

***Lourinhanosaurus antunesi*,**
A New Upper Jurassic Allosauroid
(Dinosauria: Theropoda)
from Lourinhã, Portugal

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Abstract

A new Allosauroid dinosaur (Saurischia: Theropoda) was found at Peralta near Lourinhã, Portugal (Upper Jurassic, Lower Tithonian). It is described under the name *Lourinhanosaurus antunesi*. It's diagnosable by the all vertebral centra longer than tall, neural spines of the anterior caudal vertebrae with a well-developed spike-like anterior process, the pubic blade is perforated by a large vertical ellipsoidal foramen and the lesser trochanter is well separate from the main body of the femur in lateral view. In the rib cage were found 32 gastroliths. This is the first non-avian theropod found with gastroliths.

Resumo

Descreve-se uma nova espécie de dinossauro alossauróide (Saurischia: Theropoda) com o nome *Lourinhanosaurus antunesi* gen. et sp. nov. descoberto em Peralta (Lourinhã, Portugal; Jurássico Superior, Títoniano inferior). É diagnosticável por todos os corpos vertebrais mais compridos que altos, pelo processo anterior do espinho neural das vértebras caudais anteriores bem desenvolvido e em forma de espigão, pelo foramen na púbis elipsoidal e o trocanter anterior bem destacado do resto do fémur em vista lateral. Na caixa torácica foram encontrados 32 gastrólitos. Este é o primeiro terópode (excluindo as aves) conhecido com gastrólitos.

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INTRODUCTION

Mesozoic reptile remnants are known in Portugal since long ago: Sauvage (1897-98), Zbyszewski (1946), Lapparent and Zbyszewski (1957), Antunes (1976) and Galton (1980)(1991) among others. Recently a theropod nest with about 100 eggs was found in Paimogo, Lourinhã (Mateus *et al.*, 1997) about 7 km from the site where the specimen described here was found.

In the Lourinhã area (mainly Lower Tithonian and Upper Kimmeridgian levels) were discovered several dinosaur remains ascribed to *Brachiosaurus atalaiensis* (Sauropoda), *Dacentrurus armatus* (Stegosauria), *Dracopelta zbyszewskii* (Ankylosauria), *Hypsilophodon* sp. (Ornithopoda), *Megalosaurus insignis* and *Megalosaurus pombali* (Theropoda regarded as *nomina dubia* by Molnar, 1990) as well as an unidentified Ceratosauria, other remains from unidentified sauropods and unidentified Ornithopod (Galton, 1980; Galton, 1991; Helmdach, 1973-74; Lapparent & Zbyszewski, 1957; and unpublished data).

In 1982 a farmer (Mr. Luis Mateus) discovered some fossil bones from one individual in anatomical connection that he had removed and later delivered to the GEAL- Museum of Lourinhã. Parts of the bones were already without the hard sediment cover. Unfortunately the block containing the dinosaur was broken in order to make the transportation easier. The resulting fragments are kept at the GEAL- Museum of Lourinhã.

SYSTEMATIC PALAEONTOLOGY

Dinosauria Owen, 1842
Saurischia Seeley, 1888
Theropoda Marsh, 1881
Avetheropoda Paul, 1988
Allosauroidea Currie & Zhao, 1993
Lourinhanosaurus gen. nov.
Lourinhanosaurus antunesi gen. et sp. nov.

ABBREVIATIONS:

GEAL - Grupo de Etnologia e Arqueologia da Lourinhã;
ML - Museum of Lourinhã.

Etymology- *Derivatio nominis*

Lourinhanosaurus refers the place (Lourinhã, Portugal) where the specimen was found; *antunesi* after Prof. Miguel Telles Antunes, Portuguese palaeontologist.

Holotype

ML370. Remnants from a single individual (see fig. 1): axial skeleton (six cervical vertebrae with 6 ribs, five dorsal vertebrae with ribs, 5 sacral vertebrae, 14 caudal vertebrae with 8 chevrons). Appendicular skeleton: femora (left femur without tibial and fibular condyles; in right femur lacks the proximal end); proximal part of the right tibia and fibula in anatomical connection; two ilia, proximal parts of both pubes and ischia, and proximal end of one metatarsus (?). Associated material: 32 gastroliths.

