Success and Vulnerability in the Amazon

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External Project Partners:
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Context

Few tasks in science are more important and urgent than revealing the rules that govern why some living things are more dominant than others and which will be most vulnerable in our rapidly changing world. Most life on Earth is in the tropics, but understanding and predicting responses here is particularly challenging because of the scale and complexity of tropical ecosystems. Amazonia, for example, still includes 5 million square kilometres of forest, nearly twenty times the size of the United Kingdom. Indeed, the forests of South America are among the most important ecosystems on Earth. Not only do they support unparalleled diversity (more than 10,000 tree species in the Amazon alone), but they also lock up huge amounts of carbon (more than a hundred billion tonnes), slow climate change, and support human livelihoods (e.g., Pan et al. 2011, Brienen et al. 2015, ter Steege et al. 2013, Phillips et al. 2017). *How species and ecosystems here respond to climate change and other threats will in turn define the future of life and people everywhere.*

The aim of the project is to combine new biogeographical, ecological and evolutionary tools *to reveal why some species are more successful than others - and whether or not the rules of success are now changing in our changing world*.

This project takes advantage of three major developments in large-scale biodiversity science. These are making it possible to measure the success and the vulnerability of species in the most vital part of the planet (e.g., Enquist et al. 2016, Baker et al. 2017, Esquivel-Muelbert et al. 2017, Coelho de Sousa 2017). First, in

biogeography, records on where exactly each species has been collected are available with the precision to map their range, together with the analytical tools to model these biogeographical data and their reliability. *Thus it is now possible to reveal species ranges and know the climate and soil conditions within which they currently exist*. Second, in *ecology*, detailed long-term fieldwork to measure tropical population distributions and dynamics is being brought together by ecologists – enabling assessment of species abundance, biomass, growth and population change over time. *Thus it is possible to trace how successful different species are, where, and under what conditions*. Finally, in *evolutionary science*, researchers are piecing together the evolutionary tree of life – the relatedness of all things to each other – with ever greater precision. *Thus it is now possible for the first time to explore the relationship between evolutionary history and ecological success.*

Focussing on the Amazon and adjacent ecosystems, relevant and significant questions to develop include:

* How and where does biogeographic success predict ecological success? (For example, exploring whether the most widespread species also actually dominate Amazon forests in terms of abundance or biomass).
* Is ecological success ultimately predictable from evolutionary history, or does it occur randomly across the tree of life? (For example, testing whether the most dominant species in Amazon forests tend to be closely related to one another).
* Are species' sensitivities to climate warming and droughts written into their biogeographical distributions? (For example, investigating whether species from the dry margins of South American forests are starting to benefit from recent climate changes).

The student will have the opportunity to explore these questions while working with leaders in these fields and with scientists across South America. Guided by the supervisors the student may choose to learn and use a variety of approaches, including:

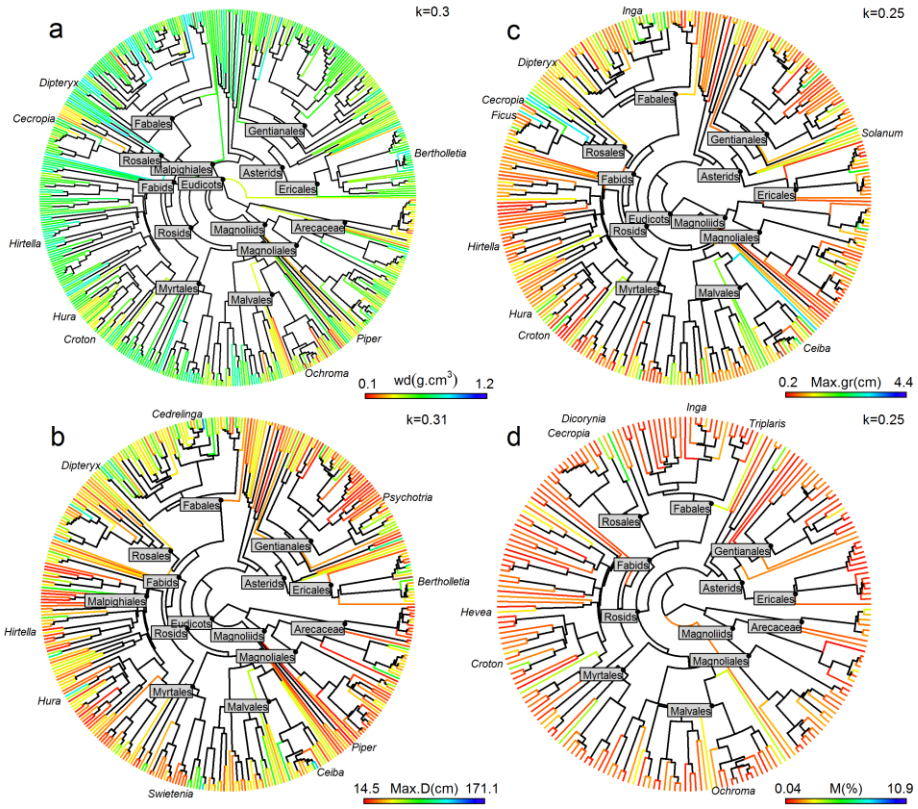
- Field work remeasuring of long-term forst plots with our partners across the RAINFOR network of permanent plots in the Amazon, focussing on areas of most rapid warming or drying (e.g., with external partner Beatriz Marimon in Brazil).
- Analysing long-term records of size, growth and death of trees across South American forest plots.
- Modelling species ranges for tropical trees, including millions of records of species occurrences and associated data.
- Advanced biogeographic and evolutionary analyses of tropical plants, including visiting the lab of external partners Brian Enquist, founder of the BIEN plant data network, and Tiina Sarkinen, evolutionary scientist at Edinburgh, for further training.

