

# The response of weevil communities (Coleoptera: Curculionoidea) to the altitudinal zones of beech stands

J. BERÁNEK

*Faculty of Forestry and Wood Technology, Mendel University of Agriculture and Forestry in Brno,  
Brno, Czech Republic*

**ABSTRACT:** Good knowledge of geobiocoenoses is one of the primary preconditions for biogeographical differentiation of the landscape, protected territory tending and preservation of forest ecosystems. For deepening the knowledge of the complex geobiocoenological relations the study of curculiocoenoses was conducted. It was conducted in eighteen permanent research plots based in beech stands of the 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> altitudinal zone in the regions of South Moravia and East Bohemia. The relation of weevils to altitudinal zones was proved on the basis of some ecological index numbers and statistic methods DCA and CCA ( $P \leq 0.001$ ). It was found out that curculiocoenoses of the investigated altitudinal zones overlapped and some species decreased or increased their dominance and abundance with increasing altitude. Characteristics of the beech stand curculiocoenoses have been proposed for the 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> altitudinal zone, which can be used as an ancillary component of the geobiocoenological or typological system. For a more complex conclusion similar research of weevils should be carried out in the beech stands of other altitudinal zones and also in other forest stands.

**Keywords:** altitudinal zones; beech stand; geobiocoenology; weevils; Curculionoidea; zoocoenosis

Study of biocoenoses has been a problematic process for a long time; its origins can be found already at the beginning of the AD era (KLIKA 1948). Although since the 1950s the specialists have been interested more deeply in the relations between phytocoenoses and zoocoenoses (SCHMÖLZER 1953; HEYDEMANN 1955; VAŠÁTKO 1972; POVOLNÝ, ŠUSTEK 1981; ŠUSTEK 1993; MAZUR 2001; HOLECOVÁ, SUKUPOVÁ 2002; HOLECOVÁ, SLAŠŤANOVÁ 2003; BROUAT et al. 2004; EYRE et al. 2005, and others), there are still certain deficiencies (BUČEK 2000; LACINA, VAŠÁTKO 2004).

Thanks to some of their characteristics invertebrates seem to be the most useful for geobiocoenological differentiation of the landscape (VAŠÁTKO

2000). In recent years more and more authors have been concerned with insects, in the animal component a part of geobiocoenoses (e.g. TURIN et al. 1991; PELIKÁN 1996; POVOLNÝ, ZNOJIL 1998; SCHLAGHAMERSKÝ 2000; ŠUSTEK 2000; HOLUŠA 2003b; STEJSKAL 2006). Although many insect species are not so closely connected with the ecotope as plants – usually because of their mobility and the way of obtaining their food, it is possible to record certain relationships to certain coenoses (e.g. THIELE 1977; ŠUSTEK 2000; HOLUŠA 2003b; STREJČEK 2003; STEJSKAL 2006). Next to anthropogenic influences, altitudinal zones (AZ) are one of the important factors influencing insect communities (KRÁLÍČEK, POVOLNÝ 1978; ŠUSTEK 2000;

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Table 1. Basic characteristics of all permanent research plots

PRP	Location	Topography	Altitude (m a.s.l.)	Exposition	Soil type	Humus form	Annual mean rainfalls (mm)	Annual average temperature (°C)	Stand density	AZ	Trophic sequence
1	B	easy slope	440	N	MC	TM	637	7.4	10	3	AB
2	B	easy slope	420	NE	MC	TM	626	7.6	10	3	AB
3*	B	easy slope	410	NE	MC	MM	621	7.6	9	3	AB
4*	B	easy slope	495	NE	MC	TM	667	7.1	10	3	B
5	B	easy slope	415	NE	MC	TM	623	7.6	10	3	B
6	B	easy slope	420	NE	MC	TM	626	7.6	9	3	B
7	B	easy slope	530	NW	MC	TM	687	6.9	10	4	B
8	B	easy slope	490	NE	MC	TM	665	7.1	9	4	AB
9*	CT	easy slope	490	NE	MC	TM	810	6.6	9	4	B
10	CT	easy slope	505	NE	MC	TM	819	6.5	10	4	BC
11	CT	easy slope	510	NE	MC	TM	821	6.4	10	4	B
12*	CT	easy slope	480	NE	MC	TM	805	6.6	9	4	B
13*	CT	easy slope	550	NE	MC	TM	843	6.2	9	5	BC
14	CT	easy slope	570	NE	MC	TM	854	6.1	10	5	BC
15	CT	easy slope	590	NE	MC	TM	865	5.9	9	5	B
16*	CT	easy slope	540	NE	MC	TM	838	6.2	9	5	AB
17	CT	easy slope	570	NE	LC	TM	854	6.1	10	5	AB
18	CT	easy slope	560	NE	MC	TM	849	6.1	10	5	B

\*Research was conducted also in 2005, B – in the environs of Brno, CT – in the environs of Česká Třebová, LC – Luvic Cambisol, MC – Modal Cambisol, MM – Mull-Moder, TM – Typical Moder, N – North, NE – North-East, NW – North-West

JUKES et al. 2002; HOLUŠA 2003a,b; STEJSKAL 2006; BERÁNEK 2008).

