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Spinosaurus mirabilis: Scimitar-Crested Spinosaurid Unearthed in the Central Sahara Reshapes the Evolution of Semiaquatic Dinosaurs

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Deep within the hyper-arid sand seas of central Niger, an international paleontological expedition led by University of Chicago evolutionary biologist Paul C. Sereno has unearthed the fossilized skull, axial skeleton, and appendicular elements of a remarkable new predatory dinosaur: Spinosaurus mirabilis [1, 2] . Described in the journal Science , the 95-million-year-old theropod from the Cenomanian-age Farak Formation represents the first well-substantiated new species of the genus Spinosaurus named in more than a century [1, 2] . Reaching approximately 12 meters (nearly 40 feet) in body length and weighing between 5 and 7 metric tons, Spinosaurus mirabilis is distinguished by an extraordinary, scimitar-shaped midline cranial crest that rose high above its orbits and was sheathed in living keratin -- an anatomical structure that combined visual display with a specialized inland piscivorous lifestyle [1, 3] .

Cranial Osteology: The Vascularized Scimitar Crest and Interdigitating Rostrum

The species epithet mirabilis -- Latin for "astonishing" -- refers directly to the animal's hypertrophied naso-frontal crest [1, 2] . While previously known specimens of Spinosaurus aegyptiacus from Egypt and Morocco's Kem Kem Group possess a relatively low, fluted nasal ridge between the eyes, the cranial crest of S. mirabilis projects dorsally as a tall, laterally compressed bony blade curving backward like a scimitar [1, 3] . High-resolution computed tomography (CT) scans of the holotype cranium reveal an intricate internal network of neurovascular canals alongside deep external longitudinal grooves and foramina [1] .

In extant archosaurs -- such as cassowaries (Casuarius) and helmeted guineafowl (Numida meleagris) -- this osteological signature indicates that the underlying bone core was encased in an even taller, brightly pigmented keratinous sheath supplied by a dense vascular bed [1, 2] . Because the thin, pneumatic crest bone lacked the cross-sectional modulus to withstand high mechanical bending loads during prey dispatch, Sereno and colleagues conclude that the scimitar crest functioned primarily as a socio-sexual visual signal visible above shallow water and riparian vegetation, potentially augmented by thermal regulation across its vascularized surface [1, 3] .

Anterior to the crest, the elongated, crocodile-like snout (rostrum) exhibits classic spinosaurine adaptations for capturing slippery aquatic prey. The premaxillary and dentary jaws form a terminal rosette of conical, unserrated teeth that interlocked (interdigitated) when the jaws closed, creating a vertebrate fish -trap capable of impaling large lungfish, bichirs, and coelacanths [1, 4] . Simultaneously, neurovascular pits peppering the tip of the snout connected to

trigeminal nerve branches, providing mechanoreceptive pressure sensitivity in turbid freshwater currents [1, 4] .

Anatomical & Paleoecological Telemetry: Spinosaurus mirabilis vs. Spinosaurus aegyptiacus

Comparing the inland Niger holotype of Spinosaurus mirabilis against coastal North African Spinosaurus aegyptiacus and earlier baryonychine spinosaurids (such as Suchomimus tenerensis from the Aptian Elrhaz Formation of Niger) clarifies how spinosaurids radiated across Cretaceous Gondwana [1, 4, 5] .

