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Evolution of a new monkeyflower in Leadhills

Overview

Between September 2015 and October 2016, **Hopetoun Estates** graciously allowed me to conduct a field experiment in the area of **The Hass, Leadhills Estate, Leadhills**. The goal of this experiment was to grow the newly discovered Scottish monkeyflower (*Mimulus peregrinus*) in a small parcel along with related monkeyflowers, to measure plant survival and reproduction under field conditions. The study was successfully completed, and the results presented at an international scientific congress in the Netherlands (August 2017). The results of the work carried out in The Hass is also part of ongoing work that will be submitted for publication to a peer-reviewed international journal. When the paper is submitted I will make sure to acknowledge the support of Hopetoun Estates in making this study possible.

Summary of approach and results

In the Autumn of 2015, we set up a small parcel to hold approximately 800 individuals of monkeyflowers. The plants were brought from the University of Stirling, and planted with the help of several volunteers over the space of a week. For the following 12 months, we conducted regular surveys to follow the survival, flowering and reproduction of all experimental plants. We found very high winter mortality across all types of monkeyflowers, and only a few individuals made it to the flowering stage. Fruits were removed before maturation to avoid seeds dispersing into the local environment. A follow up survey in the Summer of 2017 confirmed that by then all experimental plants had died, and the plot was free of monkeyflowers. The high mortality and null establishment of experimental plants was likely due to a combination of a harsh winter, rabbit predation, and

grass overgrowing the plot. We speculate that natural survival of monkeyflowers is higher as they tend to be associated with shingly areas of river banks that can confer protection from both grazers and acute grass competition. However, the differential mortality we observed among different types of monkeyflowers provided key insights into the evolution of the Scottish monkeyflower.

Novel scientific insights

The main scientific discovery done in this experiment was that both of the local monkeyflower types (the Scottish monkeyflower, and its ancestor *M. x robertsii*) achieved highest initial survival compared to other monkeyflowers (*M. guttatus*, *M. luteus*, and other experimental plants). The higher survival of local plants suggests that these have become adapted to the local conditions and it may help explaining why other types of monkeyflowers are absent from the area. More generally, the field experiment is one of the few demonstrations that a newly evolved species can be better adapted to its ecological surroundings than its close relatives. There are few studies on the ecological properties of recently evolved species, and the work carried at Leadhills is one of them.

Academic training

The project carried out in Leadhills was a central part of the academic work of one postdoctoral fellow, one research technician, and one undergraduate student in an Erasmus European exchange. Thus, beyond the scientific insights of the experiment, this study has provided a key contribution to the academic training of one students and two early career researchers at the University of Stirling.

Dissemination of results

Although the work is still in progress (scientific projects can take years to complete), we have already begun the dissemination of results. The most remarkable of this has been the presentation of the results of this study as part of an invited conference presentation at the XVI Congress of the European Society for Evolutionary Biology at Groningen, The Netherlands on 20-25 August 2017. This ESEB Congress is the largest gathering of evolutionary biologists in Europe (approximately 2,000 delegates), and one of the largest societies for the study of Evolution in the world. I presented the Leadhills experiment in a parallel session focused on Hybridisation and Speciation under Global Change.

Acknowledgements

I want to express once more my sincere thanks to Hopetoun Estates for their incredible support in carrying out this project. Without their help, this work would not have been possible. I also want to thank enormously the help of Andy Stuart and Billy Steel in helping me to coordinate the research work we carried out. In particular, Billy Steel helped me to locate the plot for the experiment, source local contractors to prepare the land, and continually offered his advice and support on working in the Leadhills area. I am thankful and indebted to all of you for your help and support.



Looking into the future

I continue to be interested in carrying out field surveys and experiments in the Leadhills area. If I am able to secure the participation of students and obtain research funds from my University or other organisations I would be most grateful if I could get in touch with the Estates again to ask for permission to carry similar studies in the future.

Please do not hesitate in contacting me if I can be of further assistance.

Sincerely,

A handwritten signature in black ink, appearing to read 'Mario Vallejo-Marín'.

Dr. Mario Vallejo-Marín