The supervisors lead successful global projects that support this exciting investigation, including the RAINFOR network, the ForestPlots.net group of international ecologists, and the BIEN initiative on botanical information. Working with leaders in these fields in the U.K., the U.S.A., and Brazil, you will have opportunities to develop a wide range of techniques. As the project advances you will be interacting collaboratively with many colleagues worldwide.

External Partners
Prof. Brian Enquist (University of Arizona),
Prof. Beatriz Marimon (Mato Grosso University),
Dr. Tiina Sarkinen (Royal Botanic Garden Edinburgh).

Potential for High Impact Outcomes
This project addresses fundamental questions at the intersection of ecology, biodiversity, evolution, and climate change. It therefore contributes to globally-important understanding on what makes plants especially successful, or vulnerable - with potential also for risk-profiling and for developing conservation management responses to help those at risk. The supervisors, collaborators, and teams they lead have strong record of high-impact outcomes from research on tropical forest biodiversity, ecology, and carbon storage and sequestration.

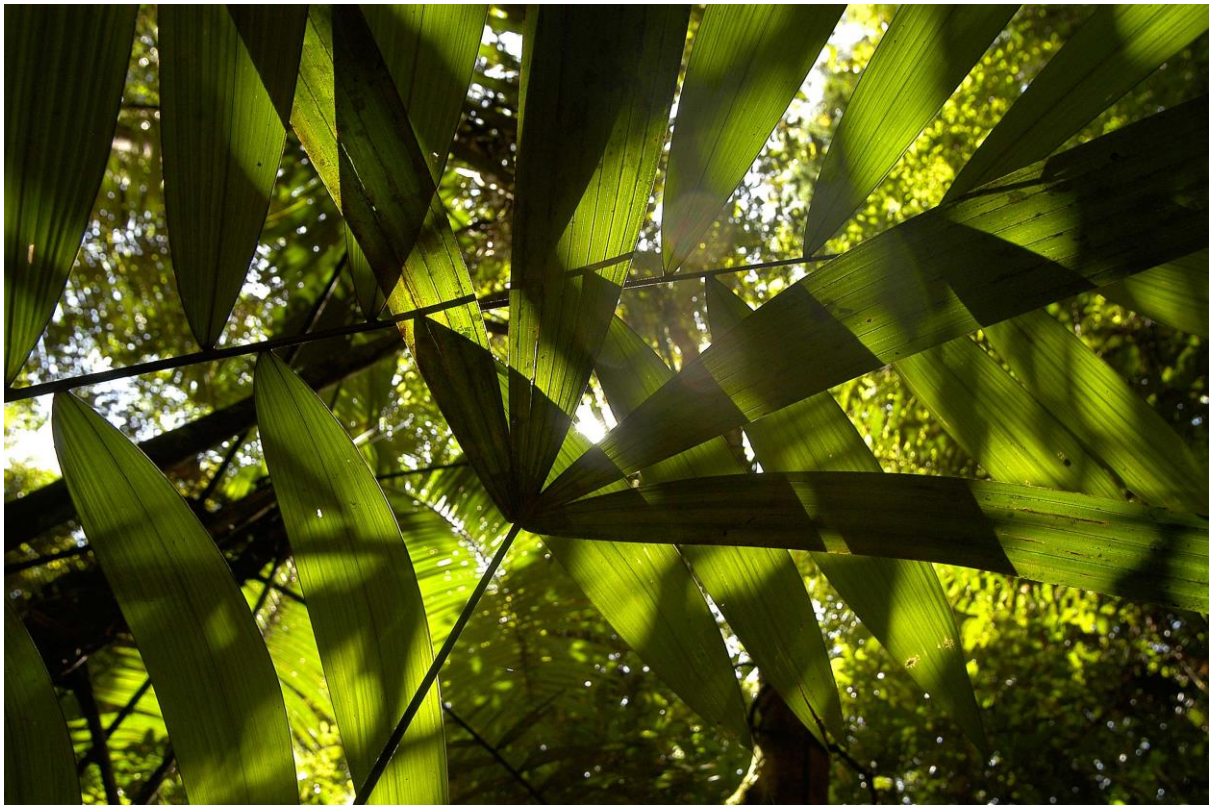
Training
The student will work closely with Oliver Phillips and Tim Baker at University of Leeds, and will also be interacting and collaborating with scientists from the RAINFOR network and other colleagues. There will be opportunities in particular for (1) *tropical fieldwork* led by the supervisors and external partner Beatriz Marimon in Brazil, and for visiting (2) the Tiina Sarkinen lab at Royal Botanic Garden Edinburgh, and (3) the Brian Enquist lab at the University of Arizona, *including for support with biogeographical and evolutionary analyses*. Training at Leeds will include management and analysis of large datasets, field observational techniques, and



ecological and phylogenetic analyses, as well as guidance for developing more equitable balanced and professional relationships with collaborators.

The Ecology and Global Change group in the School of Geography at Leeds, where the student will be based, is a dynamic and world-leading group that focusses on tropical ecology, biodiversity, carbon, climate, and global change.

Student Profile: ***We welcome applicants who are highly motivated and have a strong background in ecology, evolution, and / or statistics. Being willing to travel widely including to work in the field in tropical forest conditions is also important.***



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