

## Evolution & Behavior

# *T. rex* Growing Pains: The King of Dinosaurs was First a Tyrannical Teenager

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### ABSTRACT

*Studying the bone microstructure of the skeletons of two medium-sized Tyrannosaurus rex, we investigated their early life. We discovered that they were teenagers, rather than a smaller 'Nanotyrannus' species. Additionally, we found that T. rex adjusted annual growth based on resource abundance; it exploited carnivore niches at the exclusion of other species.*



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Without a doubt, *Tyrannosaurus rex* is the most famous dinosaur in the world. Its adult body length of 40 feet, 5-foot-long head, and bone-crushing teeth are the stuff of legend, but we know surprisingly little about its childhood. What did it look like then? How fast was it? How did it eat before it was big enough to crush bones? In the early 2000s, the fossil skeletons of two (comparatively) small *T. rex* were collected from the badlands of Montana, by the Burpee Museum of Natural History. Nicknamed “Jane” and “Petey”, the tyrannosaurs would have been slightly taller than a draft horse and twice as long. Their bones have been intensively studied to understand every aspect of bone shape change *T. rex*

went through as it grew up. Bone and skull shape provide clues to behavior and diet, but even more, information is locked away inside the bone itself. We know that the microscopic structures of bones in living animals record annual growth, maturity status, and even absolute age. Because of their relatively small size, such information within the bones of Jane and Petey is critical for a better understanding of *T. rex*'s early life history. So, we set out to see what bone tissue microstructure could reveal about the life and death of immature *T. rex*.

To study bone microstructure, we had to remove a small piece from the leg bones of each tyrannosaur.

We then molded and made replicas of the pieces, so the overall shape of the original bone remained intact. Next, we embedded the fossil pieces in a plastic resin that hardened around them. This resin gave them strength and support so that we could cut a thin slice from each embedded piece. We then glued the slices of bone surrounded by plastic to large transparent slides. Then, we hand-polished the glued slices on a jeweler's wheel using progressively finer grit sandpapers, until the slice was so thin that light passed through it. At this point, we could view the thin section slides with a polarizing light microscope. In doing so, the fossilized bone tissue microstructures were visible for interpretation.

By looking at the bone mineral organization and comparing it to those of animals living today, we found that Jane and Petey were growing as fast as modern-day mammals and birds. And bones, much like trees, form annual growth rings that can be counted to age an animal. By doing this, we found that Jane was 13 years old when it died, while Petey was 15. We found no evidence of slow bone growth that would suggest that Jane and Petey were nearing adult size. They were still-growing teenagers when they died.

However, some scientists argue that Jane and Petey are not *Tyrannosaurus rex* at all, but individuals belonging to a smaller, "pygmy" relative, '*Nanotyrannus*'. The genus '*Nanotyrannus*' was named in 1988 based on an isolated skull, and Jane's skull resembles it very closely in size and shape. In the 1990s and 2000s, researchers published compelling arguments that the isolated skull

assigned to '*Nanotyrannus*' is instead from a juvenile *T. rex*. Still, supporters for a '*Nanotyrannus*' that lived alongside the larger *Tyrannosaurus* persist to this day.

Since arguments favoring the validity of '*Nanotyrannus*' have been mainly based on skull and bone shape, the bone tissue assessment of Jane and Petey allows us to test the '*Nanotyrannus*' hypothesis independent of bone shape. Jane's and Petey's bone microstructure reveals they would have grown much more had they lived. Also, *Tyrannosaurus rex* is the only large tyrannosaur known from Montana. Thus, the most likely explanation is that Jane, Petey, and the isolated skull were juvenile *T. rex*.

The tyrant king probably underwent drastic changes as it grew larger, in the process dominating several carnivore niches, or roles, within the food web. Juveniles such as Jane and Petey were fast, fleet-footed, and had knife-like teeth for cutting, whereas adults were lumbering bone crushers. Not only that, but the spacing between annual growth rings suggests that if the food was scarce during a particular year, *T. rex* just didn't grow as much. And if the food was plentiful, it grew a lot. So, *T. rex* could remain in a certain size niche for a while if the food wasn't abundant enough for it to grow larger. Our results suggest *T. rex* assumed the crown of tyrant king long before it reached adult size. Still, only future bone tissue examinations of additional immature *T. rex* individuals will allow us to further refine our interpretations.