Influence of top effect on spatial structure of ground beetle (Coleoptera, Carabidae) community in an oak-beech forest

Vplyv vrcholového efektu na priestorovú štruktúru spoločenstva bystruškovitých (Coleroptera, Carabidae) v dubovo-bukovom lese

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Abstrakt

Vplyv vrcholového efektu na prietorovú štruktúru spoločenstva bystruškovitých sa sledoval v Malých Karpatoch na vrchu Veterlín v nadmorskej výške 500 – 723.5 m. Na južnom svahu v bukovej dúbrave bol výrazne vyší počet druhov a kumulatívna abundancia a suchá biomasa celoročných vzoriek než na severnom svahu v čistej bučine. Preriedenie bukovej dúbravy na vrhole Veterlín sa prejavilo ojedinelým výskyto druhov otvorejej krajiny. Vplyv vyšších hodnôt týchto parametrov na južnom svahu vyzneval ešte tesne za vrcholom hrebeňa. Najnižčí počet druhov, kumulatívna abundancia a biomasa boli v strede severného svahu. Pri jeho úpätí sa opäť zvyšovali. Pozorované rozdiely boli dôsledkom kumulovaného efektu rozdielov v teplote, hĺbke a štruktúre pôdy, hustote bylinnej vegetácie a sklonu svahu.

Abstract

Influence of top effect on spatial structure of Carabid community was studied in the Little Carpathian on the ridge Veterlín of altitude 500 – 723.5 m a. s. l. On the southern slope, there was much higher number of species and cumulative abundance and dry biomass of the one-year samples than on the northern slope. Thinner tree coverage at the ridge top resulted in individual occurrence of species of open landscape. Influence of higher values of these parameters was visible still behind the top of the ridge. The lowest number of species and cumulative abundance and biomass were in the central part of the northern slope. Near to its foot these values tended to increase. The observed differences were a consequence of cumulated effect of differences in temperature, depth and structure of soil, density of herbage stratum and slope declination.

Introduction

The terrain relief has a strong influence on microclimate of each habitat and on distribution of plants and animals and structure of their communities. It increases variability of community parameters within the geobiocenologically defined classification units of plant or animal communities. Knowledge of such influence is necessary for a reliable typification of the communities and for specification of data on autecology of individual animal species. Influence of the terrain relief also can strongly bias results and interpretation of bioindicative studies oriented to assess impacts of different anthropogenic activities or natural disturbance. For these reason, knowledge of concrete cases of its influence in natural or seminatural conditions has an essential theoretical and practical significance.

The aim of this contribution is to show, what changes appear in a Carabid community in oak-beech and beech forests along a transaction crossing the Veterlín ridge in Little carpatians.