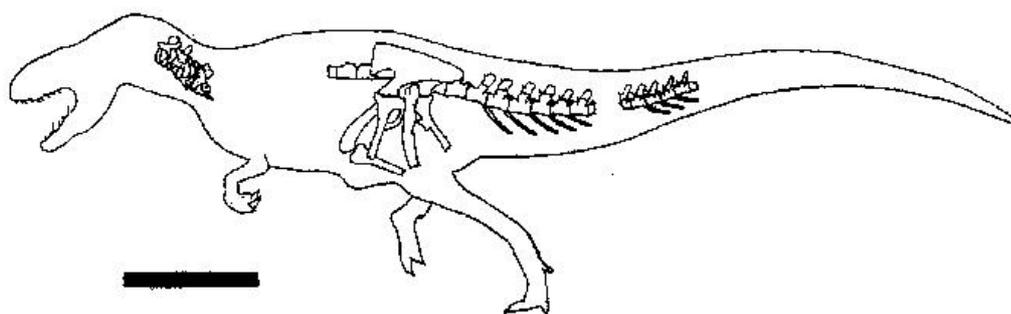


Fig. 1- Type of *Lourinhanosaurus antunesi*. Scale bar 0.5 m.

Generic diagnosis

As shown below, the Peralta (Lourinhã) dinosaur can be assigned as Allosauroidea. This specimen differs from all the others in the group because all vertebral centra are longer than tall, the neural spines of the anterior caudal vertebrae with a well-developed spike-like anterior process, the pubic blade perforated by a large vertical ellipsoidal foramen, and the lesser trochanter is well separated from the main body axis of the femur in lateral view. These characters point out to a new genus to which the name *Lourinhanosaurus antunesi* is given.

Type species, *Lourinhanosaurus antunesi* sp. nov.

Species diagnosis

As for the type genus (see above).

Locality and age

The dinosaur was discovered at Peralta, about 75 Km NW of Lisbon (Portugal), near Lourinhã (UTM coordinates: MD707443) - Upper Jurassic (Upper Kimmeridgian/Tithonian, Sobral Unit) Manuppella (*this volume*). The remnants are preserved in a gray, micaceous, fine sandstone.

DESCRIPTION

The holotype of *Lourinhanosaurus antunesi* corresponds to a partial skeleton that was found lying on its right side. It comprises part of the axial skeleton, the pelvis girdle and hindlimb remained in anatomical connection, not showing any diagenetic etching or deformation.

Vertebrae (Fig. 2; table 1)

The neural arch is fused to the centra. All vertebral centra are longer than tall which is a diagnostic feature, no showed in any other similar theropod.

All cervical vertebrae found were in articulation. The cervical centra present one pair of pleurocoels. The centra are strongly opisthocoelous. The ventral surface presents a median keel. In articulation the cervical series produce a curve concave in dorsal view. There are paired ribs. Diapophyses are reduced.

The eleventh to fourteenth vertebrae are present in *Lourinhanosaurus* considering that bears 14 dorsal vertebrae as in *Sinraptor* (Currie & Zhao, 1993), *Allosaurus* (Madsen, 1976), and *Acrocanthosaurus* (Stovall & Langston, 1950). The centra of the posterior dorsal vertebrae are amphicoelous and relatively longer than in *Allosaurus fragilis*. The centra are not pleurocoelous and are narrowed just ventrally to the neural canal. The dorsal vertebrae exhibit prominent neural spines and diapophyses.

Five sacral vertebrae are present. Sacral centra are not pleurocoelous.

All the caudal vertebra centra are longer than high. The caudal centra are neither hollow nor cavernous. The anterior caudal vertebrae are moderately

