Future in flux: ectotherms might like it


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I was quite excited to see the new book, Climate change and insect pests, edited by Christer Björkman and Pekka Niemelä, because of the relevance of this subject today. The book is written by entomologists (mostly) for the wider scientific community, and therefore is an interesting way to see the subject of climate change interpreted. The book is composed of fourteen chapters, divided into three sections: “General issues and patterns” (five chapters), “Agricultural pests” (three chapters), and “Forest pests” (six chapters). The book has a north-temperate forest bias. But of course, we anticipate the vast northlands of the northern hemisphere to be increasingly impacted by substantial climate change. However, the book is not intended to be solely focused on the northern region, and the authors do consider insect pests and climate change broadly.

After a compelling foreword by Matt Ayres, the opening chapter by Andrea Battisti and Stig Larsson, “Climate change and insect pest distribution range,” really gets to the point right away with a literature review of forests and agriculture insect pests that have been documented to expand their range due to climate change. Their initial table breaks the idea up into three categories: range expansion observed and mechanism known for seven forestry pests and one agriculture pest; range expansion observed and mechanism unknown for thirteen forest pests and four agriculture pests; and range expansion predicted based on models with nineteen agricultural pests and six forestry pests. Considering the dimensions of concern, it is interesting that so few examples of documented climate-driven range expansion by forest or agriculture pests are in the literature. Perhaps this indicates that it is time to apply more scientific focus, because management of forest and agricultural pests in a changing climate is the future. The authors contend that one way to begin to do this is to use elevation as a template to study how the life history of specific pests varies with changing temperature. But of course, there is more to it than just changing temperature, and all the chapters in the book make this point. The opening section contains chapters on species distributional modeling, two plant-focused chapters on adaptive responses of plants to insect herbivores, and climate change and boreal woody tree species resistance to insect pests affected by climate change, and finishes with a chapter on interactions of pests with natural enemies in the context of changing climate. The plant-focused chapters add a particularly good perspective on host changes with changing CO$_2$, temperature, and other climate factors.

The “Agricultural pests” section contributes to our understanding of insect pests via chapters on insect physiology and how this varies in agricultural landscapes, biological control and climate change implications, and European agricultural pests. These chapters are exceptionally interesting and point to the complexity and uncertainty of factors that pertain to insects and climate change. Human-assisted migration, pesticide use, quarantines, and other factors such as changing crops as the climate changes, all influence range expansion of agricultural pests. The chapter by Eigenbrode et al., “Climate change and biological control in agricultural systems: principles and examples from North America,” brings much of this complexity to light as tri-trophic interactions of host, pest, and biocontrol agent interact with increasing CO$_2$, temperature, and changing precipitation.

One example noted is a rather simple one, but it illustrates clearly how life history and behavior influence responses. The authors cite a study by Barton and Schmitz (2009. Experimental warming transforms multiple predator effects in a grassland food web. Ecology Letters 12:1317–1325) in which the herbivorous red-legged grasshopper, Melanoplus femurrubrum (Orthoptera: Acrididae) is controlled by two spiders, Phidippus rimator (Araneae: Salticidae), a jumping spider, and Pisaurina mira (Araneae: Pisauridae), a nursery web spider, in an old field in Connecticut. The spiders tend to divide the habitat with P. mira being a “sit and wait” species feeding in the canopy, while P. rimator is an active hunter who works around the base of plants. They both contribute to the biological control of the grasshopper. Barton and Smith (2009) used a mesocosm approach. Increased temperature forced the canopy spider down and caused intra-guild predation and local extinction of one spider species, resulting in release of the grasshopper from biological control.

The complexity of these interactions is further discussed by Lindström and Lehmann in the chapter, “Climate change effects on agricultural insect pests in Europe.” Although a broad chapter, they make many interesting points, including the observation that
introductions in Europe from the plant trades can result in more genetic diversity in Europe than in the native ranges of pests. For example, silverleaf whitefly (Bemisia tabaci) (Hemiptera: Aleyrodidae) individuals found on ornamentals and vegetables in the United Kingdom originated from the following countries: Lebanon, Belgium, the Netherlands, Poland, India, Malaysia, Singapore, Sri Lanka, Thailand, Cambodia, Ghana, Nigeria, Sierra Leone, and Jordan!

