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Tyler Hu *

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Review

The Function and Evolution of Cranial Crests in *Dilophosaurus wetherilli*: An Analysis of Their Morphological and Behavioral Significance

Tyler Hu

Mission San Jose High School; drbball935@gmail.com

Abstract: This literature review examines the function and evolution of cranial crests in *Dilophosaurus wetherilli*, a notable theropod dinosaur from the Early Jurassic period. The review synthesizes morphological data and behavioral theories to provide a comprehensive analysis of the crests' roles in the dinosaur's life. Cranial crests, characterized by their distinctive, elongated structures extending from the skull, have intrigued paleontologists due to their unique appearance and apparent function. This review utilizes findings from recent fossil discoveries, comparative anatomy, and biomechanical studies to explore hypotheses regarding the crests' primary functions. Key theories suggest these structures may have served for display purposes, thermoregulation, or defensive mechanisms. Evidence from cranial and postcranial anatomy, as well as comparisons with extant analogs, provides insights into the possible evolutionary pressures influencing the development of crests in *Dilophosaurus wetherilli*. Additionally, the review considers the role of sexual dimorphism and social behavior in shaping these features. By integrating these diverse lines of evidence, the review aims to offer a nuanced understanding of how cranial crests might have contributed to the survival and social interactions of *Dilophosaurus*. This analysis not only advances our knowledge of *Dilophosaurus wetherilli* but also contributes to broader discussions on the evolution and functional morphology of early theropods.

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Dilophosaurus wetherilli was a carnivorous theropod from the Early Jurassic Period of the Mesozoic Era, with several key aspects that made it a successful dinosaur. It was a relatively large theropod, measuring around 6 m in length, 1.8-2.1 m in height at the hip, and 450-680 kg in weight. These dimensions allowed *Dilophosaurus* to be relatively large compared to other dinosaurs of its time, even though it was an early form of theropod. Additionally, *Dilophosaurus* wielded a slender and lightweight body, long legs for efficient running, serrated teeth for slicing flesh, and conical teeth for gripping prey.

The most notable feature of *Dilophosaurus wetherilli* is its cranial crests. Elongated and curved, they extended backward from the top of the skull, creating a distinctive, sweeping appearance. *Dilophosaurus* had two separate crests, one on each side of its head. These crests were symmetric and positioned roughly parallel to each other. The crests were made of bone and likely covered in a layer of keratin, also found in modern bird beaks and claws, which could have been colorful or patterned. However, the exact texture and coloration of the crests have yet to be discovered since keratin does not fossilize.

In this literature review, I will discuss the function and evolution of the cranial crests observed in *Dilophosaurus wetherilli*. I will begin with a thorough analysis of the functional morphology of

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Dilophosaurus' cranial region and its distinct cranial protrusions. Then, I will investigate the types of behavior that *Dilophosaurus* engaged in, such as mating rituals and displays of dominance. Finally, I will conclude with an overall determination of *Dilophosaurus wetherilli*'s cranial crests, arriving at their significance and functions in the lifestyle of *Dilophosaurus*.

Morphology of *Dilophosaurus wetherilli*

Dilophosaurus wetherilli was a unique creature, wielding traits that were not commonly seen in other dinosaurs of the Mesozoic Era. From the Early Jurassic Period, this carnivorous theropod was relatively large and developed in size, allowing it to be a formidable predator in its ecosystem. To understand the purpose of *Dilophosaurus*' cranial crests, we must first analyze the morphology of them and the types of activities they were involved in.

A study conducted by Marsh & Rowe (2020) provided a comprehensive study on the cranial anatomy of *Dilophosaurus wetherilli* and its implications for early theropod evolution. It was observed that the cranial crests were elongated, thin, and blade-like, extending along the dorsal midline of the skull. The nasal bones are fused and contribute to the formation of the crests. The skull of *Dilophosaurus* was of a slender and lightly built construction. The premaxilla and maxilla were elongated, and the overall skull morphology indicates a relatively gracile build compared to later theropods. The dentition of *Dilophosaurus* contains a series of teeth that are laterally compressed and recurved. The teeth have serrations on both the anterior and posterior edges, with the largest teeth located in the premaxilla and anterior part of the maxilla. *Dilophosaurus* jaw structure and teeth arrangement suggest a predatory diet, likely involving small to medium-sized prey. There was presence of several fenestrae, including the antorbital fenestra, which is large and triangular. This would have reduced the weight of the skull while maintaining structural integrity, a common feature in theropod dinosaurs.

Therefore, the cranial crests observed in *Dilophosaurus wetherilli* were elongated, distinct protrusions positioned along the midline of the theropod dinosaur. As it was from the Early Jurassic Period, *Dilophosaurus*' cranium was not as evolved as later carnivorous theropods. Hence, it likely preyed on smaller creatures due to its inability to handle and bite larger prey items, as well as the feeding technique of quick, snapping bites.

