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WINDBREAKS AND LINE COMMUNITIES AS MIGRATION CORRIDORS FOR CARABIDS (*Col. Carabidae*) IN THE AGRICULTURAL LANDSCAPE OF SOUTH MORAVIA

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Abstract

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The migration and community changes of *Carabidae* are studied in three different line vegetation formations in South Moravia, namely in two windbreaks (one connected with a forest, one isolated in fields) and in a seminatural wooded hedge in the field continuously bound with a forest reservation). The primary factors deciding about the migration through such corridors are the composition and density of vegetation and litter and the corridor width. The corridors consisting of the autochtonous trees and bushes make possible migration of the forest and eurytopic carabids in the intensity up to 30 % of their representation in the forest. The corridors consisting of the introduced exotic trees allow their migration only up to 1 – 3 % of their representation in the forest. The corridor length has only a secondary effect on the migreation of carabids. A positive influence of the carabids in the corridor on their community in the surrounding fields was observed only in the seminatural wooded hedge. The prerequisition of some types of vegetation formations to be effective as refuges or biocorridors for *Carabidae* in agricultural landscape is discussed.

Introduction

The deep degradation of the biota in a strongly agriculturally exploited landscape like South Moravia and Slovakia has more causes. They are not only the hyper-utilization of the pesticides, industrial fertilizers and heavy machines in the fields but also changes of the landscape structure after the collectivization of the agriculture during the fifties. As a result of it, the boundaries, hedges and small parcels of non-utilized land have been liquidated and large fields with the same crop have become characteristic of our landscape. The chance of animals to find a refuge and a suitable food or reproduction basis was minimized. The decrease in the landscape diversity has a heavy impact on the species diversity of fauna and flora and on population size of many species.

One of the possibilities to reclaim the present state is to restore the original landscape structure and to find the optimum proportion of the exploited and non-exploited parcels. A special role in this task is played by the line formations of more natural vegetation which could serve as corridors and refuges for animals and plants. However, there exists nearly no knowledge about the ecological parameters which are necessary to a line formation may play its role without a substantial reduction of the agricultural production in adjacent fields.

