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Affecting Evolution and Extinction

by David Pescovitz

Professor Anthony D. Barnosky, seen here in a cave searching for fossils, is also a curator at UC Berkeley's Museum of Paleontology.

Every so often, a huge number of species on Earth are wiped out relatively quickly. The last time a large extinction event occurred, between 50,000 and 10,000 years ago, two-thirds of large mammals were swept into the dustbin of history. Why? UC Berkeley paleontologist Anthony Barnosky sifts through the fossil record to understand how environmental changes can cause mammals to move, evolve, and sometimes die off. His research could even help reveal whether we're headed for another mass extinction.

"Rather than doing experiments, I use the natural experiments that have already taken place on Earth and study their remains," says Barnosky, a professor of Integrative Biology. "By interpreting the information in the fossil record, we can say something about how ongoing changes now are going to affect the ecosystems of the future."

Barnosky's work can be categorized into two areas based on the timescale that the environmental shifts occur. The first are climate changes that take place over thousands of years. The aim there, he says, is to differentiate between effects of climate change that are natural, and those that could be harbingers of a bigger problem. That way, the researchers can better determine how much impact, say, global warming, as a form of human-induced climate change, is having on mammals.

"Is part of being a species the fact that you move around in response to climate change and it's no big deal?" Barnosky says. "I'm trying to establish

a natural baseline of how much communities change in response to climate change in the past."

To do that, Barnosky and his research group dig deep into the sediment where they can find a recorded history of climate change. Comparing that data with the fossil record reveals how communities of mammals may have shifted as the climate changed. Late last year, Barnosky used this approach to investigate the cause of large mammal extinctions in the late Pleistocene period, 50,000 to 10,000 years ago.

Historically, scientists have thought that human populations of the time over-hunted, killing off animals such as mammoths, ground sloths, native American horses, and camels. However, Barnosky and his colleagues discovered that human impact wasn't the sole cause of the extinctions. Rather, climate change combined with the over-hunting was a "one-two punch" leading to the extinction, he says. The big concern, Barnosky says, is that the state of the planet then is not so different from today.

"We've ramped everything up," he says. "Global warming has never been faster and human populations are exploding exponentially. Realistically, I think the ecosystem will change pretty dramatically."

A jumble of fossil mammoth bones being excavated from a fossil site in southeastern Washington State. Mammoths, which looked like shaggy elephants, were hunted by prehistoric humans who arrived in North America about 11.4 thousand years ago, as shown by the close intermingling of spear-points with fossil mammal skeletons. However, they also went extinct coincident with climate change in areas where significant human presence has not been shown, such as Alaska, and coincident with climate change in areas where they had coexisted with humans for hundreds of thousands of years, such as parts of Europe. *(Anthony D. Barnosky photo)*

The second thread of Barnosky's research runs through the fossil record over millions of years rather than thousands. This is the time it takes the physical landscape to transform as mountain ranges push up from the Earth's surface and valleys form between them. Barnosky examines how these long-term physiographic changes correspond with evolutionary transformations.

"I'm interested in whether the formation of new species is driven solely by interactions between different species, like an arms race between predator and prey, or whether it's also caused by external changes in the physical environment," he says.

Again, the researchers look at geological records of how topography and climate of a particular region has changed over millions of years. Then they dive into their Miocene Mammal Mapping Project, a massive database they're building of all the fossil records of mammal species from the Western United States from about 5 million years ago to 30 million years ago. The database is integrated with layers of Geographic Information Science maps of the Western U.S.

"We can now trace how species move around through time and space," Barnosky says. "By comparing those patterns with the geologic information and the various expectations from evolution theory, you begin to get some answers."

For example, there is controversy among evolutionary biologists as to how much climate change impacts the evolutionary process. The thought is that as glaciers grow and melt, mammal populations will be separated in different ways, leading to speciation. To investigate the matter, Barnosky analyzed information in his database and compared that with other published information about mammal species that lived within the last 1.8 million years, a period when the climate shifted every 100,000 years or so. His research suggests that climate changes can indeed influence evolution, but only if the change lasts for at least a million years.

"All of this research is about coming up with better methods to understand the natural patterns of biodiversity," Barnosky says. "That way, we can really know when it's time to worry."

Related Web Sites

- Anthony D. Barnoksy's home page
- Barnosky Lab
- Miocene Mammal Mapping Project (MioMap)
- UC Berkeley Museum of Paleontology
- "Climate change plus human pressure caused large mammal extinctions in late Pleistocene" by Robert Sanders (Media Relations, 30 September 2004)
- "Colorado cave yields million-year-old record of evolution and climate change" by Robert Sanders (21 October 2003)