



Book Review

Sex Allocation. Stuart West.

Princeton, NJ: Princeton University Press, 2009. xii + 466 pp. ISBN13: 978-0-691-08964-5 (paper), \$45.00; ISBN13: 978-0-691-08963-8 (cloth), \$99.50.

The study of sex allocation (i.e., the allocation of resources to male and female reproductive function in sexual species) is often considered the most successful branch of evolutionary biology, primarily due to numerous empirical studies that support its theoretical predictions. Despite many success stories, however, the explosion of research on sex allocation (ever since Charnov's [1982] landmark contribution published nearly 30 years ago) has left the field in a fragmented and somewhat confused state that is in great need of synthesis and organization. Research on sex allocation biology spans broadly across taxonomic groups (within plants and animals) and encompasses a diversity of issues that center on why and when we might expect parents (primarily mothers) to differentially invest into male and female offspring. This vast literature is now elegantly summarized and synthesized in Stuart West's book entitled *Sex Allocation*, which is the 44th addition to the series "Monographs in Population Biology" published by Princeton University Press. Stuart West is a leading expert on sex allocation biology and, as evident in this book, has a commanding grasp of the large body of theoretical and empirical work on this topic. This impressive contribution provides a broad synthesis of early and recent research, unifies theoretical and empirical studies, discusses successes and failures, clarifies many misconceptions, and directs avenues for future work in this active area of biology.

This book consists of 11 chapters pertaining to several inter-related topics. The first chapter puts the field into a historical context by briefly discussing landmark contributions that have been critical for sex allocation research (e.g., work of Darwin, Fisher, Hamilton, Trivers, and Charnov). Within the context of past research, the author provides a clear description of the objectives and utility of this book (e.g., to unify theoretical and empirical work, to highlight how studies of sex allocation can address broader questions in evolutionary biology). West outlines the structure of the book, providing a reader-friendly format from the onset. For example,

the first table is a useful guide that will enable readers to quickly navigate through the book so they can jump to particular topics or to case studies of interest. Additionally, West carefully lays out what this book does and does not contain, and in many places refers interested readers to important reviews of related topics that are beyond the scope of this book (e.g., mechanisms of adjustment of sex ratios, details of mathematical models, and methodology for assessing sex ratios).

Chapter 2 provides additional historical background and examines Fisher's theoretical explanation of why females are expected to invest equally into sons and daughters (i.e., the theoretical foundation for most, if not all, research on sex allocation). The author provides insightful descriptions of common misconceptions and reviews empirical tests of Fisher's fundamental theoretical work. Chapters 3–5 focus on how cooperative and competitive interactions among relatives can favor biased sex allocation. These chapters review specific situations (e.g., local resource competition, local resource enhancement, local mate competition) that violate Fisher's expectations of equal investment, which can ultimately lead to sex biases in parental investment. Numerous case studies on a wide range of taxa are used to illustrate when selection should favor biased sex allocation in natural populations. Chapters 6 and 7 focus on the Trivers–Willard hypothesis (and its extensions) to explain when biased sex allocation will be favored in response to a variety of environmental conditions. By using examples from diverse taxa, West beautifully illustrates how this single concept unifies a large area of research on sex allocation, thereby providing explanations for the evolution of conditional sex allocation, environmental sex determination, and patterns of sex change.

Chapter 8 examines facultative adjustment of sex allocation in species with overlapping generations. Here, West explores the consequences of sex-specific perturbations in population parameters (mortality and recruitment), and illustrates how this relatively understudied area of sex allocation is in great need of more theoretical and empirical attention. Chapter 9 examines how selfish reproductive interests can result in conflict over sex allocation between individuals (e.g., parent–parent; parent–offspring; sibling conflict). His discussion clearly lays out how studies

of social hymenopteran insects have provided some of the best support for theories of sex allocation and kin selection. Chapter 10 further explores aspects of conflict, but in terms of selfish heritable elements (e.g., nuclear genes, cytoplasmic elements, and endosymbionts). Here, West provides a fascinating discussion of these heritable elements (called sex ratio distorters), which can modify sex ratios produced by their hosts in ways that increase their own transmission, often at the expense of their carriers' fitness. The final chapter brings the entire field together by reiterating numerous success stories of research into sex allocation, explaining how sex allocation theory can be used as a tool to illustrate general concepts in evolutionary biology (e.g., selection, adaptation, and constraint), and how it can be applied for purposes of conservation or biocontrol. The chapter ends with an important discussion of many problems and gaps that remain open, which will hopefully guide future research in the field.

I have nothing but compliments for this book. The text is well-written, easy to follow, and engages the reader in this exciting and active field of research. The clarity of figures and tables will reinforce the readers' understanding of the complex patterns described in the text. Moreover, small line illustrations of study organisms accompany each empirically derived figure, providing a quick and convenient way to remind readers of the focal taxa used in case studies. Further enhancing readability, some of the specialized jargon used throughout the book is repeatedly defined by short parenthetical statements; I found this particularly useful because it eliminates the frustration involved with trying to find definitions hidden on some previous page where the word is first mentioned. This is also helpful for making each chapter stand on its own so that readers can easily skip to particular topics of interest without reading intensive background in previous chapters.

Additionally, West purposely avoids extensive use of mathematics to make the book accessible to a broad audience. My feeling is that this approach will be welcomed by many empiricists and those with a peripheral interest in the field, but may be viewed as a weakness by those who are more mathematically inclined.

In my view, West has succeeded in synthesizing the massive sex allocation literature and has clearly connected the theoretical and empirical aspects of this field. He has demonstrated how research into sex allocation has provided critical insights into other areas of evolutionary biology. After reading this book, I now have greater confidence in my understanding of where this field stands and where future research would most profitably be directed. This book will unquestionably benefit students and professional scientists who are seeking either a basic introduction to sex allocation biology or a comprehensive sourcebook that integrates the major issues of the field. Additionally, this book would serve as an excellent resource for specialized graduate-level courses in evolutionary biology. Overall, this is an outstanding and comprehensive book that extends beyond the topic of sex allocation and is an essential tool for anyone with a serious interest in behavioral or evolutionary ecology.

Reference

Charnov EL. 1982. *The theory of sex allocation*. Princeton (NJ): Princeton University Press.

Daniel A. Warner
Department of Ecology, Evolution and
Organismal Biology
Iowa State University
Ames, IA 50011, USA
E-mail: dwarner@iastate.edu