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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 237-240

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

<http://om.ciheam.org/article.php?IDPDF=801248>

To cite this article / Pour citer cet article

Donat M.P., Dopazo C., Cabrelles V., Herreros M.J., Segura G. **Study of the evolution of the floristic diversity in areas of pasturage in Titaguas and Tuéjar (Valencia, Spain)**. In : Porqueddu C. (ed.), Ríos S. (ed.). *The contributions of grasslands to the conservation of Mediterranean biodiversity*. Zaragoza : CIHEAM / CIBIO / FAO / SEEP, 2010. p. 237-240 (Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 92)



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Study of the evolution of the floristic diversity in areas of pasturage in Titaguas and Tuéjar (Valencia, Spain)

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Abstract. In several zones of the Mediterranean area grazing is used to contribute to the control of the vegetation with an objective of prevention of fires. This study tries to evaluate the influence of grazing on the evolution of the floristic diversity in cleared bushes and submitted to this process. The effects of the grazing produced by goats were studied in an area that had been mechanically cleared. The study extended for a period of four years and included communities of bushes dominated by *Quercus coccifera*, *Thymus vulgaris* and *Rosmarinus officinalis* (*Rhamno lycioidis-Quercion cocciferae*). The floristic diversity was calculated by means of the indexes of Shannon in grazed zones and control zones (fenced, not grazed). The first samplings were carried out in the years 2006 and 2009. With regard to the evolution in the time, during the first year the specific diversity did not change significantly after the grazing, but after three years the registered specific diversity was higher in the grazed plots. The Shannon's index values obtained are similar for the relative frequency of species. Nevertheless there have been changes in the catalogue having slightly increased the number of taxa, some have not appeared and others have appeared.

Keywords. Floristic diversity – Grazing – Mediterranean vegetation – Control vegetation.

Étude de l'évolution de la diversité floristique dans des zones de pâturages à Titaguas et à Tuéjar (Valencia, Espagne)

Résumé. Dans diverses zones de l'aire méditerranéenne on emploie le pâturage pour aider au contrôle de la végétation dans un objectif de prévention des incendies. L'étude vise à déterminer l'influence du pâturage sur l'évolution de la diversité de la flore dans des maquis débroussaillés et qui ont été employés pour le pâturage. Nous avons étudié les effets du pâturage pour le bétail caprin après le débroussaillage mécanique et sur une période de quatre ans dans des communautés de buissons dominées par *Quercus coccifera*, *Thymus vulgaris* et *Rosmarinus officinalis* (*Rhamno lycioidis-Quercion cocciferae*). La diversité a été déterminée par l'index de diversité de Shannon dans des zones de pâturage et des zones de contrôle (clôturé, non pâturé). Les premiers échantillonnages ont été réalisés en 2006 et 2009. Par rapport à l'évolution dans le temps, la richesse spécifique de la première année n'a pas varié de façon significative par l'activité du bétail, mais après trois ans, la richesse spécifique trouvée est plus élevée dans les parcelles pâturées. Les valeurs qui ont été obtenues pour l'index de Shannon sont similaires à celles de fréquence relative des espèces. Néanmoins il y a eu des changements dans le catalogue, le nombre de taxons ayant légèrement augmenté, certains ne sont pas apparus et d'autres sont apparus.

Mots-clés. Diversité flore – Pâturage – Végétation méditerranéenne – Contrôle de la végétation.

I – Introduction

Quantifying species diversity is one of the main goals of conservation biology and there exists an array of documents debating the best way to quantify changes in plant diversity (Olszewski, 2004). The Shannon information index is the most widely used measure of diversity in and it

has been used frequently in the literature to measure the effects of grazing on plant species diversity. But these indexes do not evaluate the specific changes in the diversity. If due to a disturbance in the ecosystem a change takes place in the species, but not in their number nor in the relative proportion of individuals, the indexes do not detect these floristic variations. Therefore, in order to evaluate the effects of the grazing on the flora an exploration is carried out hereby not only on the numerical variation but on the variation in the floristic catalogue. The present study focuses on the effects produced by grazing on the floristic wealth of a territory.

