

13. PALEONTOLOGICAL COLLECTIONS OF THE MUSEUM OF LOURINHÃ (PORTUGAL)

MATEUS, Octávio

Resumo: É dada uma visão geral das coleções paleontológicas do Museu da Lourinhã, em Portugal, que tem um rico acervo de paleontologia, em particular de dinossauros do Jurássico da Formação da Lourinhã (Kimmeridgiano-Tithoniano). É dado destaque aos seguintes espécimens holótipos: estegossauro *Miragaia longicollum*, terópode *Lourinhanosaurus antunesi*, saurópode *Dinheirosaurus lourinhanensis*, ornitópode *Draconyx loureiroi*, terópode *Allosaurus europaeus* e mamífero *Kuehneodon hahni*. São mencionados outros exemplares de dinossauros incluindo o ninho e os ovos e embriões de *Lourinhanosaurus*. Portugal é muito produtivo no que diz respeito a vertebrados do Jurássico Superior, sendo o sétimo país com mais táxones de dinossauros.

Palavras-chave: Paleontologia; dinossauros; Jurássico Superior; Museu da Lourinhã; vertebrados.

Abstract: The paleontological collections of the Museum of Lourinhã, in Portugal, has a rich paleontological collection, particularly of Late Jurassic dinosaurs of the Lourinhã Formation (Kimmeridgian-Tithonian). Most salient highlights comprehend the following dinosaur holotype specimens: stegosaur *Miragaia longicollum*, theropod *Lourinhanosaurus antunesi*, sauropod *Dinheirosaurus lourinhanensis*, ornithopod *Draconyx loureiroi*, theropod *Allosaurus europaeus*, and, a mammal, *Kuehneodon hahni*. Other dinosaur specimens are referred including the nest and eggs and embryos of *Lourinhanosaurus*. Portugal is very productive in Late Jurassic vertebrates, being the seventh country bearing more dinosaur taxa.

Keywords: Paleontology; Dinosaurs; Museum of Lourinhã; Late Jurassic; vertebrates.

Museu da Lourinhã
CICEGe, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa
omateus@museoulourinha.org

INTRODUCTION TO THE MUSEUM OF LOURINHÃ

The Museum of Lourinhã is managed by a non-profit and non-governmental association named GEAL (Grupo de Etnologia e Arqueologia da Lourinhã) (fig. 1). The Museum of Lourinhã houses a collection of Ethnography, Archaeology, and Paleontology comprising one of the most important dinosaur collections from the Late Jurassic of Portugal, particularly the dinosaurs of the Lourinhã Formation (Kimmeridgian-Tithonian). The collection of paleontology started being amassed by local amateurs in 1979-80, even before the formalization of GEAL as an association. The Museum of Lourinhã was founded in June 24, 1984. A brief history of the dinosaur paleontology of Portugal is given by Antunes and Mateus (2003), and Mateus and Antunes (2008), specifically about the Museum of Lourinhã by Mateus and Mateus (2003). With a vast array of fossilized bones, tracks, eggs and embryos, the Museum have been visited by 22.000 people per year (values of 2009), and has been able to do cutting-edge research in vertebrate paleontology. Although specialized in the Late Jurassic

of Portugal, the institution has also participated in international scientific projects in Africa (Angola and Mozambique), Europe (France and Germany), and North America (Texas).

Lourinhã is in the central west coast of Portugal (at 39°14'N, 9°18'W), at one of the most rich areas for Late Jurassic dinosaurs in Europe (Antunes and Mateus, 2003; Mateus, 2006).

The Museum of Lourinhã is nearly financially sustainable in two thirds on the normal financial turnover. On other words, the yearly budget is one third as a subsidy by the town's municipality Câmara Municipal da Lourinhã, one third by the entrance fee ticket, and the other third by projects, donations, merchandising, services, memberships, and others. Most recent research has focused on faunal assembly comparison between main terrestrial vertebrate sites, ontogeny of theropod dinosaurs, niche partitioning in dinosaur herbivorous fauna, dinosaur track diversity, evolution of the teeth and mandible in ornithopod dinosaurs, left-right asymmetry in dinosaurs, synapsid fauna from Lunho Basin in Mozambique, amniote fauna from the Cretaceous of Angola, among other topics.

