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The effect of different grazing intensities on sward structure

Thesis extended summary

PRAGUE 2012

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FAKULTA ŽIVOTNÍHO PROSTŘEDÍ

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Czech University of Life Sciences Prague
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THE EFFECT OF DIFFERENT GRAZING INTENSITIES ON SWARD STRUCTURE

(Vliv různé intenzity pastvy na strukturu travního porostu)

Thesis extended summary

Vendula Ludvíková

Prague 2012

Doktorská disertační práce **"The effect of different grazing intensities on sward structure (Vliv různé intenzity pastvy na strukturu travního porostu)"** byla vypracována v rámci doktorského studia na Katedře ekologie Fakulty životního prostředí České zemědělské univerzity v Praze.

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Obor: Ekologie

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Obhajoba disertační práce se koná dne 30. října 2012 v 11:00, ve velké zasedací místnosti Z 239 Fakulty životního prostředí České zemědělské univerzity v Praze, Kamýcká 129, Praha 6 - Suchdol.

S disertační prací je možné se seznámit na Oddělení pro vědu a výzkum FŽP ČZU v Praze, Kamýcká 129, Praha 6 - Suchdol.

CONTENTS

1.1 GENERAL INTRODUCTION

Grazing by large herbivores is the most common land use of grassland worldwide. Recently the aspects of grazing are the subjects of research and in the field of science deserve respected attention. In contrast to cutting, grazed grasslands are influenced by several factors (Rook et al. 2004). Grazing is not only the removal of leaf material from plants; the effects of defoliation by grazing are complex. As is widely known, the effect of grazing on vegetation can be subdivided into the following categories: the selective defoliation by animals, trampling and in situ nutrient addition by urine and faeces and seed dispersal (Rook et al. 2004). Many and many studies have focused on the effects of grazing defoliation (e.g. Distel et al. 1995; Cingolani et al. 2003; Pavlů et al. 2007); trampling (e.g. Kobayashi et al. 1997; Kohler et al. 2004) and dung or urine deposition and nutrient availability (e.g. Malo & Suarez 1995; Dai 2000; Kohler et al. 2004; Güsewell et al. 2005; Auerswald et al. 2009) on different types of grasslands.

Grazing management usually leads to enhanced structural heterogeneity of the sward canopy. The specific effects of grazing also depend on the type of grazing animals, grazing pressure, the timing and duration of grazing (Ausden 2007), type of habitat and on spatial scale (Olff & Richie 1998).

Studied effects of grazing management are often interpreted as results of only selective defoliation and manipulation of nutrients availability and trampling effects are frequently underestimated or ignored. Only a few studies have underlined the impacts of dung deposition (Dai 2000) and trampling (Curll & Wilkins 1983; Kohler et al. 2004) on vegetation and have shown an indeed impact of these disturbances on plant species pattern. To date majority studies dealing with the effect of cattle trampling have been short-term, and so the results can only show the typical temporary changes that mostly follow after introduction of a new management treatment or they reflect an inter-seasonal dynamic (Kohler et al. 2004), thus we focused

our research (**Chapter 2**) on how long-term absence/presence of trampling affects the plant species composition.

The immediate effect of grazing on the heterogeneity of vegetation depends on the interaction between the pre-existing spatial pattern of vegetation and the spatial pattern of grazing, not only at the paddock scale (Adler et al., 2001). If the spatial heterogeneity of grazing is stronger than the spatial heterogeneity of vegetation, then the spatial heterogeneity of vegetation will increase following grazing and stable patches will thus be formed (Adler et al., 2001). Thus, variations in grazing intensity within a paddock may be greater than that among paddocks (WallisDeVries et al., 1998). However there are generally few references to the structure of patchiness, even though it is one of the most important indicators of pasture conditions (Bakker et al., 1984), and one which distinguishes pastures from meadows. Detailed vegetation studies focusing directly on sward-height patches are not common (see Willms et al., 1988; Van Den Bos and Bakker, 1990; Sasaki et al., 2005; Dumont et al., 2007; Marion et al., 2010), and studies from Central European temperate species-rich grasslands are even rarer (Sahin Demirbag et al., 2009). To date, there have been only a few studies concerning the relationship between stocking intensity and the height structure of sward patches in detail (Wrage et al., 2012; Dumont et al., 2012). Given the importance of the structure of patchiness as outlined above, we focused our research on patch structure (**Chapter 3, Chapter 4**) comparing different classes of sward-height patches under two different stocking densities. **Chapter 3** deals with the rate of sward-height patches and its floristic composition; **Chapter 4** addresses the rate of each C-S-R strategy in a given sward-height patch categories.

