The Evolution of Biodiversity: A Simulation Approach

by

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Submitted to the Department of Electrical Engineering and Computer Science
in partial fulfillment of the requirements for the degree of

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Abstract

What have been the most important factors in the diversification of life? A configuration (individual-based) model (MoD) was constructed to examine the origins and maintenance of species diversity through time. The model represents a species as a connected component in a graph of the potential mating relationships between organisms. This allows us to detect speciation events and track species diversity over time, and so test many “untestable hypotheses” for the causes of diversification. The results suggest that much of the emphasis placed on the evolutionary innovations, in resource utilization and predation interactions, in order to explain the diversification of a group, is flawed at best. Furthermore, habitat heterogeneity had little impact on species diversity. Instead, the model points to the importance of geographical isolation as a primary causal factor for diversification, along with the evolution of specialization and sexual selection, in the form of positive and negative assortative mating. The influence of assortative mating is particularly interesting because it is opaque to the methods of paleobiology. Finally, both theoretical and experimental tests are sketched that may help to falsify the predictions of the model.

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Prologue

This dissertation is an attempt to understand the fundamental processes of biology through the construction of a computational model. It is thus an interdisciplinary work spanning one of the chasms between biology and computer science. I am committed to communicating to audiences in both fields, as well as the general public. I have striven to make what mathematical analysis I include both clear and accessible to the non-mathematically inclined. On the other hand, I have also tried to avoid excessive use of jargon from the oversized lexicon of biology. Where I do use technical terms, I usually tag them with an explanatory phrase or follow-up sentence. I can only ask the analytically inclined reader's forgiveness if she feels that I am insulting her mathematical talents. Similarly, I must ask the indulgence of my biologist colleagues for my preference for common English over the concise terms of their trade.

Perhaps one further note on style, or apology, should be made. I am worried by the cultural division between academia and the general public. I have taken a cue from an article a concerned relative once clipped for me. It was written by a historian who was worried about the same problem. One of the contributing phenomena to this chasm is the dry language in which most science, and for that matter, academic writing is couched. A century and a half ago, Darwin stunned the world with his arguments rich in metaphor and imagery (Darwin 1859). Of course, it took him twenty years to finish it. Not only must we bore our readers to tears in an attempt to sound objective, but we also seem to prefer impenetrable prose, as if to say, "if you don't understand me, it is probably because I am smarter than you." It is a nauseating kind of school-yard attitude. So I hope you will appreciate, or at least understand, why I have chosen to write with a relatively loose style and even a sprinkling of colloquialisms. I do not think I have sacrificed any rigor or precision. Although, I am sure that I have padded the text. With any luck, you may even ... *gasp* ... enjoy reading this. Well, I may be going a little too far there, but at least that is my ambition. Rod Brooks always says to set your sights high.