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book review

A case for microbial endemism

Biogeography of microscopic organisms: is everything small everywhere?, by Diego Fontaneto (editor) 2011, Cambridge University Press, 365 pp. ISBN: 978-0-521-76670-8

Price: £60.00 (Hardback); <http://www.cambridge.org/>

Biogeography of microscopic organisms will be recommended reading for all my students and postdocs interested in microbial biogeography. Yet I admittedly cracked this book with few expectations. The everything-is-everywhere (EiE) discussion has dominated this growing field for the past decade, and I could not imagine reading 300+ more pages on this topic. Moreover, the chapter list is biased in its coverage towards eukaryotes, whereas I (unfairly) prefer reading about Bacteria, Archaea, and viruses (the last of which are not considered). Despite my initial skepticism, however, I am now convinced that Dr. Fontaneto has done the field of microbial biogeography a great service. The compilation provides a thorough dissection of the EiE hypothesis, a wealth of fascinating case studies, and testable hypotheses for future research. Perhaps most importantly for the field, it compiles ample evidence for microbial endemism from all corners of microbial life.

Part I introduces the EiE hypothesis and its history. Briefly, the idea is that because of their size, microorganisms are not dispersal limited (Baas Becking 1934, Finlay 2002), and as a result there are few, if any, endemic microorganisms. Beyond the introductory section, each chapter is also independently framed in terms of the EiE hypothesis. This format is enlightening (if a bit repetitive), because it demonstrates that much of the debate lies in *what* the hypothesis is, as well as whether the data support it. For instance, although it is not always explicit, the contributing authors vary in their definitions of dispersal. Bass & Boenick (Chapter 6) seem to define dispersal as the movement of individuals to a new location “whether they grow or not (*as long as they have the potential to do so*).” In contrast, Geml (Chapter 9) estimates migration rates using models of gene flow, implicitly focusing on individuals that reproduce and mix with a local gene pool.

The middle three sections of the book con-

sider case studies from biogeographically intriguing groups, such as thermophilic bacteria (Chapter 4), lichen fungi (Chapter 10), and microscopic animals (Chapters 13 and 14). I envision returning often to these sections in the future for vivid examples in writing or teaching. Most of these chapters conclude that there is evidence for endemism within their focal group. Although innumerable earlier studies have come to this conclusion, the broad diversity of taxa considered in one place drives home the point. For instance, Ganter (Chapter 8) consolidates data from cactophilic yeast isolated from North and South America, the Caribbean Islands, and Australia. Many of these species appear to be endemic to a geographic region, whereas only two are ubiquitous among these locales. Similarly, Medina et al. (Chapter 11) conclude that, as for flowering plants, mosses (which disperse as microscopic spores) include both endemic and cosmopolitan species.

Beyond a general agreement that some microorganisms have restricted distributions, many chapters note the same complications hampering a resolution of the EiE debate. In particular, several discuss how taxonomic resolution and depth of sampling affect the likelihood of observing endemism. Perhaps the clearest cases are comparisons between taxa defined by morphology versus those defined by molecular markers. Another common theme is that, at the very least, the EiE hypothesis is an over-simplification because size is not the only factor determining microbial dispersal. Foissner (Chapter 5) illustrates this point beautifully with a variety of micrographs that showcase the role of resting cysts in protist dispersal.

The differences among the case studies are as informative as their similarities. Although the field is quickly moving towards primarily nucleotide sequencing, the studies here give the reader of an overview of the methodological and analyti-

cal approaches used up to now. I personally found Geml's (Chapter 9) application of coalescent models quite interesting. His results suggest much greater intercontinental dispersal among alpine fungi than boreal-temperate species. Although population genetics principles have previously been applied to environmental microorganisms (e.g., Whitaker et al. 2003, Vos and Velicer 2008), the study demonstrates again the power of further adapting such approaches.

The fifth and final part of the book focuses on how biogeographic patterns illuminate the processes creating these patterns. Each of these chapters suggests several testable hypotheses for future research. For instance, Jenkins et al. (Chapter 15) consider the relationship between local abundance and range size. The authors succinctly argue that the EiE hypothesis predicts that the microbial abundance and range should not be correlated, in contrast to the positive relationship widely observed for larger organisms. In fact, several recent microbial studies have noted a positive abundance–range size relationship in their data (e.g., Barberán et al. 2012, Nemergut et al. 2011), providing another line of evidence for restricted distributions. In another chapter, De Meester (Chapter 16) draws from metacommunity theory to suggest that priority effects might be important in determining microbial distributions; a recent study of marsh bacteria may provide such an example (Martiny et al. 2011).

Even my worry about a eukaryotic bias was put to rest by the end of the book. After all, the EiE debate centers around the idea of an abrupt change in the processes underlying the distribution of organisms just under 1–2 mm in size (Finlay 2002). It is thus perhaps only appropriate to focus on organisms closer to this size limit, rather than the much smaller prokaryotes. I was also pleasantly surprised that many chapters cited studies outside of their particular microbial domain. Finally, Dr. Fontaneto clearly spent a great deal of time editing the chapters. While the chapters vary greatly by style, they are consistently well written.

In sum, *Biogeography of microscopic organisms* is a thorough and readable introduction to the EiE literature. Perhaps more importantly, how-

ever, it provides a springboard for microbial biogeography to move beyond this discussion. After all, biogeographic patterns do not even require endemism; even if all microorganisms were globally cosmopolitan, their relative abundances could still be non-randomly distributed over space and time. Hopefully, this book helps to move the field beyond the EiE discussion to the many outstanding and varied questions about the distribution of microbial diversity.

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