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GROUND BEETLES (*COLEOPTERA*, *CARABIDAE*) AGROCENOSES OF SPRING AND WINTER WHEAT

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Abstract

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On two monitoring areas of the Central Institute for Supervising and Testing in Agriculture (ÚKZÚZ) loaded with risk elements we carried out investigations of beetles of the family *Carabidae* (*Coleoptera*) in agricultural stands of winter and spring wheat. The focus of the present study is on synecological characteristics and in some extent on the impact of agricultural practise on the population and seasonal dynamics of the most important representatives of ground beetles. This paper precedes the following article aimed to contents of heavy metals in ground beetles.

ground beetles, *Carabidae*, agrocenoses, bioindication, winter wheat, spring wheat, *Triticum aestivum* L.

Ground beetles (*Coleoptera*, *Carabidae*) are used for bioindication of conditions of the environment and degree of landscape disturbance (Martiš, 1980), impact of emission (Lesniak, 1980; Novák, 1988) and recreation (Gryuntal, 1991).

On the basis of bioindication characteristics of the respective species of ground beetles their population can be used to estimate the originality or degree of disturbance of the locality (Hůrka et al., 1996; Nenadál, 1998). Kula et al. (2002), Purchart, Kula (2004), Krejčová et al. (2000) and Šťastná, Bezděk (2002a, 2003) applied this information in forest, meadow and field ecosystems.

The only objective of the present study is to present the faunistic results of investigations of ground beetles (*Carabidae*, *Coleoptera*) in field biotopes and applying synecological characteristics to evaluate the state of carabidocenoses and in some extent the degree of agricultural disturbance of the studied agrocenoses. Contents of heavy metals in ground beetles will be dealt with in another paper.

METHODS

In field biotopes of monitoring areas of the Central Institute for Supervising and Testing in Agriculture (ÚKZÚZ) 25 formalin (2–4% solution) ground traps (4 l volume) placed in a row 10m apart were installed in 2001 (Zlín-Tečovice) and 2003 (Brno-Chrlice). Traps were installed 1st May; they remained active throughout the vegetation period (1 May–5 November) and were collected in six-week intervals (Chrlice \ Tečovice – 10 \ 15 June, 15 \ 19 July, 2 \ 7 September and 5 \ 1 November).

The trapped soil fauna was fixed in 75% ethanol. Ground beetles determined junior author and are deposited at Department of Wood Ecology. The nomenclature of ground beetles is used in accordance with Hůrka (1996).

The synecological characteristics include: species spectrum, dominance (Schwerdtfeger, 1975), Shannon-Weaver's index of species diversity (Shannon, Weaver, 1963), equitability (Sheldon, 1969) and index of the community of the ground beetles (IKS)

(Nenadál, 1998). The trapped ground beetle species were divided into ecological groups (A-adaptable, E-eurotopic and R-relict) (Hůrka et al., 1996).

Characteristics of the localities

Tečovice (Zlín) – altitude 195 m

Warm climate district, moderately humid (T3), average annual temperature 7.5 °C and annual sum of precipitation 650 mm. Sugar-beet production region, flat relief, arable land (fluvisol, clay-loam heavy soil). It is a cultivated field with winter wheat (*Triticum aestivum* L.) and full coverage degree (2001) (ÚKZÚZ, written information).

Chrlice (Brno) – altitude 190 m

Warm climate district, moderately dry (T2), average annual temperature 9.9 °C and annual sum of precipitation 509 mm. Sugar-beet production region, flat relief and arable land (fluvisol, clay-loam medium heavy soil). It is a cultivated field with spring wheat (*T. aestivum*) and high stand density (2003) (ÚKZÚZ, written information).

