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Climate change, ecology, and systematics

Hodkinson, Trevor R., Michael B. Jones, Stephen Waldren, and John A. N. Parnell, editors. 2011. **Climate change, ecology and systematics.** The Systematics Association Special Volume Series 78. Cambridge University Press, New York. xi + 524 p. $125.00, ISBN: 978-0-521-76609-8.

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The climate is changing, species are disappearing faster than they can be described, and ecologists are modeling the grim future. Do we really need another book on the perils of climate change, the plight of taxonomy, and the inability of ecological models to accurately forecast the future? The organizers of, and participants in, the 2008 Joint Conference of the Systematics Association and the Linnean Society of London on Climate Change and Systematics thought so, and the 21 chapters in *Climate change, ecology and systematics* do indeed provide some new perspectives on these topics.

About one-half of the chapters provide concise overviews of the development and use of global circulation models (GCMs) and ecological niche/climate envelope models (CEMs), or systematic assessments of biological diversity. Three chapters are especially noteworthy. Caballero and Lynch summarize the history of GCMs, from Phillips' 1956 article, "The general circulation of the atmosphere: a numerical experiment" (*Quarterly Journal of the Royal Meteorological Society* 82:123–164), which won the first Napier Shaw Memorial Prize, to current state-of-the-art models used by the Intergovernmental Panel on Climate Change. The fundamental equations and physical laws governing climate have been known for hundreds of years, but these equations are analytically intractable and development of GCMs has paralleled the evolution of computational power. Current GCMs still simplify or omit key processes and have a high degree of uncertainty; hindcasting paleoclimates continues to reveal limitations of the models, and forecasts beyond two or three decades generally are unreliable. But perhaps most importantly, Caballero and Lynch emphasize the essential stochastic and chaotic nature of the climate system, noting that analysis of both Cenozoic and Phanerozoic climate reconstructions illustrates that "the climate system appears never to have been in a steady state, even over time spans comparable to the age of the earth." This message hovers over, but rarely penetrates, the book's other chapters, which continue to search for constancy in species-environment interactions (hence the use of CEMs: Chapters 10–15) or the utility of protected area networks (Chapter 16) and other strategies for conserving species in a rapidly changing climate (Chapters 17–21).

Bateman, who as President of the Systematics Association conceived of the conference that led to this volume, also has written the most inspiring and thoughtful chapter. He focuses on the importance of taxonomy as an enabling discipline—it erects, but does not test, hypotheses. Knowing the identity of an organism is the prerequisite for formulating and addressing ecological and evolutionary questions and deciding on methods and priorities for conservation. Bateman distinguishes taxonomy from systematics: taxonomy describes, delimits, and names organisms, whereas systematics organizes taxonomic information into a (phylogenetic) framework that undergirds any biological study that uses the comparative method (virtually all of evolutionary biology, ecology, biogeography, macroecology, etc.). Despite their central role, taxonomy and systematics (together: systematic biology) are poorly supported—both financially and in terms of the respect accorded them by the broader scientific community; Bateman argues for long-term, performance-driven, core funding schemes that can support enabling sciences such as systematic biology and thereby remove them from the short-term grant cycle that drives hypothesis-testing sciences. At the same time, he wants to broaden the mandate of taxonomy—descriptions of species should include substantial information on morphology, genetics, habitat, distribution, and autecology, not simply a terse, technical, morphological description of a Platonic type-specimen that does not reflect the coevolution of a species with its environment. Like the message from the preceding chapter by Caballero and Lynch, Bateman's key messages transcend, but poorly infiltrate other chapters in this book with a systematic focus, including otherwise interesting ones on terrestrial green algae (Rindi, Chapter 9); biogeography of *Cyclamen* (Yesson and Culham, Chapter 12); Tethyan laurels (Rodríguez-Sánchez and Arroyo, Chapter 13); East African rain forest trees (Chatrou et al., Chapter 14); hybridization of *Fraxinus* (Thomasset et al., Chapter 15); or climate change and the Cyperaceae (Simpson et al., Chapter 19).

