

Ecological and Environmental Physiology of Amphibians

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Amphibian Physiology

Ecological and Environmental Physiology of Amphibians. Stanley S. Hillman, Philip C. Withers, Robert C. Drewes, and Stanley D. Hillyard. Oxford University Press, 2008. 464 pp., illus. \$65.00 (ISBN 9780198570325 paper).

Some 365 million years ago, a small group of lobe-finned fishes emerged from the Devonian swamps and ventured onto land, giving rise to the first terrestrial vertebrates—the amphibians. What evolutionary forces propelled these early tetrapods to give up their cozy aquatic existence for what must have been an uncertain and challenging terrestrial life is unknown, though a number of ideas are fiercely debated. Regardless of the evolutionary pressures involved in their origin, these early amphibians thrived and diversified, eventually giving rise to all terrestrial vertebrates—a vast and highly successful group. Today, there are nearly 6000 species of amphibians within three orders (frogs, salamanders, and caecilians) found in habitats ranging from tropical rainforests to deserts and Arctic tundra.

The study of amphibians has experienced a surge of interest in recent years, due in large part to both the recognition that amphibians worldwide are declining and the infusion of talent and funding to better understand the causes of these declines. Coincident with this expanding interest has been the publication in recent years of a number of excellent and significant books on amphibian biology, including *Amphibian Declines*, edited by Michael Lanno; *The Ecology and Behavior of Amphibians*, by Kentwood Wells; and *Rise of the Amphibians*, by Robert Carroll. Noticeably absent from this list has been a current synopsis of amphibian physiology; *Ecological and*

Environmental Physiology of Amphibians seeks to fill this void and join the list of must-have books for the amphibian biologist.

Ecological and Environmental Physiology of Amphibians consists of a detailed review and synthesis of amphibian physiology, with emphasis on physiological mechanisms that allow amphibians to adapt to a wide range of environments and habitats. Authors Stan Hillman, Philip Withers, Robert Drewes, and Stan Hillyard all are recognized scientists who have made important contributions to our understanding of amphibian physiology. Reflecting the interests of the authors, the book has strong emphasis on water balance and respiration. This restricted focus is both its strength and its weakness—it gives the book coherence and allows the authors to write in their primary areas of expertise, yet it ignores large swaths of environmental physiology (e.g., environmental toxicology), limiting the appeal and utility of the book.

The book is divided in six long chapters. Chapter 1 provides an introduction to amphibian characteristics, phylogeny, and principles of physiology. Basic physiological systems in amphibians, including water and ion exchange, energy budgets, respiration, and cardiovascular dynamics, are discussed in chapter 2. The third chapter covers specialized physiological systems of amphibians (including skin and bladder adaptations for water and ion exchange, dehydration tolerance, temperature tolerance, metabolism, nitrogen excretion, and developmental plasticity), while chapter 4 explores physiological adaptations to extreme environments. In chapter 5, the authors discuss experimental techniques and approaches, and chapter 6 wraps things up by drawing conclusions about what we know, what we don't know, and future directions of the field.

Manageable in size, with 381 pages of primary text (469 pages total), *Ecological and Environmental Physiology of Amphibians* offers a strong phylogenetic approach and examples from a wide range of amphibian taxa. The book does a good job of portraying the science behind the principles, giving excellent coverage to the research literature. More than 1600 references, which appear to be current through 2007, provide an invaluable entre to the literature of amphibian physiology. Although advertised as accessible to graduate students, researchers in amphibian biology, and professional herpetologists, much of the book is technical and written largely for experienced physiologists. Equations are often used without defining variables, and complex terminology is introduced without explanation. I was disappointed to see so little introduction to general physiological principles, which would have been helpful to nonphysiologists and beginning students.

A noticeable shortcoming of the book is the almost exclusive focus on adult amphibians. Much physiological work has been done on larval amphibians, but this research is largely ignored in the present volume. Finally, given the current interest in amphibian declines and concerns about global climate change, one might expect to see emphasis given to physiological aspects of these current topics. Yet other than a few asides, these subjects are hardly mentioned. Discussion of how our current knowledge of amphibian physiology contributes to an understanding of amphibian responses to climate change, pollution, and emerging diseases would have greatly enhanced the book.

