

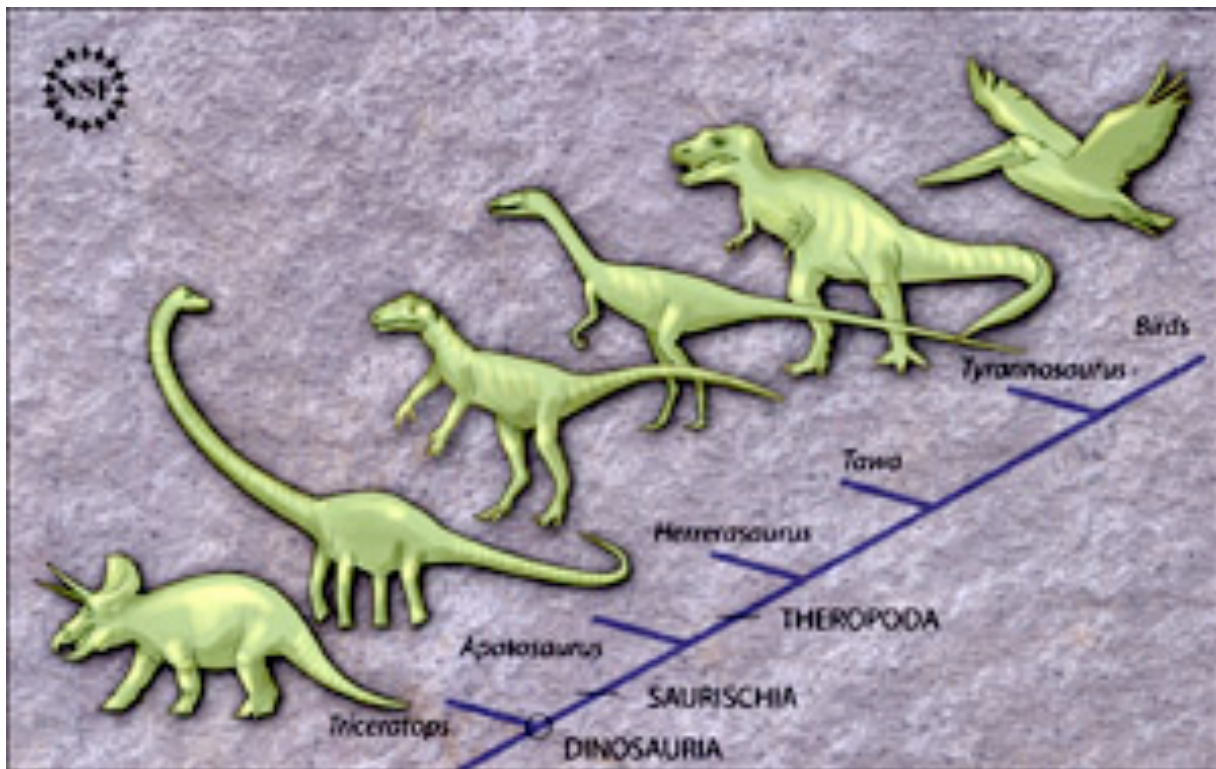
"Long before it's in the papers"

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## Newfound fossils said to clarify dinosaur evolution

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Courtesy Science  
and World Science staff

**Paleontologists, helped by amateur volunteers, report that they have found a previously unknown meat-eating dinosaur fossil, settling a debate about early dinosaur evolution, revealing a period of explosive diversification and hinting at how dinosaurs spread across the supercontinent Pangaea.**



Some researchers now propose that dinosaurs originated in what is now South America and soon after diverged into ornithischians (like Triceratops), sauropodomorphs (like Apatosaurus) and theropods (like Herrerasaurus, Tawa and T. rex), before dispersing across the Triassic world more than 220 million years ago. The theropods are thought to have evolved into modern-day birds, although Tawa split off from the ancestral branch early on and was not a direct bird ancestor. (Image courtesy Zina Deretsky, National Science Foundation)

**The new species, found in northern New Mexico and given the name *Tawa hallae*, is described in the Dec. 10 issue of the research journal *Science*.**

Fossil bones of several individuals were found, including a nearly complete skeleton of a juvenile about the size of a large dog, but with a much longer tail. It stood about 28 inches (70 cm) tall at the hips and was about 6 feet (2 meters) long from snout to tail, scientists said. It is estimated to have lived 214 million years ago.

