For some feathered dinosaurs, bigger not necessarily better

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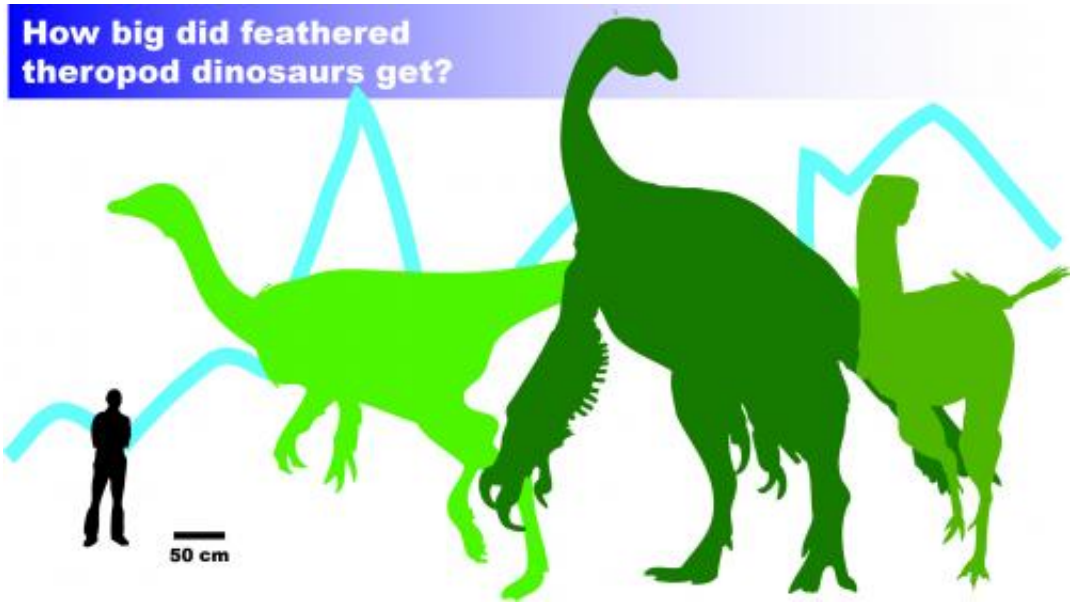

This scale illustration shows size of feathered theropod herbivores compared to humans. Credit: Lindsay Zanno, NC State and NC Museum of Natural Sciences

Every kid knows that giant carnivores like *Tyrannosaurus rex* dominated the Cretaceous period, but they weren't the only big guys in town. Giant plant-eating theropods – close relatives of both *T. rex* and today's birds – also lived and thrived alongside their meat-eating cousins. Now researchers have started looking at why dinosaurs that abandoned meat in favor of vegetarian diets got so big, and their results may call conventional wisdom about plant-eaters and body size into question.

Scientists have theorized that bigger was better when it came to plant eaters, because larger digestive tracts would allow dinosaurs to maximize the nutrition they could extract from high-fiber, low-calorie food. Therefore, natural selection may have favored increasing body sizes in groups of animals that went meatless.

Three groups of giant feathered theropods from the Cretaceous period seemed to follow that rule of thumb – the biggest specimens were also the plant-eaters. Lindsay Zanno, research assistant professor of biology at North Carolina State University and director of the Paleontology & Geology Research Lab at the North Carolina Museum of Natural Sciences, and Peter Makovicky, associate curator of paleontology at the Field Museum in Chicago, decided to see if diet was the determining factor when it came to size. Makovicky notes that "Having three closely related lineages of dinosaurs adapting to herbivory over the same geological time span and showing evidence of increasing size provided a near perfect test case."

Zanno and Makovicky estimated body mass for 47 extinct species of feathered dinosaur, representing three major groups that abandoned a strictly meat-eating diet – ornithomimosaurs ("bird-mimics"), oviraptorosaurs ("egg-thieves"), and the bizarre therizinosaurs ("scythe-lizards"). Most species in these lineages also possessed a toothless beak, three-toed feet, and shorter tails than your average dinosaur, making them look a lot like modern birds.

All three groups evolved gigantic proportions: the largest oviraptorosaur weighed over 7,000 pounds, and the biggest ornithomimosaurs and therizinosaurs topped out at over 13,000 pounds. "The largest feathered dinosaurs were more than 100 times more massive than your average person," says Zanno. "The reality is that for most of us, it is downright difficult to imagine a feathered animal of gigantic proportions."

The researchers also found that average body mass did increase in these groups over time (on average, the earliest members were smallest and the last species to evolve were among the largest). But this simple correlation didn't indicate whether large size was an evolutionary advantage.

To test whether these groups were being driven to get bigger by natural selection, Zanno and Makovicky fitted different evolutionary models to the data, looking to see which model best described the patterns of body mass from ancestor species to descendant species. They found that these theropod groups were experimenting with different body masses as they evolved, with some getting bigger, while others were getting smaller. In short, there was no clear-cut drive to get big – size seemed to provide no overwhelming advantage during the evolution of these animals.

The researchers' results appear in *Proceedings of the Royal Society B*.

"Results of our study don't rule out diet as affecting body mass, but do seem to indicate that fluctuating environmental conditions over time were trumping the benefit of becoming a giant," Zanno says. "The long and short of it is that for plant-eating theropods, bigger wasn't always better."

"Where resources permitted, these animals could get as big as elephants, but that clearly was not the case in all environments and time periods," says Makovicky. "Factors such as resource abundance and competition with other herbivores likely played a more significant role." He added that uneven sampling in the fossil record, such as preferential preservation of smaller species in earlier time periods and larger species in later ones, could also impact the results.

More information: "No evidence for directional evolution of body mass in herbivorous theropod dinosaurs" Lindsay E. Zanno, Department of Biology, North Carolina State University, Paleontology and Geology

Laboratory, Nature Research Center, North Carolina Museum of Natural Sciences, Department of Geology, Field Museum of Natural History, Chicago, IL; Peter J Makovicky, Department of Geology, Field Museum of Natural History, Chicago, IL, *Proceedings of the Royal Society B*, 2012.