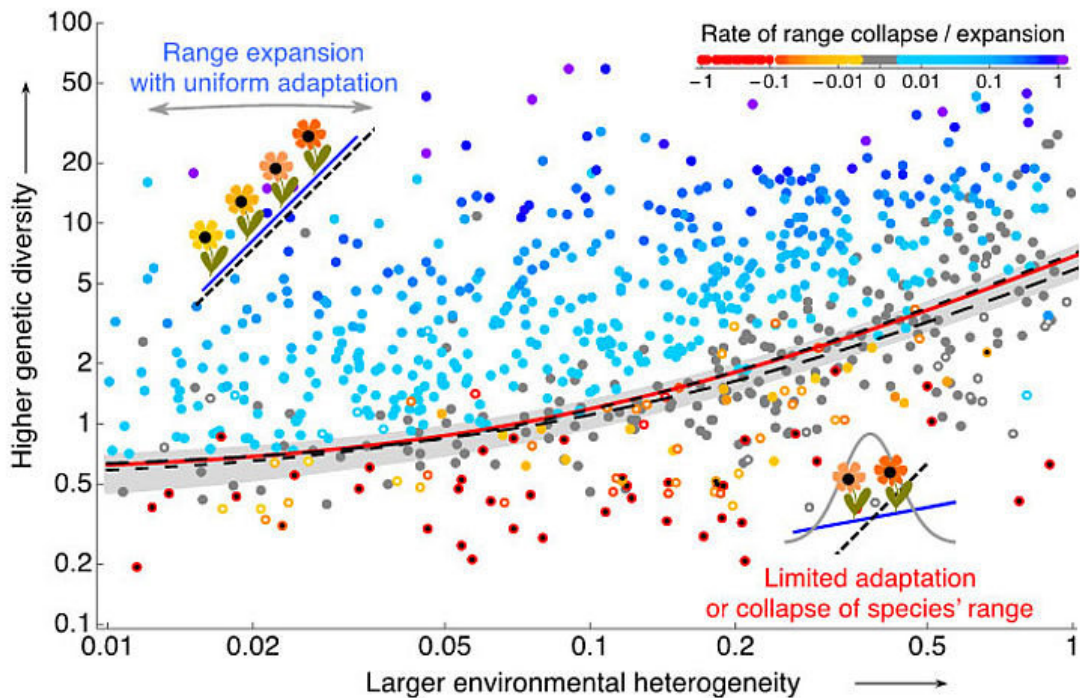


On the expansion threshold of a species' range

June 19 2018



Species' range margins arise due to intrinsic interplay between ecological and evolutionary dynamics. The collapse of adaptation can be explained by just two dimensionless parameters - these are depicted on the axes. Adaptation fails when genetic drift reduces genetic diversity below that required for adaptation to heterogeneous environment. Credit: Polechova

What stops a species adapting to an ever-wider range of conditions, continuously expanding its geographic range? The biomathematician

Jitka Polechová, an Elise Richter Fellow at the University of Vienna, has published a paper in *PLoS Biology* which explains the formation of species' range margins. The theory shows that just two compound parameters, important for both ecology and evolution of species, are fundamental to the stability of their range: the environmental heterogeneity and the size of the local population.

All species have restricted distributions. Yet a joint coherent [theory](#) explaining the span and borders of species' ranges has been missing both due to the complexity of the problem and the disparate traditions in ecology and evolution. Jitka Polechová provides a general, testable prediction for formation of species' range margins. The theory includes both population and evolutionary dynamics, and elucidates the role of dispersal for adaptation across a species' range. Dispersal has conflicting effects: on the beneficial side, it increases the genetic variation that is necessary for adaptation and counters the loss of genetic diversity due to genetic drift. However, dispersal also carries a cost: it may swamp adaptation to local conditions. This interplay is crucial for the evolution of a species' range.

The novel theory demonstrates that adaptation across a species' range depends on two dimensionless parameters: i) the fitness cost of dispersal—a measure of environmental heterogeneity, and ii) the strength of genetic drift—a measure of the reduction of genetic diversity. The more heterogeneous is an environment, the more challenging it is to expand into, and the lower the genetic diversity, the more limited is the scope for potential adaptation. Together, these two parameters define an expansion threshold: adaptation fails when the number of individuals accessible by dispersal within one generation is so small that [genetic drift](#) reduces [genetic diversity](#) below that required for adaptation to a heterogeneous environment. This threshold provides a testable prediction for the formation of a range margin and for the collapse of a species' range.

Interestingly, the parameters are independent of the genetic architecture, offering a wide scope for empirical tests of the theory across many [species](#). Furthermore, the theory explains that the benefits of [dispersal](#) into marginal populations are likely to outweigh the costs, offering a theoretical base for management strategies of threatened populations.

More information: Jitka Polechová et al. Is the sky the limit? On the expansion threshold of a species' range, *PLOS Biology* (2018). [DOI: 10.1371/journal.pbio.2005372](#)

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