RESULTS AND DISCUSSION

In 2001 on the monitoring area Tečovice 4793 specimens of the family *Carabidae* belonging to 45 species were trapped (Tab. I). In 2003 in Chrlice we monitored 10456 specimens of 31 species of ground beetles (Tab. II). Šťastná and Bezděk (2002b) monitored a similar great difference in the total number of specimens between fields with spring wheat (*T. aestivum*) and with winter wheat. In our case is difference due to the very high abundance of *Anchomenus dorsalis* in Chrlice (Tab. II), which probably had optimal conditions (see text below).

According to Petřvalský (1986) values of Shannon-Weaver's index of species diversity higher than 1.9 indicate a relatively balanced distribution of the populations of ground beetles, at the same time indicating that the populations are not much affected by exogenous factors (e.g. anthropogenic factors). The estimated value of the index of species diversity in Tečovice (1.63) and in Chrlice (1.42) is low and demonstrates an irregular distribution of the specimens into the respective species. Also the very low value of equitability both in Tečovice (0.43) and Chrlice (0.41) confirmed this fact.

Dominance explains and confirms the values of equitability. The ground beetle community in Tečovice consisted of 3 eudominant (*Poecilus cupreus* – 47.19%, *Pterostichus melanarius* – 28.02%, *Pseudoophonus rufipes* – 10.39%) and one subdominant species (*Anchomenus dorsalis* – 3.42%). The other species are recedent (3) and 38 species are subrecedent (Tab. I).

Among the ground beetle fauna in Chrlice we found 2 eudominant (*A. dorsalis* – 59.22% and *P. rufipes* – 17.87%), one dominant (*Calathus erratus* – 8%) and 4 subdominant species (*Harpalus affinis* – 3.95%, *Calathus fuscipes* – 2.96%, *P. melanarius* – 2.38% and *P. cupreus* – 2.35%). The remaining 24 species belong to the group of subrecedent species (Tab. II).

A. dorsalis, *P. melanarius*, *P. cupreus* and *P. rufipes* are typical species and in most cases a permanent dominant component of the species spectrum of agricultural cultures. Depending on conditions of the site and geographical position of the locality they are accompanied by species, which can become dominant, e.g. *Calathus fuscipes*, *C. erratus*, *Carabus scheidleri*, *Harpalus affinis* and *Bembidion lampros* (Šťastná, Bezděk, 2002b, 2003; Krejčová et al., 2000; Petruška, 1967, 1971, 1986, 1987, 1988; Skuhravý, 1958) analogous to Chrlice.

In terms of the representation of ground beetle species in ecological groups (Hůrka et al., 1996) in Tečovice representatives of all ecological groups were present (A – 35.56%; E – 62.22%; R – 2.22%) (Tab. I); while in Chrlice the relict species were absent (A – 25.81%; E – 74.19%) (Tab. II). The incidence of only one specimen of relict macropteric species *Pterostichus guentheri* in Tečovice was accidental and did not affect the evaluation of the locality. The high proportion of eurytopic species in both cases shows a considerable influence of anthropogenic (agricultural) activities on the ground beetle fauna, indicating the high degree of disturbance of the site.

These findings are in accordance with the index of the community of ground beetles (IKS); the values of 2.5 (Tečovice) and 4.2 (Chrlice) clearly show that in both cases they are typical communities on habitats under heavy anthropogenic (agricultural) influence (Nenadál, 1998).

Seasonal dynamics of the dominant species

Anchomenus dorsalis

This is a spring species (Petruška, 1971, 1986; Skuhravý, 1958), which considerably differes in terms of abundance and seasonal dynamics of the populations. While in Tečovice only 165 specimens were trapped (3.42%) (Tab. I), in Chrlice it was a eudominant species (6192 specimens, 59.22%) (Tab. II). Differences in the total numbers of specimens in these biotopes are consistent with data of Skuhravý (1958) and Petruška (1971) who also monitored different abundance in the course of several years of studies of ground beetles in the field biotope with the same crop. The differences in the abundance on these localities could be associated with the soil type because according to Lohs (1953) this species prefers lighter cultivated soils (Chrlice) and avoids heavier soils (Tečovice).

