Animal Osmoregulation

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conservation requirements of insects. His selected case studies are from insect orders including Coleoptera, Diptera, Lepidoptera, Odonata, and Plecoptera in Australia, Europe (particularly the United Kingdom), Japan, New Zealand, and North and South America. New educates readers about many insect conservation topics, including laws, policies, priorities, and strategies; inferring and defining threats (including habitat destruction, alien species, pesticides, and overcollecting); bioclimatic variables and climate change; and future needs. Readers learn about conservation methods such as *ex situ* and *in situ* programs; site modification and restoration; and captive breeding, monitoring, reintroduction, and translocation methods.

Public education, acceptance, and promotion are key parts of insect conservation programs. Many children go through a "bug phase" during which they are fascinated with insects. Teachers and society as a whole should nurture and protract this phase as part of lifetime Earth stewardship. Nature deficit disorder is on the rise worldwide as more children spend more and more time indoors in our increasingly technological world. We need additional adopt-a-caterpillar (and other larvae) programs, such as the one New described for *Ornithoptera richmondia* (Richmond birdwing butterfly) in Australia, not only to help the insects in the short term but also to raise children's and others' awareness of nature in the long term. Further, New understands the positive reasons for insect collecting and suggests that collectors sometimes be allowed to gather even rare species in moderation, because amateur entomologists often provide important biological information and can be staunch conservationists as well. A child's insect collection, which need not contain any rare species, can lead to a career in conservation biology or other science, as occurred with several biologists I know.

When reading, I tried to put myself in the shoes of a hands-on, very busy, dedicated conservation manager who is unfamiliar with insects to try to imagine how such a person would relate to the book. *Insect Species Conservation* covers laws, taxa, biological and conservation concepts, and conservation measures that require training and experience—biological and otherwise—to understand fully; I concluded, then, that this postulated conservation manager would want to consult additional sources, such as conservation recovery plans and reports, scientific articles and books, and accurate Internet pages, to augment his or her understanding. Governments (e.g., Australia and the United States) provide online information sheets on many threatened and endangered species and legislation; New makes little reference to this wealth of online material.

If the hypothetical conservation manager were a visual learner, he or she would want to see inspirational and informative photographs of focal taxa and their habitats; there aren't any in this book, save for two photographs on the cover. To help identify and decipher the many concepts, legislation, and species covered in the text, this manager would profit from an excellent glossary, an annotated list of legislation, and an annotated list of the insect taxa mentioned in the book. I began gathering these things for myself to guide my reading for deeper understanding. The book has a comprehensive index that helps readers find topics, but it is not a good substitute for synthesized lists. In addition, I think New could have made his book more readily understandable and saved the reader time by using more subtitles and section summaries. His chapter summaries are helpful, but he could have eliminated them if he had used more descriptive, subject-verb-type subtitles. Overall, the book is well edited, but the light font and words trapped in the gutters of the pages decrease readability.

Insect Species Conservation is conceptually accurate and logical; nonetheless, it has two factual errors of note. Page 36 erroneously indicates that the Chesapeake Bay is in New England, and on page 124, readers learn about an endangered lycaenid butterfly "*Erynnis comyntas*." I could find no evidence that this "unicorn" exists after referring to my six books on North American butterflies and consulting with two Smithsonian lepidopterists. *Erynnis* is a genus of skipper butterflies and *comyntas* is the specific epithet of a so-far-non-threatened, spritely North American lycaenid butterfly called the Eastern tailed blue.

Insect Species Conservation is a significant summary and synthesis of insect conservation that should be read by conservationists and others to broaden their horizons. Conservation managers should keep this book handy to help inform their adaptive-management programs, while fully realizing that methods that work in conserving some species may not work for others.

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FINDING A WATER BALANCE

Animal Osmoregulation. Timothy J. Bradley. Oxford University Press, 2009. 320 pp., illus. $60.00 (ISBN 9780198569961 paper).

Animal Osmoregulation is the newest publication in the Oxford University Press Animal Biology Series. The small books in this series are designed to serve as brief references for scientists looking for an introduction to a topic, or as supplementary

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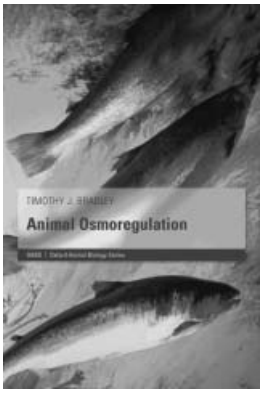
textbooks for advanced undergraduate and graduate students studying comparative biology. The books highlight common themes and use integrative examples from throughout the animal kingdom. Other titles in the series cover animal body plans, locomotion, eyes, and energetics.

In *Animal Osmoregulation,* Timothy J. Bradley, a professor of ecology and evolutionary biology at the University of California, Irvine, and a specialist in insect osmoregulation, explains how ecology and evolution interact to create diverse yet similar physiological mechanisms for osmoregulation. The book is divided into three sections: the physical properties of water and solutions, how organisms meet



the challenges of osmoregulation and volume regulation in different habitats, and a brief introduction to the cellular mechanisms of cell volume and osmotic regulation. The endocrine control of volume and osmolarity is largely absent from this text, although some hormones are mentioned in the final chapters of the book. Each chapter ends with suggestions for further reading, ranging from specialty textbooks to classic and recent research papers.

