

# The continental vertebrate fossil record from Pombal: contribution to the knowledge of Upper Jurassic faunas of the Lusitanian Basin

## O registo fóssil de vertebrados continentais de Pombal: contributo para o conhecimento das faunas do Jurássico Superior da Bacia Lusitaniana

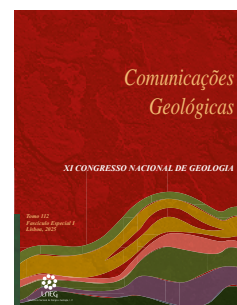
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**Abstract:** The presence of dinosaur remains is known in the region of Pombal since the end of the 19th century. The Andrés fossil site is one of the most significant paleontological localities currently known in this region, having yielded an unusually rich and diverse assemblage of vertebrates, including actinopterygians, lepidosaurs, crocodyliforms, pterosaurs, dinosaurs (ornithopods, sauropods and theropods), and mammals. In the last decades, the discovery of other localities with remarkable record of dinosaurs, especially sauropods, underlain the importance of this region for better understanding the continental faunas that inhabited this sector of the Lusitanian Basin during the Late Jurassic. This fossil record is particularly relevant for testing the possible existence of paleoenvironmental constrains in the distribution of some vertebrate taxa in different areas of the basin.

**Keywords:** Mamede sub-basin, Dinosauria, Theropoda, Sauropoda, paleoecology.

**Resumo:** A presença de restos osteológicos de dinossáurios é conhecida na região de Pombal desde finais do século dezanove. A jazida de Andrés é atualmente um dos locais paleontológicos mais relevantes conhecidos nesta região, tendo proporcionado um abundante e diversificado conjunto de fósseis de vertebrados, incluindo actinoptérgios, lepidossáurios, crocodiliformes, pterossáurios, dinossáurios (ornitópodes, saurópodes e terópodes) e mamíferos. Nas últimas décadas, a descoberta de outros locais com notável registo de dinossáurios, particularmente saurópodes, salienta a importância desta região para o conhecimento das faunas que habitaram este setor da Bacia Lusitaniana durante o Jurássico Superior. Estes registos são particularmente relevantes para testar a possível existência de restrições paleoambientais na distribuição de algumas faunas de vertebrados em diferentes áreas da Bacia Lusitaniana.

**Palavras-chave:** Sub-bacia de Mamede, Dinosauria, Theropoda, Sauropoda, paleoecologia.

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## 1. Introduction

Upper Jurassic sequences of the Lusitanian Basin are known for their rich vertebrate fossil record, especially in the coastal region (e.g.

Dantas, 1990; Antunes and Mateus, 2003). The Mamede sub-basin (sensu Fürsich *et al.*, 2021) has a scarcer record but with some localities that have yielded important occurrences of Late Jurassic vertebrates (e.g. Pérez-Moreno *et al.*, 1999; Krebs, 2000; Escaso *et al.*, 2007). The Pombal region has yielded one of the most significant records of Late Jurassic vertebrates in the Mamede sub-basin. Dinosaur remains are known in this region since the end of the 19<sup>th</sup> century, with reference to isolated theropod teeth attributed to “*Megalosaurus insignis*” (Sauvage, 1897-98). Other material from different dinosaur groups was described including a putative new theropod species “*Megalosaurus pombali*” (Lapparent and Zbyszewski, 1957), which has been interpreted as belonging to different sauropod (Mocho *et al.*, 2016) and theropod dinosaurs. The discovery of Andrés fossil site (Pombal), together with Guimarota (Leiria), with an unusually rich and diverse assemblage of vertebrate remains, has significantly increased our knowledge of the Upper Jurassic continental vertebrate faunas of this region (e.g. Pérez-Moreno *et al.*, 1999; Gassner, 2000; Hahn and Hahn, 2000; Rauhut, 2000; Wiechmann, 2000; Malafaia *et al.*, 2010). Other important records, generally dinosaurs, have been found in Batalha being particularly relevant the Casal Novo site (Escaso *et al.*, 2007). More recently, other localities with important fossil records, mainly of sauropod dinosaurs were discovered in Pombal (Mocho *et al.*, 2017, 2023). Here, we present an update on the fossil occurrences of Late Jurassic continental vertebrates from the Mamede sub-basin, and we discuss possible differences in the composition of these faunal assemblages compared to other sectors of the Lusitanian Basin.

