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Direct evidence of shark-bony fish interactions in a Valanginian (Early Cretaceous) marine ecosystem of northwestern Gondwana

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ABSTRACT

Direct fossil evidence of predator-prey interactions among marine vertebrates from the Early Cretaceous of northern South America is extremely scarce, limiting our understanding of the trophic dynamics in ancient Gondwanan ecosystems. Here, we describe a partially preserved left posterior jaw ramus of a teleost fish from the Early Cretaceous Rosa Blanca Formation in Colombia. It includes fused dentary, anguloarticular, and retroarticular bones, a condition observed in stem pholidophorids and more derived teleosts. CT scans revealed distinct internal structures between the dentary and anguloarticular bones, and the corresponding external bone textures also differed. Embedded in the lateral surface of the angulo-articular is a broken shark tooth with a lanceolate shape and apparent serrations. SEM imaging revealed a two-layer structure: an outer enameloid and an inner osteodentine core. The absence of a pulp cavity and complete mineralization of the axial surface indicate an osteodont tooth type, typical of lamniform sharks. This represents the first direct evidence of a trophic interaction between lamniform sharks and teleost fish from northern Gondwana during the Cretaceous. This discovery adds to the known vertebrate diversity of the formation and mirrors modern ecological dynamics, in which lamniform sharks prey on bony fishes. This also supports the interpretation of a complex marine ecosystem in the region, previously evidenced by the remains of pliosaurs, plesiosaurs, metriorhynchids, and pterosaurs. This finding complements earlier indirect evidence of shark predation and enriches our understanding of Cretaceous marine food webs in the tropical Gondwanan settings.

1. Introduction

Predation and competition are key ecological processes that shape the structure and function of modern communities (Kelley et al., 2003) and have also played a crucial role in past ecosystems (Bootjer, 2016). One of the main interests of paleoecological research is to reconstruct past food webs across different temporal, geographical, and environmental contexts (Roopnarine et al., 2007; Kempf et al., 2020; Fricke et al., 2022 and references therein).

The reconstruction of food webs in northwestern Gondwana marine environments during the Cretaceous remains poorly understood. Most studies include a paleoecological section that discusses potential relationships between fossil organisms (invertebrates, vertebrates, and microfossils) indirectly, typically based on their associated stratigraphic co-occurrence or features such as tooth morphology and tooth marks by predators or scavengers (Cadena and Parham, 2015; Cadena, 2015; Carrillo-Briceño et al., 2019; Maxwell et al., 2019; Páramo-Fonseca et al., 2019; Noè and Gómez–Pérez, 2020; Cortés et al., 2021; Carrillo-Briceño and Cadena, 2022; Cadena and Combita-Romero, 2023). A more in-depth and recent study, though still based on indirect evidence, inferred the food web of the Barremian to Aptian marine biota preserved in the La Paja Formation (Fm.) in the Colombian Western Andes. Using quantitative ecological network analysis, it was suggested that large marine reptiles, including pliosaurs, plesiosaurs, teleosauroid crocodyliforms, and ichthyosaurs, along with lamniform sharks, were the apex predators of the La Paja Fm. paleoecosystem (Córtes and Larsson, 2023).

A similar scenario has been proposed for the Valanginian to Hauterivian intervals in northwestern Gondwana, where pliosaurs, plesiosaurs, ichthyosaurs, metriorhynchid crocodyliforms, hybodontid sharks, and

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