The Museum also supports the international peer-reviewed on-line based Journal of Paleontological Techniques, freely available at www.jpaleontologicaltechniques.org.



Figure 1 - Main building of the Museu de Lourinhã, with a forelimb of a sauropod.

THE HIGHLIGHTS OF THE PALEONTOLOGY COLLECTIONS OF THE MUSEUM OF LOURINHÃ

In December 2009, the Museum's Paleontology catalog had 1725 entries, mostly from the Late Jurassic of Lourinhã, including six holotypes. An holotype is a single reference specimen of an organism used when the species was formally described and explicitly designated as so.

It is impossible to address in this article to all items of the collections; below, a selection of important items of the paleontological collections of the Museum of Lourinhã is given.

HOLOTYPE

All holotypes in the Museum are from the Lourinhã Formation and dated as Late Jurassic (Kimmeridgian/Tithonian, around 150 Ma) (fig. 2).

Holotype of *Miragaia longicollum* Mateus et al., 2009

Found in the village of Miragaia, the anterior part of a skeleton, which is the holotype of stegosaur dinosaur *Miragaia longicollum* Mateus, Maidment and Christiansen 2009, comprehends a nearly complete anterior half of a skeleton (ML 433) with partial cranium, 15 cervical vertebrae (atlas and axis are absent) with associated ribs, two dorsal vertebrae, both coracoids, scapulae, humeri, radii and ulnae, one

metacarpal, three phalanges, 12 rib fragments, one chevron, one dermal spine and 13 dermal plates. With 17 cervical vertebrae, this specimen is one of the non-avian dinosaurs with longest neck.

A full skeleton replica (with about 6 meters long body) of *Miragaia* is in the center of the Paleontology exhibition hall.

Holotype of *Lourinhanosaurus antunesi* Mateus, 1998

This is a 4.5 meters long basal tetanuran theropod dinosaur found in Vale Bravo, near Peralta.

The holotype is the most complete theropod found in Portugal so far and includes a single specimen comprising a partial skeleton (ML 370) found articulated and lying on its left side. It was brought to ML in several blocks: a cervical block containing an articulated series of vertebrae from the base of the neck; an anterior pelvic block, containing the last four dorsal vertebrae, the first two sacral and part of the third sacral vertebrae in articulation with the pubes, the left femur and the anterior parts of the ilia; a posterior pelvic block, containing the articulated ischia and posterior part of the sacrum and ilia; an anterior caudal block, containing the first seven caudal vertebrae in articulation; and a middle caudal block, containing an articulated series of six caudal vertebrae from a more distal position in the tail. The proximal ends of the right tibia and fibula and the distal end of the left tibia were also collected. Fragments of the skeleton are still occasionally recovered from the type locality (MATEUS, 2008).

Holotype of *Dinheirosaurus lourinhanensis* Bonaparte and Mateus, 1999

The holotype (ML414) of this diplodocid sauropod found in Praia de Porto Dinheiro is made up of two incomplete cervical vertebrae and nine rather complete, articulated dorsal vertebrae, seven fragmented centra, some incomplete neural arches, twelve dorsal ribs, and fragmentary appendicular bones (Bonaparte and Mateus, 1999). The complete body length would be quite large and the estimations give ca. 25 meters long body.

Holotype of *Draconyx loureiroi* Mateus and Antunes, 2001

The holotype (ML357) of this camptosaurid ornithopod was found in Vale Frades and includes two maxillary teeth, three mid-anterior caudal centra, one

chevron, distal epiphysis of right humerus, one manual phalanx, three manual ungual phalanges, distal epiphysis of right femur, epiphyses of tibia and fibula, astragalus, calcaneum, three tarsals (II-V), four metatarsals (I-IV) and pedal phalanges (Mateus and Antunes, 2001).

**Holotype of *Allosaurus europaeus*
Mateus, Walen and Antunes, 2007**

This genus was previously known in North America and this species found in Praia de Vale Frades contributes for the paleobiogeography discussion, suggesting the occurrence of land bridges during the Late Jurassic (Mateus *et al.*, 2006a).

