Long-term study shows effect of climate change on animal diversity

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Two species of giraffe, several rhinos and five elephant relatives, along with multitudes of rodents, bush pigs, horses, antelope and apes, once inhabited what is now northern Pakistan.

But when climate shifted dramatically there some 8 million years ago, precipitating a major change in vegetation, most species became locally extinct rather than adapting to the new ecosystem, according to an extensive, long-term study of mammal fossils spanning a 5-million-year period.

Results of the study, by University of Michigan paleoecologist Catherine Badgley and coworkers, are scheduled to be published online in the *Proceedings of the National Academy of Sciences* the week of Aug. 18.

The work has value not only in reconstructing Earth's past, but also for understanding what may lie ahead if current climate trends continue, Badgley said. "Climate is going to produce changes in ecological structure of all sorts of plants and animals around the world, now as in the past. The fossil record can help us understand how much---or how little---climate change is necessary to produce changes in ecosystems."

Badgley is part of an interdisciplinary team of geologists and paleontologists that has been studying the fossil-rich Siwalik sedimentary rocks in northern Pakistan for more than 30 years. The Siwalik Group of sediments contains one of the world's most complete and best-studied fossil records of mammals, chronicling in a two-mile-thick deposit of

rock the mammals that roamed the area from 18 to 1 million years ago. About 8 million years ago, the local climate became drier, and the prevailing vegetation changed from tropical forests and woodland to a savannah similar to that found in parts of Africa today.

What happened next can be reconstructed from the chemistry and wear of the teeth of the plant-eating mammals, as well as the longevity of each species during the period when vegetation was changing. The teeth provide evidence of the animals' diets, revealing whether they switched to eating the newly abundant grasses when their favored fruits and broad-leafed plants were no longer available.

Mammals that relied on fruit and browse disappeared early in the transition from forest to savannah vegetation and were not replaced, while those that ate broad leaves and grasses either adapted and persisted by changing their diets to include more grass or disappeared and were replaced by immigrant species with similar diets. By the time that savannah was the dominant vegetation, most herbivorous mammals in the area subsisted mainly on grass. The overall effect was a significant decline in the diversity of mammals in the area.

"We see quite a different ecological profile of the kinds of mammals that coexisted after this climate change than before," said Badgley, who is an assistant professor of ecology and evolutionary biology, as well as a research scientist in the Department of Geological Sciences and the Museum of Paleontology. "It's clear that climate has had an impact on the ecological diversity of mammals in the area."

In addition to providing compelling evidence for the effects of climate change on ecological systems, the paper is a testament to the value of long-term research in a single field area, Badgley said. "This is the kind of study you can only do after you've been working in a place with a big team for 25 years or more, because you need all the other basic data to

be thoroughly resolved before you can even start to address the kinds of questions in this work. We've been fortunate to have a team that found the various research topics so worthwhile and so interesting that they stuck with it for several decades, and we've also been fortunate to receive funding for field work for that long."

Source: University of Michigan