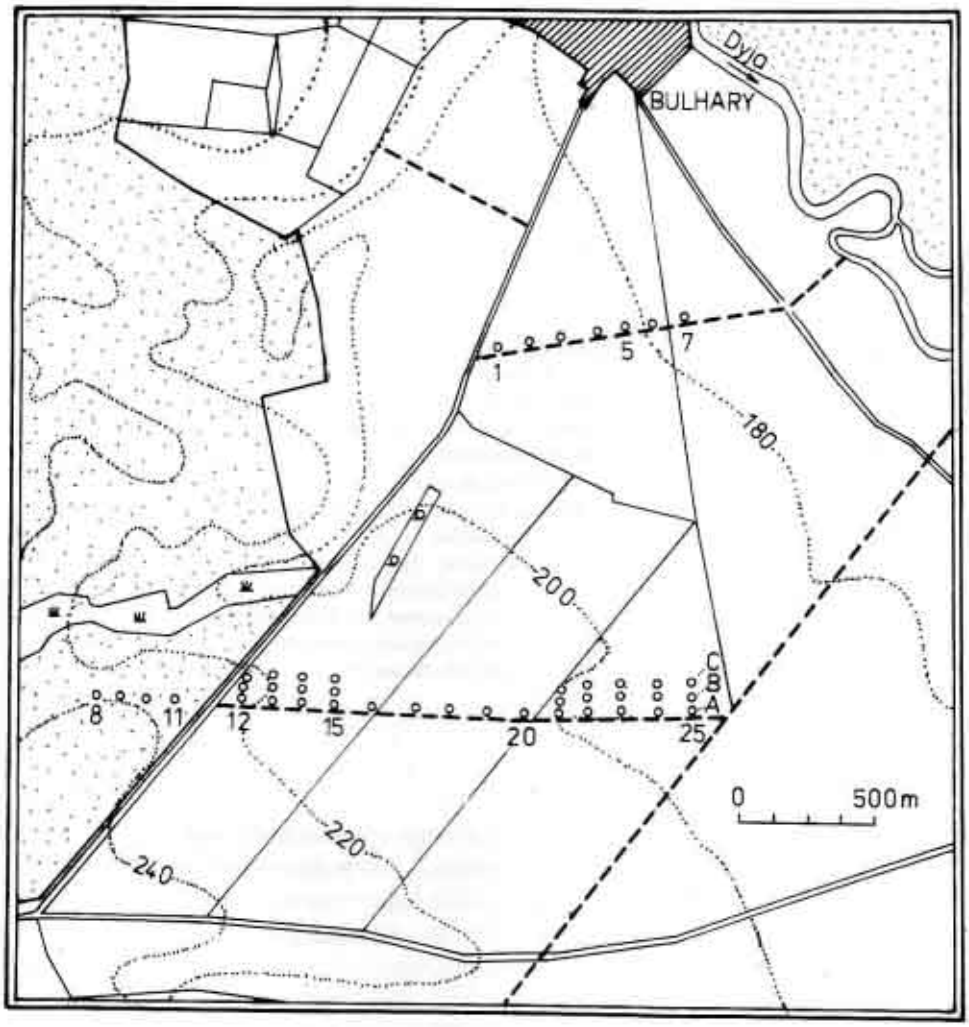

Fig. 1. Allocation of the traps in two windbreaks in the vicinity of Bulgary (dotted line - forest, dashed line - windbreaks, A - traps in the windbreaks, B - the parallel line of traps in the distance of 50 m from the windbreak, C - parallel line of the traps in the distance of 100 m).

As a contribution to the solution of these purely practical problems this preliminary study has two aims. First, to compare the changes of carabid communities along three different line formations of the woody vegetation in the agricultural landscape of South Moravia and, second, to emphasize the practical importance of the ecotones in the landscape. The carabids represent an ideal model group for this purpose.

Territory specification

The study was carried out in three line communities. Two of them are represented by wind-shelter belts situated in the centre of the triangle between the villages Bulgary, Lednice na Moravě and Sedlec in South Moravia (Fig. 1). The first wind-shelter belt consists of several introduced trees and bushes like *Robinia pseudoaccacia* or *Gleditschia triacanthos* and *Juglans nigra.* Its width fluctuates between 15 – 20 m. It has no connection with a forest and its minimum distance from it is of 600 m (Fig. 1). The shelter belt arose probably in the early fifties, but there are some indications of a way-side alee in its place on the special military map from the twenties.

The second wind-shelter belt has a similar character as the first one. It comes out from the large oak-hornbeam forest and runs through the wheat and maize fields until the distance of 2.5 km from the forest margin. Its width fluctuates between 10 – 15 m at its beginning and in its central part and it reaches even 15 – 20 m at its end. A considerable part of the shelter belt is founded on the originally wooded area, which had been cleared cut at the beginning of the thirties. The shelter belt arose in the earlier fifties. In two places it is broken by field ways.

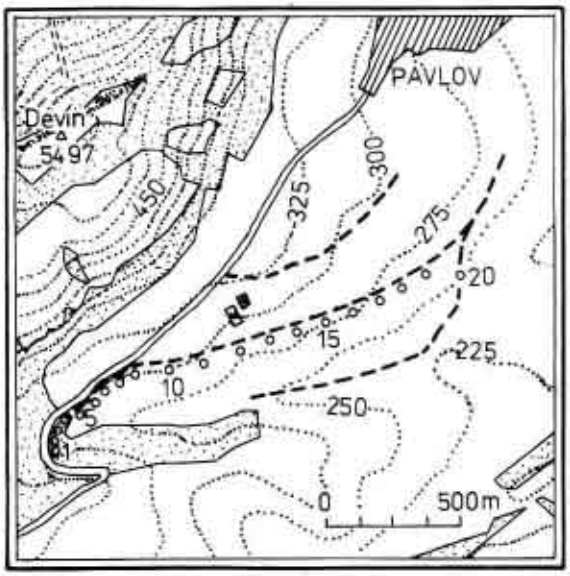

Fig. 2. Allocation of the traps in the wooded hedge in the vicinity of Pavlov (the symbols as in Fig. 1).

The third corridor finds between the villages Klentnica and Pavlov (Fig. 2) on the south-eastern slopes of the Pavlovské vrchy hills. It is represented by an old way-side alee shown already on the old military special map from the twenties. It consists mostly of the autochtonous shrubs (*Rosa spp., Sambucus nigra, Ligustrum vulgare, Prunus spinosa*) and trees (*Ulmus campestre, Acer campestre*), or fruit trees (*Prunus domestica, Juglans regia, Malus pirus, Amygdalus com-*

munis). Only at its beginning in a distance of ca 100–150 m the tree etage is dominated by *Robinia pseudoaccacia*. The herbage stratum was penetrated until the distance of 300 – 400 m by some forest species like *Arum maculatum*. The total length of the corridor was 1.5 – 1.6 km. The width of the corridor fluctuated between 5 and 20 m, but in its greates part between 10 – 15 m. In its centre it was broken by a grassy belt in the distance of ca 30 m.

