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The ground beetles (*Coleoptera: Carabidae*) of forest altitudinal zones of the eastern part of the Krušné hory Mts.

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ABSTRACT: By means of Sörensen's index and Renkonen's number, the differences in species composition and abundance of the ground beetles (*Carabidae*) were specified in 5 forest altitudinal zones (3rd, 5th–8th) and also the faunal similarity in the linking-up forest altitudinal zones. The entry of some species (*Carabus coriaceus*, *Carabus violaceus*, *Pterostichus niger* and *Pterostichus oblongopunctatus*) into higher altitudes was much more marked than is mentioned in hitherto published information. The objective of the present study was to explore the potential use of the ground beetles as an ancillary component of the geobiocoenological typological system.

Keywords: ground beetles; *Carabidae*; forest altitudinal zones; Krušné hory Mts.

It is necessary to obtain additional data on the animal component in order to characterise the basic and superstructural units of the geobiocoenological typological system (BUČEK 2000), because we see that changes in populations of important animal species, in terms of bio-indication, can be used to evaluate the situation and trends in the development of forest geobiocoenoses.

The ground beetles (*Coleoptera: Carabidae*) belong to the most numerous families of beetles (530 species in the Czech Republic), their distribution being cosmopolitan (35,000 species) (HŮRKA, ČEPICKÁ 1978; HŮRKA 1992, 1996). Their bio-indication importance (HŮRKA et al. 1996) is derived from their dependence on specific conditions of the site (humidity, temperature, soil pH, etc.), which creates conditions for their potential use in practice when elaborating descriptions and characteristics of the groups of geobiocoenosis types (STG). HOLUŠA (2003) reached the same conclusions with book lice (*Psocoptera*). PULPÁN (1968, 1971) and PULPÁN and REŠKA (1971) reported altitudinal zoning of the ground beetles and their preference to certain altitudes.

In the Krušné hory Mts. and Děčín Sandstone Uplands the Carabidae fauna has been explored in stands of substitute tree species with dominant birch (*Betula pendula* Roth) for a long time and has been used for various faunal and ecological studies (KULA 1992, 1997; KULA et al. 2002, 2003, 2004). FARKAČ (1996) described the Carabid fauna in stands of blue spruce (*Picea pungens* Engelm.). BRABEC (1989), ŠUSTEK (1993, 2000), NENADÁL (1993) and ROHÁČOVÁ (2001) examined the Carabid beetles in forest altitudinal zones.

The objective of the present study is to characterise the Carabid fauna of birch stands in forest altitudinal zones (FAZ) in the eastern part of the Krušné hory Mts.

MATERIAL AND METHODS

In accordance with typological investigations, 20 birch (*B. pendula*) stands were selected in the eastern part of the Krušné hory Mts., i.e. Forest Management Plans of the areas Litvínov, Klášterec nad Ohří, Červený Hrádek, which represent the pivotal spectrum of forest types (FT) in the 3rd oak-beech, 5th fir-beech, 6th spruce-beech, 7th beech-spruce and 8th spruce forest altitudinal zones (PLÍVA 1991) (Table 1).

The criterion for the selection of the areas was an 80–100% composition of birch (*B. pendula*) and minimal stand area > 1 ha.

The ground beetles were collected using the method of formalin ground traps (NOVÁK et al. 1969). Four-litre jars containing 2.5 litres of a 2–4% solution of formaldehyde were placed in the stand in lines (5 jars 10 m apart). The traps were placed on 1. 5. 2003 and collections were conducted in 6-week intervals (3. 6., 15. 7., 28. 8. and 29. 10.). The trapped insects were preserved in 75% ethanol.

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Table 1. Classification of stands according to the forest altitudinal zones and edaphic series

Forest altitudinal zone	3		5		6							7					8		
Edaphic series	K	S	K	S	A	F	K	N	O	S	Z	G	K	R*	S	V	G	Q	R
Locality	4	3	2	13	15	16	20	12	14	10	18	5	1	8, 19	11	17	9	6	7

*Forest type 7R in two stands

The species and sex of the ground beetles were determined according to HŮRKA (1996), and the nomenclature according to PULPÁN and HŮRKA (1993).

