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Grazing as a tool to maintain floristic diversity and herbage production in mountainous areas: a case study in north western Greece

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Abstract. Transhumant farming is a common practice in the Mediterranean region. Small ruminants grazing intensity effects on floristic diversity and herbage production in a mountainous area were studied. The research was conducted in the areas of Samarina and Dotsiko, located in northwest Greece. Both areas are grazed mainly by transhumant sheep and goats. Four experimental sites were selected: (i) two lightly grazed rangelands and (ii) two heavily grazed rangelands. An area of 9 m^2 in each rangeland was fenced in the spring of 2012, in order to be protected from grazing. Four transect lines were established in every grazed rangeland. The vegetation cover and the herbage production were measured in June 2013, and the Shannon- Wiener diversity index was calculated. Thereafter, the utilization percentage was evaluated to be on average 26% in the lightly grazed area and 91% in heavily grazed one. No significant differences were detected for ground cover and herbage production between the lightly grazed plot and the protected one. However, herbage production was significantly lower in the grazed than in the protected plot in the heavily grazed area. Different grazing intensity significantly decresed Shannon diversity index in the heavily grazed area, while in the lightly grazed one there were no significant differences. It seems that heavy grazing intensity decrease herbage production and species diversity.

Keywords. Overgrazing – Plant cover – Species diversity – Grasslands.

Le pâturage, un outil pour maintenir la diversité floristique et la production des herbages dans les zones montagneuses au nord-ouest de la Grèce

Résumé. *La transhumance est une pratique courante dans la région méditerranéenne. Les effets de l'intensité de pâturage des petits ruminants sur la diversité floristique et la production fourragère dans une région montagneuse ont été étudiés. La recherche a été menée dans les domaines de Samarina et Dotsiko, situés dans la préfecture de Grevena, au nord-ouest de la Grèce. Les deux zones sont pâturées principalement par des moutons et des chèvres transhumants. Quatre sites expérimentaux ont été choisis : deux prairies pâturées modérement et deux prairies pâturées intensivement. Une surface de 9 m^2 a été mise en défens dans chaque prairie pendant le printemps 2012, afin d'être protégée des animaux. Quatre transects ont été établis dans chacune des prairies. La composition floristique, la couverture végétale et la production fourragère ont été mesurées en juin 2013. L'indice de diversité de Shannon-Wiener a été calculé. Le pourcentage d'utilisation a été évalué à 26% en moyenne dans la zone pâturée modérément et à 91% dans la zone intensivement pâturée. Aucune différence significative n'a été détectée pour la couverture végétale et la production fourragère dans les prairies légèrement utilisées entre la zone pâturée et la zone mise en défens. En revanche, la production fourragère a été significativement plus faible dans la zone protégée dans les prairies fortement pâturées. L'absence de pâturage n'a pas modifié l'indice de diversité de Shannon-Wiener dans les prairies modérement pâturées tandis que celui-ci a significativement diminué dans les prairies fortement utilisées dans la zone pâturée compartivement à la zone mise en défens.*

Mots-clés. *Pâturage – Couverture végétale – Diversité – Production-prairies – Chevres-moutons.*

I – Introduction

Transhumance is the seasonal movement of livestock from lower pastures in winter, to higher in the summer in order to overcome difficult environmental conditions (Vallentine, 2001), which has been used for decades. However, during the last century, changes in the agricultural management and livestock farming have affected traditional forms of farming, and have led to abandonment of mountain areas as less-productive or less-accessible grasslands (Farina, 1998; Fischer *et al.,* 2008; Fava *et al.,* 2010).

Mediterranean grasslands are rich in species that contribute to high floristic diversity and herbage production (Karatassiou and Koukoura, 2009). According to Noy-Meir *et al.* (1989) livestock grazing is considered as an important tool to maintain species diversity. It is known that protection from grazing can lead to less diversity in plant species (Koukoura *et al.,* 1998). Moreover, grazing can affect positively or negatively species diversity in herbaceous plant communities, due to the foraging behavior of herbivores (Zhang, 1998), and in many cases species diversity has decreased when grazing has stopped (Noy-Meir *et al.,* 1989). On the other hand, heavy grazing pressure has been reported to reduce the diversity of herbs and shrubs in the grasslands (Zhao *et al.,* 2006) and regarded as a dominant factor of grassland degradation (Zhang, 1998). Moreover, overgrazing has altered the botanical composition and herbage production the last decades and led to disappearance of some species or to their survival through morphological or other physiological adaptations (Wang *et al.,* 2002). The aim of this study was to evaluate the effects of light and heavy grazing by small ruminants to floristic diversity and herbage production in mountainous areas.

