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Influence of grazing activities on species diversity of dung beetles in Mediterranean pastures

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Abstract. We evaluated whether different types of grasslands lead to different patterns of dung beetle assemblages by comparing two different management conditions of grasslands in central Spain. Four different sites of grasslands with high wild herbivory (deer, roe deer) were sampled inside of Cabañeros National Park and four sites with traditional agrosilvipastoral management were sampled in a sheep farm in the nearby of the park. Dung beetle species richness didn't vary among grassland conditions but total dung beetle abundance and biomass were considerably greater in park grasslands than in the grasslands of the sheep farm. Despite of the high similarity among the sampled sites in both hydric content and availability of dung, dung beetle species composition and abundance from both park and farm sites were different. These results suggest that management activities like ploughing affecting soil structure and the use of veterinary substances affecting dung quality could be important factors affecting dung beetle assemblages in terms of composition, abundance and biomass in Mediterranean ecosystems.

Keywords. Livestock – National Parks – Traditional farming.

Influence du pâturage sur la diversité des espèces de bousiers dans les pâturages méditerranéens

Résumé. *Nous avons évalué si différents types de prairies conditionnent différents modèles d'assemblages de Scarabéidés coprophages en comparant deux types de gestion pastorale de prairies du centre de l'Espagne. Quatre sites différents de prairies avec herbivores sauvages (cerf, chevreuil) ont été échantillonnés à l'intérieur du Parc National de Cabañeros et quatre sites avec activité agrosylvopastorale traditionnelle ont été échantillonnés dans une ferme de moutons dans les environs du parc. La richesse spécifique de coléoptères coprophages ne varie pas entre les conditions des pâturages, mais l'abondance totale et la biomasse ont été considérablement plus élevées dans les prairies du parc que dans les prairies traditionnelles. En dépit de la grande similitude de contenu hydrique et de disponibilité des excréments des sites échantillonnés, la composition et l'abondance des espèces de bousiers dans les sites du Parc et ceux de la ferme sont différentes. Ces résultats suggèrent que les activités de gestion pastorales, comme les travaux agricoles qui transforment la structure du sol et l'utilisation de produits chimiques vétérinaires qui affectent la qualité des excréments, pourraient être d'importants facteurs de modification de la structure des communautés de bousiers en termes de composition, d'abondance et de biomasse dans les écosystèmes méditerranéens.*

Mots-clés. *Bétail – Parcs nationaux – Agriculture traditionnelle.*

I – Introduction

Protected areas play a crucial role in biodiversity conservation allowing the natural processes of species populations. There are evidences that protected areas where grazing for wild or domestic herbivores maintain open vegetation areas and high species richness and abundance of dung beetles (Verdú *et al*., 2007; Numa *et al*., 2009). We examined the value of protected areas for conservation of dung beetle biodiversity by comparing dung beetles assemblages in grasslands with wild grazing inside the Cabañeros National Park and adjacent grasslands areas

with extensive sheep grazing. We hypothesized that in similar conditions of resources availability, dung beetle assemblages in nearby grasslands differ of grasslands within the National Park.

II – Materials and methods

1. Study area

The study area comprises the grassland of Cabañeros National Park and adjacent pastures outside of the Park. This area is located at the centre of the Iberian Peninsula (0º 35' W; 39º 24' N). Grasslands at the National Park maintain an abundant population of wild herbivores such as red deer (*Cervus elaphus*) and roe deer (*Capreolus capreolus*). The grassland sites selected outside the park was located 4.5 km from the protected area on the farm "Las Póvedas". This is a traditional sheep farm with the same soil type, vegetation structure and tree species in the park, but with a three years rotational system of plough, cereal culture, grass growth and sheep grazing.

2. Dung beetle sampling and diversity analysis

We selected 4 sampling sites at each of the two localities. Dung beetles were sampled using three pitfall traps at each sampling site, separated at least 50 m between traps and at least 600 m between sampling sites. Traps were baited with sheep dung because this type of dung resembles in form, odor and composition to the deer dung available within the park. Sampling was carried out in May 2005 over two periods of 7 days when traps were active.

Estimates of expected species richness and comparison of these predictions among park and farm grasslands, were calculate using two non-parametric richness estimators: one incidence-based and one abundance-based (ICE and ACE) using EstimateS 8.2 (Colwell, 2005). Inventory completeness at each grassland type was measured as the percentage of species observed from the total number of species predicted by estimators. We tested for differences in the mean alpha diversity and abundance of individuals among farm and park sites using Mann-Whitney tests (StatsDirect, 2005).

We also analyzed the influence of grassland types on patterns of species richness and abundance based on functional groups (Halffter and Matthews, 1966). For our analysis three categories were considered: endocoprids, paracoprids, and telecoprids. We compared species richness and abundance per functional group between management conditions using Mann Whitney tests (Stats Direct, 2005).