## 2. Geological setting

Upper Jurassic sequences of the Lusitanian Basin are associated with abundant siliciclastic inputs, mainly of continental and transition origin, related with high subsidence rates, particularly marked in the central sector (e.g. Kullberg *et al.*, 2013). A progressive progradation of terrigenous sequences from the oriental and occidental margins of the basin to the central axis, with a regional drainage for SSW, has been proposed (Pena dos Reis *et al.*, 2011). Towards the end of the Kimmeridgian, as the accommodation space decreased, the continental-marine interface migrated southward and the fluvial-deltaic, sandstone-dominated successions (Lourinhã and Bombarral formations) prograded over marine and transitional deposits represented in the Mamede sub-basin by the Alcobaça Formation (e.g. Kullberg *et al.*, 2013; Fürsich *et al.*, 2021). The Pombal and Leiria regions have yielded the richest Upper

Jurassic records of continental vertebrates in this sector of the Lusitanian Basin. Andrés is found in fine-grained fluvial sandstones interpreted as part of the Bombarral Formation (Figura 1), which is mostly Tithonian in age but that may extend to the Berriasian (Kullberg *et al.*, 2013; Fürsich *et al.*, 2021). To the south of Pombal and in the region of Leiria, the vertebrate fossils have mostly been found in a complex of fine-grained sandstones and mudstones with carbonated intercalations of the “Complexo de Vale de Lagares” (Teixeira *et al.*, 1968). This unit has recently been included in the Alcoaça Formation, corresponding to Kimmeridgian sequences of marine and transitional environments (*e.g.* Schudack, 2000; Fürsich *et al.*, 2021). Casal Novo (Batalha) is found in a coarse sandstone layer, considered to be part of the Alcoaça Formation (Escaso *et al.*, 2007). Fürsich *et al.* (2021) interpreted the sedimentary sequences to the east of Batalha as part of the Lourinhã Formation, which may have implications for the interpretation of the stratigraphic position of this fossil site. Other fossil remains found in Batalha, Porto de Mós and Vila Nova de Ourém are also likely to come from the Alcoaça Formation (Mocho *et al.*, 2017).

### 3. Late Jurassic continental vertebrate faunas in the Mamede sub-basin

Upper Jurassic localities with continental vertebrates are relatively scarce in the Mamede sub-basin, compared to the coastal sector of the Lusitanian Basin. One of the most important localities in this sector is Guimarota (Leiria), where thousands of remains attributed to different vertebrates were collected. The record of early mammals is particularly relevant, with abundant cranial and postcranial material attributed to multituberculate, docodont, and holoteria (*e.g.* Krebs, 2000; Martin, 2001, 2013). The Guimarota vertebrate record also includes actinopterygians, amphibians, lepidosauriforms, crocodyliforms, turtles, pterosaurs, and dinosaurs (*e.g.* Broschinski, 2000; Gassner, 2000; Kriwet, 2000; Rauhut, 2000; Wiechmann, 2000; Wiechmann and Gloy, 2000; Caldwell *et al.*,