Quite a close attention has been paid to some insect categories, e.g. Psocoptera (HOLUŠA 2003b), Lepidoptera (KRÁLÍČEK, POVOLNÝ 1978; LAŠTŮVKA 2003), Diptera (POVOLNÝ, ZNOJIL 1993, 1998; POVOLNÝ, ŠUSTEK 1986a,b) and particularly beetles (e.g. PULPÁN, REŠKA 1971; ŠUSTEK 1976, 2000; THIELE 1977; NENADÁL 1988; BRABEC 1989; ROHÁČOVÁ 2001; KULA, PURCHART 2004). However, next to so far preferred categories, such as ground beetles or rove beetles, there are many categories partially processed or not yet (e.g. KOVÁŘ 1996; STREJČEK 1996; STEJSKAL 2006).

The aim of this study was to complete the stand characteristics of selected geobiocoenoses with more zoocenological data and to review the influence of AZ on the occurrence of weevils, therefore to add knowledge of the complex geobiocoenological relations.

## MATERIAL AND METHODS

In accordance with the geobiocoenological investigations, 18 permanent research plots (PRP) were established in beech stands of the 3<sup>rd</sup> oak-beech, 4<sup>th</sup> beech and 5<sup>th</sup> fir-beech AZ (ZLATNÍK 1976; BUČEK, LACINA 1999). For the strengthening influence of the AZ as PRPs were found localities with relatively similar climatic, geomorphologic, soil and stand characteristics. The criteria for the selection of the PRP were 90–100% composition of beech (*Fagus sylvatica*), topography, gradient, exposition, minimal stand area  $\geq 1$  ha, stand stage, stand density and hy-

drological sequence. The altitude varied from 410 to 590 m above sea level. The study areas are situated in the South Moravian region near Brno (3<sup>rd</sup> and 4<sup>th</sup> AZ) and in the East Bohemian region near Česká Třebová (4<sup>th</sup> and 5<sup>th</sup> AZ) (Table 1).

The weevils were collected in 2-week intervals from May to October in 2003–2005. The collection of the last year was done only on 6 PRPs which represented the types of study geobiocoenoses in the best way. The weevils were caught by three methods: by formalin pitfall traps, by beating and by sweep netting (NOVÁK et al. 1969; MCGAVIN 2001). The trapped beetles were preserved in 75% ethanol. The weevil species were determined according to SMRECZYŃSKI (1965, 1966, 1968, 1972, 1974, 1976) and STREJČEK (1990). The nomenclature was used according to WANAT and MOKRZYCKI (2005).

Dominance (TISCHLER 1949) of species was found for the investigated AZ. Faunal similarity conveyed by Jaccard's index was also worked out (Losos 1992). Each species was tested from the aspect of normality of data by means of Shapiro-Wilkes *W* test from STATISTICA Cz 7.1 software.

All data were also tested in CANOCO for Windows 4.5. Canonical Correspondence Analysis (CCA) was used to find the connection between weevil species (species data) and the investigated AZ (environmental data). As a reflection of environmental conditions the whole weevil communities of each PRP were also tested by Detrended Correspondence Analysis (DCA). CANOCO tested the significance of the effect of AZ using the Monte Carlo Permutation test (999 permutations). In our case the CCAs were run with CANOCO's default options: scaling

