Climate change and mountain building led to mammal diversity patterns

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Golden-mantled ground squirrel in Utah mountains and fossil squirrel jaw document high rodent diversity in topographically complex western North America today and 16 million years ago. Credit: Squirrel photo by Catherine Badgley Fossil rodent jaw photo by University of California Museum of Paleontology, Topographic pattern from MyTopo

Travel from the tropics to the poles, and you'll notice that the diversity of mammals declines with distance from the equator. Move from lowland to mountains, and you'll see diversity increase as the landscape becomes more varied. Ecologists have proposed various explanations for these well-known "biodiversity gradients," invoking ecological, evolutionary and historical processes.

New findings by University of Michigan researchers John A. Finarelli and Catherine Badgley suggest that the elevational patterns of diversity we see today have appeared, disappeared and reappeared over Earth's history and that these patterns arise from interactions between climate change and mountain building.

The results, published online in the journal Proceedings of the Royal Society B, also have implications for conservation efforts in the face of modern-day global warming, said Finarelli, a visiting assistant professor in the Department of Geological Sciences.

In their study, focused on the Miocene Epoch, which began around 23 million years ago and ended about 5 million years ago, Finarelli and Badgley evaluated diversity for more than 400 rodent species from adjacent regions that differed in geologic history and topography. The geologically "active region," which extends from the Front Range of the Rocky Mountains to the Pacific coast, has experienced several episodes of mountain-building and volcanic activity, and as a result has a topographically complex landscape. In contrast, the relatively flat Great Plains, has been more stable geologically.

The prevailing notion has been that diversity is greater in mountainous regions than in lowlands simply because the topography is more complex. As mountains rise up, new habitats are created, and areas that once were continuous become fragmented. Such changes offer opportunities for new species to arise, increasing diversity.

But climate also enters in, the new study shows. During the Miocene, long-term, global cooling was interrupted by warm intervals. In the active region, diversity increased during a warm interval from 17 to 14 million years ago that coincided with intensified mountain building and volcanic activity, the analysis revealed. During subsequent cooling, diversity declined in the mountains and increased on the plains.

"This pattern suggests that the elevational diversity gradient arises during historical episodes associated with global warming and mountain building," said Badgley, an assistant professor in the Department of Ecology and Evolutionary Biology and a research scientist in the Museum of Paleontology and the Department of Geological Sciences. "This gradient is not a long-term feature of North American biodiversity."

Although the research focused on ancient ecosystems, the findings have implications for modern times, Finarelli said. "Based on our finding that more complex regions are more sensitive to climate change, threatened areas in mountainous regions should be a particular conservation concern, with respect to human-mediated climate change."

The work also highlights the importance of studies that merge the disciplines of paleontology and biogeography, Finarelli said. "By marrying the two subjects, we can gain a better insight into the ecological and evolutionary processes shaping the world around us."

Provided by University of Michigan

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