Vole spatial distribution and dispersal in European organic and conventional farming systems

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Introduction

North European landscapes are highly dominated by agriculture, where small biotopes, e.g. meadows, uncultivated grassland, hedge rows, field boundaries, surroundings of water ponds, only comprise a low percentage. In recent years organic farming has expanded in acreage due to customers increased awareness regarding pesticide and fertilizer use and biodiversity conservation. However, organic farming has changed from an extensive production with small fields, low mechanical impact and high crop diversity towards larger fields, intensive mechanical treatment, lower weed densities and lower field diversity. Still, organic farms could play an important role in the agricultural landscape as refuges for some small mammal species.

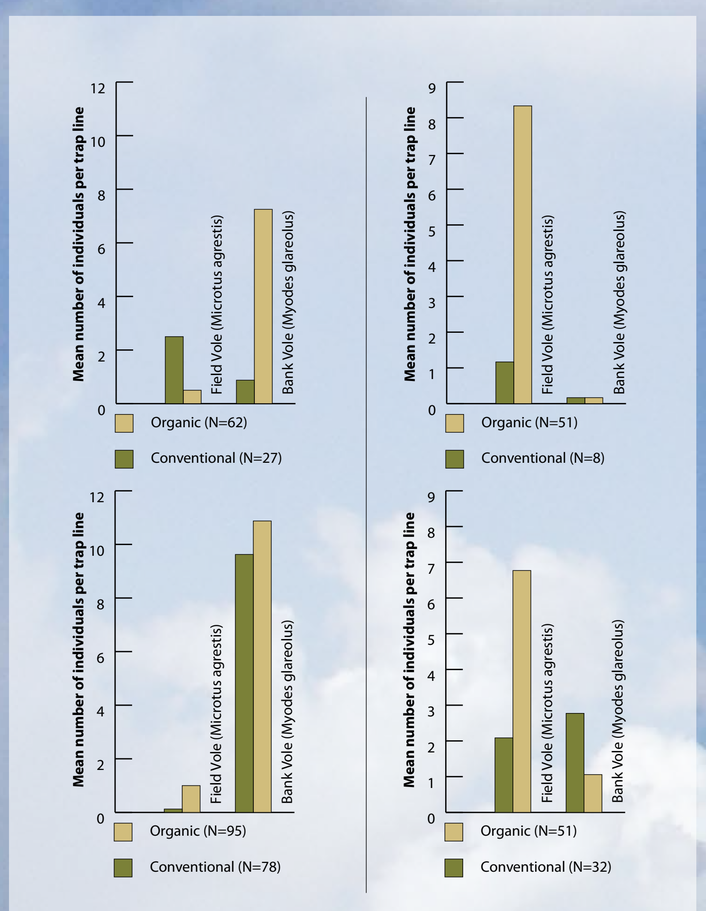

Fig. 1. Mean number of voles in hedge rows around Bjerringbro (upper histograms) and Kalø Estate (lower histograms).

Fig. 2. Mean number of voles in grassland around Bjerringbro (upper histogram) and Kalø Estate (lower histogram).

Aims and methods

We studied the responses of populations to habitat patches of different size and different surrounding management strategies (ecological and conventional farming). Studies were performed at two localities in Denmark, Kalø Estate in Eastern Jutland and the Bjerringbro area in Central Jutland. The sampling sites were represented by cultivated grassland habitat, small biotopes within cultivated fields and hedgerows between fields in rotation.

The diversity and density of small mammals were investigated by live-trapping sessions using either trap lines of 135 meters length and 15 meters between each traps, or traps ordered in a matrix defined by habitat circumference and core area. We also conducted telemetry studies on one species, the field vole (Microtus agrestis) and obtained tissue samples for DNA-studies (Marchi et al. 2010).

With the aid of high resolution orthophotos in MapInfo Professional 8.5 we determined the area (square meters) and the perimeter (meters) of each sampling site. In order to express habitat connectivity or the degree of geographical isolation, the linear distance between centre of sampling site and the nearest "stepping stone" or dispersal corridor was measured from the orthophotos. The three nearest hedgerows, nearest forest and three nearest small biotopes were included. Analysis were performed using the SAS Enterprise Guide 4.1 (SAS 2006).

Results

Small mammal species assemblages were low in numbers (6-11) in cultural farmland, and, on a property basis, not significantly different between organic and conventional farms. Very few species and individuals were present in the field matrix, and the small biotopes were by far the most important source of species richness.

Species density was positively correlated with the size of the habitat, and, generally, more voles were found in organic habitat patches than in conventional ones. More field voles (Microtus agrestis) were found in organic grassland and more bank voles (Myodes glareolus) in organic hedge rows than in conventional ones.

