

IMPACT OF DIFFERENT COVER ESTABLISHMENT TYPES AND GRAZING ON SPECIES RICHNESS AND COMPOSITION OF PASTURES ON FORMER ARABLE LAND

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Abstract

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The impact of different cover establishment types (involving either sown grass-cover mixture containing several species or one sown species) and grazing management on the botanical composition and the species richness of grassland were observed in submontane pastures located in South Bohemia, Czech Republic. Whereas one part of the observed area (HD part) was resown with a grass-clover mixture (6 grass species and 3 clover species), the other (LD part) was sown with oat undersown by ryegrass and after oat harvest, the area has retained spontaneous grassing. The cover of the herb layer, the number of species, and cover of both sown and unsown species were observed in transect of 5 permanent plots in the HD and LD part of the pasture between 2008 and 2011. After a 10-year grazing regime, the EI cover was equal in both parts; however, there was a statistically significant increase in the number of species in the LD part, by 4 species on average. Of 84 species that were recorded in total, 51 species were to be found in both locations; moreover, the HD part contained 10 additional species whereas the LD part featured 23 more species. The HD part was dominated by one expressive unsown species, *Dactylis glomerata*; the sown species significantly reduced the cover and some of them completely disappeared. The LD part was dominated by several species: in addition to *Dactylis glomerata* also *Lolium perene*, *Agrostis capillaris*, *Trifolium repens* and *Poa trivialis*. Botanical composition and species richness were influenced more by the type of cover establishment (32% of all data variability) than the grazing (5% of all data variability).

Key words: grazed ex-fields; species richness; species composition; seed mixture; vegetation.

Introduction

Central Europe has seen a significant decline in agricultural production in the last thirty years. In the 1990s, large state-owned farms ceased to exist and many properties were restituted, which often resulted in grass covers and arable land situated mostly in mountain and submontane regions, lying fallow (Pullin et al., 2009). Another milestone was the accession of the Czech Republic to the European Union in

2004. Farming intensity decreased as a result of cheaper food being imported, cropland started to be used to grow crops for the production of biofuels or even lie fallow (Pullin et al., 2009). A new type of grass cover was created due to all these changes in agricultural management in the Czech Republic and other countries over the last thirty years: grazed grass covers growing in original cropland with relatively low species richness as opposed to seminatural grass covers (Walker et al., 2004; Ruprecht, 2006).

These are mostly used to transform cropland into permanent grass covers sown with seed mixtures (Walker *et al.*, 2004). Mixtures with low species diversity include 2 to 8 species, usually dominant grass species and some herb species, and these are mostly of commercial origin; mixtures with high species diversity, on the other hand, contain at least ten species and are mostly regional mixtures coming from local sources (Török *et al.*, 2011).

Following the establishment of a new cover, it is necessary to determine the subsequent management, i.e. the type (grazing/mowing) and suitable intensity (Warren *et al.*, 2002; Lawson *et al.*, 2004). Extensive grazing is generally mentioned as the method with a more favourable impact (Isselstein *et al.*, 2005; Scimone *et al.*, 2007; Dumont *et al.*, 2007). Whereas mowing is a cheaper and more accessible option, it actually disturbs more the whole ecosystem of a grass cover (invertebrates, food web) (Török *et al.*, 2011).

Diversity on the level of species and communities is a result of traditional extensive management as well as a wide range of habitat conditions (Isselstein *et al.*, 2005; Niedrist *et al.*, 2009). Species richness of grass covers is influenced by chemical properties of the soil, notably the soil pH (Myklestad, 2004; Cousins *et al.*, 2009), as well as its altitude and slope (Marini *et al.*, 2007; Gusmeroli *et al.*, 2012).

Grass covers are also affected by climatic conditions – e.g. the alternation of wet and drier periods (Stampfli and Zeiter, 2004) or temperature in a given altitude (Gusmeroli *et al.*, 2012).

In our study, we observed grass covers established in a single field in different ways, i.e. sown with a commercial mixture with relatively high species richness (9 species) and sown with a single species. Essentially, soil and climatic conditions were the same, as was the field management (extensive grazing). What we were interested in was what influenced – after seven and nine years from the cover establishment respectively and after six years of grazing – species richness and cover composition more: was it the type of cover establishment or rather management?

Materials and Methods

Study Area

Our study was carried out on the “Zemav Rybník s.r.o.” farm (the town of Dolní Dvořiště), located at the foothills of Šumava in South Bohemia, the Czech Republic. The observed areas covered with permanent grassland are situated in the cadastral area of Jenín village, at the altitude of 760 m. The area of interest is located in a mesophytic area (Culek *et al.*, 1996) with an average temperature of 6–7°C and average

precipitations of 700–800mm, including 450–500 mm in the vegetation period (Tolasz *et al.*, 2007).