Material and methods

The carabids were collected by pitfall traps with formol as a conservation and killing solution. The glass jars "Omnia" served as a trap. The traps were placed in the distances of 50 – 100 m from each other so to they characterize sufficiently the expected gradient of community changes. The beatles dropped into the traps were taken in the intervals of six weeks. The number and location of the traps in each corridor and in the neighbouring field or forest communities are presented in the Fig. 1 and 2. The traps were exposed every year from April to November.

The total material consists of ca 90,000 carabids and staphylinids belonging to about 200 species. The complete list of the species will be presented in parts in prepared

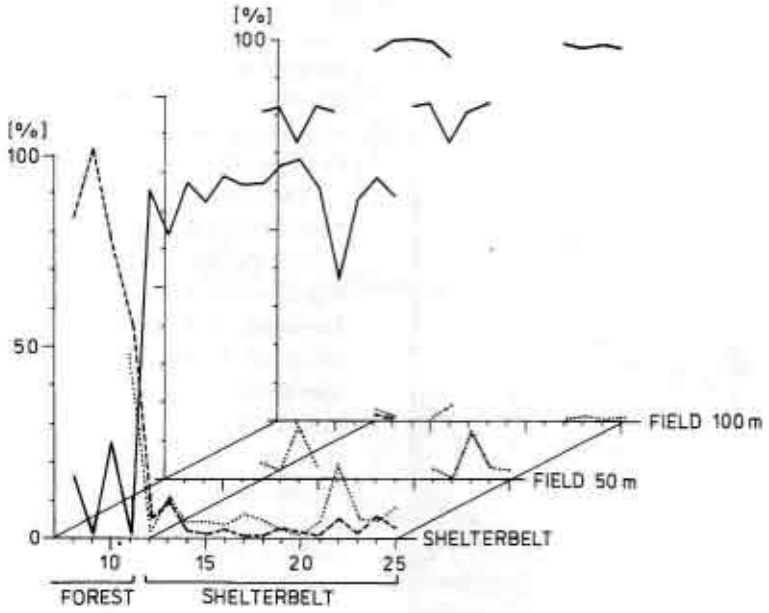

Fig. 3. Percentual representation of three ecological groups of carabids in the windbreak in Bulgary (dashed line - forest mesohygrophilous species, dotted line - eurytopic species, full line - field species).

papers. The material used in this preliminary report was collected in the first corridor in 1986, in the second in 1986 and 1987, and in the third corridor in 1988.

The unweighted group average method (Sneath, Sokal, 1973) was used for the clustering of the data. The Renkonen's index (Schwerdtfeger, 1975) was used as a similarity function. The ecological characteristics of the species were taken from Šustek (1984).

Representation of the ecological groups of carabids in the corridors and in their vicinity

The carabids were classified into four ecological groups of species, namely the hygrophilous forest, mezohygrophilous forest, eurytopic and field species. Their quantitative representation changes along the corridors as follows.

In Bulhary the cumulative dominance of the mezohygrophilous forest species starts to decline already in the forest interior (Fig. 1 and 3), but the eurytopic species *Carabus cancelatus* and *C. ullrichi* replace them. A very sudden change comes immediately between the forest margin and the first trap at the corridor begining. The cumulative dominance of the field species increases to 90 %. Within a distance of ca 100 m (the trap 13) a slight local peak of the forest and eurytopic species indicates that the representation of both ecological groups peter out in that part of the corridor. In more remote parts, the dominance of the forest species stabilizes on 1 – 3 %. Their dominance increase as early in the traps 22 – 25 in a little wider part of the windbreak, ca 1,400 m from the forest margin. The eurytopic species represent 2 – 5 % of all individuals along the whole corridor, except the traps 22 – 25 where their dominance increase similarly as in the forest species. However, the eurytopic species in the corridor were represented mostly by *Pterostichus melanarius,* which is more tolerant to the open areas than *Carabus cancelatus* or *C. ullrichi*. In two parallel lines of traps in a wheat field in the distance of 50 and 100 m from the windbreak, the forest species are missing nearly at all. The eurytopic species (mostly *Pterostichus melanarius*) represented here 0 – 12 % of all individuals. It is evident that the carabid community in the windbreak had no influence on the community in the field. However, the positive effect of the corridor width on the migration and survival of the forest and eurytopic carabids in the corridor was visible.

