Short Note

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New records on the distribution of three rodent species in NE Portugal from barn owl (*Tyto alba*) diet analysis

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In Portugal some information has been published about the spatial distribution, at a local or regional scale, for several small mammal species (e.g. Madureira & Magalhães 1980, Magalhães & Madureira 1980, Tomé 1994, Cruz *et al.* 2002, Roque 2003, Temme 2003, Vale-Gonçalves 2006, Godinho 2007, Mira *et al.* 2008, Santos *et al.* 2009, Rosalino *et al.* 2010, Machado 2011, Paupério 2012, Garrido-García *et al.* 2013). Nevertheless, in the absence of a national mammal atlas, the knowledge of small mammals´ distribution in Portugal is still very incomplete. The data available in the reference guide of terrestrial mammals of Portugal (Mathias *et al.* 1999) exhibit significant geographical gaps, since the information provided was based on data collected in 90´s of last century and the presence of the species are represented in a grid of 50x50 km cells. Therefore, this reference work needs to be updated and complemented with new records in order to best understand the spatial distribution patterns of small mammals. In this perspective, the present study aims to contribute for the knowledge upgrade on the small mammals' distribution in northeastern Portugal (Fig. 1) through a regional intensive sampling network and by using the standard indirect method of the barn owl pellets analysis.

The barn owl *Tyto alba* (Scopoli, 1769) is a nocturnal bird of prey that feeds mainly on small mammals, although birds, bats, reptiles, amphibians, insects and fishes can constitute an alternative prey (Mikkola 1983, Cramp 1985, Taylor 1994, Roulin & Dubey 2012, Roulin & Dubey 2013). Barn owl pellet analysis is an extremely valuable tool for the characterization of small mammal communities and is widely used to study their richness and composition, providing data that are difficult or impossible to detect otherwise, namely regarding the presence of less common prey species, the predator pressure, and seasonal differences in the owl´s diet (Taylor 1994, Torre *et al.* 2004, Yalden 2009).

The presence of small mammals in barn owl pellets was assumed to be related with a year-around prey availability in the surrounding areas of their nest and/or roost sites (Taylor 1994). Therefore, potential nest and roost sites were searched in the study area to detect the presence of barn owls. Indirect evidences of the species occurrence (e.g. pellets, feathers, white droppings near nests or roost sites) were considered as showing site/nest occupation and included in the experimental design as potential sampling point.

The small mammal communities and their distribution was assessed by the analysis of 2,116 pellets collected, between 2006 and 2011, in 23 sites/nests located in the districts of Vila Real,

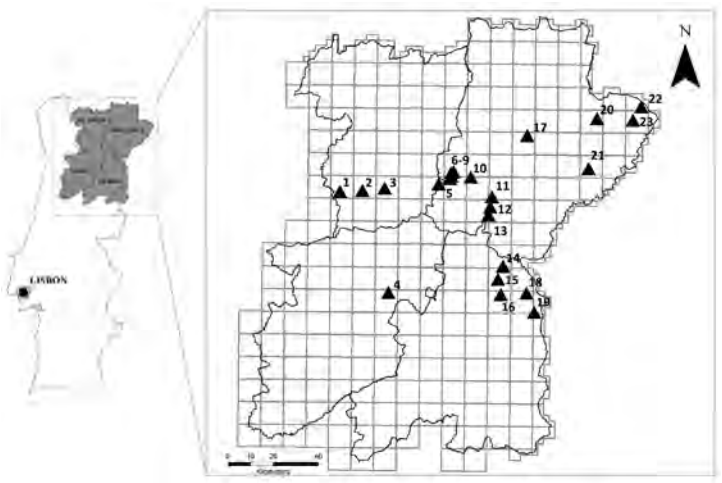

Figure 1. Geographical distribution of the studied barn owl sites/nests in the northeastern of Portugal (UTM grid of 10x10 km, Datum Lisboa/Hayford-Gauss, IGeoE).

Bragança, Viseu and Guarda (Fig. 1). All pellets were dissected separately in the laboratory by the "wet" method (Yalden 2009), and prey were identified at the species level, mainly by using reference books for cranial remains analysis (Brown & Twigg 1968, Herrera & Soriguer 1974, Blanco 1998, Yalden 2009). The spatial distribution of the small mammals' was carried out through ArcGIS 10.1 (ESRI ®).

