

New raptor dinosaur takes a licking keeps on ticking

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Raptor dinosaurs like the iconic Velociraptor from the movie franchise Jurassic Park are renowned for their "fear-factor." Their terrifying image has been popularized in part because members of this group possess a greatly enlarged talon on their foot—analogous to a butcher's hook. Yet the function of the highly recurved claw on the foot of raptor dinosaurs has largely remained a mystery to paleontologists. This week a collaboration of scientists unveil a new species of raptor dinosaur discovered in southern Utah that sheds new light on this and several other long-standing questions in paleontology, including how dinosaurs evolved on the "lost continent" of Laramidia (western North America) during the Late Cretaceous—a period known as the zenith of dinosaur diversity. Their findings will be published in the journal *PLoS ONE*.

The new dinosaur—dubbed *Talos sampsoni*—is a member of a rare group of feathered, bird-like theropod dinosaurs whose evolution in North America has been a longstanding source of scientific debate, largely for lack of decent fossil material. Indeed, *Talos* represents the first definitive troodontid theropod to be named from the [Late Cretaceous](#) of North America in over 75 years. "Finding a decent specimen of this type of dinosaur in North America is like a lighting strike... it's a random event of thrilling proportions," said Lindsay Zanno, lead author of the study naming the new dinosaur. Zanno is an assistant professor of anatomy at the University of Wisconsin-Parkside and a research associate at the Field Museum of Natural History in Chicago, Illinois. Other members of the research team include Mike Knell (a graduate student at Montana State University) who discovered

the new specimen in 2008 in the Kaiparowits Formation of Grand Staircase-Escalante National Monument (GSENM), southern Utah; Bureau of Land Management (BLM) paleontologist Alan Titus, leader of a decade-long paleontology reconnaissance effort in the monument; David Varricchio, Associate Professor of Paleontology, Montana State University; and Patrick O'Connor, Associate Professor of Anatomy, Ohio University Heritage College of Osteopathic Medicine.

Funding for the research was provided in part by the National Science Foundation, the Field Museum of Natural History, the Ohio University Heritage College of Osteopathic Medicine, and the Bureau of Land Management. Zanno's research was supported by a John Caldwell-Meeker Fellowship and by a Bucksbaum Fellowship for young scientists. The bones of *Talos sampsoni* will be on exhibit for the first time in the Past Worlds Observatory at the new Utah Museum of Natural History, Salt Lake City, Utah.

The Nature of the Beast Troodontid theropods are a group of feathered dinosaurs closely related to birds. Members of this group are among the smallest non-avian dinosaurs known (as small as 100 grams) and are considered among the most intelligent. The group is known almost exclusively from Asia and prior to the discovery of *Talos sampsoni*, only two species were recognized in the Late Cretaceous of North America—one of which, the infamous Troodon, was one of the first dinosaurs ever named from North America. As a result of their distinctive teeth and the possible presence of seeds preserved as gut contents in one species, several scientists have proposed an omnivorous or herbivorous diet for at least some troodontids. Other species possess relatively blade-like teeth indicative of a carnivorous diet. Zanno's own work on theropod diet suggests that extensive plant eating was confined to more primitive members of the group, with more advanced members of the clade like Troodon and *Talos* likely consuming at least some prey.

Several troodontid specimens have recently been discovered that not only support a close relationship with birds but also preserve remarkable evidence of bird-like behavior. These include extraordinary specimens such as eggs and embryos within nests that document transitional phases in the evolution of bird-like reproductive physiology and egg-laying behavior, as well as specimens preserved in distinctive avian-like sleeping postures with their heads rotated back and tucked under their "wings". Other troodontids provide evidence of "four-winged" locomotor capabilities, and perhaps most extraordinary, plumage coloration.

With an estimated body mass of 38 kilograms, the newly discovered *Talos sampsoni* is neither the smallest nor largest troodontid known. Its skeleton indicates that the new species was much smaller and more slender than its famous cousin *Troodon*, which is known from sediments of the same age in the northern part of Laramidia (Alberta, Canada and Montana, USA). "Talos was fleet-footed and lightly built," Zanno says. "This little guy was a scrapper."