A number of standard faunal indexes was used to evaluate the carabidocoenoses of the forest altitudinal zones (LOSOS 1980):

- dominance (D) – expression of the composition of the zoocoenosis in per cent in the FAZ using a 5-grade scale according to Schwerdtfeger (1975),
- Sörensen's similarity index (Sö) – calculation of the species identity of two or more biocoenoses (FAZ),
- similarity of dominance – Renkonen's number (Re) – calculation of similarity of biocoenoses (FAZ) using the dominance of species occurring in parallel in compared coenoses (FAZ).

The conversion key (LÖW et al. 1995) enabled interpretation of the results of ŠUSTEK (2000) based on geobiocoenological units according to ZLATNÍK (1976).

RESULTS

The ground beetles in birch stands according to forest altitudinal zones

In 2003, 5,373 specimens of the *Carabidae* family were captured belonging to 64 species in 20 birch stands situated in 5 forest altitudinal zones of the eastern of the Krušné hory Mts. (Table 2).

On the basis of one-year collection marked differences in the population of ground beetles were discovered between the 3rd (656 specimens/stand) and 5th–8th FAZ (218–244 specimens/stand) (Table 2). The faunal similarity of the individual FAZ, derived from Sörensen's index (Table 3) and Renkonen's number (Table 4), revealed a similar regularity with only a few exceptions. According to Sörensen's index the successive FAZ are generally very close to each other in similarity, i.e. 5 × 6, 6 × 7, 7 × 8, at higher altitudes also FAZ 6 × 7 × 8 (Table 3). Renkonen's number also confirmed this regularity when a distinct divergence in the similarities occurred in FAZ 3 × 5 and 5 × 6 as compared to FAZ 6 × 7, 7 × 8 (Table 4). The similarity between the 5th and 7th to 8th FAZ was lower (Tables 3 and 4). The faunal similarity of the 3rd FAZ draws near to the 5th and 6th FAZ, the similarity with the 7th FAZ being considerably lower and that with the 8th FAZ relatively high (Tables 3 and 4).

Changes in the 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 (Table 6).

The number of species and captured specimens differentiated the Carabid fauna of the investigated FAZ. The highest captures were confined to the 3rd FAZ, the most abundant fauna was discovered in the 7th and 6th FAZ (42 and 35 species, respectively). The 5th FAZ differed markedly from the other FAZ in terms of its composition of the sub-recedent species (29.4%); their proportion was 62.8% (6th FAZ) and 70.8–73.8% (3rd, 7th and 8th FAZ).

Members of the genus *Carabus* occupied a major position in the 3rd and 5th FAZ (61–64%), which was also maintained in the FAZ of higher altitudes, but on a quantitatively lower level of dominance (44–55%) (Table 5). Members of the genus *Pterostichus* occupied the cleared space in the 3rd FAZ – 12.6%; 5th and 6th FAZ – 21.35 to 24.6%; and 7th and 8th FAZ – 39.8–37.5% (Table 5). The composition of the genus *Abax* in the 3rd, 5th–6th FAZ was eudominant and in the FAZ of higher altitudes it virtually disappeared. The composition of the other genera is of minor importance for the characteristics of the individual FAZ.

The changed dominance of the genus *Carabus* in the FAZ of lower altitudes (3rd and 5th) was significantly dependent on the presence of the species *C. hortensis* and *C. nemoralis*, while the other two species of the genus *Carabus* were sub-recedent. The genus *Carabus* was the most species-abundant genus in the 6th FAZ (8 species, of which only 2 species were sub-recedent). The species spectrum of *Carabus* receded at the higher altitudes (7th–8th FAZ) (Table 2). The overall increased dominance of the genus *Pterostichus* in the FAZ is accompanied by a significant increase in the abundance, i.e. from 3 species (3rd and 5th FAZ) to 6–7 species (6th–8th FAZ). *P. niger* and *P. oblongopunctatus* occupied a major position. The species abundance of the genus *Amara* in the 7th FAZ with 8 registered species is beyond any comparison (Table 2).

