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Effect of Rotational and Continuous Grazing on Vegetation of an Upland Grassland in the Jizerské Hory Mts., Czech Republic

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Annotation:

The effect of different grazing regimes on pasture vegetation was studied during the intensive grazing of heifers in Jizerske hory Mountains during 1993 – 97. The vegetation was monitored in 3 pairs of permanent 1x1 m plots using a continuous grid of nine 0.33 x 0.33 m subplots. We applied continuous stocking and rotational grazing. Vegetation varied as a result of time and differences between treatments several prostrate dicotyledonous species (*Trifolium repens, Taraxacum sp., Bellis perennis* and *Leontodon autumnalis*) increased under continuous stocking. This treatment also promoted the growth of the perennial grass *Lolium perenne*, which was able to cope with frequent defoliation. Tall grasses sensitive to frequent defoliation (*Poa trivialis, Holcus mollis, Alopecurus pratensis* and *Elytrigia repens*) were abundant in rotationally grazed paddocks. Species diversity was not significantly influenced by the different grazing systems. The decrease in the potential sward height under continuous stocking revealed the replacing of tall dominants by lower species. Our results indicate that different grazing systems alter the composition and structure of grassland vegetation. Defining the intensity of grazing under continuous grazing and rotational grazing is complex due to the different stocking rate and the heights of sward during grazing season. Information about pasture management should therefore involve not only grazing intensity but also the grazing system used.

Hejcman Michal

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Pořadí autorů odpovídá podílu vykonané práce při přípravě předložené publikace: Effect of rotational and continuous grazing on vegetation of an upland grassland in the Jizerské hory Mts., Czech Republic.

Souhlasíme s tím, aby publikace byla předložena Mgr. Michalem Hejcmanem jako rigorózní práce v oboru botanika.

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EFFECT OF ROTATIONAL AND CONTINUOUS GRAZING ON VEGETATION OF AN UPLAND GRASSLAND IN THE JIZERSKÉ HORY MTS., CZECH REPUBLIC

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Abstract: The effect of different grazing regimes on pasture vegetation was studied during the intensive grazing of heifers in the Jizerské hory mountains during 1993–1997. The vegetation was monitored in 3 pairs of permanent 1 × 1 m plots using a continuous grid of nine 0.33 × 0.33 m subplots. We applied continuous stocking and rotational grazing. Vegetation varied as a result of time and differences between treatments. Several prostrate dicotyledonous species (*Trifolium repens*, *Taraxacum* sp., *Bellis perennis* and *Leontodon autumnalis*) increased under continuous stocking. This treatment also promoted the growth of the perennial grass *Lolium perenne*, which was able to cope with frequent defoliation. Tall grasses sensitive to frequent defoliation (*Poa trivialis*, *Holcus mollis*, *Alopecurus pratensis*, *Dactylis glomerata* and *Elytrigia repens*) were more abundant in rotationally grazed paddocks. Species diversity was not significantly influenced by the different grazing systems. The decrease in the potential sward height under continuous stocking revealed the replacing of tall dominants by lower species. Our results indicate that different grazing systems alter the composition and structure of grassland vegetation. Defining the intensity of grazing under continuous stocking or rotational grazing is complex due to the different stocking rates and the heights of sward during a grazing season. Information about pasture management should therefore involve not only grazing intensity but also the grazing system used.

Keywords: Cattle, Grazing systems, Pasture, Sward

Nomenclature: ROTHMALER et al. (1987)

INTRODUCTION

The methods of grazing used in sward management can be divided into two broad types: continuous and rotational. These vary in capital cost, labour to operate, simplicity of operation, degree of control of the stock, and interaction between the stock and sward. Under rotational grazing the area is divided into a series of fields or paddocks that are grazed in sequence, each use being followed by a rest period (FRAME 1992). Under continuous stocking the animals are in the grazing area for the whole grazing season or year (HODGSON 1979).

The effect of grazing management on grassland vegetation depends on a wide range of predictable as well as random factors. The most important predictable factors are stocking rate, grazing regime, and grazing season duration. The intensity of livestock grazing (stocking rate, grazing pressure) gives scope for a wide range of selectivity of grazing and may also result in different environmental conditions. For example, many experiments in which grazing intensity is manipulated document the increasing cover of white clover under higher grazing pressure (e. g. GIBB & BAKER 1989, PARSONS et al. 1991, LAIDLAW et al. 1995). HOFMANN et al. (2001) demonstrated the spread of tall grasses adapted to infrequent defoliation under extensive grazing, and rhizomatous grasses and legumes under intensive sheep grazing. The term and duration of grazing are also important factors. WANG et al. (2001) recorded higher species diversity under intensive but short-term rotational grazing and lower diversity in continuously stocked paddocks. In a long-term experiment BULLOCK et al. (2001) showed an increase of species diversity in plots with spring and winter sheep grazing over those grazed in the summer. SMITH & RUSHTON (1994), for instance, recommended autumn and spring grazing, which maintains the diversity of original species of upland meadows in the UK.

