

Stable temperatures boost biodiversity in tropical mountains

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We often think of rainforests and coral reefs as hotspots for biodiversity, but mountains are treasure troves for species too -- especially in the tropics, scientists say. But what drives montane biodiversity? The diversity of plants and animals in tropical mountain ranges may have something to do with the stable seasonal temperatures found in the tropics relative to higher latitudes, says a new study by scientists working at the US National Evolutionary Synthesis Center.

The study, based on nearly 200 [species](#) of bats, birds, frogs, lizards and snakes, also suggests that tropical montane species may be less flexible than their temperate counterparts in the face of climate change, the authors say. The results appeared last week in [Proceedings of the Royal Society B](#).

Montane regions are home to many species found only there and nowhere else, said lead author Daniel Cadena of the Universidad de los Andes. Steep gradients in elevation and vegetation in montane zones bolster biodiversity by offering many habitats within a small geographical area, Cadena added. "Whereas a lowland area like a rainforest offers the same habitat over a large distance, [mountain](#) areas can go from lowland tropical forest, to cloud forest, to pine forest to paramo over a very short distance," said co-author Ken Kozak of the University of Minnesota-Twin Cities.

This environmental heterogeneity makes montane regions especially rich in a pattern of biodiversity called beta diversity, in which the species composition changes as you move from one area to the next. "As you go up a mountain, two elevations may each have ten species but only share five in common," Kozak said.

The researchers wanted to know why montane biodiversity is especially high in the tropics compared to temperate latitudes. To find out, they compiled location and climate data for nearly 200

species of bats, birds, frogs, lizards and snakes living in montane regions in North, South, and Central America.

When they compared mountain ecosystems in tropical and temperate zones, they found that species living in tropical mountains experienced much milder seasonal temperature swings than their temperate counterparts. A frog living at 2000m in the Andes, for example, might experience temperature fluctuations of only 10 degrees between summer and winter, whereas a frog at the same elevation in the Rockies might experience seasonal temperature swings of 40 degrees or more.

Temperatures naturally change as you move up or down a mountain, the researchers explained. But as one moves southward on the globe from the poles toward the equator, seasonal temperature swings begin to stabilize. "Tolerance to extreme temperatures is much narrower for tropical montane species relative to temperate species," Cadena explained.

The researchers also looked at pairs of species that had recently diverged, and found that tropical species stayed more constant in their temperature preferences as one species split into two. "The thermal niches of tropical species tend to be more evolutionarily conserved over long periods of time relative to temperate zone species," Cadena added.

"The inability of many tropical species to adapt to climate conditions at other elevations forces them to stay in the particular zone that they're in, and is a key ingredient that drives the formation of new species" Kozak said. Given the inevitable climatic differences between mountain peaks and valleys, this inability to budge may prevent tropical montane species from dispersing to other elevations. Over time, the isolation leads to populations diverging to form new species, the authors explained.

"In contrast, in temperate mountains, seasonal temperature swings mean that at some point during the year the species at the bottom of a mountain experience the same cold temperatures found at the top of the mountain. So mountain peaks and valleys don't create the same barriers to dispersal which would normally cause the formation of new species," Kozak said.

The same narrow temperature tolerance that seems to boost biodiversity in tropical mountains may also make tropical montane species more vulnerable to global warming, the authors said.

"Our results suggest that maybe tropical species are less flexible, and they might be more affected by climate change," Cadena said.

More information: Cadena, C., K. Kozak, et al. (2011). "Latitude, elevational climatic zonation, and speciation in New World vertebrates." *Proceedings of the Royal Society B*. doi: [10.1098/rspb.2011.0720](https://doi.org/10.1098/rspb.2011.0720)

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