Fossil mystery solved: Super-long-necked reptiles lived in the ocean, not on land

August 6 2020

Nostrils located on the top of the snout and curved teeth, perfectly adapted for catching slippery prey: The skull of Tanystropheus has several clear adaptations for life in water. Credit: Emma Finley-Jacob

A fossil called *Tanystropheus* was first described in 1852, and it's been

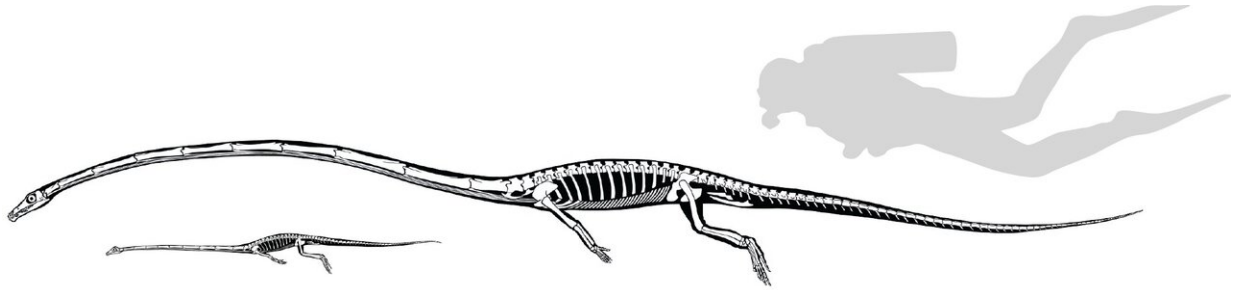
puzzling scientists ever since. At one point, paleontologists thought it was a flying pterosaur, like a pterodactyl, and that its long, hollow bones were phalanges in the finger that supported the wing. Later on, they figured out that those were elongated neck bones, and that it was a twenty-foot-long reptile with a ten-foot neck: three times as long as its torso. Scientists still weren't sure if it lived on land or in the water, and they didn't know if smaller specimens were juveniles or a completely different species—until now. By CT-scanning the fossils' crushed skulls and digitally reassembling them, researchers found evidence that the animals were water-dwelling, and by examining the growth rings in bones, determined that the big and little *Tanystropheus* were separate species that could live alongside each other without competing because they hunted different prey.

"I've been studying *Tanystropheus* for over thirty years, so it's extremely satisfying to see these creatures demystified," says Olivier Rieppel, a paleontologist at the Field Museum in Chicago and one of the authors of a new paper in *Current Biology* detailing the discovery.

Tanystropheus lived 242 million years ago, during the middle Triassic. On land, dinosaurs were just starting to emerge, and the sea was ruled by giant reptiles. For a long time, though, scientists weren't sure whether *Tanystropheus* lived on land or in the water. Its bizarre body didn't make things clear one way or the other.

"*Tanystropheus* looked like a stubby crocodile with a very, very long neck," says Rieppel. The larger specimens were twenty feet long, with their necks making up ten feet of that length. Oddly for animals with such long necks, they only had thirteen neck vertebrae, just really elongated. (We see the same thing with giraffes, which have only seven neck bones, just like humans.) And their necks were rather inflexible, reinforced with extra bones called cervical ribs.

In the same region where many of the big *Tanystropheus* fossils were found, in what's now Switzerland, there were also fossils from similar-looking animals that were only about four feet long. So not only were scientists unsure if these were land-dwellers or marine animals, but they also didn't know if the smaller specimens were juveniles, or a separate species from the twenty-footers.

