Ecology of climate change — the importance of biotic interactions

Author: Tavşanoğlu, Çağatay

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Book Review

Post E. 2013: Ecology of climate change – the importance of biotic interactions. *Monographs in Population Biology (edited by S.A. Levin & H.S. Horn), Princeton University Press, xxiii + 373 pp. ISBN: 978-0-691-14847-2 (acid-free paper).*

Understanding ecological effects of the recent human-induced climatic change is important to mitigate the negative consequences of these changes on Earth's ecosystems. We have started to observe ecological effects of the recent climate change for not more than 35 years. Therefore, global analyses on ecological effects of the climate change could not be conducted until the late 1990s due to the lack of long time series data. After this period, many researches revealed that the recent climate change affects ecosystems, species, and populations (see Walther et al. 2002). These studies faced us with the reality of the climate change and led to an increase in concerns about the future of our planet among both ecologists and the public. The first signs of the effects of climate change helped to put the issue on the agenda of the national and international governmental bodies. During the last decade, as a consequence, the ecology of the climate change achieved a popular trend among biologists, ecologists, and climate scientists. Until recent years, the focus of studies remained as the long-term effects of the climate change on distributional range shifts or changes in phenology of populations and species. Accordingly, fewer studies dealt with the species interactions in biotic communities. Actually, the effects of climate change on species interactions in communities might have been overshadowed the easier-to-be-observed long-term distributional and phenological changes in species and populations. In summary, biotic interactions have been overlooked in the study of the ecology of climate change.

The book, entitled "Ecology of climate change – the importance of biotic interactions" by Eric Post, fills this gap in the global change ecology. As an author of many milestone papers on the ecological effects of the climate change including the classical Nature paper (Walther et al. 2002), Eric Post continues to thrill the scientific community with his contributions to the global change ecology. I believe that his experiences on the Arctic and other high-latitude ecosystems (e.g. Post et al. 2009) led Post to write this book. As we will see the most dramatic effects of climatic warming on northern latitudes, the high frequency of the case studies from high latitude ecosystems throughout the book is further meaningful.

The book consists of nine chapters; each points out various aspects of ecological effects of the climate change. Chapters in the book were presented in two different approaches. Some of the chapters are completely related to ecological effects of the climate change, whereas some others start with an explanation of a basic ecological concept and later make a connection between the concept and the effects of the climate change. For example, in the third, fourth and seventh chapters, the author focus directly on the effects of the recent climate change, such as phenological and population responses, and distributional shifts in species ranges. On the contrary, in the fifth, sixth and eighth chapters, the basics of the ecological concepts such as the niche, community stability, and ecosystem function are the focal points. On the other hand, the author successfully integrates the relationship between the focal ecological concept and the climate change in these chapters. In my opinion, one of the book's novelties, therefore, comes from its success in integrating ecological effects of the climate change with basic ecological concepts. The success of this integration can be felt throughout the book.

The book starts with a preface, including a proposal of new hypotheses, "the tension and facilitation hypothesis of biotic response to climate change". Tension and facilitation hypotheses are presented as possible opposite observations that can occur in natural ecosystems in response to the climate change. These hypotheses explain the relationship between the strength of biotic interactions and climatic influence in ecological dynamics. The tension hypothesis suggests that the role of climate in such dynamics will have greater importance, in the case of biotic interactions are weak. Conversely, in the existence of strong biotic interactions, the contribution to climate to ecological dynamics will be minimized. Alternatively, the facilitation (or "promotion") hypothesis suggests that this interaction between the strengths of abiotic and biotic influences on ecological dynamics is reversed. According to the facilitation hypothesis, therefore, the strengths of the biotic and abiotic influences on ecological dynamics increase/decrease together. With the proposal of new

hypotheses, the author actually gives here the clue to what the rest of the book is related to. No doubt, these hypotheses will be tested by many studies in following years, and this will improve our understanding of how climate change affects biotic communities and populations in different ecosystems on Earth.

The first chapter gives an overview of recent climate change and its ecological context, while the extinctions triggered by Pleistocene climatic changes are the main topic of the second chapter. These chapters are good summaries of the reality of the recent climate change, and to what extent can climatic change drives species extinctions.

