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ORIGINAL ARTICLE

Effects of different management practices of organic uphill grasslands on the abundance and diversity of soil mesofauna

Iwona Gruss*, Karolina Pastuszko, Jacek Twardowski, Michał Hurej

Department of Plant Protection, Wroclaw University of Environmental and Life Sciences, Plac Grunwaldzki 24A, 50-363 Wrocław, Poland

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*Corresponding address:
iwona.gruss@upwr.edu.pl

Abstract

In this study the effect of different grassland managements (cattle grazing with different intensities and mowing) on soil mesofauna, i.e. mites (Acari) and springtails (Collembola), was studied. Mites and springtails are the most numerous representatives of soil mesofauna organisms living in the upper soil layers (up to 5 cm). Soil mesofauna groups or species are commonly used as bioindicators of soil health. The experiment was carried out from 2007 to 2009 in the West Sudety Mountains, Poland. Pastures and meadows were under organic farming management, without pesticides or synthetic fertilizers, and restricted livestock density. Soil samples were taken three times a year (in May–June, July and October) from pastures grazed at different frequencies: once, twice and four times a year, alternate management (grazed and mown pasture) and mown meadow. Mites were identified according to orders or suborders (Oribatida, Gamasida, Prostigmata, Astigmata), while springtails to the species level. The data were analysed using a general linear model (GLM). The mesofauna taxa in relation to the treatment and date were analysed with the canonical correspondence analysis (CCA). The data from three years showed that most soil mesofauna assemblages occurred in significantly higher numbers on the pasture grazed once or twice and on alternate managed pasture than in pasture grazed four times a year and mown meadow. The CCA analysis showed the preference of most springtail species to pasture grazed once a year, while mites preferred pasture grazed twice a year and alternate management. The number of species and the abundance of the most numerous species (*Protaphorura pannonica*, *Desoria multisetis* and *Folsomides parvulus*) did not differ significantly between treatments. To summarize, cattle grazing once or twice a season or alternate management (grazing and mowing once a season) have a positive impact on soil mesofauna.

Keywords: Acari, Collembola, grasslands, organic farming, pastures, soil mesofauna

Introduction

Organic grassland management is one of the most popular strategies to reduce negative environmental impacts of intensive agriculture (Whittingham 2011; Klaus *et al.* 2013). By definition organic grassland management means that no pesticides or synthetic fertilizers are used, livestock density is restricted and organic fertilizers from animal husbandry are used (maximum of 170 kg N · ha^{-1} · a^{-1}) (European Union 2008). In the organic grassland system, there is no negative relationship between productivity and plant species richness (Bakker and ter Heerdt 2005). Generally, grasslands can be classified as meadows (mowing only), pastures (grazing only) and mown pastures where mowing and grazing are combined (Socher *et al.* 2012). In Poland grasslands constitute 22.2% (3.2 million ha) of the total agricultural area (Statistical Yearbook of the Republic of Poland 2015) of which, organic grasslands constitute almost 38,000 ha (1.2% of total grassland area) (The report on organic farming in Poland in 2015–2016). Pastures and grasslands are rich habitats for plant and animal species in agricultural ecosystems (Wallis DeVries *et al.* 2002; Duelli and Obrist 2003). This results mainly from much higher plant biodiversity than on arable fields. It was found, that relatively species rich and nutrient poor grasslands lead to higher aboveground biomass production (Roscher *et al.* 2004; Cardinale *et al.* 2006). Extensive grasslands are characterized by more effective nitrogen use, higher stability of vegetation composition and beneficial CO_2 balance (Tilman *et al.* 2001). To maintain biodiversity it is also important to keep such places as extensive or organic grassland. The intensification of agricultural production as well as the abandonment of management can lead to grassland degradation and a decrease in biological diversity (Spiegelberger *et al.* 2006).

