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Influence of selected soil properties on the structures of beetle assemblages in the southern part of the Kraków-Częstochowa Upland

Wpływ wybranych cech gleby na strukturę zgrupowań chrząszczy w południowej części Wyżyny Krakowsko-Częstochowskiej

Abstrakt: W niniejszej pracy analizowano związki pomiędzy wybranymi cechami gleb, jak typ i podtyp gleby oraz rodzaj materii w poziomach ektohumusowych a zgrupowaniami chrząszczy (rodziny *Curculionidae* i *Carabidae*). Trzyletnie badania terenowe i późniejsza analiza statystyczna wykazała istnienie wpływu tych cech pokrywy glebowej na parametry zgrupowań obydwu grup chrząszczy. Nie jest to wpływ silny, gdyż zastosowana analiza regresji krokowej wstecznej wykazała istotną statystycznie korelację przy poziomie istotności około 20%. Na rozmieszczenie ryjkowcowatych wpływ mają typ i podtyp gleby, który decyduje o bogactwie gatunkowym zgrupowań, a także rodzaj ektohumusu (określa wskaźniki różnorodności Simpsona, Bergera-Parkera i McIntosha). U biegaczowatych dominujący wpływ posiada typ i podtyp gleby, który wpływa na równomierność rozkładu poszczególnych gatunków w zgrupowaniach i decyduje o wartościach indeksów różnorodności (wskaźniki Simpsona, Bergera-Parkera i McIntosha). Stanowi to wynik prawdopodobnie kilku nakładających się na siebie przyczyn. Po pierwsze, profil glebowy może decydować u wielu gatunków o sukcesie rozrodczym. W bardziej miąższym profilu istnieje większa dostępność pokarmu wypływająca z większej „pojemności środowiska", czyli egzystencji liczniejszej grupy organizmów będących pożywieniem dla drapieżnych biegaczowatych. Ponadto bardziej rozwinięty profil glebowy zwiększa zakres reakcji zamieszkującej ją fauny na niekorzystne zmiany fizykochemiczne w jej obrębie, np. na niesprzyjające dla larw owadów przesuszenie czy przemarznięcie gleby. Drugą przyczyną jest reagowanie przez gatunki chrząszczy na właściwości fizykochemiczne wyższych poziomów glebowych, a trzecią typ użytkowania ziemi.

Key words: soil, Carabid beetles, weevils, Kraków-Częstochowa Upland

Słowa kluczowe: gleba, biegaczowate, ryjkowcowate, Wyżyna Krakowsko-Częstochowska

Introduction

The animal world is an integral part of the natural environment system, i.e. according to A. Richling (1992) a system of mutually connected and mutually influencing elements of nature. Yet in the structure of the environment the role of particular constituents is not the same. When one takes a given pair of components, one of them usually plays a leading role, while the other is led. A. Richling (1992) emphasises, however, that the component being led also influences the leading one. The issue is important in so far as virtually all existing conceptions of ordering the environment elements place the animal world in the last section of the hierarchical ladder, as the one being the most susceptible to the influence of the others (Sołncew 1965, Armand 1980, Milkow 1981). Hence a conclusion can be drawn, that animals are influenced by virtually all elements of the natural environment, both through direct interactions (fig. 1A) as well as indirect ones (fig. 1B).

Soil constitutes the environment of development and life of an enormous quantity of organisms, including insects, and the organisms themselves also play an important role in the course of soil-forming processes. They influence the formation of a specific soil structure, shape its physical properties, enhance the circulation of elements, as well as control the course of many biochemical processes, which lead to the decomposition of organic matter and the origin of humus (Brady, Weil 1999, Singer 2002). In the case of beetles, most of them make use of only the top soil horizons, where they actively move, seek refuge (digging small burrows), get food or lay eggs.

