Plant translocations and climate change: bioassay, surveillance and solution to a global threat?

Sarah E. Dalrymple

School of Biological & Environmental Sciences, Liverpool John Moores University, UK,
s.e.dalrymple@ljmu.ac.uk

Synopsis

Plants deliberately translocated into ecosystems present opportunities for understanding and monitoring climate change by acting as bioassays of a shifting climate and overcoming the limitations of observational or predictive studies. Drawing on contributions from a global collaborative network of >100 plant scientists and professionals across the sectors of conservation and forestry, we will evaluate the potential of plant translocations to become robust bioassays of global climate change.

Significance and novelty of the topic

Biodiversity loss is a key, deleterious outcome of climate change. Although we are beginning to observe climate change impacts directly, various authorities have called for the creation of a global scheme for monitoring climate impacts on ecosystems[1,2,3,4]. Plants are a physical manifestation of our complex environment with niches defined by climatic limits to survival and growth across seasonal, annual and decadal timescales. In a rapidly changing world, this integrating quality is a valuable characteristic enabling the use of plants as climate biomonitors where mechanistic responses to warming and drought can be defined and monitored into the future. However, simply observing plant response to climate change is beset by problems such as the difficulties in separating climate from non-climatic causes of population loss and the confounding effect of dispersal limitation resulting in climate-vegetation disequilibrium[5]. Predictive studies are also limited by focussing on range shifts without considering sub-lethal impacts on fitness, dispersal constraints or biotic interactions.

Transplant, or translocation, studies have advantages over observational or predictive studies but are limited in number. However, threatened plant translocations and forestry provenance trials can be substituted for experimental transplants and become bioassays revealing *in situ* climate change impacts. Movement of plants beyond a species' indigenous range can reveal climatic niche limits[6] and capacity for adaptation, avoiding dispersal limits. Moreover, forestry translocations are undertaken at scales that reflect macro-climatic changes whilst threatened species translocations represent a diversity of life cycles, ecological strategies and geographic representation. Together, these translocations can be exploited to inform global monitoring of climate change impacts.

Rationale for inclusion in *Journal of Ecology*

This special feature would address the theoretical basis of using 'repurposed' translocations from forestry and conservation activities and provide a critique of some of the practical limitations that might affect our ability to learn about climate change response from plant translocations. Specifically, this collection of articles might address the topics of climate change, the validity of management interventions repurposed as long-term experiments, and the ecophysiology of plant response to extreme conditions, with the following questions posed:

1. Can plant translocations help us resolve uncertainties in plant niche theories?
    - 1.1 Are limiting resource gradients identified by translocations?
    - 1.2 What can translocations tell us about niche conservatism: how does the niche alter for different ecotypes and/or zones within the species range?

1.3 Does analysis of translocation performance tell us about the niches associated with different life stages of a plant species?

2. Can plant translocations inform understanding of plant response to climate change?
   - 2.1 Which climatic variables do plants respond to?
   - 2.2 Are plant responses to climate change linked to physiological, functional or phylogenetic groupings?
   - 2.3 Do plants adapt to new conditions post-translocation?
   - 2.4 Can translocation studies refine our understanding of the climate vulnerability of individual species?
   - 2.5 What are the climatic thresholds for maladaptation in plant species?
   - 2.6 How do climate extremes and patterns vary with site and climate change, and what are the implications for translocation?
3. Can plant translocations help us better understand invasive behaviour?
4. How can plant translocations be used to monitor climate change?
   - 4.1 What data are available on plant translocations?
   - 4.2 What are the constraints when using such data?
   - 4.3 Are there commonalities in translocation methods or results that can improve the use of translocations as a surveillance tool?
5. Can translocations be used to inform our understanding of scales of response to climate change?
   - 5.1 At what scales are climate responses evident in the differential success of past translocations?
   - 5.2 Can past translocations inform our understanding of processes operating at microhabitat scales?

Contributors

The potential for plant translocations to form bioassays of climate change was developed from previous research on threatened plant translocations and gained momentum when I started to work with Dr Richard Winder, a forestry researcher at Natural Resources Canada. We have since established the Plant Translocation Network, now numbering > 100 members in 17 countries including notable plant scientists across the disciplines of conservation ecology, forestry and climate change biology (https://sarahedalrymple.github.io/Plant-Translocation-Network/). This network has developed a set of 42 research questions from which, the questions above have been drawn. The individuals below have been identified through the activities of the network and conveyed an interest in contributing to a special feature on the proposed topic. We anticipate that more authors can be recruited through this network should we be successful in this special feature application.

Prof Chris Thomas, University of York
Dr Maria Hällfors, University of Helsinki
Dr. Debojyoti Chakraborty, University of Natural Resources and Life Sciences, Vienna
Dr Sandrine Godefroid, Botanic Garden Meise

References

1. Runge, M. C. et al. (2016). *Nature Climate Change*, 6, 861–864.
2. Bonebrake, T. C. et al. (2018). *Biological Reviews*, 93, 284–305.
3. Stanturf, J. A. (2015). *New Forests*, 46, 615–644.
4. Urban MC. (2019). *Wiley Interdiscip Rev Clim Chang*. 10(4). doi:10.1002/wcc.585.
5. Svenning J.C. & Sandel B. (2013). *American Journal of Botany*. 100(7):1266–1286.
6. Lee-Yaw J.A. et al. (2016). *Ecology Letters* 19(6):710–722.