In grasslands most of the ecosystem services depend on the activity of organisms and biological processes, like decomposition (Weigelt *et al.* 2009). In the presented work the effect of different grassland managements on soil mesofauna, i.e. springtails (Collembola) and mites (Acari) was studied. Springtails and mites in grassland ecosystems inhabit mainly the upper soil level (0–20 cm), as well as the litter layer (Bardgett *et al.* 1993). Springtails and mites are the most numerous representatives of soil mesofauna. Springtail densities, ranging from about 100 in crops to 670,000 individuals · m^{-2} in the forest ecosystem have been found in different habitats (Petersen and Luxton 1982), while mites (Acari) can reach up to 100,000 individuals per m^2 (Gulvik 2007). In the grassland ecosystem soil mesofauna can be much more abundant than in crops, because there is no interference in the soil environment with ploughing or other agricultural management (Menta 2012). In the soil food web most of the analysed organisms are secondary decomposers (Rusek 1998). Mites and springtails can modify the community composition of microorganisms and thus affect litter and other decomposition (Coleman and Wall 2015). In a meta-analysis García-Palacios *et al.* (2013) showed that mesofauna enhances litter decomposition up to nearly 30% on a global scale. Because soil mesofauna representatives respond relatively quickly to changes in the soil environment, single species or ecological groups are commonly used as bioindicators of soil health (Gulvik 2007; Twardowski *et al.* 2016; Twardowski *et al.* 2017). The most important factors that affect changes in mesofauna assemblages are: soil chemistry (Cassagne *et al.* 2003), soil microclimate (mainly moisture and temperature) (Wang and Ruan 2011) or crop management practices (Twardowski *et al.* 2017). Considering the ecological requirements of springtails, three ecomorphological species are described: epigeic species living on the soil surface, euedaphic species living in deeper soil layers and hemiedaphic living in litter or the surface soil layer (Karaban *et al.* 2012). Most species extracted with Tullgren funnels belong to the last two groups (Gruss and Twardowski 2016). Mites living in the soil are generally beneficial (Gruss *et al.* 2018). Mites from the order Oribatida and most of Astigmata as well as Prostigmata groups are saprophages. All Gamasida representatives and some families from the suborder Prostigmata are predators (e.g. Smarididae), while some Astigmata and Prostigmata species are described as phytophagous (Gulvik 2007).

Grassland vegetation develops extensive root systems with a distinct structure and rhizosphere (Curry 1994; Schenk and Jackson 2002). These habitats have a high turnover of shoot and root biomass and in consequence a large pool of labile organic matter at the soil surface (Detling 1988). Also, grasslands usually have relatively rich plant diversity, which positively affects the soil food web (Eisenhauer *et al.* 2013). The influence of cattle grazing on soil mesofauna is mainly indirect and inconclusive. Cattle grazing affects soil properties in different ways, e.g. due to nutrient input, litter removal (Bardgett and Cook 1998) or stimulating decomposition (Dormaar *et al.* 1989). One of the most significant effects of grazing is soil compaction, resulting in a reduction of total pore space and movement of soil mesofauna (Battigelli *et al.* 2003). Many authors have studied the positive effects of reduced cattle grazing on soil mesofauna (Bardgett and Cook 1998; Clapperton *et al.* 2002; Schon *et al.* 2011, 2012; Miller *et al.* 2014). The impact of mowing on soil mesofauna has been studied less. Humbert *et al.* (2012) described the negative effects of mowing on field fauna, but mainly on epigeal animals. Józefowska *et al.* (2016) showed positive effects of mowing on earthworms and bacterial activity.

In the present study we wanted to determine what are the effects of the management type and its frequency on mites and springtails belonging to soil mesofauna groups.