Over recent years, a number of papers concerning mutual connections between the environment features and the distribution of beetles have been published. However, most of them deal, first of all, with the influence of various agricultural operations within soil (e.g. ploughing) on the abundance and diversity of insect assemblages. Such studies concerning the group of Carabid

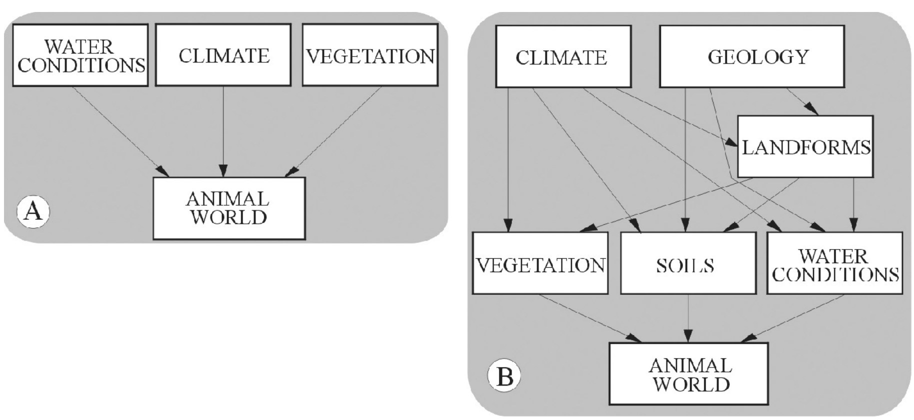

Fig. 1. Hierarchical models of connections between the natural environment components (A, B) (after: Maciejowski 2004)

Ryc. 1. Hierarchiczne modele powiązań pomiędzy elementami środowiska przyrodniczego (A, B) (Źródło: Maciejowski 2004) beetles were carried out by, among others: B.R. Stassart et al. (1983), T. Hance, C. Grégoire-Wibo (1987), T. Hance et al. (1990) or M. Baguette, T. Hance (1997). An interesting experiment was carried out by a team of researchers (Fadl et al. 1996), who investigated changes in the population of a Carabid beetles *Pterostichus melanarius* under the influence of agricultural operations over the vegetation season.

There are, in fact, only a few papers that describe relationships between the occurrence of insects and soil properties. One of the first was the work by W.W. Dowdy (1944), who proved the influence of temperature on vertical migrations of soil vertebrates in various types of soil. The relationships between the properties of ectohumus horizons and the occurrence of various groups of soil fauna (including insects) in southern Poland have recently been investigated by M. Drewnik et al. (1999), W. Maciejowski (2000) and T. Skalski et al. (2003). Those studies did not show any close relations, though. What was proven was a clear dependence of insects' abundance on the kind of ectohumus and its thickness, as well as a significant influence of soil reaction in upper soil horizons on the abundance of some species.

Aim and methods

The aim of the presented study was an attempt to investigate the influence of selected soil features on the structures of beetle assemblages. Taking into consideration the exceptional diversity of that group of animals, the study was focused on weevils (*Nemonychidae, Rhynchitidae, Attelabidae, Apionidae, Dryophthoridae, Erirhinidae, Curculionidae*) and Carabid beetles (*Carabidae*), as those families occur widely and are well studied in Poland. The research was based on the assumption that the thicker the ectohumus horizons, the greater the number of beetles, and that there might exist dependencies between beetle assemblages characteristics and various soil types. Those theses were put forward on the basis of earlier studies by the authors either dealing with beetle assemblages but conducted in the mountains (Skalski et al. 2003), or concerning the composition of mesofauna in humus horizons of mountain soils in the Bieszczady Mountains (Drewnik et al. 1999, Maciejowski 2000) as well as the example of the May beetle (*Melolontha melolontha*), which needs a soil profile at least 40-50cm thick to overwinter and pupate (Janssens 1960, Stebnicka 1978).

The field work, consisting of collecting individuals belonging to the two beetle groups at sites with different soil cover features, was carried out at 30 sites in the southern part of the Kraków-Częstochowa Upland from 2001 to 2003. During the field work a set of methods of physical geography was used, including the method of physicogeographical mapping (Czeppe, German 1978). Soil mapping was carried out using procedures commonly used in soil survey (Skiba et al. 2000, Singer 2002); soil units (types and subtypes) mapped and used for statistical analyses were distinguished according to the current Polish classification (*Systematyka gleb Polski* 1989) and international names of soil units were given using the World Reference Base system (WRB 1998). Entomological methods used to collect beetles comprised pitfall traps (Greenslade 1964, Thiele 1977) and sweepnet collection (Karpiński 1958, Duelli i in. 1999).