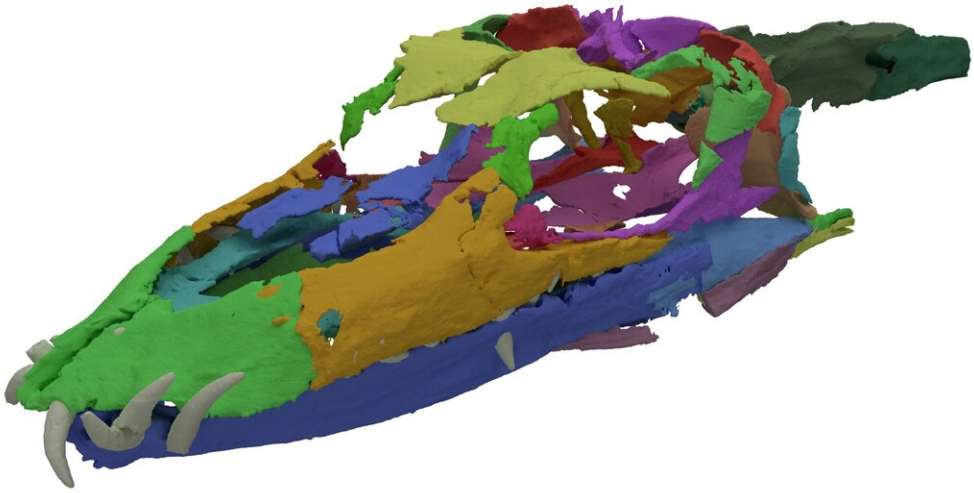


Size comparison of *T. hydroides, T. longobardicus*, and a human. Credit: Stephan Spiekman et al.

To solve these two long-standing mysteries, the researchers used newer technologies to see details of the animals' bones. The large *Tanystropheus* fossils' skulls had been crushed, but Stephan Spiekman, the paper's lead author and a researcher at the University of Zurich, was able to take CT scans of the fossil slabs and generate 3-D images of the bone fragments inside.

"The power of CT scanning allows us to see details that are otherwise impossible to observe in fossils," says Spiekman. "From a strongly crushed skull we have been able to reconstruct an almost complete 3-D skull, revealing crucial morphological details."

The skulls had key features, including nostrils on top of the snout like a crocodile's, that suggested *Tanystropheus* lived in the water. It probably lay in wait, waiting for fish and squid-like animals to swim by, and then snagged them with its long, curved teeth. It may have come to land to lay eggs, but overall, it stayed in the ocean.



The digitially reconstructed skull of *Tanystropheus*, using CT scans of the crushed skull pieces. Credit: Stephan Spiekman et al.

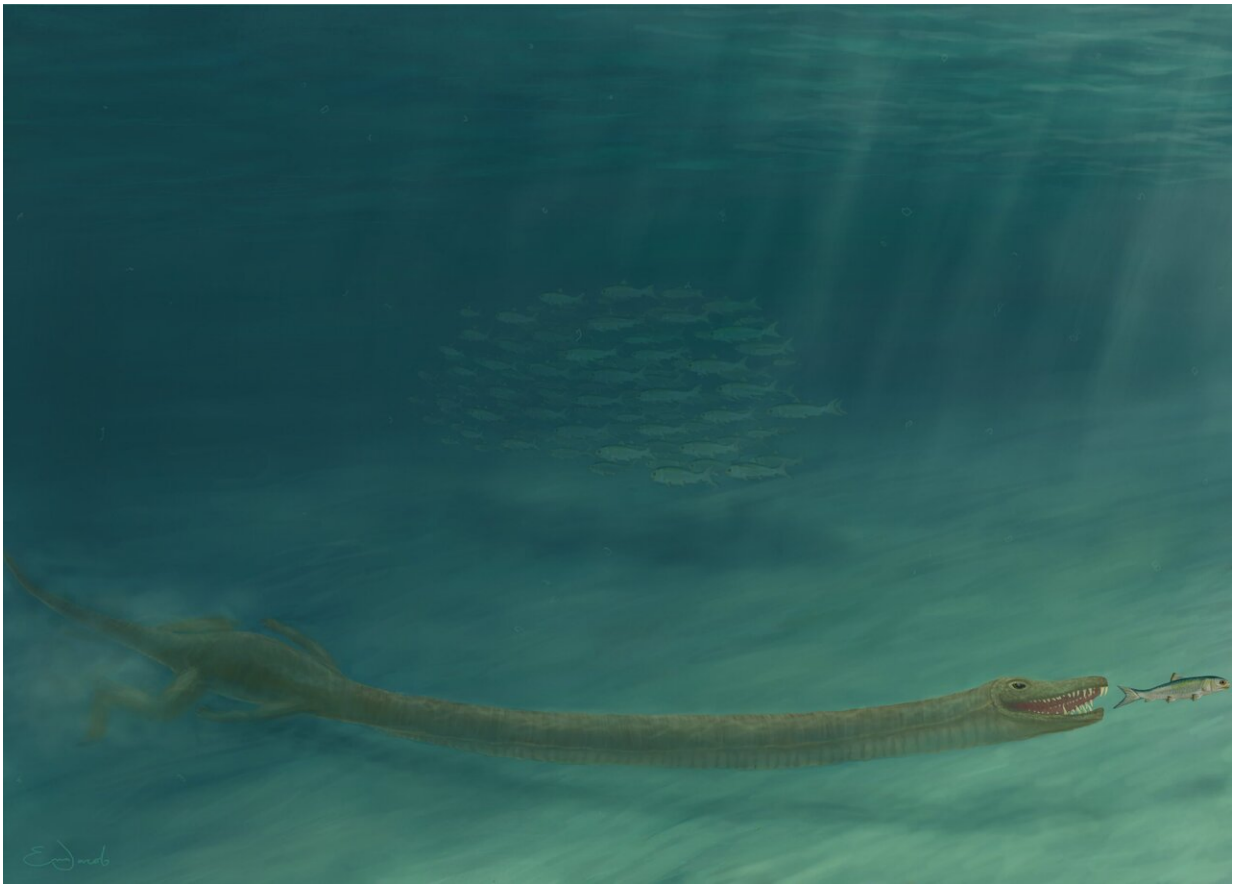
Rieppel wasn't surprised that evidence pointed to a water-dwelling *Tanystropheus*. "That neck doesn't make sense in a terrestrial environment," he says. "It's just an awkward structure to carry around."

