Arthropod biodiversity in a landscape with grass and leguminous vegetation cover

Frydrych J.[1], Barták M.[2], Lošák M.[1], Cagaš B.[1], Rotrekl J.[3] and Kolařík P.[3]

[1]*OSEVA PRO Ltd., Grassland Research Station, Rožnov-Zubří, Czech Republic*
[2]*Czech University of Life Sciences Prague, Faculty of Agrobiology, Food, and Natural Resources, Prague, Czech Republic*
[3]*Research Institute for Fodder Crops, Ltd., Troubsko, Czech Republic*
E-mail: frydrych@oseva.cz

Abstract

Hemiedaphic arthropod biodiversity was studied in the following 5 grassland agroecosystems in North Moravia: Kelč (intensive seed production system), Horní Lideč (organic seed production system), Střítež (organic hay production system), Střítež (mulched meadow without biomass harvesting), and Zubří (spontaneous fallow). The highest number of both (morpho)species and specimens and simultaneously the highest Margalef's species richness index was found in the organic hay production system (Střítež); on the contrary, the lowest numbers in corresponding characters were found in intensive systems or systems without biomass harvesting (mulch and fallow). Both the diversity and equitability indices were more equally spread among the various agricultural systems.

Keywords: arthropods, grassy agroecosystems, agriculture, biodiversity

Introduction

In addition to its primary production function (of food and fibres) and contribution to food safety, agriculture fulfils important environmental, economic, and social functions. OSEVA PRO Ltd., Grassland Research Station, Rožnov-Zubří, Czech University of Life Sciences Prague, and the Research Institute for Fodder Crops, Ltd., Troubsko have set up a project *Impact on insect biodiversity in the landscape through various methods of farmland exploitation and agricultural technologies with respect to grass and leguminous pests and their bio-regulators*. The project focuses on the monitoring of the variability of insects under different systems of farmland exploitation and agricultural technologies with respect to the variability of pests and their bioregulators under grassland and leguminous vegetation cover. As a part of the research, the variability of insects in grassland and leguminous vegetation cover in systems of organic and conventional farming will be compared. This aim fulfils the recommendation of the decision IV/6 of the 1998 Conference of Parties to the Convention of Biological Diversity: 'evaluate the effect of different agricultural practices on wild biodiversity'.

Materials and methods

Collecting method – to catch only autochthonous species and simultaneously to reach a high taxonomic resolution, we used emergence traps. The traps (1 trap per locality) with a quadrangular pyramid shape (effective capture area = bottom of the trap = 1 m^2) were

made of fine polyamide fabric (mesh less than 0.1 mm). The sides of the traps were shallowly buried in the soil to prevent allochthonous immigrants from entering the trap. The collecting head was filled with 70% ethyl alcohol. Approximately each month trapped material was collected by simply inserting a new collecting bottle, the sample being stored in a freeze box (–20°C).

Brief description of localities under study. Kelč: seed production system, *Festuca pratensis*, cv. Rožnovská. Intensive system with pesticides and synthetic fertilisers for more than 5 years. **Horní Lideč**: seed production system, *Festuca pratensis*, cv. Rožnovská. Organic system without pesticides and synthetic fertilisers (with organic fertilisers only) for more than 3 years. **Střítež nad Bečvou (hay)**: meadow used for hay production, the dominant species: *Agrostis stolonifera*. Organic system without pesticides and synthetic fertilisers, 2–3 cuttings per year, this system has prevailed for more than 10 years. **Střítež nad Bečvou (mulch)**: meadow without harvesting, cut biomass (2 cuts per year) left on the surface as mulch, the dominant species: *Agrostis stolonifera*. Organic system without pesticides and synthetic fertilisers, 2–3 cuttings per year, this system has prevailed for more than 3 years. **Zubří**: spontaneous fallow, without any agricultural management for more than 5 years (formerly used as a meadow for hay production), the dominant species: *Agrostis stolonifera*.

Material processing

First, each sample was sorted into the following taxonomic groups: *Araneae, Collembola* (they were omitted for the purpose of this article), *Dermaptera, Psocoptera, Heteroptera, Auchenorrhyncha, Sternorrhyncha, Thysanoptera, Neuroptera, Coleoptera, Diptera, Hymenoptera,* and *Lepidoptera. Heteroptera, Coleoptera*, and *Diptera* were further subdivided into families, and *Hymenoptera* were sorted into superfamilies. Then all the groups were separately divided into morphospecies or true species according to our knowledge and similarity in appearance and counted.