The obtained material was identified using the key by K. Hurka (1996) and was subject to statistical analysis. For the description of dependencies between soil features (soil type and subtype, kind of ectohumus) and beetle assemblages' structures the method of multiple reverse stepwise regression was used (Jongman et al. 1995), and the statistical significance of results was calculated using variance analysis (ANOVA). Beetle assemblages' structures were described with the following parameters: abundance, species richness, species diversity described with the Shannon-Wiener (Magurran 1988), Simpson (Ludwig and Reynolds 1988), Berger-Parker (Berger and Parker 1970) and McIntosh (Magurran 1988) indexes, and also with species distribution evenness (Whittaker 1975).

Area of study

The research area was located in the southern part of the Kraków-Częstochowa Upland, within a 10–15 km distance north-west of Cracow. The area comprises the southern margin of the Olkusz Upland being a wavy planation surface with mogotes, cut by deep karst river valleys of the Racławka, Szklarka and Będkówka, as well as fragments of the Krzeszowice Graben and the Tenczyn Horst. The bedrock of most of the area is built of limestones and dolomites (Devonian-Carboniferous, Jurassic-Cretaceous), strongly subject to karst processes, deformed by fault tectonics (Gradziński 1972), and in the Krzeszowice Graben occur impermeable Miocene sediments. A large fragment of the area is covered with loess. The vegetation cover is characterised by the occurrence of 25 communities, with the largest areas occupied by arable fields (*Secali-Violetalia arvensis*), continental mixed forest (*Querco roboris-Pinetum*), subcontinental deciduous forest (*Tilio-Carpinetum*) and the Carpathian beech forest (*Dentario glandulosae-Fagetum*). Places exposed to sun are occupied by rocky outcrops communities (*Festucetum pallentis*) and warm bush (*Peucedano cervariae-Coryletum*) (Michalik 1980). The varied properties of bedrock, which is the substrate for soil formation, as well as the variety of landforms, strongly conditioning microclimatic conditions and vegetation, are responsible for the fact that the soil cover of the area is a mosaic (Greszta, Bitka 1977, Adamczyk, Kobylecka 1980). Data from Soil-Farming Maps 1:5000 (1978), papers by Komornicki (1980), Skiba and Trafas (1987) and Zalewa (2001), as well as the authors' observations, made it possible to distinguish four basic soil associations

(*Leptosols*, *Luvisols* and *Cambisols*, *Fluvisols*, anthropogenic soils and soil materials), each consisting of several different soil taxonomical units.

Leptosols in the studied area are developed from hard, massive carbonate rocks (mainly dolomites and limestones). The association occupies the western slopes of the Racławka, Szklarka and Będkówka karst valleys, as well as small patches on the outcrops of carbonate rocks around mogotes and on the steep slopes of the Krzeszowice Graben. The dominant units in that association are *Calcari-Lithic Leptosols* and *Humi-Rendzic Leptosols.*

The association of *Luvisols* and *Cambisols* developed mainly on loess, and – much less frequently – on fluvial and glacifluvial sandy materials. That composed soil association occupies the largest area in the research area (nearly 70%), forming extensive patches on the surfaces of the Olkusz Upland and the Tenczyn Horst, as well as the elevated part of the Krzeszowice Graben. Soils of that association developed under mixed forests, the Carpathian beech forest and the drier varieties of deciduous forests, but presently they are used for farming. The dominant taxonomical units are *Haplic Luvisols* and *Stagnic Luvisols*, accompanied by *Eutric* and *Epidystric Cambisols*. Deepening of soil profiles, especially humus horizons, due to slope processes is very often observed, sometimes resulting in inclusions of *Phaeozems*.

Fluvisols cover all alluvial materials along river channels, most of them developed in the fine gravel and silt fractions. The largest areas of *Fluvisols* are situated in the bottom of the Krzeszowice Graben, where they are used for agricultural purposes.

The anthropogenic soils and soil materials, strongly influenced by human activity, have developed in two ways. Firstly, there are *Hortic Anthrosols* occurring in built-up areas, most often under orchards. Secondly, there are places of intensive exploitation of rock materials – limestone, dolomite and sinter quarries, resulting in the occurrence of anthropogeomorphic soil materials, without significant expression of pedogenetic processes and mainly of the *Spolic* character (WRB 1998).

