

An Overview of Nanotyrannus: A Distinct Tyrannosaur at the Close of the Cretaceous

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Life reconstruction of Nanotyrannus lancensis, based on NCSM 40000. Photo credit: Connor Ashbridge

The taxonomic identity of *Nanotyrannus* has long been one of the most controversial topics in dinosaur paleontology. For decades, paleontologists debated whether the small-bodied tyrannosaur fossils from the Hell Creek Formation represented a distinct genus or simply juvenile individuals of *Tyrannosaurus rex* (Carr, 2020; Larson, 2013). The issue centered on whether anatomical differences such as skull shape, tooth count, and limb proportions reflected immaturity or true species-level variation. A groundbreaking study by Lindsay E. Zanno and James G. Napoli (2025) titled “*Nanotyrannus and Tyrannosaurus coexisted at the close of the Cretaceous*” has now provided compelling evidence that *Nanotyrannus* was indeed a valid, distinct genus that lived contemporaneously with *T. rex* at the end of the Maastrichtian Stage, roughly 66 million years ago.

Central to Zanno and Napoli’s (2025) study is the exceptionally preserved tyrannosaur skeleton from the “Dueling Dinosaurs” fossil assemblage (NCSM 40000) discovered in the Hell Creek Formation of Montana. Histological analysis of the bone microstructure revealed that the individual had reached skeletal maturity, estimated at around 20 years old, despite being dramatically smaller than an adult *T. rex*.

The fusion of major skeletal elements, cessation of growth lines, and cortical bone structure confirmed that this animal was not a subadult but a fully mature individual (Zanno & Napoli, 2025). Additionally, the specimen displays anatomical features inconsistent with any known juvenile stage of *T. rex*, such as a higher maxillary tooth count, elongated and more robust forelimbs, a reduced number of tail vertebrae, and a distinct cranial sinus pattern (Napoli et al., 2024). These fixed traits, which do not vary through growth in other tyrannosaurids, argue strongly that *Nanotyrannus* was not part of *T. rex* ontogeny.

The skeletal morphology of *Nanotyrannus* suggests a markedly different lifestyle and ecological role compared to *T. rex*. Zanno and Napoli (2025) describe the taxon as a lightly built, cursorial predator with relatively long limbs and a more gracile skull. Its estimated adult body length was approximately 6–7 meters, about one-third that of a large *T. rex*. Its forelimbs were proportionally longer, indicating greater reach and grasping ability (Persons & Currie, 2016). The dental arrangement, with more numerous but smaller teeth, suggests a quicker feeding strike suited to softer prey rather than the bone-crushing capabilities of *T. rex* (Snively et al., 2019). These morphological differences imply that *Nanotyrannus* filled a distinct predatory niche, preying upon mid-sized ornithischians or juvenile ceratopsians rather than the colossal prey targeted by *T. rex*.

Taxonomically, Zanno and Napoli (2025) recognized *Nanotyrannus lancensis* as a valid species and introduced a second, *Nanotyrannus lethaeus*, based on additional material previously attributed to juvenile *T. rex* specimens such as the well-known “Jane” skeleton (BMRP 2002.4.1).



Life reconstruction of Nanotyrannus lethaeus. Photo credit: Connor Ashbridge

Phylogenetic analysis positioned *Nanotyrannus* outside of the derived *Tyrannosaurus* lineage, suggesting it represents a more basal branch within Tyrannosauridae or possibly a separate sister clade. This placement clarifies why its morphology diverges so markedly from *T. rex* even at full maturity. The recognition of *Nanotyrannus* as distinct carries profound implications. Numerous specimens long used in *T. rex* growth studies, biomechanical analyses, and ontogenetic reconstructions likely belong to *Nanotyrannus*, requiring reevaluation of many prior conclusions (Horner & Goodwin, 2006; Woodward et al., 2020).

One of the most significant conclusions from the 2025 study is that *Nanotyrannus* and *Tyrannosaurus rex* coexisted within the same late Maastrichtian ecosystems. Both species are represented within the Hell Creek Formation and adjacent strata, demonstrating sympatry in both time and space (Zanno & Napoli, 2025). This overturns the long-held assumption that *T. rex* reigned as the sole apex predator of its ecosystem. Instead, the coexistence of two large tyrannosaur genera suggests complex predator guilds and niche partitioning during the final million years of the Cretaceous.

