

# Tyrannosaurus remains hint at two possible species distinct from T. rex

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A new analysis of Tyrannosaurus skeletal remains reveals physical differences in the femur, other bones and dental structures across specimens that could suggest Tyrannosaurus rex specimens need to be re-categorized into three distinct groups or species, reports a study published in *Evolutionary Biology*.

Tyrannosaurus rex is the only recognized [species](#) of the group of dinosaurs, or genus, Tyrannosaurus to date. Previous research has acknowledged variation across Tyrannosaurus [skeletal remains](#) in the [femur](#) (thighbone) and specimens with either one or two slender incisor teeth on each side of front ends of the jaw.

Gregory Paul and colleagues analyzed the bones and dental remains of 37 Tyrannosaurus specimens. The authors compared the robustness of the femur in 24 of the specimens, a measure calculated from the length and circumference that gives an indication of the strength of the bone. They also measured the diameter of the base of teeth or space in the gums to assess if specimens had one or two slender incisiform teeth.

The authors observed that the femur varied across specimens, some with more robust femurs and others with more gracile femurs. The authors found there were two times more robust femurs than gracile ones across specimens, which suggests that this is not a difference caused by sex, which would likely result in a more even split. The authors also suggest that the variation in femurs is not related to growth of the specimen as robust femurs were found in some juvenile specimens two thirds the size of an adult and gracile femurs were found in some specimens that were full adult size.

Dental structure also varied across specimens, although those with both femur measurements and dental remains was low (12 specimens). Specimens with one incisor tooth were correlated with often having higher femur gracility.

Of the Tyrannosaurus specimens, 28 could be identified in distinct layers of [sediment](#) (stratigraphy) at the Lancian upper Masstrichtian formations in North America (estimated to be from between 67.5 to 66 million years ago). The authors compared Tyrannosaurus specimens with other theropod species found in lower layers of sediment.

Only robust Tyrannosaurus femurs were found in the lower layer of sediment (six femurs). The variation of femur robustness in the lower layer was not different to that of other theropod species, which indicates that likely only one species of Tyrannosaurus existed at this point. Only one gracile Tyrannosaurus femur was identified in the middle layer with five other gracile femurs in the upper layer, alongside other robust femurs. The variation in Tyrannosaurus femur robustness in the top layer of the sediments was higher than what was observed in some earlier theropod specimens. This suggests that the Tyrannosaurus specimens found at higher layers of sediment physically developed into more distinct forms compared to specimens from lower layers, and other dinosaur species.

Gregory Paul, lead author, said: "We found that the changes in Tyrannosaurus femurs are likely not related to the sex or age of the specimen. We propose that the changes in the femur may have evolved over time from a common ancestor who displayed more robust femurs to become more gracile in later species. The differences in femur robustness across layers of sediment may be considered distinct enough that the specimens could potentially be considered separate species."

The authors nominate two potential new species of Tyrannosaurus based on their analysis. The first, *Tyrannosaurus imperator* (tyrant lizard emperor), relates to specimens found at the lower and middle layers of sediment, characterized with more robust femurs and usually two incisor teeth. The authors argue these features have been retained from earlier ancestors (tyrannosaurids). The second, *Tyrannosaurus regina* (tyrant

lizard queen), is linked to specimens from the upper and possibly middle layers of sediment, characterized with slenderer femurs and one incisor tooth. The recognized species *Tyrannosaurus rex* (tyrant lizard king) was identified in the upper and possibly middle layer of sediment with specimens classed as retaining more robust femurs while having only one incisor tooth. Some specimens could not be identified based on their remains so were not assigned to a species.

The authors acknowledge that they cannot rule out that the observed variation is due to extreme individual differences, or atypical sexual dimorphism, rather than separate groups, and they also caution that the location within sediment layers is not known for some specimens. The authors discuss the difficulties of assigning fossil vertebrates to a potential new species.

The authors conclude that the physical variation found in *Tyrannosaurus* [specimens](#) combined with their stratigraphy are indicative of three potential groups that could be nominated as two new species, *T. imperator* and *T. regina*, alongside the only recognized species to date, *T. rex*.

**More information:** Gregory Paul, The Tyrant Lizard King, Queen and Emperor: Multiple Lines of Morphological and Stratigraphic Evidence Support Subtle Evolution and Probable Speciation Within the North American Genus *Tyrannosaurus*, *Evolutionary Biology* (2022). [DOI: 10.1007/s11692-022-09561-5](https://doi.org/10.1007/s11692-022-09561-5). [link.springer.com/article/10.1007/s11692-022-09561-5](https://link.springer.com/article/10.1007/s11692-022-09561-5)

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