Windbreaks as migration corridors for carabids in an agricultural landscape

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Summary

Field observations were carried out to compare the migration of the Carabids from a forest through three different windbreaks into the agricultural landscape.

The most important factors affecting the migration of the forest and eurytopic carabid species through the windbreaks were the width, composition, density and height of the windbreak.

The windbreak width should not sink below 15 m. A width of 25 m seems to be sufficient to allow migration of mesohygrophilous forest and eurytopic carabids.

The length of the windbreak and short breaks have only a secondary effect on the migration of carabids through the windbreak.

Introduction

Intensive agriculture has contributed to a considerable simplification of the landscape structure. The hedges or small non-utilized parcels have disappeared and large fields covered by the same crop have become characteristic of the lowlands. The size of the fields exceeds the migration ability of many species. So, the chance of the animals to find a refugium or a suitable food resource and to reproduce has been drastically reduced. All these factors have caused a considerable decrease in species diversity and population size of many species.

From these reasons, many authors (e.g. Górny 1968, 1971: Forman 1983; Boháč & Pospíšil 1984; Farkač & Farkačová 1990) focused their attention on the ecological role of the line and strip vegetation formations in the landscape. However, some of them (Tischler 1951; Thiele 1964; Pollard 1968; Fuchs 1969; Farkač *et al.* 1990) are sceptical about the role of such formations in maintaining the ecological equilibrium of the landscape. The different opinions of individual authors are considerably biased by their choice of the experimental sites and variety of surrounding conditions. The aim of this contribution is to show how the different properties of windbreaks may influence the migration of carabids from a forest refugium into the agricultural landscape in South Moravia.

Material and methods

The beetles were caught by pitfall traps with formalin solution. The traps were placed in the axis of each windbreak. The numbers of the traps and their mutual distance were modified according to the expected gradients in properties of each windbreak. The traps were exposed during the whole vegetation period. Three windbreaks surrounded by wheat fields were chosen:

1. The 2.6 km long windbreak in Bulhary (Fig. 1) was founded in the fifties. It consists mostly of the introduced trees and shrubs (*Robinia*, *Wisteria*, cultivars of poplars). It is separated from an oak-hornbeam forest by an asphalt road. The windbreak width fluctuates between 8–25 m.
2. The 1.7 km long windbreak in Pavlov (Fig. 2) was represented by an old woody hedge consisting mostly of autochtonous trees and shrubs (*Rosa* spp., *Sambucus nigra*, *Crataegus* spp., *Prunus spinosa*, *Prunus domestica*, *Juglans regia*, *Amygdalus communis*, *Ulmus campestre*). It is directly connected with an oak-hornbeam forest. Some forest plants like *Arum maculatum* penetrated up to the dis-

K. Desender et al. (eds.), Carabid Beetles: Ecology and Evolution, 377–382.

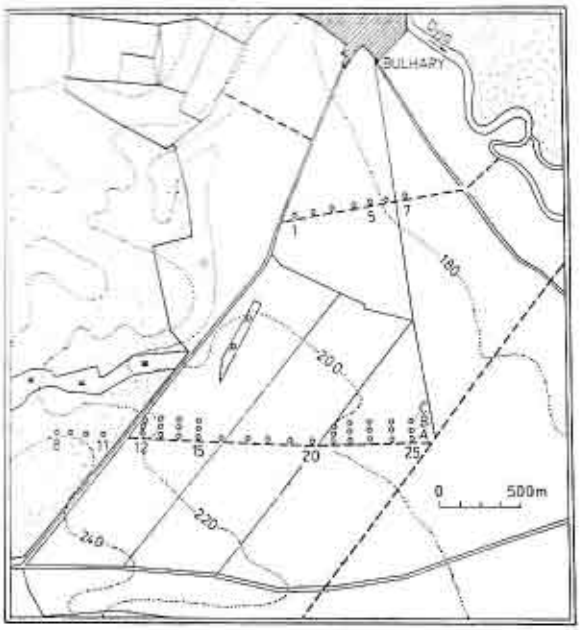

Fig. 1. Surroundings of the windbreak in Bulhary and position of the traps.