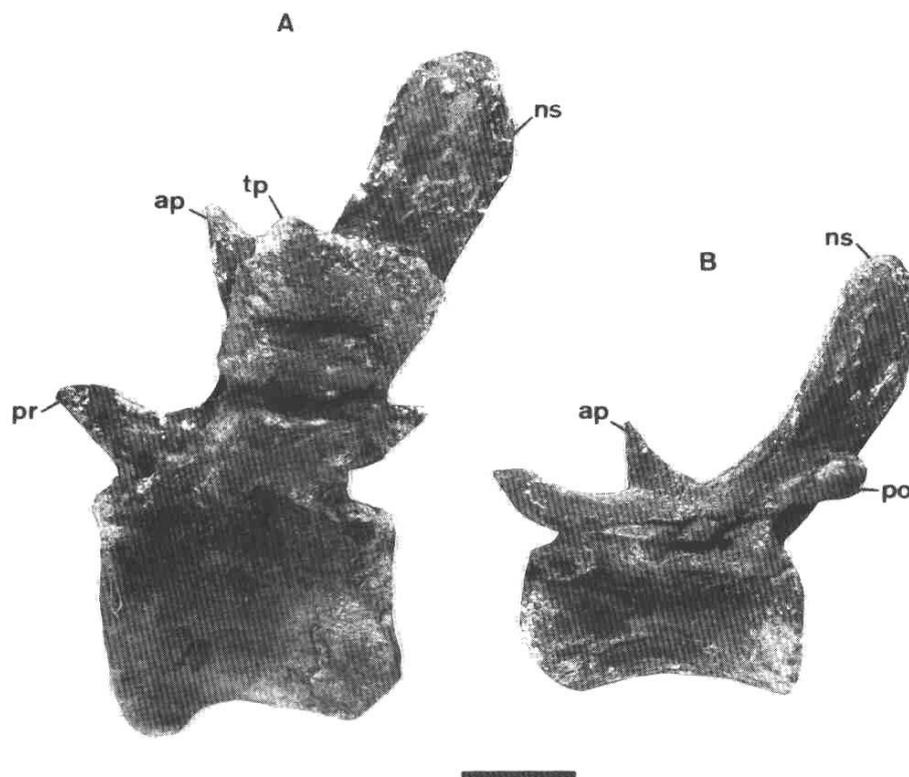


Fig. 2- *Lourinhanosaurus antunesi* gen. et sp. nov. .A: third caudal vertebra; B: twelfth caudal vertebra. ap: anterior process of the neural spine; ns: neural spine; po: postzygapophysis; pr- prezygapophysis; tp: transverse process. Scale bar 5 cm.

Table 1 - Measurements of the vertebrae of ML370 *Lourinhanosaurus antunesi*

	D _{12?}	D _{13?}	D _{14?}	S ₄	S ₅	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	C ₉	C ₁₀	C ₁₁	C ₁₂
Length	7.3	7.5	7.6	6.7	7.1	6.2	6.4	7.0	6.4	7.0	7.0	7.0	7.0	6.4	6.2
Height anterior end	6.1	5.6	6.5	5.5	5.7	5.9	6.2	6.2	5.8	5.7	5.7	--	--	--	3.1
Width anterior end	6.6	7.8	--	5.7	5.2	6.3	--	--	--	4.4	4.1	3.9	3.8	3.7	3.5

Measurements in centimetres.

amphicoelous. In the ventral surface of anterior caudal centra there is a longitudinal groove. A decreasing transverse process is present, at least, to the

fifteenth caudal vertebra. Neural spines decrease in size caudalwards. The transverse processes are long and

placed near the middle of centrum. The neural spines of the anterior caudals are thin and blade-like, with the anterior process spike-like present to, at least, the fifteenth caudal vertebrae (see fig. 2). The anterior processes of the caudal neural spines are more or less developed amongst allosauroids but not so much as in *Lourinhanosaurus*. Except for the first caudal vertebrae the centra have an anterior and posterior chevron facet and corresponding chevron. The chevrons are deeper than long and not expanded distally. The chevron shafts are slightly curve posteriorly. The chevron bases have paired anterior and posterior processes. The haemal canal is close in the proximal end.

Pelvic Girdle (Fig. 3)

The three pelvic elements are not fused.

In lateral view the posterodorsal margin of ilia describes a slightly ventral curve. The posterior end of ilium is pointed, and less truncated than in *Allosaurus*. Almost whole of the blade border bears some roughness corresponding to the pelvic muscle's insertions. The preacetabular portion is expanded dorsoventrally; the postacetabular portion is significantly longer than the preacetabular one. Pubic peduncle forms an angle of nearly 45° with the main axis. The anterior end is expanded, and projects slightly beyond the pubic peduncle. The posterior end is much more expanded beyond the ischial peduncle. The medial blade is fused to the fifth sacral vertebra. The pubis peduncle is longer than ischial peduncle but both are at the same level. The pubic peduncle is twice as long anteroposteriorly as broad transversely.

