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in

Porqueddu C. (ed.), Ríos S. (ed.).

The contributions of grasslands to the conservation of Mediterranean biodiversity

Zaragoza : CIHEAM / CIBIO / FAO / SEEP

Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 92

2010

pages 247-250

Article available on line / Article disponible en ligne à l'adresse :

<http://om.ciheam.org/article.php?IDPDF=801250>

To cite this article / Pour citer cet article

Kyriazopoulos A.P., Abraham E.M., Parissi Z.M., Korakis G., Abas Z. **Floristic diversity of an open coppice oak forest as affected by grazing.** In : Porqueddu C. (ed.), Ríos S. (ed.). *The contributions of grasslands to the conservation of Mediterranean biodiversity.* Zaragoza : CIHEAM / CIBIO / FAO / SEEP, 2010. p. 247-250 (Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 92)



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Floristic diversity of an open coppice oak forest as affected by grazing

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Abstract. The effect of grazing intensity on the understorey vegetation of an open coppice oak forest was studied. The research was conducted in the area of Great Dereio, which is located in Evros prefecture, northeast Greece. There, an open silvopastoral system occurs, extending in the thermophilous deciduous oak zone (*Quercion frainetto*). The area is grazed mainly by goats. Two experimental areas were selected: (i) a moderately grazed plot; and (ii) a heavily grazed plot. An area of 25 m² in each plot was fenced in the autumn of 2008, in order to be protected from grazing. Four transect lines were established in every grazed and protected plot. The plant cover and the species composition were measured in June 2009 and ecological diversity indices were determined. Plant cover was significantly increased in the protected ungrazed areas. Different grazing intensity significantly altered species composition. The contribution of woody species was increased while the contribution of grasses was decreased in the heavily grazed plot compared to the moderately grazed one. Protection from grazing significantly increased the contribution of woody species and decreased the contribution of forbs. Moreover, protection from grazing resulted in a significant reduction of floristic diversity.

Keywords. Overgrazing – Plant cover – Silvopastoral system – Species composition.

Diversité floristique du sous-bois d'une chênaie en taillis et bosquets affectée par le pâturage

Résumé. L'effet de l'intensité du pâturage sur la végétation de sous-bois dans des chênaies en taillis et bosquets est étudiée. L'étude a été conduite dans la région de Grand Dereio dépendant de la préfecture de Evros, dans le Nord de la Grèce. Une zone de pâtures en milieu boisé y existe sur la végétation thermophile et caduque composée de chênes (*Quercus frainetto*). Le pâturage est principalement dû aux chèvres. Deux zones expérimentales ont été sélectionnées: une zone modérément pâturee et une seconde où la pression du pâturage est plus intense. Au cours de l'automne 2008, une parcelle de 25 m² dans chacune des deux zones a été grillagée pour la protéger des chèvres. Quatre profils linéaires ont été définis dans chaque zone protégée ou non protégée. La couverture végétale et la composition spécifique y ont été mesurées en juin 2009 et les indices de diversité écologique déduits. La couverture végétale augmente significativement dans les parcelles protégées. Les zones de pâtures montrent une composition spécifique altérée. La proportion de plantes ligneuses et semi-ligneuses augmente d'autant plus que la part des graminées diminue dans la zone surpâturée. La protection des zones de pâturage contribue à une augmentation de la proportion de plantes ligneuses et semi-ligneuses et à une baisse des plantes herbacées dicotylédones. En outre, cette protection aboutit à une baisse de la diversité floristique.

Mots-clés. Pâturage intensif – Couverture végétale – Système sylvopastoral – Composition spécifique.

I – Introduction

Traditionally, the multiple agroforestry land uses of oak forests contributed to the improvement of animal husbandry, wildlife, and the environment, and are of great ecological and economic interest. Oak forests occupy 1,471,839 ha in Greece. Most of these forests, especially the open

coppice, are grazed by livestock, as silvopastoralism is well adapted to the Mediterranean environment (Papanastasis *et al.*, 2009b).

The most common effects of grazing in natural plant communities include changes to vegetation structure and composition as certain species are favoured by grazing so that their numbers and cover will increase, while other species are disadvantaged and will reduce in number and cover (Belsky, 1992). Grazing by domestic livestock can significantly alter the structure of the vegetation by preventing recruitment of trees and shrubs (Gibson and Kirkpatrick, 1989). Furthermore, livestock grazing is considered essential to maintaining species diversity, and in many communities species diversity has decreased when grazing has stopped (Noy-Meir *et al.*, 1989).

It has been well documented that species composition and diversity can be used as indicators of past management practices in forested areas (Kneeshaw *et al.*, 2000). Therefore, understanding the influence of livestock grazing on understorey plant diversity in open oak ecosystems is important for their long-term sustainable management. This paper evaluated the effect of different grazing intensity by small ruminants on the understorey vegetation of an open coppice oak forest.

