ANNALI DELL'UNIVERSITÀ DI FERRARA

Sezione di

FISICA E SCIENZE DELLA TERRA

Volume speciale (2014)

7th International Meeting on Taphonomy and Fossilization 10th–13th September 2014, Ferrara, Italy

EDITED BY

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UNIVERSITÀ DEGLI STUDI DI FERRARA

2014

DINOSAUR TAPHONOMY IN THE LOURINHÃ FORMATION (LATE JURASSIC, PORTUGAL)

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The Upper Jurassic Lourinhã Formation is known by the richness in vertebrate specimens, mostly dinosaurs, mainly in the middle section of the formation, i.e. within or close to the Porto Novo and Praia Azul Members. The bone preservation in the upper part of the formation (Assenta and Santa Rita Mbs.) are rarer, maybe due to geochemical conditions (i.e., pH) unfavorable to bone fossilization. These conditions may resulted of the paleoenvironment: less confined channel in more distal delta position, which induced more fluid circulation.

Skeletons. In the Lourinhã Formation, dinosaur skeletons have been found, mostly incomplete. Articulation mainly occurs in fine sandstones that correspond to confined river channels in a meandric deltaic river system, while grey mudstones usually preserve microfossils (such as crocodylomorph and mammaliamorph teeth or albanerpetontid bones) but seldom macro-skeletal remains. Full articulation is rare but occasional association is more common, while complete disarticulation and preservation of isolated bone parts is frequent. Incomplete, but associated to articulated skeletons have been found for the holotypes of the tetanuran theropods *Lourinhanosaurus antunesi* and *Allosaurus europeus*, the diplodocid *Dinheirosaurus lourinhanensis*, the camptosaurid *Draconyx loureiroi*, and the nodosaurid *Dracopelta zbyszewskii.* High association (but not fully articulation) was present in the holotypes of the brachiosaurid *Lusotitan atalaiensis*, the basal neosauropod *Lourinhasaurus alenquerensis*, the turiasaur *Zby atlanticus*, and the Dacentrurinae *Miragaia longicollum*. Many other type specimens are based upon isolated bones.

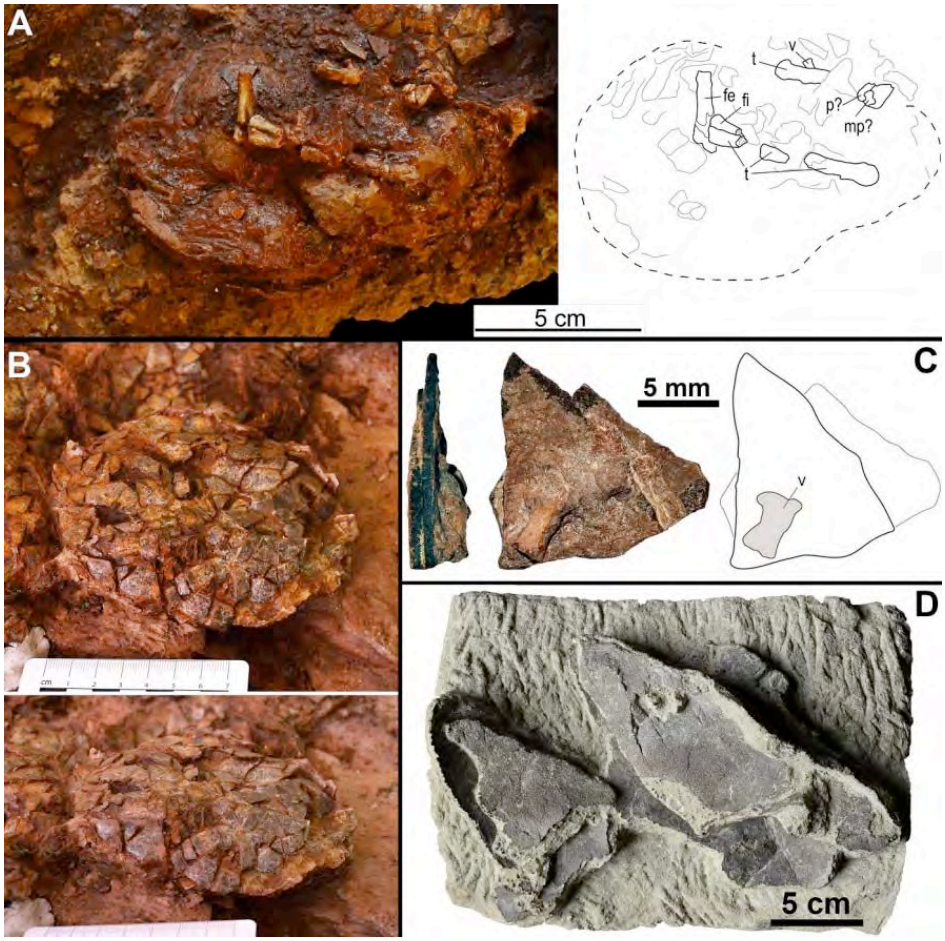
Z. atlanticus ML 368 comprised a hindlimb, chevron and complete tooth with root: due to the presence of the crown, we can assume it was disaggregated *post-mortem* out of the skull (though unpreserved), thus it was not a shed tooth. In *L. antunesi*, where bones were found broken with sandstone infills, and in *Z. atlanticus*, where the radius presents a concavity made by the pressure contact with a manual phalanx. These cases show a strong lithostatic pressure during the diagenesis, but while the bones still preserved a certain degree of elasticity. Signs of sclerobiont activity are rare.