The two pubes are in articulation. The pubis is strong and straight, with postero-proximal expanded ischiac articulation. The pubic plate presents a large, vertical ellipsoid pubic foramen or fenestra. The border of the acetabulum is longer than in *Allosaurus fragilis*. Unfortunately the distal ends of both pubes are not complete and the presence of the pubic boot, which is very diagnostic of Allosauridae (Holtz, 1994), cannot be ascertained.

The ischium projects caudoventrally. The shaft is straight with a minimum diameter of 2.2 centimetres. There is a slender “neck” at the pubic peduncle. The obturator process is placed proximally with trapezoidal shape (it is narrower near the ischial shaft than in the anterior edge). There is a notch between the pubic and obturator processes.

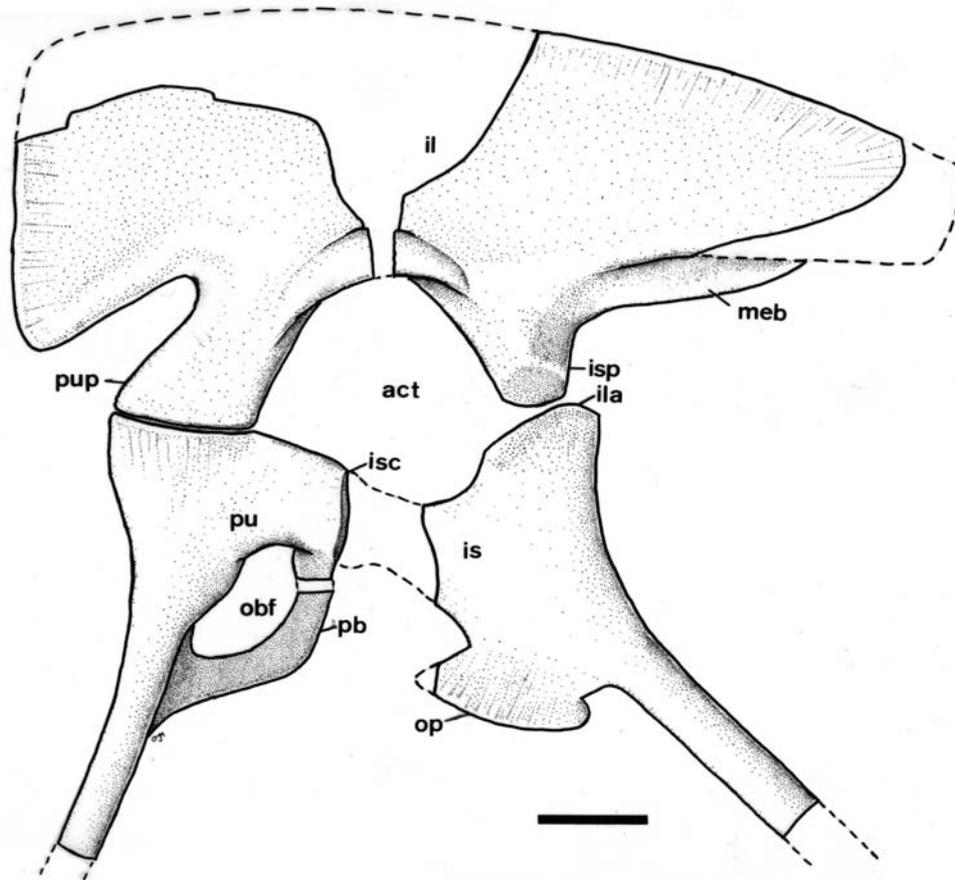


Fig. 3- *Lourinhanosaurus antunesi* gen. et sp. nov., reconstruction of the pelvic girdle. act: acetabulum; il: ilium; ila: iliac articular process; ilp: iliac peduncle; is: ischium; isc: ischiac articular process; isp: ischial peduncle; meb: medial blade; obf: obturator foramen or fenestra; op: obturator process; pb: pubic blade; pu: pubis; pup: pubic peduncle of ilium; Scale bar 5 cm. The ilium was reconstructed with the features of both ilia.

