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## NOTE BRÈVE

### ASSEMBLAGES OF MILLIPEDES AND CENTIPEDES ACCORDING TO THE TYPE OF PASTURE MANAGEMENT: PRELIMINARY RESULTS FROM THE CZECH REPUBLIC

Jan MIKULA<sup>1</sup>, Bořivoj ŠARAPATKA<sup>1</sup>, Oldřich KOPECKÝ<sup>2</sup> & Ivan H. TUF<sup>1,\*</sup>

RÉSUMÉ. — *Les peuplements de millipèdes et de centipèdes résultant du type de gestion des pâturages: résultats préliminaires en République tchèque.* — Le but de cette étude était de comparer la répartition et les structures des groupements de centipèdes et de millipèdes dans les pâturages en fonction de différents types de gestion. Les types de gestion évalués étaient le pâturage de moutons, le fauchage et le paillage dans diverses combinaisons. Différents modes de fondations de pâturages ont également été évalués - mélange commercial des cultures fourragères, semences locales mélangées avec des proportions différentes de plantes dicotylédones, et une jachère spontanée. Malgré la rareté des centipèdes et des millipèdes, l'effet le plus positif pour les millipèdes a été observé dans le cadre du paillage car celui-ci offre de la matière organique morte. La meilleure façon de gérer le pâturage est d'utiliser un mélange local de semences à forte proportion de plantes dicotylédones comme nourriture de qualité supérieure en comparaison du gazon.

SUMMARY. — The aim of this study was to compare distribution and assemblage structures in centipedes and millipedes in pastures with different management arrangements. The evaluated types of management included sheep grazing, mowing, mulching and various combinations of these treatments. Different foundation modes of pasture were also evaluated – commercial mixtures of fodder crops, local mixtures of seeds with different proportions of dicotyledonous herbs, and spontaneous fallow land. Despite low abundance of both centipedes and millipedes, the most positive effect observed in millipedes was in mulching due to the surplus of dead organic matter. The best way to manage pasture is to use a mixture of local seeds with a high proportion of dicotyledonous herbs as food of higher substantiality compared to grass.

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Soil invertebrates play an important role in ecosystem function as they improve the nutrient cycle through decomposition processes and its regulation by predation and they modify the physical properties of soil (Ekschmitt & Griffiths, 1998; Wolters, 2001; Lavelle *et al.*, 2006). Although their role is underestimated, they irreplaceably participate in a self-organizing soil system and provide valuable ecosystem services (Lavelle *et al.*, 2006). Thus, for instance, they play an important role during ecological restoration of disturbed areas (Tajovský, 2001; Snyder & Hendrix, 2008). For these reasons, it seems to be important to manage soil macrofauna in

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order to maintain soil fertility, especially in agroecosystems (Lavelle *et al.*, 1994). Hence, any management regime modifying the community structure of soil macro-invertebrates is likely to have an important effect on processes ultimately regulating the provision of forage for livestock.

Centipedes (Chilopoda) and millipedes (Diplopoda) represent important groups of soil macrofauna in Central European conditions. Centipedes are predators regulating populations of smaller invertebrates (e.g. springtails, potworms, earthworms, oribatid mites, etc.), decomposing organic matter (Poser, 1988); millipedes are detritivores destroying litter and furthering biochemical decomposition by bacteria (Förster *et al.*, 2006), and they are classified as litter transformers (Lavelle *et al.*, 1997). Both model groups of soil invertebrates have been used before for evaluation of quality of pastures with one main result – the main negative factor of conventional agriculture management is the use of pesticides (Klinger, 1992; Blackburn & Arthur, 2001). Complete abandonment of management is useful for myriapods in pastures as well as meadows (Seeber *et al.*, 2005). Our study was aimed to evaluate the impact of different types of pasture management on assemblages of centipedes and millipedes.

