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Global Climate Change and Terrestrial Invertebrates: An invertebrate book with spine

Global Climate Change and Terrestrial Invertebrates, by Scott N. Johnson & T. Hefin Jones (editors), 2017

Wiley-Blackwell, 416 pp. £85 (hardback), ISBN: 9781119070900

In introducing their book, Scott Johnson and Hefin Jones quote the great E.O. Wilson, who described invertebrates as ‘the little things that run the world’. It therefore seems appropriate to begin this review with another gem by Wilson: “We are drowning in information, while starving for wisdom. The world henceforth will be run by synthesisers, people able to put together the right information at the right time, think critically about it, and make important choices wisely.” *Global Climate Change and Terrestrial Invertebrates* provides an enormous amount of information but I am sure Wilson would be pleased to find a great deal of wisdom here, too. The editors have succeeded in finding these synthesisers and in bringing together diverse fields of climate change science and invertebrate ecology. They cast a critical view over the recent literature and have created a polished textbook that not only comprehensively reviews the field but could equally act as a foundation for designing and carrying out investigations of invertebrate systems.

There are now many books available that explore climate change; *Global Climate Change and Terrestrial Invertebrates* fills a gap in assessing the interactions of global change with an enormously diverse group of animals. The contents, of course, tend to focus on changes in temperature and precipitation but many contributors also consider the phenomena of changing concentrations of atmospheric chemicals including carbon dioxide and ozone. The 44 contributors come from diverse fields and their input has been very well edited to create this volume, which synthesises “the current state of knowledge about how terrestrial invertebrates will respond and adapt to predicted changes in our climate and atmosphere, and, in some cases even moderate the impacts of such changes”.

The 18 Chapters of *Global Climate Change and Terrestrial Invertebrates* are conveniently separated into four main themes. The first theme, which encompasses Chapters 2-4, describes the main approaches for studying invertebrates in the context of climate change; the theme explores the use of historical data and citizen science in measuring changes in abundance and distribution, as well as experimental approaches to investigate the impacts of global change. These contributions are likely to be exceptionally useful in providing a thorough basis for the design of future investigations, even dealing with issues such as statistical power, pseudoreplication and the human dimension of ecological research. The second theme (Chapters 5 - 9) considers the impacts of global change on our invertebrate “Friends and Foes” which, respectively, provide ecosystem services (pollination, Chapter 5; biological control, Chapter 6) and act as pests (Chapter 7) or vectors of human (Chapter 8) and plant (Chapter 9) diseases.

The third theme (Chapters 10 – 15) deals with multi-trophic interactions and invertebrate community ecology, investigating herbivore-natural enemy interactions (Chapter 10) and soil invertebrate communities (Chapter 11) before delving into aboveground-belowground invertebrate community interactions (Chapter 12) and how these are affected by precipitation changes and elevated carbon dioxide. Elevated carbon dioxide is one of the suite of atmospheric changes considered in Chapter 13, which focuses on global change impacts on forest communities. In their own ways, Chapters 14 and 15 step a little out of the overall focus of this volume; Chapter 14 moves away from terrestrial invertebrates to discuss the impacts of global change on freshwater invertebrates, but draws attention to how these

impacts are mediated by changes to terrestrial ecosystems. Chapter 15 then shifts focus to a range of vertebrate taxa and how three climatic drivers may influence vertebrate-invertebrate interactions, occasionally slipping away from terrestrial to marine ecosystems. Across the first three themes, the contributors make excellent use of examples and case studies to illustrate our knowledge; there is some recurrence of examples between Chapters, but each time from a unique perspective. The examples are used not only to illustrate our knowledge but, perhaps more importantly, to highlight gaps in the literature. This is further refined in the fourth theme, which explicitly deals with emerging perspectives.

In the fourth and final theme (Chapters 16-18), we encounter discussions of evolutionary responses to global change (Chapter 16), and how the concepts of exposure and vulnerability might influence our future conservation strategies (Chapter 17). *Global Climate Change and Terrestrial Invertebrates* then concludes with Chapter 18, which highlights common refrains encountered in previous chapters and provides a perspective on gaps in our understanding and requirements for future research. Concluding with a section on perspectives and future directions reflects a pattern throughout this volume, which is one of the book's main strengths. Each chapter explicitly outlines gaps in our knowledge and understanding, and there appears to be a concerted effort to highlight where and how we might best focus future research efforts to address these shortfalls. Some chapters do this better than others, with many dedicating a whole sub-chapter to the topic, which is both useful and thought-provoking.

Global Climate Change and Terrestrial Invertebrates covers an enormous range of subjects; a better subject index and a thorough glossary would therefore not go amiss in future editions. The subject index is currently surprisingly lacking in certain key terms – for example there is no mention of phenology, microclimate or even temperature as index terms, except as sub-indices of other terms, making the text harder to navigate than it should be.

Overall, this volume is thorough and concise. It would be all too easy to fall back on the oft-repeated sentiment that it is difficult to discern patterns in invertebrate responses to global change, which are often taxa, region or case-specific. The comparisons of conflicting case studies presented throughout the book are useful, but the reader is occasionally left wanting more insight into potential reasons for conflicting results, whether they be methodological or otherwise. However, the contributors have done an excellent job of synthesising the available evidence to discern patterns, and gone further in identifying key areas for future research.

In *Global Climate Change and Terrestrial Invertebrates* there is sufficient spatially-explicit material to appeal to biogeographers, though the volume contains a great deal of information on other aspects of invertebrate ecology that will also appeal to wider audiences. The examples and case studies used are global in scope and deal with a diverse range of taxa, rather than being frustratingly limited to the more data-rich Lepidoptera and model invertebrates such as *Drosophila*. This volume is therefore likely to have broad appeal to amateur entomologists, undergraduates and researchers interested in global change and invertebrate ecology.

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