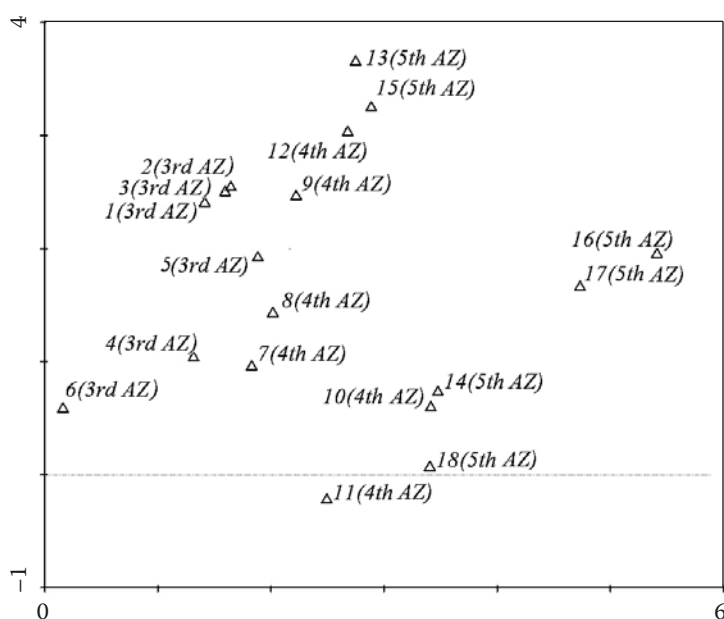

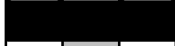

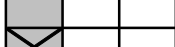
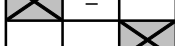
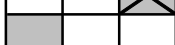
















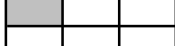
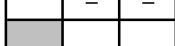
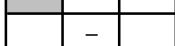


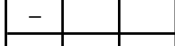


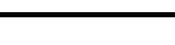





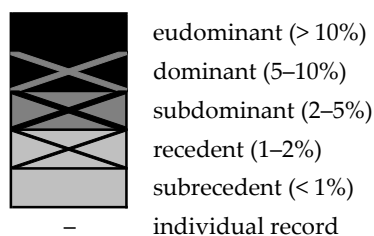
Fig. 1. DCA results of similarity of weevil communities on PRPs (investigated AZ)

Table 2. The species spectrum of weevils in beech stands of the investigated AZ

Weevil species	Abbreviation	Altitudinal zone						Total
		3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	
<i>Acalles camelus</i>	Acal_cam	3.45	6.36	3.92				114
<i>Acalles fallax</i>	Acal_fal	0.87	1.09	0.69				32
<i>Amalus scortillum</i>	Amal_sco	0.00	0.00	0.37			–	1
<i>Anthribus nebulosus</i>	Anth_neb	0.13	5.58	4.19				107
<i>Apion frumentarium</i>	Api_fru	0.09	0.00	0.00	–			1
<i>Barynotus obscurus</i>	Baryn_ob	0.00	0.50	0.07			–	7
<i>Barypeithes vallestris</i>	Baryp_va	7.05	0.05	0.12		–	–	50
<i>Betulapion simile</i>	Bet_sim	0.00	0.79	0.36				10
<i>Brachysomus echinatus</i>	Brach_ec	0.08	0.00	0.00	–			1
<i>Ceratapion gibbirostre</i>	Cerat_gi	0.07	0.07	0.11	–	–	–	3
<i>Ceutorhynchus alliariae</i>	Ceut_all	0.49	0.00	0.00				5
<i>Ceutorhynchus erysimi</i>	Ceut_ery	0.00	0.00	0.18			–	1
<i>Ceutorhynchus obstructus</i>	Ceut_obs	5.38	2.51	0.06			–	117
<i>Ceutorhynchus scrobicollis</i>	Ceut_scr	0.08	0.00	0.00	–			1
<i>Ceutorhynchus sulcicollis</i>	Ceut_sul	0.00	0.04	0.00		–		1
<i>Ceutorhynchus typhae</i>	Ceut_typ	0.28	1.18	1.05				15
<i>Cionus hortulanus</i>	Cion_hor	0.09	0.00	0.00	–			1
<i>Cionus tuberculosus</i>	Cion_tub	0.75	0.14	0.00		–		12
<i>Curculio glandium</i>	Curc_gla	0.07	0.05	0.00	–	–		2
<i>Deporaus betulae</i>	Dep_bet	0.34	0.91	0.00				19
<i>Eutrichapion viciae</i>	Eutr_vic	0.28	0.00	0.00				2
<i>Holotrichapion ononis</i>	Holot_on	0.00	0.05	0.00		–		1
<i>Hylobius abietis</i>	Hyl_abi	0.00	0.05	0.02		–	–	2
<i>Hypera meles</i>	Hyp_mel	0.09	0.00	0.00	–			1
<i>Ischnopterapion virens</i>	Ischn_vi	0.15	0.24	0.17	–	–		4
<i>Kalcapion pallipes</i>	Kalc_pal	0.15	0.00	2.98	–			4
<i>Larinus planus</i>	Lar_pla	0.00	0.00	0.18			–	1
<i>Lasiornychus olivaceus</i>	Las_oli	0.52	0.22	0.00				9
<i>Lepyryus capucinus</i>	Lep_cap	0.00	0.05	0.00		–		1
<i>Liophloeus lentus</i>	Lio_len	0.16	0.16	0.00	–	–		2
<i>Nedus quadrimaculatus</i>	Ned_qua	0.92	0.39	0.18				20
<i>Neocoenorrhinus aeneovirens</i>	Neoc_aen	0.07	0.00	0.00	–			1
<i>Onyxacalles pyrenaicus</i>	Onyx_pyr	0.08	0.00	0.00	–			1
<i>Orchestes fagi</i>	Orch_fag	25.40	3.74	1.51				297
<i>Otiorhynchus corvus</i>	Otio_cor	0.08	0.00	0.00	–			1
<i>Otiorhynchus equestris</i>	Otio_equ	0.00	0.00	0.45				6
<i>Otiorhynchus perdix</i>	Otio_per	0.00	0.00	0.06			–	1
<i>Otiorhynchus porcatus</i>	Otio_por	0.09	0.00	0.00	–			1
<i>Otiorhynchus raucus</i>	Otio_rau	2.55	0.00	0.00				19
<i>Otiorhynchus scaber</i>	Otio_sca	0.85	5.40	8.75				167
<i>Otiorhynchus singularis</i>	Otio_sin	0.00	0.00	0.18				8
<i>Oxystoma ochropus</i>	Oxys_och	0.15	0.00	0.00	–			1
<i>Oxystoma opeticum</i>	Oxys_ope	1.40	0.14	0.00		–		19