The type (ML415) includes the posterior part of the skull. The preserved bones include jugal, lacrimal, postorbital, frontal, palatine, quadratojugal, nasal, parietal, prefrontal, squamosal, articular, sclerotic bones, surangular, angular, pterygoid, basisphenoid, paraoccipital process and the most posterior tooth) and the 4th to the 6th cervical vertebrae and ribs.

Holotype of *Kuehneodon hahni* Antunes, 1998

Kuehneodon is a very small multituberculated mammal (not more than 10 cm long), based on a dental (ML1357, Antunes 1998; Fig. 3), found within the dinosaur nest of Paimogo (see below about the Paimogo nest).

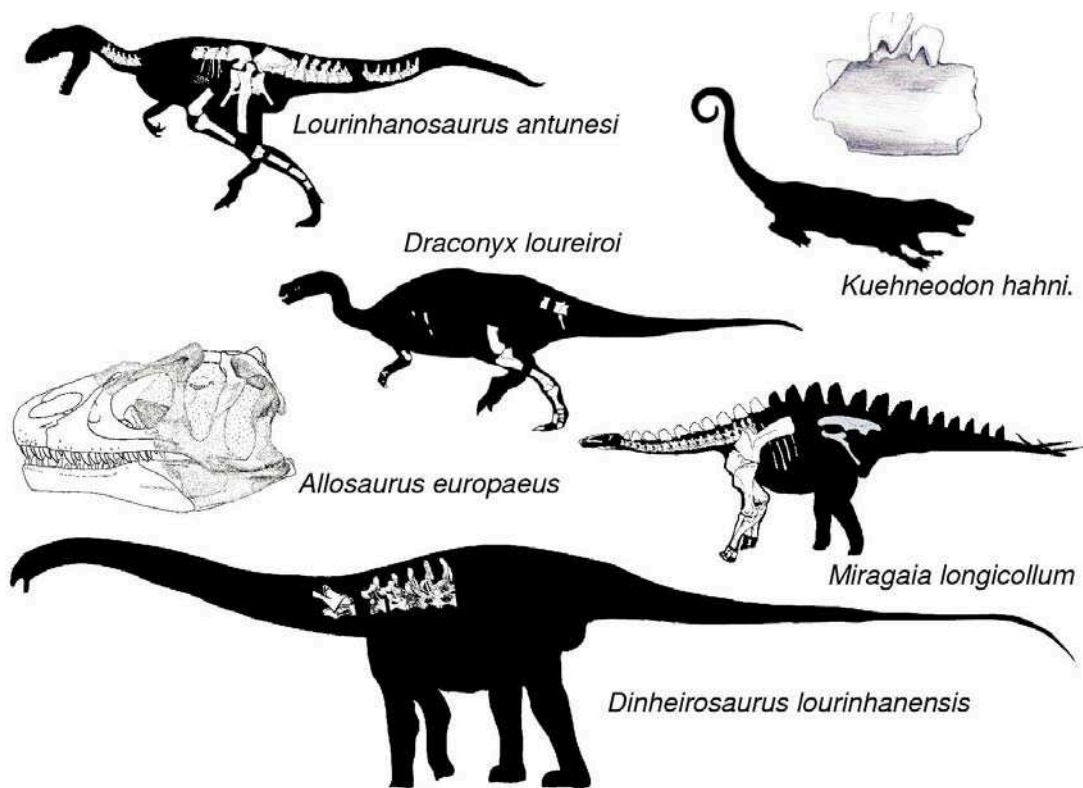


Figure 2 - The six holotypes from the Museum of Lourinhã: *Lourinhanosaurus antunesi*, *Kuehneodon hahni* (dental image from Antunes, 1998), *Allosaurus europaeus* (image from Mateus *et al.*, 2006), *Draconyx loureiroi*, *Miragaia longicollum*, and *Dinheirosaurus lourinhanensis*.