Interestingly, the holotype specimen of *Talos* also tells us something about theropod behavior, particularly raptor behavior. This is because the second toe - that is, the one with the enlarged talon - of the left foot of the new specimen is deformed, indicating that the animal suffered a fracture or bite during its life.

This Little Talos Takes a Beating

When the team first began studying the *Talos* specimen, they noticed some unusual features on the second digit of the left foot, but initially assumed they were related to the fact that it belonged to a new species. "When we realized we had evidence of an injury, the excitement was palpable," Zanno commented. "An injured specimen has a story to tell." That's because evidence of injury relates to function. The manner in

which an animal is hurt can tell you something about what it was doing during life. An injury to the foot of a raptor dinosaur, for example, provides new evidence about the potential function of that toe and claw. In order to learn about the injury to the animal's foot, the team scanned the individual bones using a high-resolution Computed Tomography (CT) scanner, similar to those used by physicians to examine bones and other organs inside the human body.

"Although we could see damage on the exterior of the bone, our microCT approach was essential for characterizing the extent of the injury, and importantly, for allowing us to better constrain how long it had been between the time of injury and the time that this particular animal died," noted Patrick O'Connor, associate professor of anatomy at Ohio University. After additional CT scanning of other parts of the foot, Zanno and her team realized that the injury was restricted to the toe with the enlarged claw, and the rest of the foot was not impacted. More detailed study suggested that the injured toe was either bitten or fractured and then suffered from a localized infection.

"People have speculated that the talon on the foot of raptor dinosaurs was used to capture prey, fight with other members of the same species, or defend the animal against attack. Our interpretation supports the idea that these animals regularly put this toe in harm's way," says Zanno.

Perhaps even more interesting is the fact that the injured toe exhibits evidence of bone remodeling thought to have taken place over a period of many weeks to months, suggesting that Talos lived with a serious injury to the foot for quite a long time. "It is clear from the bone remodeling that this animal lived for quite some time after the initial injury and subsequent infection, and that whatever it typically did with the enlarged talon on the left foot, whether that be acquire prey or interact with other members of the species, it must have been capable of doing so fairly well with the one on the right foot," added O'Connor.

Trackways made by animals closely related to Talos suggest that they held the enlarged talon off the ground when walking. "Our data support the idea that the talon of raptor dinosaurs was not used for purposes as mundane as walking," Zanno commented. "It was an instrument meant for inflicting damage."

What's in a Name?

The name Talos pays homage to a mythological Greek figure of the same name, believed to have protected the island of Crete by throwing stones at invading ships. It is said that the Greek Talos, who was often depicted as a winged bronze figure, could run at lightning speed and circled the ancient island three times a day. The dinosaur Talos belongs to a group of theropods known to have feathery integument (and in some cases "wings"), lived on the small island continent of Laramidia or west North America during the Late Cretaceous, and was also a fast runner. The team chose the name Talos because of these similarities but also because the Greek Talos was said to have died from a wound to the ankle and it was clear that Talos had also suffered a serious wound to the foot. The species name "sampsoni" honors another famous figure—Dr. Scott Sampson of the PBS series *Dinosaur Train*. Sampson, a research curator at the Utah Museum of Natural History and research faculty at the University of Utah, helped to spearhead a collaborative research effort known as the Kaiparowits Basin Project, a long-term research project that has been surveying and documenting the Late Cretaceous dinosaur fauna of the Kaiparowits Basin in southern Utah, with a focus on the Kaiparowits and Wahweap formations exposed in Grand Staircase-Escalante National Monument (GSENM). Thus far this effort has resulted in the discovery of up to a dozen new dinosaurs from GSENM that are challenging previous ideas regarding Late Cretaceous dinosaur evolution and diversity within Laramidia and spurring new ideas regarding dinosaur biogeography in the region.