My bias being forests, I was especially interested in the final section of the book, which has some really nice chapters about major forest insect pests, including chapters on abiotic factors, tree-killing bark beetles, the Eurasian spruce bark beetle, pine wood nematode, northern geometrids (Lepidoptera: Geometridae), where range expansion is well documented, and finishes with a chapter on the implications of forest management on interactions of forest pests and climate change. About the time I began reading the chapters on forests, a paper came out by Loehle et al. (2016. Physiological and ecological factors influencing recent trends in United States forest health responses to climate change. Forest Ecology and Management 363: 179–189), which states that climate change is having no effect on forest pests and on the contrary, increasing CO2 is increasing tree resistance to insect herbivory, and increasing plant productivity, while N deposition is fertilizing trees and improving tree health, and temperature is having no effect. I guess the authors have not seen this book!

I was especially impressed with the chapter by Raffa et al., “Responses of tree-killing bark beetles to a changing climate.” This is the most synthetic and up-to-date assessment of the topic I have seen yet. It is written quite well and really nails the complex interactions with examples of specific interactions. In particular, the recent outbreak of the mountain pine beetle (Dendroctonus ponderosae) (Coleoptera: Curculionidae: Scolytinae) in western North America is well told. This is an epic yet complex story of perhaps the largest-recorded insect outbreak in history, where temperature and climate, mutualistic fungi, and historically exposed versus naïve hosts interact under extreme beetle pressure with northward and higher elevation impacts being most relevant to climate change.

Complexity and the potential for significant future negative interactions are especially prominent in the chapter by Roques et al., “Pine wood nematode, pine wilt disease, vector beetle, and pine tree: how a multiplayer system could reply to climate change.” The pine wood nematode (Bursaphelenchus xylophilus) (Aphelegnidia: Parasitaphelenchidae) is vectored by wood-boring beetles in the Genus Monochamus (Coleoptera: Cerambycidae). The genus is widely distributed throughout the world, and when the nematode is introduced, the native beetle species readily pick it up and form new vector associations. These authors contend that temperature increases have already influenced landscape mortality patterns in Asia and Europe, where this pest has been introduced, and that future warming will allow expansion into forests currently not being impacted.

The final chapter by Björkman et al., “Effects of new forest management on insect damage risk in a changing climate,” focuses on the managed forests of Fennoscandia, which include Norway spruce (Picea abies) and Scots pine (Pinus sylvestris), and occasionally some hardwoods such as oak (Quercus species) and birch (Betula sp.). This chapter provides a really interesting discussion that nicely weaves climate-change ideas with the natural history of regeneration pests, defoliators, and bark beetles. Then the authors contrast conventional clear-fell forestry that involves multiple thinnings with four potential alternative management models: continuous cover forestry, mixed forests, short rotation with no thinning plantations, and exotic tree plantations. Now I know that Heterobasidion root disease is a huge issue in these forests, so I was disappointed when there was no mention of this potential interaction, but this chapter is still incredibly interesting and thought provoking.

It pains me to single out specific chapters in this book and not mention others, but of course the breadth of the book makes discussion of all the chapters impossible. Suffice it to say, the chapters are all well researched, complement each other nicely, have awesome reference sections, provide lots of ideas for how best to investigate insect (pest) response to climate change in agriculture and forest landscapes, and provide specific examples of various insect species or groups. My only complaint about the book is limited to the general protocol in entomology to follow common name with (Species) (Order: Family), or simply scientific name with (Order: Family). The chapters all did not use this protocol; not being a true-blue entomologist, I had to keep my iPad next to me so I could Google the order and family of species with which I was not familiar.

By and large, this book is a wonderful contribution to our understanding of insect pest ecology in the context of climate change, and I would recommend it to anyone interested in the topic. I believe it would be of utility to graduate courses in entomology, ecology, forest health, and climate change, although faculty might only use particular chapters that fit their needs. I personally enjoyed this book so much, as it is an epic synthesis of applied insect natural history, and I feel natural history and ecology are the keys to insect pest management. A great book for ecologists!

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