II – Materials and methods

The study was conducted in the region of Samarina (1438 m) and Dotsiko (1047 m), two neighboring mountainous villages, which are located in Grevena prefecture, northwestern Greece. The climate of both study areas is classified as a sub-Mediterranean and belongs to humid bioclimatic floor with severe winter (Mavromatis, 1978). For decades, both areas have received high grazing pressure mainly by transhumant sheep and goats from May to October. Last years, the transhumant number of animals have been decreased in Dotsiko (data not shown), and thus there is a low grazing intensity in the area. In the contrary, there is no animal reduction in Samarina, where the grazing intensity is heavy. Four experimental sites of similar herbage functional groups of vegetation consist of grasses, legumes and forbs, but with different grazing intensity were selected: (i) two lightly grazed sites in Dotsiko village (L_1 and L_2) and (ii) two heavily grazed sites in Samarina village (H_1, and H_2). In each experimental grassland, a plot of 9 m^2 was fenced in the spring of 2012, in order to be protected from grazing.

The vegetation cover and the floristic composition were measured by using the line-point method (Cook and Stubbendieck, 1986) in June 2013. Four transect lines of 20 m long were established in every grazed grassland. Contacts were obtained every 20 cm (100 contacts per transect). The herbage production was measured in the same period by harvesting the above ground biomass of the vegetation from three 0.5 m x 0.5 m quadrats in the protected plots. Herbage production in the grazed areas was measured in the same way with three quadrats along each transect. The samples were oven-dried at 60°C for 48 hours and weighed in order to calculate the utilization percentage (UP) of vegetation as the difference between the protected and grazed production (Cook and Stubbendieck, 1986). Floristic diversity was calculated by using Shannon-Wiener index of α-diversity (H) (Henderson, 2003).

For all measured parameters differences between the study areas were calculated using one-way ANOVA (Steel and Torrie, 1980). All statistical analyses were performed using the SPSS® statistical software v. 18.0 (SPSS Inc., Chicago, IL, USA).

III – Results and discussion

Forage utilization percentage (UP) was calculated to be on average 26% in the lightly grazed area and 91% in heavily grazed one (Table 1). In both lightly grazed areas, there were no significant differences in vegetation cover (P≥0.05) between protected and grazed plots. Concerning the heavily grazed areas, vegetation cover was significantly lower in the grazed compared with protected in one of them, while in the other there was no significant difference. A reduction in vegetation cover was expected due to high UP (Brady *et al.,* 1989). However, this was not the case in our study, at least in one site most probably because of the deep and fertile soil of the specific area (see also Abraham *et al.*, 2009).

Table 1. Vegetation cover (%), herbage production kg/ha, species diversity index and utilization percentage (UP) in different grazing intensities, light (L) and heavy (H)

Grazing intensity	Cover %		Production kg/ha		Diversity		UP%
	Protected	Grazed	Protected	Grazed	Protected	Grazed	
L1	91.3a	81.0a	243a	227a	1.88a	1.67a	30.0
L2	93.3a	94.3a	494a	255a	1.91a	1.89a	22.5
H1	98.0a	87.3a	2270a	320b	1.71a	1.42b	89.6
H2	95.7a	66.7b	1770a	280b	1.97a	1.40b	92.2

* Means for the same parameter in the same row followed by the same letter are not significantly different (P≤0.05).

Herbage production was significantly lower in grazed sites, compared to protected sites in the heavily grazed area, while there was no significant difference between grazed and protected sites in the lightly grazed area (Table 1). According to Ali-Shtayeh and Salahat (2010), there is a direct effect of grazing on the vegetation growth through the foraging behaviour and trampling of animals. Despite the short time of animal exclusion in the protected plots, plant diversity was found significantly decreased in the grazed sites compared to the protected ones in heavily grazed areas. According to Noy-Meir (1998) the total biodiversity tends to be higher in grazed than in protected plots, except extremely heavily grazed areas as in our study. Moreover, heavy grazing can lead to low plant diversity (Noy-Meir *et al.,* 1989; Olsvig-Whittaker *et al.,* 1993). On the other hand, in the lightly grazed areas there were no significant differences between the grazed and the protected sites. Under-grazing could have similar negative effects to biodiversity like overgrazing (Metera *et al.,* 2010), while long-term grazing abandonment can led to the decrease about 60% of grassland species in these grasslands (Peco *et al*., 2006).

IV – Conclusions

The results of the current study suggest that heavy grazing intensity decreases herbage production and species diversity despite the short time of animal's exclusion. Additional experiments and observations involving other areas would provide more information to support the current datasets.

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