

The Evolution of Primary Sexual Characters in Animals

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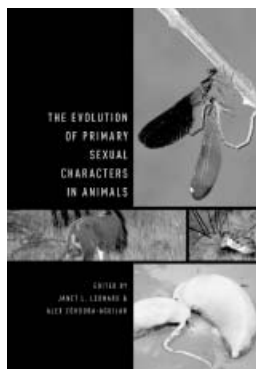
EQUAL OPPORTUNITY FOR SEXUAL EVOLUTION

The Evolution of Primary Sexual Characters in Animals. Janet Leonard and Alex Córdoba-Aguilar, eds. Oxford University Press, 2010. 552 pp., illus. \$79.95 (ISBN 9780195325553 cloth).

Survival is just a prerequisite for the ability to reproduce. It follows, then, that reproduction is a core aspect of evolution. And what has evolved, according to *The Evolution of Primary Sexual Characters in Animals*, is a magnificent reproductive diversity that is to be explored, celebrated, and understood. This volume—almost 600 pages about animal genitalia—is fascinating, thorough, and evolutionary. Both students and researchers studying reproductive biology will appreciate the book's explanation of underlying complex selective processes, which takes the reader beyond the basics of describing the variable forms and functions of genitals. Reproductive diversity is highlighted, but the processes and phenomena are the primary focus. On another topic, it is the male genitalia and sperm competition that have historically been emphasized in books in this field, but I happily report that *Primary Sexual Characters* has the ambition to address both female and male structures and perspectives.

Reproduction, animal behavior, and evolution (especially of banana slugs and marine invertebrates) have been strong themes in editor Janet L. Leonard's research at the Institute of Marine Sciences, part of the University of California at Santa Cruz. Alex Córdoba-Aguilar, coeditor, is also an invertebrate researcher, at the Instituto de Ecología at the Universidad Nacional Autónoma de México. He works primarily with insects and has an evolutionary focus on the form and function of genitalia. The joint interest of the editors in evolution, combined

with their global network of colleagues, has resulted in an impressive array of top scientists in the field listed among their contributors. I find it encouraging that these contributions are well coordinated and provide a diverse but coherent product—a clear indication that the editors maintained a dialogue with their authors.



It would have been an easy mistake for the editors of such an extensive book as *Primary Sexual Characters*, which is filled with knowledge on genital morphology in both males and females, with an evolutionary perspective on sexual selection, to present this volume as an all-encompassing reference text. On the contrary, each chapter introduces multiple topics for future research just waiting to be pursued. In the first part of the book, more generalized aspects of reproductive biology are addressed, as important and timely theoretical discussions challenge and promote scientific thinking. These chapters cover reproductive diversity and the rapid morphological divergence of genitalia with an updated viewpoint by the noted authority in the field, W. G. Eberhard. Other chapters approach the evolution of sex and anisogamy, and the actual definitions of *primary* and *secondary sexual characters* are discussed by Michael T. Ghiselin. He points to the ambiguity of what we mean when using the terms *sex*, *character*, and *adaptation*. Although the chapter concludes that the terminology for primary, secondary, and tertiary sexual characters is based on the type of selection that is underlying

the character, this discussion is likely to continue in future debates over terminology. In chapter 3, Patricia Adair Gowaty and Stephen P. Hubbell present a refreshing outlook on sexual conflict by formulating “the killing time hypothesis for male organs of seizure and prevention of female escape.” They argue that male coercion structures evolve to manipulate a female's subsequent reproductive decision, emphasizing adaptive flexibility in individual decisions.

A more descriptive part of the book follows, taking the reader through 16 chapters discussing various animal taxa. One chapter highlights the timing of gamete release in broadcast-spawning marine invertebrates; another presents intriguing details of genital structure and function in, for instance, molluscs and arthropods. Thorough illustrations support each chapter's discussion of the interactive selective pathways underlying genital structure. In chapter 10, many common garden snails are highlighted, and the effects on life history and habitat when studying primary sexual trait evolution are emphasized. Chapters 14–16 cover insects (some of them being frequent model organisms) with interesting discussions that reflect recent scientific achievements. A cautionary word: It is possible for the reader to become lost within the rich details of many of these chapters, but my advice is to press on. Each chapter's conclusions are worth reading.