The soil cover of the study area reflects the diversity of bedrock and the variety of landforms (Kobylecka 1981, Skiba and Trafas 1987), showing certain, specific regularities (fig. 2). An interesting phenomena can be observed on the slopes of karst valleys. Their western slopes are occupied by associations of *Calcari-Lithic Leptosols* and *Rendzic Leptosols*, while the eastern slopes are occupied by *Luvisols*, whose horizons are often deepened due to slope transport of silt. The reason for that pattern is the asymmetry of karst valleys resulting from the monoclinal arrangement of bedrock strata and differences in loess accumulation, caused by the irregular distribution of rainfall and wind directions.

The development of the surface, ectohumus horizons is influenced by the characteristics of vegetation communities and the relief of terrain. On flat

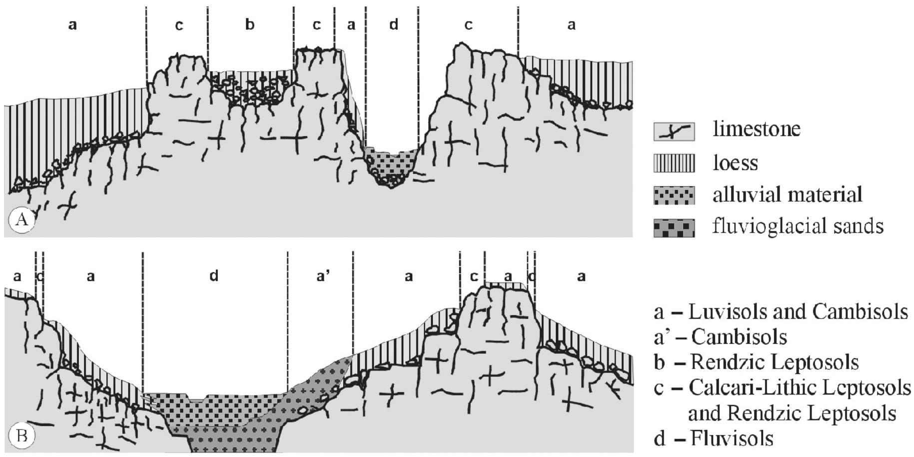

Fig. 2. A scheme of the distribution of soils in relation to bedrock in the Olkusz Upland (A) and in the Krzeszowice Graben (B) (after: Skiba, Trafas 1987, with changes)

Ryc. 2. Schemat rozmieszczenia gleb w zależności od podłoża na Wyżynie Olkuskiej (A) oraz w Rowie Krzeszowickim (B) (• ródło: Skiba, Trafas 1987, nieco zmienione)

hill tops and on slopes not steeper than 35^o, under deciduous *Tilio-Carpinetum*, *Luzulo-Fagetum* and *Dentario glandulosae-Fagetum*, characterised by a rather weakly developed storey of ground cover, ectohumus horizons of the Ol type develop. They are built of relatively freshly fallen leaves and their thickness does not exceed a couple of centimetres. Morphogenetic processes acting with a greater force on steeper slopes cause a poorer development or even a lack of Ol horizons. In forest communities with a well-developed storey of ground cover (*Querco roboris-Pinetum*, *Carici-Fagetum*, *Alno-Ulmion*) ectohumus horizons are usually thicker and enriched with undecomposed fragments of grasses, so they are of the Olf type. Then, under grasses and herbs of natural and secondary xerothermic swards thick ectohumus horizons (Of), built of weakly decomposed grass fragments, develop.

Structures of beetle assemblages in relation to soil types and kinds of ectohumus horizons

The analysis of the influence of soil features on the structure of the assemblages of weevils (*Curculionidae)* and Carabid beetles (*Carabidae*) showed the existence of certain dependencies. Statistical tests of correlations (tab. 1 and 2) and the analysis of reverse stepwise regression (tab. 3) point out that the assemblages' parameters are influenced by certain features of the soil cover i.e. soil type and subtype and the kind of substance forming ectohumus horizons.

