Understanding what drives variations in rates of phenotypic evolution: a new phylogenetic comparative approach

A major goal of macroevolution is to understand the ecological processes that modulate evolutionary rates, such as rates of phenotypic evolution, across lineages[1,2]. However recent comparative methods have focused on i) estimating lineage-specific evolutionary rates, therefore describing how? but not why? rates vary across lineages, or ii) relating evolutionary rates at a given time to abiotic conditions such as temperature[3], which can explain variations in evolutionary rates across time, but not lineages. Here we propose to develop phylogenetic comparative methods aimed at understanding why phenotypic rates vary across lineages and that can be applied to neontological data, paleontological data, or both. The models to develop will relate lineage-specific rates of phenotypic evolution to lineage-specific variables such as ecological (e.g., body-size, niche size) or geographical characteristics of the lineage (e.g., latitude, altitude). To do so, we will explore the use of "stochastic volatility" models developed in Finance to study time-series[4] along with algorithms recently developed to fit related models on phylogenetic trees[5]. In addition, we will explore variable selection procedures that allow selecting the variables with most explanatory power among a set. The performance of the approach will be evaluated through computer simulations (which will also allow the candidate to learn how to use a computing cluster). Finally, the new models will be applied to resource-use traits in vertebrate clades (e.g., birds and mammals) to study rates of evolution as a function of past climatic changes and reconstructed latitudinal ranges. This will allow re-evaluating, in a phylogenetic context, long-standing questions such as: are the rates of evolution lower for species with large geographic ranges[6]? Are rates of evolution higher at low latitude[7,8]? Are rates relatively higher during cold periods for species with short latitudinal range (e.g., increased habitat harshness and selective pressures on short ranged species[9,10])? The proposed methodological development will be of great interest to evolutionary biologists who want to link evolutionary dynamics to ecological, environmental and geographic factors.

Keywords: phylogenetic comparative methods, phenotypic evolution, evolutionary rates, modelling.

Competences: The candidate will participate to the development of the proposed model (that has been initiated by the supervisor), test it through simulations, and will apply it to empirical data (data for extant Avian clades are readily available from a collaboration with Dr. J.P. Drury, University of Durham, UK). He/She must have strong interest and good competences in phylogenetics, statistics and mathematical modelling (coding in R is prerequisite).

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