Materials and Methods

Study area and experiment design

The experiment was carried out from 2007 to 2009 in the West Sudety Mountains, in an area belonging to the Radomierz Experimental Research Station of the University of Environmental and Life Sciences in Wrocław, Lower Silesia, Poland (50.914 N, 15.900 E). Meadows, pastures and mown pastures constituted the research area which is located on the southern slopes of Skopiec (the highest peak in the Kaczawskie Mountains) at an altitude of 500 to 600 metres above sea level. The maximum slope of the research area was 15%. Mean annual precipitation is 678 mm and mean annual temperature – 7.4°C (Statistical Yearbook of the Republic of Poland 2015). The investigated pastures are classified as weak and very weak grasslands with podzols and pseudopodzols as soil types. Meadows and pastures were under organic farming management. Five different treatments were chosen to examine the abundance of Collembola and Acari assemblages: three types of grasslands with different grazing frequency (CG1, CG2, CG3, CG4), one alternate managed grassland (AM – mown and grazed), and one mown grassland (M) (Table 1). The distance between the studied sites was not greater than 250 m. The studied areas were interspersed with fragments of arable land and forest. On the pastures the grazing intensity was calculated by multiplying the livestock per 1 ha by the mean grazing period per year (days). The highest grazing intensity was observed on pastures grazed two times a year (465.12). On other grazed areas the grazing intensity was nearly the same (from 205.0 on the pasture grazed four times a year to 237.89 on pasture grazed once a year). An additional factor was the frequency of management (mowing or grazing) from four (on pastures grazed four times a year) to one (on mown grassland).

Using phytosociological analysis, the observed plant species were classified in the Diantho-Armerietum elongatae group from the Koelerio glaucae-Corynephoretea canascentis class. The grass cover of the research area was 38.3%. The most abundant species from the family Poaceae were: *Dactylis glomerata* L., *Holcus lanatus* L., and *Poa trivialis* L. In Fabacea the dominant plant species were: *Trifolium pratense* L., *T. dubium* Sibth. and *T. repens* L. From Asteracea the most abundant species were *Taraxacum officinale* F.H. Wigg. and *Prunella vulgaris* L.

Mesofauna sampling and identification

Soil samples for mesofauna abundance in 2007 and 2008 were collected three times (May, July and October) and twice in 2009 (May, July) (Table 1). Twenty soil samples were taken radially (at 5 m intervals), from the centre of each treatment, thus on each of the sampling dates 100 soil samples were taken. For sampling a metal core sampler (5 cm diameter, 10 cm depth) with a cutting edge was used. Soil arthropods were extracted from the soil samples over 24 h with the use of Tullgren funnels modified by Murphy (1962). The duration of the extraction was validated on the basis of preliminary studies on the same equipment and soil type. After extraction, mites were classified into the following groups: suborder Oribatida (Cryptostigmata), order Gamasida (Mesostigmata), suborder Prostigmata (Actinedida), cohort Astigmata (Acaridida). Springtails were identified to the species level with the use of the following keys: Pomorski (1998), Potatov (2001), Fjellberg (2007).

Data analysis

The differences between individual taxa of soil fauna were calculated using general linear model (GLM) in SAS University Edition version 9.04 from 2017. The GLM procedure can perform ANOVA also for unbalanced data. For analysis the procedure proc GLM was performed. The dependent variables were treatment (in five variants) and date (in three variants). The

Table 1. Characteristics of five studied grasslands in Radomierz (Poland) with respect to management frequency and intensity, date of management and date of sampling

Type of management	Designation	Frequency of management (per year)	Latitude	Field size [ha]	Grazing intensity*	Date of management		
						2007	2008	2009
Cattle grazing	CG 1	1	50.910 N 15.899 E	2.27	79.3 × 3 = 237.89	21–23.08	24–26.05	23–25.05
	CG 2	2	50.9125 N 15.9112 E	3.87	46.5 × 10 = 465.12	6–12.06 5–10.09	27–01.06 8–12.08	17–19.05 21–23.08
	CG 4	4	50.914 N 15.910 E	12.00	15.0 × 14 = 205.00	9–16.07 9.08 19–25.09 18.10	20–26.07 14.08 6–10.09 16.10	1–5.07 1.08 1–4.09 30.09
Mowing	M	1	50.9105 N 15.9016 E	2.5	–	1.06	11.06	21.06
Alternate management	AM	1/1	50.9111 N 15.897 E	3.01	59.8 × 4 = 219.27	16.06 25–28.08	10.06 20–23.08	20.06 8–9.08
Date of soil sampling								
	2007		2008			2009		
I	May 14		May 20			June 18		
II	July 13		July 24			July 23		
III	October 2		October 20			–		