Last part of the thesis focuses on the impact of different managements of grasslands (including grazing) on sward structure after changes in land use or after changes in grazing exploitation. Vegetation changes in grazed grasslands occur due to diverse mechanism of response of individual species to different grazing regimes and season (Bullock et al. 2001). However the

studies evaluated changes during the whole vegetation season are rare. **Chapter 5** is focused on detailed vegetation changes during the course of the first vegetation season after management implementation in a previously intensively grazed pasture. The effects of initial vegetation changes after reintroduction grazing management after deforestation are described in **Chapter 6**.

The summarizing aims of the thesis are to answer the following questions:

i) How does the a long-term absence of trampling affect vegetation height, plant species richness, abundance of main functional groups and plant species composition? Can the long-term effects of no trampling be detected by differences in soil compaction?

ii) What is the effect of different intensity of cattle grazing on the proportion of the patches? How are simple vegetation traits and plant species composition affected by sward different patches? What is the effect of different intensities of cattle grazing on primary plant strategies?

iii) What is the effect of different grazing management on sward structure in an upland grassland, during the first vegetation season after management introduction? What are the effects of initial vegetation changes after the reintroduction of grazing management following deforestation?

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Chapter 2

Long term defoliation by cattle grazing with and without trampling differently affects soil compaction and plant species composition

Abstract

There are no long-term experimental studies dealing with soil compaction and plant community responses to trampling. Here we report results of soil compaction and plant species changes in mesotrofic temperate Central European grassland after 12-year grazing management with and without trampling. There have been applied five grazing treatments (intensive and extensive grazing; cut for hay in June followed by intensive and extensive grazing and intensive grazing defoliation with no trampling under permanent electric fencing) with two replicate blocks since 1998. In year 2010 species richness, cover of vascular plant species and bryophytes, sward height and soil penetration resistance were recorded in five distantly triplet plots. For statistical analyses we used one way ANOVA and RDA with the Monte Carlo test. Long term grazing by large herbivores has a significant effect on a soil compaction. The lowest soil compaction has been recorded in not trampled treatment. Legumes with the dominant *Trifolium repens* and short forbs (especially *Veronica serpyllifolia)* were supported by intensively defoliated and trampled treatments whereas tall forbs (mainly *Aegopodium podagraria, Hypericum maculatum*) prevailed under the extensively ones. The cover of tall and short graminoids was not depended on applied treatments. The not trampled treatment had the highest prevalence of bryophytes (with more than 95% dominancy of *Rhitidiadelphus squarosus*) and showed to be a most rich in a number of vascular plant species, on the other hand was the least equitable one.

The long-term defoliation by grazing animals without trampling does not lead to creation of typical pasture community. Species forming pasture communities are essentially dependent on both types of disturbances i)

regular defoliation by grazing and ii) regular trampling by hoofs which causes higher soil compaction and as well as sward disruption.

Citation: *Long term defoliation by cattle grazing with and without trampling differently affects soil compaction and plant species composition. Submitted paper.*

Authorship: Ludvíková V., Pavlů V., Gaisler J., Hejcman M., Pavlů L.

Key words: Fence-lines, bryophytes, disturbances, heifers grazing, floristic composition, soil penetration resistance

Chapter 3

Structure of sward-height patches under intensive and extensive grazing management in Central Europe

Patchiness is one of the important features of grazed temperate grasslands, but little is known of the structure of sward height patches under different grazing intensities. The present study examined the effect of continuous intensive and extensive stocking of heifers on the proportions of sward-height patch categories (short <5cm, moderate 5.5-10 cm, tall >10.5 cm) and their plant species composition. A four-year study was performed on species-rich grassland maintained under a long-term grazing experiment in the Jizera Mountains (Jizerské hory), Czech Republic. The main difference between intensive and extensive grazing management of species-rich grassland was seen in the proportions of short and tall sward-height patches, while the proportion of moderate-height patches was similar under both stocking densities. Floristic composition of patches within the same sward height depended upon stocking density. Moderate and tall patches under a given stocking density had similar botanical composition. Vegetation within short patches differed considerably from that of other patches under extensive grazing, whereas under intensive grazing the differences between short, moderate and tall sward-height patches were small. The findings show grazing intensity is a key driver of the proportion as well as the floristic composition of sward-height patches.