II – Materials and methods

The area of study is placed in the north-western end of the Valencia province, and is part of the Iberian Mountains foothills. The territory is in the Mediterranean Western Subregion, between the Valencian-Catalan-Provençal Province and the Mediterranean Central Iberian Province (Rivas-Martínez, 2007). The area belongs to the Mediterranean pluviseasonal oceanic climate and to the Mesomediterranean bioclimatic belt with a dry ombroclimate, with an annual average rainfall around 565 mm.

The area of study is in a zone of transition between the mesomediterranean calcareous series of *Quercus ilex* subsp. *rotundifolia*, *Quercetum rotundifoliae* Br.-Bl. & O. Bolòs in Vives 1956 *sigmetum* and the series mesomediterranean semiarid of the coscoja or *Quercus coccifera*: *Rhamno lycioidis-Quercetum cocciferae* Br.-Bl. & O. Bolòs 1954 *sigmetum*. The current dominating vegetation corresponds with *Pinus halepensis* with a more or less dense ground vegetation depending on the coverage of the pinegrove, with species as *Quercus coccifera*, *Rhamnus lycioides*, the rosemary (*Rosmarinus officinalis*) and *Erica multiflora*. The "maquia" in the driest zones is replaced for shrub communities characterized by a minor coverage and with species as *Thymus vulgaris*, *Sideritis* spp., *Stipa tenacissima*, etc. The herbaceous communities are dominated by *Brachypodium retusum*. The tests have been carried out in firebreaks, where two experimental areas have been established between Titaguas's (Fuente del Rebollo, FR) and Tuéjar (Montalbana, MO) municipalities. The areas where the information has been taken are flat or with a light slope and the slightly deep soils (5 to 15 cm) are developed on calcareous materials. The firebreaks were made in the year 1994. In November 2003 the last clearing of bushes was made by means a bush shredder. In every firebreak grazes different herds of goats, used to meat production; which have stopped its activity in the spring of 2005 and in early 2009. The effects of the constant gazing after the cleaning of brushes has been estimated with the information gathered in April 2006 and July 2009. In each of the locations (FR and MO) two treatments have been made: grazed and control; for every treatment and location four permanent transects of 20 m x 0.5 m located at random have been measured. 16 transects in total have been used each year: 8 in FR, 4 grazed and 4 control; and 8 in MO, 4 grazed and 4 controls. Data about the presence and abundance of each species have been collected in these transects, counting the presence or absence of the species every half square meter of transect.

III – Results and discussion

The floristic inventory is made up of 121 species; among them 56 are common to the grazed and control transects. However there have been changes in the catalogue: some species have appeared and others have not appeared. Figures 1 and 2 show these changes. The values that have been obtained of Shannon's index vary from 2.53 to 3.58, not existing significant statistical differences. The values are high compared with the obtained ones by other authors for other Spanish pastures, though the comparison of values is inadvisable in studies that have used different methods of sampling (Ferrer *et al.*, 2001).

To see the variations of the species at a ecological level the ecological characteristics have

been grouped in two types: serial, for those species that form a part of the serial natural vegetation of territory (potential vegetation and bushes of substitution) and ruderal-arvense, for those subnitrophilous or nitrophilous species typical of transformed environments.

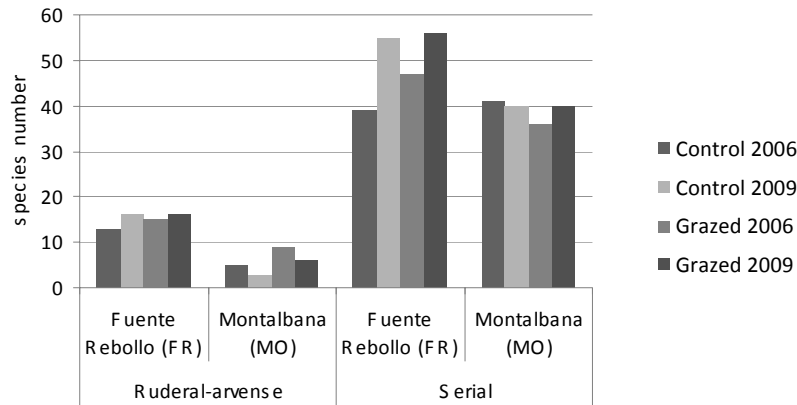


Fig. 1. Relation between species number, locality, treatment and years.