Femora, right tibia and fibula (Fig. 4 and 5)

The femoral head is medially directed. The fourth trochanter is long and it is situated on the posterior surface of the femoral shaft where there is an obvious muscle scar. Length of the fourth trochanter is, at least twice the femur shaft diameter just below. The greater trochanter does not bear a cleft. It presents an aliform lesser (or anterior) trochanter extended by a distally placed lamella of bone, well separated from the main body of femur in lateral view (see fig.4).

The distal condyles are separated by a deep intercondylar groove. This groove is more developed posteriorly than anteriorly. There is no *crista tibiofibularis* (which is characteristic of Ceratosauria).

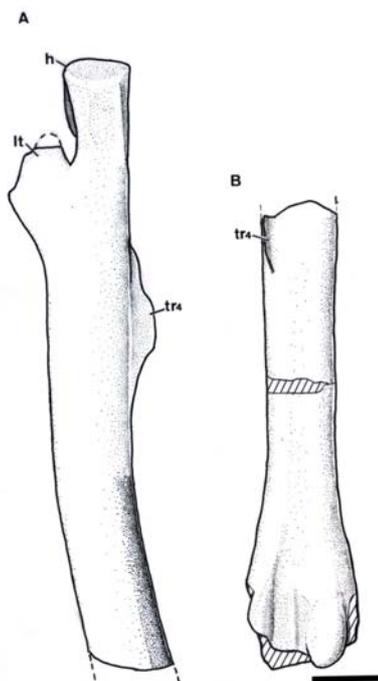


Fig. 4- *Lourinhanosaurus antunesi* gen. et sp. nov., A- left femur in lateral view; B- right femur in posterior view. h- femoral head, lt- lesser trochanter, tr4- fourth trochanter. Scale bar 5 cm.

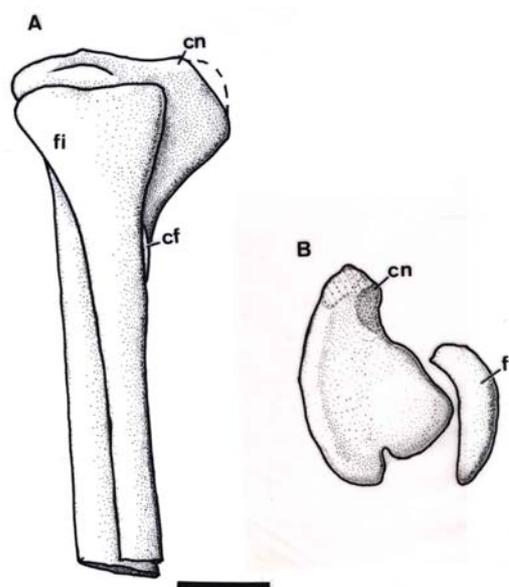


Fig. 5- *Lourinhanosaurus antunesi* gen. et sp. nov., right tibia and fibula in lateral (A), and proximal (B) view. cf- crista fibularis of tibia; cn- cnemial crest; fi- fibula; Scale bar 5 cm.

The proximal articular surface of the tibia is flattened. The cnemial crest is much less developed than in *Allosaurus fragilis* and does not arise out of the lateral surface as in tyrannosaurids. The medial surface is curved outwards and shows the muscular insertion. The lateral and posterior borders are grooved to form a buttress for the proximal attachment of the fibula. The tibial shaft has a sharp ridge (*crista fibularis*) placed laterally, for clasping the fibula. The shaft is slightly curved anteriorly. The tibia seems shorter than the femur.

The shaft of the fibula is slender and straight. It is expanded proximally, being convex in lateral view and concave in medial view. The distal end is lacking.

Table 2 - Measurements of ML370 *Lourinhanosaurus antunesi*

Greatest length of Iliac*	46.0
Mid-diameter of femoral shaft	5.2
Length of femur *	54.0
Width of proximal end of fibula	7.9
Width of proximal end of tibia	12.7

Measurements in centimetres.

*- Estimated measurement.

Associated material

Gastroliths

Gastroliths have been described in Ornithopoda, Ceratopsia, Prosauropoda, Sauropoda, Lacertilia, Crocodylia, extant birds and seals (Stokes, 1987; Christiansen, 1996) but not in non-avian theropods until now. The specimen had 32 gastroliths and the enveloping sediment preserved the negative imprint of 3 additional gastroliths. The maximum observed gastrolith length is 22 millimetres. Near the pebbles were three small bone fragments that seemed to be food remains. The gastroliths have been found in the rib cage below the eleventh dorsal vertebra. The high number, concentration and relative size of the gastroliths suggest that they belong to this specimen, and that they had not been swallowed when eating other dinosaur's stomach.