A total of 6,955 preys were recorded from the analysis of the 2,116 barn owl pellets collected, which was dominated by small mammals species (n= 6,842; 98.38%) (Table 1). Fifteen small mammals species were identified, 11 belonging to the Rodentia order (n= 4,617; 66.38%) and 4 to the Soricomorpha order (n= 2,225; 31.99%). The most frequent barn owl prey identified was the greater white-toothed shrew *Crocidura russula* (Hermann, 1780), followed by the Lusitanian pine vole *Microtus lusitanicus* (Gerbe, 1879), the Algerian mouse *Mus spretus* (Lataste, 1883) and wood mouse *Apodemus sylvaticus* (Linnaeus, 1758) (Table 1).

Overall, taking into account the spatial indicators that emerge from our results, the obtained distribution for the small mammals at the study area, projected for a UTM grid of 10x10 km cells, allowed us to identify new occurrence areas for three species, namely the Cabrera vole *Iberomys cabrerae* (Thomas, 1906) (Fig. 2) (Mira *et al.* 2008, Garrido-García *et al.* 2013), the common vole *Microtus arvalis* (Pallas, 1778) (Fig. 3) (Cruz *et al.* 2002) and the garden dormouse *Eliomys quercinus* (Linnaeus, 1766) (Fig. 4) (Mathias *et al.* 1999).

Concerning to the Cabrera vole spatial distribution (Fig. 2), these outputs are encouraging since they represent new occurrence sites for the Luso-Carpetano core of their distribution area (Garrido-García *et al.* 2013), and a step forward in

Table 1. Total amount and proportion of prey items recorded from the barn owl diet analysis and their representativeness considering the sites/nests selected in the northeastern of Portugal.

Preys	No. of preys (%)	No. of sites/nests (%)
Small mammals		
Talpa occidentalis	7 (0.10)	5 (21.74)
Sorex granarius	35 (0.50)	2 (8.70)
Sorex spp.	18 (0.26)	4 (17.39)
Neomys anomalus	7 (0.10)	2 (8.70)
Crocidura russula	2,158 (31.03)	23 (100)
Eliomys quercinus	2 (0.03)	2 (8.70)
Apodemus sylvaticus	1,066 (15.33)	23 (100)
Mus spretus	1,090 (15.67)	23 (100)
Mus musculus	36 (0.52)	13 (56.52)
Mus spp.	8 (0.12)	4 (17.39)
Rattus rattus	4 (0.06)	4 (17.39)
Rattus norvegicus	1 (0.01)	1 (4.35)
Arvicola sapidus	12 (0.17)	7 (30.43)
Microtus lusitanicus	1,993 (28.66)	23 (100)
Microtus agrestis	231 (3.32)	6 (26.09)
Microtus arvalis	11 (0.16)	2 (8.70)
Iberomys cabrerae	163 (2.34)	19 (82.61)
Birds	82 (1.18)	19 (82.61)
Insects	26 (0.37)	10 (43.48)
Bats	3 (0.04)	3 (13.04)
Reptiles	2 (0.03)	2 (8.70)

assessing their effective regional distribution in the North of Portugal. The first record of common vole in North Portugal was described by Cruz *et al.* (2002) also by using barn owl pellet analysis. However, in this study our records revealed new occurrence areas for this species at the most north known Portuguese locations considering the previously identified ones (Fig. 3). Recently, in the province of Castilla-León (Spain), a demographic explosion of common vole was reported and listed as an agricultural pest (Luna 2010), which may contribute to increase the local abundance of this species now confirmed in the Portuguese contiguous habitats. The spatial distribution of the garden dormouse is described as a continuous area in Spain (Palomo *et al.* 2007). Conversely, in Portugal the distribution of this species has been considered fragmented mainly due the absence of sufficient information from field records (Mathias *et al.* 1999). Therefore, the new occurrence areas recorded in our work represent a relevant upgrade contribution for the knowledge of the species distribution in Portugal (Fig. 4).

This findings show that the analysis of barn owl pellets is an useful starting point in order to confirm and improve the knowledge about the distribution patterns of small mammals species, with added value in integrative multi-scale approaches regarding the nature of the distinct drivers of change acting on vulnerable species, guilds and communities. Additionally, this could be used to improve also the quality of knowledge about some more specific issues, such as the potential areas of sympatry between the Cabrera vole, the common vole and the field vole *Microtus agrestis* (Linnaeus, 1761), namely to assess if this co-existence contributes to the understanding of the respective population trends among the vole community.