Table 2 to be continued

<i>Phyllobius arborator</i>	Phyl_arb	1.07	0.53	1.58		28
<i>Phyllobius argentatus</i>	Phyl_arg	13.53	15.66	19.01		879
<i>Phyllobius calcaratus</i>	Phyl_cal	0.00	0.08	0.07		3
<i>Platyrhinus resinosus</i>	Platyr_r	0.07	0.00	0.00		3
<i>Platystomus albinus</i>	Platys_a	1.09	0.05	0.00		4
<i>Plinthus tischeri</i>	Plin_tis	0.00	0.00	1.13		4
<i>Polydrusus cervinus</i>	Polyd_ce	0.07	0.00	0.00		3
<i>Polydrusus impar</i>	Polyd_im	0.00	0.11	1.17		16
<i>Polydrusus marginatus</i>	Polyd_ma	0.61	0.00	0.00		9
<i>Polydrusus mollis</i>	Polyd_mo	5.14	0.15	0.68		24
<i>Polydrusus pilosus</i>	Polyd_pil	0.07	0.00	0.00		3
<i>Polydrusus tereticollis</i>	Polyd_te	7.89	13.23	15.33		619
<i>Protapion apricans</i>	Prot_apr	0.65	0.13	0.94		12
<i>Protapion fulvipes</i>	Prot_ful	0.47	0.41	0.28		13
<i>Rhinomias forticornis</i>	Rhin_for	2.32	13.27	6.45		316
<i>Rutera hypocrita</i>	Rut_hyp	2.04	0.56	0.72		46
<i>Sciaphilus asperatus</i>	Scia_asp	0.49	0.26	1.00		12
<i>Scleropteridius fallax</i>	Scler_fa	0.12	0.19	0.00		2
<i>Simo hirticornis</i>	Sim_hirt	0.00	0.04	0.52		22
<i>Sitona hispidulus</i>	Sit_hisp	1.85	0.03	0.00		5
<i>Sitona humeralis</i>	Sit_hum	0.07	0.20	0.18		9
<i>Sitona lepidus</i>	Sit_lep	0.00	0.05	0.00		1
<i>Sitona lineatus</i>	Sit_lin	0.23	0.57	0.97		14
<i>Sitona macularius</i>	Sit_mac	0.00	0.00	0.12		1
<i>Sitona sulcifrons</i>	Sit_sulc	0.00	0.08	0.47		5
<i>Sphenophorus striatopunctatus</i>	Sphen_st	0.49	0.00	0.00		2
<i>Stenocarus ruficornis</i>	Stenoc_r	0.00	0.14	0.11		2
<i>Stenopteropion tenue</i>	Stenop_t	0.15	0.00	0.00		2
<i>Stereonychus fraxini</i>	Ster_fra	0.00	0.04	0.00		1
<i>Strophosoma capitatum</i>	Stroph_c	0.00	0.14	0.00		1
<i>Strophosoma melanogrammmum</i>	Stroph_m	14.41	22.46	23.78		1,349
<i>Synapion ebeninum</i>	Synap_eb	0.09	0.00	0.00		1
<i>Trachodes hispidus</i>	Trach_hi	0.00	0.05	0.00		1
<i>Tropiphorus elevatus</i>	Trop_ele	0.00	1.86	0.00		10
Total		1,101	1,973	1,417		4,491



focused on inter-species distances, scaling type: biplot scaling ( $L^a$ ), no transformation of species data + rare species downweighted. The CANOCO's default options for DCA were: method of detrending

selected by segments, no transformation of species data + rare species downweighted. The CanoDraw for Windows 4.13. was used for the visualization of processed data.