I – first sampling term, II – second sampling term, III – third sampling term
* Livestock (unit · ha^{-1}) × mean extent of grazing (days) = grazing intensity

interaction treatment × date was also analysed. Date (in analyses for each separate year) or year (for 3 years together) were used as repeated effect type = arh(1). To find significant differences between treatments, Tukey's HSD test was performed. The mean abundance of mesofauna groups was presented as the number of individuals per m². To graphically show the influence of type of management, sampling date, as well as management frequency and grazing intensity on soil mesofauna abundance, the Canonical Correspondence Analysis (CCA), CANOCO version 4.5 (Ter Braak and Šmilauer 2002) was performed. The statistical significance of the first ordination axis and all axes was tested separately by the Monte Carlo permutation test ($p \leq 0.05$).

Results

Mean abundance of mites and springtails

The mean number of springtails ranged from 10 to 1,200 individuals per m² in different years and treatments (Table 2). The assemblages of mites i.e the mean number of specimens, ranged from 269 to 2,624 individuals per m². The most numerous groups of mites were Oribatida (3.95 thousand individuals and Gamasida (2.1 thousand individuals). In 2007 three mesofauna groups differed significantly between treatments – Acari assemblages, Oribatida and Gamasida. Acari was significantly more abundant on the pasture grazed once or twice a year and alternate management in comparison to the habitat grazed four times a year. The suborders Oribatida and Gamasida occurred significantly more frequently on the alternatively managed pasture than on the pasture grazed twice per year. In 2008 almost all mesofauna groups (except Prostigmata and Astigmata) differed significantly between treatments and the interaction of treatment and date. Significantly more springtails were found on the mown habitat than with alternate management. Acari as the assemblages and Oribatida group occurred in significantly higher numbers on the pasture grazed four times a year than with alternate management. Gamasida were significantly more numerous on the pasture grazed once than on mown and alternatively managed pasture. At the same time, more mites were

Table 2. The abundance of mesofauna groups per m² in five types of grassland management from 2007 to 2009

Mesofauna groups	CG1	CG2	CG4	M	AM	Effect – treatment (F, p)*	Effect – date (F, p)	Effect treatment × × date (F, p)
2007								
Collembola	992.37	550.71	10.0	592.73	1,199.84	0.68, 0.5	5.14, 0.008	0.87, 0.5
Acari	1,491.49 a	1,106.87 a	865.14 bd	1,269.27	2,624.78 c	4.20, 0.002	1.34, 0.3	0.71, 0.6
Oribatida	904.29	577.97	356.23	413.11 b	1,569.78 a	5.64, 0.001	0.42, 0.6	0.54, 0.8
Gamasida	397.34	185.39 b	508.91	305.34 b	559.8 a	3.26, 0.02	5.21, 0.006	1.32, 0.3
Prostigmata	9.79	54.53	0	20.95	41.1	1.87, 0.1	1.92, 0.2	0.51, 0.8
Astigmata	129.18	134.5	0	38.92	254.45	1.32, 0.3	0.19, 0.8	0.78, 0.6
2008								
Collembola	46.79	254.45	363.3	502.38 a	149.68 b	3.77, 0.006	5.85, 0.004	4.28, 0.0002
Acari	413.49	471.49	592.31 a	277.94 b	269.42 b	3.91, 0.005	4.82, 0.009	2.56, 0.02
Oribatida	186.07	320.31	349.17 a	168.33 b	176.62 b	3.60, 0.008	3.37, 0.04	2.64, 0.01
Gamasida	195.61 a	127.23	207.8 d	93.95 b	83.82 bc	5.46, 0.0004	3.97, 0.02	3.25, 0.003
Prostigmata	0	1.5	5.65	5.22	0	1.20, 0.3	4.00, 0.02	1.40, 0.2
Astigmata	12.72	11.97	24.03	7.83	2.99	0.88, 0.5	0.98, 0.38	1.05, 0.4
2009								
Collembola	599.2	715.65	403.73	656.95	389.07	1.82, 0.1	4.05, 0.05	7.36, <0.0001
Acari	1,196.75	1,496.5 a	637.83 b	650.01 b	477.71 b	5.16, 0.0007	8.00, 0.005	4.34, 0.003
Oribatida	581.14	922.39 a	310.43 b	312.28 b	208.49 b	5.43, 0.0004	4.88, 0.03	3.83, 0.006
Gamasida	503.98	313.3	229.01	266.02	174.01	1.12, 0.3	2.18, 0.1	0.99, 0.4
Prostigmata	1.64 b	23.85 a	3.39 b	9.25 b	0 b	5.05, 0.0008	9.68, 0.002	3.88, 0.005
Astigmata	111.63	254.45	95.00	69.4	95.21	2.28, 0.06	3.05, 0.08	0.65, 0.6

