Quantifying adaptive genetic variation for the conservation and management of East African tropical trees (Ref IAP2-18-64)

University of Stirling, Biological and Environmental Sciences
In partnership with Centre for Ecology and Hydrology and end-users Kenya Forestry Research Institute and Biodiversity International

Supervisory Team
- Alistair Jump, University of Stirling
- Stephen Cavers, Centre for Ecology and Hydrology
- David Odee, Kenya Forestry Research Institute
- Christopher Kettle, Biodiversity International

Key Words
1. Tropical forest
2. East Africa
3. Adaptation
4. Genetic diversity
5. Deforestation

Overview

In common with many tropical regions, East Africa is experiencing a rapid loss of forest cover. New knowledge and approaches are urgently needed to support conservation and management of indigenous tree species. A key part of this strategy is characterisation of the extent and spatial distribution of genetic diversity within species.

Across their distributions tree species are adapted to local environments to varying extents, producing spatially organised patterns of adaptive genetic variation. This ‘gene pool’ constitutes a resource that is essential for the persistence of the species, valuable for the restoration of degraded populations and potentially useful for improvement and breeding. However, for the vast majority of these species, little or nothing is known about adaptive genetic diversity.

Given the scale of the task, it is impossible to evaluate patterns of adaptive genetic diversity in all threatened tree species. Consequently, proxy metrics for adaptive variation are used, such as multivariate climatic variation or potential natural vegetation, to attempt to predict where adaptive diversity is likely to lie. However, it is not yet clear how effective such proxies are for most species, and so empirical testing of...
adaptive genetic variation via common garden or provenance testing experiments are needed.

This project will evaluate the extent to which adaptive variation, as assessed in experimental trials, reflects forecasts of adaptive diversity made using a range of proxy approaches. The project will require fieldwork in tropical East Africa and is likely to suit candidates with a keen interest in conservation, evolutionary biology and the developing world.

**Methodology**

The project will combine field data with laboratory-based genetic analysis and existing databases. Spatial datasets on climate, soils, topography and vegetation will be used to assess patterns of geographic variation. These patterns will be overlaid with distribution data to forecast patterns of adaptive variation in the focal tree species. In parallel, the project will identify phenotypic traits of the tree species likely to be of adaptive significance in different life history dimensions, such as growth, physiology, defence and reproduction, and evaluate extent and patterns of variation through measurement in existing experimental trials. Analysis of trait data will make use of mixed models to evaluate components of variation. Finally, as an understanding of the extent to which distinct adaptive ‘units’ within species are connected by gene dispersal is important to their effective management the project may also undertake marker-based population genetic analysis of the source populations.

This highly international project will be undertaken in collaboration with Dr David Odee, from the Kenya Forestry Research Institute (KEFRI) who has many years of experience working on the genetics of East African trees and Dr Chris Kettle, who leads on Forest Genetic Resources and Restoration for Bioversity International. KEFRI and Bioversity International deliver scientific evidence, management practices and policy options to use and safeguard agricultural and tree biodiversity and will lead on transfer of project findings into agroforestry policy and guidance at local and regional scales. The successful applicant will work closely with KEFRI when in Kenya and will undertake a policy training stay at Bioversity International. The student will, therefore, benefit from outstanding opportunities for in-country knowledge, supervision and support via Dr Odee and direct experience in transferring findings into management via both organisations.

*Acacia*-dominated woodland in East Africa

**Timeline**


*Acacia senegal*, valued for gum and wood for charcoal.
Flowering in *Melia volkensii*, an adaptively important trait

**Training & Skills**

The project is an exciting opportunity to develop a wide range of skills including experimental design, quantitative trait analysis, evaluation of spatial variation, GIS, molecular lab and data analysis, presentation, scientific writing and publication.

In addition to equipping the successful applicant with the right skills and experience for a range of future careers in research or beyond, the collaborative nature of the project is a chance to gain insight into the operation and application of international research. The student would receive training, advice and guidance from a diverse and experienced team of supervisors including direct experience of working with end users to translate research into policy and management guidance.

**References & Further Reading**

**The State of the World’s Forest Genetic Resources. 2014.** Commission on Genetic Resources for Food and Agriculture, Food and Agriculture Organization of the United Nations, Rome, Italy.


**Jump et al. 2014.** Genetic divergence during long-term isolation in highly diverse populations of tropical trees across the Eastern Arc Mountains of Tanzania. *Biotropica*, 46, 565-574


**Habel et al. 2017.** East African coastal forest under pressure. *Biodiversity and Conservation*, 26, 2751–2758

**Further Information**

Alistair Jump: a.s.jump@stir.ac.uk, 01786 467848

Biological and Environmental Sciences, University of Stirling, FK94LA

Stephen Cavers: scav@ceh.ac.uk, 0131 445 8552

Centre for Ecology and Hydrology, Bush Estate, Penicuik, EH26 0QB