Table 3. Jaccard's index (%)

AZ	3	4	5
3		45.96	37.06
4			52.00
5			

## RESULTS

Altogether 4,491 weevil specimens were collected. They represented 77 species: 3 species of fungus weevils (Anthribidae), 3 species of leaf-rolling weevils (Rhynchitidae), 13 species of pear-shaped weevils (Apionidae) and 58 species of true weevils (Curculionidae). In the 3<sup>rd</sup> AZ 1,101 individuals and 53 species, in the 4<sup>th</sup> AZ 1,973 individuals and 48 species and in the 5<sup>th</sup> AZ 1,417 individuals and 40 species were captured (Table 2).

Certain qualitative and quantitative differences of the studied curculiocoenoses were revealed by DCA analysis, which are proved by their arrangement from left to right, where the influence of the site conditions, let us say AZ, on the single weevil communities is apparent. Axis 1 covered up 20.4% of the cumulative variance of the species-environment relation of tested data. Axis 1 and axis 2 covered up 58.4% of the cumulative variance of the data together (Fig. 1). It is also obvious in the declining character of the ratio of the researched species in investigated AZ (Fig. 2). Gradual influence was also confirmed by faunal similarity based on Jaccard's index, where the curculiocoenoses in the 3<sup>rd</sup> and 4<sup>th</sup> AZ and 4<sup>th</sup> and 5<sup>th</sup> AZ are more similar than those of the 3<sup>rd</sup> and 5<sup>th</sup> AZ (Table 3). The differences in the weevil species composition are dependent on the ecological demands of the individual species. Some of them increase or, on the contrary, decrease their dominance and abundance with increasing altitude. *Otiorhynchus scaber*, *Phyllobius argentatus*, *Polydrusus impar*, *P. tereticollis* and *Strophosoma melanogrammum* belong to the species with increasing dominance, while *Barypeithes vellestris*, *Ceutorhynchus obstrictus*, *Cionus tuberculosus*, *Orchestes fagi*, *Oxystoma opeticum* and *Rutera hypocrita* belong to those with decreasing dominance (Table 2).

The result of CCA analysis showed the condition convenience for the existence of some weevil species in the researched AZ. In the case of the 3<sup>rd</sup> AZ the canonical axis (axis 1) explained 26.1%, axis 2 explained 68.5% and axis 3 explained 65.8% of total variability in the species data. 9.4% of total variability in the species data was explained by axis 1, 68.6% by axis 2 and 67.4% by axis 3 in the case of the 4<sup>th</sup> AZ. In the 5<sup>th</sup> AZ axis 1 explained 15.8%, axis 2 explained 68.5% and axis 3 explained 66.1%. The

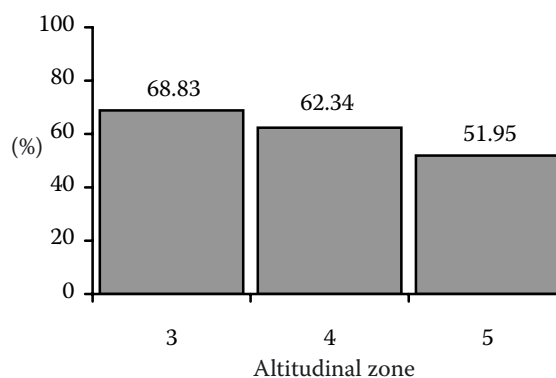


Fig. 2. Ratio of weevil species in investigated AZ (%)

first two unconstrained axes after axis 1 explained more variability than the canonical axis in all cases and the explanatory effect of each AZ was significant ( $P \leq 0.001$ ). Explanation by the particular axes for all investigated AZ was 27.6% (axis 1), 8.3% (axis 2) and 68.5% (axis 3), whereas the explanatory effect was also significant ( $P \leq 0.001$ ). It is evident that the condition favourableness for the weevil communities of investigated AZ is the best in the 3<sup>rd</sup> AZ (Fig. 3).