OTHER HIGHLIGHTS

One of the most relevant specimens of the Museum of Lourinhã is the nest with embryos of *Lourinhanosaurus* (ML565, Mateus *et al.*, 1997, 1998, 2001). It includes the only embryos of dinosaurs known in Europe and the second oldest in the world. The nest was quite large: about 100 eggs or eggshell concentrations were detected, within a today's

eggshell dispersion of, at least, 11 meters. The about 100 embryonic remains allow a taxonomical identification and to understand the ontogeny, evolution and reproductive strategy in this dinosaur (Ricqlès *et al.*, 2001). Eggs, eggshells, and even embryos from others Late Jurassic localities of Lourinhã Formation are also part of the collections (Castanhinha *et al.*, 2009).

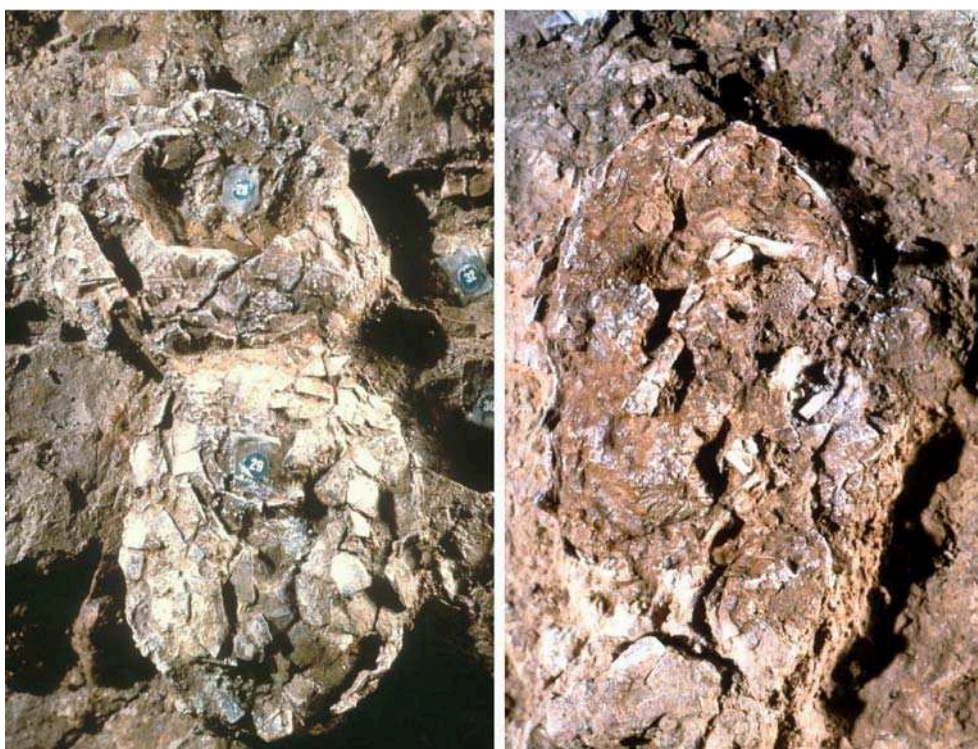


Figure 3 - Eggs and embryos from Paimogo nest (Photo by Dennis Serrette).

Within sauropod dinosaurs, the Museum display the forelimb (ML368) of a sauropod close to *Turiasaurus* (see Mateus, 2009, for discussion) of which the replica is in the front entrance of the Museum building (fig. 1). A tail (ML351) assigned to cf. *Lourinhasaurus alenquerensis* was mounted in life-position in the center of the exhibition hall, and although not in display, a fibula and sacrum of the same specimen also incorporate the collections.

Theropod dinosaurs are represented by the left maxillary (ML1100) of the theropod *Torvosaurus tanneri* allowed the recognition of the occurrence in Portugal of largest terrestrial predator during the Jurassic. This species was previously known in United States and now known in Portugal (Mateus *et al.*, 2006).

A set of footprints of theropods, sauropods, ornithopod and stegosaurs dinosaurs are also an important part of the collections. This includes one of the largest Late Jurassic theropod tracks, the largest Late Jurassic ornithopod track, and stegosaur and sauropod footprints with skin impressions (Milàn *et al.* 2005; Mateus and Milàn, 2008a, 2008b, 2009).