## MATERIAL AND METHODS

The field investigation was performed on three localities in East Moravia, in the Czech Republic. The first locality is situated near the town of Morkov (49°32.3' N, 18°4.3' E) on fragmented pasture representing a mosaic of different types of management. Different combinations of several diverse treatments were performed on individual plots (size of plot 5×10 m). The treatment variants were: 1) permanent sheep grazing, 2) mowing, 3) alternate grazing-mowing, 4) mulching. These treatments were combined with the presence or absence of fertilization (N, P, K) and with unequal frequency of mowing (2 or 3 times per year). The second and third locality are located near the village of Zubri (N 49°28', E 18°6'), situated on a field with a mosaic of plots (size of plot 5×5 m) sown with different types of seed mixtures: 1) commercial mixture of fodder crops, 2) mixture of local plant seeds with a high proportion of dicotyledonous herbs and 3) mixture of local plant seeds with a low proportion of dicotyledonous herbs. The control plot was spontaneous fallow land. The second and third locality differed mainly in the number of years for which the field has been controlled. The second locality (Zubri-young) was created in 2006. The third locality (Zubri-old) has been treated since 1997, when the experiment began.

Soil invertebrates including myriapods were collected from 54 pitfall formaldehyde traps (a glass jar with a metal cover and an inserted plastic pot with 2 dl of 4 % formaldehyde, 3 traps per plot arranged in a line with 3 m interspacing, exposed from May to November 2007, checked monthly). Quantitative data from pitfall traps was evaluated by CANOCO programme for Windows 4.5© (Ter Braak & Šmilauer, 1998). The effect of different types of management on myriapod distribution was evaluated by unimodal canonical correspondence analysis (CCA), and Monte-Carlo permutation tests.

## RESULTS

Altogether, 104 individuals of centipedes and millipedes were trapped, representing 5 species of millipedes from the Polydesmidae, Nemasomatidae and Julidae families and 4 species of centipedes from the Henicopidae and Lithobiidae families respectively (Tab. I). The highest numbers of individuals were recorded from two plots with different management treatments, one represented by alternate grazing-mowing with fertilization and the other by a mixture of local seeds with a high proportion of herbs (Tab. I). The Shannon-Weaver diversity index was highest on pasture mowed twice a year.

Due to the low number of individuals, only material from the Morkov locality was analysed by CANOCO. CCA biplot summary (Fig. 1) shows the distribution of myriapods, the first axis describes 21.4 % and the whole model describes 59.2 % variability of species data. The whole model is significant ( $F = 2.836$ ,  $p = 0.0020$ ), the significant effect on distribution of myriapod species is evident in alternate grazing-mowing ( $F = 6.29$ ,  $p = 0.002$ , describing 44 % variability) and mulching ( $F = 2.15$ ,  $p = 0.048$ , describing 28.8 % variability). One of the most important results refers to the high preference of the *Unciger foetidus* millipede for sites with mulching. This pattern was also evident for all millipedes in analysis.

Besides the low number of trapped individuals on small plots at the Zubri-old and Zubri-young localities it is evident that spontaneous fallow land is an uncomfortable site for myriapods.

TABLE I

Recorded species of myriapods (ind./3 traps/5 months) on pastures with different types of management and calculation of Shannon-Weaver diversity index of assemblages