Like Bateman, Bernardo emphasizes the importance of taxonomy as a hypothesis-generating discipline. Through a detailed discussion of the meaning and identification of cryptic species in the broader context of conservation and climate change, Bernardo demolishes a number of pervasive misconceptions. For example, the existence of cryptic species is often thought to reflect new species concepts and better use of molecular tools, but in fact cryptic species were recognized by Darwin, and the term itself dates to 1940 (coined by Darlington, coincidentally in the first of the Systematics Association's special volumes; the book under review is the 78th). Use of genetic data to delineate species often is thought either to be insufficient relative to morphological data or to be causing taxonomic inflation, unnecessarily splitting taxa into units that do not merit status as unique species. However, Bernardo clearly shows that there is no logical primacy to morphological data, and that genetic data, like morphological data, have led as often to combining taxa as to splitting them. By viewing taxonomic descriptions as hypotheses to be tested rather than as revealed truth that can only be upset by revisionary systematics, Bernardo shows the importance of Bateman's multiple lines of evidence (morphology, sequence data, behavior, biogeography, and evolutionary history, among others) not only to identify cryptic species but also to avoid classical Type I and Type II errors (here, recognizing more species than actually exist or failing to detect species that really do exist, respectively). Finally, Bernardo demolishes the argument that identification and description of cryptic species endangers conservation programs either because more species reduce resources available for conserving any given species or because instability in species lists makes it difficult to establish patterns of endemism or hot-spots of species diversity that are focal areas for conservation efforts. Rather, detection and recognition of cryptic species can help conservation biologists design refuges to limit interbreeding of distinct lineages, preserve genetic diversity, and target more precisely local threats that can endanger specific taxa.

Other overviews and syntheses show that extinction rate has increased when global climates have warmed (Mayhew,

Chapter 4), but that (plant) speciation rate has increased along with CO_2 concentration (McElwain et al., Chapter 5) throughout the Phanaerozoic. The result of these interacting processes—speciation and extinction, temperature and CO_2—regrettably is left unexamined. Baas and Wheeler (Chapter 6) argue for the analysis of relationships between climate and wood anatomy, and Donnelly et al. (Chapter 8) summarize phenological changes of bud burst, insect emergence, and bird migration with recent climatic change, but neither chapter breaks new ground. The remaining chapters of the book elaborate case studies that illustrate applications of general principles but rarely explore broader implications suggested by the details of the case studies themselves.

As with most edited volumes, there is only limited cross-talk among chapters, despite many of the authors having presented their papers to each other at the 2008 Conference on Climate Change and Systematics. The text is generally clean and well edited, although the perils of spell-checkers occasionally are in evidence: my favorite is the observation that the bleaching responses of coral reefs to extreme temperatures during the 1997–1998 El Niño was "exasperated" by limited dispersal of symbionts between reefs. Overall, however, *Climate change, ecology and systematic* provides a useful starting point for contemporary research and synthesis into the relationships between climatic changes, biological diversity and speciation, and ecological dynamics. Graduate students embarking on biogeographical studies, applying niche models to existing datasets, or revising existing taxonomies would do well both to read this book and to heed Bateman's explicit (and Bernardo's implicit) message that there is a damaging imbalance between data-mining and synthesis versus generating the new empirical data required to test hypotheses about relationships between organisms and their changing environment.

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Spotlight

Recent Publications of Interest

Brebbia, C. A., editor. 2012. **Ecodynamics: the Prigogine legacy.** WIT Press, Boston, Massachusetts. vi + 341 p. $316.00, ISBN: 978-1-84564-654-7. This book is dedicated to Ilya Prigogine, a dominating personality in the world of ecosystems. It is a compilation of previously published papers connecting ecosystems to evolutionary thermodynamics.

Li, Judith L., and Michael T. Barbour, editors. 2011. **Wading for bugs: exploring streams with the experts**. Oregon State University Press, Corvallis, Oregon. xiv + 160 p. $19.95, ISBN: 978-0-87071-608-9 (alk. paper). Aimed at non-scientists, this book provides personal accounts by researchers on 23 groups of aquatic insects (including stoneflies, mayflies, dragonflies, and others). Pen and ink drawings and 3-page descriptions of their life histories and morphologies accompany the essays.

Books and Monographs Received Through November 2011

Alkon, Alison Hope, and Julian Agyeman, editors. 2011. **Cultivating food justice: race, class, and sustainability.** Food, Health, and the Environment. The MIT Press, Cambridge, Massachusetts. xiv + 389 p. $54.00, £39.95 (cloth), ISBN: 978-0-262-01626-1 (alk. paper); $27.00, £18.95 (paper), ISBN: 978-0-262-51632-7 (alk. paper).

Allison, Ian, Nathaniel Bindoff, Robert Bindschadler, Peter Cox, Nathalie de Noblet-Ducoudré, Matthew England, Jane Francis, Nicolas Gruber, Alan Haywood, David Karoly, Georg Kaser, Corinne Le Quéré, Tim Lenton, Michael Mann, Ben McNeil, Andy Pitman, Stefan Rahmstorf, Eric Rignot, Hans Joachim Schellnhuber, Stephen Schneider, Steven Sherwood, Richard Somerville, Konrad Steffen, Eric Steig, Martin Visbeck, and Andrew Weaver. 2011. **The Copenhagen diagnosis: updating the world on the latest climate**