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Transitions and multistability in macroevolutionary dynamics of large mammals

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On multi-million-year timescales, the climate system of the Earth exhibits complex wandering behaviour. We investigate the evolutionary impacts of long-term climate change by analysing the dynamics of Cenozoic mammal evolution, looking for the presence of state transitions, stable equilibrium states and their association with long-term climate evolution. We perform Bayesian modelling of Artiodactyla, Carnivora, and Perissodactyla evolutionary histories. We then use recurrence plot analysis of the species richness time series, identifying the main transitions and regimes in large mammal evolution. Joint recurrence plots of diversity-Cenozoic oxygen isotope record as well as recurrence quantification analysis are used to further investigate the coupled dynamics of climate and mammal evolution. We find that several transitions between different states of the long-term climate evolution correspond to subsequent transitions and multistable states of diversity. The evidence for several climate transitions is recovered from joint recurrence states of diversity time series alone, indicating coordinated behaviour of three different mammalian orders and climate. The diversity fluctuations increase in amplitude during the Coolhouse regime in Oligocene and Miocene, with the diversity evolution starting an unprecedented decline during the Icehouse. Our results suggest that mammal diversity evolution has been coupled with the dynamical state of paleoclimate on multi-million-year timescales.

Key words: Mammalia, macroevolution, evolution, nonlinear dynamics, recurrence plots.

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