The book opens with chapters on the physical properties of water, osmosis, and the interactions between water and proteins and lipids, when dissolved and when in the plasma membrane. The first two chapters review concepts that most students will have encountered in their introductory chemistry and biology courses: surface tension, density changes with temperature, and the colligative properties of water. Bradley uses a quantitative approach that highlights the biophysics of aqueous solutions in living systems. Readers are introduced to Raoult's law governing the relationship between vapor pressure and solution concentration, and to equations for water fluxes across membranes, diffusion coefficients, and the reflection coefficient. The book's mathematical expressions are clearly explained with illustrative examples and relevant problems.

Chapter 4 introduces the next block of chapters by briefly reviewing the osmotic challenges faced by animals as they evolved from unicellular to complex multicellular structures, and then as they migrated from the ocean into freshwater and finally onto land. Bradley describes two major physiological mechanisms that organisms use to meet these challenges: osmotic regulation and volume regulation. The discussion of volume regulation is further subdivided into cell volume regulation and extracellular fluid volume regulation for those multicellular organisms whose cells are bathed in an extracellular fluid. The next four chapters examine the challenges presented by the three aforementioned habitats and how different taxa have met those challenges.

In the ocean we find osmoconformers, whose body fluid concentrations mirror the animal's external environment, and hyporegulators, who maintain an internal concentration lower than their environment. In freshwater, the challenge for hyperregulators is to keep their internal concentration higher than that of the surrounding fluid. And for terrestrial organisms, the goal is to obtain and conserve water while minimizing dehydration. However, these four strategies are not explicitly laid out in chapter 4, an omission that may leave naïve readers wondering where the text is leading.

Each of the four "challenge" chapters begins with an overview of the habitat and a discussion of some general mechanisms animals use to battle the osmotic challenges therein. The remainder of each chapter is divided into sections, one for each major group of animals found in the habitat. This organization leads to some redundancy, particularly in the discussion of fish gills (repeated in chapters 6 and 7) and insect Malpighian tubules (repeated in chapters 6, 7, and 8). I would have preferred a single, detailed description in the introduction to a given topic, with a reference to that discussion when the subject reappears in later chapters; the redundancy does, however, ensure that a researcher picking up the book to look at one chapter will find everything she or he is looking for in one place. The repetition is also probably good for students, who may not remember the first presentation of the material.

The final three chapters of the book turn to the cellular mechanisms by which animals carry out osmotic and volume regulation. For me, this was the book's least satisfying section. Chapter 9, "Membranes as Sites of Energy Transduction," begins with a brief section on separation of charge across biological membranes, followed by a short discussion of mitochondrial ATP (adenosine triphosphate) production. When I first read this, I was confused by the inclusion of these sections because membrane potential and electrical charge had not previously been discussed, so details of the chemiosmotic theory of ATP production seemed off topic. I was also puzzled by the section on vertebrate intestinal transport as a cellular model for transepithelial transport. Intestinal water absorption was mentioned only briefly in the middle chapters, whereas the vertebrate renal tubule, which was discussed in some detail, uses the same transporter proteins and is more relevant to osmoregulation. Perhaps a different chapter introduction that reviewed the principles of active and passive transport while explaining how potential energy for transport can be stored in gradients would have made the relationship between the first two sections and osmoregulation clearer.

The final two chapters describe some of the combinations of membrane transporters that animals use for osmoregulation, both in transepithelial transport (chapter 10) and for the regulation of individual cell volume (chapter 11). A few of the hormones involved in osmoregulation are mentioned briefly, but I found myself wanting to know more about how these hormones alter cell transporters under various conditions. I also would have liked more information on how animals integrate information about changes in volume and internal osmolarity to maintain homeostasis.

Bradley has a very clear writing style that makes reading this book a pleasure. He writes so conversationally that I sometimes found important definitions slipping by. The absence of bolded or italicized words made it difficult to go back and find the initial mentions of important terms. In many cases, the brief index was also no help because the term was not listed there, either (*euryhaline* is an example).

There were a few factual inconsistencies in the book. For example, creation of dilute urine by the mammalian kidney was attributed to the loop of Henle in two places, and to the distal tubule in a third. There were also omissions: the role of urea in osmoregulation was discussed for elasmobranchs but ignored in the mammalian renal medulla. But most of these failings were minor. The one major topic I found missing from the book was discussion of the anadromous and catadromous fishes, which move between fresh- and saltwater and flip-flop their osmoregulatory mechanisms as they do so. This is one example that I always teach, and I would have liked to have seen it included, as the switch between hyporegulation and hyperregulation and the endocrine control of this switch is a beautiful illustration of how animals meet the osmoregulatory challenges of migration between habitats.

Overall, *Animal Osmoregulation* is a very readable book that will appeal to students and faculty alike, and I recommend it to readers who are looking for a supplementary textbook or an introduction to the field.

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NEW TITLES

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