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Effects of juniper encroachment on herbage production and biodiversity in a natural grassland: Preliminary results

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Abstract. The encroachment of woody species in natural grasslands has recently increased, especially in arid and semi-arid environments. In the Mediterranean region, this is mainly attributed to the dramatic decrease of the traditional human activities such as pastoral management and fuelwood collection, which controlled the encroachment of woody species. The purpose of this study was to investigate the effects of *Juniperus oxycedrus* encroachment on herbage production and floristic diversity in a natural grassland. The research was conducted in the area of Megalo Dereio, which is located in Evros region, in north-eastern Greece in 2010. Herbage production was measured and ecological diversity indices were determined at three different shrub cover regimes (open, moderate, dense). Herbage production decreased progressively as juniper cover increased. Floristic diversity was significantly higher in the moderate shrub cover regime, while it was dramatically reduced in the dense shrub cover regime.

Keywords. Forage – Shrubs – Floristic diversity – Invasion.

Les effets d'empiètement de genièvre sur la production d'herbage et la diversité biologique dans un pâturage naturel : Résultats préliminaires

Résumé. *L'empiètement d'espèces boisées dans les pâturages naturels a récemment augmenté, surtout dans les environnements arides et semi-arides. Dans la région Méditerranéenne, c'est surtout attribué à la diminution dramatique des activités humaines traditionnelles comme l'administration pastorale et la collection du bois de chauffage, qui a contrôlé l'empiètement d'espèces boisées. L'objectif de cette étude était d'enquêter sur les effets de l'empiètement de* Juniperus oxycedrus*, sur la production d'herbage et la diversité floristique dans un pâturage naturel. La recherche a été réalisée dans la région de Megalo Dereio, qui se trouve dans la région d' Evros, au nord-est de la Grèce, en 2010. La production d'herbage a été mesurée et les indices de la diversité écologique ont été déterminés à trois différents régimes de couverture de buisson (ouvert, modéré, dense). La production d'herbage a diminué progressivement à mesure que la couverture de genièvre a augmenté. La diversité de Floristique était de façon significative plus haute dans le régime de couverture de buisson modéré, pendant qu'il a été radicalement réduit dans le régime de couverture de buisson dense.*

Mots-clés. *Fourrage – Buissons – Diversité floristique – Invasion.*

I – Introduction

The invasion and/or the encroachment of woody species in rangeland ecosystems is increasing in many regions, especially in arid and semi-arid environments (Van Auken, 2000; Van Auken, 2009). In the Mediterranean region, this phenomenon is attributed to major socioeconomic changes of the past few decades (Seligman and Perevolotsky, 1994), which have led to a dramatic decrease of traditional human activities such as pastoral management and fuelwood

collection, which controlled the encroachment of woody species (Watkinson and Ormerod, 2001; Papanastasis and Chouvardas, 2005).

Shrub encroachment suppresses grasses and other herbaceous species (Knapp *et al.,* 2008). Many of the encroaching woody species are often unpalatable to livestock, even to browsers. Thus, shrub encroachment may reduce the carrying capacity for livestock (Ward, 2005) and consequently it may no longer support the pastoral economy (Reynolds *et al.,* 2007).

Moreover, shrub encroachment is widely recognised as one of the major threats to biodiversity in rangeland ecosystems (Bartolome *et al.,* 2005; Dalle *et al.,* 2006), as these communities are composed of a few dominant woody species (Rousseau and Loiseau, 1982). Papadimitriou *et al.* (2004) reported that floristic diversity reduced progressively as shrub density increased.

The purpose of this study was to investigate the effects of *Juniperus oxycedrus* encroachment on herbage production and floristic diversity in a natural grassland.

II – Materials and methods

The study was conducted in the area of Megalo 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. The grasslands of the study area are composed of herbaceous vegetation, while some woody species such as *Juniperus oxycedrus* subsp. *oxycedrus* and *Cistus incanus* subsp. *creticus* are also present. The area is grazed mainly by goats and cattles.

Three experimental areas with different shrub cover regimes were selected in early June 2010: (i) open shrub cover (10%), (ii) moderate shrub cover (25%) and (iii) dense shrub cover (50%). The dominant shrub species was *Juniperus oxycedrus* subsp. *oxycedrus*. Four permanent transect lines of 20 m long were established in every shrub cover regime. The plant cover and the floristic composition were measured by using the line-point method (Cook and Stubbendieck, 1986) with contacts obtained every 20 cm. The sampling of herbage yield was carried out in two 0.5 m x 0.5 m quadrats in every permanent transect established in each shrub cover regime. All samples were oven dried at 60ºC for 48 h and weighed.