Tab. 1. Pearson's correlation coefficients and statistically significant relationships between soil properties and parameters of the assemblages of weevils (*Curculionidae*) and ground beetles (*Carabidae*) (statistical significance level $p < 0{,}05$)

Tab. 1. Współczynniki korelacji Pearsona i istotne statystycznie zależności pomiędzy cechami pokrywy glebowej a parametrami zgrupowań ryjkowcowatych i biegaczowatych (statistical significance level $p < 0{,}05$)

Soil property	**Beetle assemblages parameters**	**N**	**R_P**	**p**
	Curculionidae (snout beetles)			
Soil type and subtype	Species richness (S)	30	0,397	0,033
Ectohumus type	Simpson index (D)	30	0,376	0,044
	Berger-Parker index (d)	30	0,378	0,043
	McIntosh index (Q)	30	0,373	0,046
	Carabidae (ground beetles)			
Soil type and subtype	Simpson index (D)	30	0,454	0,013
	Berger-Parker index (d)	30	0,451	0,014
	McIntosh index (Q)	30	0,450	0,014
	Distribution evenness (J)	30	–0,617	0,000

N – maximum number of samples, R_P – Pearson's correlation coefficient, p – statistical significance level
After: Maciejowski 2004

Tab. 2. Spearman's rank-order correlation coefficients, and statistically significant relationships between soil properties and parameters of the assemblages of weevils (*Curculionidae*) and ground beetles (*Carabidae*) (statistical significance level $p < 0{,}05$)

Tab. 2. Współczynniki korelacji porządku rang Spearmana i istotne statystycznie zależności pomiędzy cechami pokrywy glebowej a parametrami zgrupowań ryjkowcowatych i biegaczowatych (poziom istotności statystycznej $p < 0{,}05$)

Spearman's rank-order correlation between soil properties and beetle assemblages parameters	**N**	**R_S**	**t(N-2)**	**p**
Curculionidae (snout beetles)				
Soil type and subtype & abundance (A)	29	0,372	2,085	0,047
Carabidae (ground beetles)				
Soil type and subtype & Shannon-Wiener index (H')	29	–0,387	–2,183	0,038
Soil type and subtype & Simpson index (D)	29	0,422	2,418	0,023
Soil type and subtype & Berger-Parker index (d)	29	0,460	2,695	0,012
Soil type and subtype & McIntosh index (Q)	29	0,422	2,418	0,023
Soil type and subtype & distribution evenness (J)	29	–0,618	–4,082	0,000

N – maximum number of samples, R_S – Spearman's rank– order correlation coefficient, t – number of samples analyzed in a series, p – statistical significance level. *After: Maciejowski 2004*

Tab. 3. Correlation coefficients and statistically significant dependencies between soil features and assemblage parameters of weevils and Carabid beetles based on the analysis of regressive multiple regression ($p < 0,05$)

Tab. 3. Współczynniki korelacji oraz istotne statystycznie zależności pomiędzy cechami pokrywy glebowej a parametrami zgrupowań ryjkowcowatych i biegaczowatych na podstawie analizy regresji wielokrotnej wstecznej (poziom istotności statystycznej $p < 0,05$)

