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General palaeontology, systematics and evolution

The earliest European badger (*Meles meles*), from the Late Villafranchian site of Fuente Nueva 3 (Orce, Granada, SE Iberian Peninsula)

Le blaireau européen le plus précoce (Meles meles) provenant du site Villafranchien supérieur de Fuente Nueva 3 (Orce, Grenade, Sud-Est de la Péninsule ibérique)

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ABSTRACT

Paleontological and molecular data suggest that the divergence of the European and Asian badgers (*Meles meles* and *Meles leucurus*, respectively) from their ancestor *Meles thorali* might have taken place in the Middle to Late Villafranchian boundary (ca. 1.8 Ma). However, the available record of Late Villafrachian European badgers is scanty and poorly known, and this hypothesis needs more paleontological data in order to be tested. The badger hemimandible from the Iberian locality of Fuente Nueva 3, a locality placed in the beginning of the Late Villafranchian, supports the idea of an early divergence between European and Asian badgers.

RÉSUMÉ

Les données paléontologiques et moléculaires suggèrent que la divergence des blaireaux européens et asiatiques (respectivement *Meles meles* et *Meles leucurus*) de leur ancêtre (ca. 1,8 Ma) *Meles thorali* aurait pu avoir lieu à la limite entre le Villafranchien moyen et supérieur. Toutefois, le registre disponible des blaireaux du Villafranchien supérieur européen est rare et mal connu, et cette hypothèse nécessite plus de données paléontologiques afin d'être testée. L'hémi-mandibule de blaireau de la localité ibérique de Fuente Nueva 3, une localité située au début du Villafranchien supérieur, soutient l'idée d'une divergence précoce entre les blaireaux européens et asiatiques.

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1. Introduction

The living Eurasian badgers (*Meles* sp.) have a Palearctic distribution, ranging from the Iberian Peninsula in the west, to the Japanese Islands in the east, including the British Islands, Scandinavia, Palestine, Iran and southern China. Throughout this wide distribution area, there is a remarkable geographic variation in both the osteological characters and the external appearance of these carnivores (Abramov and Medvedev, 2003; Abramov et al., 2009; Baryshnikov et al., 2002). Recently, several researchers have suggested that European, Asian and Japanese badgers may represent two or even three separate species. For example, Baryshnikov et al. (2002) recognized two distinct species on the basis of dental morphology: *Meles meles* Linnaeus, 1758 (Europe, south-western and central Asia) and *Meles anakuma* Temminck, 1844 (rest of Asia). Nevertheless, cranial morphology, coloration patterns of face marks and baculum structure support at least three distinct species (Abramov, 2001, 2002, 2003; Abramov and Medvedev, 2003): *M. meles* (in Europe and south-western and central Asia), *M. anakuma* (in Japan) and *M. leucurus* Hodgson, 1847 (in the rest of continental Asia).

On the basis of paleontological data, it has been suggested that the *Meles* lineage appeared in Asia, during the Early Pliocene, from a species of the genus *Melodon* Zdansky, 1924 (Neal and Cheeseman, 1996; Petter, 1971). In addition, paleontological evidence has confirmed that *Meles* reached the Iberian Peninsula before the beginning of the glacial-interglacial cycles in the northern hemisphere (ca. 2.6 Ma) (Madurell-Malapeira et al., 2009), thus indicating that this genus was widely distributed during the Early Villafranchian, soon after its first appearance in eastern Asia.

Even though the Plio-Pleistocene fossil record of European badgers is scanty and poorly known, six *Meles* species are historically recognized in this continent from the Late Pliocene to the Middle Pleistocene (Madurell-Malapeira et al., 2009, 2011). Nevertheless, in a recent review of the genus *Meles* based on the extensive fossil record from the Epivillafranchian localities of the Vallparadís section (Terrassa, Catalonia, Iberian Peninsula) (Madurell-Malapeira, 2010; Madurell-Malapeira et al., 2011), we suggested that the Early to Middle Villafranchian European badger remains might correspond to a single species, *M. thorali*, and the Late Villafranchian remains must be assigned to the extant species, *M. meles*. Following this hypothesis, *M. thorali* might have been the ancestor from which extant Asian and European badger species originated through vicariance during the Middle to Late Villafranchian boundary (ca. 1.8 Ma). This inference is supported by mtDNA and nuclear DNA data, which indicate that the divergence between both lineages might have occurred in the top of the Olduvai subchron (ca. 1.8 Ma) or before (Marmi et al., 2006; Sato et al., 2003).

According to Madurell-Malapeira (2010), the oldest European remains of *M. meles* might correspond to the localities of Pirro Nord (Italy) and Apollonia-1 (Greece). Unfortunately, the last two Late Villafranchian sites do not provide long stratigraphical sequences calibrated on the basis of magnetostratigraphical and biostratigraphical data, and the estimated age for the badger remains covers a wide chronological range (1.3–1.7 Ma) (Arzarello et al., 2007; Koufos, 1992). In this paper, we describe a badger remain from the Late Villafranchian Iberian locality of Fuente Nueva 3. This remain has a clear geological, magnetostratigraphical and biostratigraphical context, and additionally an absolute age was determined by the ESR method (Duval, 2008; Oms et al., 2010). The combinations of the former methods results in an estimated age of 1.3–1.4 Ma for the described badger remain. These data confirms that the extant European badgers were distributed throughout Europe by the Late Villafranchian, slightly later of their divergence from their ancestor *M. thorali* in the Middle-Late Villafranchian boundary (ca. 1.8 Ma).

Abbreviations: L: mesiodistal length; Lext: mesiodistal length of m1 on the buccal side; Ltal: mesiodistal length of m1 talonid; Ltrig: mesiodistal length of m1 trigonid; W: buccolingual width of m1.

2. Systematic palaeontology

Carnivora Bowdich, 1821
Mustelidae Fisher, 1817
Melinae Bonaparte, 1838
Meles Brisson, 1762
Meles meles Linnaeus 1758
(Table 1; Fig. 2)

Synonymy

Meles atavus Kormos, 1914: original description of the species.

Meles meles atavus Kormos, 1914: in Kretzoi (1938).

Meles hollitzeri Raebeder, 1976: original description of the species.

Meles n. sp.: in Mais and Raebeder (1984).

Meles dimitrius Koufos, 1992 (partim): original description of the species.

Meles meles sp. indet.: in Moullé (1992).

Meles atavus Kormos, 1914: in Wolsan (1993).

Meles hollitzeri Raebeder, 1976: in Baryshnikov (1993).

Meles hollitzeri Raebeder, 1976: in Wolsan (2001).

Meles meles Linnaeus, 1758: in Moullé et al. (2006).

Meles meles Linnaeus, 1758: in Petrucci (2008).

Meles Meles Linnaeus, 1758: in Madurell-Malapeira (2010).

Referred specimen: FN3 2005 V92 no. 142, partial right hemimandibular corpus with c1-m2, housed at the Museo de Prehistoria y Paleontología of Orce (Granada, Spain).

Stratigraphy, age and associated fauna: The Fuente Nueva 3 locality is placed in the village of Fuente Nueva, nearby to the town of Orce (Granada, SE Iberian Peninsula) (Fig. 1). The sediments in the locality consist in a 20 m-thick section mainly composed of three lacustrine carbonate layers interspersed by silty-calcareuos beds. These Early Pleistocene deposits are arranged in an upward-shallowing sequence that represents a depositional unit with distinctive features in the tectosedimentary history of the Baza intramontane basin (García-Aguilar and Palmqvist, 2011). The combination of biochronological,