



Original Investigation

The influence of local, landscape and spatial factors on the distribution of the Lusitanian and the Mediterranean pine voles in a Mediterranean landscape

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ABSTRACT

This study evaluated the relative contributions of local and landscape factors, and of spatial structure on the regional distribution of both the Lusitanian (*Microtus lusitanicus* Gerbe, 1879) and Mediterranean pine voles (*Microtus duodecimcostatus* de Selys-Longchamps, 1839) over an area of 1613 km² within a Mediterranean landscape in central Portugal.

Three sets of explanatory variables (20 local, 23 landscape, and 6 spatial) were analysed independently by means of a generalized linear model, followed by a variance partitioning procedure.

Variance in the distribution patterns of *M. lusitanicus* and *M. duodecimcostatus* largely was explained by fine-scale environmental factors but spatial effects also were important, especially for the distribution of *M. duodecimcostatus*. The close proximity of verges and the high abundance of humidity and coarse sand in the soil were the most influencing local-scale factors for the presence of *M. lusitanicus*; meanwhile on a larger scale, the high abundance of linear habitats was the main landscape feature determining its occurrence. Regarding the presence of *M. duodecimcostatus*, the close proximity of verges, high tree canopy cover and herbaceous vegetation biomass were the most influential local explanatory variables for its occurrence, while the absence of shrubs in the surrounding habitat was the main factor regulating species presence at a landscape scale. Similarities identified between the two species primarily were related to descriptors of cover, food and burrows, while differences were related to opposing spatial trends and coarse-scale descriptors.

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Introduction

Scale is a determining factor in species ecology, because it influences the conclusions drawn by an observer and whether results can be extrapolated to other times or locations (Legendre and Legendre, 1998; Cushman and McGarigal, 2002). Traditionally, species habitat models have focused on fine spatial scales; but it is being increasingly recognised that species–habitat relationships may vary across different spatial scales, like biogeographic, regional, and local (Suárez-Seoane and Baudry, 2002; Miller et al., 2004). Moreover, the spatial scale to which a given species responds is influenced by how habitat features are perceived and used by that species (Wiens, 1996; Suárez-Seoane and Baudry, 2002). These differences in scales of perception and habitat use by animals largely are influenced by physiological, morphological and behavioural characteristics, such as body size, ability to move, avoidance of predators, and resource use (Farina, 2000).

Spatial autocorrelation is a common phenomenon in species distribution studies, corresponding to the situation whereby the closer two locations are, the more similar their measured values are (Legendre, 1993; Legendre and Legendre, 1998). When modelling species distributions, the occurrence of spatial autocorrelation leads to dependence among observations (Legendre, 1993). This characteristic violates the assumption of independence of residual errors in correlation and regression models, resulting in underestimates of variance and overestimates of the significance of a given explanatory variables' effect (Legendre, 1993). Quantifying the spatial components can help to correct for the presence of spatial autocorrelation, and may clarify the importance of spatial trends and neighbourhood effects on species distribution processes (Legendre, 1993; Segurado et al., 2006).

A large number of endemic species of small mammals live in the Mediterranean peninsulas (Bilton et al., 1998), including Iberia, contributing to the recognised importance of the Mediterranean Basin as a hotspot of biodiversity (e.g., Médail and Quézel, 1999). Despite this, basic ecological data remain inadequate for certain Iberian species, namely the microtines (Paradis and Guédon, 1993). The Lusitanian pine vole (*Microtus lusitanicus* Gerbe, 1879) and the Mediterranean pine vole (*Microtus duodecimcostatus* de

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