DISCUSSION

This specimen shares the following theropod synapomorphies: presacral vertebrae with pleurocoels; five sacral vertebrae; long preacetabular process on the ilium; pronounced brevis fossa on caudal part of the ilium; femur convex cranially; fibula closely appressed to the tibia and attached to a tibial crest; and thin walled, hollow, long bones (see Gauthier, 1986). The species is clearly a tetanuran and avetheropod (neotetanuran sensu Sereno *et al.* 1994, Allosauroidea + Coelurosauria) because the chevrons bases have paired anterior and posterior processes, the iliac-ischial articulation is smaller than the iliac-pubic articulation, ischial obturator notch is present, the femoral anterior trochanter is blade-shaped, the iliac preacetabular fossa is present, and iliac

pubic peduncle is twice as long anteroposteriorly as broad transversely (Sereno *et al.*, 1996).

No features cited in Sereno *et al.* (1994; 1996) are available to diagnostic *Lourinhanosaurus* as Allosauroida because only cranial characters are used. However because of the mid cervical centra least than 20% broader than tall, the elevation of the anterior face present in mid cervical centra, the developed lesser trochanter, the presence of more than 15 caudal vertebrae with transverse processes, the ischial obturator flange trapezoidal and the reduced fibular fossa it is possible to classify this species as a non Carcharodontosaurid nor Coelurosaurian Avetheropoda.

Holtz (1994) produced a single, most parsimonious cladogram of the Theropoda. The data-matrix was criticised by Clark *et al.* (1994) and Charig & Milner (1997). After that, Holtz (1995, 1996) and Sereno *et al.* (1996) published new theropod relationship data. Using the data-matrix of Holtz (1994) with the modifications introduced by Charig & Milner (1997) the specimen from Lourinhã was placed as a basal Avetheropoda Paul, 1988. For this study the Hennig86 programme was run. The cladogram has a consistency index (C.I.) of 49%, a retention index (R.I.) of 70% and 236 steps length (see fig. 6 A).

The data-matrix of Sereno *et al.* (1996) was also run in Hennig86 with *Lourinhanosaurus* characters showing a C.I. of 81%, R.I. of 84% and 80 steps

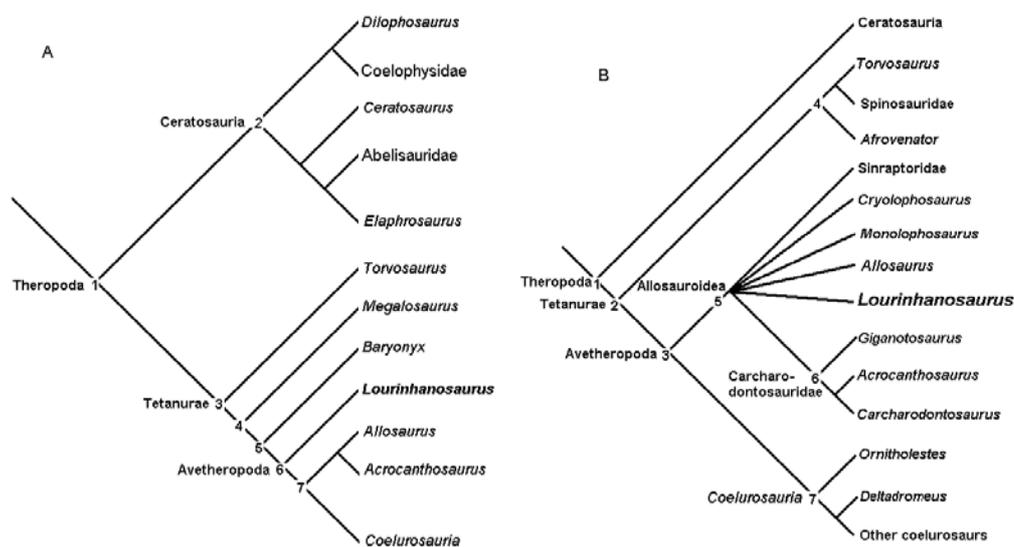


Fig. 6- Cladogram of the Theropoda including *Lourinhanosaurus*, **A-** after HOLTZ (1994) with the modifications of CHARIG & MILNER (1997); **B-** SERENO *et al.* (1996).

length. The *Lourinhanosaurus* was placed within Neotetanurae in a polytomy among Sinraptoridae, *Cryolophosaurus*, *Monolophosaurus*, *Allosaurus* and Carcharodontosauridae (see fig. 6B).