The Zemav Rybník s.r.o. farm breeds beef cattle (the Aberdeen Angus, Simmental and Charolais breeds). Herds are driven to pasture around 1st May and grazing ends in October/November. Grazing is rotational and the observed pasture is grazed twice or three times per season. Pastures are not fertilized; they are harrowed in the spring and ungrazed patches are mown in the autumn. The grazing density of pastures amounts to 0.45 LU ha⁻¹ on the average (1 LU = 500 kg of live weight).

The field containing the observed plots always belonged to a single soil block which was used for applying a simple crop rotation, namely winter rape – winter wheat – winter barley – winter rape. In 1999 it was divided into two parts. One of them was sown with a grass-clover mixture in 1999 (Table 1). The area was mown twice a year by 2001 and has been grazed since 2002. This part, sown with a species-rich mixture, is called the “HD part”. The second part of the field had been used as arable land by 2001 when the field was sown with oat undersown by perennial ryegrass in the density of 15 kg ha⁻¹ no herbicides were applied. Following the oat harvest and the removal of straw, the area was not resown and was left to be grassing spontaneously instead. It started to be grazed gradually from 2002 (Table 1). This part, sown with a single species, is called the “LD part”.

Since 2002, both parts have been joined into a single enclosure and therefore their grazing intensity and methods have been equal (Table 1).

Experimental Design and Measurement

A line of five permanent plots (each stretching over an area of 16 m²) at a fifty-meter distance was established in both parts of the pasture. A phytosociological vegetation relevé, cover of herb layer (E1) and the total number of species (N) were recorded at each plot three times a year (May, July and September) (Moravec, 1994; Prach, 1994) in the period 2008–2011.

In order to evaluate the stability of the community, species persistence (K) was calculated as a percentage share of phytosociological relevés in which the species occurred (n_i) in the total number of observed phytosociological relevés (n): $K = n_i/n \times 100$ (%). Plant species were classified into three categories: permanent species with persistence 51–100%, additive species with persistence 26–50% and random species with persistence up to 25% (Moravec, 1994).

To demonstrate the grazing intensity, “unconsumed biomass” was sampled in the grazing area in 2011. The “ungrazed biomass” is defined as a percentage share of the ungrazed biomass of the total biomass and it consisted of over-

Table 1
The management history of experimental sites

Site	HD part (plots 1-5)	LD part (plots 6-10)
Altitude	760 metres a. s. l.	760 metres a. s. l.
Exposure	East	East
Slope	6.6°	11.2°
GPS	48°39'10; 14°23'16	48°39'10; 14°23'16
Date of sowing	1999	2001
Sowing of mixture	8 kg <i>Festuca pratensis</i> (27%) 6 kg <i>Phleum pratense</i> (20%), 5 kg <i>Festuca rubra</i> (17%), 3 kg <i>Lolium perenne</i> (10%), 2.5 kg <i>Lolium multiflorum</i> (8%), 2.5 kg <i>Poa pratensis</i> (8%), 1.25 kg <i>Trifolium pratense</i> (4%) 1 kg <i>Trifolium repens</i> (3%), 1 kg <i>Trifolium hybridum</i> (3%) 30 kg in total	120 kg <i>Avena sativa</i> (70% of usual sowing in a monoculture) 15 kg <i>Lolium perenne</i> (50% of usual sowing in a monoculture) 135 kg in total
Further treatment	1999-2001 - cutting 2002-2011 - grazing from May to October	2001 – sown with oat (<i>Avena sativa</i>) undersown by ryegrass (<i>Lolium perenne</i>); oat harvest and straw removal 2002-2011 - grazing from May to October

mature vegetation with low-quality fodder, poisonous, spiny, stinging and other less palatable types of plant and the surroundings of soiled places (Mládek et al., 2006). The total biomass is sampled from a 1m² cage; the ungrazed biomass from a 1m² surface following each grazing cycle (Veselá et al., 2004). Samples of the total and ungrazed biomass were taken three times a year in three repetitions in order to establish the annual average.

Data Analyses

The difference between transects and years for N and E1 was analysed with the ANOVA for repeated measurements. The E1 values were ArcSin transformed before calculation, the percentage of cover was used for the purposes of visualisation in graphs. The difference between cover of a selected species in the first and last year of observation was analyzed by One-way ANOVA. We used the STATISTICA software, version 9.0 (Statsoft Inc, 2008).