Remarkably, the skeletons show little sign of having been flattened during fossilization, as usually occurs, paleontologists noted.

*Tawa*, named after a Hopi Indian word for a sun god, is classified as part of a group of dinosaurs called theropods, which includes *Tyrannosaurus Rex* and *Velociraptor*. Theropods mostly ate meat, walked on two legs and had feathers. Though most went extinct by 65 million years ago, scientists generally believe some lineages survived to spawn modern birds.

Sterling Nesbitt, a postdoctoral researcher at The University of Texas at Austin, conducted the research with colleagues while a graduate student at Columbia University's Lamont-Doherty Earth Observatory and the American Museum of Natural History in New York.

One of *Tawa's* biggest contributions to science has to do with what it said about another dinosaur, *Herrerasaurus*, according to Nesbitt and colleagues. *Herrerasaurus* has been at the center of a lively debate since its discovery in Argentina in the 1960s.



Diagrams of *Tawa* bones. (Courtesy Science/AAAS)

*Herrerasaurus* had some similarities with theropods—including large claws, carnivorous teeth and certain pelvic features—but lacked other theropod traits. Some paleontologists claimed it was so unusual it was outside the evolutionary tree of theropods, or even of dinosaurs. Others placed it among the earliest theropods.

“The question was did those carnivorous traits arise in *Herrerasaurus* and in theropods independently or were they traits from a recent common ancestor that got passed down,” said Nesbitt. “Now that we have *Tawa*, we think we have an answer.”

*Tawa* had a mix of *Herrerasaurus*-like characteristics—such as in the pelvis—and features found in firmly established theropods, such as pockets for airsacs in the backbone, according to the discoverers. This confirms, they said, that characteristics that *Herrerasaurus* shares uniquely with theropods such as *Tawa* didn't arise independently and that *Herrerasaurus* is indeed a theropod.

The firm classification of *Herrerasaurus* as a theropod points up an interesting fact about dinosaur evolution, scientists said: once dinosaurs appeared, they very rapidly diversified into the three main lineages that persisted for more than 170 million years. *Herrerasaurus* was found in a South American rock layer alongside the oldest members of two major lineages—the sauropods and the ornithischians.

“*Tawa* pulls *Herrerasaurus* into the theropod lineage, so that means all three lineages are present in South America pretty much as soon as dinosaurs evolved,” said Nesbitt.

*Tawa* skeletons were found beside two other theropod dinosaurs from around the same period. Nesbitt noted that each of the three is more closely related to a known dinosaur from South America than they are to each other. This suggests these three species each descended from a separate lineage in South America, rather than all evolving from a local ancestor, Nesbitt and colleagues said. They later would have dispersed to North America and other parts of Pangaea, a supercontinent that included all of today's continents gathered up as one, before about 200 million years ago.

The finding also suggests there were multiple dispersals out of South America, according to the group.

The first *Tawa* fossils were discovered in 2004 by volunteers taking a week-long paleontology seminar with experts at the Ruth Hall Museum of Paleontology in Abiquiu, New Mexico. The dig site, known as Hayden Quarry, is in a hillside on Ghost Ranch made famous by the painter Georgia O'Keefe. Alex Downs, an instructor for the course, contacted Nesbitt and a colleague to ask if they'd like to see the fossils.

"When we saw them, our jaws dropped," said Nesbitt. "A lot of these theropods have really hollow bones, so when they get preserved, they get really crunched. But these were in almost perfect condition." He was also surprised by how much material was preserved at this one site. The fossil bone bed extends for tens of meters along the hillside, promising years of painstaking work and perhaps additional significant discoveries, he said.