DISCUSSION

Characteristic of the investigated region of the eastern part of Krušné hory Mts. is a sudden, short and abrupt transition between the 3rd and 5th FAZ, where the 4th FAZ is such a small area that it is not demarcated within the forest management plan area. It can be assumed that the similarity between the 3rd and 4th FAZ is high, because ŠUSTEK (1976) also mentioned the link-up between the neighbouring FAZ. For typological use, however, the fauna has to be evaluated within the forest type complex and it is necessary to know to what extent the tree species and the stand conditions are able to modify the numerical and species composition. The Carabid coenosis responds to the changes of the FAZ more readily in the numeri-

Table 2. The species spectrum of ground beetles in birch stands of the particular FAZ (2003, method of ground traps)

Species/Forest altitudinal zone	3	5	6	7	8	Total
Abax parallelepipedus (Piller et Mitterpacher, 1783)	×	×	×			503
Abax parallelus (Duftschmid, 1812)	×					12
Amara aenea (De Geer, 1774)				×		1
Amara aulica (Panzer, 1797)				×		1
Amara communis (Panzer, 1797)	×	×	×	×	×	33
Amara convexior Stephens, 1828	×	×	×	×	×	26
Amara eurynota (Panzer, 1797)	×					1
Amara famelica Zimmermann, 1831				×		1
Amara familiaris (Duftschmid, 1812)				×		1
Amara lunicollis Schioedte, 1837				×	×	6
Amara similata (Gyllenhal, 1810)				×		1
Badister lacertosus Sturm, 1815	×					4
Bembidion biguttatum (Fabricius, 1779)				×		1
Bembidion guttula (Fabricius, 1792)				×	×	3
Bembidion lampros (Herbst, 1784)	×	×	×	×	×	25
Bembidion lunulatum (Fourcroy, 1785)					×	1
Bradycellus czikii Laczó, 1912				×		2
Calathus fuscipes (Goeze, 1777)	×					1
Calathus micropterus (Duftschmid, 1812)				×	×	3
Carabus arcensis arcensis Herbst, 1784		×	×	×		104
Carabus auronitens auronitens Fabricius, 1792		×	×	×	×	500
Carabus cancellatus cancellatus Illiger, 1798	×					1
Carabus convexus convexus Fabricius, 1775					×	1
Carabus coriaceus coriaceus Linnaeus, 1758	×	×	×	×		466
Carabus hortensis hortensis Linnaeus, 1758	×	×	×		×	837
Carabus intricatus intricatus Linnaeus, 1761			×			6
Carabus linnaei Panzer, 1810			×			11
Carabus nemoralis nemoralis O.F.Müller, 1764	×	×	×	×	×	415
Carabus problematicus gallicus Géhin, 1885			×			2
Carabus sylvestris sylvestris Panzer, 1796			×	×	×	122
Carabus violaceus violaceus Linnaeus, 1758		×	×	×	×	434
Cychrus caraboides (Linnaeus, 1758)	×	×	×	×	×	57
Demetrias monostigma Samouelle, 1819				×		1
Dromius fenestratus (Fabricius, 1794)		×				1
Dyschirius globosus (Herbst, 1784)				×		5
Epaphius secalis (Paykull, 1790)		×	×	×	×	145
Europhilus micans (Nicolai, 1822)					×	1
Harpalus latus (Linnaeus, 1758)	×		×	×	×	12
Harpalus luteicornis (Duftschmid, 1812)			×			1
Harpalus quadripunctatus Dejean, 1829	×		×			2
Harpalus rufipalpis Sturm, 1812			×			1
Leistus terminatus (Hellwig in Panter, 1793)				×		6
Loricera pilicornis (Fabricius, 1775)				×		5
Molops elatus (Fabricius, 1801)	×					2

Species/Forest altitudinal zone	3	5	6	7	8	Total
Nebria brevicollis (Fabricius, 1792)					×	1
Notiophilus aquaticus (Linnaeus, 1758)			×	×		3
Notiophilus biguttatus (Fabricius, 1779)			×	×	×	5
Notiophilus germynyi Fauvel in Grenier, 1863	×		×			3
Notiophilus palustris G.R.Waterhouse, 1833	×		×	×	×	23
Ophonus nitidulus Stephens, 1828			×			1
Poecilus versicolor (Sturm, 1824)	×		×	×	×	48
Pseudoophonus rufipes (De Geer, 1774)	×		×	×	×	7
Pterostichus aethiops (Panzer, 1797)			×	×	×	65
Pterostichus burmeisteri Heer, 1841		×	×	×		219
Pterostichus diligens (Sturm, 1824)				×	×	8
Pterostichus melanarius (Illiger, 1798)	×		×		×	30
Pterostichus niger (Schaller, 1783)	×	×	×	×	×	937
Pterostichus nigrita (Paykull, 1790)				×		1
Pterostichus oblongopunctatus (Fabricius, 1787)	×	×	×	×	×	206
Pterostichus strenuus (Panzer, 1797)			×	×	×	12
Syntomus truncatellus (Linnaeus, 1761)				×		1
Trechus quadristriatus (Schrank, 1781)				×		7
Trechus splendens Gemminger et Herold, 1868			×	×		5
Trichotichnus laevicollis (Duftschmid, 1812)	×	×	×	×		27
Total	1,313	487	1,565	1,310	698	5,373
Average number of specimens in stand	656.5	243.5	223.6	218.3	232.7	