2015). Dinosaurs are mostly represented by isolated teeth of small ornithomorphs (hypsilophodontids and iguanodontians), and indeterminate macronarian sauropods (Rauhut, 2001; Mocho *et al.*, 2017). Theropods are abundant, mostly represented by isolated teeth interpreted as belonging to *Compsognathus*, velociraptorines, dromaeosaurines, troodontids, cf. *Richardoestesia*, cf. *Paronychodon*, tyrannosauroids, and possibly allosaurids and *Ceratosaurus* (*e.g.* Zinke, 1998; Rauhut, 2000). Some isolated teeth were referred to cf. *Archaeopteryx* (Weigert, 1995), but they were later considered to be distinct from this taxon (*e.g.* Rauhut *et al.*, 2017) and a possible attribution to a yet undescribed non-avian theropod was proposed (Louchart and Pouech, 2017). Besides teeth, theropod are also known from other elements, including a maxilla of a hatchling *Allosaurus* and an ilium of a tyrannosauroid taxon, *Aviatyrannis jurassica* (Rauhut, 2003; Rauhut and Fechner, 2005).

Another important locality in this region with similarities to Guimarota in terms of abundance and diversity of the fossil record is Andrés. A large assemblage of vertebrates has been collected, including actinopterygians, sphenodontians, and several archosaurian groups represented by: (1) isolated teeth of pterosaurs; (2) cranial and postcranial elements of at least three neosuchian crocodyliforms (Figura 2a); and (3) material attributed to different dinosaur groups (*e.g.* Pérez-Moreno *et al.*, 1999; Malafaia *et al.*, 2010). Cranial and postcranial remains of sphenodontians (Figura 2b) are abundant, representing different individuals that may belong to the same taxon. Preliminary analysis of this material suggests a close relationship to *Opisthias* (Ortega *et al.*, 2006) from correlative levels of the Morrison Formation (*e.g.* Evans *et al.*, 2001). The most common vertebrates are theropod dinosaurs, particularly *Allosaurus* (Pérez-Moreno *et al.*, 1999; Malafaia *et al.*, 2010). A partial post-cranial skeleton from this locality was assigned to *Allosaurus fragilis* (Pérez-Moreno *et al.*, 1999), but this identification has been reviewed following later discovery of other material in Andrés, including abundant cranial elements (Figura 2c), and the description of the species *Allosaurus europaeus* from Praia de Vale Frades, in Lourinhã (Mateus *et al.*, 2006). Apart from *Allosaurus*, the record of dinosaurs is scarce, but represents a diverse fauna that includes camptosauroid and dryosaurid ornithomorphs, diplodocoids, titanosauriformes, potential turiasaurian sauropods (Figura 2d), and possible coelurosaurian theropods (Malafaia *et al.*, 2010; Mocho *et al.*, 2017). It was also identified a mandible of a mammal (Figura 2e), which shows similarities with Dryolestidae from Guimarota (*e.g.* Martin, 2000). However, the possible relationship with the taxa described from this locality is still under evaluation.

Other recently found localities in Pombal have yielded important fossil records, mostly of sauropods: (1) Junqueira, with some axial elements, mostly dorsal vertebrae (Figura 2f) and rib fragments; (2) Monte Agudo, where a partially articulated series of dorsal vertebrae and ribs, was collected; and (3) Mouriscas, with an abundant accumulation of sauropod remains, represented by disarticulated appendicular and axial elements, together with scarce material of crocodyliforms and theropods. Preliminary analysis of these sauropod specimens indicates a relationship with brachiosauroid titanosauriformes (Mocho *et al.*, 2023). Isolated dinosaurian remains from other localities in Pombal (*e.g.* Vermoil and Albergaria dos Doze) are attributed to indeterminate sauropods, eusauropods, and indeterminate theropods (Sauvage, 1897-98; Lapparent and Zbyszewski, 1957; Mocho *et al.*, 2017). This material has been interpreted as coming from the Bombarral Formation, but in this area there is an extensive sequence of the “Vale de Lagares” complex, which was recently interpreted as part of the Alcoaça Formation (Teixeira *et al.*, 1968; Fürsich *et al.*, 2021). In Colmeias, Cortes and Abadia (Leiria), there are references to dinosaur remains, including a tooth crown fragment attributed to “*Megalosaurus insignis*” (Lapparent and Zbyszewski, 1957) and some unpublished vertebral fragments of possible sauropod dinosaurs. In Casal Novo (Batalha), a partial skeleton of an ornithischian dinosaur attributed to *Stegosaurus* was collected, together with few isolated elements