In summary, *Ecological and Environmental Physiology of Amphibians* is an important and significant resource, with an excellent review of the state of our current understanding of

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amphibian physiology, particularly with regard to water balance. The book is valuable to physiologists and to those amphibian biologists whose research focuses on water exchange, but I suspect that its usefulness to a wider audience is limited by its technical prose and restricted focus.

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GIVING THE AMOEBAE EQUAL TIME

The Social Amoebae: The Biology of Cellular Slime Molds. John Tyler Bonner. Princeton University Press, 2008. 156 pp., illus. \$19.95 (ISBN 9780691139395 cloth).

In *The Social Amoebae*, John Tyler Bonner, professor emeritus of ecology and evolutionary biology at Princeton University, writes about his beloved slime molds—organisms he has cherished for more than 60 years. While we often hear that men are from Mars and women are from Venus, slime molds are truly from Earth, and after reading Bonner's book, one feels the need, as I did, to walk outside, pick up a handful of soil, and look for a slime mold—to study, to admire, and to gain down-to-earth knowledge and insight into the fundamental processes that make all life on Earth possible.

Bonner describes the stages and transformations that occur in the life cycles of the cellular slime molds. He explains how these molds have provided researchers with many opportunities to conduct meaningful studies, using simple equipment, that enabled

us to understand general biological problems, including the differentiation of cells, functional redundancy, cell motility, cell signaling, self organization, and the development of multicellularity. The life cycle of a cellular slime mold begins when a spore germinates to form a single-celled amoeba that feeds on bacteria. As long as there is plenty of food, the amoebae divide and live as single-celled organisms. As the bacterial food source becomes depleted, however, the amoebae aggregate to form a multicellular slug in response to a chemical signal from a single group of cells or a single founder cell. By sensing light, thermal or gaseous gradients, the multicellular slug then migrates to find an appropriate location for fruiting so that the spores can be dispersed by animals living in the soil. Bonner shares with us that "When one arrives in the laboratory in the morning, the slugs in every culture dish will all be pointing towards the window." Upon finding a suitable location, the cells of the slug transform into stalk cells or spore cells as they form the fruiting body, or sorocarp. Information on cellular slime molds obtained from slowly publishing individual craftspeople using inexpensive equipment is currently being supplemented by information obtained by rapidly publishing, multinational consortia using expensive molecular techniques.

Realizing that the number of publications on cellular slime molds had risen from an average of 3.4 per year to an average of 224 per year over the course of his career, Bonner decided to write *The Social Amoebae* as an exercise to place the "factual bricks" created by the growing literature on the molecular biology of cellular slime molds into a coherent "mansion," so that the curious layperson could gain a complete picture of the biology of slime molds. In so doing, I believe he found that the new molecular facts had such a short half life and rapid turnover rate that he wrote *The Social Amoebae* so practicing cellular slime mold biologists would plan and analyze their work with a "more generalized biological

point of view" to guarantee that "the lessons learned would last for some time."

The book is extremely well written. In fact, the rhetorical style reminds me of the funeral oration given by Mark Antony in *Julius Caesar*. In the introduction of *The Social Amoebae*, Bonner writes: "The molecular genetics of the developmental biology of *D. discoideum* (which was now simply called *Dictyostelium*, reflecting its newfound status as a model organism) became central. The most recent high point in this program has been the sequencing of its entire genome: now it is possible to find out how many genes we share with a slime mold. The result is that our insights and understanding of the development of *Dictyostelium* has vastly increased." Although Bonner acknowledges "that it is inconceivable to study the biology today of any organism without genetics and molecular biology," he warns us in the chapter titled "The Future" that "we are looking at finer and finer details at the risk of losing the big picture," and "it is increasingly obvious that knowing all the genes identified in an organism does not really tell us how the organism is constructed or how it develops. Again, it is a pile of bricks and the architect's plans are hidden from us."

Another motivation for writing *The Social Amoebae* came from Bonner's realization that research on the non-molecular biological aspects of cellular slime molds had been overshadowed by the number of workers and publications in molecular developmental biology. In order to illuminate the aspects of cellular slime mold biology that have been overshadowed, Bonner gives "equal time to their evolution, their ecology, their behavior, both as single amoeba and as cell masses, and their development."

To me, "equal time" to general biology is a euphemism used by Bonner to remind biologists that there are many valid approaches to study the cellular slime molds besides the reductionist approach of doing molecular biology (or "omics") for its own sake, without extensive integration with the

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