Large areas of meadows were incorporated into arable land or temporary grasslands. Many low-yield meadows and pastures in the Czech Republic were ploughed and reseeded with more productive species and cultivars after World War II. Another method of grassland improvement was the draining of wet meadows. Forty-eight thousand hectares of meadows and pastures were ploughed and reseeded by productive species and 33,000 ha out of a total of 724,000 ha of grasslands in the Czech Republic were drained in the 1970s (KLESNIL et al. 1982). Grassland improvement continued until the change of the political regime in 1989. In many cases the improvement was not successful and led to the infestation of meadows by *Rumex obtusifolius*, *R. crispus*, *Taraxacum* spp., or the spread of weedy grasses such as *Elytrigia repens* or *Holcus mollis*. Although the attempted improvements for upland meadows in recent decades were not successful, research has focused on the study of the herbage quality of highly-productive and successfully improved grasslands (KRÁLOVEC & RAIS 1991, RAIS & KRÁLOVEC 1989), and on the biodiversity and conservation of seminatural species rich grasslands (KRAHULEC et al. 2001, LEPŠ 1999).

Before 1989, the predominant pasture management in the Czech Republic consisted of rotational grazing, and continuous stocking was introduced in the 1980s because of the decrease in capital costs (RAIS & KRÁLOVEC 1989). Studies of the effects of diverse grazing systems refer primarily to high-productive pastures (i.e. ERNST et al. 1980, SCHLEPERS & LANTIGA 1985, HUNT 1989), but little is known about the reaction of grasslands that were not successfully improved.

The main purpose of this study was to examine the effect of rotational grazing and continuous stocking on the vegetation development of a poorly improved meadow. We test the effect of different grazing management on plant species composition, functional groups and the potential height of the sward.

MATERIALS AND METHODS

Site description

The experiment was carried out in an experimental pasture near the town of Liberec in the uplands of the Jizerské hory mountains (50°49′ N, 15°02′ E), Czech Republic. The altitude of the study site is 420 m a.s.l. Mean annual temperature is 7.2 °C and the average annual precipitation is 803 mm (Liberec meteorological station). The geological substratum is granite underlying medium deep brown soil (cambisol) with the following attributes: pH/KCl = 4.8, C_{ox} = 3%, available P content = 43 mg kg^{-1}, available K content = 70 mg kg^{-1}, and available Mg content = 68 mg kg^{-1}. According to the phytosociological nomenclature (MORAVEC et al. 1995), the vegetation of the experimental pasture was classified as *Cynosurion*. The dominant species before the start of the experiment were *Elytrigia repens*, *Agrostis capillaris*, *Lolium perenne*, *Trifolium repens* and *Taraxacum* spp. The experimental area was ploughed and reseeded with the productive grasses (*Dactylis glomerata*, *Festuca pratensis*, *Lolium perenne*, *Phleum pratense*) in the early 1980s and overdrilled with *Trifolium repens* and *Lolium perenne* in March 1990. The improvement was not fully successful and lead to the spread of *Elytrigia repens* and *Poa annua*. During 1987 and 1992, rotational grazing was used, and fertilizer was applied to the whole pasture (N (40–140 kg ha^{-1} – NH_4NO_3), P (40 kg ha^{-1}– $Ca(H_2PO_4)_2$), K (120 kg ha^{-1}– KCl)). No fertilizers have been applied since 1992. The productivity of pasture varied from 5 to 7 t ha^{-1} of dry biomass.

Design of the experiment

The experiment was set up in the spring of 1993. The treatments were rotational grazing (R) and continuous stocking (C). The R treatment consisted of six paddocks, each with 0.166 ha (see Fig. 1 for details). Four to six heifers were moved from one paddock to another when the sward height was reduced to about 7 cm. The grazing period was 2–7 days in the summer and autumn or in the spring, respectively. The C treatment was established in one large 1 ha paddock. The average sward height of 5–7.5 cm was maintained by varying the grazing area available for the treatment and by reducing the number of animals in late summer. Both treatments were grazed by two separate herds of young heifers (Czech Pied, Friesian or crossbreeds Friesian × Czech Pied, Czech Pied × Charolle). The grazing season started in early May and ended in September or mid-October.

Actual height of sward

To evaluate the intensity of grazing the actual height of the grazed sward was used. In the C treatment, sward height was measured twice a week using the first-contact method (modified point-quadrat method), both before and after the grazing of each paddock in the R treatment. The target sward height in the R treatment was estimated by a control measurement. Each measurement consists of 100 records for C (20 m transect) and 50 records for R (10 m transect). The different number of records was due to the different size of the grazed paddocks.