CG1 – grassland grazed once a year, CG2 – grassland grazed twice a year, CG4 – grassland grazed four times a year, M – mown grassland, AM – alternate management
Different small letters in lines denote significant differences between treatments (GLM, $p \leq 0.05$).
*results of general linear model (GLM) procedure

found with alternate management than in pasture grazed four times a year. The same effect was observed for Oribatida and Gamasida.

Considering the analysis of the data from three years, some significant effects of the treatment, date and the interaction treatment × date were found (Fig. 1). Management type significantly affected all analysed mesofauna groups. Significantly more Collembola, Oribatida, and Gamasida were found on the pasture grazed once a year than with the other treatments. At the same time, more individuals were found on the pasture grazed once and alternate management than on the mown meadow and pasture grazed four times a year. Of the Acari assemblage significantly more mites were found on the pasture grazed once or twice than on pasture grazed four times a year and mown habitat. There were significantly more Astigmata on the pasture grazed once than with all other treatments. With the exception of Oribatida, all mesofauna groups were significantly affected by the date. Considering

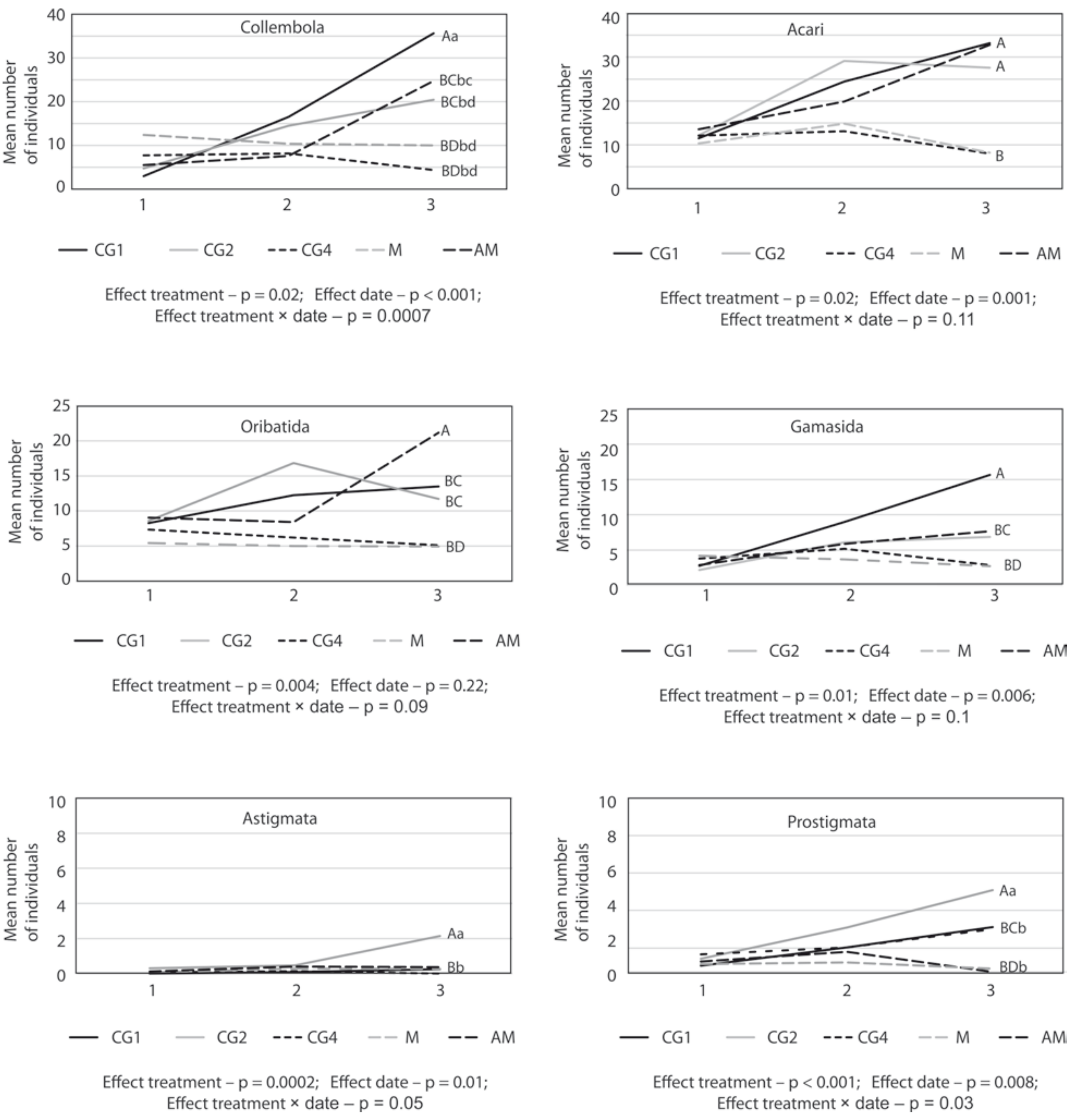

Fig. 1. Mean abundance of different mesofauna groups in 3 years of the study over time

CG1 – grassland grazed once per year, CG2 – grassland grazed twice per year, CG4 – grassland dgazed four times a year, M – mown grassland, AM – alternate management

Different large letters on the graph denote significant differences between treatments (GLM, p ≤ 0.05)

Different small letters on the graph denote significant differences between treatments in particular dates (GLM, p ≤ 0.05)