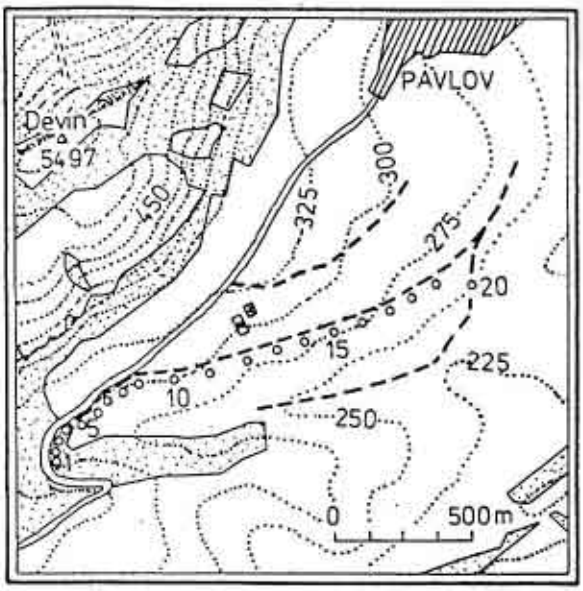

Fig. 2. Surroundings of the wooded hedge in Pavlov and position of the traps.

tance of 300–400 m from the forest. Its width is 7–25 m.

3. The 1.4 km long windbreak in Klentnica (Fig. 3) was founded in the early fifties. It consists of ten rows of poplar cultivars and of a rich seminatural shrub stratum with *Crataegus* spp., *Rosa* spp., *Cornus sanguinea* and locally also with dense islands of *Prunus spinosa*. In the concave southern part the poplars had dried and a wide grassy strip replaces the windbreak. The northern part of the windbreak is connected with a sparse oak forest and the southern part with a lime-maple stand. The width is constantly 25 m.

The material used here was collected in 1987 in Bulhary, in 1988 in Pavlov and in 1991 in Klentnica. The unweighted average linkage method was used for the analysis of data. Renkonen's index was used to measure similarity between the pitfall sites. The nomenclature of the carabids is taken from Freude *et al.* (1976).

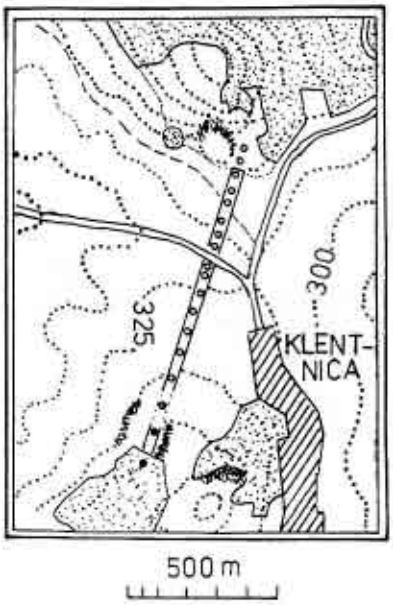

Fig. 3. Surroundings of the windbreak in Klentnica and position of the traps.

Results

The carabid species were classified into four ecological groups of species, viz. the hygrophilous

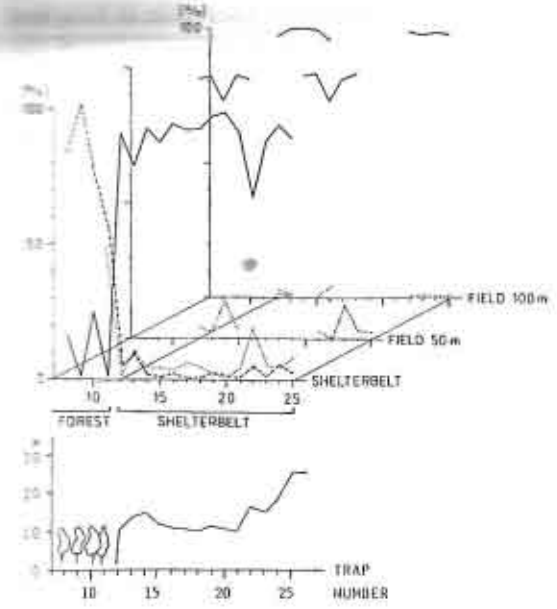

Fig. 4. Changes in the proportion of the carabid ecological groups along the windbreak in Bulhary. (dotted and dashed – hygrophilous forest species, dashed – mesohygrophilous forest species, dotted – mesohygrophilous eurytopic species, full – field species).