| Trait / Parameter | | Spinosaurus mirabilis (Niger) | | Spinosaurus aegyptiacus (Morocco / Egypt) | | Evolutionary & Ecological Significance |

| Stratigraphic Horizon & Age | | Farak Formation (Jenguebi, Niger); ~95 Ma (Cenomanian) | | Kem Kem Group & Bahariya Formation; ~99-94 Ma (Cenomanian) | | Demonstrates contemporaneous inland and coastal spinosaurine lineages across North Africa [1, 3] . |

| Adult Body Length & Mass | | ~12 m (39 ft); 5-7 metric tons | | ~14-15 m (46-49 ft); 6.5-8 metric tons | | Slightly more gracile axial frame adapted to inland riverine channels [1, 2] . |

| Midline Cranial Crest | | Tall, scimitar-shaped naso-frontal blade with keratinous sheath | | Low, narrower nasal ridge anterior to the orbits | | Indicates strong species-recognition and sexual-selection divergence within Spinosaurus [1, 2] . |

| Dentition & Rostral Mechanics | | Conical, fluted, interdigitating piscivorous teeth | | Conical, straight crowns in expanded terminal rosette | | Specialized for seizing large-bodied freshwater fishes rather than tearing terrestrial flesh [1, 4] . |

| Depositional Paleoenvironment | | Inland alluvial plains and braided freshwater rivers (>600 km from sea) | | Nearshore deltas, tidal flats, and brackish estuarine channels | | Confirms spinosaurines were not restricted to marine coastlines or deep coastal lagoons [1, 3] . |

Inland Fluvial Taphonomy and the "Wading Heron" vs. Diving Pursuit Debate

Few questions in vertebrate paleontology have generated more intense biomechanical debate over the past decade than how Spinosaurus moved and hunted in water [4, 5, 6] . One hypothesis -- supported by high compact bone density (osteosclerosis) in the femora and ribs and a tall, flexible caudal fin reconstructed from Kem Kem tail vertebrae -- models Spinosaurus as a subaqueous pursuit predator that propelled itself completely underwater [4, 6] . A competing hydrodynamic model -- citing high center-of-buoyancy instability, massive pneumatic dorsal spines, and high drag coefficients -- argues that Spinosaurus was primarily a shoreline and shallow-water wader ("hell heron") that ambushed fish from above or at the water surface [1, 5] .

The taphonomic context of Spinosaurus mirabilis provides crucial paleoenvironmental constraints on this debate [1, 3] . The Jenguebi quarry in the Farak Formation preserves coarse-grained fluvial sandstones, overbank mudstones, and braided river

channels deposited more than 600 kilometers inland from the nearest Cenomanian Tethyan seaway [1, 2] . Rather than co-occurring with marine sawfish and open-water sharks typical of coastal estuaries, S. mirabilis was buried alongside strictly continental dinosaurs and freshwater fauna in shallow, seasonally fluctuating river corridors [1, 3] .

This inland riverine setting demonstrates that spinosaurines were ecological generalists across freshwater and brackish habitats. Even with dense limb bones that functioned as ballast to stabilize the animal against river currents, Spinosaurus mirabilis navigated shallow, tree-lined continental waterways where wading and plunge-striking were essential foraging modes [1, 5] .

Stepwise Radiation of Spinosauridae Across Cretaceous Gondwana

Phylogenetic analysis incorporated into the Science monograph resolves a three-stage evolutionary progression across Spinosauridae [1] . During the Early Cretaceous (Barremian-Aptian, ~125-112 million years ago), ancestral baryonychines such as Baryonyx in Europe and Suchomimus in Niger evolved elongated snouts and enlarged manual claws while retaining moderately long hindlimbs and low dorsal neural spines [1, 5] . By the Albian-Cenomanian transition (~100-95 million years ago), Gondwanan spinosaurines underwent rapid cranial and postcranial specialization: the external nostrils (nares) retracted posteriorly up the snout, the hindlimbs shortened relative to the trunk, the dorsal neural spines elongated into a towering sail, and cranial crests diversified rapidly [1, 4] .

The discovery of Spinosaurus mirabilis proves that late-stage spinosaurines did not consist of a single pan-African species (S. aegyptiacus) patrolling the Tethyan coast [1, 2] . Instead, distinct species occupied partitioned ecological niches from coastal mangroves to deep continental river basins -- right up until late Cenomanian sea-level transgressions and climatic shifts extinguished the spinosaurid clade around 94 million years ago [1, 3] .

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