Stocking rate

Calculating the stocking rates enabled us to compare the effectiveness of sward use in the tested treatments. The stocking rate is defined as the animal's load on the pasture (see HODGSON 1979 for details). The stocking rate in both treatments was calculated monthly from the actual animal's weight per available grazed area: live weight of animals (kg) / available grazed area (m^2). The results were recalculated on a per ha basis for both treatments.

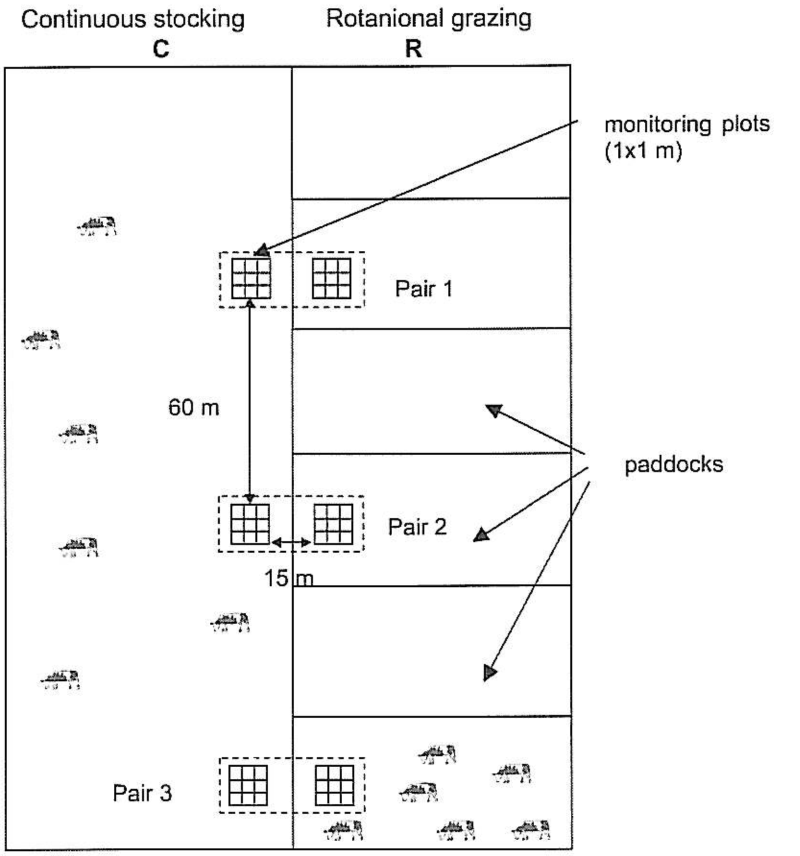

Fig. 1. Spatial arrangement of the experiment. Rotational grazing was performed in six paddocks while continuous grazing in one paddock.

Plant species composition

Relevés were collected in permanent 1m × 1m plots using a continuous grid of nine 0.33 × 0.33 subplots in three distantly paired plots (see Fig. 1). The monitoring plots were established 7.5 m from a permanent fence to avoid the effects from excessive trampling by animals, because animals prefer to walk up and down fence lines.

Plots were visually sampled before the start of grazing in May each year, from 1993 to 1997. An initial sampling was conducted before the first experimental manipulation in order to provide baseline data for each plot.

Functional groups

Based on descriptions of vascular plants in the regional flora (DOSTÁL 1989), all plant species within the study area were *a priori* categorized according to their main traits. We

Table 1. Functional groups of the study sward.

Tall grasses	Short grasses	Prostrate herbs	Annuals
Alopecurus pratensis	*Agrostis capillaris*	*Bellis perennis*	*Capsella bursa-pastoris*
Dactylis glomerata	*Lolium perenne*	*Hypochoeris radicata*	*Cirsium vulgare*
Elytrigia repens	*Poa pratensis*	*Leontodon autumnalis*	*Poa annua*
Festuca pratensis		*Leontodon hispidus*	*Veronica arvensis*
Holcus mollis		*Plantago major*	
Poa trivialis		*Taraxacum* spp.	
		Trifolium repens	

recognized these following categories: tall grasses, short grasses, prostrate herbs (dicotyledonous perennial species with creeping or prostrate growth), annuals (annual monocotyledonous and dicotyledonous species) and other species (Table 1).

Species diversity

To reveal the effect of grazing systems on the diversity of vascular plant species, the number of species per 1 m^2 were counted and analyzed by repeated measures ANOVA.

Potential height of sward

To reveal the expected relationship between the average height of a particular species and its response to C/R treatments, the mean height of each species (DOSTÁL 1989) was weighted according to the species' cover in a particular relevé. The potential height of the sward was defined to generalize the reaction of all sward components together and to test the effect of grazing systems on the replacement of the sward dominants according to their heights. The potential height of the sward (instead of actual heights – which define only the intensity of grazing) enables us to briefly reveal changes in the species composition of the sward in relation to grazing treatments.

