

Life history trade-offs and genetic constraints at elevational range limits in *Cardamine hirsuta* (Brassicaceae)

Aaditya Narasimhan, Yvonne Willi

Department of Environmental Sciences, University of Basel

Species are limited in their spatial distribution. There are several potential causes of range limits, ranging from ecological ones such as dispersal limitation to evolutionary ones such as limited genetic variation at range margins, small population sizes and accumulation of deleterious alleles due to genetic drift. While there is good support for their relevance in some species and for some range limits, there are also many cases where none of them seem to be at play. One neglected and likely cause of range margins is the multivariate nature of selection and the genetic integration of traits, which can constrain adaptation at range margins. Here, we used three populations of the montane annual crucifer *Cardamine hirsuta*, collected at low, mid, and high elevation sites of its elevational distribution. We reared plants in the greenhouse, subjecting them to two growth treatments (heat and control), and measured plant growth and leaf functional traits. We found the consistent trade-off between growth rate and plant size – fast growing plants end up being smaller. Next, we found that plants with higher acquisition capacity (specific leaf area) had lower dry mass in their leaves, they were less robust. There was considerable variation among populations in their response to heat, e.g., low-elevation plants were smaller than high-elevation plants in the control treatment, but the opposite was observed under heat. Our results indicate that such trade-offs can limit species ranges, effectively constraining the evolution of important traits due to their tight genetic integration.