Collembola, Acari, Gamasida and Prostigmata, the individual numbers significantly increased during the season on the pasture grazed once or twice and or with alternate management. The Astigmata number significantly increased only on the pasture grazed twice. A significant effect of the interaction treatment × date was found for Collembola, Astigmata and Prostigmata. Significant differences were found on the last date (in October). The differences were the same as described for the effect of the treatment.

Species diversity of springtail species

Considering species diversity of springtails, three species accounted for more than 10% of the whole springtail population, namely, *Protaphorura pannonica*, *Desoria multisetis* and *Folsomides parvulus* (Table 3). The abundance of any of the species did not differ significantly between treatments. The number of species ranged from five to six on the pasture grazed two and four times during the season to 13 and 14 on the mown meadow and the pasture grazed once.

The eigen values of the two first CCA axes were 0.061 and 0.037, respectively (Fig. 2). After the Monte Carlo test the first axis had significance $p = 0.050$ and all axes $p = 0.002$. The length of the vectors of the given variable indicates the importance of the variable on the canonical plot. The taxon located close to the vectors had a strong relationship with them. The majority of Collembola species were in opposition to management frequency and grazing intensity and at the same time were related with the pasture grazed once a year. This group of springtails consisted mostly of dominant species: *Protaphorura pannonica*, *Desoria multisetis*, *D. tigrina* and *Folsomides parvulus*. Of the mites, Prostigmata and Astigmata were more abundant with greater grazing frequency, while Oribatida with grazing intensity. It was found that alternate management and grazing twice a year were strongly correlated and had similar effects on mesofauna.

