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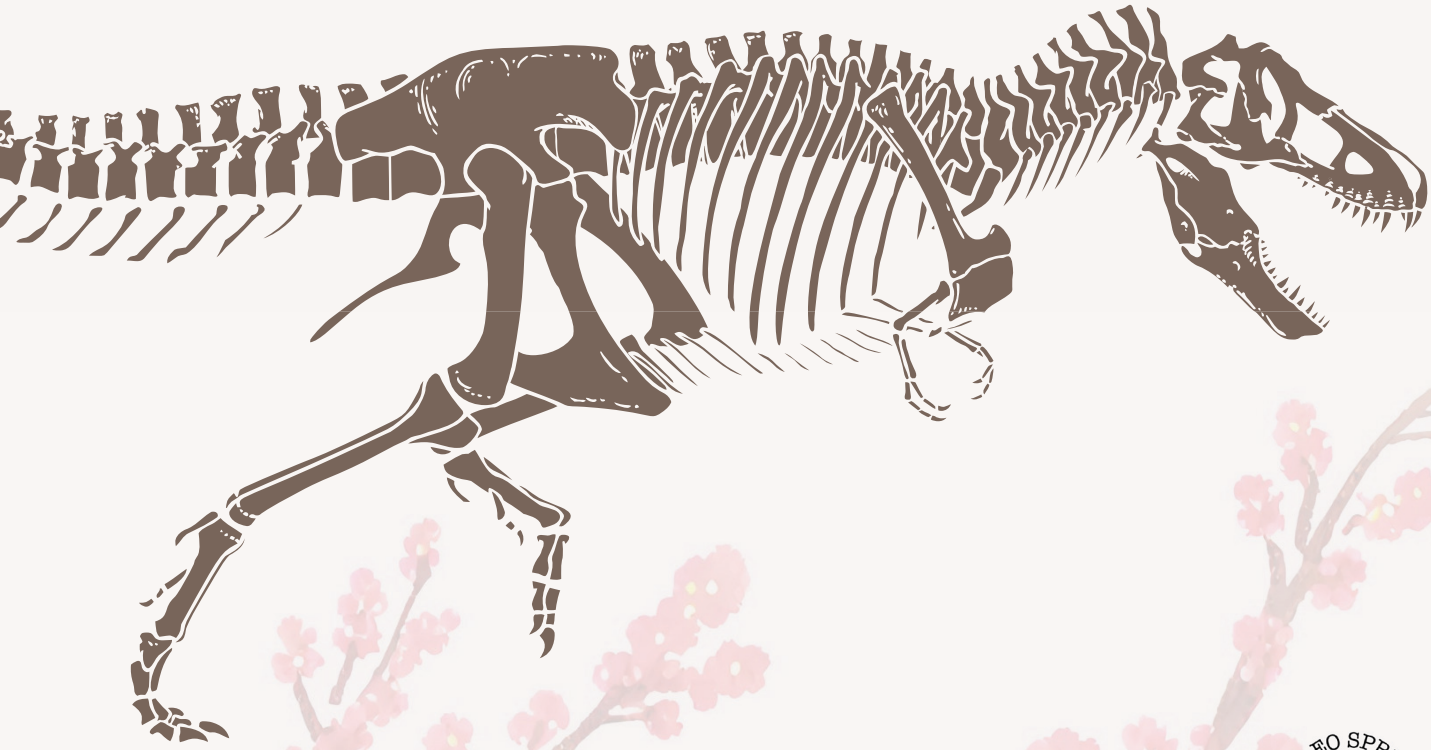
ACTAS DO PALEO SPRING MEETING
PROCEEDINGS OF THE PALEO SPRING MEETING



Pedro Fialho, Roberto da Silva
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NOTES ON THE TYPE SPECIMENS OF *ALLOSAURUS ATROX* AND *A. FEROX* (THEROPODA, ALLOSAURIDAE)

NOTAS SOBRE OS ESPÉCIMES TIPOS DE *ALLOSAURUS ATROX* E *A. FEROX* (THEROPODA, ALLOSAURIDAE)

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ABSTRACT
Allosaurus Marsh, 1877 is one of the most iconic theropods of the Late Jurassic of USA and Portugal. However, since the first description the genus was used as taxonomical wastebasket to which several species were described. We revisit three type specimens, *Allosaurus fragilis* YPM 1930, *A. atrox* YPM 1890 and *A. ferox* USNM 2315. We interpret the vertebral material of *A. atrox* and support it as a junior synonym of *A. fragilis*, and *A. ferox* as *Allosaurus* indet. rather than *A. fragilis*.
Keywords: Morrison Formation, Allosauridae, North America, *Creosaurus*, *Allosaurus fragilis*.