Most of the book's chapters discuss invertebrates, since they are a main interest of the editors (e.g., spawning marine invertebrates, various gastropod taxa, scorpions, spiders, harvestmen, insects, dragon- and damselflies, beetles), but fish, birds, amphibians, reptiles, and mammals are also adequately represented. The chapters on vertebrates strongly emphasize evolutionary theory and present many stimulating perspectives reflecting structural diversity as well as a diversity in the selection processes that operate on them. Throughout the book, historical key references combined with a significant number of recent scientific papers

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offer a balanced and thorough wealth of knowledge about a broad array of animals. One criticism is warranted, however. When I wanted to use the index to refer to what I had previously read, remembering a particular *Callosobruchus* seed beetle or a banana slug, to my surprise, no species were listed, by neither common nor scientific name.

Primary Sexual Characters fashionably coincides with the present era of sexual conflict studies and postcopulatory sexual selection research. It offers thorough evolutionary thinking, presents careful definitions of concepts, and provides fresh perspectives that bring science forward. The book will serve either as an in-depth tour for the curious or as a helpful and detailed descriptive reference guide for those already in pursuit of further study in the fields of reproductive and evolutionary biology. I now envision teaching my marine biology students during their field course to look into the genital world of gastropods, nudibranchs, and other invertebrates, but I also see two broader conclusions emanating from reading this book: Sexual selection acts on primary as well as secondary sexual characters, and beneficial research is gained by the study, in equal measure, of genital evolution in both sexes.

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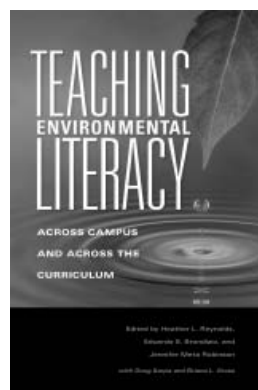
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CRITICAL COMPETENCE

Teaching Environmental Literacy: Across Campus and across the Curriculum. Heather L. Reynolds, Eduardo S. Brondizio, and Jennifer Meta Robinson, eds. Indiana University Press. 2009. 240 pp., illus. \$21.95 (ISBN 9780253221506 paper).

Teaching *Environmental Literacy: Across Campus and across the*

Curriculum has been long overdue. Its central tenet is a simple yet powerful idea: People from all disciplines share their unique perspectives to create a holistic approach to the teaching and learning of environmental literacy. Written primarily by faculty (the majority from Indiana University) for faculty, the book is well written, engaging, thought provoking, and refreshingly free of errors. A particularly detailed and effective index is provided, as is an appendix. The volume is both inspirational and functional.



Comprising a collection of essays organized into four sections, the work stems from grassroots faculty conversations on teaching environmental literacy at Indiana University. The contributors hail from an impressive and laudably disparate array of disciplines—biology, anthropology, public and environmental affairs, physics, law, geography, economics, philosophy, chemistry, political science, English, religious studies—all united by the overarching goal of crafting arguably the most important competency of our time—that of environmental literacy.

The rationale for such an initiative is compelling: “Some 30 years after the first Earth Day, only a third of Americans can pass basic tests of environmental knowledge with a grade of C or better” (p. xiv) and “no student should graduate from college or university without a basic understanding of the ecological infrastructure that underpins human society” (p. 20).

However, in the final chapter, Eduardo Brondizio, playing devil’s advocate, poses the question of whether environmental literacy is a worthy or even appropriate goal for institutes of higher learning. I contend that far from being a questionable pursuit, environmental literacy is the single most pressing issue facing humanity today. In *Teaching Environmental Literacy*, passionate advocacy springs from every page, but the book is also full of insights and pragmatic strategies to help engage an entire community of scholars and practitioners from both the top down and the bottom up. In effect, its thesis is to restore the university to its role as a truly synthetic place of learning, and it goes a long way toward reinstating the original medieval concept of a meaningful *universitas scholarium*.

Part 1 presents a well-considered and detailed model for a grassroots, multidisciplinary faculty inquiry, the genesis of which was the Environmental Literacy and Sustainability Initiative, which successfully engaged faculty, administrators, students, and operational groups in a two-year conversation at Indiana University. A four-part model is presented for cultivating and sustaining a campus conversation about environmental literacy, from which three broad themes emerge: ecosystem services, ecological footprint, and sustainability.

Part 2 is a collection of eight short essays, opening with Keith M. Vogelsang and Eric J. Baack’s “At the forest’s edge,” a poignant piece wrought with the perspective and clarity perhaps only biologists can provide. They look at the historical and contemporary effects of deforestation using Indiana’s southern forests as an example to engage students at a personal and local level. In “Population, energy, and sustainability,” Bennet Brabson presents an unsettling scenario of current and future energy production and consumption and shows conclusively that the only variable over which we have any control is the per capita energy use of Americans. He sees the working

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