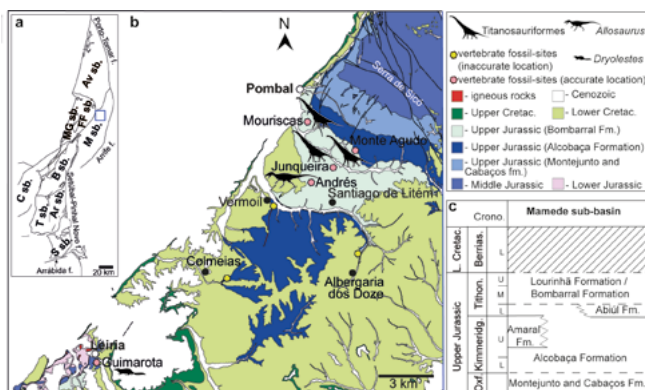


Figure 1. Geological context of the Pombal and Leiria regions: a. Main structural elements and sub-basins of the Lusitanian Basin (Fürsich *et al.*, 2021); b. Geological map with localities yielded vertebrate fossils (from Teixeira *et al.*, 1968; Manuppella *et al.*, 1978); c. Simplified stratigraphy of Upper Jurassic sequences in the Mamede sub-basin (Kullberg *et al.*, 2013; Fürsich *et al.*, 2021). Legend: Ar sb, Arruda sub-basin; Av sb, Aveiro sub-basin; B sb, Bombarral sub-basin; C sb, Consolação sub-basin; M sb, Mamede sub-basin; MG sb, Marinha Grande sub-basin; T sb, Turcifal sub-basin.

Figura 1. Contexto geológico da região de Pombal e Leiria: a. Principais elementos estruturais e sub-bacias da Bacia Lusitânica (Fürsich *et al.*, 2021); b. Mapa geológico com as localidades onde foram recolhidos fósseis de vertebrados (modificado de Teixeira *et al.*, 1968; Manuppella *et al.*, 1978); c. Esquema estratigráfico simplificado para as sequências do Jurássico Superior na sub-bacia de Mamede (Kullberg *et al.*, 2013; Fürsich *et al.*, 2021). Legenda: Ar sb, sub-bacia de Arruda; Av sb, sub-bacia de Aveiro; B sb, sub-bacia de Bombarral; C sb, sub-bacia de Consolação; M sb, sub-bacia de Mamede; MG sb, sub-bacia de Marinha Grande; T sb, sub-bacia de Turcifal.

of crocodyliforms (Escaso *et al.*, 2007). A caudal and a sacral vertebra first attributed to “*Megalosaurus pombali*” from Torrinhãs (Batalha) are reinterpreted as belonging to indeterminate stegosaurian and ornithomimid, respectively (Malafaia *et al.*, 2024). Other localities in the region of Porto de Mós and Batalha have yielded fragmentary material, some of them may belong to diplodocine sauropods (Mocho *et al.*, 2017). Finally, several dinosaurian specimens were identified in Ourém, including isolated teeth attributed to macronarian and possible turiasaurian sauropods (Mocho *et al.*, 2017), a fragment of a humerus of an indeterminate eusauropod and some caudal vertebrae of allosauroid theropods (Malafaia *et al.*, 2024). The exact provenance of these materials is unknown, but they probably came from the Alcobaça Formation (*e.g.* Mocho *et al.*, 2017; Fürsich *et al.*, 2021; Malafaia *et al.*, 2024).