The seasonal dynamics of the species were different. In Tečovice after spring culmination (May – June) the abundance in summer considerably decreased and in the autumn collection the species did not appear at all (Tab. I). Petruška (1971) reported similar dynamics of ground beetles in barley fields. In Chrlice two abundance peaks were monitored; the first in spring followed by a decline in early summer. The second, and considerably higher, peak appeared in summer and declined in autumn. According to Skuhravý (1959) it is possible that spring culmination corresponds with the feeding of adults after wintering and the first copulation of part of the population, which is followed by a lower activity. Summer culmination takes place with copulation of the major part of adults of the same population followed by a decline in abundance. Similar behaviour was also monitored in sugar-beet fields (Petruška, 1971) where the insects were most active in summer to late summer.

Poecilus cupreus

This is a spring species (Petruška, 1967, 1971) with similar seasonal dynamics on both localities (Tab. I, II) in accordance with the data of Petruška (1967). Abundance was highest in spring months when the wintering imagoes reproduced (May–June), then the abundance gradually decreased due to imago mortality. Specimens of the new generation appeared in autumn (Tab. I). According to Skuhravý (1958) the high spring abundance is influenced by the low mortality of imagoes during spring agricultural practice. Differences in the abundance were contrary to the previous species. In Tečovice *P. cupreus* was the eudominant species (2262 specimens; 47.19%), while in Chrlice it was a subdominant species (246 specimens; 2.35%). Since the effect of agricultural measures on the population of the species is minimal (Petruška, 1967; Skuhravý, 1958), explanations of the differences in abundance cannot be based on this datum. In Tečovice we confirm Heydemann's (1955) finding that *P. cupreus* is a quantitative indicator of heavy soils growing winter cereals.

Pseudoophonus rufipes

This is a species, which reproduces in autumn (Petruška, 1974; Skuhravý, 1958). The seasonal dynamics is the same on both localities. Although the abundance was different (Tečovice 498 specimens, Chrlice 1868 specimens), the species was eudominant on both localities (Tečovice – 10.39%; Chrlice – 17.87%) (Tab. I, II). Petruška (1974) pointed out the existence of two peaks, while Skuhravý (1958) admits one and two-peak seasonal dynamics. On the explored localities however only one culmination was monitored. In spring and early summer the activity of imagoes was low, in summer the abundance of adults culminated and in autumn the activity rapidly declined (Tab. I, II). This finding corresponds with Petruška (1967, 1971). Populations in fields with winter cereals where no agricultural measures are carried out from autumn and where the new generation can develop have two culmination peaks. In the Chrlice locality a one-peak course was monitored, partly shifting into a later period than in Tečovice, corresponding with the gradual hatching of beetles from June (Skuhravý, 1958). The one-month difference in the coming of imagoes in Chrlice (Tab. I, II) was caused by soil tillage (Petruška, 1971).

Pterostichus melanarius

This is an autumn species (Petruška, 1974; Skuhravý, 1958). Analogous to *P. cupreus* it was a eudominant species in Tečovice with 1343 specimens (28.02%), while only 249 specimens (2.38%) were trapped in Chrlice.

In Chrlice (Tab. II) its activity was consistent with the well-known seasonal dynamics of the species (Petruška, 1974) when early June is the period of the first increased activity of wintering adults, which then gradually die. The incoming new generation gradually increases its activity, which is maximal in August and then abruptly declines. In Tečovice we see an earlier appearance of adults (Tab. I) than in Chrlice (Tab. II). In winter wheat stands no agricultural methods are applied (Tečovice) in spring so the pupae, which are the most sensitive developmental stage of the species, do not die, in contrast to fields tilled for spring sowing of wheat (Chrlice). According to Skuhravý (1958) the maximal abundance of adults on such areas takes place later, usually not until August when specimens migrating from surrounding areas complete the numbers.