RESUMO
Allosaurus Marsh, 1877 é um dos terópodes mais icónicos do Jurássico Superior dos EUA e Portugal. No entanto, o género foi usado como "caixote do lixo" taxonómico no qual várias espécies foram descritas. Revisitamos dois espécimes tipo, *Allosaurus atrox* YPM 1890 e *A. ferox* USNM 2315. O material vertebral do *A. atrox* é intrepretado como sendo sinónimo júnior de *A. fragilis*, e *A. ferox* um *Allosaurus* indet. em vez de *A. fragilis*.
Palavras-chave: Formação de Morrison, Allosauridae, América do Norte, *Creosaurus*, *Allosaurus fragilis*.

The holotype of *Allosaurus fragilis* Marsh 1878 is composed by nondiagnostic bones, a dorsal centrum and tooth YPM 1930 (Figure 1) from Felch Quarry 1, Garden Park, which is dated to the Kimmeridgian/Tithonian of Morrison Fm. of Colorado. Paul and Carpenter (2010) proposed the nearly complete skull USNM 4734, as neotype, which we support, because it has distinctive diagnostic characters supported by phylogenetic analyses. This position was ratified by ICZN (ICZN, 2023). Until recently, many of the named species of *Allosaurus*-related taxa were considered as junior synonyms of *Allosaurus fragilis* since the original description in 1878. But all this changes with the recognition of two valid *Allosaurus* species (*A. europaeus* ML415 Mateus et al., 2006 and *A. jimmadseni* DINO 11541 Chure and Loewen, 2020), because most of types lack diagnostic characters to distinguish between the three species. Most disputed types cannot clearly be attributed to a junior synonym of *A. fragilis* and now fall into the genus *Allosaurus* (species indet.) or even as Allosauridae indet.

We focus, using bibliographic analysis, reference images and unpublished images, on two *Allosaurus* type specimens: "*Allosaurus atrox*" YPM 1890 and "*Allosaurus ferox*" USNM 2315.

Institution abbreviations: DINO Dinosaur National Monument, Jensen, Utah, USA; YPM Yale Peabody Museum, New Haven, USA; USNM National Museum of Natural History, (formerly United States National Museum); Smithsonian Institution, Washington, D.C., USA; ML Museu da Lourinhã, Lourinhã, Portugal; ICZN, International Commission on Zoological Nomenclature.

"*Allosaurus atrox*" (Marsh 1878), originally *Creosaurus* (Figure 2-4), syntype is YPM 1890, that includes teeth, ilium, right jugal, metapodial, pedal phalanges (including one ungual), dorsal, sacral and caudal vertebrae, many of which have never been figured. The type was collected by Samuel Wendel Williston in Quarry 1, Como Bluff, Wyoming, from the Kimmeridgian/Tithonian of the Morrison Formation.

The ilium of "*A. atrox*" figured by Marsh (1878, 1879) (Figure 2) show two main alleged differences from *A. fragilis*: 1) the lack of anteroventral lobe of iliac preacetabular process, forming a V-profile; and 2) and shape and proportions of the pubic peduncle, smaller and more triangular in *A. atrox*. If these differences were real, then *A. atrox* would bear enough diagnostic traits to support even its own genus *Creosaurus*. However, Hay (1908) and Chure (2000) agree that the anterior margin of this ilium and the pubic process suffer "some loss" providing its artificially unusual outline.

Figure 1. *Allosaurus fragilis* Marsh 1878 type YPM 1930 (Photo by Octávio Mateus).
Figura 1. *Allosaurus fragilis* Marsh 1878 tipo YPM 1930 (fotografia por Octávio Mateus).