#### 4. Discussion and conclusions

Theropod and sauropod dinosaurs, together with early mammals, are the best represented Jurassic vertebrates in the Mamede sub-

basin. In Guimarota, it is worth highlighting the record of mammals, representing one of the largest samples of Upper Jurassic mammals in the world (Martin, 2001). Theropods are mainly represented by abundant material attributed to *Allosaurus* and by a great diversity of small-sized coelurosaurians. Among sauropods, titanosauriformes seems to be the most common clade, in contrast to the record from other areas of the Lusitanian Basin where these forms are scarce (*e.g.* Mocho *et al.*, 2017). Ornithischian remains are scarce, represented mainly by *Stegosaurus* and hysilophodontid and iguanodontian ornithomimids. Crocodyliforms are relatively well-represented, with several taxa related to teleosaur and neosuchian clades. Pterosaur remains are limited to isolated teeth and rare postcranial material. Testudines are also scarce, represented by fragmentary specimens from Guimarota, contrasting with the noteworthy record from other sectors (*e.g.* Pérez-García and Ortega, 2011). Lepidosaurs are represented by abundant sphenodontian material from Andrés and by several specimens attributed to different Squamata groups from Guimarota. The record of this group shows a pattern similar to other Mesozoic localities, in which when squamates are common, rhynchocephalians are rare, or vice versa, suggesting possible ecological differences for these groups (Evans and Jones, 2010).

Some peculiarities seem to characterize the faunal association of Upper Jurassic continental vertebrates from the Mamede sub-basin. The predominance of allosauroid theropods and the absence of taxa well-known in other sectors (*e.g.* *Torvosaurus*) as well as the high abundance of titanosauriform sauropods and the scarce record of Testudines may indicate some paleoenvironmental constraints on the distribution of these faunas. The study of the fossil record recently found in Pombal may provide important information to test this hypothesis and to better understand the Upper Jurassic faunas of continental vertebrates in this sector of the Lusitanian Basin.

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#### References

- Antunes, M. T., Mateus, O., 2003. Dinosaurs of Portugal. *Palevol*, 2: 77–95.
- Broschinski, A., 2000. The lizards from the Guimarota mine. *Guimarota - A Jurassic Ecosystem*. Verlag Dr. Friedrich Pfeil, München: 59–68.
- Caldwell, M. W., Nydam, R. L., Palci, A., Apesteguía, S., 2015. The oldest known snakes from the Middle Jurassic-Lower Cretaceous provide insights on snake evolution. *Nature Communications*, 6(5996):1–62.
- Dantas, P., 1990. Dinossáurios de Portugal. *Gaia*, 2: 17–26.
- Escaso, F., Ortega, F., Dantas, P., Malafaia, E., Pimentel, N., Pereda-Suberbiola, X. *et al.*, 2007. New evidence of shared dinosaur across Upper Jurassic Proto-North Atlantic: *Stegosaurus* from Portugal. *Naturwissenschaften*, 94:367–374.
- Evans, S. E., Jones, M. E. H., 2010. The origins, early history and diversification of lepidosauromorph reptiles. *New aspects of Mesozoic biodiversity*. Lecture notes in earth sciences. Springer Berlin/Heidelberg: 22–44.