In order to explore the effects of the treatments on the change in species composition, the interaction of treatment and time (HD part/LD part*year and grazing*year) was tested using the Redundancy Analysis (RDA) in a split-plot design in the CANOCO software (ter Braak and Šmilauer, 1998). Environmental variables were tested gradually based on the forward selection, and the significance of the axes was tested by the Monte Carlo permutation test with 499 permutations. The analysis was visualized using the CanoDraw software (ter Braak and Šmilauer, 2002).

Results

84 plant species were identified in the pasture, with 75 species to be found in the LD part and 62 species in the HD part. Of the 84 identified species, 51 species occurred in both locations. Moreover, whereas the HD part contained 10 additional species (1 grass species, 6 weed species and 3 meadow and pasture species), 23 species were found in the LD part (6 grass species, 6 weed species, 8 meadow and pasture species and 3 species originating in other habitats, such as the *Betula* juv.).

44% of the grazing area on average was represented by ungrazed patches, i.e. 56% of biomass on average was consumed by livestock. Grazing intensity of the farm was generally low.

Species richness

The cover of the herb layer differed between the LD and HD areas ($F_{1,118}=7.37$, $p=0.007$), mainly in the first years of our observation. The cover in the HD part was relatively high (89%), slightly increasing in time (up to 92%); a greater increase (84% up to 91%) was observed in the LD area, mainly in the last year. However, the differences between the individual years were not statistically confirmed (Figure 1).

The average number of species to be found in permanent plots indicated a statistically significant difference ($F_{1,118}=60.005$, $p=0.0000$), with around twenty species in the

HD part and some 24 species in the LD part (Figure 2). In 2009, a statistically significant decrease in the number of species ($F_{3,118}=7.12$, $p=0.0002$) was observed equally in both locations: by 3 species in the HD part and even 5 species in the LD part. The number rose in 2010 again: the HD part reached the original number, with a slight decrease in 2011; in the LD part the number of species only rose by three, with a slight increase in 2011 (Figure 2). However, these differences are not statistically significant.

Species composition

We found significant changes in abundance of sown species in the HD part of pasture. Two species completely disappeared even before the beginning of our observation (*Poa pratensis* and *Lolium multiflorum*) and two species had a minimum cover of 0.1% at most (*Festuca rubra* and *Trifolium hybridum*) throughout our observation. The cover signif-

icantly dropped in four observed species (*Lolium perenne*, *Trifolium repens*, *Trifolium pratense* and *Phleum pratense*). *Festuca pratensis* maintained its stable abundance cover throughout our observation (Table 2).

The type of cover establishment and grazing influenced the species composition of covers in the observed plots (Figure 3). From all variability explained in the first two axes (37.6%), the type of cover establishment explains 32% of variability ($F=56.14$, $p=0.002$), and pasture explains 5% of data variability ($F=8.75$, $p=0.002$). The cover of the individual species rises in the direction indicated by the arrow. The species of *Dactylis glomerata*, *Arrhenatherum elatius* and the sown species *Festuca pratensis* had a higher cover in the HD plot. An increase in the cover of some of the sown species (*Lolium perenne*, *Trifolium hybridum*, *Phleum pratense*) was observed in the area where they had not been sown. In the LD plot, at the same time, we observed a higher cover in some of the herbaceous species, mainly *Plantago lanceolata* and *Plantago major*, reaching the cover of 3.5% and 1.6% respectively. On the other hand, the cover of the individual herbaceous species in the sown plot amounted

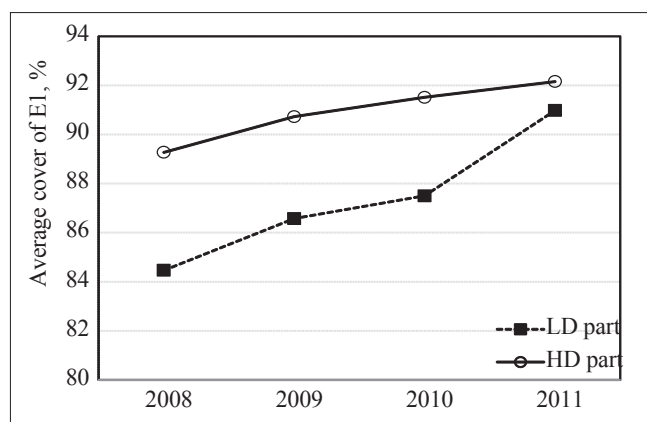


Fig. 1. Average cover of E1 in the observed years, verticals indicate 0.95 confidence intervals

