The dinosaur postcranial fossils of the La Cantalera-1 site (Barremian, Lower Cretaceous) in Josa (Teruel, Spain)

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Keywords: Ornithopoda, Thyreophora, Sauropoda, Paleobiodiversity, Taxonomy.

Introduction

La Cantalera-1 site was discovered in the 1990s in the locality of Josa (Teruel, Aragón, Spain). Since then, thousands of fossils remain have been recovered, most of them replaced teeth from vertebrates, predominantly ornithopod dinosaurs (Canudo et al. 2010). This outcrop is located in the basal levels of the lower sequence of the Blesa Formation, the unit that marks the beginning of Cretaceous sedimentation in the Oliete sub-basin (Maestrazgo Basin). The site is found in a level of red clays representing deposits from distal alluvial to palustrine mudflat, with local sheet flood and debris flow deposits (Aurell et al. 2018).

The presence of *Atopochara trivolvis triquetra* has allowed to date the site as Early Barremian (Aurell et al. 2018). Canudo et al. (2010) conducted an initial review of the vertebrate palaeobiodiversity at the site through the study of isolated teeth, identifying 31 different taxa. This biodiversity has been further expanded through the continued analysis of isolated teeth from various groups, such as ornithopods (Gasca et al. 2014), crocodylomorphs (Puértolas-Pascual et al. 2015), and theropods (Alonso & Canudo, 2016). In addition, more than 10 different ootaxa have been described, two of which were first defined at this site (Moreno-Azanza et al. 2014).

Despite the numerous studies carried out on this paleontological site, the majority of non-dental bones from macrovertebrates remain unexamined. Most of the material are small, broken and difficult to assign fragments of bones. Despite this, a significant portion of these remains belong to axial skeleton bones of ornithopod dinosaurs, although fossils of sauropods, ankylosaurs, and, to a lesser extent, theropods have also been recovered.

Material and Methods

All the material described is housed at the Museum of Natural Sciences of the University of Zaragoza. Most of the remains were recovered during excavation campaigns carried out in the 1990s and in 2002. Some fossils were discovered by amateur collectors and donated to the museum, while others were excavated using a grid-based collection methodology, in which sediment was gathered in bags for later washing. As a result, the exact provenance of most fossils within the site is unknown, and for others, only the grid square is known, but not the precise position within it. This makes it impossible to assign most of the fossils to the same skeleton, making it difficult to determine the number of individuals or taxa.

Results and discussion

Thyreophora

Several fragments of the dermal skeleton and some complete osteoderms have been recovered and identified. Most of the material has previously been reviewed by

Parrilla-Bel & Canudo (2017) and Perales-Gogenola et al. (2019). Both studies agree in assigning the material to a Polacanthinae, although the presence of two different taxa cannot be ruled out. Specimen CAN1-724 is a fragment of a vertebral centrum. The dimensions of the articular surface—wider than tall, heart-shaped, and concave—are consistent with the anterior to middle caudal vertebrae of ankylosaurid dinosaurs. This morphology can be observed in *Polacanthus*, *Panoplosaurus*, *Europelta* and *Gastonia* (Raven et al. 2020 and references therein). CAN1-724 may be related to Polacanthinae and could represent the second caudal vertebra identified at the site

Ornithopoda

Most of the recovered and assignable macrovertebrate fossils correspond to ornithopod dinosaur bones. Several dorsal and caudal vertebrae have been recovered, as well as some nearly complete ribs. Regarding the appendicular skeleton, a scapula, two tibiae, a fibula, and an ungual phalanx from ornithopod dinosaurs have been identified. Most of these fossils were found isolated at the site, and some show evidence of deformation or compression—such as the scapula—while others are in excellent condition. All the recovered ornithopod vertebrae share characters related with the Styracosterna clade. The absence of pleurocoels and the amphiplatyan or platycoelous vertebral centra with a sinuous suture with the neural arch are features typical of ornithopod dinosaurs (Norman, 2004). Additionally, the caudal vertebrae exhibit lateral ridges on the centra, a trait commonly observed in iguanodontians (Norman, 2004). The recovered middle to posterior caudal vertebrae exhibit consistent morphology and size, with four of them preserved in articulation. These vertebrae represent the only evidence of anatomically connected material found at the La Cantalera-1 site. The presence of two tibiae and one fibula of markedly different sizes indicates the presence of three different ornithopods at the site. This variation may be due to different ontogenetic stages (hatchling, juvenile, and adult) or to the presence of distinct taxa (hypsilophodontids, and medium and large-sized styracosternans).

Sauropoda

The sauropod material has been recently reviewed by Medrano-Aguado et al. (2023). It consists of several tooth crowns and two vertebrae. The tooth crowns are associated with the asian clade Euhelopodidae, as they exhibit a bulge on the lingual surface—a feature considered a synapomorphy of the group. The vertebrae display typical characteristics of somphospondylan sauropods, which is consistent with the dental assignment.

Theropoda

This is the least represented group at the site in terms of identifiable non-dental remains. Only a single ungual phalanx fragment has been tentatively assigned to Theropoda indet. It is an elongated, straight, pointed phalanx with a subtriangular cross-section, taller than it is wide. The proximal end is missing, but a rounded cavity can be seen inside the phalanx. It features a deep, rounded lateral groove, which is much less pronounced on the medial side. This phalanx differs markedly from those of ornithischian and sauropod dinosaurs. Among theropods, ornithomimosaurs may possess relatively straight manual ungual phalanges (Cuesta et al. 2022), making them a possible source of this fossil, especially since they have already been identified in the Barremian of the Iberian Peninsula. However, it cannot be ruled out that the specimen belongs to a hypsilophodontid ornithopod, whose ungual phalanges differ from those of styracosternan ornithopods and whose teeth have already been found at the La Cantalera-

1 site. The ungual phalanges of hypsilophodontids are characterized by their slenderness and well-defined grooves (Galton, 1975). The extreme slenderness of this phalanx appears to be more consistent with theropod dinosaurs, suggesting that this could be the first postcranial remain of this group recovered from the La Cantalera-1 site.

Conclusions

Most previous research at the La Cantalera-1 site have focused on assessing the diversity of various vertebrate groups based on isolated teeth, which represent the most abundant fossil elements at the site. As shown in this brief review of the postcranial elements, the remains of medium-sized ornithopods are particularly abundant at the site, whereas those of other vertebrate groups are comparatively scarce. The discovery

of caudal vertebrae preserved in anatomical articulation, along with additional elements attributable to a medium-sized styracosternan ornithopod, supports the presence of a partially disarticulated skeleton at the site. Despite the large number of fossils recovered from La Cantalera-1, the site remains far from exhausted. Future excavations are likely to yield diagnostically informative postcranial elements that will enhance species-level identifications, as well as isolated remains of vertebrate groups currently underrepresented in the Barremian fossil record of the Iberian Peninsula.

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