Data analysis

Redundancy analysis (RDA) in the CANOCO program (TER BRAAK & ŠMILAUER 1998) was used to evaluate the multivariate vegetation data. Redundancy analysis is a direct gradient analysis method based on the assumption of a linear response and was used because the data set was relatively homogeneous. In all analyses we used centering by species and a log transformation ($y' = \log_{10}(y+1)$) of species data. Pairs were defined by covariables. In a direct gradient analysis, various combinations of environmental variables, covariables and their interactions were used with an appropriate Monte Carlo permutation test to test a wide range of hypotheses (TER BRAAK & ŠMILAUER 1998). Our data are in the form of repeated measures; using the permutation scheme adjusted to the repeated measures design provided an opportunity to test particular effects in a way directly comparable to repeated measures ANOVA. We used the split plot design, and permutations were performed within each pair of plots. Whole plots were records of one 1 m^2 monitoring plot repeated in time and were permuted completely at random. The mean of nine subplots was used for statistical evaluation – this solution enables the use of the single split plot design. Time series of each plots were not

Table. 2. Mean sward (± s.e. of the mean) height and stocking rate under rotational (R) and continuous (C) grazing for years 1993–1997.

	1993	1994	1995	1996	1997
Sward height (cm)					
R – before grazing	11.73 ± 0.39	15.64 ± 0.68	11.28 ± 0.37	13.15 ± 0.37	14.11 ± 0.46
– after grazing	6.89 ± 0.30	8.60 ± 0.39	6.99 ± 0.28	6.09 ± 0.26	6.55 ± 0.22
C – during grazing	6.90 ± 0.06	6.63 ± 0.07	6.03 ± 0.06	5.83 ± 0.05	6.69 ± 0.05
Mean stocking rate of heifers (kg ha^{-1})					
R	1205	1395	1370	1229	1459
C	1610	1735	1745	1611	1654

permuted. The significant effect of time and treatment interaction indicates divergent temporal development of plots under different managements. The biplot ordination diagram, was used to visualize the results of the analyses. ANOVA for repeated measurements was used to analyze univariate data (actual and potential height of sward, coverage of functional groups, species diversity data).

RESULTS

Height of the sward

Actual height of the sward

Although the average sward height after grazing in the R and C treatments for entire seasons were similar (see Table 2), there were remarkably significant differences in actual heights (Fig. 2). Under continuous stocking, sward heights were relatively constant during the entire grazing season. In comparison, rotational grazing resulted in an increase in the sward height during the rest period without herbivores and a decrease following grazing.

Potential height of the sward

We recorded a gradual decrease in the potential sward height under continuous stocking treatment (see Fig. 3, interaction time and treatments $F = 13.39729$, $P = 0.001$). This result indicates a replacing of tall dominants by species with a higher proportion of biomass under the maintained height of the sward. The mean potential heights of the sward were 54 cm under the C and 57.5 cm under the R treatment, before the start of the experiment. At the end of the experiment, the mean potential sward heights were 42.2 cm under the C and 52.9 cm under the R treatment. Potential sward heights under the C treatment tended to decrease in all grazing seasons, while it fluctuated in the R treatment.

Stocking rate

The average stocking rate was higher in the C treatment in spring (Fig. 4) due to the higher grazing pressure used to maintain the target height of the sward. At the end of each grazing season, the stocking rates were similar under both treatments. For this reason the mean annual stocking rates were moderately higher under the C treatment (Table 2).