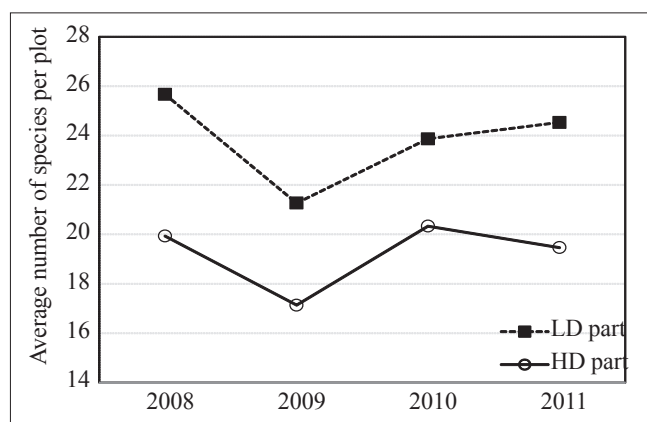


Fig. 2. Average number of species in the observed years, verticals indicate 0.95 confidence intervals

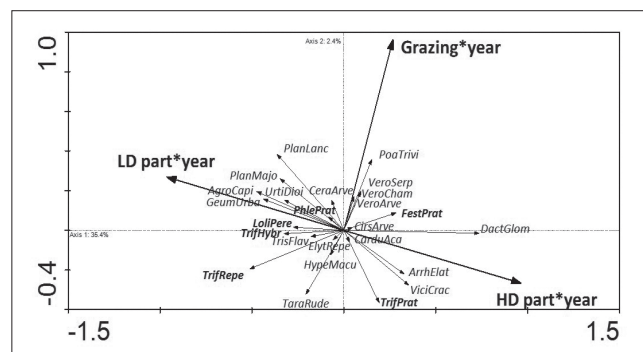


Fig. 3. The RDA analysis of the impact of the type of establishment and grazing on the species composition of the cover (with the species of the first permanent class displayed). Sown species are highlighted in bold print.

Used abbreviations for the species names:

Agrocapi (*Agrostis capillaris*), *Arrhelat* (*Arrhenatherum elatior*), *Cardacan* (*Carduus acanthoides*), *Ceraarve* (*Cerastium arvense*), *Cirsarve* (*Cirsium arvense*), *Dactglom* (*Dactylis glomerata*), *Elytrepe* (*Elytrigia repens*), *Festprat* (*Festuca pratensis*), *Festrubr* (*Festuca rubra*), *GeumUrba* (*Geum urbanum*), *Hypemacu* (*Hypericum maculatum*), *Lolipere* (*Lolium perenne*), *Phleprat* (*Phleum pratense*), *Planlanc* (*Plantago lanceolata*), *Planmajo* (*Plantago major*), *Poatrivi* (*Poa trivialis*), *Tararude* (*Taraxacum sec. Ruderalia*), *Trifprat* (*Trifolium pratense*), *Trifrepe* (*Trifolium repens*), *Trifhybr* (*Trifolium hybridum*), *Trisflav* (*Trisetum flavescens*), *Urtidioi* (*Urtica dioica*), *Verocham* (*Veronica chamaedrys*), *Veroserp* (*Veronica serpyllifolia*), *ViciCrac* (*Vicia cracca*)

Table 2
The species in the HD and LD part of pasture listed according to their persistence, with their mean value of E1 (%) in the first (2008) and in the last year (2011) of the observation and statistical difference between them. P level means: ns > 0.05 , * < 0.05 , ** < 0.01 , *** < 0.001