SUMMARY

On monitoring areas in Tečovice and Chrlice we trapped 4793 (45 species) and 10456 specimens (31 species), respectively. Difference in numerousness between localities is caused by very high abundance of *Anchomenus dorsalis*. Anthropogenic disturbance of the localities shows the proportion of ecological groups of ground beetles, the community index (2.5 / 4.2). The index of species diversity 1.63 / 1.42; equitability 0.43 / 0.41; and IKS 2.5 / 4.2 characterises the localities Tečovice / Chrlice, respectively. On

both localities the dominant species were *Poecilus cupreus*, *Pterostichus melanarius*, *Pseudoophonus rufipes* and *Anchomenus dorsalis*. In the locality with spring wheat (Chrlice) the species *Calathus erratus*, *C. fuscipes* and *Harpalus affinis* were also important. In general the eurytopic species predominate over the adaptable ones. In spite of partial difference the seasonal dynamics of the most important representatives of *Poecilus cupreus*, *Pterostichus melanarius*, *Pseudoophonus rufipes* and *Anchomenus dorsalis* confirm the hitherto findings. *A. dorsalis* preferred lighter soils (Chrlice) on the one hand and *P. cupreus* indicated heavy soils (Tečovice) on the other.

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I: *Species spectrum, dominance (%) and ecological groups of ground beetles (Tečovice)*

Species	ec.	15. 6. 2001		19. 7. 2001		7. 9. 2001		1. 11. 2001		Total	
	gr.	N	D	N	D	N	D	N	D	N	D
Amara consularis (Duftschmid, 1812)	E			1	0.08					1	0.02
Amara convexior Stephens, 1828	E							2	0.69	2	0.04
Amara convexiuscula (Marsham, 1802	E			3	0.23	1	0.11			4	0.08
Anchomenus dorsalis (Pontoppidan, 1763)	E	82	3.53	64	4.96	18	2.02			164	3.42
Anisodactylus signatus (Panzer, 1797)	E					31	3.49			31	0.65
Bembidion lampros (Herbst, 1784)	E	1	0.04							1	0.02
Brachinus crepitans (Linnaeus, 1758)	E	8	0.34	17	1.32	1	0.11	2	0.69	28	0.58
Brachinus explodens Duftschmid, 1812	E			1	0.08	8	0.90			9	0.19
Calathus fuscipes (Goeze, 1777)	E			4	0.31	27	3.04	11	3.82	42	0.88
Carabus coriaceus Linnaeus, 1758	A	1	0.04	1	0.08					2	0.04
Carabus granulatus Linnaeus, 1758	E	14	0.60	8	0.62	13	1.46	3	1.04	38	0.79
Carabus scheidleri Panzer, 1799	A			1	0.08	1	0.11			2	0.04
