The world's oldest known snake fossils: Rolling back the clock by nearly 70 million years

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Paleo reconstructions of three Jurassic to Lower Cretaceous snakes are shown. Top left: *Portugalophis lignites* from Portugal; top right: *Diablophis gilmorei* from

Colorado; bottom center: *Parviraptor estesi* from England. Credit: Julius Csotonyi

Fossilized remains of four ancient snakes have been dated between 140 and 167 million years old - nearly 70 million years older than the previous record of ancient snake fossils - and are changing the way we think about the origins of snakes, and how and when it happened. The findings have been published in the prestigious peer-reviewed journal *Nature Communications*.

"The study explores the idea that evolution within the group called 'snakes' is much more complex than previously thought," says lead author and professor Michael Caldwell in the Faculty of Science at the University of Alberta. "Importantly, there is now a significant knowledge gap to be bridged by future research as no fossils snakes are known from between 140 to 100 million years ago."

The oldest known snake, from Southern England, near Kirtlington, *Eophis underwoodi*, is known only from very fragmentary remains and was a small individual, though it is hard to say how old it was at the time it died. The largest snake, *Portugalophis lignites*, from coal deposits in Portugal, near Guimarota, was a much bigger individual at nearly a meter or more in length. Several of these ancient snakes (*Eophis*, *Portugalophis* and *Parviraptor*) were living in swampy coastal areas on large island chains in western parts of ancient Europe, while the North American species, Diablophis gilmorei, is found in river deposits from some distance inland in Western Colorado.

This new study makes it clear that the sudden appearance of snakes, some 100 million years ago, reflects a gap in the fossil record, not an explosive radiation of early snakes. From 167 to 100 million years ago,

some 70 million years, snakes were radiating and evolving towards the elongate, limb-reduced body plan characterizing the now well known, ~100-90 million year old, marine snakes from the West Bank, Lebanon, and Argentina, that still possess small but well developed rear limbs. As is always the case, the distribution of these newer oldest snakes, and the anatomy of the skull and skeletal elements, makes it clear that even older snake fossils are waiting to be found.

"Based on the new evidence and through comparison to living legless lizards that are not snakes," explains Caldwell, "the paper explores the novel idea that the evolution of the characteristic snake skull and its parts appeared long before snakes lost their legs."

He adds that the identification of definitive snake skull features reveals that the fossils, previously associated with other non-snake lizard remains, represents a much earlier time frame for the first appearance of snakes. The concept of how snakes originated and evolved needs to be reassessed in light of this new information, and the unique ideas presented in this paper.

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