

# **Synchrotron X-ray sheds light on some of the world's oldest dinosaur eggs**

April 9 2020

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Some of the world's oldest known dinosaur eggs and embryos. The clutch of *Massospondylus carinatus* eggs discovered in 1976 in Golden Gate Highland National Park, South Africa. Credit: Brett Eloff

An international team of scientists led by the University of the Witwatersrand in South Africa has produced highly detailed reproductions of the skulls of some of the oldest known dinosaur embryos in 3-D, using powerful and non-destructive synchrotron techniques at the ESRF, the European Synchrotron in France. They found that the skulls develop in the same order as those of today's crocodiles, chickens, turtles and lizards. The findings are published today in *Scientific Reports*.

The scientists have published the 3-D reconstructions of the ~2-cm-long embryonic skulls in *Scientific Reports*. The embryos, found in 1976 in Golden Gate Highlands National Park (Free State Province, South Africa) belong to South Africa's iconic dinosaur *Massospondylus carinatus*, a 5-meter-long herbivore that nested in the Free State region 200 million years ago.

The scientific usefulness of the embryos was previously limited by their extremely fragile nature and tiny size. In 2015, scientists Kimi Chapelle and Jonah Choiniere from the University of Witwatersrand brought them to the European Synchrotron (ESRF) in Grenoble, France for scanning. At the ESRF, an 844-metre ring of electrons traveling at the speed of light emits high-powered X-ray beams that can be used to scan matter non-destructively, including fossils. The embryos were scanned at an unprecedented level of detail, at the resolution of an individual bone cell.

With these data in hand, and after nearly three years of data processing at the Wits laboratory, the team was able to reconstruct a 3-D model of the baby dinosaur skull. "No lab CT scanner in the world can generate these kinds of data," said Vincent Fernandez, one of the co-authors and scientist at the Natural History Museum in London (U.K.). "Only with a huge facility like the ESRF can we unlock the hidden potential of our most exciting fossils. This research is a great example of a global collaboration between Europe and the South African National Research Foundation," he adds.

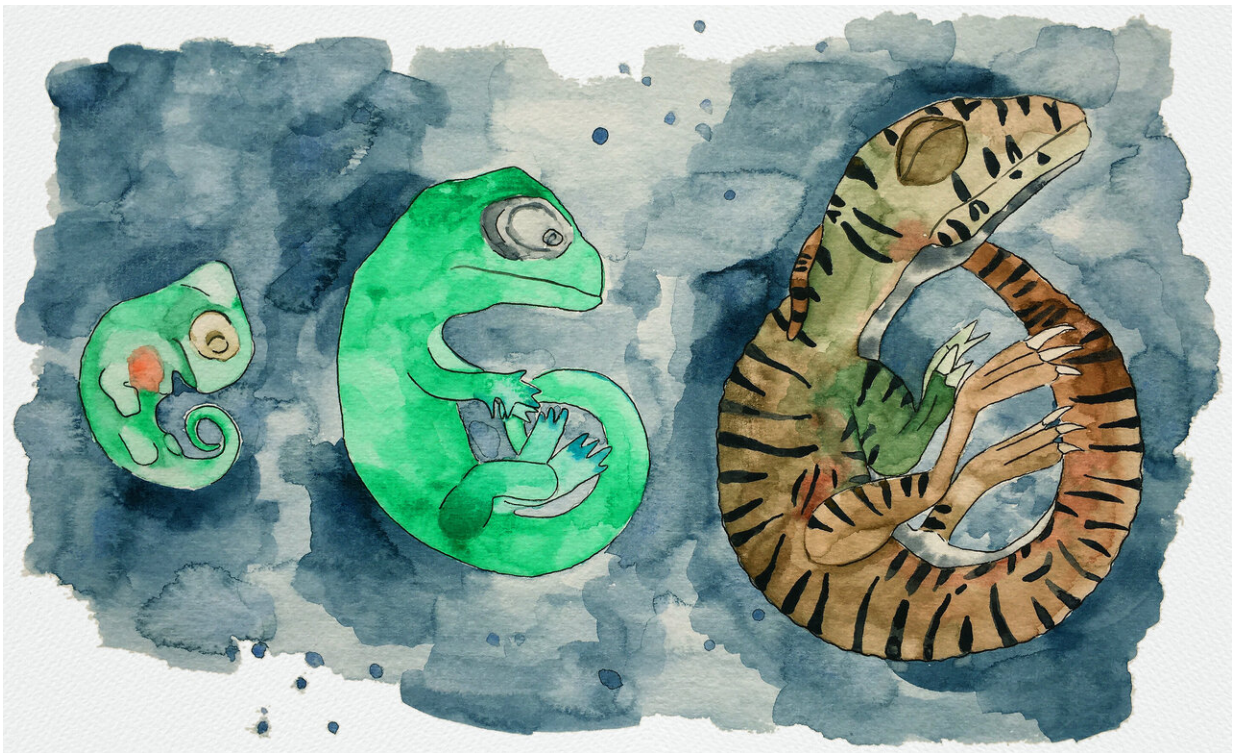
Up until now, it was believed that the embryos in those eggs had died just before hatching. However, during the study, lead author Chapelle noticed similarities with the developing embryos of living dinosaur relatives (crocodiles, chickens, turtles, and lizards). By comparing which bones of the skull were present at different stages of their embryonic development, Chapelle and co-authors demonstrated that the *Massospondylus* embryos were actually much younger than previously thought and were only at 60% through their incubation period.

The team also found that each embryo had two types of teeth preserved in its developing jaws. One set was made up of very simple triangular teeth that would have been resorbed or shed before hatching, just like geckos and crocodiles today. The second set was very similar to those of adults, and would be the ones that the embryos hatched with. "I was really surprised to find that these embryos not only had teeth, but had two types of teeth. The teeth are so tiny; they range from 0.4 to 0.7 mm wide. That's smaller than the tip of a toothpick," says Chapelle.

The researchers concluded that the [dinosaurs](#) developed in the egg just like their reptilian relatives, whose embryonic developmental pattern hasn't changed in 200 million years. "It's incredible that in more than 250 million years of reptile evolution, the way the skull develops in the egg remains more or less the same. Goes to show—you don't mess with a

good thing," says Jonah Choiniere, professor at the University of Witwatersrand and also co-author of the study.

The team hopes to apply their method to other dinosaur embryos to estimate their level of development. They will be looking at the rest of the skeleton of the *Massospondylus* embryos to see if it also shares similarities in development with today's dinosaur relatives. The arms and legs of the *Massospondylus* [embryos](#) have already been used to show that hatchlings likely walked on two legs.



Watercolor painting of the *Massospondylus carinatus* dinosaur embryos at 17% through the incubation period, 60% through the incubation period and 100% through the incubation period. Credit: Mélanie Saratori

**More information:** Conserved in-ovo cranial ossification sequences of extant saurians allow estimation of embryonic dinosaur developmental stages, *Scientific Reports* (2020).

Kimberley E. J. Chapelle et al. A quantitative method for inferring locomotory shifts in amniotes during ontogeny, its application to dinosaurs and its bearing on the evolution of posture, *Palaeontology* (2019). [DOI: 10.1111/pala.12451](https://doi.org/10.1111/pala.12451)

Provided by European Synchrotron Radiation Facility

Citation: Synchrotron X-ray sheds light on some of the world's oldest dinosaur eggs (2020, April 9) retrieved 29 April 2024 from <https://phys.org/news/2020-04-synchrotron-x-ray-world-oldest-dinosaur.html>

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