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Ancient African Megadroughts May Have Driven Human Evolution -- Out Of Africa

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Science Daily — From 135,000 to 90,000 years ago tropical Africa had megadroughts more extreme and widespread than any previously known for that region, according to new research.

Learning that now-lush tropical Africa was an arid scrubland during the early Late Pleistocene provides new insights into humans' migration out of Africa and the evolution of fishes in Africa's Great Lakes.

"Lake Malawi, one of the deepest lakes in the world, acts as a rain gauge," said lead scientist Andrew S. Cohen of The University of Arizona in Tucson. "The lake level dropped at least 600 meters (1,968 feet) -- an extraordinary amount of water lost from the lake. This tells us that it was much drier at that time." He added, "Archaeological evidence shows relatively few signs of human occupation in tropical Africa during the megadrought period."

The dynamically-positioned drilling barge Viphya, departing port. Lake Malawi is one of the world's largest and deepest lakes, and along with Lake Tanganyika contains more than 80% of the surface freshwater on the African continent. New drill core evidence shows that the 700 m-deep lake was reduced by more than 500 m prior to 75,000 years ago, indicating periods of severe aridity.

The new finding provides an ecological explanation for the Out-of-Africa theory that suggests all humans descended from just a few people living in Africa sometime between 150,000 and 70,000 years ago. "We've got an explanation for why that might have occurred -- tropical Africa was extraordinarily dry about 100,000 years ago," said Cohen, a UA professor of geosciences. "Maybe human populations just crashed."

Other researchers have documented droughts in individual regions of Africa at that time, such as the Kalahari desert expanding north and the Sahel expanding south, he said. "But no one had put it together that those droughts were part of a bigger picture."

Tropical Africa's climate became wetter by 70,000 years ago, a time for which there is evidence of more people in the region and of people moving north. As the population rebounded, people left Africa, Cohen said.

The newly discovered drastic drought also suggests the famous cichlid fishes of Lake Malawi evolved four to eight times slower than previously thought, altering scientists' view of fish evolution in the African Great Lakes.

Cohen and his colleagues have been working for years to learn more about ancient Africa's climate and ecology by coring Africa's deepest lakes.

The scientists discovered the ancient megadroughts by studying sediments cored from the bottom of Lake Malawi, an African rift lake that is currently 2,316 feet (706 meters) deep, and comparing those findings with similar records from Lakes Tanganyika and Bosumtwi. "What's unique about the Malawi, Tanganyika and Bosumtwi cores is that they're continuous records. We can see what happened in one place over a long period of time," Cohen said.

Extracting cores from Lake Malawi required the kind of rig used in ocean-going drilling expeditions. Those

expeditions just sail a drill-equipped ship to the desired site.

However, the Lake Malawi Drilling Project's target was land-locked. The international research team collected the equipment necessary, shipped it overland, rented a barge and outfitted it to become a scientific drilling vessel. They equipped the ship, M/V Viphya, with the type of GPS positioning system needed to hold the large ship steady under windy and wavy conditions. The drilling equipment was lowered 1,942 feet (592 meters) to the lake bottom and bored into the lake's sediment another 1247 feet (380 meters). If the ship didn't hold its position over the drilling site, the expensive drilling equipment might snap.

The work was successful -- the team extracted a series of cores, some as much as 1247 feet (380 meters) long, representing hundreds of thousands of years of African history. Such lake cores contain a high-resolution record of the things that fell in or died in the lake -- plankton, aquatic invertebrates, charcoal from fires on land, pollen from the surrounding vegetation. Scientists analyze those materials to figure out what the vegetation and the lake conditions were like at a particular point in time. The researchers used radiocarbon and other dating techniques to establish the age of regions of the Malawi cores. Then researchers took samples at 300-year-intervals. Samples from the megadrought times had little pollen or charcoal, suggesting sparse vegetation with little to burn.

Cohen said, "The area around Lake Malawi, which today is heavily forested and has rainfall levels comparable to the southeastern U.S., at that time would have looked like Tucson." One indicator of drought present in the cores were species of invertebrates and plankton that only live in shallow, turbid, algae-rich waters -- a situation very different from the deep, clearwater lake that Malawi is now. "During the megadrought, Lake Malawi was algae-filled and pea-soup green, much like modern-day Lake Turkana," Cohen said. "Lake Turkana is known as the Jade Sea." The African Great Lakes are known for the spectacular biological diversity of their cichlid fish species, which number in the hundreds. A dramatic increase in the number of species was thought to happened after a dry spell about 25,000 to 15,000 years ago.

In contrast, Cohen and his colleagues suggest that the rise in species diversity happened after the megadroughts. By 70,000 years ago the lake had risen to more or less its current level and it had become a freshwater lake as it is today.

Although the team has used the lake cores to peer back in time 150,000 years, there's still much more to do: the Lake Malawi core represents as much as 1.5 million years of tropical Africa's past.

The research article by Cohen, UA researchers Jeffery Stone, Peter Reinthal and David Dettman and their colleagues, "Ecological consequences of early Late Pleistocene megadroughts in tropical Africa," is scheduled for early online publication the week of Oct. 8 in the Proceedings of the National Academy of Sciences. Another article by members of the Lake Malawi Drilling Project, "East African megadroughts between 135 and 75 thousand years ago and bearing on early-modern human origins," is online at the Proceedings of the National Academy of Sciences. Christopher Scholz of Syracuse University in N.Y. is first author and Cohen and others are co-authors.

Both articles are scheduled for publication in the Oct. 16, 2007, print edition of the Proceedings of the National Academy of Sciences. A full list of authors for each article is at the end of this release. The National Science Foundation, the International Continental Drilling Program and the Smithsonian Institution funded the research. Cohen's co-authors on "Ecological consequences of early Late Pleistocene megadroughts in tropical Africa" are David Dettman and Peter N. Reinthal of The University of Arizona; Jeffery R. Stone of The University of Arizona and the University of Nebraska at Lincoln; Kristina R. M. Beuning and Sarah J. Ivory of the University of Wisconsin-Eau Claire; Lisa E. Park of the University of Akron in Ohio; Christopher A. Scholz of Syracuse University in N.Y.; Thomas C. Johnson and Erik T. Brown of the University of Minnesota, Duluth; John W. King of the University of Rhode Island at Narragansett; and Michael R. Talbot of the University of Bergen in Norway.

Cohen's co-authors on "East African megadroughts between 135 and 75 thousand years ago and bearing on early-modern human origins," are Christopher A. Scholz and Robert P. Lyons of Syracuse University in N.Y.; Thomas C. Johnson, Erik T. Brown and Isla S. Castaneda of the University of Minnesota, Duluth; Jonathan T. Overpeck and Timothy M. Shanahan of The University of Arizona; John W. King and Clifford W. Heil of the University of Rhode Island at Narragansett; John Peck of the University of Akron, Ohio; Michael R. Talbot of the University of Bergen in Norway; Leonard Kalindekafe of the Malawi Geological Survey Department in Zomba; Philip Y. O. Amoako of the Geological Survey Department of Ghana in Accra; Steven L. Forman, Jeanette Gomez and James Pierson of the University of Illinois at Chicago; Lanny R. McHargue of the Scottish Universities Environmental Research Centre in East Kilbride; and Kristina R. Beuning of the University of Wisconsin-Eau Claire.