A Tale of Two Continents

Dinosaurs of the Late Cretaceous were living in a greenhouse world. A warm and equitable global climate that was devoid of polar ice caps and above average spreading at mid-oceanic ridges caused massive flooding of low-lying continental areas and created expansive epicontinental seaways. In North America, a shallow seaway running from the Gulf of Mexico through to the Arctic Ocean divided the continent into two landmasses, East America (Appalachia) and West America (Laramidia) for several million years during the Late Cretaceous. It was during this time that the dinosaurs achieved their greatest diversity, and scientists have been working overtime to understand why. Take for example the dinosaurs of Laramidia. The natural assumption is that being large bodied, those dinosaurs that lived on the small island continent would have roamed the whole area. However, recent fossil discoveries, particularly new dinosaurs from the Kaiparowits Formation, tell us that the true pattern is exactly the opposite. Thus far the dinosaurs from the Kaiparowits Formation in southern Utah are entirely unique, even from those dinosaurs living just a few hundred miles to the north in what is now Montana and Alberta. Monument Paleontologist Alan Titus observed, "When we began looking in the remote Kaiparowits badlands we expected to see at least a few familiar faces. As it turns out, they are all new to science." And while recent discoveries from the Kaiparowits have substantiated this pattern for large-bodied herbivores like duck-bill and horned dinosaurs (for example Utahceratops), the pattern among small-bodied theropods was not clear. "We already knew that some of dinosaurs inhabiting southern Utah during the Late Cretaceous were unique," Zanno said, "but Talos tells us that the singularity of this ecosystem was not just restricted to one or two species. Rather, the whole area was like a lost world in and of itself."

A Monumental Discovery

Talos sampsoni is the newest member of a growing list of new dinosaur species that have been discovered in Grand Staircase Escalante National Monument (GSENM) in southern Utah. Former President Clinton founded the monument in 1996, in part to protect the world class paleontological resources entombed within its 1.9 million acres of unexplored territory. GSENM is one of the largest recently designated national monuments managed by the BLM, and one of the last pristine dinosaur graveyards in the US. The area has turned out to be a treasure trove of new dinosaur species, with at least 15 collected in just the past decade. Titus admits, "We had very few large fossils to substantiate the claim of 'World Class' paleontology when I started in 2000. Now, I feel GSENM could easily qualify as a world heritage site on the basis of its dinosaurs alone, dozens of which have been found preserving soft tissue." He also adds, "BLM support has been critical to the long term viability of the region's paleontology research and is paying off in countless ways both to the public and scientists."

Zanno, along with colleague Scott Sampson, named the first dinosaur from the monument—Hagryphus giganteus—in 2005. Hagryphus (widely touted in the press as the "turkey" dinosaur) is also a theropod dinosaur, but one that belongs to a different subgroup known as oviraptorosaurs (or egg thief reptiles). Other GSENM dinosaurs include five new horned dinosaurs including the recently described and bizarrely ornate Kosmoceratops and Utahceratops, three new duck-bill dinosaurs including the "toothy" Gryposaurus monumentensis, two new tyrannosaurs, as well as undescribed ankylosaurs (armored [dinosaurs](#)), marine reptiles, giant crocodyliforms, turtles, plants, and a host of other organisms.

The discovery of a new troodontid from the monument is the latest in a long string of incredible fossil discoveries from the area. "I was surprised when I learned that I had found a new dinosaur," Knell said. "It is a rare discovery and I feel very lucky to be part of the exciting

research happening here in the monument." Knell stumbled across the remains of *Talos sampsoni* while scouring the badlands of the Kaiparowits Formation for fossil turtles as part of his dissertation research.

Work continues every year in GSENM and new, significant fossil finds are made every field season. Considering there are hundreds of thousands of acres of outcrop that have yet to be surveyed, it is no exaggeration to claim the region will remain an exciting research frontier for decades to come.

More information: Zanno LE, Varricchio DJ, O'Connor PM, Titus AL, Knell MJ (2011) A New Troodontid Theropod, *Talos sampsoni* gen. et sp. nov., from the Upper Cretaceous Western Interior Basin of North America. PLoS ONE 6(9): e24487. [doi:10.1371/journal.pone.0024487](https://doi.org/10.1371/journal.pone.0024487)

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