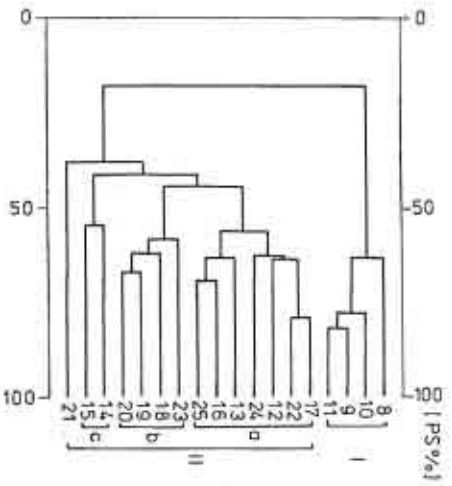

Fig. 5. Classification of the species assemblages from individual trapping sites in the windbreak in Bulhary.

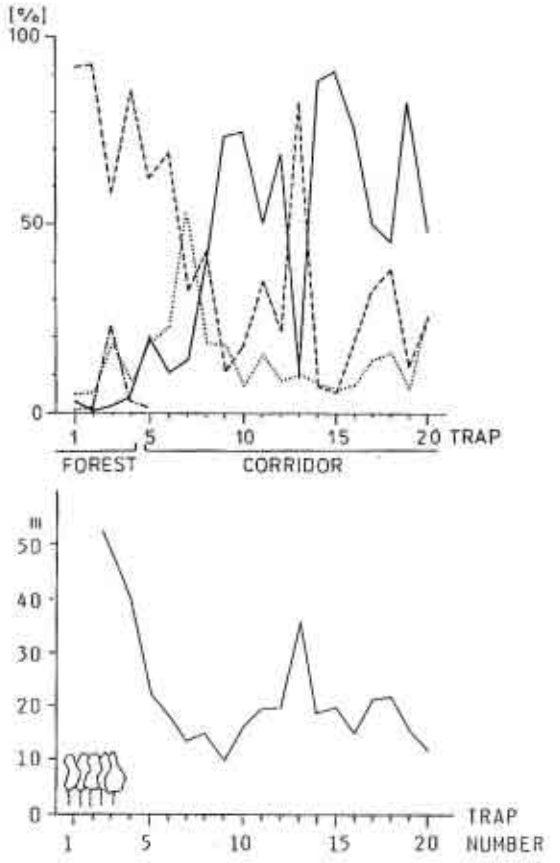

Fig. 6. Changes in the proportion of the carabid ecological groups along the wooded hedge in Pavlov (symbols as in Fig. 4).

forest, mesohygrophilous forest, mesohygrophilous eurytopic and field species. Their representation along the corridors changed as follows:

1. In Bulhary (Fig. 4) the proportion of the mesohygrophilous forest species started to decline already in the forest interior and the eurytopic *Carabus cancellatus* and *C. ullrichi* replaced them. A sudden change occurred immediately between the forest margin and the first trap at the windbreak beginning. The proportion of the field species increased to 90%. Within the distance of ca. 100 m the proportion of the mesohygrophilous forest species strongly declined and stabilized at 1–3% in more remote parts. Their proportion increased locally in the wider part at the distance of ca 1,400 m from the forest margin. The eurytopic species represented 2–5% of all individuals

