

ABUNDANCE AND DISTRIBUTION OF EUROPEAN BADGER – *MELES MELES* (LINNAEUS, 1758) IN THE SIERRA DE MARIOLA NATURAL PARK (C. VALENCIANA)

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I. INTRODUCTION AND OBJETIVES

The badger (*Meles meles*) is a carnivorous and territorial species that inhabits around the world (Revilla and Palomares, 2002a; Revilla and Palomares, 2002b; Del Cerro, 2011). Its habitat ranges from deciduous forests, natural pastures and wetlands to semi-desert and urban areas (Revilla *et al.*, 2000; Molina-Vacas, *et al.*, 2009). The home range has an average size of 525 hectares in the Iberian southwest (Rodríguez, 1996). Its occurrence is favoured by tree and shrub cover and the presence of natural corridors and arable crops (Pereira, 2011).

The diet is varied including fruits (Pigozzi, 1991), rabbits (Martín *et al.*, 1995), birds (Hounscome and Delahay, 2005), insects (Murdoch and Buyandelger, 2010) or earthworms (Kruuk and Parish, 1981). It is accepted that its diet is opportunistic (Neal and Cheeseman, 1996; Revilla and Palomares, 2002a); however other authors suggest a specialized diet (Kruuk and Parish, 1981).

In Europe the badger is classified as Least Concern according to the International Union for Conservation of Nature (IUCN) because its stable population trend. The main threats are illegal hunting, human disturbance and habitat destruction (Belda *et al.*, 2008; Belda *et al.*, 2009; Mangas, 2009).

Using models of distribution and abundance is proving effective in designing conservation plans for wildlife (Ferrier, 2002; Graham *et al.*, 2006).

In 2009 a new research group was created for investigating mammals and their relationship with the landscape in Sierra de Mariola Natural Park (Belenguer *et al.*, 2011). These studies can serve to improve park management plans, helping to increase the quality of habitat for this mustelid (Ballesteros, 1998; Chase, 2000, Angulo, 2003; Lombardi, 2003), and it allows to the hunting managers to make quick and effective decisions (Mathevet and Tamsier, 2002; Stoate *et al.*, 2004).

The main objective of this study is to estimate the abundance and distribution of the badger in the Sierra Mariola Natural Park using camera trapping, that turns out to be a cheap, safe and reliable technique. This is the first contribution to the knowledge of this species in the study area.

II. STUDY AREA

Sierra de Mariola is a mountain area located in the Iberian southeast. It covers an area of 17.500 hectares. Its climate is typically Mediterranean, with mild temperatures, autumn rains and a dry period in summer. The climax vegetation is the holm-oak wood (association *Hedero heliis-Quercetum rotundifoliae* subas. *ulicerosum parviflorae*) (Belda *et al.*, 2009).

III. METHODS

The methodology used to determine the presence/absence and relative abundance of the badger was based on camera trapping. It is a non-invasive practice, used in many areas of ecology and environmental education. Its autonomy, low price and low maintenance allow long-term studies in broad areas.

The study area was divided into 63 squares of 4 km² each. Two cameras (model Stealth Cam-IR®) were installed in each square during 2 weeks. The sampling period lasted from August 2008 to September 2009.

All the captured photos were stored in a laptop and were analysed with an own software to manage images from camera trapping. This software allows creating geographic databases from these images, and then exploring this information with a GIS, creating reports and mapping (Martínez *et al.*, 2011).

IV. RESULTS AND DISCUSSION

In total 72.347 images have been collected (more than 93 Gb) of which 29.941 show some animal contact within defined grids. From these images 48 belong to the badger. This represents the 0.16% from the total of the valid photos. On the other hand, the badger has been detected in 6 grids, the 9.38% of the total (n=63). The nocturnal behaviour has been confirmed in this species, since all captured photos were taken at night.

The badger distribution in relation to land uses shows that the highest abundances occur in the irrigated crops, followed by areas with riparian vegetation. Irrigation only represents the 1% of the study area, and it is characterized by the modernization in fruit trees, olive trees, vineyards and vegetable patches located in flat areas. Also appears in some points of rainfed land (24%), formed by small plots of olive and almond trees in the higher elevations,

while sunflower and wheat predominate in the valleys. The grids with natural vegetation and abandoned crops host fewer presences. The natural land use occupies the largest area of the park (67%) and is characterized by the presence of old pines, holm-oaks and dense scrubs. Nevertheless, the surface occupied by abandoned crops (olive and almond trees with a low profitability) only represents the 13% of the total. The three areas with the greatest presence of the species are the southwest sector which coincides with the river Vinalopó and associated riparian vegetation, with the adjacent rainfed and irrigated crops. Moreover, there are two other areas in the northeast sector with the presence of badger, characterized by small ravines inserted into mature wooded areas, with small farms (*masías*), where the badgers easily find shelter and food.

In other similar studies, in Mediterranean environments, badgers also occur in low frequency or even do not appear using camera trapping. It is possible that a limitation of this technique is the bait used, which does not attract in the same way to all species of carnivores. That is why it may be appropriate to combine different baits for photographing a greater number of carnivore species, such as synthetic combined with commercial baits (Torre *et al.*, 2009).

In Europe low population densities have been found in the Mediterranean area (0.2-0.7 ind./km², SW Spain, Revilla and Palomares, 1999) and Central Europe (0.2 ind./km², Polonia, Kowalczyk *et al.*, 2003), while very high densities are described in British Isles (2-38 ind./km², Johnson *et al.*, 2002). Thus, the badgers from dense areas make up groups of many individuals who share a main sett and occupy a very small territory (0.14 km², Cheeseman *et al.*, 1981). Instead, the badgers who live in low or median densities (continental Europe) form groups with only one breeding pair and occupy large areas (13 km², Kowalczyk *et al.*, 2006). Therefore, the social structure of this carnivore is more organized and with less flow of migrants in high-density areas than in low-density areas, owing to the ecological purpose of migration of male badger is to find resources and to mate with receptive females not related to him.

At first glance, according to the data obtained in this study, it can be concluded that the land uses are closely related to the relative abundance of badgers. Thus, crops that are interspersed in the natural area must be taken into account in management plans that seek to badger conservation. The information provided in this survey can serve park managers for future management actions and habitat improvement.

In Mediterranean areas the studies focusing on the conservation of badgers are very scarce, especially in the southeast of Spain. The main threats to this animal have been the impact of road infrastructure during the last decades and the development of intensive agriculture and cattle raising, which leads to habitat fragmentation (Molina-Vacas *et al.*, 2009; Lankester *et al.*, 1991; Clarke *et al.*, 1998; Virgós *et al.*, 2005).

This work is pioneer because it provides data and analyses so far not addressed in this territory. Thus, the continuation of this study involves analysing other mammals that inhabit the park, checking its current situation and the interaction between different species. The images captured by camera traps, together with the proposed software, will contribute to have new data and studies about mammal populations inhabiting the Sierra de Mariola. Moreover, enabling specific steps for wildlife in road infrastructure and control of poaching are two objectives to be achieved by controlling the high mortality of badgers and promoting good conservation status of these populations.