Persistence class	HD_part				LD_part						
	Stability, %	Species	Cover 2008, %	Cover 2011, %	p-level	Stability, %	Species	Cover 2008, %	Cover 2011, %	p-level	
Permanent species (51-100%)	100.0	<i>Dactylis glomerata</i>	35.1	51.5	*	100.0	<i>Lolium perenne</i>	7.6	14.3	*	
	100.0	<i>Taraxacum sect. Ruderalia</i>	10.1	4.2	*	100.0	<i>Dactylis glomerata</i>	12.0	21.0	*	
	91.7	<i>Vicia cracca</i>	1.1	0.6	ns	98.3	<i>Trifolium repens</i>	11.2	7.3	ns	
	90.0	<i>Lolium perenne</i>	12.4	2.6	**	98.3	<i>Taraxacum sect. Ruderalia</i>	12.9	4.5	***	
	88.3	<i>Veronica chamaedrys</i>	0.7	0.9	ns	98.3	<i>Plantago lanceolata</i>	1.6	3.7	*	
	85.0	<i>Poa trivialis</i>	3.1	14.0	***	96.7	<i>Plantago major</i>	0.8	1.6	ns	
	85.0	<i>Trifolium repens</i>	6.4	0.5	***	86.7	<i>Poa trivialis</i>	3.9	6.1	ns	
	83.3	<i>Veronica serpyllifolia</i>	0.0	0.1	ns	85.0	<i>Agrostis capillaris</i>	9.1	11.5	ns	
	78.3	<i>Plantago major</i>	0.6	0.4	ns	83.3	<i>Veronica chamaedrys</i>	0.6	1.1	ns	
	75.0	<i>Trisetum flavescens</i>	1.8	1.6	ns	75.0	<i>Trisetum flavescens</i>	3.5	1.9	ns	
	75.0	<i>Veronica arvensis</i>	0.1	0.1	ns	75.0	<i>Trifolium pratense</i>	0.8	0.8	ns	
	73.3	<i>Festuca pratensis</i>	1.8	1.7	ns	71.7	<i>Carduus acanthoides</i>	1.2	0.3	*	
	73.3	<i>Trifolium pratense</i>	2.8	0.3	**	70.0	<i>Phleum pratense</i>	2.5	3.1	ns	
	73.3	<i>Plantago lanceolata</i>	0.6	0.9	ns	70.0	<i>Cerastium arvense</i>	0.4	0.5	ns	
	68.3	<i>Carduus acanthoides</i>	0.7	1.3	ns	68.3	<i>Elytrigia repens</i>	3.0	2.1	ns	
	63.3	<i>Arrhenatherum elatius</i>	3.0	1.8	ns	65.0	<i>Geum urbanum</i>	0.4	0.3	ns	
	61.7	<i>Cerastium arvense</i>	0.3	0.4	ns	58.3	<i>Trifolium hybridum</i>	1.8	0.8	ns	
	55.0	<i>Hypericum maculatum</i>	0.4	0.3	ns	58.3	<i>Cirsium arvense</i>	0.6	0.4	ns	
						55.0	<i>Hypericum maculatum</i>	0.4	0.2	ns	
						51.7	<i>Vicia cracca</i>	0.3	0.3	ns	
						51.7	<i>Urtica dioica</i>	0.7	0.8	ns	
		18 species (28%)	81.0 (90.7%)	83.3 (90.3%)			21 species (29%)	75.2 (89%)	82.7 (90.9%)		
	Additional species (26-50%)	50.0	<i>Cirsium arvense</i>	0.4	0.6	ns	46.7	<i>Festuca pratensis</i>	0.3	1.3	*
		46.7	<i>Ranunculus repens</i>	0.6	1.5	ns	41.7	<i>Ranunculus repens</i>	0.9	1.1	ns
45.0		<i>Elytrigia repens</i>	2.8	1.3	ns	40.0	<i>Crepis biennis</i>	1.5	0.1	*	
36.7		<i>Rumex obtusifolius</i>	0.2	0.6	*	33.3	<i>Stellaria graminea</i>	0.1	0.2	ns	
31.7		<i>Equisetum arvense</i>	0.2	0.1	ns	33.3	<i>Chaerophyllum aureum</i>	0.2	0.2	ns	
26.7		<i>Agrostis capillaris</i>	0.4	0.8	ns	31.7	<i>Tripleurospermum inodorum</i>	0.2	0.1	ns	
26.7		<i>Stellaria media</i>	0.2	0.1	ns	30.0	<i>Rumex crispus</i>	0.0	0.4	**	
						26.7	<i>Anthriscus sylvestris</i>	0.1	0.3	ns	
						26.7	<i>Epilobium sp.</i>	0.4	0.0	***	
						26.7	<i>Alchemilla monticola</i>	0.1	0.2	ns	
						26.7	<i>Odonites vernus</i>	0.0	0.4	***	
Random species (0-25%)		7 species (11.3%)	4.8 (5.4%)	5.1 (5.5%)			11 species (14.7%)	3.9 (4.6%)	4.2 (4.6%)		
Total	37 species (59.7%)	3.5 (3.9%)	3.8 (4.1%)			43 species (57.3%)	5.3 (6.3%)	4.0 (4.4%)			
	62 species	89.30%	92.2%			75 species	84.5%	91%			

to 1% at maximum (*Veronica chamaedrys*) (Table 2). *Poa trivialis* was greatly supported by grazing, which led to a significant increase in its covering capacity in the HD plot in particular. On the contrary, the current grazing method was not suitable for the species of *Trifolium repens*, *Taraxacum sect. Ruderalia* and *Trifolium pratense*.

