

POLISH JOURNAL OF ECOLOGY (Pol. J. Ecol.)	55	4	633–635	2007
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The authors dedicate this set of papers to the memory of Professor dr Lech Ryszkowski (1932–2007) Head of the Research Center for Agricultural and Forest Environment PAS who was devoted to the idea of linking agricultural management and ecology and who initiated our investigations in agricultural landscape.

Special section on:

ORGANIC MATTER CONTENT AND SOIL FAUNA IN AGRICULTURAL LANDSCAPE: EFFECTS OF DISTANCE TO FORESTED STRIPS AND OF STRIP AGE

PREFACE

We present the second set of papers concerning the impact of midfield forests on adjacent fields. The first one entitled “*Impact of midfield shelterbelts on agricultural landscape*” (Eds: A. Kajak, J. Karg, L. Ryszkowski) was printed in parts in 2003 and 2004 (in *Polish Journal of Ecology* 51: 3 and 52: 2 and 4). The investigations were carried out in the experimental area of the Research Center for Agricultural and Forest Environment Polish Academy of Sciences. In XIX century this agricultural landscape was enriched with linear woods. That historical network was supplemented in the last decade with new midfield forest strips of diverse tree species composition. Prof. Lech Ryszkowski submitted the idea of introducing young shelterbelts and to undertake interdisciplinary studies there.

The objective of research has been to determine the extent to which alterations in the landscape structure by planting midfield forest strips could enhance organic matter accumulation in the field soil, pest control, as well as density and diversity of soil fauna.

Recently one of the crucial challenges of ecology is the problem of climatic changes and the increase of CO₂ concentration in the atmosphere. The soil is the great sink of organic matter, that can regulate carbon storage,

and decrease its diffusion (Lal 2004). The management is an important factor determining the rate of carbon transformations in agroecosystems. Soil organic matter decides also on the nutrient and water retention. The potential of carbon absorption in agricultural soils is high because they occupy large areas and they lost a considerable fraction of carbon, which can be restored. Possibility to sequester organic matter in croplands without changing farming practice, by changing landscape structure only, seems promising. Results of the investigations carried out in Poland have indicated, that organic matter content increases in fields at least in the several ten meters wide belt along forest strips (Karg *et al.* 2003, Kostro-Chomać 2004, Bernacki unpublished).

The present studies concern mainly the soil fauna and litter decomposition. The role of the fauna is not well known, but the last decade provides new data showing that it influences substantially organic matter transformations and stabilization. Soil fauna, as was shown in the microcosm experiments can change soil structure, the size of soil aggregates and the proportion of the decomposition resistant humus fraction. This role

is especially important in low fertile soils (Bronick and Lal 2005, Fox *et al.* 2006).

It was indicated that the total detritus input, passes at least once through alimentary tracts of invertebrates (Bal 1970, Rusek 1975, Seastedt 2000). As was shown by thin soil sections the vast bulk of the upper soil layer constitutes of decomposition resistant excrements of meso- and macrofauna (Davidson and Grieve 2005). The most resistant are compact excrements of Acarina and Collembola surrounded by chitin-rich layer and casts of enchytraeids and earthworms, formed by mixing recalcitrant organic compounds with mineral particles (Webb 1977, Martin and Marinissen 1993, Hansen 2000, Seastedt 2000, Coleman *et al.* 2004). In the croplands especially important may be Collembola, Acarina, Enchytraeidae and Diptera larvae, relatively abundant in this area; their excrements formed stable aggregates (Rusek 1975, Striganova 1980, Altieri 1990, Martin and Marinissen 1993, Jastrov 1996, Juma 1994, Marinissen and Didden 1997, Hansen 2000, van Vliet *et al.* 2004, Lavelle *et al.* 2006).

Another important focus are the relations between faunal diversity, landscape structure and soil carbon dynamics (Dauber *et al.* 2003, Marshall *et al.* 2006). Ecosystems with high diversity sequester more organic matter in soil and biota, than those with reduced diversity (Kajak and Wasilewska 1997, Lal 2004, Bronick and Lal 2005).

The studies were performed in the two periods: 1999–2000 and 2003–2004, differing significantly in the total sum of precipitation (551, 538 respectively in 1999 and 2000 and 338, 538 in 2003, 2004 *versus* 590 mm as long term mean). Altogether in both periods strips 2, 6, 7, 11 and 150 years old and adjacent fields were compared.

The main problems considered in the present set are:

1. To verify the previous results concerning the distribution pattern of soil fauna across the transect: forest strip – adjacent field basing on larger material, gathered in the landscape enriched with forest strips differentiated by age, in different climatic conditions (the drought period in 2003),

2. To compare faunal communities and decomposition processes of the fields located in the strip – managed area with the field located in the deforested area.

3. To assess whether the decomposition rate of litter depends on the distance to the forest strip and on the colonization of this litter by fauna.

4. To assess the influence of the introduced small portions of litter exposed on the soil surface on the properties of the underlying soil.

The density, biomass and diversity of microfauna (Nematoda), mesofauna (Collembola, Acarina, Enchytraeidae) and macrofauna (insect larvae, Formicidae, Symphyla) and patrolling intensity of spiders were estimated. The present results confirm previous conclusions – midfield forests enhance soil organic matter content, the biomass and diversity of soil meso- and macrofauna in adjacent fields and increase the proportion of predators in the community. So, it can be suggested, that planting of midfield forest strips is beneficial for organic matter content in adjacent fields (Kajak 2007, Nowak 2007, Olechowicz 2007, Olejniczak 2007). The biomass of microfauna (nematodes) opposite to the biomass of larger animals, was similar in the field and forest area, but the composition of nematode communities differs significantly (Dmowska 2007).