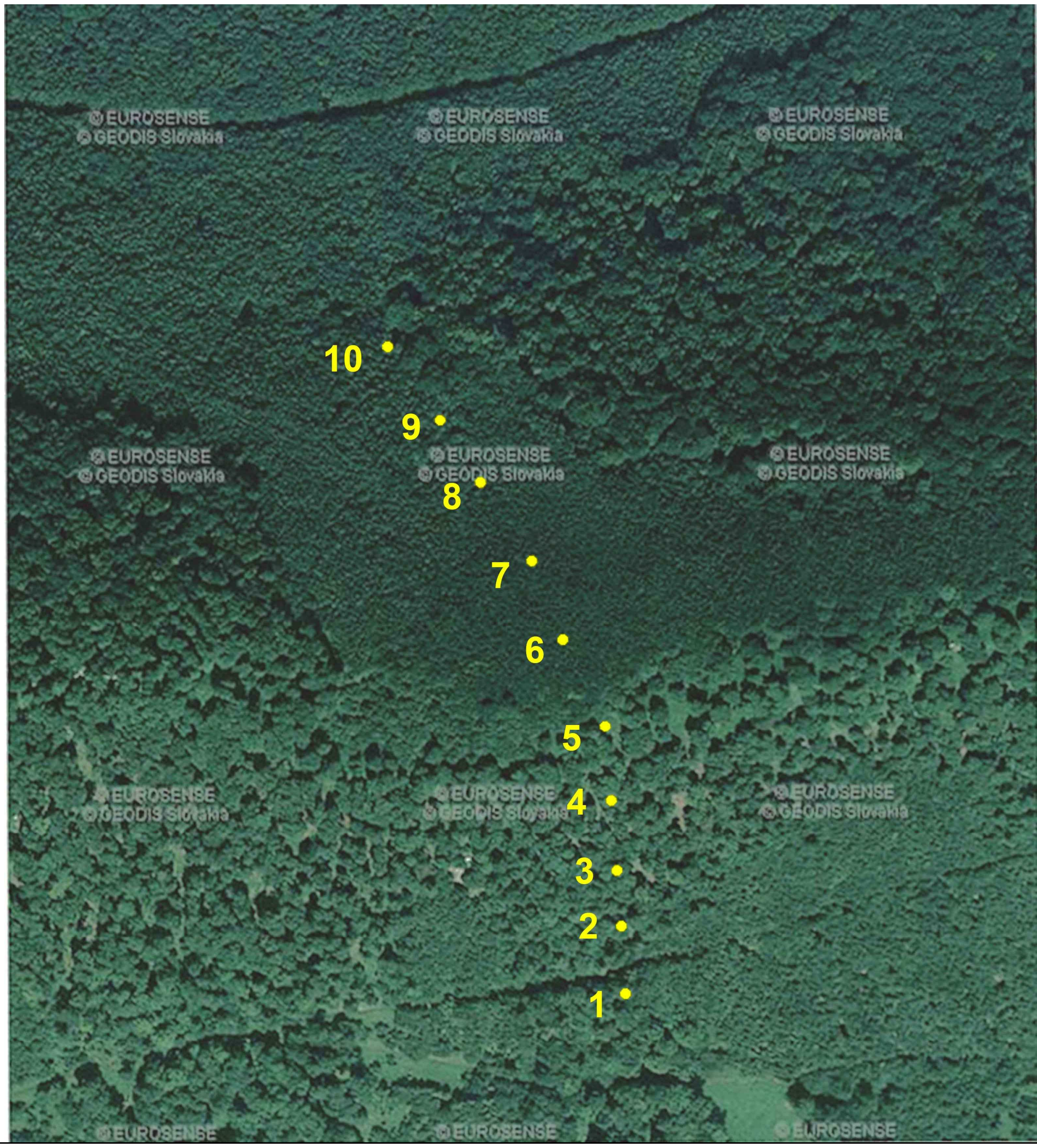

Fig. 1. Dislocation of the transects and position of individual trap in the of the Veterlín ridge

Methods

The investigations were carried out in the Veterlín hill in Little Carpathians (Fig. 1). Veterlín is represents a ridge in altitude of 500 – 723.5 m a. s. l., running approximately east-west direction. Its southern slope is covered by a mature almost natural oak-beech forest (*Querci-fageta*) in trophic series BD and in oak-beech vegetation tier (RAUŠER & ZLATNÍK 1996) with a rich herbage stratum and deep soil. The northern slope was covered by a pure beech stand (*Fageto pauper*) in the trophic series BD and beech vegetation tier, almost without any herbage stratum. The soil surface was covered by a discontinuous layer of beech litter. Locally the soil surface consisted of fine stony skeleton and scree. Declination of the southern slope was 22º - 30º, while that of the northern slope 20º - 40º.

The beetles were pitfall trapped. The glass jars "Omnia" of 0.75 l with mouth diameter 90 mm were used as traps. 10 traps were situated in a line crossing both slopes in mutual distance approximately 100-120 m (Fig. 1 and 2) at altitude of 540 – 660 m . The traps were emptied once a month.