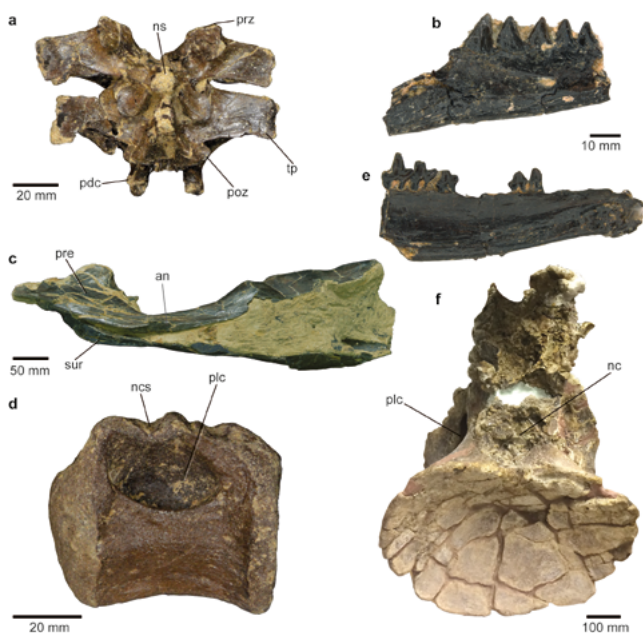


Figure 2. Vertebrate fossil remains of different Upper Jurassic localities from Pombal. a–e, specimens from Andrés: MNHN/UL.AND.526, two articulated dorsal neural arches of a neosuchian crocodyliform in dorsal view (a); MNHN/UL.AND.351, left mandibular ramus of a sphenodontian in lingual view (b); MNHN/UL.AND.013, posterior part of a left mandible of *Allosaurus* in medial view (c); MNHN/UL.AND.308, centrum of a dorsal vertebra of a juvenile sauropod in left lateral view (d); MNHN/UL.AND.404, left mandible of an indeterminate mammal in medial view (e); MNHN.unnumbered dorsal vertebra of a titanosauriform sauropod from Junqueira in posterior view (f). Abbreviations: an, angular; nc, neural canal; ncs, neurocentral suture; ns, neural spine; pdc, pedicels; plc, pleurocoel; poz, pós-zigapófise; pre, pré-articular; prz, prezigapófise; sur, surangular; tp, transverse process. MNHN/UL, Museu Nacional de História Natural e da Ciência (Universidade de Lisboa).

Figura 2. Restos fósseis de vertebrados de diferentes localidades do Jurássico Superior de Pombal. a–e, exemplares recolhidos em Andrés: MNHN/UL.AND.526, dois arcos neurais dorsais articulados de um crocodyliforme neosucoio em vista dorsal (a); MNHN/UL.AND.351, ramo mandibular esquerdo de um esfenodonte em vista lingual (b); MNHN/UL.AND.013, parte posterior de uma mandíbula esquerda de *Allosaurus* em vista medial (c); MNHN/UL.AND.308, centro de vértebra dorsal de um saurópode juvenil em vista lateral (d); MNHN.sem número, vértebra dorsal de um saurópode titanosauriforme em vista posterior recolhida na localidade de Junqueira (f). Abreviaturas: na, angular; nc, canal neural; ncs, sutura neurocentral; ns, espinha neural; pdc, pedicelos; plc, pleurocelo; poz, pós-zigapófise; pre, pré-articular; prz, pré-zigapófise; sur, surangular; tp, processo transversal. MNHN/UL, Museu Nacional de História Natural e da Ciência (Universidade de Lisboa).