II – Materials and methods

The study was conducted in the area of Great Dereio which is located in Evros prefecture, northeast Greece at 380 m a.s.l. The climate of the area is classified as sub-Mediterranean, with a mean air temperature of 13.7°C and an annual rainfall of 560 mm. There, an open silvopastoral system occurs, extending in the thermophilous deciduous oak zone, i.e. *Quercion frainetto* subzone *sensu*, Horvat *et al.* (1974). The area is grazed mainly by goats. Two experimental areas of similar vegetation but with different grazing intensity were selected: (i) a moderately grazed plot; and (ii) a heavily grazed plot. An area of 25 m² in each plot was fenced in the autumn of 2008, in order to be protected from grazing. A similarly-sized area was assigned next to the fenced plot. Herbage yield was measured by clipping four 0.5 m x 0.5 m quadrats in every grazed and protected plot in June 2009. The difference of fenced and open plots yield was used to calculate forage utilization percent. It was calculated to be 45% in moderately grazed plot and 65% in the heavily grazed one. Four transect lines of five m long were established in every grazed and protected plot.

The plant cover and the floristic composition were measured by using the line-point method (Cook and Stubbendieck, 1986) in June 2009. Contacts were obtained every 10 cm (50 contacts per transect). The nomenclature of the recorded taxa follows Strid and Tan (1997-2002) and Tutin *et al.* (1968-1980, 1993). Floristic diversity was determined by Shannon-Wiever index of q-diversity (H') and the Berger-Parker dominance index (d). The formulae of the indices are given below (Henderson, 2003):

$$H' = - \sum_{i=1}^S p_i \ln p_i$$

$$d = \frac{N_{\max}}{N_T}$$

where S is the maximum recorded number of taxa, p_i is the proportional abundance of the i -th taxa, N_{\max} is the number of records of the dominant taxon and N_T is the total number of records.

General linear models procedure (SPSS 14 for Windows) was used for ANOVA. The LSD at the 0.05 probability level was used to detect the differences among means (Steel and Torrie, 1980).

III – Results and discussion

The plant cover decreased significantly in the heavily grazed plots compared to the moderate with grazing plots (Table 1). However, despite the short protection period, protection from grazing significantly increased plant cover in both grazing intensities. Apparently, these results confirm that grazing causes a reduction in vegetative cover (Pluhar *et al.*, 1987).

Floristic biodiversity, as described by Shannon's diversity index and by Berger-Parker dominance index, was significantly higher when grazing was applied (Table 1). Many authors have found that grazing abandonment leads to a decrease in plant species richness (Poschlod *et al.*, 2005; Guretzky *et al.*, 2007). Floristic diversity tends to be higher in the moderately grazed plot compared to the heavily grazed one, but this increase did not produce significant results.

Table 1. Plant cover (%) and species diversity indices of the different grazing treatments

	Heavily grazed		Moderately grazed	
	Grazed	Protected	Grazed	Protected
Plant cover	62.75c	80.00ab	77.25b	86.75a
Diversity indexes				
Shannon's index (H)	2.10a	1.51b	2.40a	1.72b
Berger-Parker index (d)	0.25b	0.40a	0.18b	0.38a

a,b,c: Means in the same row followed by the same letter are not significantly different ($P \leq 0.05$).

Different grazing intensity significantly altered the species composition. The highest percentage of grasses was found under moderate grazing (Fig. 1), while their contribution to vegetation composition decreased significantly when heavy grazing occurred. On the contrary, the highest percentage of woody species was found under heavy grazing. Protection from grazing did not affect the grasses but it significantly increased the woody species in both cases. Similar results have been reported by Petit *et al.* (1995). Despite the fact that the dominant woody species were the less palatable *Juniperus oxycedrus* subsp. *oxycedrus* and *Cistus incanus* subsp. *creticus*, livestock grazing controlled their expansion. The significant reduction of the contribution of forbs in the protected plots could be attributed to the dominance of the woody species which shaded them away (Papanastasis *et al.*, 2009a). The dominance of woody species in the protected plots can explain the reduction of the floristic diversity indices.

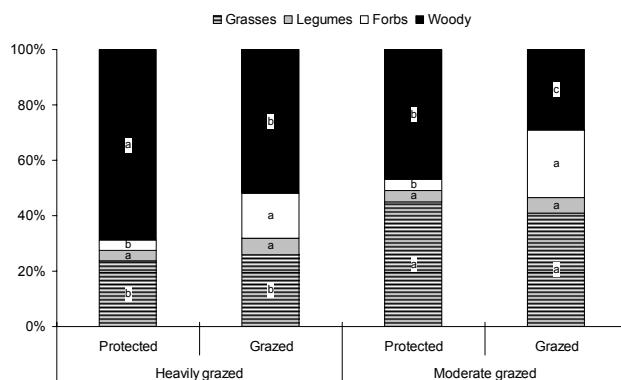


Fig. 1. Composition (%) of species in the different grazing treatments. Means within each group of species followed by the same letter are not significantly different ($P \leq 0.05$).

Acknowledgements

The authors wish to acknowledge the financial support received from the Prefecture of Evros.

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