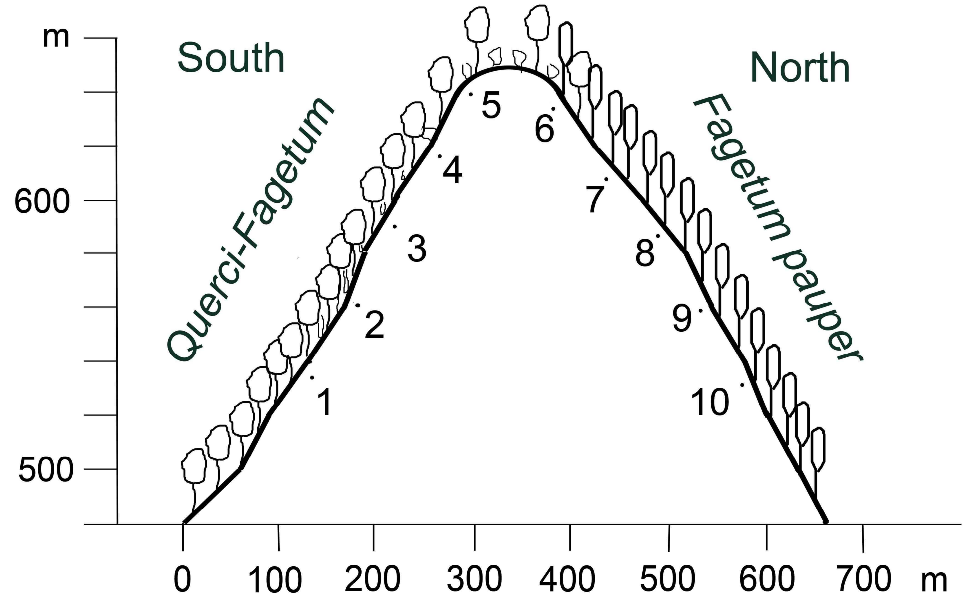

Fig. 2. Profile of the of the Veterlín ridge and approximative position of the traps

The ecological characteristics of Carabids were taken from BURMEISTER (1939), HŮRKA (1996), LARSON (1949), ŠUSTEK (2000, 2004) and THIELE (1977). The hierarchical classification was carried out by the unweighted average linkage method (ORLÓCI 1978). As similarity function the Bray-Curtis index was used. The calculations were carried out by the program CAP. The direct ordination of Carabid communities (POOLE 1974) was made according to preference of individual species for vegetation cover and humidity. A four-degree semiquantitative scale of the vegetation cover preference and a eight-degree semiquantitative scale of the humidity preference (ŠUSTEK 2004) was used for this purpose. The ordination scores were calculated as arithmetical mean of preferences of individual species weighted by their abundance.

Results

Community structure

The Carabid assemblage in the entire locality consisted of 21 species (Tab. 1). Almost all species were typical stenotopic forest species. Among them, the rare and rather stenotopic species *Licinus hoffmansegi* deserves a special attention. It indicates a high degree of naturalness of the locality. Only five individually occurring species, *Amara similara, Bembidion lampros, Calathus fuscipes, Harpalus distuinguendus* and *Notiophilus rufipes* were open landscape species. All species were mesohydrophilous, or mesohydrophilous with slightly increased or reduced requirements to humidity. The community as such can bee considered as natural and comparable with communities in similar consitions in natural reserves in Central Europes (ŠUSTEK 1984).

In the whole transect, the species *Abax papralellopipedus*, *Carabus coriaceus* and *Pterostichus burmeisteri* predominated, but they were represented by very different numbers of individuals in its individual parts (Tab. 1). Abundance of some species occurring in large number on the southern slope (*Carabus nemoralis*, *Carabus hortensis*) strongly declined immediately after the ridge top. In the central part of the northern slope these species disappeared. The only species, occurring predominantly on the northern slope was *Carabus intricatus.* Although this species is distributed in whole Central Europe, its never exceeds position of a recedent or subrecedent species in Carabid communities of natural or seminatural forest geobiocoenoses. It occurrence on the northern slope probably results from its preference for skeleton-like substrates. With this preference is probably connected the fact that its is the only representative of the genus *Carabus* in Central Europe, which successfully penetrates in center of large cities. Within the southern slope, clear competitive relationships are visible between some almost equally sized species, for example *Carabus nemoralis* (culmination at the traps 3-4), *C. hortensis* (culmination at the trap 1), *C. coriaceus* (culmination at the traps 2-3). Similar relationships were observed along longer transects also in other localities (ŠUSTEK & ŽUFFA 1985, 1988).

