Ecological and Environmental Physiology of Birds

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remarkable field ornithologists in the late twentieth century (e.g., Theodore A. "Ted" Parker III) deserve a place in a history of ornithology dedicated to biographies of ornithologists. It is a pity that they did not receive attention.

Just as it is the rare review that does not contain criticism, it is the rare book that does not contain errors. One such error in this volume is that the last Carolina parakeet died not in 1914—the year that Martha, the last passenger pigeon, died—but in 1918. The two birds died in the same cage in the Cincinnati Zoo. Furthermore, Ernst Mayr's career in America unfolded not exclusively, as is implied, at the American Museum of Natural History but also (for decades) as a professor at Harvard's Museum of Comparative Zoology, where he arguably published his most important syntheses.

For all its shortcomings, this work redeems itself in its sumptuous use of illustration—some 250 images overall, from the sixteenth to the twentieth centuries, and many in color. The artists include painters, engravers, lithographers, and others with household names (e.g., Ulisse Aldrovandi, Lucas Cranach the Elder, Roelant Savery, Mark Catesby, Eleazar Albin, George Edwards, Alexander Wilson, John James Audubon, Louis Agassiz Fuertes) and many without (e.g., Lukas Schan, Alexandre Isidore Leroy de Barde, François-Nicolas Martinet, Georg Foster, Jacques Barraband, Polydore Roux, Jean-Gabriel Prêtre, George Robert Gray, John Gerrard Keulemans, Edward Lear). Anyone lacking encyclopedic knowledge of bird artists will learn something new in every section of this book. Collectively, their remarkable images of birds not only brighten *All About Birds* but awaken the reader, whose aesthetic engagement with birds will be at or near the height of experience by this reading. Despite the cautions expressed in this review, it is the art—together with a text that is unusual for its clarity, an elegant design, and a printing of high quality—that should guarantee a wide readership. This book, no doubt, will reinforce *la passion* in those who already know something of the field and will instill it in all for whom ornithology awaits as revelation.

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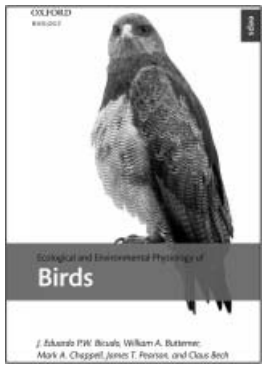
AN ENDURING UNION

Ecological and Environmental Physiology of Birds. J. Eduardo P.W. Bicudo, William A. Buttemer, Mark A. Chappell, James T. Pearson, and Claus Bech. Oxford University Press, 2010. 328 pp., illus. $65.00 (ISBN 9780199228454 paper).

Ecological and Environmental Physiology of Birds is an eclectic summary of current thought in the field of avian ecological physiology. The book is designed to provide a concise and current overview of physiological ecology in birds for graduate students, beginning researchers in comparative physiology, and ornithologists. The contributors to this book are a diverse group of ecological physiologists from around the globe, most with an academic pedigree linking them to early pioneers of the field. Eduardo Bicudo studied with Knut Schmidt-Nielsen, Mark Chappell with George Bartholomew. William Buttemer and James Pearson studied with mentors who were students of Bartholemew. Claus Bech was supervised by Kjell Johansen, who did his PhD work at the University of Oslo, where Per Scholander was a professor of zoophysiology. Each contributor brings his extensive research background to the text, adding to our knowledge of how avian biology functions at a mechanistic level.



Born of a marriage between comparative physiology and natural history, the discipline of ecological physiology is intended to explain how the physiological machinery of organisms enables them to cope with their changing natural environment and how natural selection has modified, and continues to modify, physiological phenotypes to solve difficult environmental problems. The field emerged during the late 1940s and early 1950s with Schmidt-Nielsen's exploration of how kangaroo rats could survive their desert environment without drinking water, Bartholomew's work on the electrolyte balance of birds in deserts and in salt marshes, and Scholander's research on the respiratory physiology of diving marine animals. A common theme in their research was a fascination with the myriad ways in which free-living animals functioned in their natural environments (Schmidt-Nielsen 1987, Dawson 2005, Weibel 2007).

Studies of birds by these scientists played a prominent role in the development of ecological physiology. Interested in how marine birds could survive without drinking freshwater, Schmidt-Nielsen discovered avian nasal salt glands, which are extrarenal structures that allow marine birds to drink seawater. Later, he discovered that airflow in the bird lung is unidirectional (unlike that of mammals), an adaptation that allows birds to fly at high altitudes. Bartholomew modeled how seed-eating birds could survive without drinking and

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elucidated the circumstances under which metabolic water could supply all of a bird's water requirements. Scholander measured the heat loss of small Arctic birds, which resulted in the Scholander model of heat transfer for endotherms, which is taught in animal physiology classes today.

As a result of this research into avian physiological adaptation, a fascination has developed about birds' ability to occupy nearly every habitat on Earth, including the cold Arctic and the hot deserts of the world. A better understanding of how birds live where they do is necessary as our global climate patterns change. Birds have unusual physiological attributes—higher rates of metabolism, higher body temperatures, and higher plasma glucose levels than mammals of similar size—yet they have a longer life span. Examining the physiological machinery in birds may explain the differences in life histories and could be important in our quest to understand human aging.