The conditions of the 3<sup>rd</sup> AZ were favourable for the species *Otiorhynchus raucus*, *Polydrusus marginatus*, *Ceutorhynchus alliariae*, *Barypeithes vellestris*, *Oxystoma opeticum*, *Cionus tuberculosus*, *Rutera hypocrita*, *Orchestes fagi*, or *Polydrusus mollis*. The occurrence of the species *Hypera meles*, *Polydrusus pilosus*, *P. cervinus* and *Platyrhinus resinosus* is impossible to determine definitely with regard to a small number of found specimens. In the case of the 4<sup>th</sup> AZ the conditions were favourable for the species *Tropiphorus elevatus* and *Rhinomias forticornis*. Owing to its occurrence in other AZ the species *Acalles fallax*, *A. camelus*, *Ceutorhynchus typhae*, *Phyllobius argentatus*, *Polydrusus tereticollis*, and *Anthribus nebulosus* need to be considered as accessory or associate ones. The 5<sup>th</sup> AZ with its conditions was favourable to the species *Otiorhynchus singularis*, *O. scaber*, *Simo hirticornis* and *Polydrusus impar* (Fig. 3).

On the basis of this research complementary zoocoenological characteristics have been proposed in the investigated AZ, where some of the found weevil species have been divided into 3 groups: representative, accessory and associate species (Table 5).

Table 4. Results of the CCA environmental variable data

	Axe 1	Axe 2
3 <sup>rd</sup> AZ	0.6443	0.1144
4 <sup>th</sup> AZ	-0.1591	-0.4003
5 <sup>th</sup> AZ	-0.4192	0.3217



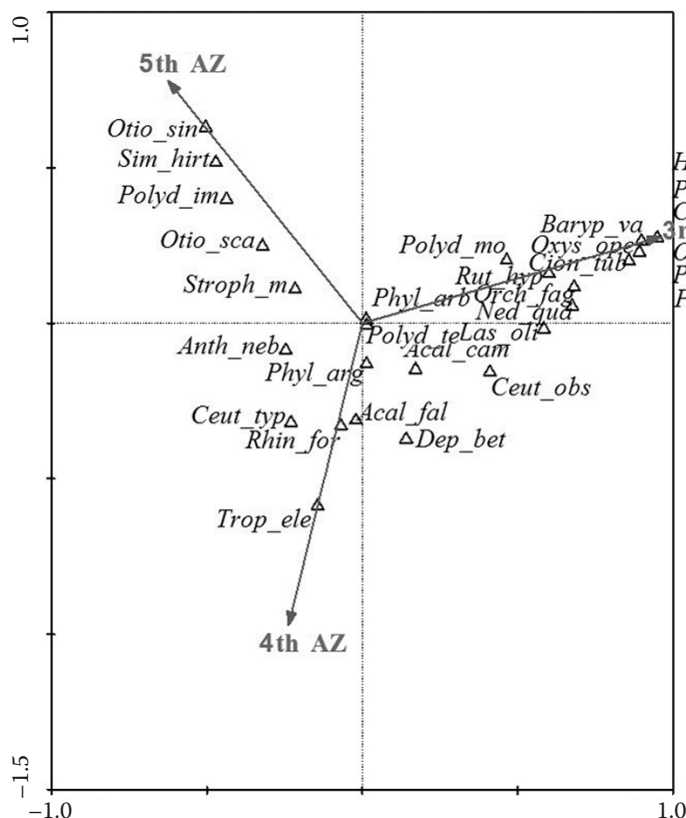


Fig. 3. CCA results of the AZ influence on single weevil species of beech stand geobiocoenoses (the abbreviations see Table 2)

## DISCUSSION

The influence of the altitudinal zones on the structure of entomocoenoses was proved by many authors (KRÁLÍČEK, POVOLNÝ 1978; KULA 1981; POVOLNÝ, ZNOJIL 1993, 1998; ŠUSTEK 1993, 2000; HOLUŠA 2003b; KULA, PURCHART 2004; STEJSKAL

2006). Similarly like carabicoenoses (ŠUSTEK 1976, 2000; KULA, PURCHART 2004), curculiocoenoses of beech stands of the 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> AZ showed greater similarity of curculiocoenoses of adjoining AZ. The curculiocoenoses, analogously to carabicoenoses (KULA, PURCHART 2004), responded more readily to the changes of the investigated AZ in the numerical

Table 5. Ancillary zoocoenological characteristics of the beech stand curculiocoenoses of the investigated AZ