The sparser tree canopy at the top of the ridge (Fig. 1 and 2) resulted in presence of several open landscapes species like *Amara similata, Bembidion lampros, Calathus fuscipes* and *Notiophilus rufipes* at the top of the ridge (trap 5). They were also accompanied by eurytopic *Pterostichus melanarius* in top part of the transect.

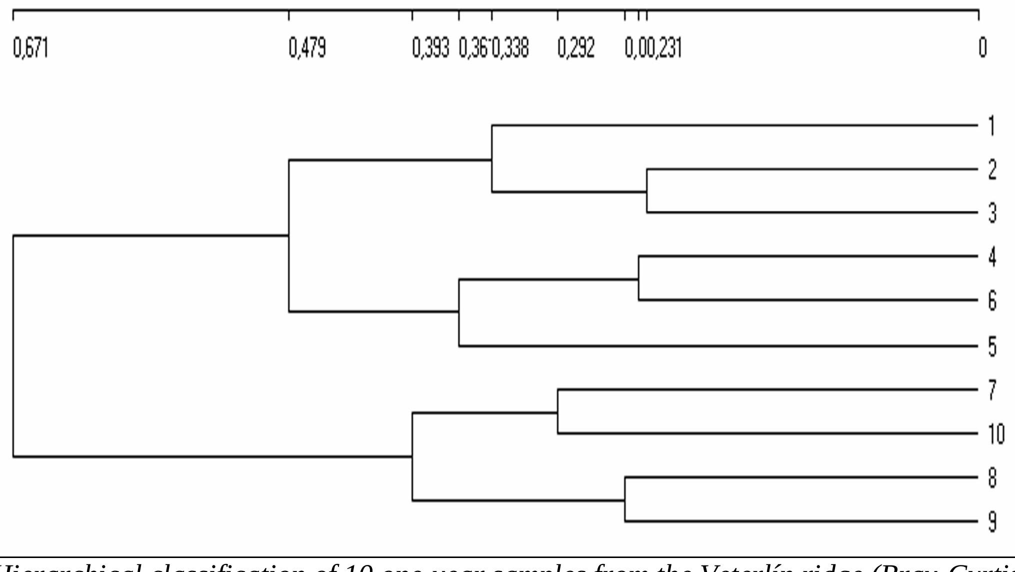

Fig. 3. Hierarchical classification of 10 one-year samples from the Veterlín ridge (Bray-Curtis index).

The described relationships are clearly illustrated by the hierarchical classification using the Bray-Curtis´s similarity index (Fig. 3). There are formed the cluster at dissimilarity level 0.479 – 0.671. The first contains the samples (1 – 3) from the foot of the southern slopes, the second the samples from the top of the ridge (4-6) and the third from the northern slope. The third cluster splits at the similarity level 0,393 into two subclusters. One includes the very poor sample from the central part of the northern slope (8-9), other includes richer samples from its upper and lower part (7 and 10).

In the scatter diagram of the direct ordination (Fig. 4), the samples form two groups. One included the sample 1, 2, and 7 –10, which consist almost exclusively of the stenotopic forests species. The second includes samples 3 – 6, which also consist the open landscape species or the eurytopic species *Pterostichus melanarius*. Position of the samples along the humidity axis results first of all from quantitative representation of the species with moderately higher requirements to humidity (*Carabus coriaceus, Carabus scheidleri, Carabus violaceus, Pterostichus burmeisteri* and *Pterostichus melanariusm,* Tab. 1)

Community productivity

On the southern slope, there was higher number of species (min. 10, max. 15, mean 11.6, variance coefficient 17.8%), individuals (min. 147, max. 330, mean 232, variance coefficient 38.8 %) and biomass of one-year sample (min. 345 g, max793 g, mean 600.8 g, variance coefficient 30.6 %) than on the northern slope, where the following values were established: number of species - min. 4, max. 9, mean 7, variance coefficient 26.7%, number of individuals - min. 27, max. 141, mean 63, variance coefficient 72.5 % and biomass - min. 55 g, max. 365 g, mean 154.7 g, variance coefficient 76.2 %. Hence all highest values observed on the northern slope were lower than the lowest values on the southern slope. In addition they were subjected to a twice-larger variability. The lowest values of these community parameters were observed in the central part of the northern slope (Tab. 1, Fig. 2).