Beetle assemblages parameters		Regression equation adjustment at a significance level p		Explained variance	Soil feature		SE	B	SE B	t(N-3)	p
Weevil assemblages	Species richness (S)	F(1,27) = 5,0507 R = 0,397	p < 0,033	$R^2 = 0,16$	*free term*	–	–	11,247	6,698	1,679	0,105
					Soil type and subtype	0,397	0,177	4,149	1,846	2,247	0,033
	Simpson index (D)	F(1,27) = 4,4461 R = 0,376	p < 0,044	$R^2 = 0,14$	*free term*	–	–	0,118	0,030	3,976	0,000
					Ectohumus type	0,376	0,178	0,048	0,023	2,109	0,044
	Berger-Parker index (d)	F(1,27) = 4,5008 R = 0,378	p < 0,043	$R^2 = 0,14$	*free term*	–	–	0,229	0,047	4,926	0,000
					Ectohumus type	0,378	0,178	0,075	0,036	2,122	0,043
	McIntosh index (Q)	F(1,27) = 3,3593 R = 0,373	p < 0,046	$R^2 = 0,14$	*free term*	–	–	0,339	0,035	9,667	0,000
					Ectohumus type	0,373	0,179	0,056	0,027	2,088	0,046
Carabid assemblages	Simpson index (D)	F(1,27) = 7,0023 R = 0,454	p < 0,013	$R^2 = 0,21$	*free term*	–	–	0,035	0,090	0,385	0,703
					Soil type and subtype	0,454	0,171	0,066	0,025	2,646	0,013
	Berger-Parker index (d)	F(1,27) = 6,8959 R = 0,451	p < 0,014	$R^2 = 0,20$	*free term*	–	–	0,134	0,102	1,317	0,199
					Soil type and subtype	0,451	0,172	0,074	0,028	2,626	0,014
	McIntosh index (Q)	F(1,27) = 6,8635 R = 0,450	p < 0,014	$R^2 = 0,20$	*free term*	–	–	0,297	0,078	3,827	0,001
					Soil type and subtype	0,450	0,172	0,056	0,021	2,620	0,014
	Distribution evenness (J)	F(1,27) = 16,601 R = 0,617	p < 0,000	$R^2 = 0,36$	*free term*	–	–	0,959	0,070	13,755	0,000
					Soil type and subtype	–0,617	0,151	–0,078	0,019	–4,074	0,000

– value of the constant coefficient regression, SE – standard error of the constant coefficient , B – value of the variable coefficient of linear regression, SE B – standard error of the variable coefficient B, t – number of samples analyzed in a series, p – statistical significance level *After: Maciejowski 2004*

Soil type and subtype

There is a statistically significant relationship between the soil type and subtype and the structures of both studied beetle groups' assemblages. In weevil assemblages it shows exclusively positive correlations with abundance (R_S= 0,372) and species richness (R_P = 0,397). It means that the soil type and subtype, determined by its physical and chemical properties, and its profile morphology and thickness, influences the growth of the values of the studied weevil assemblages' parameters. In Carabid beetle assemblages that soil feature correlates with all indexes of species diversity (H', D, d, Q) and distribution evenness (J). For the Shannon-Wiener diversity index (R_S = –0,387) and distribution evenness (R_P = – 0,617, RS = –0,618) it shows negative correlations, whereas for the Simpson (R_P = 0,454, RS = 0,422), Berger-Parker (R_P = 0,451, RS = 0,460) and McIntosh (R_P = 0,373, R_S = 0,422) indexes the correlations are positive (table 1 and 2). So, changes of soil taxonomical units, in the study area usually connected with changes in profile thickness, from the shallowest *Calcari-Lithic Leptosols* to the deepest *Cambisols*, influence an increase in the contribution and abundance of the dominant species and a simultaneous decrease in the contribution of rare, occasionally found species. It is probably a result of several overlapping causes. First, a thicker profile for many species determines a larger procreation success. It is an effect of a higher availability of food resulting from an increased "environment capacity", i.e. there can exist a more numerous group of organisms being Carabid beetles' food. Moreover, a better-developed soil profile increases the reaction span of the fauna inhabiting the soil to unfavourable physical and chemical changes in the soil, e.g. dryness or occurrence of frost, being unfavourable for insects' larvae. That is because it enables an escape down the soil profile or even seasonal vertical migrations (Demel 1967). Tarnawski (2000) reports that *Staphylinidae* larvae during autumn chills can even go down to a depth of 50 cm. Another cause is the reaction of beetle species to the physical and chemical properties of the upper soil horizons. They may prefer specific physical properties, e.g. texture and compactness, which facilitate digging a refuge (nest), getting food or enhance the development of larvae (Demel 1967), or appropriate moisture conditions (Hurka 1996). Lindroth (1945, 1953) proved a conscious choice of carbonate ground by Carabid species from the *Harpalus* genus. It is also known that the *Carabidae* subfamily of *Cicindelinae* is confined to sandy ground. That fact might explain a lack of that subfamily species in the study area, as sand terrains practically do not occur there at all. Soil chemical properties are not indifferent to animals, either. For example, some Carabid species respond to changes in soil reaction (Hurka 1996), and Lindroth (1949) pointed out such preferences for two Carabid species from the *Bembidion* genus (*Bembidion aeneum* i *B. minimum*), whose zoogeographical distribution was closely related to the chemistry of the ground. A similar choice may be noticed in the study area, as on the alkaline and shallow *Calcari-Lithic Leptosols* only four Carabid species (*Carabus cancellatus*, *C. coriaceus*, *C. nemoralis*, *Abax parallelepipedus*) were recorded, while on the leached and much deeper *Luvisols* a dominance of numerous other species was observed. It may be explained with a low availability of food and, simultaneously, exceptionally unfavourable habitat conditions (e.g. high temperature amplitudes, strong dryness) in *Calcari-Lithic Leptosols*, nonetheless there is a third reason that most probably has a crucial influence on the observed distribution of species and assemblages. It is the type of land use. That is supported by both the proven relationships indicating Carabid beetles' preference of forest communities as most suitable for them, as well as the fact that in areas used by man (meadows, pastures, arable fields) occur their assemblages of a deformed dominance structure. Probably that has the largest influence on the increase in the Simpson and Berger-Parker indexes, and thus a simultaneous decrease in the Shannon-Wiener and distribution evenness indexes. That problem remains an open issue, because observing such species as *Asaphidion pallipes*, *Carabus violaceus* or *Amara curta* one can notice that they appear in arable lands and in forests, but only on acid ground, lacking calcium carbonate (usually on *Luvisols* and *Epidystric Cambisols*). The ultimate answer may be found during further studies comparing a series of areas on different soil units and of varied land use, with other elements of the environment remaining uniform.