Weevil species			
AZ	Representative	Accessory	Associate
3	<i>Barypeithes vellestris</i>	<i>Orchestes fagi</i>	<i>Acalles camelus</i>
	<i>Otiorhynchus raucus</i>	<i>Phyllobius argentatus</i>	<i>Ceutorhynchus obstrictus</i>
	<i>Oxystoma opeticum</i>	<i>Polydrusus tereticollis</i>	<i>Polydrusus mollis</i>
		<i>Strophosoma melanogrammum</i>	<i>Rhinomias forticornis</i>
4	<i>Tropiphorus elevatus</i> *	<i>Phyllobius argentatus</i>	<i>Rutera hypocrita</i>
		<i>Polydrusus tereticollis</i>	<i>Acalles camelus</i>
		<i>Rhinomias forticornis</i>	<i>Anthribus nebulosus</i>
		<i>Strophosoma melanogrammum</i>	<i>Ceutorhynchus obstrictus</i>
			<i>Orchestes fagi</i>
5	<i>Otiorhynchus equestris</i>	<i>Phyllobius argentatus</i>	<i>Otiorhynchus scaber</i>
	<i>Polydrusus impar</i>	<i>Polydrusus tereticollis</i>	<i>Acalles camelus</i>
		<i>Strophosoma melanogrammum</i>	<i>Anthribus nebulosus</i>
			<i>Otiorhynchus scaber</i>
			<i>Rhinomias forticornis</i>

\*Occurrence of this species has to be observe yet

composition of the individual species than by faunal diversity.

With increasing AZ a relatively fluent decrease in species was recorded. It was probably caused by a decrease in the host plants on which nearly a half of the collected weevil species is utterly dependent. With regard to the fact that the research was conducted in three AZ only – relatively small altitudinal span, only in a segment of geobiocoenoses – it is impossible to define the outline of the occurrence of the found species. Many faunal researches suggest the possibility of the occurrence of most of the species, however, often in completely different geobiocoenoses. Therefore the researches may have a misguiding character in some cases.

With regard to the fact that curculiocoenoses in the investigated AZ overlap and some of the researched species show certain tendency or preference to lower or higher altitudes, it is possible to agree with STEJSKAL (2006). In his study STEJSKAL divides weevils into three or four basic groups: lowland, upland, foothill and highland. PULPÁN and REŠKA (1971) or ŠUSTEK (2000) divided the carabicoenoses in a similar way.

The division of selected species of the investigated AZ into representative, accessory and associate ones was just an attempt to complete zoocoenological characteristics of beech stands. The inclusion of *Barypeithes vallestris*, *Otiorhynchus raucus* and *Oxystoma opeticum* among the typical species of the 3<sup>rd</sup> AZ, and also the inclusion of *Otiorhynchus equestris* and *Polydrusus impar* among the typical species of the 5<sup>th</sup> AZ is not in contradiction with other published data (JAVOREK 1947; SMRECZYŃSKI 1966, 1981; FRIESER 1981; STEJSKAL 2006). It is interesting that mainly the beech species *Tropiphorus elevatus* (ČUDAN 1996) occurs only in the 4<sup>th</sup> AZ. Although it is possible to exclude the influence of the nutritive plant (SMRECZYŃSKI 1966) on the occurrence of this species, as it has not been present in the stands of the 5<sup>th</sup> AZ, it is necessary to make further searches. Although according to SMRECZYŃSKI (1972) the species *Rutera hypocrita* occurs in highlands, according to the search it occurs mostly in the 3<sup>rd</sup> AZ. On the contrary, *Simo hirticornis* occurs mostly in the 5<sup>th</sup> AZ, but STEJSKAL (2006) detected it in the same numbers in the 2<sup>nd</sup> and 3<sup>rd</sup> AZ. The discovery of the species *Acalles camelus*, *Anthrribus nebulosus*, *Orchestes fagi*, *Otiorhynchus scaber*, *Phyllobius argentatus*, *Polydrusus tereticollis*, *Rhinomias forticornis* and *Strophosoma melanogrammum* confirms them as dominants of beech stands (JAVOREK 1947; SMRECZYŃSKI 1966, 1972; LOHSE 1983; PETRYSZAK et al. 1994; LÖF et al. 2004). For more complex con-

clusions it is necessary to make similar researches on the weevils of the other AZ and also in other forest stands.

Although it is possible to use curculiocoenoses as a complementary characteristic of individual AZ, it is incompetent to judge only the presence or absence of the species. It is important to confront the structure of entomocoenoses with the overall character of geobiocoenosis, herbal and wood vegetation or anthropic influence.