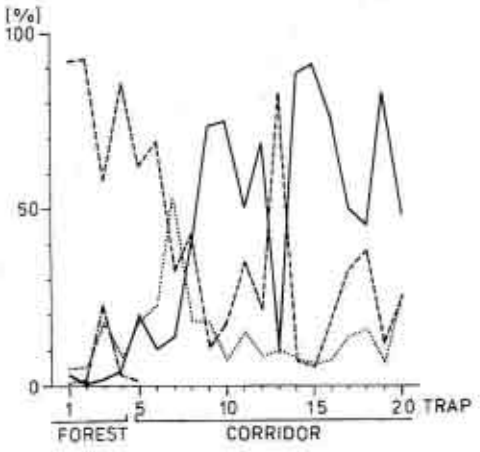

Fig. 4. Percentual representation of three ecological groups of carabids in the wooded hedge in Pavlov (symbols as in Fig. 3).

In comparison with the artificial windreak in Bulgary, the wooded hedge in Pavlov enables the migration of the forest species until a relatively unlimited distance in the intensity of ca 10 – 30 % of their dominance in the forest. The strong fluctuations of their dominance along the corridor are caused partly by the trapping biases but in a considerable degree they reflect the local differences in the ecological parameters of the corridor. Its wider and shadower parts are preferred by the forest and eurytopic species. It is observable mainly in the more remote parts (Fig. 4). At the beginning (the traps 7 – 9) the unfavourable conditions (narrow, insolated part dominated by locust trees) are compensed by an intensive migration and small distance from the forest as a biocentre. With a certain degree of simplification it can be said that the cumulative dominance of the forest species is distributed logistically along the corridor in Pavlov, while the eurytopic species seem to have the Gaussian distribution. They culminate in the distance of 100 – 200 m from the forest margin (Fig. 4). The field species are represented at most in the second third of the corridor, where the woody cover is thinner and narrower. The positive influence of the carabids in the corridor on the community in the field was observable in June and July, when the wheat was already high. In that time a considerable number of *Carabus cancelatus* and a fewer one of *C. ullrichi* penetrated deeply the field. At the beginning of the vegetation period these species were found only in the corridor or in the adjacent forests.

Clustering of the samples from the corridors

The clustering of the samples from all traps from each corridor was made on the base of their proportional similarity (s. c. Renkonen's index).

The samples from Bulgary from May-June 1986 form three clusters on the similarity level of 15 % (Fig. 5). The cluster I contains four of seven samples from the first windbreak (traps 1 – 7). The cluster II includes all samples from the oak-hornbeam forest and the cluster III includes all samples from the second windbreak and three samples from the first one. The cluster III consists of six groups of samples. The group IIIa includes two samples from the first corridor and two samples from the end of the second one. These samples are characterized by a slightly higher dominance of the eurytopic species. The group IIIb contains the samples from the beginning of the second corridor, where the representation of the forest species remains still higher than in the more remote parts. The group IIIb includes also the sample 25 from a little wider part at the end of the corridor, where the dominance of the forest species increases. The group IIIc joins the samples from the centre of the corridor and from the parallel line of traps in the field. They are characteristic by a little higher dominance of the eurytopic *Pterostichus melanarius*. The group IIId includes the samples from the wider parts of the corridor with the local maxima of the dominance of the forest species. The groups IIIb-IIId form a well defined subcluster on the similarity level of 70 %. The samples from the second windbreak prevail in this subcluster. The fifth group IIIe is formed exclusively by the samples from the field, similarly as the group IIIf. They are

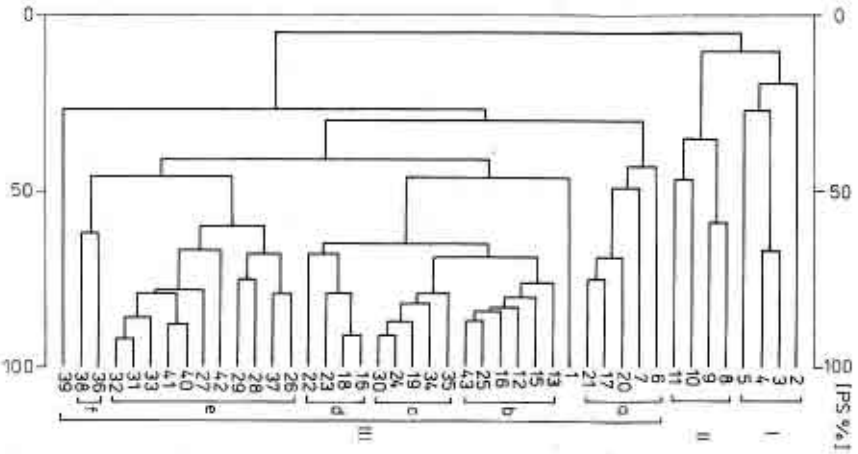

Fig. 5. Clustering of the samples from Bulgary from May - June 1986 according to the proportional similarity of the carabid species spectra (the numbers 1 - 25 correspond with those in Figs 1 and 3, the numbers 26 - 29 correspond with 12b - 15b, 30 - 34 with 21b - 25b, 35 - 38 with 12c - 15c, 39 - 43 with 21c - 25c in Fig. 1 and 3).