Behavior of *Dilophosaurus wetherilli*

As we have determined the functional morphology of *Dilophosaurus*' cranial crests and cranium, we will now delve into the behavior of this dinosaur and the potential usage of the crests. We will also discuss the evolutionary significance of the crests and other cranial distinctions, as well as establish the various functions that *Dilophosaurus*' cranial crests might have served.

A study by Lida et al. (2015) focused on the structural stability of *Sinosaurus* crests. It was discovered that the cranial crests were robust and capable of withstanding large amounts of force. However, *Sinosaurus* had more developed crests than *Dilophosaurus*, as it appeared later in the Mesozoic Era and wielded larger, more robust crests. It is likely that the thinness and fragility of *Dilophosaurus*' crests would not support the mechanical stresses associated with head-butting or other forms of physical combat. Instead, the crests can be interpreted as having been used for visual display purposes. The cranial crests likely played a role in species recognition and sexual selection, aiding in the identification and attraction of mates through visual cues.

We also explore the functional implications of cranial features in theropods. For *Dilophosaurus*. The cranial crests, while prominent, did not contribute significantly to the mechanical aspects of feeding. Early theropods like *Dilophosaurus* were positioned within the basal theropod group, showing primitive features that are retained in more derived theropods. Additionally, features such as crests and frills evolved independently in various lineages, hinted at by Padian & Horner (2011). The crests were considered to have been primarily for display, with evolutionary pressure favoring the development of such features for social or sexual signaling.

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A key insight can be found by comparing the cranial crests of *Dilophosaurus* with those of modern animals that have similar display structures, such as birds (e.g., crested pigeons) and reptiles (e.g., iguanas with display frills). The crests in *Dilophosaurus* are found to be similar in function to the display structures in these modern animals, which are used for visual signaling rather than physical combat. This comparative analysis highlights that the crests of *Dilophosaurus* would have been visible from a distance and could have served to attract mates or establish dominance within social groups. Furthermore, Gay (2001) determined that there existed variations among *Dilophosaurus* individuals that might have allowed for species recognition and social communication. In addition, by comparing the cranial protrusions of *Dilophosaurus* to those of other dinosaurs, such as *Ceratopsidae*, *Pterosauria*, and other theropods, as observed by Hone et al. (2012), Brusatte et al. (2010), Sampson & Witmer (2007), Smith et al. (2007), and Zhao & Currie (1993), similar display structures were present throughout the reptilian lineage, thus determining that the probable primary function of *Dilophosaurus*' crests was display.

The cranial features of *Dilophosaurus* can be compared with those of other early theropods and later theropods. Later theropods had more specialized structures for thermoregulation. For example, *Spinosaurus aegyptiacus* and *Therizinosaurus* were noted to have more extensive cranial fenestrae and larger surface areas for heat exchange, reflecting an evolutionary trend towards more effective thermoregulation. While early theropods like *Dilophosaurus wetherilli* had some adaptations for thermoregulation, these were less pronounced than those seen in later theropod species. Considering that numerous fossil findings have determined some of *Dilophosaurus*' environments to be desert and semi-arid, rivers and floodplains, and vegetated regions, it is likely that thermoregulation would have proven useful in these areas.

Overall, the cranial crests of *Dilophosaurus wetherilli* served a primary function of display, allowing for a mechanism of visual signaling and establishing dominance within populations. Additionally, they likely played a role in thermoregulation, enabling *Dilophosaurus* to dissipate heat to a certain extent. Although these functions were primitive forms, the development of cranial crests observed in *Dilophosaurus* and other similar theropods had a massive impact on the evolution of the dinosaurs.

Conclusions

Limitations on Existing Research

Existing research on the cranial crests of *Dilophosaurus wetherilli* is limited by several factors. First, the incomplete fossil record and lack of soft tissue preservation make it challenging to reconstruct the exact appearance and function of the crests, as their coloration and texture remain speculative. Studies on cranial morphology and biomechanical performance rely on assumptions about the structures' soft tissue, which could affect the accuracy of their findings. Furthermore, while biomechanical analyses suggest that the crests were not suited for physical combat, the potential for these structures to have served multiple functions, such as display and thermoregulation, is difficult to fully substantiate without more direct evidence. Behavioral interpretations based on comparisons with modern animals may not fully account for the unique ecological and social context of *Dilophosaurus*. Overall, these limitations highlight the need for more comprehensive data and advanced modeling to better understand the functional and evolutionary significance of cranial crests in this early theropod.

Takeaway

The cranial crests of *Dilophosaurus wetherilli*, a relatively large Early Jurassic theropod, were primarily used for display rather than physical combat. These elongated, symmetric crests likely served in visual signaling for species recognition and mating, similar to modern display structures in birds and reptiles. Despite their prominent appearance, the crests' slender build suggests they were not suited for head-butting or other forms of physical confrontation. Additionally, the crests might

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have had a secondary role in thermoregulation, helping the dinosaur dissipate heat in its diverse environments. This dual function highlights the crests' evolutionary significance, contributing to social behavior and possibly aiding in temperature regulation.

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