

What 40-million-year-old tropical reef corals tell us about climate change

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View inside the collection drawers: 40-million-year-old tropical reef corals from present-day France. Credit: Stefan Krüger

Unusually well-preserved reef corals from the Geological and Paleontological Collection at Leipzig University hold a great secret:

They allow us to travel far into the past and reconstruct climatic conditions in our latitudes. Researchers from Leipzig University, the Universities of Bremen and Greifswald, and UniLaSalle in Beauvais have now succeeded in doing just this. Using chemical analyses, they were able to model seasonal temperature fluctuations of this period and show for the first time that corals already lived in symbiosis with algae 40 million years ago. Their results, which may also serve to improve current climate forecasts, have been published in the journal *Science Advances*.

In the Middle Eocene, some 40 million years ago, a tropical [climate](#) prevailed in our latitudes: It was warm and humid, as evidenced by fossils from Lake Geiseltal near Halle, for example. It was so warm, in fact, that [coral reefs](#) extended far to the north—to about the 45th degree of latitude, roughly the level of present-day southern France. Some of these tropical reef corals are now fossils in Leipzig University's Geological and Paleontological Collection. They come from the Paris Basin, a large marine bay that extended into what is now France.

Among these fossils, Professor Thomas Brachert and his team found some very special corals: They were not fossilized like many others, but escaped this process. "This makes them a wonderful environmental archive. A coral skeleton grows every year much like a tree. But what is special about it is that the skeleton is something of an archive of several hundreds to a thousand years of climate history," said Professor Thomas Brachert from the Institute of Geophysics and Geology at Leipzig University.



Professor Thomas Brachert discovered the special tropical reef corals in the Geological and Palaeontological Collection of Leipzig University. Credit: Stefan Krüger

Skeleton reveals small seasonal temperature fluctuations

The geologist and his team took samples from the coral's calcareous skeleton and analyzed the material using geochemical methods. Based on the chemical properties, the scientists were able to deduce the

temperature of the water in which the corals lived. The ratio of oxygen isotopes in the samples showed that the seasonal temperature differences were very small for this latitude. They correspond to about half of the current value of 15 degrees Celsius difference between seasons. "This means that our study confirms what had been expected but could never be measured so well: the fact that there were very small seasonal differences in the planet's warm periods," says Brachert.

New discovery: Corals already lived in symbiosis back then

The researchers also investigated the feeding habits of corals 40 million years ago. By analyzing the carbon isotopes, they were able to show for the first time that even back then corals lived in a [symbiosis](#) with unicellular "[algae](#)," so-called [zooxanthellae](#). These perform photosynthesis, giving the sugar they produce to the coral. The coral in turn digests the sugar and returns important nutrients to the algae for photosynthesis. But if the seawater gets too hot, the corals expel the algae and starve to death. So they were already susceptible to coral bleaching back then and probably affected by it repeatedly.



Skeletal structure of tropical reef corals at 20x magnification. An interruption in growth, clearly visible in the middle of the image, is due to a partial death of the coral colony and may have been caused by coral bleaching. Credit: Professor Thomas Brachert

Study data to improve current climate calculations

The research team's data not only allows conclusions to be drawn about the climate in the Middle Eocene, it can also be used to improve current climate models. "We can use our new findings about extreme warm periods as a comparison for the future. Our current computer models are based on assumptions that are not necessarily all correct. On the basis of

our data, we can make assessments of the extent to which these models provide useful results," summarized Professor Thomas Brachert.

More information: Thomas C. Brachert et al, Slow-growing reef corals as climate archives: A case study of the Middle Eocene Climatic Optimum 40 Ma ago, *Science Advances* (2022). [DOI: 10.1126/sciadv.abm3875](https://doi.org/10.1126/sciadv.abm3875)

Provided by Leipzig University

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