

# New study suggests animals may have evolved vastly earlier than fossil evidence suggests

**Animals may have evolved up to 200 million years earlier than their first appearance in the fossil record. This is according to new research that challenges key assumptions scientists have used to date the origins of animal life.**

The earliest animals may have evolved hundreds of millions of years before their first unmistakable fossils are found, according to a new study led by the University of Oxford. The findings, published today ([add date](#)) in *Science Advances*, suggest animals may have originated deep in the Neoproterozoic Era, even before some of the most extreme ice ages in Earth's history.

The finding could transform our understanding of one of evolution's greatest mysteries: why animals seem to appear relatively suddenly in the fossil record just before the Cambrian Period (539 to 487 million years ago), despite other evidence suggesting that their evolutionary history began much earlier.

At the heart of the study is a problem with the way scientists have recently used the fossil record to set a maximum age for the origin of animals.

A roughly 590-million-year-old fossil deposit known as the Weng'an Biota in rocks of Ediacaran age in China preserves microscopic organisms in extraordinary detail, none of which are definitive animals. Scientists have therefore inferred that the first animals must have originated after Weng'an, assuming that this exceptional fossil deposit would have preserved them if they existed at this time.

## How new fossils from Mongolia challenge assumptions

The research team, which included members from the University of California Berkeley, ETH Zürich, and Yale University, carried out a comprehensive survey of exceptionally well-preserved microfossils from the Kheseen Biota in Mongolia. The Kheseen Biota is more than 40 million years younger than Weng'an, even though they share some species. By this time animal fossils are known from sites elsewhere around the world, including Namibia and South China.

The researchers studied over 140 samples, including some from previously undocumented localities, and examined them using scanning electron microscopy. This revealed exquisite new microfossil species including acritarchs (tiny spherical organisms with spines and branching projections) as well as embryo-like fossils containing internal cells. Yet, despite this remarkable level of preservation, none can be confidently identified as an animal.

Senior author [Associate Professor Ross Anderson](#) (Museum of Natural History, Oxford University) said: "The Kheseen Biota breaks the argument that the exceptional microfossils of Weng'an mean we would have seen animal fossils in the assemblage had they existed at the time. The Kheseen microfossils are just as well-preserved, yet animals continue to be absent – despite the fact we know at that point they existed."

Animals must have lived in different environments from those that preserved the fossils in the Kheseen Biota, or the chemical conditions there failed to preserve animal remains.

## A hidden history of animal life

Given that the Kheseen Biota was preserved when animals were present but they are nonetheless not preserved as fossils, the researchers argue that Weng'an does not automatically qualify as evidence that no animals existed at that time and only appeared later than 590 million years ago. Instead, they looked much further back, to several deposits dating from roughly 850 to 730 million years ago. These included the Svanbergfjellet Formation (Norway), Bitter Springs Group (Australia)

and Chuar Group (Arizona, USA) - all fossil-rich deposits with the potential to preserve animals, even though they have eluded discovery. These deposits have previously been used as maximum dates for the origin of animals.

Using these older geological constraints, the researchers used a technique called molecular clock analysis. This method compares genetic differences between living species and, using dates from the fossil record as reference points combined with rates of evolution, works backwards to estimate when their ancestors lived. Compared with analyses constrained by the younger Ediacaran Weng'an deposit, this approach shifted the estimated origin of animals backwards by around 200 million years, to between 800 and 700 million years ago.

There are already clues that such a hidden history exists. Chemical fossils, or biomarkers, preserved in ancient rocks provide evidence consistent with sponges living at least 650 million years ago, tens of millions of years before the oldest definitive macroscopic animal fossils.

These early animals would have been small and soft-bodied, without the shells, bones or other hard structures that make later animals easier to preserve. Whether such creatures were fossilised depended on their environment and on an unusual combination of chemical conditions after death.

### **Could animals pre-date Snowball Earth?**

An origin between 800 and 700 million years ago raises striking possibilities: animals may already have evolved before Earth entered some of the most extreme ice ages in its history or even appeared during that inhospitable interval.

During the Cryogenian Period, which began around 720 million years ago, enormous glaciers spread across the planet in episodes commonly known as Snowball Earth. The study reopens questions about whether the conditions associated with Snowball Earth played a role in the origin and early evolution of animal life.

First author, PhD student Orin Lole Durbin (University of Oxford undergraduate at the time of the study, now at Virginia Tech) said: "Pre-Ediacaran animal body fossils still elude us, and this analysis does not prove that animals existed 800 million years ago. However, our new fossil evidence from Mongolia undermines one of the main arguments for restricting animal origins to the Ediacaran interval. Meanwhile, our molecular-clock analyses show how much further back their evolutionary history could extend."

The researchers say that future work should explore fossil deposits from different parts of the world, representing different environments and modes of fossilisation, in the search for animals. This should also consider all available evidence for animals, including body fossils, traces of their activity and chemical biomarkers.

Professor Anderson added: "Until that evidence becomes available, the precise birth date of the animal kingdom remains uncertain."

### **Notes to editors:**

For media enquiries and interview requests contact: [[suggest either Ross Anderson or Caroline Wood – or, if Caroline is away news.office@admin.ox.ac.uk](#)]

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The study 'Re-evaluating molecular clock maximum age calibrations revives pre-Ediacaran divergence estimates for animals' will be published in Science Advances at [[TIME/DATE](#)] at [[URL](#)]. To

view a copy of the paper before this under embargo, access the *Science Advances* press pack <https://www.eurekalert.org/press/vancepak> or contact: [vancepak@aaas.org](mailto:vancepak@aaas.org)

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