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Global Warming May Be to Blame for Sudden Collapse in Ancient Biodiversity

Scientists have unearthed striking evidence of a sudden collapse in plant biodiversity from a trove of 200-million-year-old fossil leaves collected in East Greenland that raises new concerns about the dangers of global warming. One of the most likely culprits for this great loss of plant life, to be reported in the Friday, June 19, issue of the journal *Science*, was a relatively small rise in the greenhouse gas carbon dioxide, which caused the Earth's temperature to rise.

The international team, which includes researchers from the Smithsonian's National Museum of Natural History, University College Dublin and the University of Oxford, found rapid reductions in the density of plant-fossil distribution in the samples collected. In analyzing the stratigraphy of the sampled areas, they found normal patterns of density and diversity of life in the first 20 meters. "But the final 10 meters show dramatic losses of diversity that far exceed what we can attribute to sampling error," said Peter Wagner, paleobiologist at the museum. "The ecosystems were supporting fewer and fewer species of notable abundance."

Global warming due to a rise in greenhouse gasses has long been considered a cause for the extinction of species. The surprise find from this new study is that it looks like much less carbon dioxide in the atmosphere is needed to drive an ecosystem beyond its tipping point than previously considered.

Despite the probability of a carbon dioxide-fueled extinction, lead author Jennifer McElwain of UCD cautions that additional atmospheric gasses such as sulfur dioxide from extensive volcanic emissions may also have played a role in plant extinctions. "The problem is that as yet we have no way of detecting changes in sulfur dioxide in the past, so it is difficult to evaluate if sulfur dioxide in addition to a rise in carbon dioxide influenced the pattern of extinction we see among the fossils," said McElwain.

The time interval under study, between the boundary of the Triassic and Jurassic periods, is known to have witnessed plant and animal extinction on a grand scale. However, until this work, the pace of the extinctions was thought to have been gradual, occurring over millions of years. It has been difficult to tease out details, such as the pace of extinction, using fossils because they can inherently provide only “snapshots” or glimpses of the organisms that once lived and thrived at different times in the past.

Using a new technique pioneered by Wagner, the team was able for the first time to detect very early signs that these ancient ecosystems were deteriorating before plants started going extinct. The method is pioneering in that it reveals the early warning signs that an ecosystem is at risk of extinction.

If estimates of how much carbon dioxide is needed to tip an ecosystem out of balance are correct, then the study may have alarming relevance to the modern world. By the year 2100, it is expected that the amount of carbon dioxide in the atmosphere may reach as high as two-and-a-half times today’s level, assuming a continued intensive use of fossil fuel energy. This is a worst-case scenario, but it is at exactly this level (900 parts per million) at which McElwain and co-authors detected their ancient biodiversity crash in the Late Triassic world of East Greenland.

“Our study on ancient ecosystems shows that we must take heed of the early warning signs of deterioration within modern ecosystems,” said McElwain. She also noted that very high levels of species extinctions can occur very suddenly, “but they are preceded by long interval of ecological change.”

The majority of modern ecosystems have not yet reached their tipping point in response to climate change. However, many have already entered a period of prolonged ecological change, and the early warning signs of deterioration are apparent. “Even relatively small changes in carbon dioxide and global temperature can have unexpectedly severe consequences for the health of ecosystems,” said McElwain.

The National Museum of Natural History, located at 10th Street and Constitution Avenue N.W. in Washington, D.C., is the most visited natural history museum in the world. For more information about the museum, go to www.mnh.si.edu.

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