The following features justify including *Lourinhanosaurus* in the Allosauroidea: transverse processes of middle caudal series placed near the middle of the centrum, rather than posteriorly on the centrum; slender “neck” at the pubic peduncle of the ischium; ischium with trapezoidal (in lateral view) obturator process; small notch at the distal end of the ischial obturator process and aliform lesser trochanter. This specimen differs from all other allosauroids because all vertebrae are longer than tall, the neural spines of the anterior caudals vertebrae with a well-developed spike-like anterior process, posterior end of ilium is pointed not truncated, and the pubic blade perforated by a large vertical ellipsoid fenestra.

Three genera have been reported to the Allosauridae: *Allosaurus*, *Neovenator* and *Saurophaganax* (CHURE, 1995; HUTT *et al.*, 1996). Recently, SMITH (1998) reclassified *Saurophaganax maximus* into the genus *Allosaurus* as the new species combination *Allosaurus maximus*. *Acrocanthosaurus* is claimed to be Allosaurid by HOLTZ (1994) and Carcharodontosaurid by SERENO (1996). The family Sinraptoridae (with genera *Sinraptor*, *Szechuanosaurus*, and *Yangchuanosaurus*) and Carcharodontosauridae (with genera *Carcharodontosaurus*, *Bahariasaurus* and *Giganotosaurus*) are related to Allosauridae (CURRIE & ZHAO, 1993; HOLTZ, 1996; SERENO *et al.*, 1996). The taxonomic position of *Chilantaisaurus*, *Cryolophosaurus* and *Monolophosaurus* remains uncertain.

Neovenator salerii is the only Allosaurid known in Europe so far (HUTT *et al.*, 1996). However *Lourinhanosaurus* is distinct from *Neovenator* by the last dorsal vertebrae which is not pleurocoelous, and by the position of the fourth trochanter on the posterior surface of the femoral shaft in *Lourinhanosaurus antunesi*. Several features are similar to those found in *Allosaurus* (ischial obturator process trapezoidal and aliform lesser trochanter, MADSEN, 1976) but it differs by proportionally longer vertebrae, cnemial crest of tibia less developed and by the others diagnostic characters cited above. The chevron of *Saurophaganax* differs from those in *Lourinhanosaurus* by the distal expansion. In *Saurophaganax* the shape of the ischial and pubic obturator processes doesn't resemble the Portuguese dinosaur.

The reduced cervical diapophyses are more similar to *Sinraptor* than to *Allosaurus fragilis*. The neural spine is much less developed than in *Acrocanthosaurus atokensis*. The obturator process is placed proximally and it is trapezoidal-shaped as in *Allosaurus fragilis* (Madsen, 1976), or in *Acrocanthosaurus atokensis* (Stovall & Langston, 1950).

The pubic blade gap in *Lourinhanosaurus* could be the fusion of the pubic fenestra with the pubic obturator foramen (the two gaps, pubic fenestra and obturator foramen, are present in *Coelophysis* (Colbert, 1989) and *Syntarsus* (Raath, 1980)), or an enlargement of the obturator foramen present in non avetheropoda as *Piatnitzkysaurus*, *Torvosaurus* and *Carnotaurus* as well in *Monolophosaurus* (Zhao & Currie, 1993), in the sinraptorid *Yangchuanosaurus shangyouensis* (Dong *et al.*, 1983). Considering the taxonomic approach of these last two species to allosaurids (see Holtz, 1996), the second hypothesis (enlargement of the obturator foramen) is more probable. *Sinraptor* bears such similar character but with a small opening which forms an obturator notch. This similarity suggests that *Lourinhanosaurus* is more primitive than allosaurids and it is probably a sinraptorid. In conclusion this is the only sinraptorid known in Europe so far.

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