



## Mesozoic mammals of the Iberian Peninsula: An approach to their paleoecology

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Two thirds of the history of mammalian evolution is developed during the Mesozoic. The most abundant and continuous European Mesozoic mammal fossil record comes from the Iberian Peninsula (IP). Mammalian remains are found, together with dinosaurs and other terrestrial vertebrates, in twenty-two sites with ages spanning from the Late Jurassic to the Late Cretaceous. Considered as a whole, the Iberian fauna includes representatives of most of the Mesozoic mammalian lineages: multituberculates, docodontans, "symmetrodontans", eutriconodontans, "eupantotherians", and therians, with some species having being only found in the IP (Badiola *et al.*, 2008; 2011; 2012; Canudo & Cuenca, 1996; Cuenca-Bescós *et al.*, 2011; 2014; Cuenca-Bescós & Canudo, 2003; Gheerbrant & Astibia, 1994; Henkel & Krebs, 1969; Krebs, 1991; Kühne, 1961, Martin, 1999; Martin *et al.*, 2015).

In a small number of sites, such as the Guimarota Lignites and Las Hoyas, the mammalian remains are found as articulated and almost complete skeletons (Lillegraven & Krusat, 1991; Martin *et al.*, 2016). Nevertheless, isolated jaws and teeth represent the majority of the Iberian Mesozoic mammalian specimens (Canudo & Cuenca, 1996; Badiola *et al.*, 2012; Cuenca-Bescós *et al.*, 2014). The fossils have been obtained by a combination of screen-washing and quarrying in the sites of Guimarota, Uña and Las Hoyas, while in all other sites (Table 1) the fossils were recovered by screen-washing. The aim of this paper is to review the fossil record of Mesozoic mammals of the Iberian Peninsula (MMIP) and propose an approximation to their paleoecology, with the analysis of both, the sedimentary environment and the paleontological content of the sites.

The Kimmeridgian of Portugal and the Barremian of Spain provided the most complete and best known specimens (Table 1). Other mammal fossil bearing sites are found in Berriasian, Valanginian, Campanian and Maastrichtian deposits. Despite of the extensive continental



outcrops present in the IP, Aptian or Albian mammals have not been found yet. The Cenomanian to Santonian interval comprises shallow marine facies in most of the IP, so continental tetrapod remains are scarce. Therefore, MMIP present an intermittent fossil record of nearly 85 million years, which ranges from the Kimmeridgian up to the Maastrichtian, with an important Aptian to Santonian Vacuum (lack or record) of 35 million years. We have analysed both the geological and palaeobiological features of the localities bearing MMIP, with data obtained from a total of 69 articles of the literature and our own work.

		Age	Guimarota	Porto das Barcas	Pai Mogo	Porto Pinheiro	Ptélago 0	Pochancalo	Cantalera	Cuesta Corrales 2	Colladico Blanco	Pelejón 2	Yacimiento Herrero	Cerrada Roya Mina	Poca	Molino Alto 1	Vallipón	Uña	Las Hoyas	Buenache	Pté Pajarón	Laño	Taveiro	Quintanilla del Coco		
Cretaceous	Late	Campanian-Maastrichtian																						F	L	
		Campanian																							L	
	Early	Aptian to Santonian vacuum																								
		Late Barremian																	C	L	L	P	L			
		Early Barremian									P	L	L	L	FM	F	LM	L								
Jurassic	Late	Valanginian-Hauterivian							FM																	
		?Late Berriasian							L																	
		Berriasian							FM																	
		Tithonian						FM	FM																	
		Kimmeridgian						LM																		

Table 1. Facies: L=lacustrine; LM= lacustrine with marine influence; F= fluvial; FM: fluvial with marine influence; P= palustrine; C=shallow marine. See text for explanation.

The MMIP are found in six types of sedimentary facies (Table 1): lacustrine and fluvial with or without marine influence (L, LM, F, FM), shallow marine (C), and palustrine (P). Lacustrine facies (L=10) are the most common MMIP bearing localities, representing almost half of the assemblages, with lacustrine assemblages with marine influence adding two more instances (LM=2). The fluvial assemblages are also abundant (FM=5), with two additional records in fluvial assemblages without marine influence (F=2). Palustrine (P=2) and shallow marine (C=1) are the facies with the less number of MMIP localities. The most diverse and rich locality in number of taxa and individuals is by far the Guimarota coal mine. We may guess that during the Jurassic, the most favourable habitats for the tiny mammals where the swampy lacustrine habitats with marine influence represented in the Guimarota Lignites. This high diversity is in part a consequence of sampling bias, since the Guimarota quarry, the only Kimmeridgian site, has being sampled with an intensity only comparable to the Las Hoyas site. During the Barremian, the number of localities with MMIP is bigger, being the lacustrine and palustrine facies the most abundant. This result may



be influenced by sampling bias, because our research team has been used the methodology of screen-washing in the numerous sites of the Barremian of Aragón (Spain).

The MMIP are found in different continental facies. The most favourable habitats for the life of these mammals were environments linked to the recurring presence of water, which most probably had a well-developed plant cover suitable for the omnivore multituberculates and the predator guild symmetrodonts, “eupantotherians” and eutherians. The coastal assemblages were more diverse and rich, probably due to a taphonomic bias (Table 1). The multituberculates are the most abundant mammals, and they are represented in nearly all the sites, from the Late Jurassic to the Early Cretaceous. Interestingly, the mammalian associations are very different in the Late Cretaceous localities, where most of the groups of mammals are not recorded, and the eutherians (placentals) are the only present lineage. This contrasts with the global record, when archaic Mesozoic mammals, such as dryolestids (“eupantotherians”), survived until the Late Cretaceous in South America, and multituberculates until the Oligocene in North America.

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