EVOLUTION

Evolutionary Pulse Found, But Complexity as Well

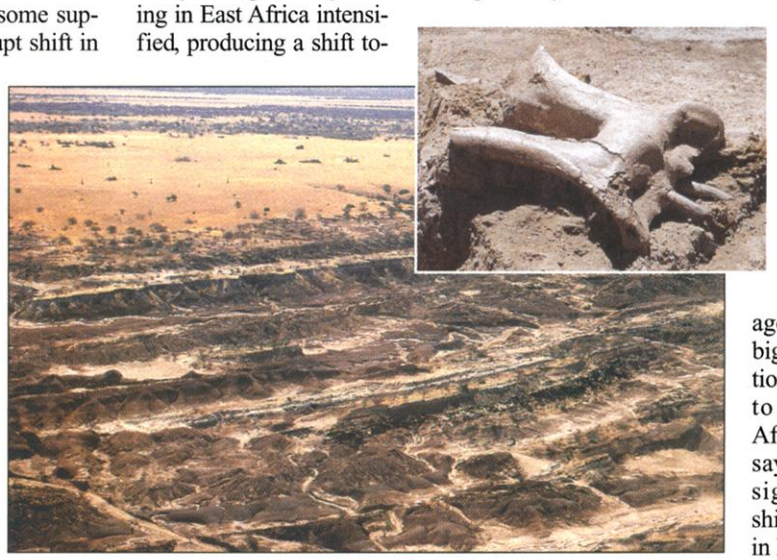
East African animals responded to abrupt climate change 2.8 million years ago, but climate's effect on human ancestors remains unclear

Species come and species go. A huge asteroid or comet brought an untimely end to all the dinosaurs, giving mammals their chance, but why are we humans dominating the planet rather than some big, furry equivalent of *Tyrannosaurus rex*? The answer, according to one much-discussed theory, is climate change: The world took an abrupt step toward glaciation, the East African cradle of the human species dried to grasslands, and human ancestors coped with dwindling forests by evolving bigger and better brains (*Science*, 26 July 1996, p. 431).

A new study of one of the best fossil records for testing the connection between climate and human origins lends some support to the theory: It finds an abrupt shift in East African species that coincided with a known climate change 2.8 million years ago. But the story emerging from East Africa is not a simple one, and the link to human evolution remains tenuous at best. "The record is really quite rich and very complex in terms of the variety of faunal changes at this time," says paleontologist René Bobe of the Smithsonian Institution's National Museum of Natural History (NMNH) in Washington, D.C. He published the analysis of fossils from southern Ethiopia in the current issue of *Paleobiology Memoirs* with Gerald Eck of the University of Washington, Seattle.

The fossils that Bobe and Eck analyzed were collected by an international consortium, which included Eck, in the 1960s and '70s. Each day in the field—in the Omo River valley of far southern Ethiopia—Eck and his crew would systematically collect all the fossils of certain types visible in a representative cross section of the Shungura Formation, an eroded pile of sediments almost 800 meters thick laid down by a meandering river. This systematic approach yielded a statistically workable number of reasonably representative fossils from a single formation. And the age of each fossil was particularly well known, which would allow dating of any response of animals to climate.

Bobe and Eck whittled the total collection of 22,335 specimens of mammalian crania, jaws, horns, teeth, and foot bones down to 4233 bovid fossils—the remains of grass-grazing animals such as antelopes, gazelles, wildebeests, and buffaloes—that met rigorous collection criteria. The two researchers then calculated how the abundance of each taxon varied between 2 million and 3 million years ago. "We found a significant shift in abundance [of bovid taxa] at about 2.8 million years ago," says Bobe, "followed by continuing but more gradual change 2.8 million to 2.0 million years ago." It was 2.8 million years ago that cycles of cooling and drying in East Africa intensified, producing a shift toward grassier environments (*Science*, 14 January 1994, p. 173). These changes, in turn, resulted in the jump in the number of bovids adapted to those environments, Bobe and Eck conclude.



Mammal treasure trove. East Africa's Shungura Formation holds a wealth of 2-million- to 3-million-year-old fossils, like this hippo mandible.

CREDITS: G. ECK

Paleontologist Elizabeth Vrba of Yale University has long argued that bovids around Africa underwent a "turnover pulse" about 2.8 million years ago, as the climate shift triggered a surge of both extinctions of existing species and originations of new ones. Although Bobe and Eck tracked changing abundances of various bovids rather than the turnover of species, "my results could be very compatible," she says. "This is so close in timing to what has been proposed, it fits very well."

Paleontologist Anna K. Behrensmeyer of NMNH has also reported a shift in species in that era, but she found a different pattern: a gradual transition but no pulse in mammalian fossil data from the Turkana Basin just to the south of Omo (*Science*, 26 July 1996, p. 431). The three studies could be seeing different aspects of climate-related animal evolution—a spurt of extinctions and originations or gradual changes in abundance—depending on the type of analysis and the particular fossil collection, she notes. Still, Bobe and Eck's analysis suggests that "2.8 million years ago does seem to be a time of particular turnover" that coincides with the climate shift, she says. "Global-scale climate change was penetrating this area enough to be correlated with species turnover around 2.8 million years ago." But then change continued, only it involved changing species abundances, not extinctions.

Just how complex the climate-evolution link might be is further illustrated by an as-yet-unpublished study by John Barry of Harvard University and his colleagues about fossils from the late Miocene epoch in Pakistan. About 8 million years ago, when grasslands surged into dominance in Pakistan, the number of new species jumped, but extinctions didn't climb until half a million years later. Earlier, 10.3 million years ago, animals experienced "a big turnover" of both extinctions and originations similar to the pulse Vrba sees in Africa 2.8 million years ago, says Barry, but there is no sign of a climate-induced shift in grassland dominance in Pakistan at that time.

Paleontologists agree that many more studies like these are needed to establish any firm link between climate and animal evolution. Extending the chain to human origins looks even more daunting—especially because the recent discovery of two very ancient hominid fossils has confused the picture of early human evolution (*Science*, 13 July, p. 187). "You find a couple new [hominid] fossils, and all of a sudden you have a whole new branch on the family tree," says Bobe. "With the more recent [fossil] discoveries from Kenya, it's now very unclear" when a key branching in the hominid family tree once dated at 2.8 million years ago actually occurred. The "why" of human origins must await a clearer "how." **–RICHARD A. KERR**