Many other items of the Late Jurassic of Portugal incorporate the collections, with reference to molluscs and other invertebrates, teeth and bone material from selachians, osteichthyes,

albanerpetontids, anurans, crocodylians, lizards, plesiosaurs, pterosaurs, dinosaurs and mammals. Some of the taxa above mentioned comprise part of a large-scale sieving campaign initiated in 2008 for collecting microvertebrates (Araújo *et al.* 2009).

Among the fossils of other ages and sources, an emphasis is given to cranial and postcranial material of the theropod dinosaur *Baryonyx* (Mateus *et al.*, 2008) and to Neocene saphhead whale skulls (Klaus Post, pers. comm.).

Temporarily, the Museum of Lourinhã also incorporates fossils of fishes, mosasaurs, plesiosaurs, chelonians and dinosaurs from Angola (Jacobs *et al.*, 2006; Mateus *et al.*, 2006b), and mammal-like reptiles from Mozambique resulting of the participation of annual scientific expeditions in Africa since 2005. All this material, however, will be returned to the countries of origin after preparation and study.

In addition to the material mentioned above, the Museum of Lourinhã has in public display (in December 2009) skull replicas of *Triceratops*, *Brachiosaurus*, *Camarasaurus*, and *Europasaurus*, and a skeleton of *Deinonychus*.

The specimens have been curated by the staff and associated team that gave the focus to the preparation and study. For that, the Museum is equipped with a Preparation Laboratory with basics

classic tools for physical preparation including airscribe and sandblaster system. The specimens that are not in Museum display are stored in the Microvertebrate Collection and Laboratory at the Museum building or in the Large Specimens Collection Facilities, in the outskirts of the town. The information about the specimens is stored in a collaborative cloud-computing database and about 70% of the specimens are photographed. The packing and storing still requires large improvements.

IMPORTANCE OF PORTUGAL IN THE RECORD OF DINOSAURS AND OTHER FOSSILS

Several counting assessments can be made to test the importance of a given area or age concerning the wealth of dinosaur and other fossils.

According to the database provided in Socha and Madzia (2006) for values of 2006 with the update for Portugal, the ten countries with more dinosaur taxa (species or genus) are: USA (with 140 dinosaur taxa), China (131), Argentina (64), Mongolia (62), Canada (44), United Kingdom, (40), Portugal (25), France (23), Brazil (18) and South Africa (16). Portugal is in the seventh position in number of dinosaur taxa, which is remarkable given the area of the country. Portugal descends to the 8th or 9th position in other counting methods that depends of the recognition of valid taxa for each country.

From the 10 richest countries, if one estimates the number of dinosaurs per exposure area, Portugal ranks first. The seventh position might subsequently vary as new species are being regularly described in Portugal and other countries. Other important public-available dinosaur collection include the Geological Museum of Lisboa with the holotypes of *Lusotitan atalaiensis*, *Lourinhasaurus alenquerensis*, *Dracopelta zbyzewski*, *Aviatyrannis jurassica*, *Alocodon kuehnei*, *Phyllodon henkeli*, and *Trimucrodon cuneatus* (Lapparent and Zbyszewski, 1957; Antunes and Mateus, 2003).

Nevertheless, Portugal is not only rich in dinosaurs. It has other highlights in Paleontology: a rich one of the best world records for Ordovician trilobites, Late Jurassic mammals, and Cretaceous plants with early flowers (see, for example, Fries *et al.*, 2009). Moreover, has one of the most complete and rich stratigraphic series Lower Jurassic, continental Late Jurassic, and Miocene. Two GASP stratotypes are also internationally recognized for

Portugal: the Pliensbachian-Toarcian boundary (Lower Jurassic) in Cabo Mondego and the Bajocian-Bathonian transition (Middle Jurassic) in Cabo Mondego (see Kullberg *et al.* 2006, for this and for general overview on the relevance of the Lusitanian Basin).

