

Avian physiological ecology: old questions, new systems and new approaches

Fisiología ecológica de aves: preguntas viejas, sistemas y aproximaciones nuevas

FRANCISCO BOZINOVIC¹ & CARLOS MARTINEZ DEL RIO²

¹Departamento de Ecología, Facultad de Ciencias Biológicas, P. Universidad Católica de Chile,
Casilla 114-D, Santiago, Chile.

²Department of Ecology and Evolutionary Biology, Biological Sciences West Room 310, University of
Arizona, Tucson, Arizona 85721, USA. Present address: Department of Zoology and Physiology,
University of Wyoming, Laramie, Wyoming 82071-3166, USA
e-mails: ¹fbozinov@genes.bio.puc.cl, ²cmdelrio@uwoyo.edu

In an analysis of current directions in animal physiological ecology, Feder & Block (1991; *Functional Ecology* 5: 136-144) claimed that the goals of the discipline (among others) are: the analysis of physiological mechanisms, how variation in physiology affects and is affected by the distribution of animals in space and time, and both the patterns and process by which physiological variation evolve or persists". They also indicated that a major goal of physiological ecologists should be to determine: "how animals can exploit environments from which a more ordinary physiology might prohibit them, and physiological limitations translate into diminution of fitness or death at the edges of a species' or population range".

The contributors of this special volume explore through new technological and theoretical approaches an old question in avian physiological ecology. Namely, what are the ecological and evolutionary consequences and correlates of a bird species' physiology and behavior. Specifically, they explore how birds can survive biotic and abiotic environments that pose serious challenges to the maintenance of homeostasis, survival and ecological success.

The present volume results from an integration of selected papers presented at the symposium "Ecophysiology of Birds" and "Bird-Plant Mutualisms in the Neotropics: What's New?" that took place at the VI Congreso de Ornitología Neotropical, held on 4-10 October 1999 in Monterrey, México. We were so taken by the quality and scope of the contributions to the symposia that we decided to ask participants to write their contributions as mini-reviews for an edited volume. The result is this issue of the *Revista Chilena de Historia Natural*. The issue in your hands is unique because it is probably the first volume of any Hispano-American ISI-

indexed journal to be dedicated to the physiological ecology of vertebrates.

Contributors to this volume deal with a variety of classical and contemporary topics in physiological ecology (osmoregulation, energetics and thermoregulation, digestive strategies and feeding behavior, as well as the role of environmental contaminants in avian biology). Although papers use birds as models, we hope that this volume will be appreciated by biologists from all disciplines and that it will inspire students and researchers to take up the many challenges and questions outlined in each paper.

The papers in this volume range widely from classical environmental and comparative physiology to the mechanistic study of animal-plant interactions. To provide readers with a rough guide to the volume we briefly describe each contribution. Blair Wolf discusses the challenges posed to small birds by heat and drought in hot subtropical deserts, as well as global warming and avian occupancy of deserts. He describes the complementary interaction between physiology and behavior that allows small birds to maintain homeostasis and conserve vital resources such as water in these challenging environments. Pablo Sabat review a classical topic in avian comparative physiology in a novel system: he consider the osmoregulatory problem posed by marine environments to birds with characteristically limited renal concentrating abilities. Sabat present a remarkable system that offers interesting opportunities to understand avian osmoregulation: passerines of the genus *Cinclodes*, lack salt glands but species inhabit both marine and freshwater environments.

Birds can be challenged both by abiotic and biotic factors. M. Victoria López-Calleja and Francisco Bozinovic tackle the question of how small herbivorous birds meet energy/nutrient

requirements when feeding on extremely poor diets. They focus on *Phytotoma rara*, possibly the smallest herbivorous bird. They conclude that fast passage rates, effective physical breakdown of cell walls, and exceedingly high physiological capacities (i.e. enzymatic activities) permit highly nutritious cell contents to be available to the small herbivore without the anatomical adaptations for the use of cell walls. In the same vein Martin Cippolini reviews the role of secondary chemistry of ripe fleshy fruits in influencing frugivory in birds.

After analyzing a number of hypotheses concerning the adaptive significance of secondary metabolites in fleshy, bird-dispersed fruits, he emphasizes that comparative studies addressing adaptive hypotheses and the degree of co-adaptation should be conducted within a phylogenetic framework. In addition, Carlos Bosque and M. Andrefina Pacheco emphasize that to ameliorate the constraints of a nitrogen poor diet, frugivorous birds should at least select fruits with high nitrogen content, adjust nitrogen:energy intake, maximize nitrogen absorption and minimize endogenous nitrogen losses. Todd McWhorter and M. Victoria López-Calleja adopt an integrative approach to the study of the physiological ecology of hummingbirds. They

review the interplay of diet, physiological constraints, and ecology as determinants of food intake. They conclude that central and peripheral organ function constraints may impose severe challenges to the energy budgets of these small birds, and therefore may play a significant role in determining their distribution and life-history.

Finally, William Karasov and Michael Meyer conclude the papers in this volume by adopting and advocating an applied perspective. They review several studies in which different approaches are used to test hypotheses about the effect of environmental contaminants on the success of birds. They highlight the importance of adopting and testing multiple hypotheses to a single phenomenon. They argue that a natural research avenue for animal physiological ecologists can be found in ecotoxicological research, the approaches of which can be put to use with high rewards for society.

The ad-hoc editors of this volume are thankful to contributors for exciting symposium and enlightening papers. Authors acknowledge Marivic and Pablo for their friendship and lot of fun at Monterrey. We would like to extend special thanks to F. Patricio Ojeda editor-in-chief of the *Revista Chilena de Historia Natural* for dedicating this issue of the *Revista* to our symposium.