Paleontologists link leg length to running ability in bipedal carnivorous dinosaurs

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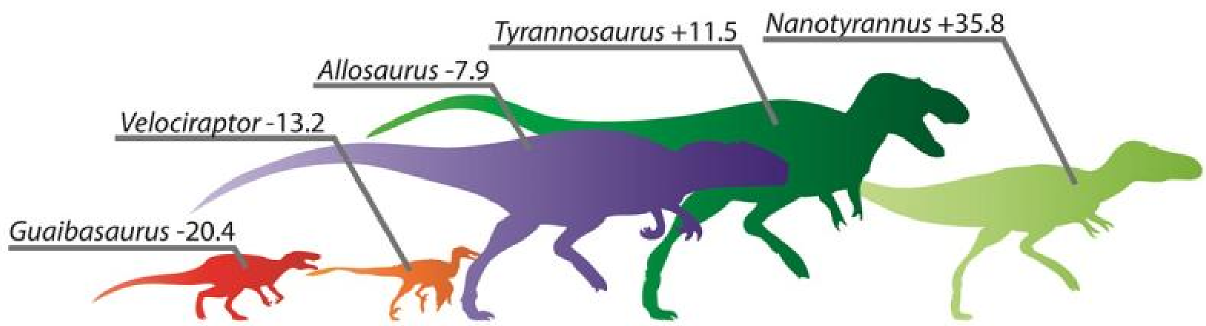

Calculated speed adaptation scores for various dinosaurs. (From left) Guaibasaurus was an early dinosaur with a low score typical of primitive forms; despite its pop culture status, Velociraptor is revealed to be among the least swift of the carnivorous dinosaurs; the Jurassic predator Allosaurus was large and moderately adapted for speed; despite its bulk, Tyrannosaurus scores high on the speed charts; the controversial species Nanotyrannus was the bipedal dino best adapted for speed—the Usain Bolt of its era.

A new study in leg length among carnivorous dinosaurs has yielded a formula to identify adaptations for speed. The theory is simple: to run faster, dinosaurs evolved longer legs.

"How fast a predator can run is obviously important," says University of Alberta paleontologist Scott Persons, who led the study as part of his doctoral research. "Speed determines what prey you can catch, how you hunt it and the sort of environment that you are most successful in. That's true for modern carnivores, and must have been true for dinosaurs ."

The relationship between speed and leg length is a general anatomical rule observable today in living animals. For example, cheetahs are faster and have proportionately longer legs than lions, which are faster and have proportionately longer legs than hyenas.

Specifically, fast-running animals have proportionately longer lower legs—that is, their legs are lengthened from the knee down. As a rule, the longer the lower leg is in comparison with the upper leg, the faster the animal is.

However, while allowing faster speeds, long legs are also relatively weaker and less suited to supporting great weight. "Over evolution, you have these two conflicting forces: the need for speed and the need for weight support," explains Persons. "You cannot just compare little dinosaurs to big dinosaurs; you have to factor out the influence of body mass."

To do that, Persons and his supervisor Philip Currie (biological sciences) spent years collecting leg measurements from more than 50 species of predatory dinosaurs from museum collections all over the world, ranging in size from smaller than a chicken to longer than a school bus.

With this data, Persons developed an equation to determine a dinosaur's "cursorial limb proportion score," a measure of how strongly adapted for speed a particular dinosaur species was.

Scoring up

The results are both interesting and surprising. "The early ancestral dinosaurs, the primitive prototypes, just weren't built for speed," says Persons. "In general, it seems that carnivorous dinosaurs got faster over time—although there were exceptions."

For one example, despite its Hollywood depiction as a lightning-fast predator and its name—which literally means "fast plunderer"—Velociraptor and its close relatives were found to be among the least adapted for fast running. "Velociraptor is relatively small, so it looks fast," explains Persons. "But compare it to other small dinosaurs or calculate its limb score, and it becomes clear that raptors do not deserve their reputation as particularly speedy dinosaur predators. In fact, they are among the least adapted for running."

Persons even has a theory for why. "Raptors share a close ancestor with birds," he says, "an ancestor that was doing things like climbing trees and gliding on primitive wings. If you're doing those sorts of things, you don't need to adapt for fast running on the ground."

When it comes to adaptations for speed, the five-metre-long beast called Nanotyrannus leads the pack, leaving the respectably high-scoring Tyrannosaurus rex and even known juveniles of other tyrannosaur species in the dust. Nanotyrannus' status as a distinct species has been debated for years among scientists due to its strong resemblance to a juvenile T. rex, but its uniquely elongated limbs now indicate that Nanotyrannus really was its own distinct species.

"In terms of Cretaceous ecology," Persons says, "T. rex was the lion and Nanotyrannus was the cheetah. As far as I'm concerned, it was the scariest dinosaur. Sure, it might take it four to five bites to eat you, whereas T. rex could do it in just one or two, but eaten is eaten—and no dinosaur was better adapted to chase you down."

The new research on dinosaur limb proportions was published this week in the peer-reviewed journal *Scientific Reports*.

Provided by University of Alberta