

The evolution of range shifts: understanding and predicting species' responses to changing environments

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Abstract

Understanding the processes shaping the uneven spatial and temporal distribution of biodiversity can inform predictions of future distribution changes. Recently, this knowledge has become of prime importance to face the ongoing redistribution of biodiversity, which includes both extinctions and biological invasions characterised by small population size. Why do some populations fail to survive changing environmental challenges while others thrive and even spread outside their historical range? Can we predict whether a population facing a new environment will contract, move, or expand? Much remains unclear about why species are present where they are and how they will respond to environmental changes. The proposed project explores the evolutionary mechanisms underlying range shifts by contrasting failing and successful colonisations in *Littorina saxatilis*. This marine snail represents an excellent and easily accessible study system to elucidate evolution at range edges in naturally replicated dispersal events. The PhD study will focus on the recent, likely human-aided introduction in the Mediterranean Sea (Venice Lagoon, Italy), where the snail represents the first confirmed alien species of this basin, and yet is becoming extinct. This population will be compared to its source and other successful and failing range expansions. Multidisciplinary data from genomes to environments will be collected and analysed by integrating evolutionary, genomic, bioinformatic, behavioural, morphometric, demographic, physiological, ecological and conservation approaches. Such diverse and unprecedented insights will clarify colonisation histories, demographic trajectories, and the interaction among evolutionary background, erosion of genetic diversity, fast-track adaptation, and environmental changes in shaping the fate of marginal populations. These findings will illuminate why some range shifts succeeded while others failed, advancing our understanding of ecological success. They will contribute to the urgently needed improvement of knowledge of the fundamental mechanisms that originate and maintain biodiversity to inform effective actions in wildlife management. Activities and results from this study will be disseminated to the scientific community, stakeholders, and citizens to draw attention to biodiversity research, increase social trust and build resilience against the global decline of biodiversity, economy, and society.