Carabus violaceus Linnaeus, 1758	A			4	0.31	1	0.11			5	0.10
Clivina collaris (Herbst, 1784)	E	4	0.17	4	0.31					8	0.17
Clivina fossor (Linnaeus, 1758)	E	15	0.64	19	1.47	1	0.11			35	0.73
Demetrias atricapillus (Linnaeus, 1758)	E	3	0.13							3	0.06
Drypta dentata (Rossi, 1790)	E			1	0.08			5	1.74	6	0.13
Harpalus affinis (Schrank, 1781)	E	2	0.09	3	0.23					5	0.10
Harpalus caspius roubali Schauberger, 1928	A	32	1.38	29	2.25					61	1.27
Harpalus distinguendus (Duftschmid, 1812)	E					1	0.11	1	0.35	2	0.04
Harpalus marginellus Dejean, 1829	A			6	0.47					6	0.13
Harpalus tardus (Panzer, 1797)	E			2	0.16					2	0.04
*Chlaenius spoliatu*s (Rossi, 1790)	A	1	0.04							1	0.02
Leistus ferrugineus (Linnaeus, 1758)	E					1	0.11	15	5.21	16	0.33
Lionychus quadrillum (Duftschmid, 1812)	A			1	0.08					1	0.02
Loricera pilicornis (Fabricius, 1775)	E	1	0.04	7	0.54					8	0.17
Nebria brevicollis (Fabricius, 1792)	A							1	0.35	1	0.02
Notiophilus palustris (Duftschmid, 1812)	E	1	0.04							1	0.02
Ophonus azureus (Fabricius, 1775)	E					1	0.11			1	0.02
*Ophonus puncticolli*s (Paykull, 1798)	A			1	0.08					1	0.02
Oxypselaphus obscurus (Herbst, 1784)	A			1	0.08					1	0.02
Platynus assimilis (Paykull, 1790)	A	1	0.04	3	0.23					4	0.08
Poecilus cupreus (Linnaeus, 1758)	E	1898	81.60	359	27.83			5	1.74	2262	47.19
Poecilus versicolor (Sturm, 1824)	E	2	0.09			25	2.81			27	0.56
Pseudoophonus rufipes (De Geer, 1774)	E	68	2.92	142	11.01	195	21.93	93	32.29	498	10.39
Pterostichus diligens (Sturm, 1824)	A	72	3.10							72	1.50
Pterostichus guentheri (Sturm, 1824)	R					1	0.11			1	0.02
Pterostichus macer (Marsham, 1802)	A			2	0.16					2	0.04
Pterostichus melanarius (Illiger, 1798)	E	49	2.11	594	46.05	551	61.98	149	51.74	1343	28.02
Pterostichus niger (Schaller, 1783)	A	47	2.02	2	0.16	10	1.12			59	1.23
Pterostichus nigrita (Paykull, 1790)	E			1	0.08					1	0.02
Pterostichus oblongopunctatus (Fabricius, 1787)	A	1	0.04	1	0.08					2	0.04
Pterostichus strenuus (Panzer, 1797)	E	13	0.56			1	0.11			14	0.29
Stomis pumicatus (Panzer, 1796)	A	10	0.43	7	0.54			1	0.35	18	0.38
Trechus quadristriatus (Schrank, 1781)	E			1	0.08	1	0.11			2	0.04
Total		2326	100	1290	100	889	100	288	100	4793	100