ACKNOWLEDGMENTS

I wish to do very special and personal acknowledgment to all members of the Museum of Lourinhã Direction Boards and collaborators, for all the years supporting my work at the institution. From many collaborators and friends, I would like to underline four persons: Dário de Matos, Hernâni Mergulhão, and Isabel and Horácio Mateus. To Ricardo Araújo that perused the manuscript.

BIBLIOGRAPHY

- ANTUNES, M.T., 1998. A new Upper Jurassic Paulchoffatiid Multituberculata (Mammalia) from Paimogo, Portugal and a few comments on Walter Georg Kühne. *Memórias da Academia de Ciências de Lisboa*, **37**: 125-153.
- ANTUNES, M.T. & MATEUS, O., 2003. Dinosaurs of Portugal. *C. R. Palevol.*, **2**: 77-95.
- ARAÚJO, R., MATEUS, O., WALLEN, A., Christiansen, N., 2009. Preparation techniques applied to a stegosaurian Dinosaur from Portugal. *Journal of Paleontological Techniques* **5**: 1-24.
- CASTANHINHA, R., ARAÚJO, R., MATEUS, O., 2009. Dinosaur eggshell and embryo localities in Lourinhã Formation, Late Jurassic, Portugal. *Journal of Vertebrate Paleontology*, **29**(3): 76A.
- ARAÚJO, R., POUND, M., NATÁRIO, C., 2009. Sieving methods in the search of a microvertebrate fauna from the Late Jurassic of Lourinhã Formation. In J.M. Brandão, P. M. Callapez, O. Mateus and P. Castro (Eds.) - International Conference on Geological collections and museums. *Journal of Paleontological Techniques*, **6**: 22.
- BONAPARTE, J.F. & MATEUS, O., 1999. A new diplodocid, *Dinheirosaurus lourinhanensis* gen. et sp. nov., from the Late Jurassic beds of Portugal. *Revista del Museo Argentino de Ciencias Naturales*, **5** (2): 13-29.
- CASTANHINHA, R., ARAÚJO, R., Mateus, O., 2009. Dinosaur eggshell and embryo localities in Lourinhã Formation, Late Jurassic, Portugal. *Journal of Vertebrate Paleontology*, **29**(3): 76A.

