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Title

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Journal

Frontiers of Biogeography, 5(1)

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Publication Date

2013

DOI

10.21425/F5FBG16084

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Handbook for opening the vault: a helpful guide to using and interpreting paleontological data

Paleontology in Ecology and Conservation. Julien Louys (editor), 2012, Springer. 273 pp. \$129/£90 (hardback) ISBN: 9783642250378; <http://www.springer.com>

In a past incarnation as a research student working on nature reserve selection and design algorithms, I kept coming across provisos in the conservation planning literature such as ‘we need long-term data on populations and ecosystems but because these are largely unavailable we must rely on the limited, static species data that are available.’ I wondered why the palaeo-record was not being used to fill this information gap. The first time I suggested this to a colleague, the response was predictable: what would data spanning ‘geologic’ time offer to modern conservation efforts? However, as is argued in this book, the fossil record is not limited to deep-time (fossil data can provide insights into changes in extant populations and ecosystems over the past few centuries). Further, ecological data across all time-scales are necessary for good management that supports the biodiversity and the ecosystem processes that make ecosystems resilient to environmental change (Mace et al. 2012).

This book is aimed at researchers working in ecology and conservation who are interested in making use of the vast amount of information stored within the fossil record. The greatest strength of the book is that it teaches conservation planners how to access the vertebrate paleontological record, in order to extract the long-term demographic data that they require. This includes data on animal demographics (mortality, age structure), predator–prey interactions, species richness and abundance, phylogenetic diversity, habitat usage and biotic recycling of nutrients. Conservation biologists will be interested in the review of evidence from the fossil record

of the possible mechanisms by which animal and plant species may respond to future environmental change (extinction/extirpation, relocation and adaptation) and the context in which each response is likely to occur (Chapter 6).

The authors address in detail the issues involved in using and interpreting the fossil record to understand and manage modern ecosystems, such as differences in scale (temporal, spatial and taxonomic) between palaeoecology and neo-ecology, as well as the taphonomic processes that affect the composition of the fossil record (i.e. the death assemblage). However, the unique contribution of this book is the focus on the positive aspects of these differences, including guidance on dealing with potential problems. For example, the process of taphonomy—the creation, movement, deposition and preservation of fossils—is described in terms of the novel information it offers (Chapter 5) to neo-ecological research. There is also an excellent review of the spatial, temporal and taxonomic scales of long-term neo-ecological studies, and guidance on ways that palaeoecological data can be integrated with these (Chapter 4) in order to extend the time scale of our observations of biodiversity and ecological and evolutionary processes.

The fossil record does not only provide depth in terms of temporal scales; the integration of multiple fossil records across space provides insights into the macro-scale ecological and evolutionary processes that are likely to be affected by current and future global environmental change. This book provides a number of good examples of integrating records

across both space and time in order to map changes in species distributions from fossil bone assemblages, identify areas for conservation based on relative levels of phylogenetic diversity, and relate functional traits of extant species to past environmental gradients across North America. While there is a brief mention of the importance of global databases of paleontological information (e.g. FAUNMAP, Neotoma) for reconstructing changing species distributions through time, particularly in response to climate change, the treatment is not thorough enough to provide guidance to biogeographers interested in pursuing this type of analysis. I hope a future second edition might fill this gap.

One drawback of this book is the tendency of the editor to paint a rather dire picture of the current usage of palaeoecological data in ecology and conservation. In particular, the author suggests that the usefulness of palaeoecology for testing ecological theories and studying ecological processes is a 'neglected' aspect of the field (Chapter 3 and Louys et al. 2009). But this ignores developments over the last 20–30 years that have moved palaeoecology away from qualitative reconstruction and toward a quantitative science that can be used to test ecological theories and hypotheses (Davis 1981, Battarbee et al. 1985, Birks et al. 1990, Peglar and Birks 1993, Jeffers et al. 2011), and investigate the dynamics of long-term changes in ecosystem processes (Committee on the Geologic Record of Biosphere Dynamics 2005, Sayer et al. 2010, Willis et al. 2010, Jeffers et al. 2012). However, most of these developments have occurred within the sub-field of palaeolimnology and have focused mostly on plant–environment interactions (although reconstruction of past mammalian herbivore density dynamics is increasingly being conducted from dung fungal spore analysis of lake sedi-

ments; Baker et al. 2013). It would be more accurate to state that recent developments within vertebrate paleontology, which is the focus of this book, have enabled researchers to expand the range of long-term ecological information available, from assemblages of fossil bone records, on many aspects of biodiversity and ecosystem processes (including multiple trophic interactions).

This discrepancy highlights the need for greater integration across the sub-disciplines of palaeoecology and vertebrate palaeontology. There is one chapter within this book where these apparently disparate sources of data (i.e. fossil pollen and fossil bone densities) are brought together in order to situate the reconstructed density dynamics of selected mammals within the concurrent changes in vegetation composition (Chapter 10, modified from Guthrie 2006). In this chapter, Zimov and colleagues further demonstrate how the insights provided by an integrated understanding of ecosystem dynamics—one that incorporates independent records of vegetation and animal populations—can be used to understand modern ecosystem processes and support efforts to restore the extinct mammoth-steppe biome to the arctic tundra.

Might this book spur greater dialogue between practitioners in paleontology, ecology and conservation science (p.5)? Reading the book has led me to expand my own thinking about the impact of environmental change on complex interactions between trophic levels and how this might be inferred from an integration of multiple sources of fossil data within an ecosystem. Will it have a similar effect on researchers who are not inclined to appreciate the usefulness of the fossil record? I would argue that it provides the building blocks required in order to achieve greater integration between palaeo- and neo-ecology

and conservation biology; actually achieving this will continue to depend on the efforts of individual researchers who are willing to step over the long-standing divide between the disciplines.

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Edited by Markus Eichhorn