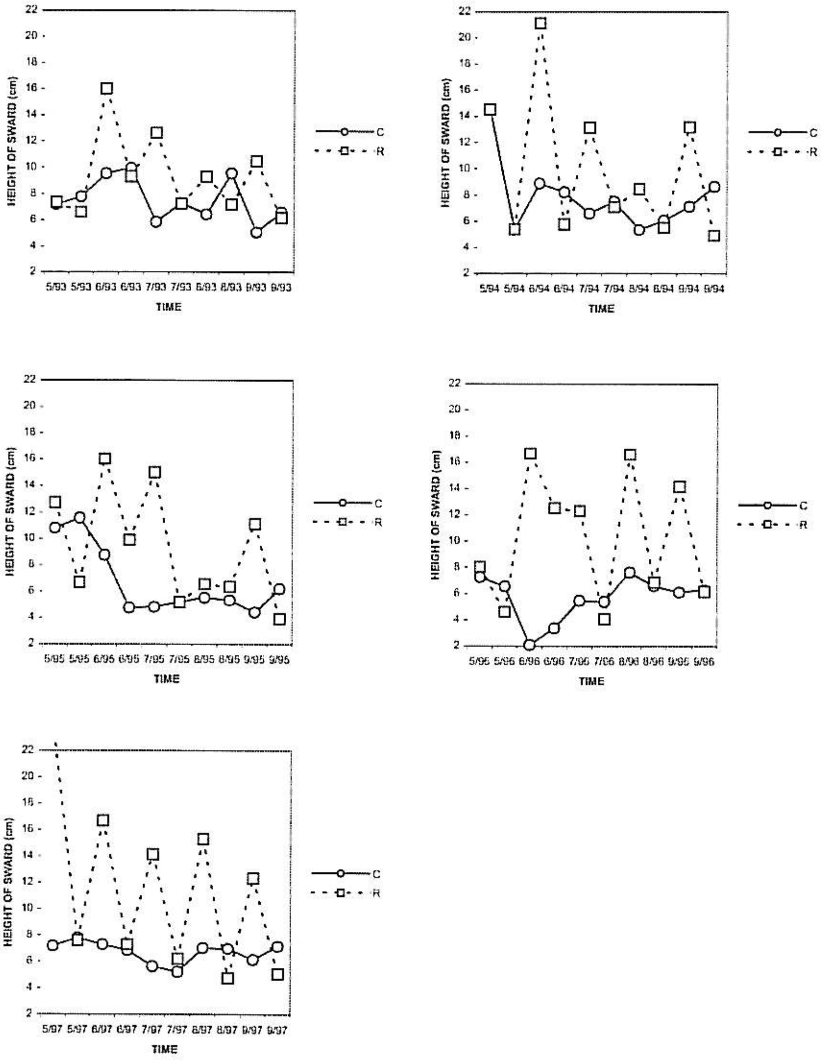

Fig. 2. The actual height of sward under continuous (C) and rotational grazing (R) during the grazing seasons 1993–1997.

Plant species composition

Significant differences between continuous stocking and rotational grazing management were detected (see Table 3, analysis A1 for details). Species that thrived under the C treatment were *Lolium perenne*, *Campanula patula*, *Leontodon autumnalis*, *Bellis perennis*, *Cirsium vulgare*, *Veronica serpyllifolia*, *Trifolium repens* (see Fig. 5). Species associated with the R

Table 3. Results of the RDA analyses of cover estimates. % explained variability = species variability explained by canonical axis 1 (measure of explanatory power of the explanatory variables); *F*-ratio = *F* statistics for the test of particular analysis; *P*-value = corresponding probability value obtained by the Monte Carlo permutation test.

Tested hypotheses	Explanatory variables	Covariables	% explained variability	*F*-ratio	*P*-value
A1 Is there any effect of treatments on species composition?	Yr*R, Yr*C	Yr, PlotID	9.4	2.287	0.028
A2 Is there a common successional trend in species composition?	Yr	Yr*R, Yr*C, PlotID	13.4	3.493	0.006

treatment were *Achillea millefolium*, *Veronica chamaedrys*, *Plantago lanceolata*, *Alchemilla* spp., *Anthriscus sylvestris*, *Ranunculus repens*, *Dactylis glomerata*, *Poa trivialis*, *Aegopodium podagraria*, *Alopecurus pratensis* and *Holcus mollis*. Remarkable successional development independent of experimental treatments was also recorded (see Table 3, analysis A2 for details).

Functional groups

A significant effect of treatments on the coverage of tall grasses, short grasses and prostrate herbs was revealed, but no differences were detected for annuals (see Fig. 6 and Table 4 for results of analyses). Tall grasses increased under the R, but strongly decreased under the C treatment. The most remarkable result was the increase of *Poa trivialis* and the decrease of *Elytrigia repens*. Short grasses substantially increased under the C, but slightly decreased under the R treatment. The most conspicuous was the promotion of *Lolium perenne*. Prostrate herbs were almost constant under the C treatment in 1993, 1994 and 1995 with mean coverage around 14%, but quickly increased to more than 42% in 1996 following the two previous years of summer drought. *Trifolium repens* increased the most. Under the R treatment, the amount of prostrate herbs fluctuated approximately 10% each year. *Taraxacum* spp. gradually increased under both treatments during the study period. The cover of dandelion was 5% in 1993 and 20% in 1997 under continuous stocking whereas under R treatment the increase was not so remarkable. The coverage of annuals decreased under both treatments during the experimental period. The mean coverage of annuals was higher under continuous stocking except in 1996. The most frequent annual species was *Poa annua*, which was responsible for the reduced coverage of functional groups instead of an increase of *Veronica arvensis*.

