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Evolutionary tipping-points in a shifting climate

Abstract: Under which conditions can a population adapt to and persist in a continuously changing environment? Numerous quantitative genetics models have explored this question since the early nineties and are currently used to better understand the adaptation challenges associated with contemporary climate change. These models predict that a population will evolve to adapt to the ever changing environment, but lag behind the optimal phenotype in the current environment. If this lag is too large, the population will go extinct. A critical speed of environmental change can then be predicted, over which the population cannot persist. More recent models have shown that some particular shapes for the fitness function, linking phenotypes to the population growth rate, lead to more complex dynamics, characterized by tipping-points over which the population abruptly goes from viable to non viable with an ever increasing lag. These tipping-points are also associated with a strong sensitivity to the initial maladaptation of the population. We here revisit these results at the light of new theoretical developments and propose that such tipping-points, far from being a bizarre consequence of odd fitness functions, emerge naturally from a large spectrum of realistic selection scenarios in structured populations where individuals in different stages differ in their contribution to population growth. These include populations structured by space, age and size. Evolutionary tipping-points should therefore be much more common than we imagined and raise further concern on our ability to predict the adaptation of species to current and future climate change.