	<i>Polydesmus inconstans</i> Latzel, 1884	<i>Nemasoma varicorne</i> C.L.Koch, 1847	<i>Cylindroiulus latestriatus</i> (Curtis, 1845)	<i>Unciger foetidus</i> (C.L.Koch, 1838)	<i>Unciger transsilvanicus</i> (Verhoeff, 1899)	<i>Lamyctes emarginatus</i> Newport, 1844	<i>Lithobius forficatus</i> Linnaeus, 1758	<i>Lithobius muticus</i> C.L.Koch, 1847	<i>Lithobius microps</i> Meinert, 1868	Number of individuals	Number of species	Shannon-Weaver diversity index
<b>Morkov</b>										65	5	
sheep grazing	-	-	-	-	+	-	+	+	-	10	3	0.46
sheep grazing with fertilization	-	-	-	+	+	-	-	-	-	6	2	0.28
alternate grazing-mowing	-	-	-	-	-	+	+	-	-	3	2	0.28
alternate grazing-mowing with fertilization	-	-	-	-	-	+	+	+	-	12	3	0.40
2 mowings per year	-	-	-	+	+	-	+	+	-	10	4	0.53
3 mowings per year	-	-	-	+	-	-	+	-	-	4	2	0.30
2 mowings per year with mulching	-	-	-	+	+	-	-	+	-	11	3	0.37
3 mowings per year with mulching	-	-	-	+	+	-	-	-	-	8	2	0.29
2 mowings per year with fertilization	-	-	-	-	-	-	+	-	-	1	1	0.00
3 mowings per year with fertilization	-	-	-	-	-	-	-	-	-	-	-	-
<b>Zubri-young</b>										33	7	
local seed mixture with low proportion of herbs	+	-	+	-	-	-	+	-	+	8	4	0.47
local seed mixture with high proportion of herbs	+	+	+	-	-	-	+	+	-	12	5	0.48
commercial mixture of fodder crops	+	-	+	-	-	+	-	-	-	7	3	0.35
spontaneous fallow land	-	-	+	-	-	-	+	-	-	6	2	0.20
<b>Zubri-old</b>										6	2	
local mixture of seeds with herbs (20 kg/ha)	-	-	-	-	+	-	-	-	-	1	1	0.00
local mixture of seeds with herbs (40 kg/ha)	-	-	-	-	+	-	+	-	-	3	2	0.28
commercial mixture of fodder crops	-	-	-	-	+	-	-	-	-	2	1	0.00
spontaneous fallow land	-	-	-	-	-	-	-	-	-	-	-	-

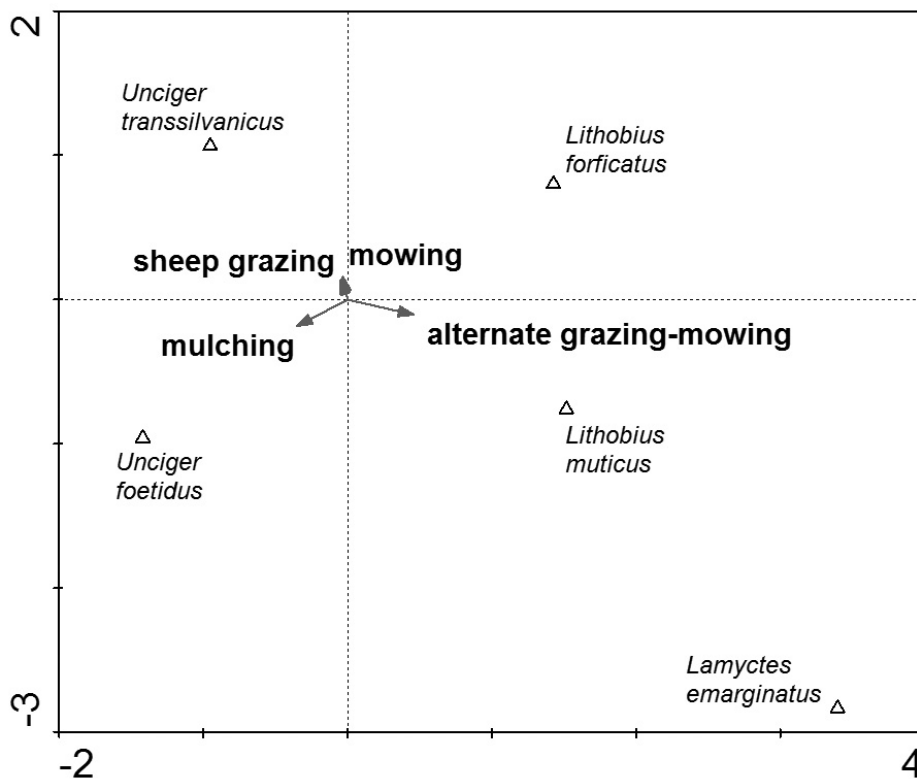


Figure 1.— CCA biplot of distribution of myriapods at sites according to type of pasture management (locality Morkov).