Species diversity

During the study period no significant effect of treatments to species diversity was revealed. The diversity of species during continuous stocking in 1993, 1994, 1995 and 1996 was lower than values from rotational grazing, but was higher in 1997 (see Fig. 7). In 1993, there was on average, 15.3 and 15.7 species per 1 m^2 under the C and R treatments respectively. The lowest species diversity in both treatments during the whole study period

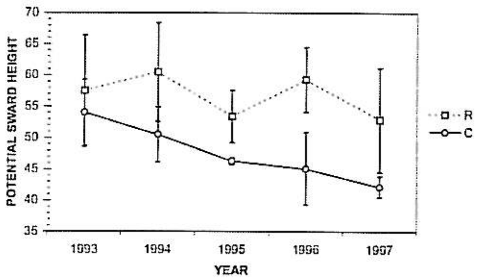

Fig. 3. Potential sward height of presented species under continuous (C) and rotational grazing (R) over five years of investigation. The height of sward was calculated as a weighted average of height of particular species present in the relevé and its cover. The height of species was obtained from local flora (DOSTÁL 1989).

Table 4. Results of repeated measurements ANOVA analyses.

Effect	*F*- ratio	*P*-value
Tall grasses*Year	9.21	0.004
Short grasses*Year	5.21	0.023
Prostrate herbs*Year	3.94	0.041
Annuals*Year	0.78	0.560

occurred in 1996. The mean species diversity values were 11.7 and 12.7 under the C and R treatments, respectively. In 1997, in contrast to the previous years, a higher species diversity was present in the C treatment, with 16.7 species per 1 m^2 recorded under the C treatment and 13.7 under the R treatment.

DISCUSSION

Plant species composition and functional groups

Several prostrate species (*Trifolium repens*, *Taraxacum* spp., *Bellis perennis* and *Leontodon autumnalis*) increased in cover more under continuous than rotational grazing. These results correspond with the conclusions of TER HEERDT et al. (1991) that ascribed the differences in vegetation between heavily and lightly grazed plots to the availability of light. The common pasture legume *Trifolium repens* (white clower) was more abundant under continuous stocking and was accompanied by frequent defoliation. The creeping stem and clonal growth of *T. repens* enables it to avoid the defoliation of the majority of the aboveground biomass and to quickly colonize bare ground (THÓRHALLSDOTTIR 1990). In the sward *T. repens* behaved similarly as *Taraxacum* spp. and our results support the hypothesis of SANDERSON et al. (2002) that states that in a grazed sward with an increasing proportion of white clover, *Taraxacum* spp. becomes dominant within the fraction of forbs just as *Lolium perenne* does within the fraction of grasses. The successively increase of prostrate herbs under both treatments is in accordance with the findings of BULLOCK et al. (1994) that dicotyledonous species generally increase under heavier grazing.

The ability of perennial grasses to regrow seems to be the best explanation for their response in the treatments tested. The dominant short grass *Lolium perenne* is a species able to persist under frequent defoliation (FOTHERGILL et al. 2001), hence its association with continuous stocking, whereas *Agrostis capillaris* was not influenced by treatments and its cover was relatively constant. In terms of abundance, the grazing itself seems to be more important than the type of grazing management. However, tall grasses sensitive to frequent defoliation (*Poa trivialis*, *Holcus mollis*, *Alopecurus pratensis*, *Dactylis glomerata*, *Elytrigia repens*) were more abundant in rotationally grazed paddocks. Both BELSKY (1992) and MITCHLEY (1988) describe the replacement of tall grasses by mid grasses or short grasses

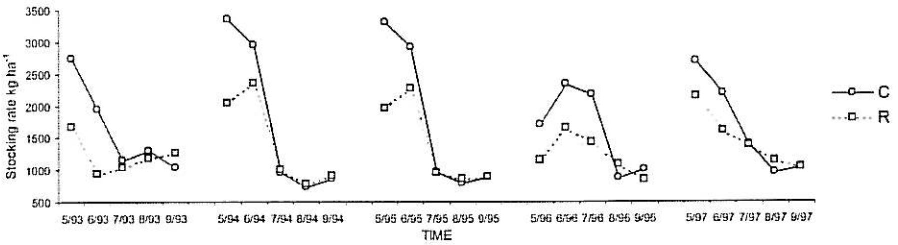

Fig. 4. Mean stocking rate (kg ha^{-1}) under continuous (C) and rotational grazing (R) for years 1993–1997.

