

## Project Summary

### Overview (include sponsoring scientists and institutions):

Ecosystems are defined by both the organisms inhabiting them, and the interactions among these organisms. Quantifying the influence of these interactions on the evolution of the participants should therefore be a priority in evolutionary biology, but remains difficult [1,2]. Instead, common comparative methods account for phylogeny, but ignore how cohabiting lineages influence one another phenotypically and spatially. My research goal is to extend our existing toolkit to include methods which more accurately account for macroecology in macroevolution. This includes incorporating (1) inter-lineage interactions, (2) intra-lineage variation, and (3) historical biogeography, to better explain observed patterns in trait diversity. The proposed research will require expanding my understanding of the intersections of evolutionary and computational biology. I will be guided in my journey by two experts in these fields. My computational and methodological mentor **Dr. Brian O'Meara** (*University of Tennessee, Knoxville*) is a world expert in comparative methods, bringing together mathematical advances with empirical evolutionary studies. My curatorial and biological mentor **Dr. Mike Lee** (*South Australian Museum*) has been actively researching macroevolution and the complex origins of reptiles for over two decades, incorporating the often disparate fields of morphological and molecular evolution. Together, these sponsors (and their institutions) provide the opportunity to expand my theoretical understanding of evolutionary biology, and the computational and methodological abilities to apply it.

### 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. I aim 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. I will develop models that account for intralinear trait variation and biogeographic histories, which will make phylogenetic comparative methods more biologically meaningful. My research will blend together the fields of macroecology and macroevolution, and in the process, bring together ecologists with evolutionary biologists, and museum curators with computer scientists.

### Broader Impacts

During 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 (morphology, 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 plan to use collections of the *South Australian* and *Western Australian Museums*, and will integrate collected data back into the **Atlas of Living Australia** database. Working in museums will also afford me the opportunity to enrich the experience of others by interacting with the public, and 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.