Strepsiptera larvae or the contracted life cycles observed in cave-dwelling beetles. Across four chapters, the author introduces examples from species with divergent life strategies, behaviors, and ontogenies. These chapters are hefty in entomological and taxonomic jargon, which can slow the reading for those not used to it; however, well-annotated illustrations help visualize the diversity of forms, stages, and life cycles presented.

The third topic revolves around the physiological and molecular understanding of metamorphosis. Belles strives to condense the known mechanisms and main players, including hormonal signals (e.g., ecdysone, juvenile hormone) and associated gene cascades. The knowledge at the molecular level is harder to obtain in many insects for practical reasons and relies strongly on model species such as *Drosophila melanogaster*. However, in this book, readers will find data from representative lineages that reach different branches of the phylogenetic tree of insects, highlighting evolutionary trends on conserved molecule cascades. The information gathered in four chapters provides an excellent resource for anyone interested in the molecular details behind molting. Finally, the last topic covered in the closing three chapters focuses on the main hypotheses behind insect metamorphosis evolution, bringing together some of the main ideas discussed throughout the book. Thus, the author proposes the case in which the Hemimetabola metamorphosis innovation followed the evolutionary appearance of the insect wings. Here, interactions of a deeply conserved gene network, such as the MEKRE93 pathway and the exaptation of the Broad-Complex gene, could have evolved to establish the final molt from immature to adult.

One of the highlights of this volume is the postulation of hypotheses and some potential ways to test them. The epilogue includes the author's wish list of experiments/data to address knowledge gaps. The book provides a critical compilation of data and inspiration for future endeavors from entomologists, physiologists, and cell and molecular biologists. It is my hope that new techniques and technological advances will allow our ecological and molecular understanding of one of the most fantastic transformations in animal history.

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Animal Physiology: An Environmental Perspective. *By Patrick J. Butler, J. Anne Brown, D. George Stephenson, and John R. Speakman. Oxford and New York: Oxford University Press.* $82.95. xii + 1089 p.; ill.; index. ISBN: 978-0-19-965545-8. 2021.

When I was an undergraduate and then a teaching assistant, textbooks were standard fare in all biology classes. We complained then of the cost and physical size. Since then, volumes have gotten not only more expensive but also larger to the point that carrying them around in your backpack has become unfeasible. With the advent of online materials, many faculty (myself included) now eschew use of a textbook. That said, I do recognize their value. For me, they served as references to which I would return when I needed to refresh my memory regarding a particular topic and also when I began teaching my own courses. But I think students today are different. I believe that current students are far less likely to purchase a textbook and much more likely to sell it once a course is finished.

When I received the softcover version in the mail I was shocked by the size of this book: more than six pounds and 1000 pages. What had I gotten myself into? I literally do not have the desk space to open such a volume while I try to write something about it. Fortunately, the publisher sent a PDF version. A couple of years ago I reached the point in my way of working where materials that I cannot get as a PDF are virtually dead to me. I cannot imagine that students are much different, not to mention that people are increasingly mobile and have less space to store such things as physical books.

What is the purpose of *Animal Physiology*? The authors state that: "[w]e aim to show how an understanding of the physiology of animals in their natural habitats helps us to understand not only how and why animals evolved the way they did, but how we can act to protect at least some of them from the extreme effects of the changes affecting their environments. In short, we show how environmental physiology can inform conservation"; "[w]e also examine how different animal species have evolved to spend the whole or part of their lives in extreme environmental conditions"; and "[w]e also reveal how other animals are able to perform exceptional feats of endurance such as long-distance, non-stop migrations. Where appropriate, we discuss the use of molecular technologies to advance our understanding of how animals have evolved and become adapted to their different environments" (p. viii). So, the authors claim to emphasize an ecological/evolutionary/organismal approach (e.g., see M. E. Feder et al. 1987. *New Directions in Ecological Physiology*. Cambridge (U.K.): Cambridge University Press; T. Garland Jr. and P. A. Carter. 1994. *Annual Review of Physiology* 56:579–621; K. J. Gaston et al. 2009. *American Naturalist* 174:595–612; L. B. Martin et al. 2015. *Integrative Organismal Biology*. Hoboken (NJ): Wiley Blackwell).