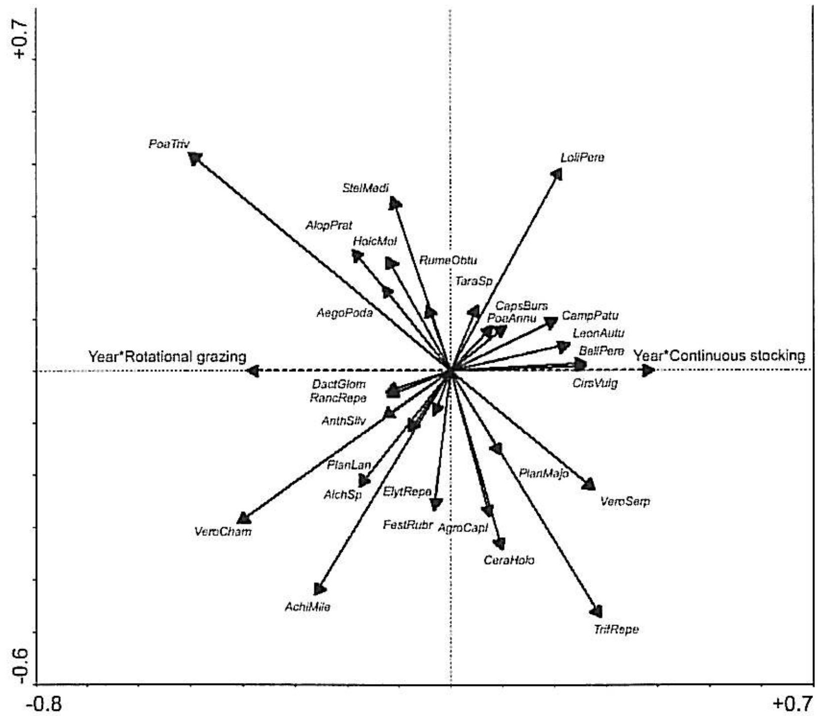

Fig. 5. Ordination diagram showing the result of RDA analysis. Abbreviations: * – indicates interaction of environmental variables, AegoPoda – *Aegopodium podagraria*, AgroCapi – *Agrostis capillaris*, AchiMile – *Achillea milefolium*, AlchSp – *Alchemilla* spp., AlopPrat – *Alopecurus pratensis*, AnthSilv – *Anthriscus silvestris*, BellPere – *Bellis perennis*, CampPatu – *Campanula patula*, CapsBurs – *Capsella bursa-pastoris*, CeraHolo – *Cerastium holosteoides*, CirsVulg – *Cirsium vulgare*, DactGlom – *Dactylis glomerata*, ElytRepe – *Elytrigia repens*, FestRubr – *Festuca rubra*, HolcMol – *Holcus mollis*, LeonAutu – *Leontodon autumnalis*, LoliPere – *Lolium perenne*, PlanLan – *Plantago lanceolata*, PlanMajo – *Plantago major*, PoaAnnu – *Poa annua*, PoaTriv – *Poa trivialis*, RancRepe – *Ranunculus repens*, RumeObtu – *Rumex obtusifolius*, StelMedi – *Stellaria media*, TaraSp – *Taraxacum* spp., TrifRepe – *Trifolium repens*, VeroCham – *Veronica chamaedrys*, VeroSerp – *Veronica serpyllifolia*.

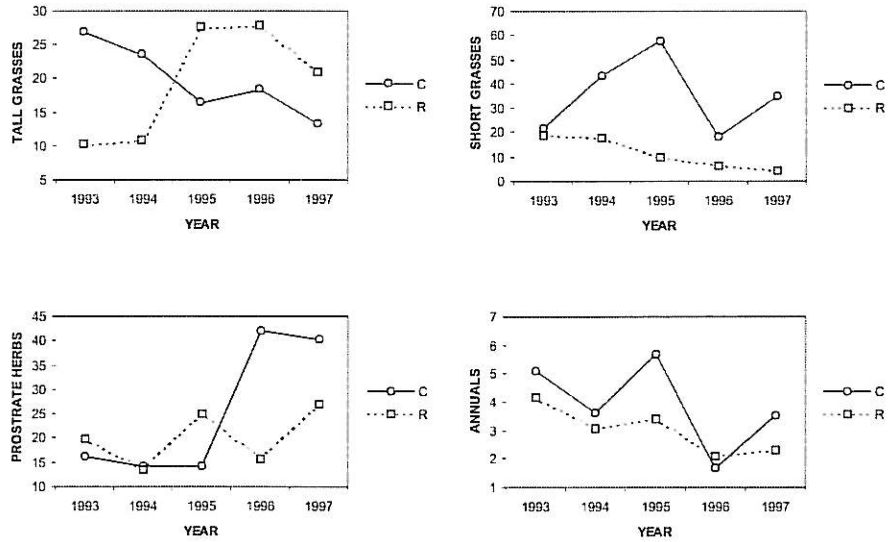

Fig. 6. Changes in coverage (%) of tall grasses, short grasses, prostrate herbs and annuals under continuous (C) and rotational grazing (R) over five years of investigation.

under frequent defoliation. Generally, the changed environmental conditions led to a remarkable replacement of tall grass dominants by species that restrict most of their biomass below the maintained sward height (see Fig. 6). The low regrowth ability of *Elytrigia repens* after frequent defoliation (HOFMANN et al. 2001) is a reasonable explanation for its decline under both treatments. Similarly, BULLOCK et al. (2001) has recorded 20 times more abundant *E. repens* in non-spring grazed paddocks than in spring ones.