- FRIIS, E.M., PEDERSEN, K.R., CRANE, P.R., 2009. Early Cretaceous mesofossils from Portugal and eastern North America related to the Bennettitales-Erdtmanithecales-Gnetales group. *American Journal of Botany*, **96**: 252-283.
- JACOBS, L.J., MATEUS, O., POLCYN, M.J., SCHULP, A.S., ANTUNES, M.T., MORAIS, M.L., TAVARES, T.S., 2006. The Occurrence and Geological Setting of Cretaceous Dinosaurs, Mosasaurs, Plesiosaurs, and Turtles from Angola. *J. Paleont. Soc. Korea*, **22** (1): 91-110.
- KULLBERG, J.C., ROCHA, R.B., SOARES, A.F., REY, J., TERRINHA, P., CALLAPEZ, P.M., MARTINS, L., 2006. A Bacia Lusitaniana: Estratigrafia, Paleogeografia e Tectónica. In Geologia de Portugal no contexto da Ibéria. In: R. Dias, A. Araújo, P. Terrinha & J. C. Kullberg (Eds.). Univ. Évora, pp. 317-368.
- LAPPARENT, A.F. et G. ZBYSEWSKI, 1957. Les dinosauriens du Portugal. *Mémoires des Services Géologiques du Portugal, nouv. sér.*, **2**: 1-63.
- MATEUS, O., 2006. Late Jurassic dinosaurs from the Morrison Formation, the Lourinhã and Alcobaça Formations (Portugal), and the Tendaguru Beds (Tanzania): a comparison. in Foster, J.R. and Lucas, S. G. R.M., eds., 2006, Paleontology and Geology of the Upper Jurassic Morrison Formation. *New Mexico Museum of Natural History and Science Bulletin* **36**: 223-231.
- MATEUS, O., 2009. The sauropod *Turiasaurus riodevensis* in the Late Jurassic of Portugal. *Journal of Vertebrate Paleontology*, **29**(3): 144A.
- MATEUS, O. & ANTUNES, M.T., 2001. *Draconyx loureiroi*, a new Camptosauridae (Dinosauria: Ornithopoda) from the Late Jurassic of Lourinhã, Portugal. *Annales de Paleontologie*, **87**(1): 61-73.
- MATEUS, O. & ANTUNES, M.T., 2008. Landmarks in the history of dinosaur paleontology in Portugal, focusing on skeletal remains., Dinosaurs - A Historical Perspective, Abstract volume, 6-7 may 2008, London.
- MATEUS, O., ANTUNES, M.T. & TAQUET, P., 2001. Dinosaur ontogeny: The case of *Lourinhanosaurus* (Late Jurassic, Portugal). *Journal of Vertebrate Paleontology*, **21** (Suppl. 3): 78A.
- MATEUS, O. & MATEUS, I., 2003. História do Museu da Lourinhã. *Revista CAIS*, **79**.
- MATEUS, I., MATEUS, H., TELLES ANTUNES, M., MATEUS, O., TAQUET, P., RIBEIRO, V., MANUPPELLA, G., 1997. Couvée, œufs et embryons d'un Dinosaurien Théropode du Jurassique de Lourinhã (Portugal). *C.R Acad. Sci. Paris, Sciences de la terre et des planètes*, **325**: 71-78.
- MATEUS, I., MATEUS, H., ANTUNES, M.T., MATEUS, O., TAQUET, P., RIBEIRO, V., MANUPPELLA, G., 1998. Upper jurassic theropod dinosaur embryos from Lourinhã (Portugal). *Memórias da Academia de Ciências de Lisboa*. **37**: 101-110.
- MATEUS, O. & MILÀN, J. 2008. Sauropod forelimb flexibility deduced from deep manus tracks. 52nd Paleontological Association Annual Meeting. 18th-21st December 2008, University of Glasgow, pp. 67-68.
- MATEUS, O. & MILÀN, J., 2008. Ichnological evidence for giant ornithopod dinosaurs in the Upper Jurassic Lourinhã Formation, Portugal. *Oryctos*, **8**: 47-52.
- MATEUS, O. & MILÀN, J., 2009. A diverse Upper Jurassic dinosaur ichnofauna from central-west Portugal. *Lethaia*, 10.1111/j.1502-3931.2009.00190.x.
- MATEUS, O., MAIDMENT, S., CHRISTIANSEN, N., 2009. A new long-necked 'sauropod-mimic' stegosaur and the evolution of the plated dinosaurs. *Proceedings of the Royal Society of London B*. **276**: 1815-1821.
- MATEUS, O., MORAIS, M.L., SCHULP, A.S., JACOBS, L.L., POLCYN, M.J., 2006b. The Cretaceous of Angola. *Journal of Vertebrate Paleontology*, **26** (Suppl. 3): 96A-97A.
- MATEUS, O., NATÁRIO, C., ARAÚJO, R., CASTANHINHA, R., 2008. A new specimen of spinosaurid dinosaur aff. *Baryonyx* from the Early Cretaceous of Portugal. Livro de Resumos do X Congresso Luso-Espanhol de Herpetologia. Universidade de Coimbra, p. 51.
- 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*. in Foster, J.R. and Lucas, S. G. R.M., eds., 2006, Paleontology and Geology of the Upper Jurassic Morrison Formation. *New Mexico Museum of Natural History and Science Bulletin*, **36**: 123-129.
- MILÀN, J., CHRISTIANSEN, P., MATEUS, O., 2005. A three-dimensionally preserved sauropod manus impression from the Upper Jurassic of Portugal: Implications for sauropod manus shape and locomotor mechanics. *Kaupia* **14**: 47-52.
- RICQLÈS, A. de, MATEUS, O., ANTUNES, M.T., TAQUET, P., 2001. Histomorphogenesis of embryos of Upper Jurassic Theropods from Lourinhã (Portugal). *Comptes rendus de l'Académie des sciences - Série IIa - Sciences de la Terre et des planètes*, **332**(10): 647-656.
- SOCHA, V. & MADZIA, D., 2006. Dinosaur statistics 2006. Wild Prehistory, published online at <http://www.wildprehistory.org>.