Climate change hastens extinction in Madagascar's reptiles and amphibians

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New research from the American Museum of Natural History provides the first detailed study showing that global warming forces species to move up tropical mountains as their habitats shift upward. Christopher Raxworthy, Associate Curator in the Department of Herpetology, predicts that at least three species of amphibians and reptiles found in Madagascar's mountainous north could go extinct between 2050 and 2100 because of habitat loss associated with rising global temperatures. These species, currently moving upslope to compensate for habitat loss at lower and warmer altitudes, will eventually have no place to move to.

"Two things together—highly localized distribution close to the very highest summits, and the magnitude of these upslope shifts in response to ongoing warming—make a poisonous cocktail for extinction," said Raxworthy.

In a paper published this month in *Global Change Biology*, Raxworthy and colleagues found overall trends for elevation changes among 30 species of amphibians and reptiles. Uphill movement is a predicted response to increased temperatures, and other studies, including that of J. Alan Pounds in Costa Rica, have provided some empirical evidence of how tropical animals respond to climate change. Raxworthy's research, however, is distinguished by the number and diversity of species, the demonstrated meteorological changes over the same time period, the relatively large shifts in elevation, and the broader assessment of extinction vulnerability for tropical montane communities. Currently, there is also a dearth of information available concerning climate

impacts on biodiversity for tropical regions.

Raxworthy has been surveying the diversity of Madagascar's herpetological assemblage since 1985 and discovered the uphill migration almost by chance while in the field. On repeated surveys of northern Madagascar's mountains, the Tsaratanana Massif, he noticed that some species were missing from camps where they'd been previously observed. Moreover, some of these "missing" species popped up at the next higher elevation surveyed. "I noted this in the field as strange, but when I later sat down and looked at the data, the trend persisted," Raxworthy explains. He culled elevation records and was able to compare surveys of animals over a ten-year period.

The results were dramatic. Among 30 species of geckos, skinks, chameleons, and frogs, and controlling for sampling effort, an average shift uphill of 19 to 51 meters (62 to 167 feet) was observed over the decade. When these results were compared with meteorological records and climate change simulations, the movement of animals could be linked to temperature increases of 0.1°C to 0.37°C (0.18°F to 0.67°F) over the same decade, which corresponds to an expected upslope movement of 17 to 74 meters (59 to 243 feet). Raxworthy's results are robust because of the diversity of species included in his analyses. These animals come from five different families of amphibians and reptiles—narrow-mouthed toads, mantelline frogs, chameleons, geckos, and skinks—making it unlikely that a simple phenological change could explain the upward movement. "When you see a general trend across all these groups of organisms, it is likely to be related to a broad explanation like general temperature warming, not something more subtle such as seasonal variation," says Raxworthy.

The direct link between observed movement up mountains, possible extinction, and climate change has consequences for Madagascar's network of national parks. The government of Madagascar is currently

planning to set aside 10 percent of its landmass for conservation purposes, and previous research by Raxworthy and colleagues published in Science in April used the distribution of 2,300 species of animals to map the areas of this island nation that provide adequate habitat for all species. "The Malagasy government is creating important new reserves and protecting forests. Sadly, however, with a phenomenon like global warming, species will move upslope, and so eventually may still lose all their habitat and go extinct," says Raxworthy. "This conservation problem thus requires a global solution."

Source: American Museum of Natural History