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The role of geomorphology and climate on macroevolutionary processes in Madagascar and Sri Lanka

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Geomorpholgical processes can have a large impact on terrestrial ecosystem evolution and can therefore play an important role in macroevolutionary processes through time. We investigate how landscape evolution and climate interact to alter the connectivity and spatial distribution of habitats and influence gene flow and range limits of communities within these habitats. Present mammal species distribution, climate and topography of two passive margin islands, Madagascar and Sri Lanka, were used to investigate and define the current habitat distribution of both islands. We then used numerical modeling experiments to explore how habitats evolve through geological time to define habitat distribution, fragmentation, and connectivity. We predicted orographic precipitation patterns on a series of landscape evolution models, and habitats were defined using a combination of precipitation rate and elevation.

Madagascar and Sri Lanka are passive margin environments where drainage basin geometry is largely driven by flexural isostasy along the island margins in response to erosion of steep escarpments. Sri Lanka and Madagascar have a relatively thick and thin effective elastic thickness (Te) compared to island area, respectively, making the two islands end-members natural laboratories to observe how drainage basin evolution coupled with climate can influence biodiversity. In the case of Madagascar, where Te is thin, isostatic rebound along the island margin occurs at small wavelengths and rivers are diverted close to the island margin, resulting in the formation of large, high elevation or “perched” catchments. Where Te is relatively high, like in Sri Lanka, the wavelength of isostatic rebound is larger, and escarpment retreat occurs more rapidly. This difference in drainage basin geometry and topography also has an important effect on altitudinal temperature and orographic precipitation gradients. We find that this coupling between landscape evolution and climate can influence habitat and species distribution, particularly those with restricted species ranges. These interactions shed light on the macroevolutionary processes leading to spatial distribution of locally endemic biota that are especially vulnerable to habitat and climate change.