Table 3. Sörensen's index (%)

	3	5	6	7	8
3		53.66	61.02	39.39	50.00
5			61.54	47.46	48.89
6				62.34	63.49
7					62.86
8					

Table 4. Renkonen's number (%)

	3	5	6	7	8
3		93.63	79.65	46.97	59.76
5			95.46	72.85	78.42
6				84.72	77.21
7					86.37
8					

cal composition of the individual species than by faunal diversion.

ŠUSTEK (2000) considered *Abax parallelepipedus* to be a species of the lowest FAZ (1st to 3rd). From the 6th FAZ it is not represented in the acid series A and only marginally in series B–D. A high dominance was discovered in the extreme ecological series of edaphic category Z and may be associated with the shallow and easy-to-dry substrate (LÖW et al. 1995), which corresponds to the dry hydric series. In such conditions ŠUSTEK (2000) classified it as a sub-recedent species. The abundance corresponded to the vertical incidence (PULPÁN 1971) (Table 6).

Characteristic of *Carabus auronitens* is its preference to higher altitudes (Table 6), especially at more humid sites corresponding to hydric series 4–6 (PLÍVA 1991). The captures of this species in birch stands confirm the results of ŠUSTEK (2000), i.e. from 3rd to 8th FAZ.

Carabus coriaceus appeared in birch stands from 3rd to 7th FAZ (Table 6). ŠUSTEK (2000) detected it in the 1st to 3rd FAZ, and in the 6th FAZ its incidence was only sub-recedent. A relatively high dominance was discovered in the 7th FAZ, even at more humid and shaded sites corresponding to the waterlogged hydric series where dominant incidence is mentioned only in the case of sites damaged by human activities (ŠUSTEK 2000).

Carabus hortensis preferred lower altitudes, especially the 3rd FAZ. With increasing altitude the abundance markedly dropped (Tables 5 and 6). These data are in accordance with data of ŠUSTEK (2000).

Carabus nemoralis appeared in lower altitudes (Table 6), in accordance with the conclusions of ŠUSTEK (2000).

Carabus sylvestris gave preference to higher altitudes (6–8 FAZ), the abundance increasing considerably with

Table 5. The ground beetles with dominance > 1% in the forest altitudinal zones

3rd FAZ	D	6th FAZ	D	7th FAZ	D
Carabus hortensis	35.80	*Carabus coriaceus*	14.25	*Pterostichus niger*	33.05
Carabus nemoralis	27.95	*Abax parallelepipedus*	12.97	*Carabus violaceus*	15.88
Abax parallelepipedus	18.74	*Carabus hortensis*	12.01	*Carabus coriaceus*	13.13
Pterostichus niger	6.70	*Pterostichus niger*	10.73	*Carabus auronitens*	11.91
Pterostichus oblongopunctatus	4.11	*Pterostichus burmeisteri*	10.16	*Epaphius secalis*	5.19
Pterostichus melanarius	1.83	*Carabus auronitens*	9.20	*Pterostichus burmeisteri*	4.50
Amara communis	1.07	*Carabus violaceus*	5.37	*Carabus arcensis*	2.37
5th FAZ	D	*Epaphius secalis*	4.79	*Pterostichus aethiops*	2.29
Carabus hortensis	32.85	*Carabus arcensis*	4.22	*Poecilus versicolor*	1.37
Carabus coriaceus	13.55	*Pterostichus oblongopunctatus*	3.71	*Bembidion lampros*	1.07
Pterostichus niger	12.32	*Carabus sylvestris*	3.26	*Carabus sylvestris*	1.07
Abax parallelepipedus	11.09	*Poecilus versicolor*	1.79	8th FAZ	D
Pterostichus oblongopunctatus	9.03	*Cychrus caraboides*	1.41	*Pterostichus niger*	26.93
Carabus nemoralis	6.57			*Carabus auronitens*	26.36
Carabus auronitens	3.29			*Carabus violaceus*	18.05
Carabus violaceus	3.29			*Carabus sylvestris*	8.17
Amara convexior	2.05			*Pterostichus oblongopunctatus*	5.87
Amara communis	1.64			*Pterostichus aethiops*	4.73
Carabus arcensis	1.44			*Carabus hortensis*	2.72
Cychrus caraboides	1.44			*Cychrus caraboides*	2.15

