



Preface

How do we discover patterns in nature and what kinds of information and methods do we use to describe, evaluate, and interpret those patterns and compare them to others, including those of Earth history? **This** is what this book is about. It is aimed at the student of biogeography, yet written for all natural historians. We are both biologists, one a zoologist, the other a paleontologist; and we are both biogeographers. **To** many, these are non-overlapping, or mutually exclusive, categories; **one** may be a zoologist or paleontologist first and a biogeographer **second**. This is not our experience; it is not the way we work. We are both biologists and biogeographers at the same time.

Biogeography is a critical tool for discovering and interpreting the patterns and processes of life. A paper proposing a new hypothesis on the relationships of a group of organisms suggests other questions to biogeographers: "Where do they live?" Maps and habitat descriptions are as important as scientific illustrations or data matrices. "What do they live with?" The distribution and relationships of the entire biota is paramount, not corollary. Although not geologists, biogeographers consider patterns of Earth history, the hypotheses, the type and the amount of data that support geological patterns. Biogeographers can help geologists because biological patterns elucidate Earth history as readily as geology can inform biology.

Biogeographers are also historians, and they study not just the history of the Earth and the life on it, but also the history of ideas on how

we should interpret this information. Ultimately, biogeographers are “natural historians with maps”—the moniker that best describes who we are and what we do.

Biogeography is a classic field of investigation with a rich history. All naturalists have been biogeographers, whether they noted which bird perched on what rock or described the coherence of life around the Pacific basin. That deep tradition acknowledges that biogeographers of the past wrestled with many of the same issues we still puzzle over. This book is our view of biogeography—a tumultuous field with many methods and roiling controversies, many of which are reviewed here. A student new to biogeography may be astonished to learn that there is such discord in a field that is often defined simply as the study of the geographic distribution of plants and animals. “What lives where and why?” seems a direct question. It may be answered in many ways depending on the kinds of assumptions one makes about organisms and their relationships to their environment and their evolutionary history. It may also be answered in different ways depending on the assumptions one makes about the data used to generate an areagram—morphological versus molecular—and how an areagram (area cladogram) is interpreted. As we will describe, even how we define *areas* will affect our biogeographic interpretations.

Understanding the pattern of biotic divergence is the key to discovering and reconstructing former geographical, climatic, and ecological mechanisms or processes that were responsible for biotic evolution. This book is a comprehensive history of biogeography, its theories and methods, and developments that have led to formulation of the principal methods of what we call comparative biogeography. We begin our text in the late 18th century to set the stage for the upheavals in our understanding of the history of Earth and its biota that were soon to follow. With this background we ask, what triggers evolution of biodiversity and distribution patterns? Empirical examples question the way geologists look at the evolving Earth. Our goal is to demonstrate that comprehensive cladistic methods can extract patterns resulting from interaction with Earth processes at all scales, helping us to understand what events have caused speciation and extinction and where these events may have taken place. This unifying research theme in systematics and evolutionary biology is central to tackling the current and anticipated continued large influx of molecular data and attendant cladograms and for establishing a biogeographic framework for the next generation of research scientists.

ACKNOWLEDGMENTS

Discussions over the years with Gary Nelson, Chris Humphries, and David Williams helped shape many of our ideas on biogeography. Michael Heads and David Williams kindly read a complete draft of the book manuscript and provided valuable criticism and extensive comments, for which we are most grateful. Two anonymous reviewers posed pointed questions that we hope we have answered to their satisfaction. Other colleagues graciously read and commented on draft chapters: Roger Buick, Tony Gill, John R. Grehan, Daniel Rafael Miranda-Esquivel, and Juan Morrone. Victor G. Springer provided innumerable, valuable references on biology and geology.

Chuck Crumly, of UC Press, patiently guided us through all stages of this book and urged us to write clearly and economically. Francisco Reinking, also of UC Press, expertly oversaw book production. Production of the maps and color reproduction of the figures was supported by the office of Richard Vari and Don Wilson, successive Chairs of the Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution.

Jacques Ducasse, Nathanaël Cao, and René Zaragüeta, of the Université Pierre et Marie Curie-Paris 6, Laboratoire Informatique et Systématique, provided the systematics and biogeography software *NELSON*5 and answered our many questions about its use. Their support was critical for the completion of this book.

Illustrations were generously supplied, or permission to reproduce those previously published was granted, by Cheryl Backhouse and the Centre for Plant Biodiversity Research, Australian National Botanic Gardens; Tim Berra; John Brill; Ricardo Calejas; Giesela Dohrmann; Simone Farrer and Carla Flores, of CSIRO Publishing; Adrian Fortino; Chris Glasby; Joy Gold; Sam Gon III; John R. Grehan; Mike Hadfield; Peter Hovenkamp; Caitlin Hulcup; Ben Kennedy and Oxford University Press; Carolyn King; Evan Mantzios; Paul Muir; Rod Page; Lisa Palmer; Theodore Pietsch; David Reid and the *Journal of Molluscan Studies* (formerly *Proceedings of the Malacological Society of London*); Beatriz Rivera; Erin Clements Rushing and the Smithsonian Institution Libraries; Rick Sardinha; Georgina Steytler; Wesley Thorsson; Ángel Vilorio; Carden Wallace; Judy West; and Tony Windberg. Base maps were prepared by Dan Cole and expertly rendered by Colleen Lodge. Other technical assistance was provided by Jeffrey M. Clayton.

Tina Ramoy, and Ella, remind LRP every day that there's no place like home.