Submitted Abstract

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Abstract

von Humboldt's tree-line concept has dominated mountain ecology for almost two hundred years and is considered a key indicator for monitoring change in biome boundaries and biodiversity shifts under climate change. Even though the concept of life zones and elevation gradients are a globally observed phenomenon, they have not been thoroughly explored for many contexts. One such example is the tree-line ecotone, a widely used conceptual tool to track climate change in many regions, which has limited application in the widespread tree-sparse, grassy systems that comprise a third of the world's mountain systems. Among grasses (Poaceae), the temperature is linked to variation in photosynthetic performance and community dominance for C3 and C4 metabolic groups, due to its role in limiting photorespiration in the C3 photosynthesis process. Here, we investigate this community shift in grassland-dominated mountains to demonstrate the role of climate in driving this transition and discuss the potential applications of this tool to mountain ecosystem conservation worldwide. For identifying grass-dominated mountains worldwide, we measured the grass cover using satellite data. We then compiled Poaceae distribution data for ten grass-dominated mountains spanning from 42°S to 41°N and determined the temperature intervals and elevation range at which each genus was found, testing for effects of temperature, precipitation, and latitudinal gradients on the dominance of C3-C4 grasses. The temperature was the main driver of C3 dominance, with the richness of C3 genera tending to surpass the taxonomic dominance of C4 plants along mountain temperature gradients where the annual mean temperature was colder than ca. 14.6°C. Similar patterns were observed in eight out of ten mountains, suggesting that this may constitute an isotherm-driven ecotone. Consequently, this C3-C4 transition offers a promising tool for monitoring climate change impacts in grassy mountains. C3-C4 grass community shifts in response to environmental change will likely have major implications for fire frequency and severity, rangeland productivity and livelihoods, food security, and water budgets in mountain systems. Given the severity of the implications of global change on these social-ecological systems, we propose that a "grass-line" monitoring protocol be developed for global application.