The HD plot is dominated one species, *Dactylis glomerata* (with an increase from 35% in 2008 up to 51% in 2011), and one major subdominant species, *Poa trivialis*, which showed an increase in the covering capacity from 3% up to 14%. Of the initial subdominants that were identified in 2008, the following species receded significantly: *Lolium perenne* (from 12% to 2%), *Taraxacum sect. Ruderalia* (from 10% to 4%) and *Trifolium repens* (from 6% to 0.5%) (Table 2).

Dactylis glomerata was also the dominant species in the LD plot in 2011 (represented by an increase from 12% to 21%); however, there were more subdominant species observed: *Lolium perenne* (an increase from 7% to 14%), *Agrostis capillaris* (from 9% to 11%), *Trifolium repens* (a decrease from 11% to 7%), *Taraxacum sect. Ruderalia* (a decrease from 13% to 4.5%), *Poa trivialis* (increasing from 4% to 6%) and *Plantago lanceolata* (an increase from 1.5% to 3.7%) (Table 2).

The number of species in the persistence classes was relatively balanced throughout our observation. Of the total number of species identified in both plots, the permanent species still represented 28% (18 species) in the HD plot, and 29% (21 species) in the LD plot (Table 2). Combined together, these species represented 90% of the overall cover. Whereas seven additive species covered the HD plot in 5% of the total cover, it was 11 species in the LD plot that covered 4% of the total cover. 37 random species covered the HD plot in around 4% of the total cover and 43 random species in the LD plot represented approximately 5% of the total cover.

Most of the species to be found in the observed plots developed the same pattern of coverage throughout the observed period, such as *Dactylis glomerata*, *Festuca pratensis*, *Plantago lanceolata*, *Taraxacum sect. Ruderalia*, *Trifolium repens*, *Trisetum flavescens*, (Figure 4), *Arrhenatherum elatius*, *Elytrigia repens*, *Ranunculus repens*, *Veronica chamaedrys* or *Lathyrus pratensis*. However, some of the species – e.g. *Phleum pratense*, *Poa trivialis* (Figure 4), *Rumex obtusifolius* and *Trifolium pratense* – followed a different pattern in the last year of our observation. In addition, a relatively large proportion of the species followed a completely different pattern of coverage in HD and LD part of pasture, including two of the subdominant species – *Lolium perenne* and *Agrostis capillaris* (Figure 4) – as well as,

for instance, *Festuca rubra*, *Plantago major*, *Urtica dioica*, *Cardus acantoides*, *Galium album*, or *Vicia cracca*.

Discussion

After ten years of grazing, the cover of the E1 layer was almost equal in both parts, exceeding 90% in 2011. The E1 cover rose gradually in both parts of the pasture throughout our observation. The cover of newly sown stands was around 65% and was on a constant increase during the first five years (Hakrová et al., 2012). In 2011, the cover of the observed grasslands corresponded with well-integrated stabilized pastures, reaching the covering capacity of 90–95%, as described by Kvítek et al. (1997) or Critchley and Fowbert (2000).

The average number of species to be found in the observed covers corresponded with covers of the same age established on arable land (Critchley and Fowbert, 2000; Cousins and Lindborg, 2008); however, the number of species was higher in the LD part (by 4 species on average). A higher number of species in areas left to natural colonization was also observed by Lepš et al. (2007). The fluctuation in the number of species was similar in both parts of the pasture throughout our observation, which may indicate a certain stabilization of grass cover only after ten years of grazing. Öster et al. (2009) mention 20–30 species following 30–50 years of grazing and so it can be assumed the number of species will not rise significantly; instead, it will slightly vary in line with current climatic conditions, which seemed to happen in 2009 when the number of species plunged in both areas equally. Adler and Levine (2007), for example, identified an increase in the number of species depending on an increase in precipitation. Such dependence was observed mainly in the period following drier years.

The number of species is usually higher in sown than unsown areas immediately after sowing (1–2 years) (Losvik and Austad, 2002; Lawson et al., 2004). Whereas sown areas dominated by grasses tend to be covered with vegetation more evenly after germination, species in unsown areas grow unevenly and are mostly dominated by herb species (Losvik and Austad, 2002). The number of species is usually around eight after sowing, and soars to some sixteen species in the following two years (Hakrová et al., 2012). Cousins and Lindborg (2008) also observed around fifteen species in grazed ex-arable fields aged up to 11 years, and it was up to 25 species in older grazed ex-arable fields.