The values of cumulative abundance and biomass were positively correlated (0,87 in southern slope and 0.98 in northern slope), but there was an obvious compensation between a larger number of smaller species and smaller number of heavier species. This relationship was visible especially between *Abax paralellopipedus* and *Carabus coriaceus* (Tab. 1).

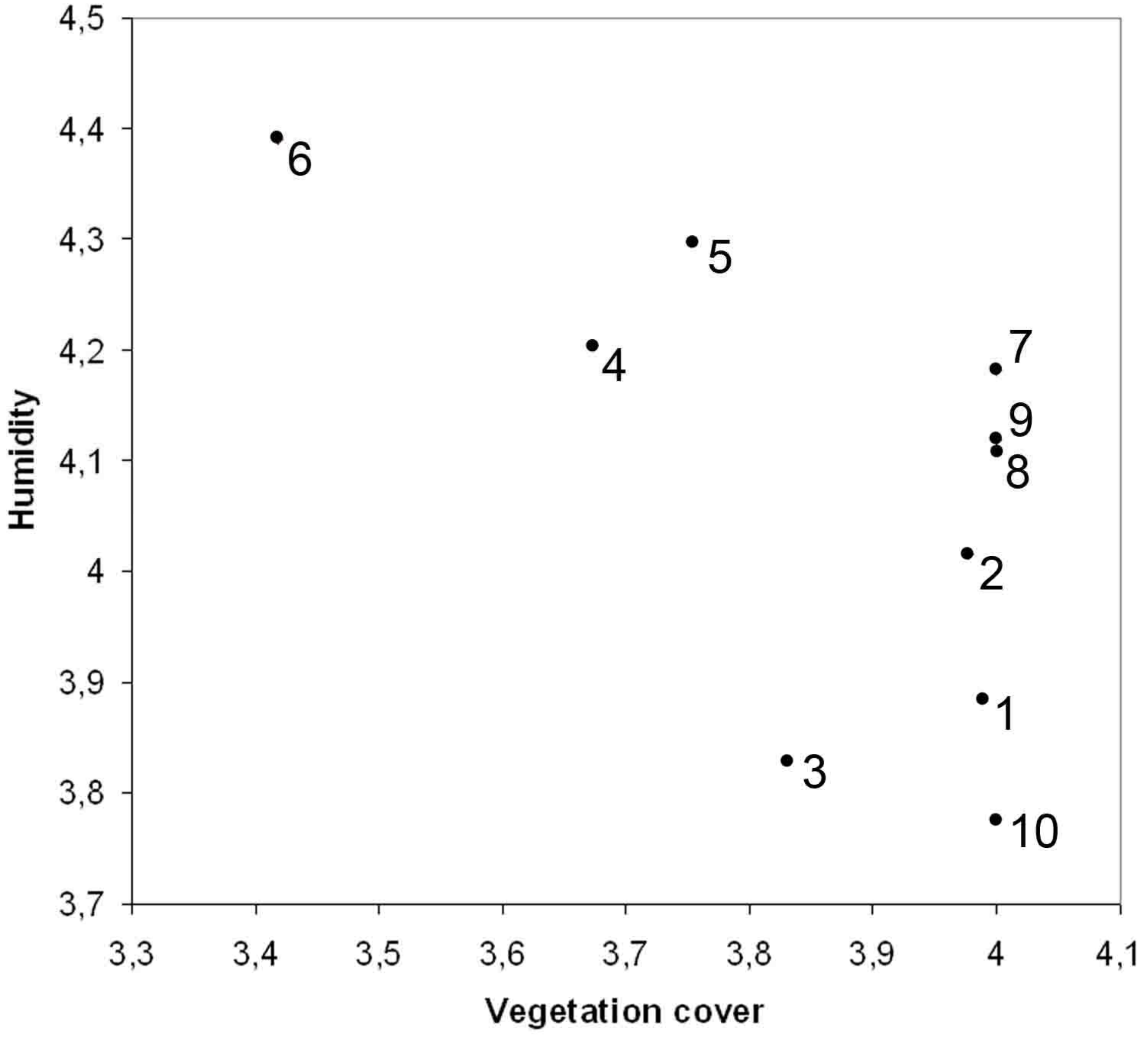

Fig. 4. *Direct ordination of 10 one-year samples from the Veterlín ridge on the base of preference for humidity (1 – xerophilous, 8 – polyhydrophilous) and vegetation cover (1 – open landscape species, 4 – forest species)*