- Evans, S. E., Prasad, G. V. R., Manhas, B. K., 2001. Rhynchocephalians (Diapsida: Lepidosauria) from the Jurassic Kota Formation of India. *Zoological Journal of the Linnean Society*, **133**: 309–334.
- Fürsich, F. T., Schneider, S., Werner, W., Lopez-Mir, B., Pierce, C. S., 2021. Life at the continental–marine interface: palaeoenvironments and biota of the Alcobaça Formation (Late Jurassic, Central Portugal), with a formal definition of the unit appended. *Palaeobiodiversity and Palaeoenvironments*, **102**: 265–329.
- Gassner, T., 2000. The turtles from the Guimarota mine. *Guimarota - A Jurassic Ecosystem*. Verlag Dr. Friedrich Pfeil, München: 55–58.
- Hahn, G., Hahn, R., 2000. Multituberculates from the Guimarota mine. *Guimarota - a Jurassic Ecosystem*. Verlag Dr. Friedrich Pfeil, München: 97–108.
- Krebs, B., 2000. The henkelotheriids from the Guimarota mine. *Guimarota - A Jurassic Ecosystem*. Verlag Dr. Friedrich Pfeil, München: 121–142.
- Kriwet, J., 2000. The fish fauna from the Guimarota mine. *Guimarota - A Jurassic Ecosystem*. Verlag Dr. Friedrich Pfeil, München: 41–50.
- Kullberg, J. C., Rocha, R. B., Soares, A. F., Rey, J., Terrinha, P., Azerêdo, A. C., Callapez, P., Duarte, L. V., Kullberg, M. C., Martins, L., Miranda, R., Alves, C., Mata, J., Madeira, J., Mateus, O., Moreira, M., Nogueira, C. R., 2013. *A Bacia Lusitaniana: estratigrafia paleogeografia e tectónica*. In: R. Dias, A. Araújo, P. Terrinha, J.C. Kullberg (eds), *Geologia de Portugal*, Vol. II. Escolar Editora: 195–347.
- Lapparent, A. F., Zbyszewski, G., 1957. Les dinosauriens du Portugal. *Memoire Services Géologiques du Portugal*, **2**(Nouvelle Série): 1–131.
- Louchart, A., Pouech, J., 2017. A tooth of Archaeopterygidae (Aves) from the Lower Cretaceous of France extends the spatial and temporal occurrence of the earliest birds. *Cretaceous Research*, **73**: 40–46.
- Malafaia, E., Ortega, F., Escaso, F., Dantas, P., Pimentel, N., Gasulla, J. M., Ribeiro, B., Barriga, F., Sanz, J. L., 2010. Vertebrate fauna at the *Allosaurus* fossil-site of Andrés (Upper Jurassic), Pombal, Portugal. *Journal of Iberian Geology*, **36**(2): 193–204.
- Malafaia, E., Mocho, P., Escaso, F., Narvaéz, I., Ortega, F., 2024. Taxonomic and stratigraphic update of the material historically attributed to *Megalosaurus* from Portugal. *Acta Palaeontologica Polonica* **69** (2): 127–171.
- Manuppella, G., Zbyszewski, G., da Veiga Ferreira, O., 1978. Carta geológica de Portugal na escala de 1:50.000: notícia explicativa da folha 23-A (Pombal). Serviços Geológicos de Portugal, Lisboa.
- Martin, T., 2001. Mammalian fauna of the Late Jurassic Guimarota ecosystem. *Publicación Especial Asociación Paleontológica Argentina*, **7**: 123–126.
- Martin, T., 2000. The dryolestids and the primitive “peramurid” from the Guimarota mine. *Guimarota - a Jurassic ecosystem*. Verlag Dr. Friedrich Pfeil, München: 109–120.
- Mateus, O., Walen, A., Antunes, M. T., 2006. The large theropod fauna of the Lourinhã Formation (Portugal) and its similarity to the Morrison Formation, with a description of a new species of *Allosaurus*. *New Mexico Museum of Natural History and Science*, **36**: 223–231.
- Mocho, P., Malafaia, E., Escaso, F., Gasulla, J. M., Marcos-Fernández, F., Narvaéz, I., Órfão, J., Páramo, A., Vidal, D., Ortega, F., 2023. The giant sauropod dinosaurs of Pombal: new discoveries. Livro de resumos XI Congresso Nacional de Geologia: Geociências e Desafios Globais. Departamento de Ciências da Terra da Universidade de Coimbra: 105–106.