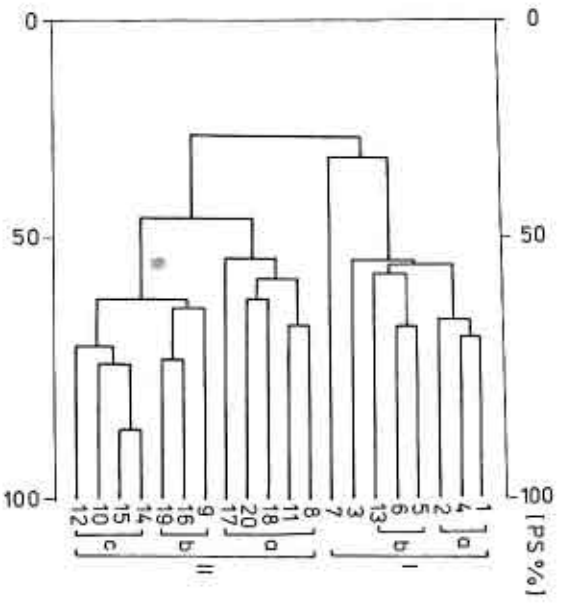

Fig. 7. Classification of the species assemblages from individual trapping sites in the wooded hedge in Pavlov.

along the whole windbreak. Their proportion increased locally in the wider parts, similarly to the mesohygrophilous forest species. In two parallel lines of traps in the neighbouring field, at a distance of 50 and 100 m from the windbreak, the forest species were completely absent. The eurytopic species (mostly *Pterostichus melanarius*) represented here at most 12% of individuals. The mutual relation of the individual ecological groups is reflected also in the clustering pattern (Fig. 5).

2. The wooded hedge in Pavlov (Fig. 6) allowed the migration of the mesohygrophilous forest species up to a relatively unlimited distance in proportions amounting to ca. 10–30% of their dominance in the forest. The occurrence of the hygrophilous forest species was limited only at a small depression at the beginning of the hedge. The eurytopic species culminated at the beginning of the hedge (nearly 50%) and in more remote parts their proportion stabilized at the level of 8–15%. Similarly, as in the mesohygrophilous forests species, their local maxima were correlated with the increasing width of the hedge. A positive influence of this woody hedge on the carabid community in the neighbouring fields was observable in June and early July, when a considerable number of *Carabus cancellatus* and *C. ullrichi* penetrated the field up to a distance of 50–100 m from the woody hedge. The clustering pattern also indicates the positive influence of the corridor width on the representation of the mesohygrophilous forest and eurytopic carabids along the corridor (Fig. 7). In spite of this, the distance from the forest biocentrum seems to be less important.
3. In Klentnica the representation of individual ecological groups of species (Fig. 8) fluctuated within wide limits along the whole corridor. The local maxima of the mesohygrophilous forest and eurytopic species were strongly correlated with the presence and density of the shrubs in the windbreak. The proportion of individual ecological groups of the carabids in the windbreak with the constant width of 25 m corresponds to their proportion in the wider parts of the woody hedge in Pavlov (Fig. 6).

Conclusions and discussion

The comparison of the carabid assemblages in three different windbreaks presented here with some unpublished data and with the results of other authors (Tischler 1951; Thiele 1964; Forman 1983; Boháč 1984; Pavlíček & Houstková 1989; Farkač *et al.* 1990) shows that the most important factors influencing migration of the mesohygrophilous forest and eurytopic species through the linear biocorridors are the width, density and composition of the corridors, which can create suitable microclimatical and light conditions for the survival and migration of the non-field carabid species. The width of the biocorridor should not sink below 15 m. The width of ca. 25 m seems to be fully satisfactory. Corridors consisting of autochtonous trees and shrubs make possible the migration of the forest or eurytopic carabids in the proportion up to 30% of their representation in a forest biocentrum. Corridors consisting mainly of introduced trees and shrubs allow the migration of the forest and eurytopic carabids only up to 1–3% of their proportion in a forest biocentrum. This striking difference is probably caused by the late and sparse foliage in