Citation: *Structure of sward-height patches under intensive and extensive grazing management in Central Europe. Submitted paper.*

Authorship: Ludvíková V., Pavlů V., Pavlů L., Gaisler J., Hejcman M.

Key words: Floristic composition, heifers grazing, patch category, pasture, RDA, vegetation

Chapter 4

Plant strategies in relation to different grazing intensities

The effect of grazing intensity on plant strategies (C-S-R signature) was studied on an experimental pasture in the Jizera Mts. (Czech Republic). The data took place during the vegetation seasons of 2003-2007 for two treatments: intensive grazing (IG) and extensive grazing (EG). Sward height was the main attribute for the analysis and the two following categories of sward patches were distinguished: i) heavily grazed (*H*): 0-5 cm and ii) rarely grazed (*R*) ii): more than 10,5 cm. The S strategy occurred in all types of patches with the lowest value. The defoliation intensity had no effect on its abundance. In the *H* patches with higher the disturbances, the R-components predominated, whereas the C strategy had the lowest value. For example, ruderals, like *Polygonum aviculare* or *Poa annua*, were present in those patches only. The C strategy had a higher proportion in the *R* patches. Although it has been shown that the IG treatment favours ruderal (R) strategy and EG treatment competitive (C) strategy, the results were affected by the abundance of different sward patches in treatments. Therefore, the rate of each C-S-R strategy was more dependent on the rate of different sward patches in treatments than by the grazing intensity itself.

Citation: *Plant strategies in relation to different grazing intensities. Grassland Science in Europe, 15, 2010: 815-817.*

Authorship: Ludvíková V., Pavlů V.

Key words: CSR strategy, defoliation, heifers grazing, sward height, sward patches

Chapter 5

Effect of different grazing systems on sward structure during the first vegetation season after management introduction

The aim of this work was to study the effect of different grazing management on sward structure in an upland grassland, during the first vegetation season after management introduction. The following treatments were applied in randomized blocks: intensive continuous stocking (C), extensive rotational grazing with two grazing cycles (2R), intensive rotational grazing with four grazing cycles (4R) and unmanaged control (U). The samples of biomass were collected by cutting (0.1 m × 0.1 m) monthly during the whole vegetation season from May to December. The functional groups of tall and short grasses had the fastest responses to different management and the significant differences were apparent in June. The accumulation of dead material between treatments differentiated following the August sampling and reflected grazing intensity C < 4R < 2R < U. The dominant short grass *A. capillaris* had a greater proportion of biomass in U and 2R treatments. Applied grazing treatments as well as successional development, regardless of treatments, significantly affected the sward structure of upland grassland during the first vegetation season after management introduction. The key factor affecting sward structure during the vegetation season is the behaviour of dominant species, plant biomass growth and dead material accumulation.

Citation: *Effect of different grazing systems on sward structure during the first vegetation season after management introduction. Grassland Science in Europe, 17, 2012: 105-107.*

Authorship: Pavlů V., Šimáčková H., Ludvíková V., Gaisler J., Pavlů L., Hejcman M

Key words: Continuous stocking, functional groups, plant above-ground biomass, rotational grazing

Chapter 6

Reindroduction of grazing management after deforestation of formerly abandoned grassland and its effect on early vegetation changes in the Western Carpathians (Slovakia)

Although the process of reforestation of grassland has been widely studied in Europe, little is known about the effect of deforestation on grassland development. Thus, the specific objective of this paper was to evaluate early changes in plant species composition, functional group, yield, and biomass quality after deforestation of long-term abandoned pastures. We established a randomized blocks with the following treatments: grazing management (G0), cutting and grazing aftermath (CG), grazing of seeded grassland (GS), grazing of burning place (GB), and unmanaged control (U). Very rapid recovery of bare ground by germination of grassland species was similar under all types of grazing management. Total plant species richness increased in all managed treatments except the GB treatment. Similarities according redundancy analyses in plant species composition were found among G0, CG, and GB treatments and especially the species *Leontodon autumnalis, Pimpinella saxifraga, Poa annua, Taraxacum* sp., *Trifolium repens*, and *Vicia cracca* correlated with them. The woody species (*Carpinus betulus*, *Cerasus avium, Betula pendula, Populus tremula*, *Rosa* sp., *Rubus* sp.), tall grasses *(Poa trivialis*, *Avenella flexuosa*, *Calamagrostis epigejos*), and tall forbs (*Viscaria vulgaris*, *Galium mollugo*) had higher abundance in the U treatment. The restoration of grassland following deforestation of formerly reforested grassland area by grazing management was a relatively fast process. Forage quality of all managed treatments was sufficient for the demands of grazing animals. However, for subsequent grassland preservation some type of grazing management is necessary to prevent reforestation, which can occur immediately after deforestation in unmanaged places.