Conclusions

The differences in temperature, depth and structure of soil, density of herbage stratum and slope declination along a transect crossing the Veterlín ridge had a deep influence on spatial structure of Carabid community. On the southern slope, with richer herbage stratum and deeper soil, there was much higher number of species and cumulative abundance and dry biomass of the one-year samples than on the northern slope, without herbage stratum and discontinuous layer of beech leaves. The only species preferring the northern slope was *Carabus intricatus*. Thinner tree coverage at the ridge top resulted in individual occurrence of species of open landscape. Influence of higher values of these parameters was visible still behind the top of the ridge. The lowest number of species and cumulative abundance and biomass were in the central part of the northern slope. Near to its foot these values tended to increase.

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Tab. 1. Survey of species, their ecological properties and activity abundance in the transsect in Veterlín in 1994.

Species	Ecol. properties			Trap									
	H	V	W [g]	1	2	3	4	5	6	7	8	9	10
Abax ovalis (DUFTSCHMIDT, 1812)	4	4	0.6283	14	4		1						
Abax paralelopipedus (PILLER ET MITTERPACHER, 1783)	3	4	1.1521	99	116	171	45	32	37	20	14	11	34
Abax parallelus (DUFTSCHMIDT, 1812)	4	4	0.5140				4	1					
Amara similata (GYLLENHALL, 1810)	3	1	0.0211					1					
Aptinus bombarda (ILLIGER, 1800)	3	4	0.0879			1		1					
Bembidion lampros (HERBST, 1784)	3	1	0.0172					2					
Calathus fuscipes (GOEZE, 1777)	4	1	0.2256					1					
Carabus coriaceus LINNAEUS, 1758	5	4	6.5950	52	90	65	33	62	38	16	9	6	11
Carabus hortensis LINNAEUS, 1758	4	4	1.7800	86	13	18	4	15	9	2			2
Carabus intricatus LINNAEUS, 1761	4	4	1.8450			1		1	2	1	1	2	
Carabus nemoralis MÜLLER, 1764	4	4	1.7370	7	13	23	17	3			2		
Carabus scheidleri PANZER, 1799	5	4	2.1885		2	2	1		1		2		1
Carabus ullrichi GERMAR, 1824	4	4	1.5132				1						
Carabus violaceus LINNAEUS, 1758	5	4	1.7457	5	5	8	10	1	11	4	2	1	7
Cychrus caraboides (LINNAEUS, 1758)	5	4	0.9256	2			1						
Harpaus distinguendus (DUFTSCHMIDT, 1812)	3	1	0.1873	1									
Licinus hoffmansegi (PANZER 1797)	4	4	0.1251	1									
Molops piceus (PANZER, 1793)	4	4	0.0443	1	2			2	1	2	1		1
Notiophilus rufipes CURTIS, 1829	4	2	0.0240					2					
Pteroastichus melanarius (ILLIGER, 1798)	5	2	0.5336		3	28	24	9	41				
Pterostichus burmeisteri (HEER, 1801)	5	4	0.1546	9	20	13	6	5	1	10	5	7	2
Number of species				11	10	10	12	15	9	7	8	4	7
Numner of individuals				277	268	330	147	138	141	55	36	27	58
Shannon´s diversity H´				1.57	1.48	1.5	1.89	1.72	1.6	1.54	1.67	1.19	1.26
Equitability H´/H´max.				0.65	0.64	0.65	0.76	0.63	0.73	0.79	0.8	0.86	0.65
Biomass [g], rounded to whole g.				643	793	735	345	488	356	143	89	55	130

Explanations: H – preference for humidity, VC – preference for vegetation cover, W – average weight of one individual