The third chapter entitled "Life history variation and phenology", presents a good synthesis of the contributors of the factors operating on the change in the timing of life history events, and acknowledges the importance of the other possible factors independent of climate change. After a comprehensive review on the geographic and taxonomic variation in phenological response to the climate change, the author concludes that "Almost universally, studies of phenological responses to climate change rely on comparing data on the timing of events and data on variation in temperature and precipitation", and links the facilitation/promotion hypothesis proposed in the preface of the book to other possible explanations independent from climate change such as density dependence and variation in resource availability. The chapter continues with modeling approaches integrating the timing of life history events and population dynamics in relation to climate change.

Chapter 4 summarizes how the dynamics and stability of populations can be affected by climate change. The author gives here many models explaining population dynamics in stochastic environments, and points out the importance of the incorporation of the effect of climatic fluctuations in these models to predict population responses to climate change. The potential role of climate change as an extinction agent via synchronization of population dynamics or eroding population cycles are also explained in two separate sections in the chapter.

Chapter 5 starts with summarizing and comparing Grinnell's (1917), Elton's (1927) and Hutchinson's (1957) niche concepts. In this chapter, readers will find a discussion on whether the response of species to the climate change induced by phenotypic plasticity or evolutionary changes, and on whether the main driver of diversification under climate changes is the evolution or niche conservatism. By giving the basic concepts and discussing the topics mentioned above first, I felt that the author prepares the readers to the section related to the bioclimatic envelope modeling at the end of this chapter. In this section, the author demonstrates that environmental niche modeling is actually based on Grinnellian niche concept, rather than Eltonian one. The usefulness of this modeling approach to predict the change in the distribution of species range due to climatic changes is emphasized with many examples. At the same time, the section also includes many case studies suggesting that the models do not predict species distributions that much well by only considering climatic variables. Overall, the author suggests that the integration of traits representative of the competitive ability of species will improve the ability of such models predicting changes in species distributions under climate changes.

The sixth chapter extends the discussions in chapter 4 to the community dynamics and stability. Major emphasis in this illuminating chapter is given to the concept of community and species interactions, and the ways of community response to the climate change. The author first discusses here what the biological community actually is, and makes community ecology terms clearer for readers. He points out that considering communities as a collection of species interacting across trophic levels is important but an overlooked approach in community ecology. He criticizes the use of "species interactions" term in a general manner and suggests ecologists to be more specific in the use of the term by referring interactions as being characterized by exploitation and interference. By this approach, he separates competition from other types of species interactions, i.e. exploitative interactions including predation, parasitism, herbivory, and mutualism. A useful discussion on how species interactions in communities can be affected by climate change is also included in the chapter. Asynchrony and trophic mismatch due to climate change discussed in detail, and the author outlines here the importance of the issue by presenting empirical data from several studies. Modeling approaches for quantifying the influence of climate change on community dynamics and stability are also given at the end.

Chapter 7 is related to biodiversity and extinctions, and starts with brief information on the drivers of biodiversity in ecosystems. A discussion on relationships between biodiversity and ecosystem function follows, and then the effects of distributional changes on biodiversity are mentioned. In the section titled "Biodiversity and stability", the author first discusses comprehensively on the stability-diversity relationship in ecosystems, and then explains

possible results of warming on this relationship with some case studies performed by many researchers including himself. At the end of the chapter, the author acknowledges the importance of the tropical deforestation in biodiversity loss and climate change, and mentioned complex interactions between climate change and tropical forest dynamics.

The eighth chapter focuses on ecosystem-level consequences of climate change. It starts with an introduction to ecosystem functioning, and includes a part on the diversity-stability relationship as in the previous chapter, but here on the ecosystem scale. Response of carbon dynamics to climate change and tropical deforestation comprises a significant part of the chapter. The author describes comprehensively possible responses of carbon dynamics to climate change and tropical deforestation based on empirical and modeling data from several studies. The chapter ends with the relevance of the role of animals, especially herbivores, in ecosystems to climate change, with a large emphasis on insect outbreaks.

The last one (chapter 9) presents some concluding remarks by emphasizing the important points of the book that may lead to further studies on climate change ecology.

Overall, Eric Post's text is comprehensive and the connection between the chapters is clear. This book can be recommended to graduate biology, ecology and environmental sciences students interested in the effects of climatic changes, and scientists working on the ecology of climate change. Since most of our understanding of ecological effects of the recent climate change is based on simpler observations at the population and species levels, focusing on the biotic interactions in communities is the strongest point of this book.

In my opinion, the book is not just related to the climate change, but beyond this, is praiseworthy since it guides how ecologists should perceive species interactions in biological communities. I believe that this book will trigger a new research wave in the climate change science.

Literature

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Çağatay Tavşanoğlu