Table 6. Height dominance of the ground beetles

Species/Forest altitudinal zone	3	5	6	7	8
Abax parallelepipedus	68.72	15.08	16.20		
Amara communis	52.22	29.84	4.26	3.73	9.95
Amara convexior	43.66	43.66	2.49	1.46	8.73
Bembidion lampros	19.35	9.68	19.35	45.16	6.45
Carabus arcensis		19.34	52.11	28.55	
Carabus auronitens		6.90	17.75	22.43	52.92
Carabus coriaceus	2.60	34.37	33.18	29.85	
Carabus hortensis	67.49	22.98	7.71		1.82
Carabus nemoralis	90.59	7.90	0.78	0.08	0.66
Carabus sylvestris			25.46	8.15	66.39
Carabus violaceus		8.28	12.41	35.86	43.45
Cychrus caraboides	6.91	24.18	21.71	12.66	34.54
Epaphius secalis		2.19	46.83	49.53	1.46
Poecilus versicolor	6.38		51.06	38.30	4.26
Pterostichus aethiops			1.75	30.70	67.54
Pterostichus burmeisteri		1.51	68.73	29.76	
Pterostichus melanarius	91.97		5.47		2.55
Pterostichus niger	18.90	12.88	10.31	30.99	26.91
Pterostichus oblongopunctatus	37.27	30.36	11.44	2.07	18.86

increasing altitude (Table 6). The data correspond with ŠUSTEK (2000).

ŠUSTEK (2000) found *Carabus violaceus* primarily in the 4th and 5th FAZ, the abundance decreasing in the 6th and 7th FAZ, i.e. its upper boundary. In the Krušné hory Mts. it populated higher altitudes and with increasing altitude its abundance grew linearly and was the highest in the 8th FAZ, particularly in humid localities of the 4th to 6th hydric series. Likewise the species *C. auronitens* and *C. coriaceus*; according to ŠUSTEK (2000) they occur only at sites damaged by human activities.

Epaphius secalis was monitored in the 5th to 8th FAZ; 96.36% of all the captured specimens were found in the 6th and 7th FAZ (Table 6). The data of PULPÁN (1971), who discovered the maximal abundance at 500–800 m altitudes, the abundance declining towards the lower and also higher altitudes, were confirmed.

Pterostichus burmeisteri was captured in the 5th to 7th FAZ, culminating in the 6th FAZ (Table 6). ŠUSTEK (2000) shifted the maximal abundance to the 4th and 5th FAZ. PULPÁN (1971) specified the maximal abundance at an altitude of 500–800 m, but admitted that it could ascend to an altitude of 800–1,200 m.

The species *Pterostichus niger* was captured in the entire profile of the FAZ in birch stands of the eastern Krušné hory Mts. ŠUSTEK (2000) monitored this species in the 1st to 5th FAZ, its abundance decreasing with higher altitudes. In the monitored area the abundance decreased continuously from the 3rd–6th FAZ, but in the 7th and 8th (or more precisely 6th and 7th) FAZ it increased relatively sharply. We can explain this discrepancy by the fact that this species was detected particularly at humid sites of the 4th to 5th hydric series it prefers (ŠUSTEK 2000), so favourable conditions for its existence can be formed also in FAZ lying at higher altitudes. PULPÁN (1971) indicates that the centre of abundance of this species is an altitude of 300–500 m (1st, 2nd and 3rd FAZ), the abundance decreasing, and with a potential abundance up to 900–1,200 m (7th and 8th FAZ).