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REFERENCES

- Altieri M.A. 1990 – The ecological role of biodiversity in agroecosystems – *Agric. Ecos. Envir.*, 74: 19–31.
- Bal L. 1970 – Morphological investigations in two moder humus profiles and the role of the soil fauna in their genesis – *Geoderma*, 4, 5–36.
- Bronick C.J., Lal R. 2005 – Soil structure and management: a review – *Geoderma*, 124: 3–22.
- Dauber J., Hirsch M., Simmering D., Waldhardt R., Otto A., Wolters V. 2003 – Landscape structure as an indicator of biodiversity: matrix effects on species richness – *Agric. Ecos. Envir.*, 98: 321–329.
- Coleman D.C., Crossley D.A., Hendrix P.F. 2004 – *Fundamentals of soil ecology* – Elsevier.
- Davidson D.A., Grieve J.C. 2005 – Relationships between biodiversity and soil structure and function: Evidence from laboratory and field experiments – *Appl. Soil Ecology*, 33: 176–185.
- Dmowska E. 2007 – Nematode communities along the transect shelterbelt- ecotone – crop field – *Pol. J. Ecol.* 55: 665–680.
- Fox O., Vetter S., Ekschmitt K., Wolters V. 2006 – Soil fauna modifies the calcitrance-persistence relationship of soil carbon pools – *Soil Biol. Biochem.*, 38: 1353–1363.
- Hansen R.A. 2000 – Diversity in the decomposing landscape (In: *Invertebrates as webmasters in ecosystems*, Eds: D.C. Coleman, P.F. Hendrix) – CABI Publishing, Wallingford, New York: 203–220.
- Jastrov J.D. 1996 – Soil aggregate formation and the accrual of particulate and mineral-associated organic matter – *Soil. Biol. Biochem.*, 28: 665–676.
- Juma N.G. 1994 – A conceptual frame work to link carbon and nitrogen cycling to soil structure formation – *Agric. Ecos. Envir.*, 51: 257–267.
- Kajak A. 2007 – Effects of forested strips on spider assemblages in adjacent cereal fields: Dispersal activity of spiders – *Pol. J. Ecol.* 55: 691–704.
- Kajak A., Wasilewska L. 1997 – Changes in meadow ecosystems as consequence of secondary succession and plant diversity (synthesis of research) – *Ekol. pol.*, 45: 839–859.
- Karg J., Kajak A., Ryszkowski L. 2003 – Impact of young shelterbelts on organic matter content and development of microbial and faunal communities of adjacent fields – *Pol. J. Ecol.*, 51: 283–290.
- Kostro-Chomać A. 2003 – Zmiany zawartości materii organicznej gleby pod wpływem pasów leśnych – [Changes in soil organic matter content as a consequence of introduction of wooded shelterbelts] – Ph. Doctor`s Thesis, Agricultural University, Warszawa. (in Polish)
- Lal R. 2004 – Soil carbon sequestration to mitigate climate change – *Geoderma*, 123: 1–22.
- Lavelle P., Decaëns T., Aubert M., Barot S., Bloin M., Bureau F., Margerie P., Mora P., Rossi J.-P. 2006 – Soil invertebrates and ecosystem services – *Eur. J. Soil Biol.*, 42: 3–15.
- Marinissen J.C., Diddden W.A.M. 1997 – Influence of Enchytraeidae on aggregate formation – *Soil Biol. Biochem.*, 29: 387–390.
- Marshall E.J.P., Wert T.M., Kleijn D. 2006 – Impacts of an agri-environment field margin prescription on the flora and fauna of arable farmland in different landscapes – *Agric. Ecos. Envir.*, 113: 36–44.
- Martin A., Marinissen J.C. 1993 – Biological and phisico-chemical processes in excrements of soil animals – *Geoderma*, 56: 331–347.
- Nowak E. 2007 – Enchytraeids (Enchytraeidae. Oligochaeta) in midfield shelterbelts of different age and in adjoining croplands – *Pol. J. Ecol.*, 55: 681–690.
- Olechowicz E. 2007 – Soil and litter macrofauna in shelterbelts and in adjacent croplands: Changes in community structure after tree planting – *Pol. J. Ecol.*, 55: 647–664.
- Olejniczak I. 2007 – Soil mesofauna (Acarina and Collembola) along transects crossed shelterbelts of different age and adjacent fields – *Pol. J. Ecol.*, 55: 637–646.
- Rusek J. 1975 – Die bodenbildende Funktion von Collembolen und Acarina, *Pedobiologia*, 15: 299–308. (in German)
- Seastedt T.R. 2000 – Soil fauna and control of carbon dynamics: Comparisons of rangelands and forests across latitudinal gradients (In: *Invertebrates as Webmasters in Ecosystems*, Eds: D.C. Coleman, P.F. Hendrix) – Wallingford, New York, CABI Publishing: 293–312.
- Striganova B.R. 1980 – Pitaniye pochvennykh saprofagov [Feeding of soil saprophages] – Nauka, Moskva, 243. (in Russian)
- Webb D.P. 1977 – Regulation of deciduous forest litter decomposition by soil arthropod feces (In: *The role of arthropods in forest ecosystems*, Ed. W.J. Mattson) – Springer Verlag, Berlin, Heidelberg, New York: 57–69.
- Van Vliet P.C.J., Beare M.H., Coleman D.C., Hendrix P.F. 2004 – Effects of enchytraeids (Annelida, Oligochaeta) on soil carbon and nitrogen dynamics in laboratory incubations – *Appl. Soil Ecology*, 25: 147–160.

Received after revising May 2007