RESEARCH ARTICLE

Boom-bust population dynamics drive rapid genetic change

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Significance

Loss of genetic diversity can reduce the evolutionary potential of declining populations, affecting their ability to respond to environmental change. This is particularly relevant given the rapid environmental changes arising from human activity. Species that naturally experience extreme booms and busts in population size provide an opportunity to investigate how genetic diversity can be maintained in populations subject to repeated episodes of population decline. Our 13-y study reveals that stable population dynamics and boom-bust population dynamics maintain genetic variation under extreme environmental fluctuations: One of our study species conserved genetic diversity by maintaining a relatively stable population size, while for a second species, gene flow during periodic booms was sufficient to maintain genetic diversity despite repeated

Abstract

Increasing environmental threats and more extreme environmental perturbations place species at risk of population declines, with associated loss of genetic diversity and evolutionary potential. While theory shows that rapid population declines can cause loss of genetic diversity, populations in some environments, like Australia's arid zone, are repeatedly subject to major population fluctuations yet persist and appear able to maintain genetic diversity. Here, we use repeated population sampling over 13 y and genotype-by-sequencing of 1903 individuals to investigate the genetic consequences of repeated population fluctuations in two small mammals in the Australian arid zone. The sandy inland mouse (*Pseudomys hermannsburgensis*) experiences marked boom-bust population dynamics in response to the highly variable desert environment. We show that heterozygosity levels declined, and population differentiation (F_{ST}) increased, during bust periods when populations became small and isolated, but that heterozygosity was rapidly restored during episodic population booms. In contrast, the lesser hairy-footed dunnart (*Sminthopsis youngsoni*), a desert marsupial that maintains relatively stable population sizes, showed no linear declines in heterozygosity. These results reveal two contrasting ways in which genetic diversity is maintained in highly variable environments. In one species, diversity is conserved through the maintenance of stable population sizes across time. In the other species, diversity is conserved through rapid genetic mixing during population booms that restores heterozygosity lost during population busts.

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Data, Materials, and Software Availability

All data and scripts for analysis have been deposited in Zenodo, at https://doi.org/10.5281/zenodo.10100615 (90).

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Competing interests: The authors declare no competing interest.

Supporting Information

Appendix 01 (PDF)

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