Much like the previous species also *Pterostichus oblongopunctatus* appeared in all FAZ. According to ŠUSTEK (2000) it should not occur in the 7th FAZ (Table 6) or only sporadically and irregularly. On the other hand, its presence in the 8th FAZ and at humid sites of the 4th to 6th hydric series may point to its ability to penetrate to higher FAZ within these series. PULPÁN (1971) claims that it is most abundant at an altitude of 300–500 m (ca. 2nd and 3rd FAZ), but in Bohemia it may appear at altitudes up to 1,200 m.

CONCLUSION

In 2003, 5,373 specimens of 64 species of the family *Carabidae* were captured in 20 localities of birch stands of the eastern Krušné hory Mts. classified in 5 forest altitudinal zones.

1. The faunal similarity of *Carabidae* monitored in successive forest altitudinal zones was confirmed using Sörensen's index and Renkonen's number. The Carabid fauna was differentiated in the particular FAZ by the number of species and captured specimens. The fauna of the 7th and 6th FAZ was the most abundant. The reduced dominance of species of the genus *Carabus* in FAZ of higher altitudes was substituted by species of the genus *Pterostichus*.
2. Counter to present information the following species move up to higher altitudes: *Carabus coriaceus* (7th FAZ), *Carabus violaceus* (8th FAZ), *Pterostichus niger* (6th to 8th FAZ), *Pterostichus oblongopunctatus* (8th FAZ), which are humid sites of the 4th to 6th hydric series damaged by human activities.

After evaluations in the forest altitudinal zones, the ground beetles may become an important additional component of the geobiocoenological system and could be used for descriptions of the group types of the geobiocoenosis.

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Střevlíkovití (*Coleoptera: Carabidae*) lesních vegetačních stupňů východního Krušnohoří

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ABSTRAKT: V pěti lesních vegetačních stupních (3., 5.–8.) byla u střevlíkovitých (*Carabidae*) potvrzena druhová a početní diferencovanost užitím Sörensenova indexu a Renkonenova čísla i faunistická podobnost navazujících lesních vegetačních stupňů. U některých druhů (*Carabus coriaceus*, *Carabus violaceus*, *Pterostichus niger*, *Pterostichus oblongopunctatus*) bylo zjištěno výrazné pronikání do vyšších poloh, než je známo z dosud zveřejněných poznatků. Studie přispívá k potenciálnímu využití střevlíkovitých jako doplňkové složky geobiocenologického typologického systému.

Klíčová slova: střevlíkovití; *Carabidae*; lesní vegetační stupeň; Krušné hory

Pro studium střevlíkovitých v lesních vegetačních stupních (lvs) východního Krušnohoří bylo vybráno 20 březových porostů zastupujících pět lesních vegetačních stupňů (tab. 1), ve kterých bylo v r. 2003 zachyceno 5 373 jedinců 64 druhů střevlíkovitých (tab. 2).

Z celkového odchytu byl zjištěn zřetelný rozdíl v abundanci mezi 3. lvs a 5.–8. lvs (tab. 2) a diference v počtu druhů (nejbohatší byl 7. lvs – 42 druhů). Sörensenův index a Renkonenovo číslo poukázaly na relativně vysokou úroveň faunistické podobnosti na sebe navazujících lvs (tab. 3 a 4).

V charakteristice jednotlivých lvs se projevil význam dominantních a recedentních druhů. Bylo zjištěno, že druhové spektrum eudominantních až recedentních druhů bylo poměrně stabilní, na rozdíl od hodnot dominance jednotlivých druhů, kde se měnil jejich poměr tím více, čím vzdálenější byly od sebe jednotlivé lvs (tab. 5). Rod *Carabus* měl výsadní postavení ve 3. a 5. lvs, kde se na

jeho celkové dominanci podílely druhy *C. hortensis* a *C. nemoralis*. Ve vyšších lvs se celková dominance rodu *Carabus* snižovala a naopak se zvyšovala celková dominance rodu *Pterostichus*, který jej nahrazoval. Mezi významné se řadí i rod *Abax* s eudominantním postavením (3., 5.–6. lvs, v 7.–8. lvs chyběl).

Ve sledovaném území východního Krušnohoří byl – oproti dosud známým údajům – zaznamenán významný výskyt ve vyšších polohách u *Carabus violaceus*, *Carabus coriaceus*, *Pterostichus niger* a *Pterostichus oblongopunctatus* (tab. 6).

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