## DISCUSSION

All recorded species are common members of communities on sites disturbed by humans such as fields, heaps or urban areas (Klinger, 1992; Leśniewska, 1996; Wytwer, 1996; Langhton, 2001); e.g. in Centre, Ile-de-France and Poitou-Charentes regions (France), Iorio (2004) observed that *L. emarginatus* is highly represented in agroecosystems, because despite captures in various habitats, almost all his data on this species came from agroecosystems (corn fields). All species were classified as eurytopic or adaptable to a Central European environment (Tuf & Tufová, 2008). The number of species is typical for this type of biotope, 2-7 species of millipedes and 1-7 species of centipedes were found on pastures in Germany as well as in the USA, the Azores, the Netherlands or the Slovakia (Zimmer *et al.*, 2000; Byers & Barker, 2000; Borges & Brown, 2003; Berg & Hemerik, 2004; Stašiov *et al.*, 2011; Urblik *et al.*, 2011).

Results from our data collected at the Morkov locality indicate that millipedes (mainly *U. foetidus*) preferred mulched plots. Millipedes are decomposers and remains of organic matter spread on the soil surface represent a food source for them; even exposed dead organic matter can be used as a trapping method for millipedes (Ožanová, 2001). The amount of dead organic matter was also the most important factor for abundance of myriapods in the Netherlands (Berg & Hemerik, 2004). By mulching, more favourable microclimatic conditions are created, i.e. more humid shelters (Perttunen, 1953). Unlike millipedes, centipedes preferred plots with alternate grazing-mowing (both with and without fertilization). This management

appears to be the best way to enhance the food supply for centipedes, i.e. consequently supports populations of soil mesofauna. It should be confirmed by further study of the bottom-up effect (Chen & Wise, 1999).

Pastures planted with a local mixture of seeds with a high seeding amount and high rate of dicotyledonous herbs are more favourable to myriapods, in comparison with spontaneous fallow land and pastures planted with commercial mixtures at the Zubří localities. The main reason can be the amount and quality of organic matter on these plots. It is known that, for detritivores, dicotyledonous plants represent food of higher quality than grasses (Hassall *et al.*, 2002, 2005). The quality of leaf litter determines millipede fertility, affecting female body size (David & Handa, 2010). The best type of pasture for myriapods seems to be a site with high abundance and diversity of plants (including dicotyledonous), with alternate grazing-mowing.

Although the number of trapped individuals is low, it is typical for this type of biotope. Centipedes as well as millipedes mainly prefer woodland areas. Meadows and pastures offer a thinner layer of litter and are inhabited typically by endogeic species with low epigeic activity (Davis *et al.*, 1977; Poser, 1990). Nevertheless we were not able to use a method of extraction of soil samples due to the high negative impact of soil sampling on pastures (health hazard for sheep) as well as the small size of plots. Manual-searching for centipedes and millipedes was not used due to the absence of suitable microhabitats (as stones, logs, shrubs, etc.). Besides the absence of microhabitats, from a metapopulation viewpoint the studied localities lack possible sources of animals (hedgcs, woods, forests) as these pastures were surrounded by fields.

Moreover, both millipedes and centipedes are frequently able to avoid falling into pitfall traps (Gerlach *et al.*, 2009). Due to the low number of trapped individuals, our findings can be considered the same as previous results and future study is necessary in order to have more confident results about the relationship between type of pasture management and soil invertebrate communities.

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