Subsequent management plays an important role after the cover establishment and germination. In vegetation with low abundance after germination, mowing increases the abundance as well as the number of sown species (Lawson et al., 2004). Vegetation in the HD part was mowed during the

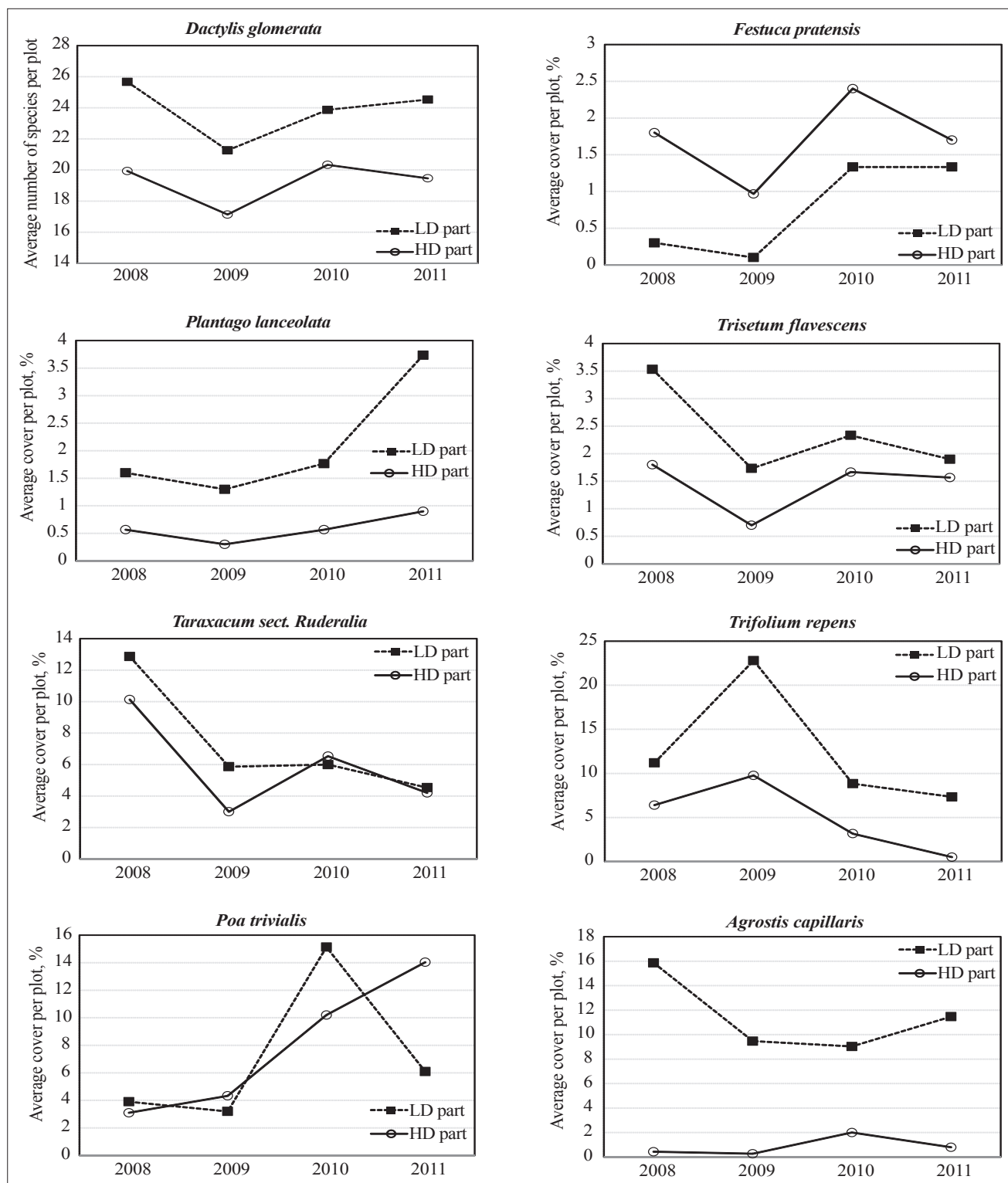


Fig. 4. Cover of dominant species (%) in the observed years, verticals indicate 0.95 confidence intervals. Sown species: *Dactylis glomerata*, *Festuca pratensis*, *Plantago lanceolata*, *Trisetum flavescens*, *Taraxacum sect. Ruderalia*, *Trifolium repens*, *Poa trivialis*, *Agrostis capillaris*

first two years which may have contributed to a higher abundance of sown species without the need to enrich it with new species from its surroundings. Species poor HD part is surrounded by a spruce forest and a pasture with the same type of establishment, while species rich LD part is surrounded by a species-rich road verge. Sown ex-fields tend to be more and more similar to their surroundings in the course of time, mostly after 10 years or more (Cousins and Lindborg, 2008; Lencová and Prach, 2011); it is only 5 years in case of rich agricultural landscapes (Critchley and Fowbert 2000).