Discussion

Grazing can largely influence grassland environments, especially plant assemblages, soil properties and soil biodiversity (Clapperton *et al.* 2002). In their habitat the soil invertebrate group is mainly affected by treading, and by nutrient cycling through dung and urine deposition (Shon *et al.* 2012). Shon *et al.* (2011, 2012) found higher diversity of macrofauna, mesofauna and microfauna on ungrazed pasture than on grazed pasture. In the present study, with data from three years, the highest numbers of mites and springtails were found on the pasture grazed once or twice and with alternate management, while the lowest numbers were found on the pasture grazed four times a year and mown meadow. Furthermore, on the grasslands, where the highest numbers of animals were found, their abundance increased significantly during the season. On pastures in Canada Clapperton *et al.* (2002) found that Oribatida and Gamasida responded positively to moderate cattle grazing, while Prostigmata abundance increased with grazing intensity (more mites on heavily grazed pasture). In another experiment in Canada (Miller *et al.* 2014) Oribatida and Collembola abundance decreased with grazing pressure, while Astigmata abundance increased on intensively grazed grasslands. In the present study no group of organisms reacted positively to heavy grazing. Considering the results of the present study and experiments conducted in Canada, it can be concluded, that moderate livestock grazing has positive effects on mite and springtail assemblages. These effects might be related to the nutrient input (cattle dung), which mites and springtails use as their food supply. Dung also enhances the rate of soil biological processes in soil, such as decomposition (Bardgett and Cook 1998). Especially Astigmata responds immediately to the addition of manure to soil (Behan-Pelltier and Kanishiro 2010). In the study of Sokołowska and Seniczak (2005) mites and springtails reacted positively

Table 3. Species diversity of Collembola assemblages in 3 years of the study

Species	CG1	CG2	CG4	M	AM	Total	Effect – treatment (F, p)*	Effect – date (F, p)	Effect treatment × × date (F, p)
Protaphorura pannonica (Haybach, 1960)	159	0	0	295	95	549	0.57, 0.64	2.45, 0.10	1.31, 0.27
Desoria multisetis (Carpenter & Phillips, 1922)	54	4	0	61	26	145	0.39, 0.76	1.68, 0.20	0.46, 0.71
Folsomides parvulus (Stach, 1922)	26	2	1	78	29	136	2.08, 0.13	2.77, 0.08	1.52, 0.23
Number of species	14	6	5	13	13	16	1.94, 0.11	0.74, 0.48	0.69, 0.68

CG1 – grassland grazed once a year, CG2 – grassland grazed twice a year, CG4 – grassland grazed four times a year, M – mown grassland, AM – alternate management

