X-rays reveal hidden leg of an ancient snake

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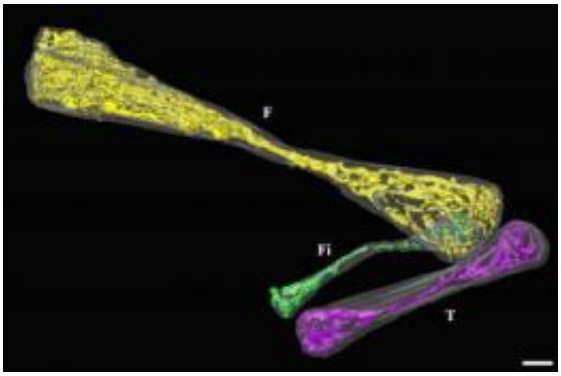

This is a 3-D reconstruction from synchrotron X-ray images of the previously hidden second leg of *Eupodophis*. The bones are artificially colored to highlight the internal structure of the bone and show how the snake's leg grew. Credit: A. Houssaye

(PhysOrg.com) -- A novel X-ray imaging technology is helping scientists better understand how in the course of evolution snakes have lost their legs. The researchers hope the new data will help resolve a heated debate about the origin of snakes: whether they evolved from a terrestrial lizard or from one that lived in the oceans. New, detailed 3-D images reveal that the internal architecture of an ancient snake's leg bones strongly resembles that of modern terrestrial lizard legs. The results are published in the 8 February issue of the *Journal of Vertebrate Paleontology*.

The team of researchers was led by Alexandra Houssaye from the Museum National d'Histoire Naturelle (MNHN) in Paris, France, and included scientists from the European Synchrotron Radiation Facility

(ESRF) in Grenoble, France, where the X-ray imaging was performed, and the Karlsruhe Institute of Technology (KIT), Germany, where a sophisticated technique and a dedicated instrument to take the images were developed.

Only three specimens exist of fossilised snakes with preserved leg bones. *Eupodophis descouensi*, the ancient snake studied in this experiment, was discovered ten years ago in 95-million-year-old rocks in Lebanon. About 50 cm long overall, it exhibits a small leg, about 2 cm long, attached to the animal's pelvis. This fossil is key to understanding the evolution of snakes, as it represents an intermediate evolutionary stage when ancient snakes had not yet completely lost the legs they inherited from earlier lizards. Although the fossil exhibits just one leg on its surface, a second leg was thought to be concealed in the stone, and indeed this leg was revealed in full detail thanks to synchrotron X-rays.

The high-resolution 3-D images, in particular the fine detail of the buried small leg, suggest that this species lost its legs because they grew more slowly, or for a shorter period of time. The data also reveal that the hidden leg is bent at the knee and has four ankle bones but no foot or toe bones.

"The revelation of the inner structure of *Eupodophis* hind limbs enables us to investigate the process of limb regression in snake evolution," says Alexandra Houssaye.

This is a photograph of *Eupodophis descouensi*, a fossil snake from the Cretaceous Period (95 million years ago) of Lebanon. The black scale bar at the bottom right equals 1 cm. Credit: A. Houssaye

The scientists used synchrotron laminography, a recent imaging technique specially developed for studying large, flat samples. It is similar to the computed tomography (CT) technique used in many hospitals, but uses a coherent synchrotron X-ray beam to resolve details

a few micrometers in size--some 1000 times smaller than a hospital CT scanner. For the new technique, the fossil is rotated at a tilted angle in a brilliant high-energy X-ray beam, with thousands of two-dimensional images recorded as it makes a full 360-degree turn. From these individual images, a high-resolution, 3-D representaton is reconstructed, which shows hidden details like the internal structures of the legs.

"Synchrotrons, these enormous machines, allow us to see microscopic details in fossils invisible to any other techniques without damage to these invaluable specimens," says Paul Tafforeau of the ESRF, a co-author of the study.

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