Ecological and Environmental Physiology of Birds begins with a discussion of the evolution of birds' body plan, with an emphasis on feathers and flight. This first chapter also includes sections on molt, nocturnal migration, and the energy cost of flight in flocks. The second chapter is devoted to basic physiological principles, such as gas exchange, heat exchange, and osmosis. The remaining chapters cover a variety of topics, including associations between avian physiology and life history, how birds obtain and process food, neural and sensory physiology, the developmental physiology of nestlings, and a discussion of special adaptations that birds exhibit in specific environments. The authors conclude with an overview of current techniques used by investigators to assess physiology in birds, especially energy expenditure, and remark on future directions in the field. The book is thought provoking, covers a broad range of topics, and includes research from over 1100 publications. The chapter on avian fecundity and life-history trade-offs is especially well written and provides insights into the complex connectivity among the endrocrine system, the immune system, metabolic rate, and the rich variation in avian life history. As a graduate student text or as a research reference, the book fills an important niche in ornithological literature and will stimulate future research in avian ecological and environmental physiology.

Despite my enthusiasm, however, I note a few limitations in the book that, to me, detract from its impact. Organizational problems, for one, led to some repetition within and among chapters. For example, chapter 2 describes water loss in bird eggs (pp. 32–34)—information that is reiterated in chapter 7 (p. 211). Chapter 5 discusses the thermal consequences of a marine lifestyle (p. 169), citing the unique plumage of cormorants (Rijke 1968). After a section on locomotion, the authors revert to another discussion of thermal exchanges, again citing the unique plumage of cormorants (pp. 179–180). The rate of heat loss in water is discussed repeatedly in these sections. In addition, some undefined words in the text may be confusing to beginning students—*pallium*, *neritic water*, *arcopallium*, *hyperstriatum*, *parasagittal*, to name a few.

Minor conceptual errors or assertions having alternative explanations are also present. An example of this is that the authors claim on page 1 that birds are viviparous (live bearing) instead of oviparous (egg laying), and on page 3 the authors suggest that flight in birds evolved during the late Jurassic period when the atmosphere was hyperoxic and hyperdense, with about 31 percent oxygen (10 percent higher than present-day oxygen levels). An analysis based on carbon isotopes of organic matter and carbonate samples collected from the Atlantic basin show, however, that during the late Jurassic, oxygen concentrations rose to current levels—21 percent, not 31 percent (Falkowski et al. 2005). On page 39, the book claims that the skin of birds is impermeable to water-vapor diffusion, but later, in chapter 5, the text describes water-vapor diffusion through skin as an important component of total evaporative water loss.

A lack of acknowledgment of certain authors who performed seminal work in the field is apparent. For example, on page 128, the book states that egg laying appears to increase daily energy expenditure by about 35 percent, with attribution given to Charles T. Robbins's book on wildlife ecology (1993), yet the major contribution of Jim King (1973, 1974) on the cost of egg laying, that of Bob Ricklefs (1974), and the more recent work of Tony Williams (2005) are all overlooked. On page 149, the book addresses seasonal and latitudinal adjustments of metabolic rate: The basal metabolic rate tends to be higher for birds in cold climates or higher in winter than in summer. It might have been appropriate here to include the work of Dave Swanson, who for the last decade has examined variation in rates of metabolism relative to the environment (Swanson 2010). Finally, on page 189, the book describes how African gray parrots use words in numerical and relational concepts—abilities once thought unique to humans. This would have been an appropriate place to cite Irene Pepperberg's (2000) work on African grays. Pepperberg demonstrated that a parrot named Alex could differentiate meaning and syntax in his language skills; his communication was not instinctive but, rather, learned.

Despite its shortcomings, *Ecological and Environmental Physiology of Birds* provides a concise overview of the current literature in avian physiology for beginning researchers, and it should stimulate discussion in lab groups and with graduate students. The book illustrates how far research in the field has come and how many topics are yet to be explored.

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References cited

Dawson WR. 2005. George A. Bartholomew's contributions to integrative and comparative biology. Integrative and Comparative Biology 45: 219–230.

Falkowski P, Katz M, Milligan A, Fennel K, Cramer B, Aubry M, Berner R, Novacek M, Zapol W. 2005. The rise of oxygen over the past 205 million years and the evolution of large placental mammals. Science 309: 2202–2204.

King JR. 1973. Energetics of reproduction in birds. Pages 78–120 in Farner DS, ed. Breeding Biology of Birds. National Academy of Sciences.

King JR. 1974. Seasonal allocation of time and energy resources in birds. Pages 4–70 in Paynter RA Jr, ed. Avian Energetics. Nuttall Ornithological Club. Publication no. 15.

Pepperberg IM. 2000. The Alex Studies: Cognitive and Communicative Abilities of Grey Parrots. Harvard Universitiy Press.

Ricklefs RE. 1974. Energetics of reproduction in birds. Pages 152–292 in Paynter RA Jr, ed. Avian Energetics. Nuttall Ornithological Club.

Rijke AM. 1968. The water repellency and feather structure of cormorants, Phalacrocoracidae. Journal of Experimental Biology 48: 185–189.

Robbins CT. 1993. Wildlife Feeding and Nutrition. Academic Press.

Schmidt-Nielsen K. 1987. Nobel—The award of the prize. News in Physiological Sciences 2: 192–194.

Swanson DL. 2010. Seasonal metabolic variation in birds: Functional and mechanistic correlates. Current Ornithology 17: 75–129.

Weibel ER. 2007. Obituary in memoriam Knut Schmidt-Nielsen 24 September 1915–25 January 2007. Journal of Experimental Biology 210: 1299–1301.

Williams TD. 2005. Mechanisms underlying the costs of egg production. BioScience 55: 39–48.

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