Digging into the origin of lizards: Ancient fossil shows only one of three predicted ancestral traits

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Lizard reconstruction scene. Credit: Bob Nicholls

A new fossil from Devon reveals what the oldest members of the lizard group looked like, and there are some surprises, according to a research team from the University of Bristol. The study is published today in *Nature*.

Today, lizards and their relatives such as snakes, together with the unique tuatara from New Zealand, are the most successful group of land vertebrates, with over 12,000 species—more than birds and more than mammals. But what is it about lizards, snakes and the tuatara, called collectively the Lepidosauria, that has made them so successful?

It was always expected that the first lepidosaurs would have had some of the lizard characters, such as a partially hinged skull, an open lower temporal bar, and abundant teeth on the roof of the mouth (palate). These are all features of modern lizards and snakes that enable them to manipulate large prey by opening their mouths super-wide (skull hinge) and using teeth on the palate to grasp wriggling small prey.

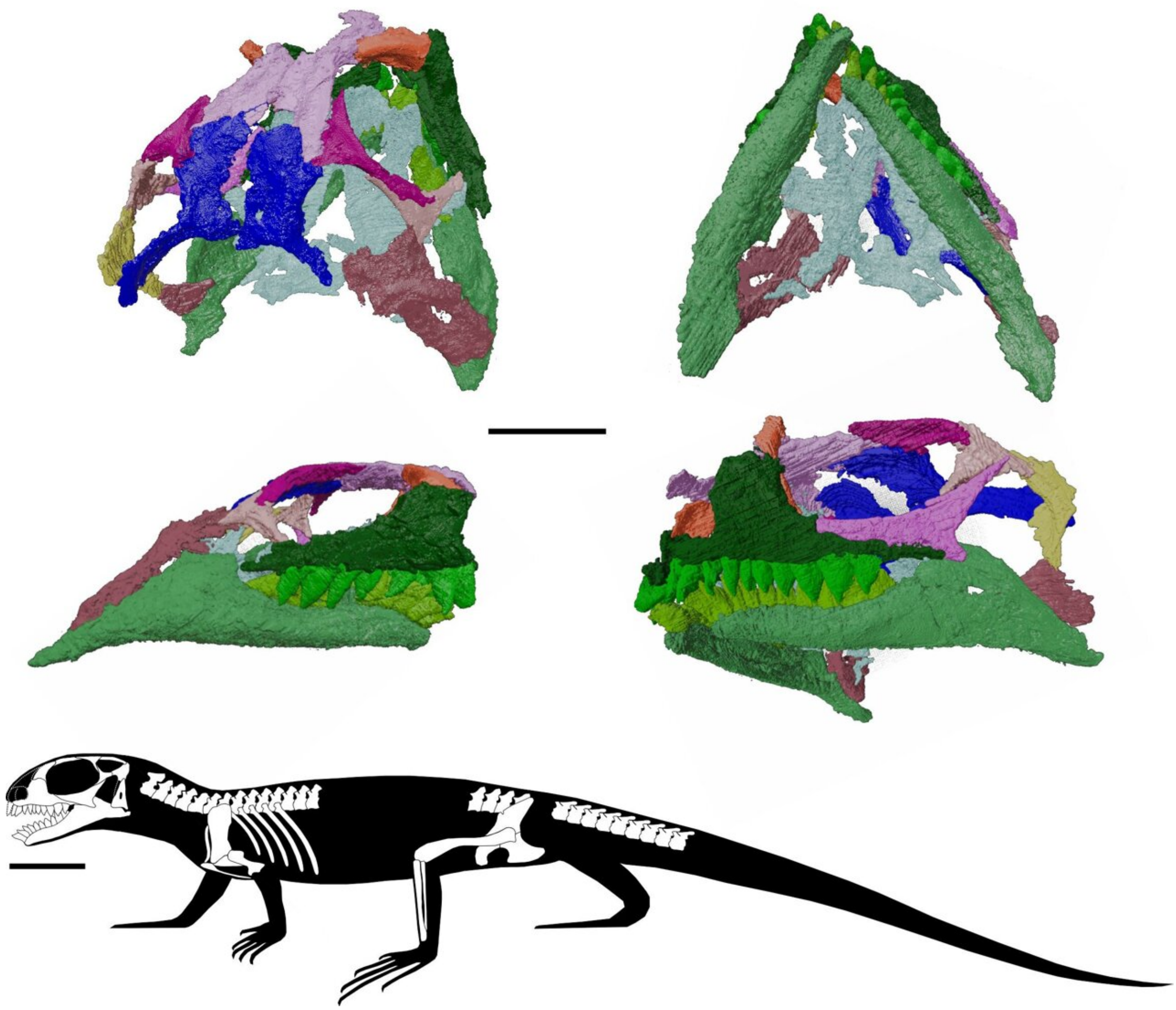
The lower temporal bar is essentially the cheek bone, a bony rod that runs between the cheek and the jaw hinge and is absent in lizards and snakes today. Snakes and many lizards have all these features, as well as some additional flexibility of the skull. Only the tuatara has a complete lower temporal bar, giving it an archaic look reminiscent of some of the earliest and ancestral reptiles; and it also has some large palatal teeth.

