

BIODEMOGRAPHY

An Introduction to Concepts and Methods

by

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FORWARD (James W. Vaupel)

Demography is an interdisciplinary. Indeed, demography is the quintessential interdisciplinary, making contributions to and drawing from research in mathematics and statistics, the social sciences, the biological sciences, the health sciences, engineering, cultural studies and policy analysis.

The title of this book is *Biodemography: Introduction to Concepts and Methods*—and it is a major contribution to the burgeoning field of biodemography, clear and accessible enough to be a stimulating introduction, focused on concepts and methods and with many concrete examples, often intriguing and thought-provoking. It covers the broad range of biodemography, structuring and fostering understanding of material previously covered, if at all, in more specialized or advanced publications.

In addition, this book introduces readers to the fundamental concepts and methods of human demography, currently by far the largest component of the interdisciplinary of demography. Other excellent introductions exist, as authors James R. Carey and Deborah Roach note, but this volume provides an alternative that addresses new advances and that provides novel illustrations.

Furthermore—and this is impressive and unprecedented—this book provides an overview of the full range of demography as an interdisciplinary. It covers a panoply of mathematical and statistical concepts and methods, drawing from the social, natural and health sciences. It forges links with disciplines as diverse as policy analysis, reliability engineering, actuarial prognosis and cultural studies. It provides cogent examples of how demographic concepts and methods can be used to study any kind of population, not just living populations of individuals (humans or in nonhuman species) but also populations structured in hierarchies and families as well as populations of organizations and other nonliving entities.

Demography rests on a bedrock of mathematics and statistics. The key mathematical and statistical concepts and methods are expertly elucidated in this book; authors Carey and Roach have decades of experience in marshalling these concepts and methods in their biodemographic research. Carey has contributed innovative methods, e.g., to estimate age from data on time to death and to summarize how individuals allocate their lifespans to life-history stages. Both Carey and Roach have pioneered major additions to age-specific demographic data on fertility, mortality and morbidity, Carey in massive studies of medflies, mexflies, mayflies, parasitoid wasps and other insects, Roach in unprecedented experiments on thousands of *Plantago lanceolata* plants over more than two decades.

Secure on this bedrock, demographers are able to contribute influential perspectives and factual findings to the airy, windy heights of public-policy discussions. This important role is touched on several times in this book, especially in the discussion in Chapter 10 of biological control, population harvesting and conservation. The treatment of pressing public-policy issues is balanced and nuanced, and the value of demographic concepts and findings in shedding light on the issues is cogently laid

out—in contrast to the heated arguments and fiery rhetoric that often characterize public discussions of, say, how medflies should be controlled in California or how elephant populations should be culled in South Africa.

The main thrust of this book is to advance the field of biodemography, a field with deep historical roots in demography, that is currently thriving and that seems likely to become a component of demography as important as its social-science components. Dobzhansky famously observed that nothing in biology makes sense except in the light of evolution. Because evolution is driven by—and drives—birth and death rates, it is equally valid that nothing in evolution makes sense except in the light of demography. And to a considerable extent vice versa—much in demography, especially age-patterns of fertility and mortality, makes sense only in the light of evolution. Two related kinds of research at the intersection of demography and biology are important. First, populations of a nonhuman species can be studied using concepts and methods also used to study human populations. Second, broad analyses can be conducted across many species to uncover basic regularities, as well as key differences, among species that govern life, including human life. Such knowledge of particular species and of overarching patterns can be used to shed light on fundamental evolutionary processes. This is basic science. On the other hand, the twin sources of knowledge can also be used to advance conservation biology and the protection of endangered species. This is applied science. Carey and Roach cover the range of studies of particular species, comparative studies across species, studies of evolutionary processes, and studies of practical importance in managing species and averting species extinction.

In the biological sciences, molecular biology has over recent decades become more and more prominent. It is possible for demographers to make contributions to the study of populations of molecules and cells, e.g., the study of the origin and growth of a cancer, and some research on this has started. Historically, a closer link ties population biology (including ecology and life history biology) with demography. The pioneers of these fields—Aristotle and Darwin—are still heroes of biology. Interest in studying populations of individuals is certainly growing—this book provides the tools—the concepts and methods—for analyzing populations. One sign of the renaissance of population studies in biology was the founding, a few years ago, of the Evolutionary Demography Society, of which Roach is past president.

The term biodemography is sometimes used to describe two different fields of study—biological demography, as discussed above, and biomedical demography, which is focused on human health. This book gives greater attention to biological demography but does not neglect biomedical demography. In particular, two sections of Chapter 8 cover basic aspects of health demography—namely, active life expectancy and multiple decrement life tables. Attention to health demography continues in Chapter 10, but with an emphasis on the health of nonhuman species. Other aspects of biomedical demography are also covered, including some epidemiological examples, in Chapter 11.

A major strength of this book is its wealth of more than 200 illustrations. The authors have chosen these illustrations with care and thought to enhance conceptual

and methodological clarity. They use a variety of kinds of graphs and schematics that are not only useful for understanding the material illustrated but also for illustrating best practices in the visualization of demographic information. In two appendices, on visualization of demographic data and on “ten visualization rules of thumbs”, they capture the gist of how to visualize demographic information.

Another major strength of this book is the choice of examples. The range of these examples is impressive, as noted above, but perhaps even more important, the examples are almost all interesting, stimulating, thought-provoking. Chapter 11 is a tour de force of 87 terse examples, ranging from survival pills to forensic entomology.

It was a great pleasure for me to read the draft of this book because it got better the more I read. The material covered in the first chapters is explained in a highly competent manner. As the basics are explained, then it becomes possible to introduce more innovative and more creative topics. So the first part of the book is satisfying in the knowledge conveyed; the second part of the book is stimulating in the new horizons opened up. The first part of the book, however, does much more than simply cover standard material any demographer should know: it introduces some basic concepts and methods that are powerful but generally not covered in overviews.

For example, all populations are heterogeneous and individuals of the same sex and age and at the same location may face radically different reproductive opportunities and mortality hazards. Surviving populations are transformed as those at greatest risk of some event drop out. Hence, underlying patterns of demographic events for individuals differ qualitatively from observed patterns for those remaining in the population. Demographers are interested in how the chance of reproduction or the risk of death changes with age for individuals but they can only observe the changes for changing populations. This is a fundamental problem of demographic analysis that Carey and Roach tackle.

They also cover other topics not found in most demography or population biology books. These include stage-structured populations, stochastic rates of growth, two-sex models, kinship models, and thanatological demography.

A treasure chest of gems enrich all the chapters of this book, short discussions that capture the essence of an important concept or method, 87 gems in Chapter 11 and many others elsewhere. An excellent example is the discussion at the onset of Chapter 3 of age-specific survival (which is the measure currently used by almost all biologists studying patterns of mortality over age) vs. age-specific mortality (which is the measure demographers use). Carey and Roach persuasively explain why biologists should stop using age-specific survival and start using age-specific mortality. They make their case in a few cogent sentences that every biologist who uses age-specific survival should read.

In sum, this book is impressive. The authors aim to “enlighten and inspire” and they succeed. They do so in a highly original way—the book is reliable but unconventional. Standard material is covered but in new ways. Important material not found in other demography or population biology books is innovated. Originality of thought, of mode of explanation, of example, of graphic illustration sparkles on almost every page.

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