Telemetry studies of field voles showed low rates of dispersal and low colonization rates of the more or less isolated small biotopes at the time of year with no vegetation cover in the surrounding fields. Earlier studies by Christensen (1999) in the same area found high dispersal rates at the beginning of the breeding season in April-May and rapid colonization of isolated small biotopes. Home range sizes were highest during the breeding season.

We found no significant correlations between distance to nearest stepping stones/dispersal corridors and small mammal densities or species composition. But due to very low numbers in general we acknowledge that the results are inconclusive. Christensen (1999) using multivariate analysis found that the number of species in the small biotopes depended on habitat area, isolation, and habitat character (e.g. vegetation height and number of strata). Moreover, Marchi et al. (2010) found that the amount of unmanaged habitat was a significant predictor of effective population size.

Conclusions

In agricultural areas landscape structure influences the small mammal species living in this fragmented habitat matrix. The value of organic farms in respect to small mammal biodiversity depends mainly upon the number and area of small biotopes, and only to a minor degree upon the management of the fields. This is presumably related to a more dense and diverse vegetation cover, due to a lack of pesticide and fertilizer treatment in the organically managed small biotopes.

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Marchi, C., Andersen, L. W., Damgaard, C. F., Olsen, K., Jensen, T. S., Loeschcke, V. (2010, subm.). "Wildlife friendly agriculture: which factors do really matter? A genetic study on the field vole (Microtus agrestis)."
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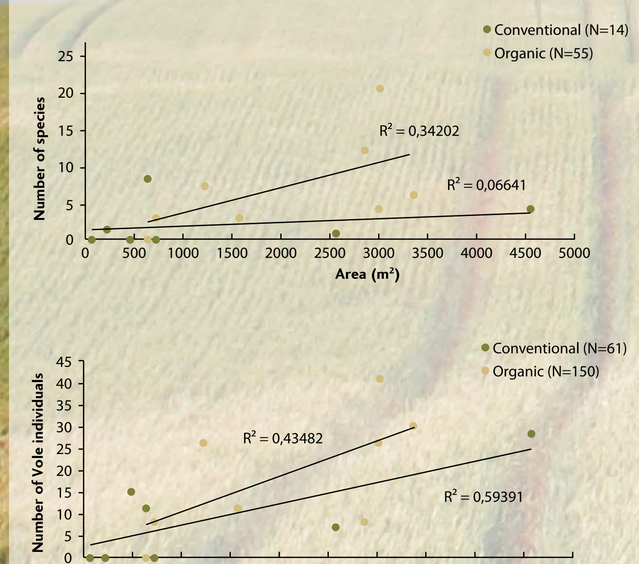

Fig. 3. Number of individuals per habitat patch size during spring (upper graph) and autumn (lower graph).

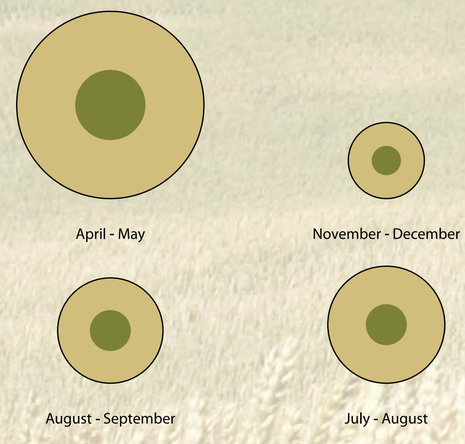

Fig. 4. Diagrammatic illustration of the relative size of field vole (Microtus agrestis) home area at different seasons. Green circles in the center represent core areas and the perimeter line represent 95% cluster. From Christensen (1999).

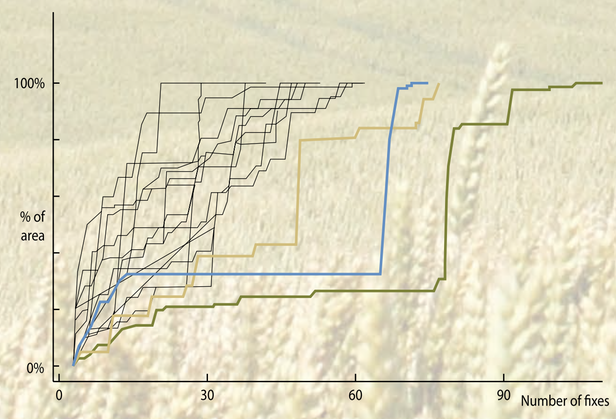

Fig 5. Incremental plots showing the range area changes, as successive telemetry fixes area added. Colours indicate vole range shift (yellow), a long sally (blue) and an emigration (green). From Keseler (1999).