**Title**
All-in-one: physics, chemistry and ecology are essential fields to thermal ecologists



**Journal**
Frontiers of Biogeography, 10(3-4)

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**Publication Date**
2018

**DOI**
10.21425/F5FBG39387

e-ISSN: 1948-6596 https://escholarship.org/uc/fb doi:10.21425/F5FBG39387

# Book Review

# All-in-one: physics, chemistry and ecology are essential fields to thermal ecologists

Principles of Thermal Ecology: Temperature, Energy and Life by Andrew Clarke
2017, Oxford University Press, 480 pp., ISBN: 9780199551668, global.oup.com

As I look back to my early career years, I realize how critical it was that I read old monographs. An example is the "Energy exchange in the biosphere" by David Gates (1962), which gave me solid foundational knowledge to undertake research on the thermal biology of cordylid lizards. I have also come to realize how lucky I was to have mentors that re-iterated the need to calibrate instruments, double-check the precision and accuracy of measurements, and to, for example, sign my initials in pencil when changes were made in my data notebooks so that these alterations were traceable for many years to come. Reading the old literature and maintaining highly rigorous standards to undertake research are increasingly constrained in modern science as the pressure to produce data and articles at high speed and submit short concise articles with limited space for detail has grown. In his book *Principles of Thermal Ecology*, Andrew Clarke reminds us that thermal ecologists cannot afford to abandon scientific rigour, be it in citation accuracy, giving credit to the right scientist for a fundamental insight, using the right terms and definitions, and understanding the first principles and mechanisms underlying ecological processes.

This book is a cornerstone for thermal ecologists whether it be students, researchers or climate change policy makers. First, in all aspects of the book, the author goes back to the first scientist(s) that introduced particular concepts and, in most cases, presents a captivating account of the history behind particular topics or discoveries. There are, in many instances, fascinating stories that few people know about or have paid attention to, and the book will assist young researchers to find and acknowledge key references for particular thermal ecology topics.

Second, the book is very well organized; figures with key information both stand out and successfully illustrate key concepts. Throughout the book, the diversity of figures reflects the fundamentals of thermal ecology: theory and mechanisms, empirical data, conceptual and statistical models; and encompasses a variety of scales, from cells to organisms to geographical maps. Text boxes are also very useful as they present condensed information on a particular topic, allowing quick reference to particular definitions, concepts or formulas. Some neat examples are boxes that cover "determining the scaling exponent" or "capturing temperature sensitivity: Q10" and definitions of terms such as "countergradient variation". Quite unusual for textbooks but very practical is that references are embedded within notes at the end of each chapter. This format makes the text flow more easily and allows the reader to concentrate on the information presented although its preference may be a matter of taste. Finally, each chapter contains a summary at the end, which provides a quick and useful way of getting the key messages of each chapter.

Third, the author states that in writing this book he has "been able to present topics in the way (he) would like to have been introduced to them as a student". The order and flow of the topics presented works really well in building from an understanding of the laws of thermodynamics and what we mean by energy, heat and temperature (Chapters 2 & 3), to modelling energy flow in organisms (Chapter 4), and ending with higher level ecological patterns (Chapters 14 & 15). Chapters 5 and 6 tackle how temperature and water are interlinked and how they affect organisms in many ways. These chapters emphasize how physiology cannot be examined in isolation or with a single stressor, but other ecological factors need to be taken into consideration. Chapter 7 - 11 are dedicated to how and why temperature affects enzymatic reaction rates to whole organism and species performance and costs, including metabolism, temperature regulation, endothermy, torpor and hibernation. What is very distinctive in these chapters is that background knowledge on first principles, physical chemistry, and bioenergetics are provided prior to depicting ecological patterns, often going from cell to higher level organization and across-species relationships. Chapters 12 and 13 include models that have been proposed to explain the scaling of metabolic rate and organismal growth. In these last few chapters, there is great emphasis to contrast different theoretical models available in the literature and how these vary depending on taxonomic group (from bacteria to birds and mammals) or ecological and environmental circumstances. Lastly, the book would not be a complete primer for a thermal ecologist without addressing global climate change (Chapter 16). Here the author provides a detailed and useful explanation of what causes temperature profiles on Earth, how climate has changed across the Earth's history, and the impacts of more recent climate changes on organisms.

As for any other scientist, the author often gives examples based on his personal interests, passions and research, and, understandably, there is emphasis on Polar Regions and marine organisms. Several chapters are more complete and balanced than others or include coverage of a greater diversity of organisms and regions. The book clearly targets principles that are essential for understanding the relationship between temperature and organisms and does not represent a book for applications on how to do measurements or complex tasks in thermal ecology. *Principles of Thermal Ecology* is a guiding book to get a solid knowledge of the building blocks that form the field of thermal ecology and does a brilliant job of achieving this. These building blocks and the relationships between physiology and ecology, as well as concepts that include larger scale patterns of life and diversity, will also be of great value to biogeographers and to wider audiences.

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Submitted: 14 June 2018
Accepted: 9 August 2018
Edited by Sally A. Keith

  