So that answered one question, about where *Tanystropheus* lived. To learn whether the small specimens were juveniles or a separate species,

the researchers examined the bones for signs of growth and aging.

"We looked at cross sections of bones from the small type and were very excited to find many growth rings. This tells us that these animals were mature," says Torsten Scheyer, the study's senior author and a researcher at University of Zurich.

"The small form is an adult, which basically sealed the case," says Rieppel. "It's proven now that these are two species." The researchers named the larger one *Tanystropheus hydroides*, after the long-necked hydras in Greek mythology. The small form bears the original name *Tanystropheus longobardicus*.



An illustration showing *Tanystropheus hydroides* hunting. Credit: Emma Finley-Jacob

"For many years now we have had our suspicions that there were two species of *Tanystropheus*, but until we were able to CT scan the larger specimens we had no definitive evidence. Now we do," says Nick Fraser, Keeper of Natural Sciences at National Museums Scotland and a co-author of the paper. "It is hugely significant to discover that there were two quite separate species of this bizarrely long-necked reptile who swam and lived alongside each other in the coastal waters of the great sea of Tethys approximately 240 million years ago."

The animals' different sizes, along with cone-shaped teeth in the big species and crown-shaped teeth in the little species, meant they probably weren't competing for the same prey.

"These two closely related species had evolved to use different food sources in the same environment," says Spiekman. "The small species likely fed on small shelled animals, like shrimp, in contrast to the fish and squid the large species ate. This is really remarkable, because we expected the bizarre neck of *Tanystropheus* to be specialized for a single task, like the neck of a giraffe. But actually, it allowed for several lifestyles. This completely changes the way we look at this animal."

This "splitting up" of a habitat to accommodate two similar species is called niche partitioning. "Darwin focused a lot on competition between species, and how competing over resources can even result in one of the species going extinct," says Rieppel. "But this kind of radical competition happens in restricted environments like islands. The marine basins that *Tanystropheus* lived in could apparently support niche partitioning. It's an important ecological phenomenon."

"*Tanystropheus* is an iconic fossil and has always been," adds Rieppel. "To clarify its taxonomy is an important first step to understanding that group and its evolution."

More information: *Current Biology*, DOI: 10.1016/j.cub.2020.07.025

Provided by Field Museum