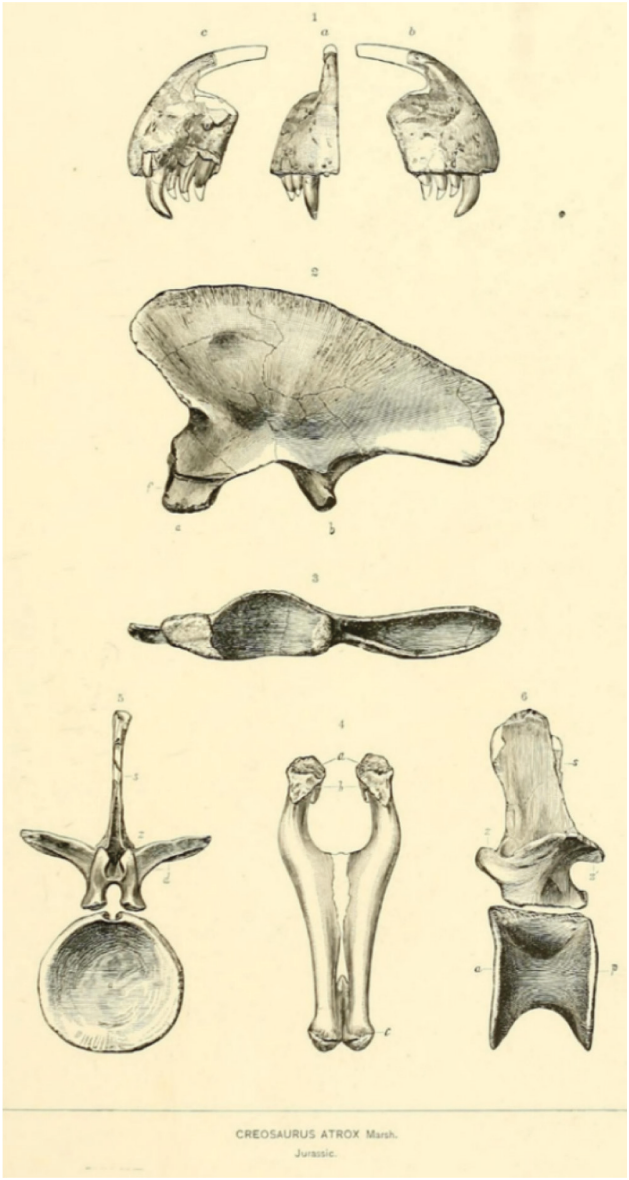

Figure 2. Type of *Creosaurus atrox* Marsh 1878.
Figura 2. Tipo do *Creosaurus atrox* Marsh 1878.

Figure 3. Jugal (left) and premaxila (right) YPM 1890, type of *Creosaurus atrox*, now seen as of *Allosaurus fragilis* (photo by Octávio Mateus).
Figura 3. Jugal (esquerda) e premaxila (direita) YPM 1890, tipo do *Creosaurus atrox*, agora visto como de *Allosaurus fragilis* (fotografia de Octávio Mateus).

Figure 4. Foot elements YPM 1890, type of *Creosaurus atrox*, now seen as *Allosaurus fragilis* (photo by Octávio Mateus).
Figura 4. Elementos do pé do YPM 1890, do tipo de *Creosaurus atrox* atualmente visto como *Allosaurus fragilis* (fotografia por Octávio Mateus).

Figure 5. Dentary USNM 2315, type of "*Labrosaurus ferox*" Marsh, 1884, an *Allosaurus* sp., with a pathological "diastema" (photo by C. Hendrickx).
Figura 5. Dentário do tipo USNM 2315 "*Labrosaurus ferox*" Marsh 1884; um *Allosaurus* sp. com um "diastema" patológico (fotografia por C. Hendrickx).

A distinct anteroventral lobe of iliac preacetabular process is likely to have existed in this animal because is a widespread trait and synapomorphy of Averostra (ceratosaurs and tetanurans; Carrano & Sampson, 2008).

The YPM 1890 includes elements not originally figured: five pedal phalanges, including an ungual, a V metatarsal (Figure 4) and a left jugal (Figure 3). The jugal is an important element because it can be used to distinguish *Allosaurus* species. In this case, the ventral curvature is similar to *A. fragilis* and unlike *A. jimmadseni* or *A. europaeus*. This allows us to attribute, with some level of certainty, "*Allosaurus atrox*" (YPM 1890) as the junior synonym of *Allosaurus fragilis*.

We reinterpret the figured vertebra by Marsh (1878) (Figure 2) as composite: the neural arch is part of an anterior caudal while the centrum is from a dorsal position, raising the question of whether the type is even from a single individual. The vertebra has been suggested to come from a site other than Quarry 4 at Como and not from Quarry 1 (Chure, 2000), and is therefore not considered part of the type. The *A. atrox* elements form a syntype (multiple indviduals), without a formalized lectotype (single main type individual), which offers additional complications to be ever consider a valid species.

Paul (1988) attributed the skull DINO 2560 as *A. atrox* but there is lack of anatomical data to support it.

"*Allosaurus ferox*" (Marsh, 1884). Originally named as *Labrosaurus ferox*, it was synonymized to *Allosaurus fragilis* by Madsen and Welles (2000). The type is a dentary (USNM 2315, Figure. 5) from Felch Quarry 1, Garden Park in Colorado (Kimmeridgian/Tithonian, Morrison Fm). This dentary shows a strange diastema-like gap that we interpret as pathological as Guilmore (1920) as suggested. Also unusual is the posterior end: in the original image by Marsh, the dentary is very projected posteroventrally, but that is the result of reconstruction as seen in Figure 3. Apart from that, the specimen is indistinguishable from other *Allosaurus* species and for this reason was considered by Chure (2000) as *Allosaurus* sp. rather than *A. fragilis* which we agree.

Conclusions

In sum, we provide new photographs of both types that may help to clear some confusions and reinterpret the composition of *A. atrox* and *A. ferox,* and agree with the interpretation of Chure (2000) that type of *Allosaurus atrox* is a junior synonym of *Allosaurus fragilis* and *Labrosaurus ferox* is *Allosaurus* sp.

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