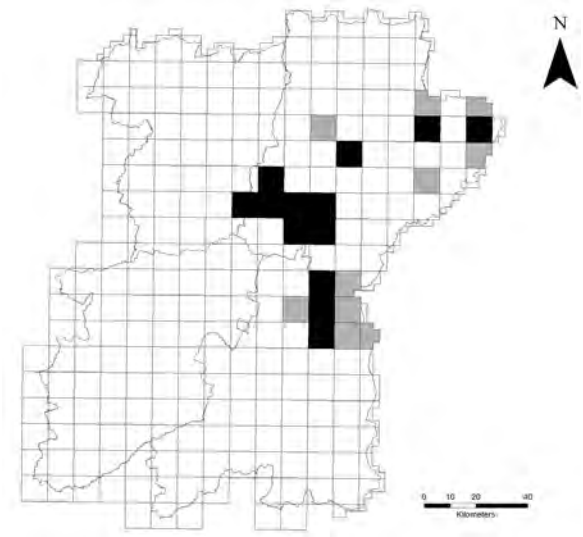

Figure 2. The *Iberomys cabrerae*, Cabrera vole distribution map projected in a UTM grid of 10x10km cells (Datum Lisboa/Hayford-Gauss, IGeoE). The grey cells represent the previous known areas (Mira *et al.* 2008, Garrido-García *et al.* 2013) and the black cells represent the new data for the species occurrence from the analysis of the barn owl pellets in the study area.

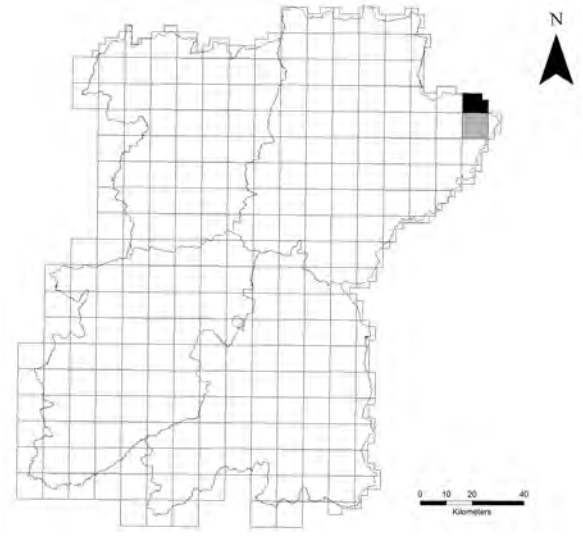

Figure 3. The *Microtus arvalis*, common vole distribution map projected in a UTM grid of 10x10km cells (Datum Lisboa/Hayford-Gauss, IGeoE). The grey cells represent the previous known areas (Cruz *et al.* 2002) and the black cells represent the new data for the species occurrence from the analysis of the barn owl pellets in the study area.

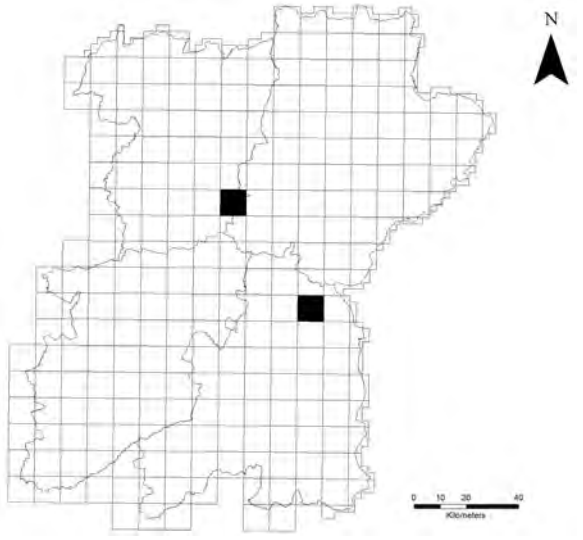

Figure 4. The *Eliomys quercinus*, garden dormouse distribution map projected in a UTM grid of 10x10km cells (Datum Lisboa/Hayford-Gauss, IGeoE). The black cells represent the new data for the species occurrence from the analysis of the barn owl pellets in the study area.

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