Although according to SPRICK and WINKELMANN (1993) the attachment of weevils to a biotope is not clean-cut, the findings of this research – like with other authors (HOLECOVÁ 1989; STREJČEK 1996, 2001, 2003; MAJZLAN 1997; HOLECOVÁ, SUKUPOVÁ 2002; STEJSKAL 2006) – show their designating significance. On the basis of our research it can be stated that next to carabicoenoses (PULPÁN, REŠKA 1971; ŠUSTEK 1976, 2000; NENADÁL 1988; KULA, PURCHART 2004) it is possible to use curculiocoenoses as an indicator of AZ of a habitat.

Characteristics built-up by more dynamic zoocoenoses can contribute to the specification of information about the state or the direction of restoration progress of coenoses (ŠUSTEK 1993). It is possible to use some groups of animals in the long-term monitoring of progress and changes of geobiocoenoses, without these changes influencing the structure of phytocoenosis (POVOLNÝ, ŠUSTEK 1986a,b; HOLUŠA 2003b). On the other hand, it is necessary to realize that most animals are directly dependent on vegetation and thus zoocoenosis is a certain reflection of phytocoenosis (LAŠTŮVKA 2003).

## CONCLUSION

In 2003–2005, 4,491 specimens of 77 species of the weevils (Curculionoidea) were captured in 18 localities of beech stands near Brno (South Moravia) and Česká Třebová (East Bohemia) classified in 3 AZ.

The influence of the AZ on the beech stand curculiocoenoses was demonstrated by DCA and CCA analyses. The investigated environmental variable quantity (AZ) was highly significant ( $P \leq 0.001$ ) in the CCA analyses. In the particular AZ the weevil spectrum was differentiated by the number of species and captured specimens.

Most of the species were associated in the 3<sup>rd</sup> AZ from the research species spectrum of investigated AZ and their number decreased with increasing AZ.

Depending on the increasing AZ *Otiorhynchus scaber*, *Phyllobius argentatus*, *Polydrusus impar*,



*P. tereticollis* and *Strophosoma melanogrammum* belong to species with increasing dominance, while *Barypeithes vellestris*, *Ceutorhynchus obstrictus*, *Cionus tuberculosus*, *Orchestes fagi*, *Oxystoma opeticum* and *Rutera hypocrita* belong to species with decreasing dominance.

Ancillary zoocenological characteristics of investigated AZ, in which some of the determined weevil species were divided into 3 groups: representative, accessory and associate ones, were proposed on the basis of all implemented searches.

After evaluations in the altitudinal zones, along with ground beetles (KULA, PURCHART 2004), weevils may become an interesting additional component of the geobiocenological system. They could also probably be used for descriptions of the group types of geobiocenoses. For more complex conclusions similar research of weevils should be carried out in the beech stands of other AZ and also in other forest stands.

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## Odezva taxocenóz nosatců (Coleoptera: Curculionoidea) na výškovou zonálnost bukových porostů

**ABSTRAKT:** Dobrá znalost geobiocenóz je jedním ze základních předpokladů pro biogeografickou diferenciaci krajiny, péči o chráněná území nebo ochranu lesních ekosystémů. Pro prohloubení poznatků o složitých geobiocenologických vztazích byla na osmnácti trvalých výzkumných plochách, založených v bukových porostech 3. až 5. vegetačního stupně východních Čech a jižní Moravy, provedena studie společenstev nosatců. Na tato společenstva byl následně na základě některých ekologických indexů a statistických metod DCA a CCA prokázán vliv vegetační stupňovitosti ( $P \leq 0,001$ ). Společenstva nosatců šetřených VS se vzájemně prolínala a dominance a abundance některých druhů s nadmořskou výškou klesala či naopak stoupala. Pro 3. až 5. VS byly navrženy charakteristiky curculiocenóz bukových porostů použitelné jako doplňkové složky geobiocenologického nebo typologického systému. Pro komplexnější závěry bude nutné provést podobné studie nosatců v bukových porostech dalších VS a rovněž v jiné druhové skladbě dřevin.

**Klíčová slova:** vegetační stupeň; bučina; geobiocenologie; nosatci; Curculionoidea; zoocenóza

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*Corresponding author:*

Ing. JAKUB BERÁNEK, Státní rostlinolékařská správa, Sekce ochrany proti škodlivým organismům, Zemědělská 1a, 613 00 Brno, Česká republika  
tel.: + 420 545 137 056, fax: + 420 545 137 024, e-mail: jakub.beranek@srs.cz

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