Citation: *Reindroduction of grazing management after deforestation of formerly abandoned grassland and its effect on early vegetation changes in the Western Carpathians (Slovakia). Grass and Forage Science, 2012. In press.*

Authorship: Novák J., Pavlů V., Ludvíková V.

Key words: Botanical composition, grassland, plant species richness, RDA, reforestation, wooded pasture

SOUHRN (SUMMARY IN CZECH)

Přínos jednotlivých studií pro vědecké poznání je patrný z abstraktů příspěvků popsaných v kapitolách 2 – 6. V následujících bodech jsou velmi stručně vyjádřeny hlavní aspekty každé studie.

Kapitola 2: Druhy utvářející typická pastevní rostlinná společenstva jsou dlouhodobě závislé na obou typech disturbancí, které pastva velkými herbivory způsobuje a to jednak na i) odstraňování nadzemní biomasy a na ii) sešlapu a narušování vegetačního krytu. V naší studii jsme ukázali, že druhy přítomné v pastevních porostech neprofitují pouze z odstraňování nadzemní biomasy pastvou, které vede ke zlepšení světelných podmínek. Tyto druhy také vyžadují narušování půdního povrchu a sešlap travního drnu, což je upřednostňuje před ostatními druhy v silné mezidruhové konkurenci. Při absenci sešlapu se nevytvořila typická pastevní struktura a v porostu převažovaly mechorosty.

Kapitola 3: Hlavním rozdílem ve struktuře travního porostu mezi intenzivní a extenzivní pastvou byla proporce nízkých spasených a vysokých nespásaných plošek, zatímco podíl středně vysokých plošek byl podobný v obou studovaných intenzitách pastvy. Druhové složení nízkých plošek se pod extenzivní pastvou významně lišilo od ostatních, vyšších a méně spásaných, plošek. Při intenzivní pastvě nebyly rozdíly ve druhovém složení mezi jednotlivými různě vysokými ploškami tak výrazné. Vyplývá z toho tedy, že malé rozdíly ve druhovém složení mezi jednotlivými různě vysokými ploškami, které se vytváří při intenzivní pastvě, může svědčit o tom, že právě intenzivní pastva podporuje botanicky homogenní porost i navzdory jeho heterogenního charakteru ve smyslu různě vysokých plošek travního porostu. Tento výsledek má dopady i v ochraně přírody, neboť tímto podporuje

doporučení extenzivní pastvy jako vhodného prostředku využívání druhově bohatých travních porostů.

Kapitola 4: Různá intenzita pastvy způsobila přítomnost rostlinných druhů s různou životní strategií (*sensu* Grime 1974). I přesto, že bylo prokázáno, že intenzivní pastva podporuje ruderální strategii a extenzivní pastva konkurenční strategii, výsledky byly ovlivněny zejména podílem různě vysokých plošek travního porostu v rámci jednotlivých variant intenzity pastvy. Z toho důvodu je míra C-S-R strategie více závislá na podílu různě vysokých plošek na pastvině než na intenzitě pastvy jako takové.

Kapitola 5: Nejen různé pastevní systémy a různá intenzita pastvy mají významný vliv na složení a strukturu travního porostu. Po zavedení různého pastevního obhospodařování dochází k signifikantním změnám již v průběhu první vegetační sezóny a to i bez ohledu na intenzitu pastvy. Jako klíčové faktory ovlivňující strukturu travního porostu v průběhu vegetační sezóny se jeví chování dominantních druhů, nárůst rostlinné biomasy a množství nahromaděné odumřelé biomasy.