"The new fossil shows almost none of what we expected," said Dan Marke, who led the project as part of his studies for the MSc in Paleobiology at Bristol. "It has no teeth on the palate, and no sign of any hinging. It does, though, have an open temporal bar, so one out of three. Not only this, but it possesses some spectacularly large teeth compared to its closest relatives."

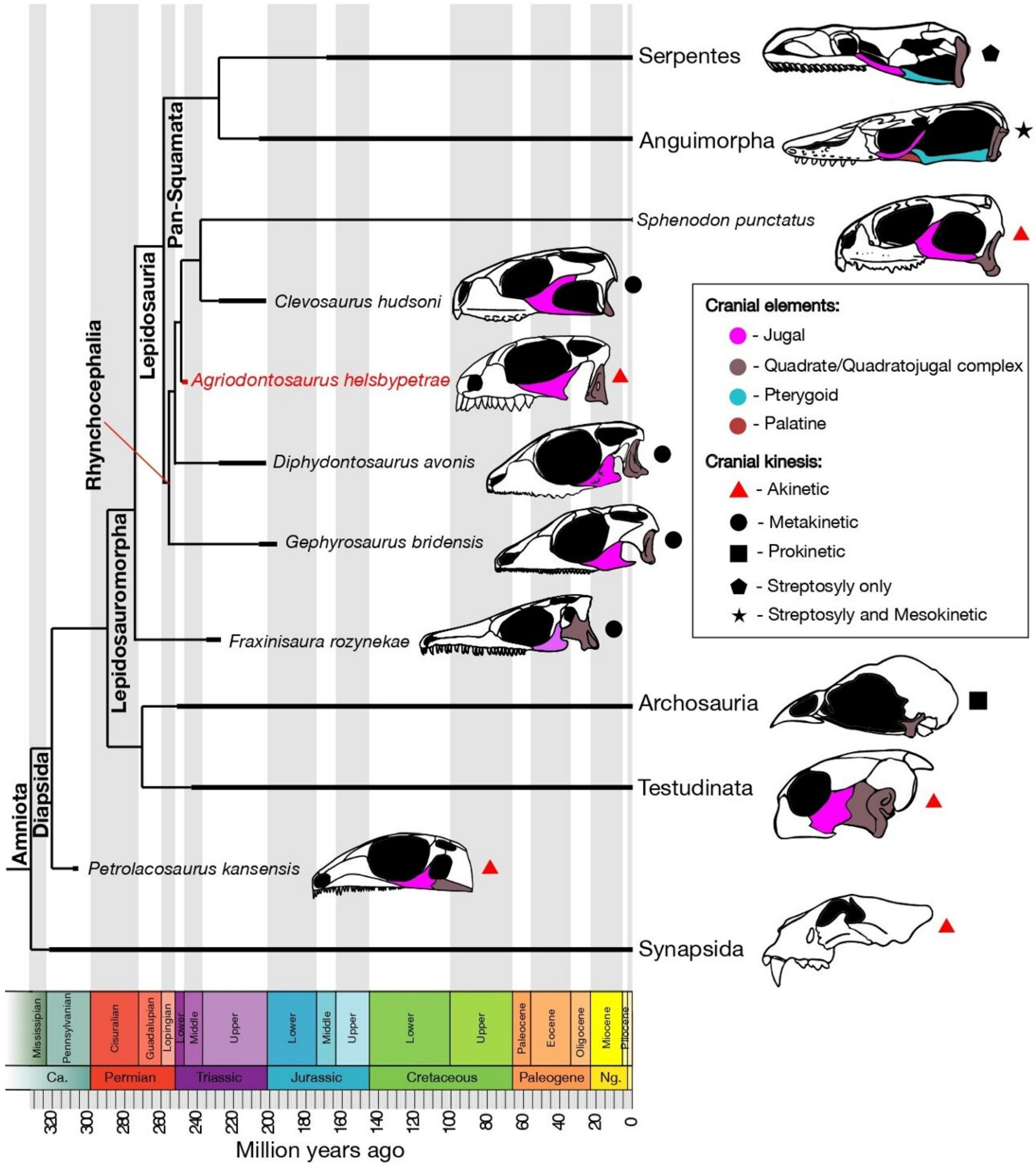
"In modern paleontological studies we often X-ray scan the fossils," added Dr. David Whiteside, a co-supervisor of the project. "But the exceptional resolution and quality of scans from synchrotron X-ray sources show us all the fine details and save any risk of damage.