Kind of ectohumus

The kind of ectohumus does not influence significantly any parameters of Carabid assemblages, while it significantly describes the parameters of weevil assemblages. Those parameters are: the species diversity indexes of Simpson ($R_P = 0{,}376$), Berger-Parker ($R_P = 0{,}378$) and McIntosh ($R_P = 0{,}373$). In each of the cases the correlation is positive. It means that with a change of litter type from leaf litter (Ol), through mixed leaf-grass litter (Olf) to pure grass litter (Of) an increase in the number of popular, frequently occurring, species along with a simultaneous increase in the contribution of the dominant species individuals is observed in weevil assemblages. The obtained results confirm the theses put forward earlier claiming that the diversity of weevils depends largely on the kind of land use, as it is the kind of land use that plays an important role in the development of ectohumus horizons, or rather – the presence or lack of them. In forest areas the litter horizon is constituted by fallen tree leaves (Ol) or leaves mixed with withered grass fragments (Olf). The kind of ectohumus, then, depends on the degree of development of ground cover and its characteristics. The better the ground cover is developed, the higher the contribution of undecomposed grass fragments in litter will be. During the vegetation period such a horizon has a very small thickness and may even be not present at all, due to a relatively fast decomposition of organic matter. It achieves its greatest thickness and best expression only in the autumn time, when vegetation dies and leaves fall down. On mowed meadows and arable fields litter horizons do not occur at all. In the study area the best-developed ectohumus horizons of grass litter character (Of) occur under natural communities of xerothermic swards or former arable lands becoming overgrown, subject to renaturalisation. Thus weevil species finding favourable conditions in such habitats form abundant clusters. A change of plant species, in turn, triggered by succession will eliminate the contribution of single beetle species, which will retreat slightly with a decrease in the diversity of communities. Therefore the influence of the kind of ectohumus is not significant in that area, especially as the development of ectohumus depends on a vegetation community under which it forms while its presence is connected with the type of land use.

Conclusions

An analysis of the influence of selected soil features on the assemblage structures of selected beetle groups showed the existence of certain dependencies. The influence is not very strong as the analysis of reverse stepwise regression showed statistically significant correlation with a small percentage of explained cases of the dependency usually reaching ca. 20%. The values of R^2 oscillated form 0,14 to 0,36 (table 3). The distribution of weevils is influenced by the type and subtype of soil, controlling species richness, and the kind of ectohumus, controlling the indexes of diversity (Simpson, Berger-Parker, McIntosh). As for Carabid beetles, there is a significant influence of the type and subtype of soil, controlling the Simpson, Berger-Parker and McIntosh diversity indexes as well as determining the distribution evenness of particular species within assemblages.

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