The nomenclature of the recorded taxa follows Strid and Tan (1997, 2002) and Tutin *et al.* (1968-1980; 1993). Floristic diversity was determined by the number of species (N), the Shannon-Wiener diversity index (H'), the Simpson diversity index (D) and the Berger-Parker dominance index (d). The formulae of the indices are given below (Henderson, 2003):

$$H' = -\sum_{i=1}^{S} p_i \ln p_i \qquad D = 1 - \sum_{i}^{S_{obs}} p_i^{\,2} \qquad d = \frac{N_{\max}}{N_T}$$

where S is the maximum recorded number of taxa, pi 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.

The obtained data were analysed with SPSS 18 for Windows. One-way ANOVA was used to analyse the effect of juniper encroachment on herbage production and on floristic diversity indices. The LSD at the 0.05 probability level was used to detect the differences among means (Steel and Torrie, 1980).

III – Results and discussion

Herbage production was gradually reduced as shrub cover increased. It significantly decreased by 37% and 58% in the moderate and the dense cover regimes respectively (Fig. 1) compared to the open one. This reduction could be attributed to the dominance of the more competitive

woody species which shaded herbaceous vegetation away. Similar findings have been reported by many other researchers (Platis and Papanastasis, 2003; Kesting *et al.,* 2009).

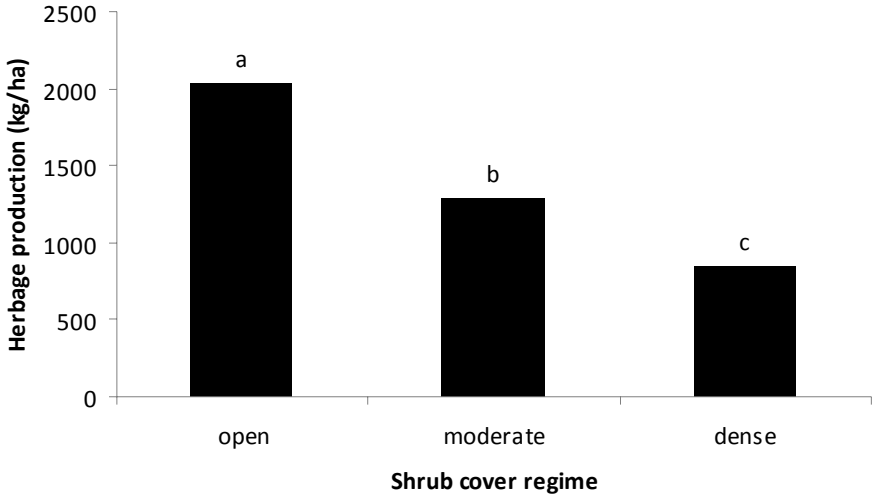

Fig. 1. Herbage production for the three shrub cover regimes. Means followed by the same letter are not significantly different (P≤0.05).

Species richness and floristic biodiversity, as described by the diversity indices, were significantly lower in the dense shrub cover regime in comparison to the moderate one (Table 1). Floristic diversity tends to be higher in the moderate shrub cover regime compared to the open one, although this increase did not produce significant results. No significant differences were detected among the shrub cover regimes for the Berger-Parker dominance index.

Table 1. Floristic diversity indices for the three shrub cover regimes

Shrub cover regime	Diversity Indices			
	N	H'	D	d
Open	15 ab*	2.05 ab	5.66 b	0.40 a
Moderate	20 a	2.46 a	9.16 a	0.29 a
Dense	12 b	1.71 b	4.06 b	0.48 a

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

Shrub encroachment is generally assumed to have negative effects on floristic diversity. On the contrary, Duelli (1997) supports that shrub encroachment leads to higher habitat heterogeneity and consequently to higher biodiversity. The results of the present study confirm that up to a certain degree shrub encroachment leads to higher floristic diversity, but after it reaches that critical point, biodiversity is dramatically reduced.

IV – Conclusions

Juniper encroachment resulted in a progressive reduction of herbage production. The moderate

juniper cover regime enhanced floristic diversity, but at the dense juniper cover regime biodiversity depleted. Therefore, shrub encroachment control is required either by browsing livestock or by clearing.

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