Preface

Following Watson and Crick's determination of the structure of DNA in 1953, the growth and self-confidence of molecular biology led not only to unparalleled understanding of fundamental biological processes, but also to divergence between molecular and cellular biology, on one hand, and what was often termed "whole-organism biology" on the other. Evolutionary biology was practiced largely by whole-organism biologists, and although they often proclaimed that evolution was the central, if not sole, unifying theory of biology, such unification, or even broad ratification of the claim, could be hard to discern.

Biology has by no means fully emerged from this schism, especially given the increasing, and necessary, specialization in training and research in the life sciences. But the separation is breaking down; the unification is happening. Like all the other life sciences, evolutionary biology has been transformed by molecular understanding and methods, and now speaks much the same language as the molecular-mechanistic disciplines. Evolutionary biology is becoming increasingly mechanistic as it explores such frontiers as the evolution of genomes, metabolomes, biochemical pathways, complex systems, and the developmental processes that translate DNA sequences into phenotypes. Conversely, scientists who work in molecular, genomic, cell, and developmental biology increasingly recognize that the interpretive framework, the principles, and the analytical methods of evolutionary biology are not only useful, but also critically important for their fields: evolutionary science is being integrated throughout biology. At the same time, the disciplines of organismal biology, including paleobiology, ecology, functional morphology and physiology, animal behavior, and systematics, continue to be central to evolutionary science and are largely framed by evolutionary principles. Together with Scott Edwards and John True, I have attempted to take a look at these many relationships between evolutionary biology and diverse biological disciplines.

An updated edition of *Evolution* is warranted because of the extraordinary pace of change of evolutionary biology, as new analytical and laboratory methods are developed and our understanding of biological mechanisms advances. Growing evidence of function for much of the nontranslated DNA that dominates eukaryotic genomes will have important implications for our understanding of molecular evolution; growing debate and evidence concern the possible evolutionary significance of epigenetic modification of genes; comparative genomics is revealing how new genetic and developmental functions have evolved. Phylogenetics and evolutionary genomics have become more powerful with the development of new analytical methods; a historical, phylogenetic perspective is reshaping community ecology; extraordinary new fossils add to our knowledge of life's history.

One of the most important changes in the field has been a more intense focus on the social and practical implications of evolutionary biology. To be sure, the possible implications of human evolution for interpreting human diversity and behavior have been obvious and controversial for 150 years, and biologists have long understood that evolutionary processes have important applications in health, agronomy, and many other fields. But these applications have now become a significant dimension of evolutionary research, treated in both traditional journals and new journals such as *Evolutionary Applications* and *Evolution, Medicine, and Public Health.* We must, moreover, address the opposition to evolution, most pronounced in the United States, that is but one face of a widespread skepticism about science that has truly dangerous implications—as the debate in the United States about global climate change shows.

I have maintained the structure of the previous edition of this book. It begins with phylogeny as a framework for inferring evolutionary history, and with history as the natural perspective for evolutionary biology. This leads into macroevolutionary patterns, which I think intrigue many beginning students and which provide opportunity for introducing some of the most important evidence for evolution—a critically important aspect of any undergraduate course in the subject. They also constitute many of the *explananda* of evolutionary biology: the observations that a theory of evolution must account for. Most of the subsequent chapters treat evolutionary processes and how they explain a wide variety of phenomena, from genomes to ecological interactions among species. The final chapters return to macroevolution, now viewed through the lens of evolutionary processes, and to the evidence for evolution, the nature of science and the failings of creationism, and some of the social applications of evolutionary biology. Human evolution is treated throughout the text rather than as a separate topic, an approach that reveals the social and personal relevance of the various topics in evolutionary science and points to the commonality of humans with the rest of the biological world. Every chapter has been updated, and the approach and coverage in a few differ substantially from the previous editions.

The literature in almost all areas of evolutionary biology has grown so voluminous, and the methods in many so altered, that it has become nearly impossible to follow—or to understand fully—all of them. So I again thank Scott Edwards (Harvard University) and John True (Stony Brook University), for contributing revised chapters on genome evolution and evolutionary developmental biology, respectively, topics that I doubt I could have competently addressed.

Innumerable colleagues and students have contributed indirectly to this book, through their lectures, publications, conversations, and questions. Among the many who have contributed more directly by providing advice, references, answers to my questions or corrections of my errors are David Begun, Michael Bell, Jerry Coyne, Liliana Dávalos, N. Delaney, Daniel Dykhuizen, Walter Eanes, Bruce Grant, Mark Kirkpatrick, Jeffrey Levinton, Joanna Masel, Hugh McGuinness, Mohamed Noor, Sally Otto, Joshua Rest, Marty Schoenhals, Brad Shaffer, Ellen Simms, Chris Simon, Jason Weir, John Wiens, and Jerry Wilkinson. I owe special thanks to Scott Edwards and John Wiens for helping to improve the treatment of phylogenetic methods. I appreciate all the advice I've received, even if I have not acted on it, and I take full responsibility for the errors or inadequacies that will surely come to light. The many colleagues who contributed photos are acknowledged in the figure captions. Aman Gill helped with some illustrations. Rob DeSalle and the American Museum of Natural History have generously provided work space in that marvelous institution, Michael Purugganan and New York University provided hospitality in the last stages of the book's preparation, and the Department of Ecology and Evolution at Stony Brook continues to provide support and intellectual sustenance. I apologize to the many colleagues who provided input, and whom I have inadvertently omitted. Scott Edwards adds his thanks to Feng-Chi Chen, Allan Drummond, and Harold Zakon for contributions to Chapter 20. John True would like to thank Prof. Jer-Ming Hu of National Taiwan University for productive discussions leading to a more thorough treatment of plant evolutionary developmental biology in Chapter 21.

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