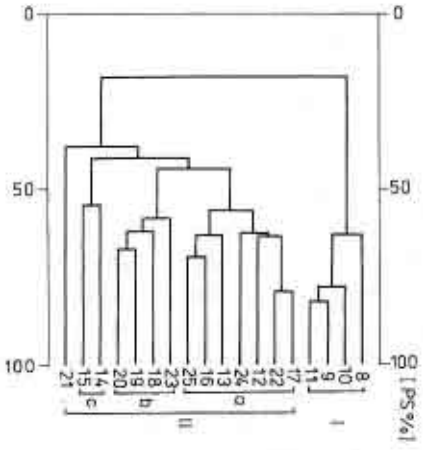

Fig. 6. Clustering of the samples from Bulgary from August 1987 according to the proportional similarity of carabid species spectra (symbols as in Fig. 5).

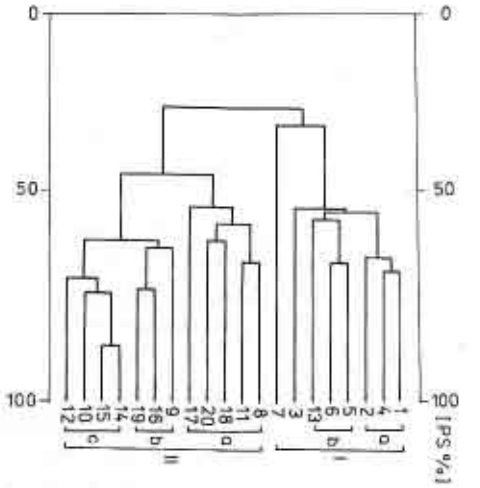

Fig. 7. Clustering of the samples from Pavlov from 1988 according to the proportional similarity of carabid species spectra (numbers of the traps correspond with those in Fig. 2).

characterized by the dominance of *Poecilus cupreus*, *P. marginalis*, *Agonum dorsale* and *Harpalus rufipes*. The samples from the group IIIf are characteristic by the full absence of the eurytopic species.

The samples from Bulgary from August 1987 (Fig. 6) form two well defined clusters. The cluster I consists of all samples from the forest. The second cluster includes the samples from the corridor. It is divided into subclusters IIa, IIb and IIc. The subcluster IIa contains samples mostly from the beginning of the corridor and from a wider part at its end. This subcluster arises due to a little higher dominance of the forest species *Carabus nemoralis* and *Abax ater*. The subclusters IIb and IIc contain mostly the samples from the central part of the corridor. Both classifications have a common clustering pattern reflecting the positive influence of lower distance from a biocentrum or of a larger width of the biocorridor on the dominance of the forest carabids in the windbreak.

The samples from the biocorridor from Pavlov (Fig. 2 and 7) form two clusters. The cluster I includes the samples from the forest and from the beginning of the corridor, where the forest and eurytopic species dominate. Their occurrence is correlated with the intensity of the diffused light of 1000 –5000 lux in the stand interior. The cluster I consists of two sublusters. The subcluster Ia includes the samples from the transition between the forest and corridor, where the cumulative dominance of the forest species starts to decrease and the eurytopic species (*Carabus cancelatus, C. ullrichi*) come on their place. A special position in the cluster I has the sample 13 from a relatively remote, but wider segment of the corridor. The forest species *Abax ater, Carabus nemoralis* and *C. coriaceus* dominate here. The relative isolation of the sample 3 in the dendrogram results from the position of the trap 3 on the margine of a narrow temporary aluvium inhabited by the hygrophilous species *Agonum asimile* and *Carabus granulatus* and by the eurytopic species *Pterostichus melanarius* and *Pt. niger*. The low similarity level on which the sample 7 links to the cluster I expresses its transitional position in the corridor.

The cluster II contains samples from the more remote segments of the corridor characterized by the intensity of the diffused light of 8,000 – 12,000 lux. The cluster II consists of three subclusters. The subcluster IIa arising on the similarity level of 45 % includes the samples with approximately 30 % of individuals of the forest species, before all *Abax ater, Carabus nemoralis* and *C. coriaceus*. The subcluster IIb contains samples with ca 10 – 15 % of individuals of the forest or eurytopic species. The subcluster IIc includes samples with ca 20 % of the forest species.