The development of vegetation is influenced by the intensity of selected management (Losvik and Austad, 2002). The grazing density 0.45 LU ha⁻¹, which is our case, can be characterized as extensive grazing (Teslík et al., 2000; Hejzman et al., 2002). Extensively grazed vegetation form a mosaic of repeatedly grazed patches covered with low vegetation and high ungrazed patches (Mládek et al., 2006; Pavlů et al., 2006). According to our observation, the identified “ungrazed biomass” indicated a surplus quantity of fodder when compared to livestock needs. Whereas the observed pasture is in most cases grazed twice per grazing season, a quality cover maintained by rotational grazing should be grazed 3–5 times a year (Hejzman et al., 2002).

The composition of the HD part was completely different from the original sown mixture: two species (*Lolium multiflorum* and *Poa pratensis*) were not identified at the beginning of our observation in the sown part and another two species (*Festuca rubra* and *Trifolium hybridum*) completely disappeared during the 4 years of our observation. Because it is not a perennial plant, the disappearance of *Lolium multiflorum* can be expected. The cover of all the remaining sown species gradually declined to 0.3–2.6% in 2011; the total cover of 9 originally sown species only reached 6.5% in 2011. In 13 years’ time these species were more or less replaced by the prevalent *Dactylis glomerata* (51.5%), subdominant *Poa trivialis* (14%) and other species.

The LD part featured more species that were originally sown in the HD part of the pasture (Figure 3), with abundance of 13.5%. It was only *Lolium perenne* (underseeded in oat) that was originally sown there, reaching an almost double – although only 14% – cover during our observation. The cover of the same species strongly decreased in the HD part (from 12% to as low as 2%). A species requiring more frequent defoliation, *Lolium perenne* recedes with low-intensity grazing (Marriot et al., 2009). On the other hand, *Lolium perenne* increased its cover in the LD part in the second year of observation. In the first three years of observation there was lower E1 cover (86% on average), thus there is enough space for expansion even under low-intensity grazing. *Trifolium repens*, which increased cover due to intense defoliation

and better access to light (Marriot et al., 2009; Pavlů et al., 2000), reacts similarly. But after an important increase in the second year of observation, its cover decreased significantly in the following years, when the total coverage of vegetation increased.

A grass species *Poa trivialis*, which increased its coverage in both parts of the pasture for three years, also prefers lower-intensity grazing and higher stubble in particular (Marriott et al., 2002). It kept increasing its cover especially in the HD part in the last year of observation, and started to replace, together with *Dactylis glomerata*, species that require grazing to a lower level of cover such as *Lolium perenne*, *Trifolium repens* and *Taraxacum sect. Ruderalia* (Carlassare and Karsten, 2003).

Dactylis glomerata is a grass species of a winter character that grows in free tussocks with rapid growth in summer, very good overgrowing after mowing (grazing) and high competitiveness (Skládanka et al., 2009). It is resistant to rough climatic conditions and it withstands the winter very well under the snow cover. Its proliferation in a cover is supported by a finished or interrupted management (Hejzman et al., 2005) as well as grazing to a higher level of cover (Carlassare and Karsten, 2003). It prevailed in the observed area almost as a single species mainly in the HD part, which contained less species than the LD part. Dainese (2011) observed a negative relation between species richness and an investment of resources in reproduction, which apparently allows for a codominance of more species in the LD part. Moreover, *Dactylis glomerata* needs to be harvested soon in order to maintain quality fodder (Jančík et al., 2011). Livestock do not accept older biomass of the species, leaving numerous ungrazed patches (Skládanka, 2005; Mládek et al., 2006), which can result in the proliferation of the species in a cover under extensive grazing as was the case in the observed pasture.

Conclusion

After more than ten years since their creation, the covers differed in both botanical composition and species richness. The part sown with a mixture containing several species was completely different from the original sown mixture, with a lower number of species and the prevalence of a single major unsown dominant, *Dactylis glomerata* (cover exceeding 50%). The part of the pasture sown with a single species contained more species than the part sown with several species. It featured the same dominant species, *Dactylis glomerata* (cover around 20%). However, the species observed in this plot also included several subdominant species with a cover exceeding 5–15%. *Dactylis glomerata* is apparently a species supported by very extensive grazing that has taken place in

the location for nine years and has gradually influenced the species composition, even though it is the type of cover establishment that still remains the most important factor influencing the species composition of the cover.

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