Gastroliths. In the Late Jurassic of Portugal, sauropod specimens are often associated with gastroliths (i.e. *Dinheirosaurus*, *Zby*, and indet. sauropods), and a well visible case in the theropod *Lourinhanosaurus antunesi* ML370 holotype, with 32 gastroliths within the ribcage and, among them, four ungual phalanges of an ornithopod.

Tracks and footprints. Dinosaur true tracks (concave epireliefs) are usually common in carbonate platforms of shallow marine facies. But in Lourinhã Formation, rocks are mainly a succession of intercalated sandstone and mudstone, with only rare limestone transgressive levels. In this situation, track preservation occurs when tracks were produced at the interface of the two lithologies, or near it. The vast majority (> 80%) of footprints in the Lourinhã Formation are sandstone natural casts infills, i.e. sand filling of the original true tracks produced in the mud surface. In some specimens, skin and claw impressions and striation marks are preserved.

Eggs and nests. Different localities provided nests and eggs with embryos of the theropodian species *Lourinhanosaurus antunesi* and *Torvosaurus gurneyi*, always preserved in mud or siltstones. In the Paimogo nesting ground, the eggs were rearranged by a flood event. The thick mudstones, stratigraphically above and below the nesting horizons, indicate a long persistence of periodic flooding, alternating with pedogenesis in a semi-arid and subtropical climate with dry and moist conditions.

Due to different levels of the eggshell solidity and porosity, the thinner and less porous eggshells of *L. antunesi* are brittle. The eggshells break as the eggs deforms vertically (down to 20%) by lithostatic pressure during the early stages of the diagenesis, with the egg being filled by mudstone. In contrast, the eggshells of *T. gurney* deformed plastically without breaking (until a certain limit) probably due to their higher porosity. In both cases, eggs are vertically compressed but they still partly preserve the original outline.



(A) ML565: photograph (left) and interpretative drawing (right) of a Paimogo egg with *Lourinhanosaurus antunesi* embryonic bone; fe = femur; fi = fibula; mp = metapodium; p = pelvis; t = tibia; v = vertebra. (B) ML565: photograph of a *L. antunesi* egg in orthogonal (upper) and oblique (lower) view. (C) ML565-046: lateral view (left), internal view (center), and interpretative drawing (right) of two eggshell fragments with a vertebra of *L. antunesi* on the eggshell internal surface; v = vertebra. (D) ML1842: photograph of the egg from Porto das Barcas attributed to the megalosaurid *Torvosaurus gurney*.