- Mocho, P., Royo-Torres, R., Escaso, F., Malafaia, E., de Miguel Chaves, C., Narvaéz, I. et al., 2017. Upper Jurassic sauropod record in the Lusitanian Basin (Portugal): Geographical and lithostratigraphical distribution. *Palaeontologia Electronica*, **20.2.27A**: 1–50.
- Mocho, P., Royo-Torres, R., Malafaia, E., Escaso, F., Ortega, F. (2016). Systematic review of Late Jurassic sauropods from the Museu Geológico collections (Lisboa, Portugal). *Journal of Iberian Geology*, **42**: 227–250.
- Ortega, F., Dantas, P., Escaso, F., Gasulla, J.M., Malafaia, E. Ribeiro, B., 2006. Primera cita de reptiles esfenodontos en el Jurásico Superior de la Península Ibérica. In: Fernández-Martínez, E. (eds.), *Libro de resúmenes de las XXII Jornadas de Paleontología*, 152–153.
- Pena dos Reis, R., Pimentel, N. L., Garcia, A. J. V., 2011. The Lusitanian Basin, stratigraphic analysis and geodynamic evolution. *Boletim de Geociências da Petrobras*, **19**: 23–52.
- Pérez-García, A., Ortega, F., 2011. *Selenemys lusitanica*, gen. et sp. nov., a new pleurostermid turtle (Testudines: Paracryptodira) from the Upper Jurassic of Portugal. *Journal of Vertebrate Paleontology*, **31**: 60–69.
- Pérez-Moreno, B. P., Chure, D. J., Pires, C., Silva, C. M., Santos, V. F., Dantas, P. et al. 1999. On the presence of *Allosaurus fragilis* (Theropoda, Carnosauria) in the Upper Jurassic of Portugal: first evidence of an intercontinental dinosaur species. *Journal of the Geological Society*, **156**: 449–452.
- Rauhut, O. W. M., 2000. The dinosaur fauna of the Guimarota mine. *Guimarota - a Jurassic ecosystem*. Verlag Dr. Friedrich Pfeil, München: 75–82.
- Rauhut, O. W. M., 2001. Herbivorous dinosaurs from the Late Jurassic (Kimmeridgian) of Guimarota, Portugal. *Proceedings of the Geologists' Association*, **112**(3): 275–283.
- Rauhut, O. W. M., 2003. A tyrannosauroid dinosaur from the Upper Jurassic of Portugal. *Palaeontology*, **46**: 903–910.
- Rauhut, O. W. M. Fehner, R., 2005. Early development of the facial region in a non-avian theropod dinosaur. *Proceedings of the Royal Society B*, **272**: 1179–1183.
- Rauhut, O. W. M., Foth, C., Tischlinger, H., 2018. The oldest *Archaeopteryx* (Theropoda: Avialiae): a new specimen from the Kimmeridgian/Tithonian boundary of Schamhaupten, Bavaria. *PeerJ*, **6**: e4191.
- Sauvage, H. E., 1897-1898. Vertébrés fossiles du Portugal. Contributions à l'étude des poissons et des reptiles du Jurassique et du Crétacique. *Direction des Travaux Géologiques du Portugal*, **29**: 1–58.
- Schudack, M., 2000. Ostracodes and charophytes from the Guimarota beds. *Guimarota. A Jurassic ecosystem*. Verlag Dr. Friedrich Pfeil, München: 33–36.
- Teixeira, C., Zbyszewski, G., Torres de Assunção, C., Manuppella, G., 1968. Carta geológica de Portugal na escala de 1:50.000: notícia explicativa da folha 23-C (Leiria). Serviços Geológicos de Portugal, Lisboa.
- Wiechmann, M. F., 2000. The albanerpetontids from the Guimarota mine. *Guimarota - a Jurassic ecosystem*. Verlag Dr. Friedrich Pfeil, München: 51–54.
- Wiechmann, M. F., Gloy, U., 2000. Pterosaurs and urvogels from the Guimarota Mine. *Guimarota - a Jurassic ecosystem*. Verlag Dr. Friedrich Pfeil, München: 83–86.
- Weigert, A., 1995. Isolierte Zähne von cf. *Archaeopteryx* sp. aus dem Oberen Jura der Kohlengrube Guimarota (Portugal). *Neues Jahrbuch für Geologie und Paläontologie Monatshefte H*, **9**: 562–576.
- Zinke, J., 1998. Small theropod teeth from the Upper Jurassic coal mine of Guimarota (Portugal). *Paliiontologische Zeitschrift*, **72**: 179–189.