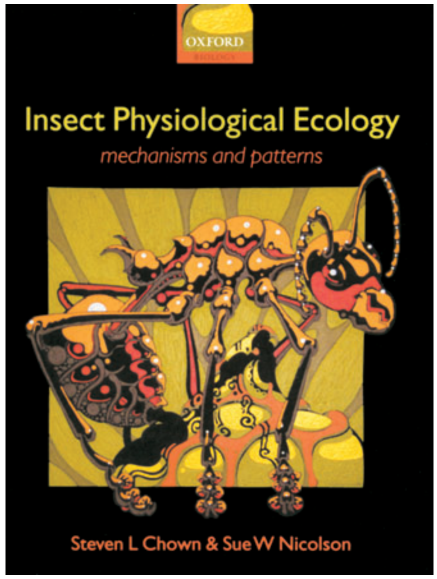
Book Review

A BUG'S STRIFE: ABIOTIC ANGST IN THE MICROCOSMOS



Insect Physiological Ecology: Mechanisms and Patterns

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In this slim volume, Chown and Nicolson lay out a broad and integrative view of physiological ecology. Entomophiles hoping for something comprehensive may be disappointed, because the book consists of just five topical chapters – on nutritional ecology and physiology, metabolism and gas exchange, water balance physiology, lethal temperature limits and thermoregulation. These five, however, are the bread and butter of most practising physiological ecologists. And rightly so, because they comprise the abiotic heart of the field. Fundamentally, insects are collections of cells controlling – or trying to control – fluxes of heat and material. The physiology, ecology and evolution of these fundamentals are what this book is about.

Historically, physiological ecologists have been preoccupied with elucidating how it works, how it varies within and among species and how that variation permits survival and reproduction across environments. Plenty of new work is described in *Insect Physiological Ecology* to keep any such enthusiast happy and current. To list just a few: O'Brien's work on the allocation and turnover of amino acid pools in Lepidoptera; the last 15 years of controversy over the origin and adaptive value (if any) of discontinuous gas exchange cycles; Marden's work on muscle physiology of flying insects; tradeoffs in metamorphosing insects among body parts drawing on the same, finite pool of materials and energy; and recent progress in understanding how cryoprotectants allow insects to withstand very cold temperatures. Contrary to well-meant suggestions that physiological ecology get over its mechanistic bent, these examples and many others in Chown and Nicolson's book demonstrate that such studies continue to afford insight and delight.

In the past twenty years, physiological ecology has undergone a series of soul searches. The most important can be found in Feder, Bennett, Burggren and Huey's edited volume, *New Directions in Ecological Physiology*, which appeared in 1987. Bennett summed up their collective feeling in his introductory essay: '*[T]he broad outlines of physiological adaptation have already been sketched and…past accomplishments do not form a totally adequate agenda for future work. Unless we are to be content with fitting more examples into well-worn analytical paradigms, we must expand our horizons to new questions and new sorts of studies.*' Many ideas from the volume have since maintained high profiles – that testing, rather than merely asserting, adaptive significance of physiological variation should be a high priority (Feder, Huey); that phylogenetic approaches offer a powerful means of controlling for non-independent data and for reconstructing historical dynamics of physiological evolution (Huey); that inter-individual variation constitutes an important and underutilized source of information relevant to evolutionary questions (Bennett); and that rapid progress can stem from analyzing problems simultaneously at different levels of organization (Powers). Other commentators have proposed infusions of optimality theory (Sibly and Calow, 1986), molecular biology (Feder and Block, 1991), life history theory (Sibly, 1991) and evolutionary biology (Feder et al., 2000).

And, indeed, these calls for change have been heeded: the degree of integration across disciplines and levels is now astonishing, and Chown and Nicolson's book provides entrée to many excellent examples. Some of the best integrative studies have used *Drosophila* – for example, Krebs and Feder's work on fitness costs and benefits of different copy numbers of Hsp70, and Gibbs and colleagues' analysis of evolved physiological mechanisms of desiccation resistance in artificially-selected strains and their comparison with the physiologies of desert-dwelling, cactophilic *Drosophila*. Moreover, as the book shows, application of phylogenetic thinking is now common in many areas of study. *Insect Physiological Ecology* also reveals, unintentionally I think, subdisciplines that have not been woven so seamlessly into more distant intellectual fabrics. For example, with notable exceptions, the chapter on insect nutritional physiology and ecology contains few descendents of ideas set out in *New Directions* – not because Chown and Nicolson have missed others, but because few exist. This observation suggests intellectual niches open for colonization.

Yet another transformation in physiological ecology stems from Chown himself. Along with several colleagues, he champions 'macrophysiology' – drawing inspiration from macroecology, which analyzes large-scale variation in species richness, abundance, and distribution through space and time. In Lawton's words (1999), macroecologists worry about '*where the woods are, and why, before worrying about the individual trees.*' Likewise, Chown, Gaston and Robinson (2004) propose that macrophysiology is '*the investigation of variation in physiological traits over large geographical and temporal scales and the ecological implications of this variation*.' This approach is unfamiliar to physiological ecologists focusing on narrowly circumscribed taxa. But examples described by Chown and Nicolson should stimulate more such work. Among the best are studies by Addo-Bediako, Chown and Gaston (2000, 2002), who undertook a global-scale analysis of standard metabolic rates of 346 insect species. After removing effects of trial temperature and body mass, they found a consistent negative relationship between mean annual temperature and metabolic rate – providing strong evidence for the reality of metabolic cold adaptation in insects. One wishes for more such macrophysiological examples in Chown and Nicolson's book – but again this lack represents less a fault of the book than a dearth of citable work.

This is a time of rapid and exciting change in physiological ecology, and *Insect Physiological Ecology* is an especially welcome overview. Though the book's title may attract those already working on insects, its contents inform broader links among physiology, ecology and evolution. The writing is clear, figures well chosen and text data-rich. It is appropriate both for graduate students entering the field and as a resource for professionals who already know parts of it well.

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