The analysis of the representation of the ecological groups of species and all three classifications shows that the distance of a segment of the corridor has a decisive role only at the beginning of the corridor, where the intensive migration of species from the forest (biocentre) can compensate effectively the negative influence of higher insolation of the corridor interior in its narrower or thinner parts on the forest or eurytopic species. Although there are striking quantitative differences between the representation of individual ecological groups of carabids in all studied corridors, there exists a common general pattern. After a differently long transition zone, where the dominance of the forest and less tolerant eurytopic species decreases, the mutual ratio of all ecological groups of carabids stabilizes and, within certain limits, does not change until the end of the corridor. The local changes depend before all on the character of

vegetation, litter, woody cover density and corridor width. The introduced trees and shrubs create rather unfavourable conditions for the carabids, especially the locust tree, which remains without leaves until the late spring. So the soil surface gets warmer and drier in a very important period for the development of majority of *Carabids*. The strong effect of the absence of foliage on *Sarcophagids* in spring was shown by Povolný, Šustek (1981). The pattern of representation changes of the ecological groups and the clustering after the proportional similarity of samples from individual parts of the corridors show that the short discontinuities in the corridor have no negative effect of the carabids migration. A good evidence for it is given especially by the first corridor in Bulgary (Fig. 1), which behaves as an island.

The spectrum of the forest species migrating from the forest through a corridor into the surrounding landscape is always narrower than the species spectrum in the forest. It is reduced in the most abundant and tolerant species, like *Carabus nemoralis, C. coriaceus, C. hortensis, Abax ater* and *Pterostichus oblongopunctatus*. These species are able to penetrate the urban ecosystems and to survive there. The abundant, but less tolerant species like *Abax parallelus* have not been found in the corridors. The spectrum of the eurytopic species is approximately the same as in the forest. The field species penetrate the corridors in an unlimited spectrum, but they are represented there by a lower number of individuals than in the adjacent fields.

Discussion

There are only few papers dealing with carabid communities in the line vegetation formation and with their potential use for the improvement of the state of the soil fauna in the fields. The results of the existing papers of Thiele (1964, in Thiele, 1977), Boháč, Pospíšil (1984), Pavlíček, Blažek (1986), Pavlíček, Houšťková (1989) and Farkač, Farkačová (1990) are strongly biased by the choice of experimental plots in different local conditions and they are mostly unsufficiently based on the typification of carabid communities in different types of ecosystems. Boháč, Pospíšil (1984) confirm in the highland conditions that the discontinuities in a corridor have not inevitably a negative impact on migration of the forest or eurytopic carabids. The experimental windbreak of Pavlíček, Blažek (1986) was strongly isolated from any immigration source. Therefore they found only a small difference between the carabid community in the field, windbreak and its margin. These differences lay within the variability limits of the carabid communities in the fields. Further, the authors have not specified, unfortunately, the crop on the studied fields. Pavlíček, Houšťková (1989) have confused material obtained during two consecutive years in two strongly different crops. They omit the fact that the quantitative structure of carabid communities in the fields are subjected every year to deep crop-dependent changes. Both above mentioned papers omit that the carabid communities are hardly to be expected to exhibit an essential difference between the interior and margin of a narrow windbreak. Farkač, Farkačová

(1990) have chosen an isolated and anthropogenously strongly influenced remnant of a flood-plain forest. It influenced their results and conclusions considerably.

Irrespective of some discutable places and approaches in the cited papers, they confirm a possibility of survival of relatively rich carabid communities in several windbreaks, tree groups and wooded hedges. The comparison of more studied cases indicates that richness and structure of carabid communities in such formations strongly depends on their ecological properties and those properties enabling the biocorridors to be effective in the ecological stabilization of the agricultural landscape can be found and defined. The negative opinions about the possibility of improvement of structure of carabid communities in the field by the immigrants, before all big zoophages, from the non-cultivated areas (e. g. Thiele, 1964, in Thiele, 1977) have three causes. As a patent from the comparison of the carabids from the hedge in Pavlov and of the windbreaks in Bulgary and in the cited papers, such conclusions were based nearly always on a study of such communities, which were realy unable to fullfil such expectances due to their ecological properties. Second, the authors omit that their experiments were carried out mostly in a landscape with the structure exceeding considerably the dispersal power of the big zoophagous carabids, which should be reintroduced into the fields. So, such results were obtained in the conditions which as such represent one of the important causes of the present state of field fauna of carabids. Third, the role of the stenotopic forest species is often overestimated and in the same time it is omitted that only the eurytopic species will be able to penetrate the fields in a sufficient number from the non-cultivated areas.

