Integrating macroecology into macroevolutionary models: Evolution in Australian reptiles

NSF Postdoc Outline
October 9, 2018

1 Project Summary (1pg max)

1.1 Overview (include sponsoring scientists and institutions):

Organismal phenotypes are the result of genetic *and* environmental forces, and the interaction between them. When explaining patterns of phenotypic evolution, we can account for some genetic influence by incorporating a phylogeny and drift, recognizing that phenotypes tend to be more similar between closely related species. Descent with modification thus provides us with some expectations as to how phenotypes should evolve. But how do we account for influence of extrinsic biotic factors on observed traits? The field of phylogenetic comparative methods has aimed to help us understand these patterns, and to explain the accumulation of diversity around us. Unfortunately, nearly all commonly used models for describing phenotypic evolution are ecologically neutral, meaning they fail to account for species interactions with one another, and their environment. This results in lifeless models that mathematically describe the *pattern* of phenotypic evolution, but lack a biological explanation of the *process*. My overarching research goal is to extend our existing toolkit to include a more diverse set of models which account for macroecology in macroevolution. This includes incorporating inter-lineage interactions, intra-lineage variation, and historical biogeography, to better explain observed patterns in trait diversity. To develop these methods, I intend to use Australian reptiles as an empirical example. As an island continent, Australia is a natural laboratory for studies of evolution. With more than 1,000 species of squamate reptiles (lizards and snakes), extensive museum collections, and curated occurrence records, Australia is a prime opportunity for investigating macroecological models of phenotypic evolution.

1.2 Intellectual Merit

Organismal interactions provide an important selective force for evolution. Predator-prey, plant-pollinator, and host-parasite relationships form the basis for ecosystems, and drive the accumulation and distribution of diversity. For a while now, both community ecologists and comparative evolutionary biologists have sought to understand how this diversity is built on local and phylogenetic scales. However, they have approached these questions from very different angles. Community ecology has been largely agnostic of evolution along phylogenies, and evolutionary biologists have relied on ecology naïve comparative methods. Now, we are on the edge of being able to appropriately incorporate community interactions into phylogenetic comparative methods of macroevolution. My specific aims are to improve our ability to identify the influence of interlineage interactions on community assembly and trait evolution, and better estimate the strength of these interactions, by accounting for intralineage trait variation and biogeographic histories. This research will help to make our evolutionary models more biologically realistic, blending together the fields of macroecology and macroevolution, and in the process, hopefully bringing together ecologists, evolutionary biologists, museum curators, and computer scientists.

1.3 Broader Impacts

For this project, I will create a number of resources for both the macroecological/macroevolutionary and general science communities. This includes curating an open-source ecological database of Australian reptiles (morphological, dietary, distributional data), designing new methods for modelling trait evolution in a phylogenetic community framework, and communicating my results through scientific publications and popular science engagements. I aim to enrich the experience by collaborating with domestic and international colleagues, including undergraduate and postgraduate students. I have also outlined a plans for a workshop on phylogenetic comparative methods (see appendix). Finally, I enjoy outreach through social media, so will continue to use my position in the community to broadcast results in an entertaining and digestible "PopSci" manner. *workshop development*

2 Project Description (6pg max)

2.1 Introduction

2.2 Research Objectives, Methods, Significance

2.3 Training Objectives

2.4 Career Development

2.5 Sponsoring Scientist and Institution Justificiation

2.6 Yearly Timetable (goals, outcomes)

2.7 Broader Impacts Narrative