE GEER, 1774)	o								1													1
Carabus scabriusculus OLIVIER, 1795	o																			1		1
Dromius agilis (FABRICIUS, 1787)	o															1						1
Harpalus calceatus (DUFTSCHMIDT, 1812)	o																	1				1
Number of individuals		12	12	44	10	76	46	54	99	143	256	53	180	41	436	616	95	175	108	98	83	2637
Number of species		17	17	19	14	17	16	18	20	21	23	18	15	20	26	25	20	24	25	34	21	64

Tab. 3. Survey of species and their abundance along a seminatural hedgerow on the southeastern slope of the Pavlovké kopce hills in 1989 (VC – vegetation cover, e – eurytopic species, f – forest species, o – open landscape species).

Species	VC	Trap number																				Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Abax paralelopipedus (PILLER et MITTERPACHER, 1783)	f	44	111	93	102	32	66	1	13	7	18	15	4	52	7	43	1	1	9	28	1	648
Carabus coriaceus LINNAEUS, 1758	f	32	22	13	25	12	7	8	14	10	34	4	4	3	2	0	4	14	16	14	6	244
Harpalus atratus LATREILLE, 1804	f	20	5	2	17	1			2	2	10	4	2	1	14				11	13		104
Platynus assimilis (PAYKULL, 1790)	f	1	1	101																		103
Abax parallelus (DUFTSCHMIDT, 1812)	f	21	21	18	8	18	2									8						96
Carabus nemoralis O. F. MÜLLER, 1764	f	5	8		4	2	9		2	2	11			5	2	1		2	13	4		70
Ophonus nitidulus STEPHENS, 1828	f					2	5	2		1	3			2	3		1	2	6	11	9	47
Carabus hortensis LINNAEUS, 1758	f	2	4	3	1	2	4	3	3	1	3	4	2			3		2	1	1	1	40
Pterostichus oblongopunctatus (FABRICIUS, 1787)	f	1	3	12												1						17
Asaphidion flavipes (LINNAEUS, 1761)	f			10	3																	13
Leistus rufomarginatus (DUFTSCHMIDT, 1812)	f			5																		5
Platyderus rufus (DUFTSCHMIDT, 1812)	f												1		1				1			3

Species	VC	Trap number																				Total
Carabus cancellatus ILLIGER, 1798	e		2	3	2	17	39	6	13	5	9	5	5	8	1	2					12	129
Pterostichus melanarius (ILLIGER, 1798)	e	2		27		2	2			2	1			2	3	3			1	4	3	52
Carabus ullrichi GERMAR, 1824	e	9	2		3						1			1		9		1				26
Syntomuss palipes DEJEAN, 1825	e							2	1		1				1			3		5		13
Stomis pumicatus (PANZER, 1796)	e	1		2	1	3	1	1	0	1					1			1				12
Notiophilus rufipes CURTIS, 1829	e			2						1					3				1			7
Carabus granulatus LINNAEUS, 1758	e			4	1																	5
Badister bullatus (SCHRANK, 1798)	e										1			1	1			1				4
Lorocera pilicornis (FABRICIUS, 1775)	e			2	1														1			4
Pterostichus niger (SCHALLER, 1783)	e			4																		4
Pterostichus anthracinus (ILLIGER, 1798)	e			2														1				3
Synuchus vivalis (ILLIGER, 1798)	e					1		1														2
Notiophilus palustris (DUFTSCHMIDT, 1812)	e																		1			1
Panageus bipustulatus (FABRICIUS, 1775)	e								1													1
Pterostichus strenuus (PANZER, 1797)	e										1											1
Microlestes plagiatus (DUFTSCHMIDT, 1812)	e																1					1
Anchomenus dorsalis (PONTOPIDAN, 1763)e	o				1	23	7	1	0	9	112	20	6	9	34		47	258	43	6	17	593
Brachynus explodens DUFTSCHMIDT, 1812	o						1		1	21	131	25	12		16	7	5	26	22	4	8	279
Pseudoophonus rufipes (DE GEER, 1774)	o	2			1	2	1			2	7	6	22	7	48		19		1	3	5	126
Ophonus rufibarbis (FABRICIUS, 1792)	o												2	1			2	63	2	4	2	76
Harpalus tardus (PANZER, 1797)	o								3		12	6			9		2	2	5	8		47
Poecilus cupreus (LINNAEUS, 1758)	o	1		1		1	1	1	4	1	1	5		1	2		8	14	1		1	43
Calathus fuscipes(GOEZE, 1777)	o				1	1		2				1			11	9	10		1			36
Brachynus crepitans (LINNAEUS, 1798)	o										3	1	4	1	9		1	3	6	1	6	35
Ophonus azureus (FABRICIUS, 1775)	o									1		2			5	4	8			1		21
Harpalus latus (LINNAEUS, 1798)	o													12						1		13
Trechus quadristriatus (SCHRANK, 1781)	o							1				1	2		1		1	2	1	2	1	12
Bembidion lampros (HERBST, 1784)	o		1	9											1							11
Zabrus tenebrioides (GOEZE, 1777)	o		1								1						2	2	1			7
Amara aenea (DE GEER, 1774)	o			1											2				3			6
Ophonus puncticollis (PAYKULL, 1798)	o											1						5				6
Amara familiaris (DUFTSCHMIDT, 1812)	o												2		1			1				4
Amara similata (GYLLENHAL, 1810)	o					1	1			1				1								4

Species	VC	Trap number																				Total
Amara cursitans ZIMMERMANN, 1831	o									1								1	1			3
Amara apricaria (PAYKUL, 1790)	o										1										1	2
Amara ovata (FABRICIUS, 1792)	o										1									1		2
Anisodactylus binotatus (FABRICIUS, 1787)	o									2												2
Calathus ambiguus (PAYKULL, 1790)	o														1			1				2
Calathus melanocephalus (LINNAEUS, 1758)	o														1			1				2
Ophonus rupicola (STURM, 1818)	o																		1	1		2
Pseudoophonus griseus (PANZER, 1797)	o																1	1				2
Microlestes maurus (STURM, 1827)	o									1								1				2
Amara aulica (PANZER, 1797)	o					1																1
Carabus hungaricus FABRICIUS, 1792	o			1																		1
Clivina collaris (HERBST, 1784)	o									1												1
Harpalus picipennis (DUFTSCHMIDT, 1812)	o																1					1
Number of individuals		141	181	315	171	121	146	29	57	72	362	87	68	107	180	90	114	409	149	112	73	2984
Number of species		13	12	21	15	17	14	12	13	20	21	15	13	16	26	12	14	25	24	19	14	58