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CARTHAGE COLLEGE

New dinosaur species sheds light on evolution, provides facial makeover for tyrannosaurs

HIGHLIGHTS

- Study shows the new relative of *T. rex* is the geologically youngest species of the lineage called *Daspletosaurus*, the 'frightful lizards'.
- The new species, *Daspletosaurus horneri*, evolved directly from its geologically older relative, *D. torosus*.
- The excellently preserved fossils reveal that the face of tyrannosaurs was covered by a mask of large flat scales, with smaller patches of armor-like skin and sheaths of horn.
- The arrangement of scales suggests *D. horneri* had a crocodile-like pressure sensing snout.

KENOSHA, Wis. – An investigation by a team of scientists from Australia, Louisiana, Montana, New Mexico, and Wisconsin has identified and named a new species of the tyrannosaur clan: *Daspletosaurus horneri* — "Horner's Frightful Lizard".

The species is named for renowned dinosaur paleontologist John "Jack" R. Horner, formerly curator at the Museum of the Rockies (MOR) in Bozeman, Montana. The tyrannosaur's name honors his discoveries of numerous dinosaur fossils and his mentorship of so many students thatlaunched them to accomplished scientific careers. The type (name-bearing) specimens are stored in the research collections of the MOR.

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The research is led by Thomas Carr, a professor in Carthage College's Biology Department and an expert on the evolution and growth of *Tyrannosaurus rex* and its closest relatives, collectively called tyrannosaurs.

The fossil resources of Montana, where the new tyrannosaur was found, are central to studies of dinosaur evolution, explains Professor David Varricchio of Montana State University: "These specimens emphasize the excellent record of dinosaurs to be found in Montana. They highlight

both the quality of the specimens, the preservation revealing the details of how these giant carnivores once looked in life, as well as the overall collection of specimens that provides insight into the evolution of the tyrannosaur group. Montana remains a wonderful place to explore the Cretaceous."

In addition to adding a new species to the tyrannosaur family tree, the team's research provides new information about the mode of evolution and life appearance of tyrannosaurs — specifically the face. This latest study, published today in Nature Publishing Group's Scientific Reports, found evidence for a rare, nonbranching type of evolution in tyrannosaurs and that tyrannosaurs had scaly, lipless faces and a highly touch-sensitive snout.

Carr said: "*Daspletosaurus horneri* was the youngest, and last, of its lineage that lived after its closest relative, *D. torosus*, which is found in Alberta, Canada. The close evolutionary relationship between the species taken with their geographic proximity and their sequential occurrence suggests that together they represent a single lineage that changed over geological time, where *D. torosus* has morphed into *D. horneri*."

Jason Moore, a professor in the Honors College at the University of New Mexico, elaborated: "One of the difficulties in demonstrating anagenetic change, as we suggest occurred in the *Daspletosaurus* lineage, is establishing that the different species in question don't overlap in time. The new radiometric dates we measured from the Two Medicine Formation not only help support that *D. torosus* and *D. horneri* did not live at the same time, but also help us refine the timeline of environmental and ecological changes recorded by the Two Medicine Formation."

Eric Roberts, a professor in geosciences with the College of Science and Engineering at James Cook University, explained: "Advances in radioisotopic dating of sedimentary deposits is key to testing this and many other evolutionary and ecological questions about dinosaurs and other ancient organisms. New age dates presented in this study are just the tip of the iceberg. Ongoing work in this field will provide unprecedented improvements in the dating of Late Cretaceous dinosaurs from western North America over the next few years."

Continued Carr, "When we consider the geological ages of the two species, the evolution of *Daspletosaurus* gives us an indication of how slowly evolution can act on large dinosaurs, which in this case happened over a span of 2.3 million years.

"This type of speciation is called anagenesis, which is different from the more common type called cladogensis, where an ancestral species splits into two or more descendant species. Although uncommon in many evolutionary studies, anagenesis has been reported in some duck-billed dinosaurs and horned dinosaurs. *Daspletosaurus* and these other dinosaurs point the way forward in picking out the evidence for anagenesis in the fossil record."

The team's work literally changes the face of tyrannosaurs, which they found was covered by a lipless "mask" of large flat scales and extensive patches of armor-like skin. This conclusion results from comparison of tyrannosaur skulls with those of crocodilians, birds, and mammals, and earlier work by other researchers who had matched bone texture with different types of skin covering.

Jayc Sedlmayr, a professor at the Louisiana State University Health Sciences Center New Orleans, explained, "Much of our research went beyond field paleontology: it was generated from lab based comparative anatomy, where you get arms deep in "blood and guts" dissecting birds as living dinosaurs and crocodilians as their closest living relatives and based on the similarities of

the facial nerves and arteries we found in those same groups that left a trace on the bones, we were able to then reconstruct them in the new tyrannosaur species."

"It turns out that tyrannosaurs are identical to crocodilians in that the bones of their snouts and jaws are rough, except for a narrow band of smooth bone along the tooth row. In crocodilians, the rough texture occurs deep to large flat scales; given the identical texture, tyrannosaurs had the same covering," explained Carr. "We did not find any evidence for lips in tyrannosaurs: the rough texture covered by scales extends nearly to the tooth row, providing no space for lips.

"However, we did find evidence for other types of skin on the face, including areas of extremely coarse bone that supported armor-like skin on the snout and on the sides of the lower jaws. The armor-like skin would have protected tyrannosaurs from abrasions, perhaps sustained when hunting and feeding."

"Strikingly, the large horn behind the eye is elevated beyond the side of the head, indicating a covering of keratin, the hard and shiny material that makes up human fingernails," he continued.

In crocodilians and tyrannosaurs, the snout and jaws are penetrated by numerous small nerve openings, allowing hundreds of branches of the trigeminal nerve to innervate the skin, producing a sensitivity that, in crocodilians, is as sensitive as human fingertips. "Given that the foramina are identical in tyrannosaurs indicates that they had super-sensitive skin as well," explained Carr.

This sensitivity is part of a bigger evolutionary story, explained Sedlmayr. "Our findings of a complex sensory web is especially interesting because it is derived from the trigeminal nerve, which has an extraordinary evolutionary history of developing into wildly different 'sixth senses' in different vertebrates, such as sensing magnetic fields for bird migration, electroreception for predation in the platypus bill or the whisker pits of dolphins, sensing infrared in pit vipers to identify prey, guiding movements in mammals through the use of whiskers, sensing vibrations through the water by alligators, and turning the elephant trunk into a sensitive 'hand' similar to what has been done to the entire face of tyrannosaurs."

View the full paper at Scientific Reports

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