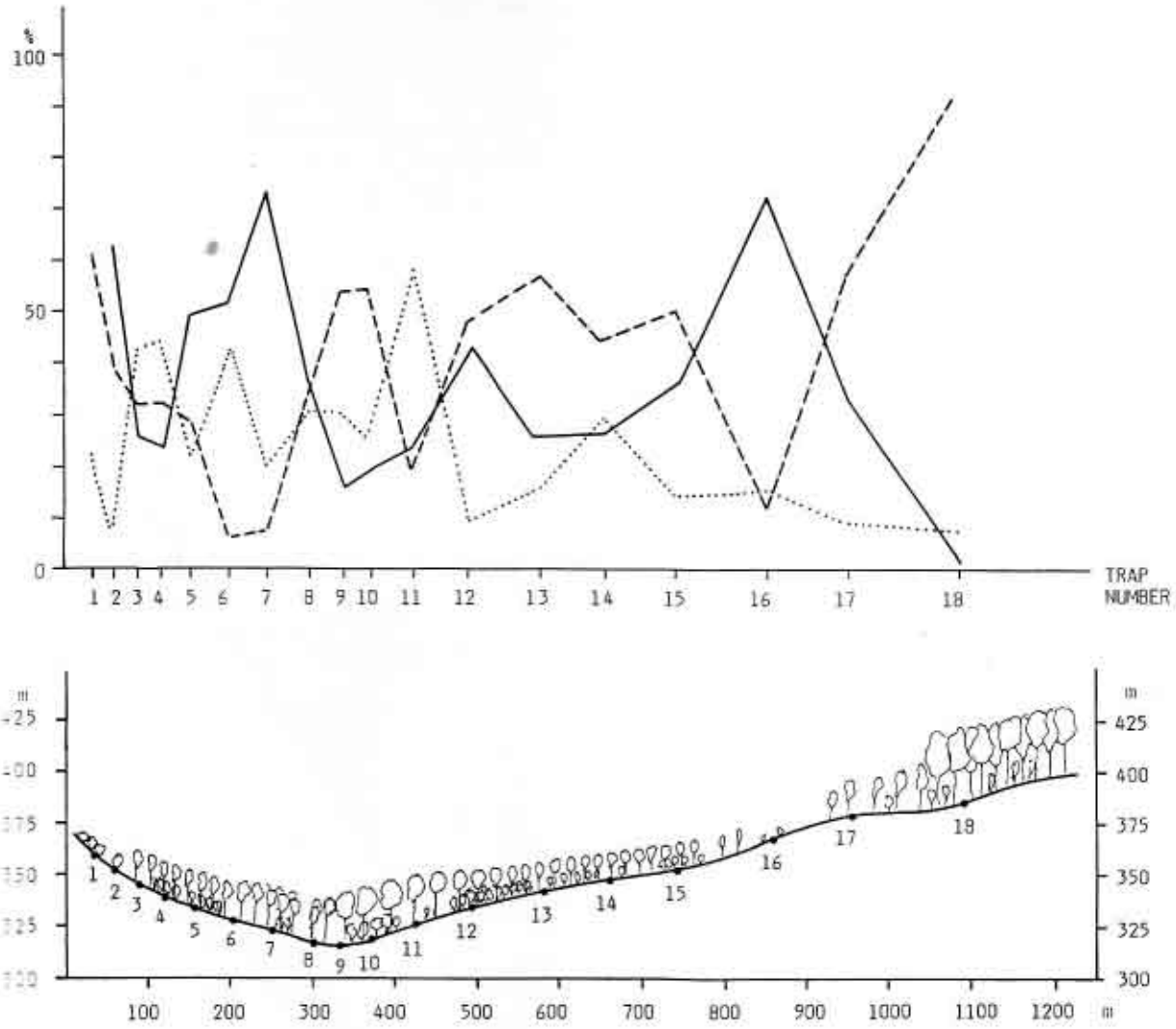

Fig. 8. Changes in the proportion of the carabid ecological groups along the windbreak in Klentnica (symbols as in Fig. 4).

some introduced woody plants (e.g. locust tree). Also the litter under the autochtonous and introduced trees and shrubs differs considerably. The composition of the shrub stratum seems to be more important than the composition of the tree stage. It can effectively compensate for the negative properties of some introduced trees.

The short discontinuities or narrower segments in a biocorridor have only local effect on the carabids and rainy periods can compensate for them. Also the length of a corridor has only a secondary effect on the migration of the carabids. A positive influence of a functionating biocorridor on the structure of the carabid assemblages in the adjacent fields is observable in the colder periods or if the crop is high and shadows the soil surface sufficiently. According to the local conditions, the positive effect of a biocorridor or small refugium was observable up to 50–200 m from its margin.

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