The lighter, faster *Nanotyrannus* likely targeted smaller, quicker prey, whereas *T. rex* dominated larger, more heavily armored herbivores. This scenario paints a far richer ecological picture than the simplified notion of a monotypic tyrannosaur ecosystem.

The study also impacts our understanding of tyrannosaur growth rates and life history. If the smaller “juvenile” specimens once thought to represent adolescent *T. rex* are actually adult *Nanotyrannus*, the extreme growth rates and short maturation times previously ascribed to *T. rex* must be revised (Zanno & Napoli, 2025). Likewise, biomechanical reconstructions that used these smaller specimens to infer adolescent locomotion or bite-force scaling will need to be reconsidered in light of their new classification. This reinterpretation effectively rewrites the developmental narrative of the most famous carnivorous dinosaur.

From an ecological and evolutionary standpoint, the confirmation of *Nanotyrannus* as a valid taxon enhances our picture of terminal Cretaceous ecosystems. Rather than indicating a decline in dinosaur diversity leading up to the Cretaceous–Paleogene extinction event, this finding supports a model of sustained ecological complexity and predator diversity up to the very end (Zanno & Napoli, 2025). The coexistence of two tyrannosaur species with divergent morphologies demonstrates that even apex predatory niches were more nuanced than previously understood. This suggests that dinosaur ecosystems were dynamic and diverse right up until their abrupt extinction. The fact that dinosaurs continued to thrive and were still extremely abundant, right up until the K–Pg extinction event has been further reinforced by the study by Flynn, A. G. et al. 2025, Late-surviving New Mexican dinosaurs illuminate high end-Cretaceous diversity and provinciality. *Science*, 390, 400–404. This illustrates the success and diversity of dinosaurs, even in their last days.

Nevertheless, open questions remain. The total number of *Nanotyrannus* specimens is still limited, and further discoveries are needed to clarify the genus’s full range of variation. Future research will aim to define its growth trajectory, population structure, and prey preferences, as well as to reassess potential interactions between *Nanotyrannus* and *T. rex*.

There is also interest in tracing the evolutionary origins of the *Nanotyrannus* lineage, possibly arising from earlier, smaller-bodied tyrannosauroids in North America (Zanno & Napoli, 2025). Continued study of histology, biomechanics, and functional anatomy will further illuminate how two closely related predators coexisted at the twilight of the dinosaur era.

In summary, the 2025 study by Zanno and Napoli represents a major paradigm shift in tyrannosaur research. *Nanotyrannus* emerges not as a juvenile impostor but as a valid, mature species that shared the late Maastrichtian landscape with *T. rex*. This recognition forces a reevaluation of tyrannosaur growth models, ecological roles, and late Cretaceous predator diversity. Histological analysis of the “Dueling Dinosaurs” tyrannosaur demonstrates that the individual had reached approximately 20 years of age and displays mature bone microstructure, including tightly spaced growth lines and reduced vascularity, indicating it was at or near full somatic maturity (Zanno & Napoli, 2025). This adult age estimate directly contradicts the long-standing interpretation that *Nanotyrannus* represents merely a juvenile growth stage of *Tyrannosaurus rex*, since a 20-year-old *T. rex* would already be near maximum adult size rather than the markedly smaller, gracile condition seen in this specimen (Zanno & Napoli, 2025). In addition, the presence of a prominent pneumatic foramen on the quadratojugal, a feature repeatedly documented in the classic *Nanotyrannus* material is not present in known ontogenetic sequences of *T. rex* skulls, and its consistency in putative *Nanotyrannus* specimens supports taxonomic separation rather than growth-related variation (Witmer & Ridgely, 2010; Carr, 2017). Together, the adult age of the specimen and the distinct quadratojugal pneumatic architecture form a combined anatomical and developmental dataset that overrides the ontogenetic hypothesis and instead supports *Nanotyrannus* as a valid, small-bodied tyrannosaurine coexisting alongside *T. rex* (Zanno & Napoli, 2025).

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