Synecological analyses

For the purpose of analyses, each sample was considered as a separate unit because it is hardly possible to homologise 'morphospecies' between individual samples even in the same locality. The following community characters were used: Simpson's index of diversity: $D = 1/\sum p_i^2$ and equitability: $E = D/Nd$, where $p_i = N_i/N$. Nd = number of species found in a given locality, N = number of specimens of the locality, N_i = number of specimens of i-*th* species in the locality. Shannon's index of diversity: $H = -\sum p_i \ln p_i$ and equitability: $J = H/\ln Nd$, where symbols are the same as in Simpson's indices. Margalef's index of species richness: $P = (Nd - 1)/\log N$, where the symbols are the same as in Simpson's indices. For details consult Begon *et al.* (1997).

The characters N, Nd, D, E, H, and J were averaged to obtain the mean value for each locality under study.

Results and discussion

The number of specimens – the mean number of specimens per sample – ranged from 2,632 to 863 (specimens m^{-2} $month^{-1}$). The highest number of specimens was found in Střítež (hay), under an organic field management regime. On the contrary, the lowest numbers of specimens were found in Zubří and Kelč.

The number of species – the mean number of species per sample – ranged from 97.5 to 130.3 (species m^{-2} $month^{-1}$). The highest number of species was found in the Střítež locality (hay), exactly as in the case of the number of specimens. Zubří displayed the lowest number of species (spontaneous fallow without harvesting biomass).
Margalef's species richness index – the highest Margalef's index was in the Střítež locality (hay); on the contrary, the lowest was in Střítež (mulch).
Shannon's index of diversity – the highest value of the Simpson's diversity index was observed in Střítež (hay) and Horní Lideč. Střítež (mulch) and Zubří displayed the lowest diversity, the first locality being under organic management and the latter being spontaneous fallow without biomass harvesting. The highest Shannon's diversity was observed in Kelč and Horní Lideč. Střítež (hay) displayed the lowest diversity
Simpson's and Shannon's indices of equitability – Simpson's equitability is the highest in Horní Lideč and Shannon's equitability is the highest in Kelč. On the contrary, the lowest Simpson's equitability was in Střítež (mulch) and Zubří. The lowest Shannon's equitability was in Střítež (hay).

Table 1. The values of synecological indices are summarised in the following table – Statistics ANOVA

	Index			No. species statistic	No. specimens statistic
	Simpson's	Shannon's	Margalef's		
Kelč	26.22[a]	1.61[a]	35.34[a]	107[a]	1,035[a]
Horní Lideč	32.35[a]	1.55[a]	36.34[a]	103[a]	1,624[a]
Střítež nad Bečvou (hay)	34.16[a]	1.28[a]	41.27[a]	130[a]	2,632[a]
Střítež nad Bečvou (mulch)	21.34[a]	1.44[a]	32.90[a]	102[a]	1,544[a]
Zubří (fallow)	23.76[a]	1.47[a]	34.02[a]	98[a]	863[a]

Conclusions and discussion

The highest number of specimens was found in Střítež (hay), an organic system. On the contrary, the lowest amount of specimens was found in Zubří (fallow) and Kelč (intensive agricultural system). The highest number of species was found in the Střítež locality (hay), exactly as in the case of the number of specimens. Zubří displayed the lowest number of species. The highest Margalef's index was in the Střítež locality (hay); on the contrary, the lowest was in Střítež (mulch). The highest Simpson's diversity was observed in Střítež (hay) and Horní Lideč, an organic system. Střítež (mulch) and Zubří (fallow) displayed the lowest diversity. The highest Shannon's diversity was observed in Kelč and Horní Lideč. Střítež (hay) displayed the lowest diversity. The Simpson's equitability is the highest in Horní Lideč (an organic system) and the Shannon's equitability is the highest in Kelč (intensive agricultural system). On the contrary, the lowest Simpson's equitability was in Střítež (mulch) and Zubří (fallow). The lowest Shannon's equitability was in Střítež (hay). The differences between the localities are not inconclusive (Table 1).

Acknowledgements: This paper was supported by the Ministry of Education, Youth and Sports of the Czech Republic, Project MSM 6046070901, and the Ministry of Agriculture of the Czech Republic, Project No. QH72151.

References

Barták M., Frydrych J., Lošák M., Cagaš B., Rotrekl J., Kolařík P. and Rudišová I. (2008) Arthropod biodiversity in grassy agroecosystems under different management practices. In: Kubík Š. and Barták M. (eds): Workshop of animal biodiversity, Jevany, 3–4 July, 2008. 1st edition. Prague, Czech University of Life Sciences Prague, 37–47. ISBN 978-80-213-1865-6.

Begon M., Harper J.L. and Townsend C.R. (1997): Ecology. Individuals, Populations, and Communities. Vydavatelství Univerzity Palackého, Olomouc, 949 pp. (in Czech)