Climate and Nutrient-Driven Regime Shifts of Cyanobacterial Communities in Low-Latitude Plateau Lakes

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Cyanobacterial blooms that form in response to climate warming and nutrient enrichment in freshwater lakes have become a global environmental challenge. Historical legacy effects and the mechanisms underlying cyanobacterial community succession are not well understood, especially for plateau lakes that are important global freshwater resources. This study investigated the temporal dynamics of cyanobacterial communities over centuries in response to nutrient enrichment and climate warming in low-latitude plateau lakes using high-throughput DNA sequencing of sedimentary DNA combined with traditional paleolimnological analyses. Our results

confirmed that nutrients and climate warming drive shifts in cyanobacterial communities over time. Cyanobacterial community turnover was pronounced with regime shifts toward new ecological states, occurring after exceeding a tipping point of aquatic total phosphorus (TP). The inferred species interactions, niche differentiation, and identity of keystone taxa significantly changed after crossing the aquatic TP ecological threshold, as demonstrated by network analysis of cyanobacterial taxa. Further, the contribution of aquatic TP to cyanobacterial community dynamics was greater than that of air temperature when lakes were in an oligotrophic state. In contrast, as the aquatic TP threshold was exceeded, the contribution to community dynamics by air temperature increased and potentially surpassed that of aquatic TP. Overall, these results provide new evidence for how past nutrient levels in lacustrine ecosystems influence contemporary cyanobacterial community responses to global warming in low-latitude plateau lakes.

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