As for the intended audience, the volume was written for "biology undergraduates who have a basic grounding in maths and science, and are now ready to study animal physiology in some detail" (p. viii). The authors do not indicate a specific time frame,

but the amount of material could certainly take an entire academic year to cover.

What is the approach that might set this textbook apart from others? Butler et al. intend for the volume to be a "readable and engaging text to keep students' interest and attention," and a "readily accessible account of the physical and chemical principles underpinning animal physiology" (p. viii). They use "carefully chosen examples to illustrate how different groups of animals have evolved different solutions to deal with the environmental problems they face" (p. ix). And they explore "animal physiology in the context of global issues," by considering "topics such as climate change and pollution from the point of view of their physiological effects on animals, exploring how our understanding of such topics can be translated into new approaches to conservation" (p. ix).

Footnotes are used liberally. Most pages contain figures (or tables), and the figures are eye-catching and informative. The production value is high.

The book includes online Instructor Resources, which I did not have access to but seem to be limited to figures, and Student Resources, which include: a glossary (I was able to download this and it is comprehensive); Bonus Case Studies, Boxes, and Experimental Panels; full solutions to numerical end-of-chapter questions; and lists of primary literature articles per chapter section. For a physical volume that is already huge, I understand why this material is not included, but it is a shame to omit some of it. For example, short bibliographies at the end of each chapter are good, but for interested/motivated students, I think that the lists of primary literature can be what helps steer them to a potential research path.

There are checklists of key concepts at the end of each chapter that are rather lengthy, have key terms in bold, and would provide good study guides. In fact, I suspect many students will start by reading these and only go to the actual text material if they really think they need to. The study questions are thought-provoking and would make good material for discussion sections or exam questions. Hints point to particular chapter sections, which is user-friendly.

The relevant undergraduate course that I teach is titled Ecological and Evolutionary Physiology. The material I cover is long on the adjectives and short on the noun. This book is the opposite, so it would not work for my course. That said, some of the chapters (e.g., Chapter 1) and many of the sections (e.g., Box 2.2 on animal respirometry, Box 2.3 on isometric versus allometric scaling, and Box 2.4 on how field metabolic rate is estimated) would be relevant. For a course more focused on animal physiology, this would certainly work as an appropriate, comprehensive textbook, especially as it includes all of the basics that students would, in theory, know before taking a physiology course, but have surely forgotten (e.g., diagrams and tables of metabolic pathways in Box 3.1 on the movement of electrical charges). But I wonder if some of the material is really warranted in a comparative physiology volume (e.g., Box 3.2 on cell division), given the length and omissions noted above. A fair amount of material seems more appropriate for an introductory biology course. And then some of the material seems overly specialized and unnecessary (e.g., Figure 4.19 on the expression of aquaporin in African clawed frog oocytes). On the other hand, skimming the figures I easily learned some new things, such as the response of crabs to changes in magnesium concentrations at different temperatures (Figure 5.2).

It is easy to criticize a textbook such as this but, overall, the volume is a considerable achievement—and one that I am happy to have, especially in an electronic format. A succinct introduction to comparative physiology it is not, but instructors who teach a comprehensive animal physiology course should seriously consider it.

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NEUROBIOLOGY

METAZOA: ANIMAL LIFE AND THE BIRTH OF THE MIND.

By Peter Godfrey-Smith. New York: Farrar, Straus and Giroux. $28.00. x + 336 p. + 8 pl.; ill.; index. ISBN: 9780374207946. 2020.

This book proposes a strictly materialist-based model of the origin and evolution of conscious selves and a sense of agency in Metazoa. Where the author's earlier volume, *Other Minds: The Octopus, the Sea, and the Deep Origins of Consciousness* (2016. New York: Farrar, Straus and Giroux), largely focused on the origins of consciousness and intelligence in cephalopods, the current book under review expands this modeling to include marine as well as early land Metazoa.

Godfrey-Smith's thesis is: increases in sensory capacity and processing are associated with corresponding increases in motility and agency (tentacles, arms, legs, fins, wings), complex senses (visual, olfactory, tactile) and, accordingly, alternative animal bodily morphologies. Together, these define an animal's sense of self, subjectivity, and agency, i.e., its "way of being" and what it is like to be that animal life form.

Where the philosopher Thomas Nagel raised the issue of animal minds in his paper, What Is It Like to