Research finds global precipitation patterns a driver for animal diversity

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With access to a mammoth set of global-scale climate data and a novel strategy, a team from Utah State University identified several factors to help answer a fundamental ecological question: what an animal eats (and how that interacts with climate) shapes Earth's diversity. Credit: Wikimedia

Since the HMS Beagle arrived in the Galapagos with Charles Darwin to meet a fateful family of finches, ecologists have struggled to understand a particularly perplexing question: Why is there a ridiculous abundance

of species some places on Earth and a scarcity in others? What factors, exactly, drive animal diversity?

With access to a mammoth set of global-scale climate data and a novel strategy, a team from the Department of Watershed Sciences in Quinney College of Natural Resources and the Ecology Center identified several factors to help answer this fundamental ecological question. They discovered that what an animal eats (and how that interacts with climate) shapes Earth's diversity.

The work was recently published in the journal *Ecology Letters*.

"Historically studies looking at the distribution of species across Earth's latitudinal gradient have overlooked the role of trophic ecology—how what animals eat impacts where they are found," said Trisha Atwood, author on the study from the Department of Watershed Sciences and the Ecology Center. "This new work shows that predators, omnivores and herbivores are not randomly scattered across the globe. There are patterns to where we find these groups of animals."

Certain locations have an unexpected abundance of meat-eating predators—parts of Africa, Europe and Greenland. Herbivores are common in cooler areas, and omnivores tend to be more dominant in warm places. Two key factors emerged as crucial in shaping these patterns: precipitation and plant growth.

Precipitation patterns across time play a big role in determining where different groups of mammals thrive, Atwood said. Geographical areas where precipitation varies by season, without being too extreme, had the highest levels of mammal diversity.

"Keep in mind that we aren't talking about the total amount of rain," said Jaron Adkins, lead author on the research. "If you imagine ecosystems

around the world on a scale of precipitation and season, certain places in Utah and the Amazon rainforest fall on one end with low variability—they have steady levels of precipitation throughout the year. Other regions, like southern California, have really high variability, getting about 75 percent of the annual precipitation between December and March."

But the sweet spot for predators and herbivores fell in a middle zone between the two extremes, he said. Places like Madagascar, where precipitation patterns had an equal split between a wet season and a dry one (six months each), had the ideal ecological cocktail for promoting conditions for these two groups. Omnivore diversity tends to thrive in places with very stable climates.

The second important factor connected with mammal diversity the work uncovered was a measure of the amount of plant growth in an area, measured as "gross primary productivity."

"It makes intuitive sense for plant-eating animals to benefit from plant growth," Adkins said.

But this measure actually impacted carnivores most, according to the research. The strong relationship between predators and plant growth highlights the importance of an abundance of plants on an entire food chain's structural integrity.

"It was surprising that this factor was more important for predators than omnivores and herbivores," Atwood said. "Why this is remains a mystery."

Although evolutionary processes are ultimately responsible for spurring differences in species, climate conditions can impact related factors—rates of evolutionary change, extinction and animal

dispersal—influencing species and trait-based richness, according to the research.

Animal diversity is rapidly declining in many ecosystems around the world through habitat loss and climate change. This has negative consequences for ecosystems. Forecasting how climate change will disrupt animal systems going forward is extremely important, Atwood said, and this research is a first step in better managing future conditions for animals around the world.

"Animal diversity can act as an alarm system for the stability of ecosystems," Atwood said. "Identifying the ecological mechanisms that help drive richness patterns provides insight for better managing and predicting how diversity could change under future climates."

In addition to Adkins and Atwood, the research included seven authors currently or previously associated with the Department of Watershed Sciences and the Ecology Center: Edd Hammill, Umarfarooq Abdulwahab, John Draper, Marshall Wolf, Catherine McClure, Adrián González Ortiz and Emily Chavez.

More information: Jaron Adkins et al, Environmental variables drive spatial patterns of trophic diversity in mammals, *Ecology Letters* (2023). DOI: 10.1111/ele.14306

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