N – number of collected specimens
D – dominance (%)

II: *Species spectrum, dominance (%) and ecological groups of ground beetles (Chrlice)*

Species	ec. gr.	10. 6. 2003		15. 7. 2003		2. 9. 2003		5. 11. 2003		Total	
		N	D	N	D	N	D	N	D	N	D
Amara littorea C.G.Thompson, 1857	E			1	0.27					1	0.01
Amara similata (Gyllenhal, 1810)	E	32	4.44	2	0.53	1	0.02			35	0.33
Anchomenus dorsalis (Pontoppidan, 1763)	E	362	50.28	110	29.18	3085	53.01	2635	74.46	6192	59.22
Badister bullatus (Schrank, 1798)	A			1	0.27					1	0.01
Bembidion lampros (Herbst, 1784)	E	10	1.39	2	0.53					12	0.11
Brachinus crepitans (Linnaeus, 1758)	E	2	0.28							2	0.02
Brachinus explodens Duftschmid, 1812	E	13	1.81			8	0.14	3	0.08	24	0.23
Calathus erratus (C.R.Sahlberg, 1827)	A	4	0.56			298	5.12	535	15.12	837	8.00
Calathus fuscipes (Goeze, 1777)	E					167	2.87	142	4.01	309	2.96
Calathus melanocephalus (Linnaeus, 1758)	E					2	0.03			2	0.02
Calosoma auropunctatum (Herbst, 1784)	A			11	2.92	45	0.77			56	0.54
Cicindela germanica Linnaeus, 1758	A			1	0.27	1	0.02			2	0.02
Harpalus affinis (Schrank, 1781)	E	53	7.36	158	41.91	193	3.32	9	0.25	413	3.95
Harpalus distinguendus (Duftschmid, 1812)	E	8	1.11	1	0.27	5	0.09	5	0.14	19	0.18
Harpalus signaticornis (Duftschmid, 1812)	E	2	0.28							2	0.02
Leistus ferrugineus (Linnaeus, 1758)	E					9	0.15	27	0.76	36	0.34
Microlestes minutulus (Goeze, 1777)	E	5	0.69	3	0.80	6	0.10			14	0.13
Notiophilus palustris (Duftschmid, 1812)	E	1	0.14							1	0.01
Notiophilus pusillus G.R.Waterhouse, 1833	E							4	0.11	4	0.04
Ophonus azureus (Fabricius, 1775)	E					1	0.02			1	0.01
Platynus assimilis (Paykull, 1790)	A					1	0.02			1	0.01
Poecilus cupreus (Linnaeus, 1758)	E	173	24.03	44	11.67	26	0.45	3	0.08	246	2.35
Poecilus virens (O.F.Müller, 1776)	A	1	0.14	1	0.27					2	0.02
Pseudoophonus calceatus (Duftschmid, 1812)	A					1	0.02			1	0.01
Pseudoophonus griseus (Panzer, 1797)	E					37	0.64			37	0.35
Pseudoophonus rufipes (De Geer, 1774)	E	33	4.58	32	8.49	1776	30.52	27	0.76	1868	17.87
Pterostichus macer (Marsham, 1802)	A			1	0.27	1	0.02			2	0.02
Pterostichus melanarius (Illiger, 1798)	E	18	2.50	9	2.39	143	2.46	79	2.23	249	2.38
Synuchus vivalis (Illiger, 1798)	E					3	0.05	1	0.03	4	0.04
Trechus quadristriatus (Schrank, 1781)	E	3	0.42			6	0.10	58	1.64	67	0.64
Zabrus tenebrioides (Goeze, 1777)	E					5	0.09	11	0.31	16	0.15
Total		720	100	377	100	5820	100	3539	100	10456	100

N – number of collected specimens
D – dominance (%)

SOUHRN

Střevlíkovití (*Coleoptera*, *Carabidae*) agrocenóz pšenice jarní a ozimé

Předkládaná práce prezentuje výsledky faunistického výzkumu střevlíkovitých agrocenóz pšenice jarní a ozimé na dvou monitorovacích plochách Ústředního kontrolního a zkušebního ústavu zemědělského (ÚKZÚZ) s cílem zhodnotit za pomoci synekologických charakteristik stav carabidocenóz zkoumaných zemědělských ploch.

Metodou formalínových zemních pastí bylo zachyceno (Zlín-Tečovice) 4793 jedinců (45 druhů) a (Brno-Chrlice) 10 456 jedinců (31 druhů). Rozdíly v početnosti mezi lokalitami jsou způsobeny vysokou abundancí *Anchomenus dorsalis*. Antropogenní narušení stanovišť udává podíl ekologických skupin střevlíkovitých, index komunity (2,5 / 4,2). Lokality Tečovice / Chrlice charakterizuje index druhové

diverzity 1,63 / 1,42; ekvitabilita 0,43 / 0,41; IKS 2,5 / 4,2. V obou lokalitách se k dominantním druhům řadily *Poecilus cupreus*, *Pterostichus melanarius*, *Pseudoophonus rufipes* a *Anchomenus dorsalis*. V lokalitě s pšenicí jarní (Chrlice) zaznamenaly významnější postavení i druhy *Calathus erratus*, *C. fuscipes* a *Harpalus affinis*. Obecně převažují druhy eurytopní nad adaptabilními. Sezonní dynamika nejvýznamnějších zástupců *Poecilus cupreus*, *Pterostichus melanarius*, *Pseudoophonus rufipes* a *Anchomenus dorsalis* přes dílčí rozdíly potvrzuje dosavadní poznatky. *A. dorsalis* preferoval lehčí půdy (Chrlice), zatímco *P. cupreus* indikoval těžké půdy (Tečovice).

střevlíkovití, *Carabidae*, agrocenózy, bioindikace, pšenice ozimá, pšenice jarní, *Triticum aestivum* L.

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