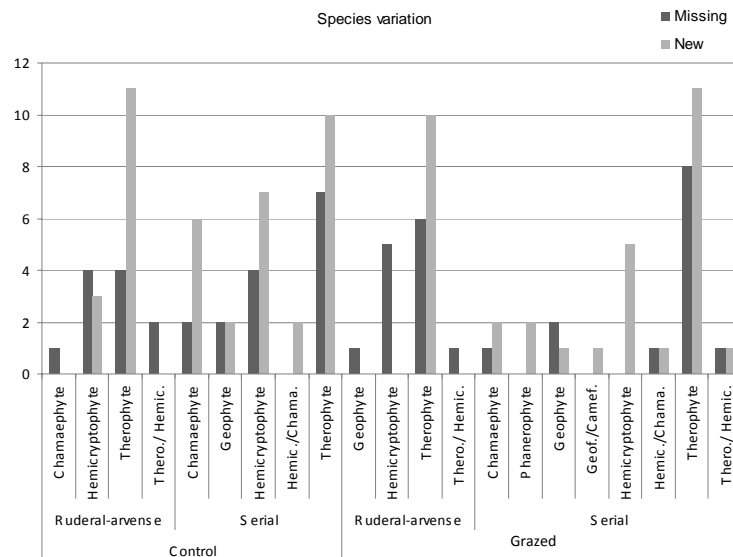


Fig. 2. Relation between species variation in the time, ecology and morphology.

We can see that the majority are typical species of the serial vegetation. To understand the presence of ruderal-arvense species in all the transects we have to take into account the specific conditions in which the experiment is carried out, in an area that has suffered previous disturbances, with the clearing of the vegetation with roller chopping. All these performances took place before the fencing of the control plots was made. This explains the presence in all

plots, also the control one, of species with subnitrophilous or nitrophilous character. And it explains that in the year 2006 there are more species associated with turned over areas (*Reseda* spp.), which presence has diminished later on.

With regard to the changes in the floristic catalogue, as time goes by there is a slight increase in the number of species, being greater generally in grazed zones than in the others. Also there is a floristic change, 52 taxa do not appear and 75 new ones appear being both of them mainly therophytes. This is due to the different months in which the inventories were made (April 2006 and July 2009). So then, in spring time species of earlier phenology appear, for example, *Hornungia petraea*. Also the annual meteorological characteristics are of great relevance and they may change notably the populations of annual and vivacious species. Among the hemicryptophytes that disappear, *Antirrhinum barrelieri* and *Cephalaria leucantha*, there was only a specimen. The variations are also observed by territories. In transects of FR area there is a greater increase of species.

Concerning the type of new species, it is mainly a question of serial vegetation typical taxa and secondly, of ruderal-arvense taxa. They are taxa located in adjacent territories. Among them they appear interesting species as the endemic *Centaurea spachii*. But we have to emphasize that there are not species of a strongly nitrophilous character or associated to a very altered vegetation as *Quenopodiaceae*, *Amarantaceae*, *Urtica* spp., etc. Grazing can have a deep impact on the species composition and on the floristic variety. Therefore it is necessary to adapt the stocking density to the suitable one for conservation purposes. These changes overlap with other disturbances and they can be slow and not observed in a few years. There are more species in the grazed zones than in control, though the differences are not significant. In this respect it would be precise a bigger number of years to evaluate the effect of the shepherding and the specific wealth, fact that coincides with the results obtained by other authors for semiarid grassland (Robles *et al.*, 2009).

IV – Conclusions

121 taxa have been catalogued in the set of the plots, 56 common at the grazed areas and not grazed areas. The values that have been obtained of the Shannon's index are similar for the relative frequency of species. There have been changes in the catalogue having increased the number of taxa, being the ones that are absent and the ones that have been incorporated. Taxa of the serial vegetation prevail over the ruderal or arvense taxa, and species of very nitrophilous character have not been introduced.

Acknowledgements

The present work has been realized in the framework of the research plots established with the funding of the Conselleria de Medio Ambiente, Agua, Urbanismo y Vivienda of the Generalitat Valenciana in the Agreement of Collaboration "Study of the effects of controlled grazing in firebreak areas. The first and second phase, year 2004 and 2005".

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