The problem of the improvement of the trophical and body-size structure of carabid communities in the fields and rise up of their ecological stability consists of two crucial questions which are to be solved. First, such vegetation formation should be found or created, where a wide spectrum of species with different ecological requirements might find supportable life conditions. So such formations might serve simultaneously as refugia and biocorridors. Second, the discordance between the dispersal power of the species having been nearly extinct in the agricultural landscape and the field size should be minimized by two ways. The proportion of the non-cultivated areas should be risen up and the size of the fields sewed with the same crop should be reduced.

In relation to the first question the primary factor making possible the survival and migration of the forest and eurytopic species in a corridor or in a small refugium seems to be the composition of the phytocoenosis, especially of the herbage stratum. E. g. a surprisingly natural carabid community was found in a small forest island on the western slope of the Pavlovské vrchy hills (Šustek, unpublished). Its diameter was only 30 – 40 m and its distance from the nearest forest margin ca 400 m. It was surrounded by vineyards and a xerothermophilous abandoned pasture. The carabids in the pasture were nearly absent while the vineayard was inhabited by a typical field community of carabids. The forest island itself consisted mainly of *Robinia pseudoaccacia*, but the herbage stratum was dominated by *Viola spp., Pulmonaria officinalis, Alium officinale* and *Poa nemoralis.* Another example is represented by a small coppice of *Robinia pseudoaccacia* and *Sambucus nigra* in the field in the vicinity of Sereď (South Slovakia),

(Šustek, 1983). It was inhabited by an enormously rich population of *Carabus scheidleri*, which penetrated the surrounding fields until the distance of ca 300 m. The ground in the coppice was covered densely by *Galium sp.*

Seemingly paradoxical are observations made in grassy patches (mostly *Calamogrostic epigeios*) in the fields on the slopes of the Pavlovské vrchy hills. They are inhabited by a low number of the eurytopic species *Carabus ullrichi* and the carrion beetle *Silpha carinata*. Other carabids were typical field species like *Poecilus cupreus, Agonum dorsale* or *Brachynus explodens*, but they occurred there only sporadically, though they were abundant in the surrounding wheat fields. A similar phenomenon was observed also on the pasture in Zádiel in East Slovakia. In contrary to the very rich carabid communities, which are mostly typical of meadows (e. g. Louda, 1973; Klimeš, Sechterová, 1989), there were found only poore carabid communities (Šustek, 1990).

A similar example is represented by the carabid communities from patches of the natural forest steppe on the slopes in the interior of the natural reservation on the Pavlovské vrch hills. There occur only few immigrants from the surrounding forests, especially during the pluvial periods. Out of it there occur sporadically the typical thermoxerophilous species *Dyschirius rufipes, Licinus cassideus* and *Zabrus blapoides* and rather rarely the typical stepicolous species *Carabus hungaricus*. An explication for it seems to be the strong extrazonality of such formations in Central Europe. Due to it, they cannot be inhabited by a characteristic spectrum of the stepicolous carabids as the steppes in South Russia and Ukraina.

The above examples indicate that some of the natural or seminatural formations are unable to act effectively in the improvement of the structure of the field fauna. The root of it is in the probable origin of the field fauna. According to some hypotheses (Thiele, 1977) it originates from the open terraces on the river banks. This hypothesis seems to be highly probable, at least from a considerable part. Such communities were found during the observation of the carabids succession on the banks of Jašterkové jazierko lake in East Slovakia (Šustek, 1990) or on the river banks in North Korea (Šustek, unpublished). But at the same time it is evident that a considerable part of the so-called field species originates evidently also from other types of ecosystems. Due to the faunogenetical heterogeneity of the field carabids, the best vegetation formation, which might serve as refugium for many species in the agricultural landscape or as a corridor linking in the same time the island of more natural ecosystems seem to be the ecotones.

Conclusions

The comparison of the carabid communities in three line vegetation formations (two windbreaks and a wooded hedge) shows that the most important factors managing the migration of the forest and eurytopic species of carabids along such line communities are their composition and width. The corridors consisting of the autochtonous trees and shrubs make possible the migration of the forest and eurytopic species in the

intensity up to 30 % of their representation in a forest refugium. The corridors consisting of the introduced exotic trees allow migration of such species only up to 1 – 3 % of their representation in a forest. The short discontinuities or narrower segments in a biocorridor have no significant effect on the migration of carabids. The length of a corridor has only a secondary effect on their migrations. A positive effect of a biocorridor on the composition and trophical and body-size structure of carabids in the neigbouring field was observed only along the seminatural wooded hedge. The emigration of the eurytopic species *Carabus cancelatus* and *C. ullrichi* took place only when the wheat was higher than ca 50 cm. The ecotonal communities seem to give the best conditions for migration and survival of a wide spectrum of carabids in the agricultural landscape.

