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Life history variation and environmental fluctuations jointly shape extinction risk of a population

For many species, life history processes and individual fitness are highly dependent on temperature. Fluctuations around some mean temperature can promote coexistence, prolong persistence times, and alter the overall species composition in a community. These effects are mediated by the thermal response of individual fitness to temperature. In this study we investigate how a population's extinction risk is altered by its environment (mean and variance of temperature fluctuations) using individual thermal response curves. We identify the amount of variation that creates different levels of population extinction risk over timescales between 10 days and 200 years. We also ask how life history variation changes the relationship between the mean and variance of the environment and the risk of extinction. We approximate a set of ordinary differential equations with a Gillespie algorithm where waiting times between birth, death, and fluctuation events are Exponentially distributed. We allow one parameter of individual fitness to follow a Gamma distribution creating intraspecific life history variation. Individual's traits are not heritable but are instead stochastic outcomes of a single distribution, leading to standing variation within a population. We find that population extinction risk is nonlinearly dependent on the mean and variance of the environment, where a population can tolerate higher variation at temperatures below its thermal optimum. Intraspecific variation in the thermal response curve buffers against extinction risk, leading to longer persistence times for populations in environments with mean temperatures around and just above its thermal optimum regardless of the variation present.