The overall decrease of *P. annua* from 1993 to 1997 is surprising because it is resistant to trampling (GRIME et al. 1988) and defoliation. One possible explanation which was recorded several times on the pasture can be the uprooting of whole plants by grazers. The other important factors causing further diminishing were probably the long dry summer periods in 1994 and 1995 when a lot of *P. annua* plants died. It can be noted that the vacant space from *P. annua* was filled preferentially by prostrate herbs (*Trifolium repens*, *Taraxacum* spp.).

Actual height of sward

The main difference between continuous stocking and rotational grazing was the sward height during a grazing season. If we take into account the sward height after grazing under the R and whole seasonal heights under the C treatment, we can conclude the same intensity of grazing (Table 2). If we take into consideration only the stocking rates, then intensity of grazing was higher under the C treatment (Table 2). From this comparison, we can conclude that there are methodological difficulties with defining the same intensity of grazing under different grazing systems. In studies where the effect of different grazing systems on the

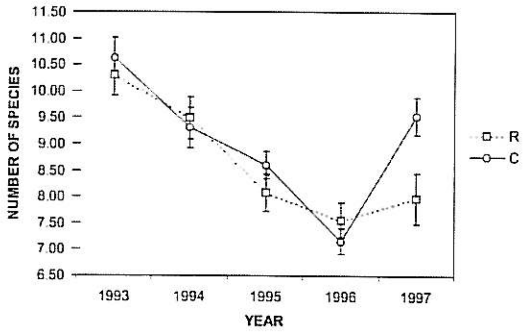

Fig. 7. Number of plant species per 1 m^2 over five years of investigation. Standard errors are indicated by the vertical lines.

development of vegetation is compared, the intensity of grazing is defined predominately only by the sward height (LAIDLAW et al. 1995, HARVEY et al. 2000) or, on the contrary, by stocking rates (DAVIES & SOUTHEY 2001, SIBBALD et al. 2002). Using both variables together enabled us to precisely define the intensity of grazing and this is necessary in these kinds of studies. In spring 1996, for example, the stocking rates used were lower in comparison with other grazing seasons and instead of this, the sward height in the C treatment decreased to below the target value (see Fig. 2). Both parameters together show a radical decrease in biomass production in spring 1995, which was probably caused by the moisture shortage in the summers of the two previous seasons. The response to this "random" event is visible from the response of short grasses, prostrate herbs, annuals (Fig. 6) and the number of species (Fig. 7). Under continuous stocking the variable stocking rates within a grazing season (Fig. 4) enabled us to maintain a relatively constant target height of the sward and to control the spring peak of biomass production. Variable stocking rates were probably also the main reason for the low selectivity of grazing and controlling of seed production of commonly little grazed pasture weeds in our study.

Potential sward height

Potential sward height revealed replacing of tall dominants by lower species under different grazing systems. The heights of different species were frequently documented as the best single predictor of species reaction to grazing (see DIAZ et al. 2001) or fertilization (LEPŠ 1999). Potential sward height reveals changes in all plant species together. Its decrease in continuously stocked paddocks indicates more suitable conditions for the development of a pasture community with a high proportion of prostrate and low species. Different reaction of both treatments under the same nutrient lever indicates also a high effect of management regime to diversification of plant communities.

Species diversity

There was an initial increase in plant species number under the R treatment that dramatically decreased after the summer drought in 1994 and 1995 (see Fig. 7), whereas under continuous stocking a gradual decrease in species number was observed throughout the treatment. The greater disturbance of lower sward under the C treatment caused by summer drought probably led to faster recolonization by *Veronica serpyllifolia*, *Plantago lanceolata*, *P. major*, *Stellaria graminea* in the following year. This result is in agreement with BULLOCK et al. (2001) study and indicates the high importance of unpredictable factors to vegetation development and the necessity of long-term studies. It also demonstrates a radical turnover in results after an unpredictable event.

In summary, this study indicates that different grazing systems alter the composition and structure of grassland vegetation. Tall grasses sensitive to frequent defoliation were more abundant in rotationally grazed paddocks whereas prostrate dicotyledonous species increased under continuous stocking. Nevertheless, the species diversity was not significantly influenced by the different grazing systems. The decrease in the potential sward height under continuous stocking revealed the replacing of tall dominants by lower species. Defining the same intensity of grazing under continuous stocking and rotational grazing is not possible because of the different stocking rates and heights of the sward during a grazing season. Information about pasture management should therefore involve not only grazing intensity but also the grazing system used.

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