III – Results and discussion

In total 9225 individuals belonging to 37 dung beetle species were collected. Our inventories had more than 90% of completeness at each study sites and at the entire study we recorded 92% of the expected species richness according to the ACE and ICE estimators (Table 1).

The cumulative alpha species diversity was similar for both grassland types, 31 and 32 species were observed in the National Park and farm area, respectively (Table 1). The species richness per sampling site did not show differences between park and farm sites ($U = 5$, $p < 0.37$) (Fig. 1), while dung beetle abundance was greater at the park than at farm sites ($U = 0$, $p < 0.02$) (Fig. 1).

The influence of type of management in grasslands was observed on species richness and abundance of functional groups. Species richness and abundance of telecoprid dung beetles was greater at the park site (species richness: $U = 0.5$, $p < 0.05$; abundance: $U < 0.01$, $p <$

0.05); species richness of paracoprids was similar between land use conditions but paracoprid abundance was greater in the park (species richness: U = 6, $p < 0.49$; abundance: U < 0.01, $p < 0.05$); where as endocoprids were similar in species richness and abundance between both land use conditions (species richness: U = 4, $p < 0.2$; abundance: U = 2, $p < 0.08$).

Table 1. Dung beetle richness and total number of species expected for each management condition according to the ACE and ICE estimators. Inventory completeness is computed as the percentage that observed richness represents from the total expected richness

	Observed cumulative richness (S)	ACE	ICE	Completeness (%)	
				ACE	ICE
Park	31	34.23	34.08	90	93
Farm	32	33.01	34.27	94	90
Total of study	37	40.62	42.23	90	92

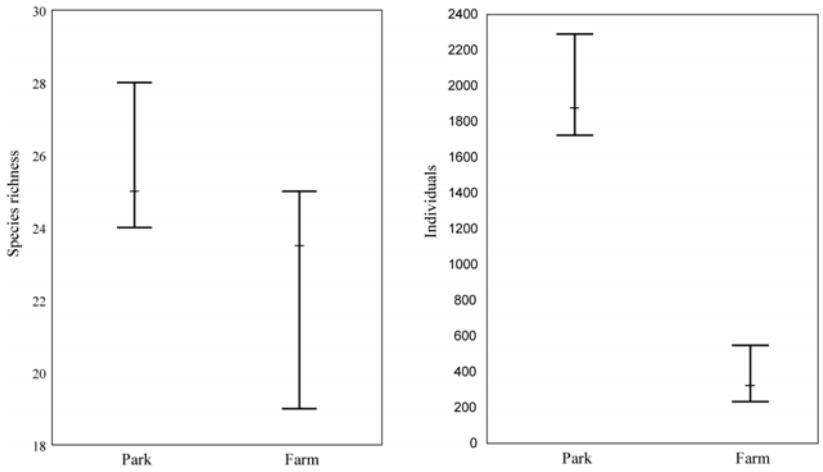

Fig. 1. Species richness and abundance of dung beetles at grasslands of Cabañeros National park and Las Póvedas farm. Bars represent maximum, minimum and median values.

Our results showed that pasture lands with similar herbivory charge, but different grazing management, differ in dung beetle assemblages. Although the species richness didn't vary among grazing systems, the main differences were observed in both species abundance and composition. Our observations on the strong decrease of both total dung beetles abundance and abundance of telecoprids in the grazing farm emphasize the need to evaluate the influence of different management activities on dung beetle assemblages. Grazing management entails, in occasions, trampling, overgrazing and activities like ploughing which affects soil structure. These activities influence microhabitat requirements for larval development of the different functional groups of dung beetles. Telecoprids (which detach a portion of dung from the mass, roll it some distance away from the source and then bury it or place it in a grass tussock) and paracoprids (which dig tunnels and construct their nests directly under the dung mass) require determinate soil characteristics for burying dung and building nests (Bertone *et al*., 2006), whereas embryogenic development of endocoprids (which create a nest chamber within the dung) occurs in the dung pat and the soil interface (Halffter and Matthews, 1966). Other farming

activity that needs more investigation is the use of veterinary medicinal products to control endoparasites in farm livestock (e.g. avermectins) (Hutton and Giller, 2003). These substances are excreted in the dung for 1 to 2 weeks after treatment, which leads to dung inhabiting invertebrates being exposed to toxic effects (Lumaret *et al*., 1993).

IV – Conclusions

Our results emphasize two important aspects of conservation of dung beetle diversity: the crucial role of the grazed protected areas maintaining greater levels of both dung beetle individuals and biomass; and the effects of livestock management on dung beetle assemblages. Traditional grazing systems are generally associated to low charge of herbivory and extensive management of livestock, but the knowledge on how management activities and chemical inputs affect the quality of both dung and soil and its effects on species assemblages and ecosystem functioning is essential to formulate effective measures of biodiversity conservation in grazing systems.

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