"An earlier MSc student, Thitiwoot Sethapanichsakul, had worked on the regular scans and found fantastic detail, but it's so tiny—the skull is only 1.5 cm long, and we could barely see the teeth. So, we were so grateful to be able to make synchrotron CT scans to get even finer resolution, using two powerful beamlines at the European Synchrotron Radiation Facility (France) and the Diamond Light Source (UK)."

Holotype specimen of Agriodontosaurus helsbypetrae, BRSUG 29950-14; and close-up of preserved skull. Scale bars: 10mm and 5mm, respectively. Credit: Thitiwoot Sethapanichsakul



Three-dimensional model of the skull of A. helsbypetrae, reconstructed using synchrotron tomography. The silhouette illustrates the individual elements preserved in the holotype specimen. Credit: Dan Marke



Phylogenetic tree showing the variation of the lower temporal bar and skull flexibility (modes of kinesis) in fossil and living amniotes (lizards, birds and reptiles). Credit: Dan Marke

"When you look at the fossil, the whole skeleton sits in the palm of your hand," explained Michael Benton, another co-supervisor and Professor of Vertebrate Paleontology in the School of Earth Sciences at the University of Bristol.

"But after the scans and the hard work of our students cleaning up the scan data, we can see the most amazing detail. The new beast has relatively large triangular-shaped teeth and probably used these to pierce and shear the hard cuticles of its insect prey, pretty much as the tuatara does today."

"The new animal is unlike anything yet discovered and has made us all think again about the evolution of the lizard, snakes and the tuatara," said Dan Marke. "We had to give it a name to distinguish it from everything else, and we chose Agriodontosaurus helsbypetrae, quite a mouthful, meaning 'fierce toothed lizard from the Helsby rock' after the Helsby Sandstone Formation in which it was discovered.

"This specimen not only provides important information about the ancestral skull of all lepidosaurs but also builds on the growing knowledge that the tuatara, while often called a 'living fossil'; belongs to a once-diverse order of ancient reptiles with a rich evolutionary history."

The fossil dates back 242 million years, in the Middle Triassic, just before the dinosaurs appeared, and since then the lepidosaurs have diversified in several stages, the early ones flitting in and out of the undergrowth under the feet of the dinosaurs. They owe their success to their amazing ability to capture insects and other prey using a variety of remarkable adaptations, including their highly flexible jaws and, in the case of some snakes and lizards, the use of venom.

"When I found the specimen back in 2015 on the beach in Devon, I had no idea what it was because there was so little of it exposed," added Dr.

Rob Coram. "It's been great to see such an amazing fossil coming from a site that has been providing fossils for 150 years."

More information: The oldest known lepidosaur and origins of lepidosaur feeding adaptations', *Nature* (2025). [DOI: 10.1038/s41586-025-09496-9](https://dx.doi.org/10.1038/s41586-025-09496-9)

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