Kapitola 6: Obnova bývalého travního porostu po odlesnění a po znovuzavedení pastvy je relativně rychlý proces v případě, že se v okolní blízkosti takové plochy nachází jiný travní porost. Klíčení a růst typických druhů travních porostů bylo velmi rychlé, navíc umělý přísev tento proces ještě urychlil. Nutno podotknout, že při obnově travních porostů je velmi důležitá také jejich následná údržba. Jakákoliv forma pastevního obhospodařování je pro zamezení opětovného zalesnění nevyhnutelná, neboť sukcesí k zalesnění na neobhospodařovaných plochách dochází záhy.

Chapter 8

8.1 CURRICULUM VITAE

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Personal information:

Date of birth:	15th April 1981
Place of birth:	Prague
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Education:

2005-till now	Faculty of Environmental Sciences, Czech University of Life Sciences Prague, study programme Ecology
2000 – 2005	Ing. (MSc.); Faculty of Forestry and Environment, Czech University of Life Sciences Prague, study programme Applied Ecology
1995 - 2000	secondary school; finished with degree examination from Italian, Czech-Italian High school Ústavní, Prague

Language knowledge:

- Italian: good
- English: good
- Spanish: basic
- German: basic

Employment:

2010 – till now	technician; Department of Ecology, Faculty of Environmental Sciences (Czech University of Life Sciences Prague)
2009 – 2011	technician; Department of Plant Ecology and Weed Science, Grassland Research Station Liberec (Research Institute of Crop Production Prague)
2005 – 2007	specialist, administrative staff and interpreter; Czech-Italian agricultural company Agrogest Praha, s.r.o.

Professional experience and other activities:

2012	September - co-organisation and participation on summer school "Ecosystems of the Balkan"
2012	July - co-organisation and participation on summer school "Ecosystems of Northern Europe"
2011	September - University of Ioaninna (Greece) – co-organisation and participation on summer school (Faculty of Environmental Sciences) "Ecosystems of Europe: Conservation & Management"
2011	June - University of Bonn (Germany) – data collection on Rengen Grassland Experiment
2010	preparation and organization of the conference Zoologické dny (Zoological days; 550 participants)
2007 - 2010	co-organisation of foreign excursions for students in Faculty of Environmental Sciences
2007 - 2009	Congress manager; preparation and organization of international scientific meeting 2nd European Congress of Conservation Biology (1200 participants)

Teaching area at the Czech University of Life Sciences:

Habitat Ecology (CZ; practise, whole course, 2005-2012)

Ecosystems Conservation and Management (CZ; one lecture, 2007 – 2012 and EN; one lecture, 2011 – 2012)

Field practise – field exercise (2006 – 2012)

Botany (CZ; practise, whole course, 2010)

Agroecosystems, Plant Ecology (CZ; two practices, 2009)

Supervision of graduated Bc. students:

2008 Bc. Halušková Dita (Diverzita travino-bylinné vegetace v závislosti na intenzitě pastvy a chemickém složení půdy)

2009 Bc. Šťastný Petr (Mulč jako půdoochranný prvek využitelný na lesní a zemědělské půdě)

2009 Bc. Keim Pavel (Vliv rekreace na životní prostředí ve vybraném modelovém území v Pardubickém kraji)

2010 Bc. Macurová Lucie (Diverzita travino-bylinné vegetace v závislosti na intenzitě pastvy)

Participation on projects:

2006 IGA 200642113126
Year-on-year stability of grazed grassland

2007 IGA 200742113131
Year-on-year stability of grazed grassland

2010 IGA 201042113146
Effect of different grazing intensity on sward structure in relation to different plant life strategies

8.2 PUBLICATION ACTIVITY

Papers in scientific journals with impact factor:

Ludvíková V., Pavlů V., Pavlů L., Gaisler J. & *Hejcman M.,* 2012: Structure of sward-height patches under intensive and extensive grazing on upland species-rich grassland in Central Europe. Submitted paper.

Ludvíková V., Pavlů V., *Gaisler J*., *Pavlů L.* & *Hejcman M*., 2012: What is the effect of cattle trampling on vegetation in a long-term grazing experiment? Submitted paper.

Novák J., Pavlů V. & Ludvíková V., 2012: Reindroduction of grazing management after deforestation of formerly abandoned grassland and its effect on early vegetation changes in the Western Carpathians (Slovakia). *Grass and Forage Science*. In press.

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