Translated by the author

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References

Boháč, J., Pospíšil, J., 1984: Ground-beetles and staphylinds in the wheat and maize fields in the relationship with the surrounding biotops (in Russ.), Ekologija, *7*, p. 22 – 34.

Duelli, P., Studer, M., Marchand, I., 1989: The influence of the surroundings on arthropod diversity in maize fields. Acta Phytopathol. et Entomol. Hung., *24*, p. 73 – 76.

Duelli, P., Studer, M. Marchand, I., Jacob, S., 1990: Population movements of arthropods between natural and cultivated area. Biol. Conservation, *54*, p. 193 – 207.

Farkač, J., Farkačová, J., 1990: Ground-beetles of the cultural landscape of South Moravia (in Czech). Zprávy Čsl. spol. ent. ČSAV, *26*, p. 55 – 59.

Klimeš L., Sechterová, E., 1989: Epigeic arthropods across an arable land and grassland interferences. Acta Entomol Bohemoslov., *86*, p. 489 – 567.

Louda, J., 1973: Die Laufkäfer des Wiesenbestandes im Vorgebirge des Böhmisch-Mährnischen Höhenzuges. Acta Entomol. Bohemoslov., *70*, p. 390 – 399.

Pavlíček, T., Blažek R., 1986: Bioindication of the ecological balance in the agricultural landscape by means of *Carabidae* (in Czech). Manuscript, J. E. Purkyně University, Brno, 43 pp.

Pavlíček, T., Houšťková, L., 1989: The problem of survival of *Carabidae* in the agricultural landscape of Southern Moravia. Scripta Fac. Sci. Nat. Univ. Purk. Brun., *19*, p. 229 – 238.

Povolný, D., Šustek, Z., 1981: On the influence of long-term deforestation on the male preconnubial aggregations of *Sarcophagidae* in the Central European landscape. Acta Univ. Agr. Brun., Ser. C, Fac. silvicultur., *50*, p. 65 – 81.

Schwerdtfeger, F., 1975: Ökologie der Tiere. Band III., Synökologie. Hamburg, Berlin, 451 pp.

Sneath, P. H. A., Sokal, R. R., 1973: Numerical taxonomy. San Francisco, 572 pp.

Šustek, Z., 1983: Influence of the fall of the nickel leaching rest in the surroundings of Sereď. In Paulech, L. et al., 1983: Basic biological-ecological investigation in the surrounding of the deposit of the nickel leaching rest in the Nickel Smelting Works in Sereď (in Slovak). Final report, Bratislava, 51 pp.

Šustek, Z., 1984: Bioindicative properties of *Carabidae* and *Staphylinidae* in the Central European City (in Slovak). PhD. thesis, Bratislava, 360 pp.

Šustek, Z., 1990: Inventarisation of *Carabidae* and *Staphylinidae* on the selected localities in the Protected Landscape Area Slovakian Carst (in Slovak). Final report, Institute of Zoology and Ecosozology, Bratislava, 24 pp.
Thiele, H. U., 1977: Carabid beetles in their environments. Berlin, Heidelberg, New York, 367 pp.

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Šustek Z.: **Vetrolamy a líniové spoločenstvá ako koridory pre migráciu bystruškovitých** *(Coleoptera, Carabidae)* **v poľnohospodárskej krajine južnej Moravy.**

Migráciu a zmeny spoločenstiev bystruškovitých sme sledovali na južnej Morave v troch rôznych líniových spoločenstvách, vo vetrolame spojenom priamo s lesom, vo vetrolame izolovanom v poliach na starej medzi s poloprirodzeným zárastom krovísk spojených s lesnou rezerváciou. Hlavné faktory riadiace migráciu bystruškovitých sledovanými biokoridormi sú zloženie a hustota vegetačného krytu a hrabanky a šírka koridoru. Koridory pozostávajúce z domácich drevín umožňujú migráciu lesných a eurytopných bystruškovitých v intenzite dosahujúcej až 30 % ich zastúpenia v lese. Koridory zložené z introdukovaných exotických drevín umožňujú túto migráciu v intenzite 1 – 3 % zastúpenia týchto druhov v lesnom biocentre. Dĺžka koridoru má na migráciu bystruškovitých podružný vplyv. Pozitívny vplyv spoločenstva bystruškovitých v biokoridore na spoločenstvo v priľahlých poliach sme zistili iba v prípade poloprirodzenej medze. V príspevku ďalej rozoberáme predpoklady rôznych rastlinných spoločenstiev pôsobiť ako refúgiá a biokoridory pre bystruškovité v poľnohospodárskej krajine.