*results of general linear model (GLM) procedure

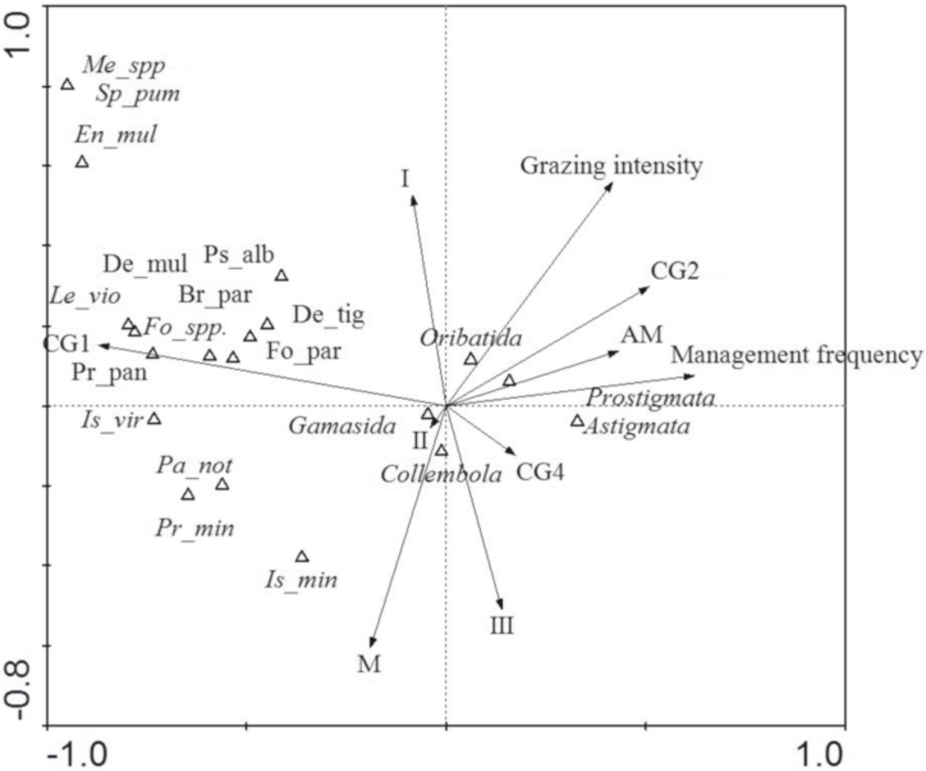

Fig. 2. Results of Canonical Correspondence Analysis (CCA) showing the effects of the type of management, sampling date, as well management frequency and grazing intensity on the occurrence of mites and springtails (2007–2009)
I – first sampling term, II – second sampling term, III – third sampling term
CG1 – grassland grazed once per year, CG2 – grassland grazed twice per year, CG4 – grassland grazed four times a year, M – mown grassland, AM – alternate management
Br_par – *Brachystomella parvula* (Schäffer, 1896), De_mul – *Desoria multisetis* (Carpenter & Phillips, 1922), De_tig – *Desoria tigrina* (Nicolet, 1842), En_mul – *Entomobrya multifasciata* (Tullberg, 1871), Fo_par – *Folsomides parvulus* (Stach, 1922), Fo_spp. – *Folsomia* spp., Is_vir – *Isotoma viridis* (Bourlet, 1839), Is_min – *Isotomiella minor* (Schaffer 1896), Le_vio – *Lepidocyrtus violaceus* (Lubbock, 1873), Me_spp. – *Mesaphorura* species, Pa_not – *Parisotoma notabilis* (Schaeffer, 1896), Pr_min – *Proisotoma minuta* (Tullberg, 1871), Pr_pan – *Protaphorura pannonica* (Haybach, 1960), Ps_alb – *Pseudosinella alba* (Packard, 1873), Sp_pum – *Sphaeridia pumilis* (Krausbauer, 1898)

to fertilization with liquid manure in the grassland ecosystem. Lovell and Jarvis (1996) found significant effects of cattle dung on the microbial biomass in the grassland ecosystem under controlled conditions. In the soil food many trophic interactions occur between microorganisms and soil invertebrates. In general an increase in the microorganisms' biomass increases the abundance of mesofauna (Scheu *et al.* 2005).

Considering the negative effects of grassland management on mites and springtails, on the one hand there is intensive grazing (pasture grazed four times a year), on the other hand mowing only. Frequently grazed pasture is more exposed to trampling, which often reduces the soil bulk density and water holding capacity (Altesor *et al.* 2006). The same authors found a significantly negative impact of grazing on the vegetation structure and mite species diversity and abundance. This could be due to the decreased pore space, which Acari and Collembola need to live (Bardgett and Cook 1998). In other experiments (Li *et al.* 2011; Basset and Fraser 2015) it was found, that heavy grazing reduces plant biomass and plant litter. On mown meadow the problem might be the absence of animal nutrients. In a study conducted in the uphill grassland in Spain the mesofauna abundance decreased in ungrazed land in comparison to grazed habitat (Epelde *et al.* 2017). After 2 years without grazing Bardgett and Leemans (1995) observed reduced soil microbial biomass and activity mainly due to the removal of sheep dung and changes in the quantity and quality of root exudates.

Considering the effect of grassland management on springtail species diversity, no significant effect was found. Also, the most abundant species did not differ between treatments. Canonical correspondence analysis showed a distinct preference of most Collembola species to the pasture grazed once, where the highest number of species was also found.

Conclusions

In conclusion, cattle grazing once or twice a season or alternate management (grazing and mowing once a season) have a positive impact on the abundance of mites and springtails. This may be due to the moderate nutrient input in these habitats, which creates the food supply for mesofauna and positively affects the microbiological and decomposition processes. In contrast, cattle grazing four times a year has negative effects on the analysed mesofauna groups. This is probably related with the litter removal caused by treading and decreased plant litter. On the mown meadow there was no animal nutrient input, which also negatively affected mesofauna.

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