BOOK REVIEW

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Biodiversity's ubiquitous signal

Review of:The Species–Area Relationship: Theory and Application
Ed. by Thomas J. Matthews, Kostas A. Triantis, and Robert J. Whittaker
Cambridge University Press.
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Sitting on an island in the middle of the Pacific doing fieldwork while another wave of the virus that's completely upended our world dominates the news makes you reflect – about the all of the projects we were supposed to do that have sat neglected for months and years (including reading and reviewing this book) as we try to keep our kids educated, our families safe, and our careers intact. Of all of the lessons we could (and should) learn during this world-upending pandemic, including epidemiological, social, economic and political, the one that most often takes a backseat despite being the proverbial "elephant in the room" is biodiversity—the numbers and types of animals, plants, microbes and viruses on Earth.

The ecological laws that drive biodiversity—both its generation and maintenance—influence every aspect of our lives, from the food and water we consume to the air we breathe. Those laws also drive the likelihood that certain viruses jump hosts when aspects of biodiversity are altered, and their subsequent evolution as they spread across a host population. And yet we have much to learn in the study of biodiversity, its patterns, its generation and maintenance, its influence on the world around us.

Thankfully, we're making progress in our understanding of biodiversity patterns and the processes that generate it. And a great deal of that progress stands on the shoulders of some very old ideas. Most notable is that biodiversity should not be thought of as a single number, but rather as a scaling-relationship. In any given sampling window across space (or time), biodiversity can be represented by a series of metrics (species richness, evenness, and so forth). However, most of those metrics change as the sampling window increases, as do measures that rely on these metrics -- such as ecosystem functions and services, network structure, etc.

This is where the science of the species-area relationship (SAR) provides a foundational tool for biodiversity science. And the edited volume by Matthews et al. provides the most comprehensive overview of the state-of-the-art of this critical area of biodiversity science that I've seen. In Part I, chapter authors provide a narrative that shows the historical depth and breadth of biogeography's most important pattern (some say 'law')—the Species Area Relationship (SAR). The pattern has been described since before the times of Humboldt, Darwin and Wallace, and efforts to understand how and why species richness increases with increasing area are almost as old. Even today, the most commonly used equations to describe the SAR were developed over 100 years ago.

Part II goes on to develop an overview of various patterns of biodiversity scaling relationships typically referred to as SARs, including variation in diversity on islands of different sizes (island SARs or ISARS), nested SARs, and SARs of different types of diversity measures, such as functional and phylogenetic diversity, as well as that of alien species.

Part III explores various theories underlying SARs, ranging from statistical questions (which SAR equation fits best?) to several different forms of theoretical expectations for SARs based on statistical geometry, sampling theory, maximum entropy, and the like. Authors of these chapters represent a virtual 'who's who' in the field, and each chapter represents an excellent overview of their world view. The final chapter of this section represents the sole contribution focusing explicitly on trophic interactions and SARs, by Holt and colleagues, who've been pushing this view for decades despite most of the field being rather agnostic towards food web interactions and their role in SARs.

Part IV tackles the applied side of SARs. Indeed, since well before MacArthur and Wilson developed the equilibrium theory of island biogeography and its predictions for SARs, ecologists were well aware that habitat loss was a principle reason for biodiversity loss, and that the ideas of the SAR (and related concepts) could help us to understand this loss -- and maybe even do something about it. Chapters in this section explore the use of a number of related SAR concepts to achieve applied conservation goals. As we move forward, the connections between basic and applied biodiversity science, and in particular, between biodiversity scaling relationships and SARs, will become more critical.

Finally, in Part V, one of the co-editors of the volume, Kostas Triantis, takes the mantle from Rosenzweig's exploration of biodiversity and SARs more than 25 years later to explore what has, and what has not, been answered in SARs and our understanding of biodiversity more generally. What is clear from the book and this chapter is that we've made a lot of progress in our recognition of SAR patterns in multiple forms, of the statistical and theoretical underpinnings of SARs, and in our understanding of their utility for understanding the conservation of biodiversity. At the same time, as Triantis shows by building on the themes from Rosenzweig, there remains much work to be done in order to develop a fully 'unified' perspective of SARs for a number of questions in ecology and evolution.

In all, I very much liked this book. In our collective exhaustion over the past two years of just trying to keep it together -- treading water, rather than reading/thinking about new things -- it was a guilty pleasure to read the depth and breadth of approaches people are thinking about in SAR research. The editors are world-class researchers, and the author list is exceptional. Nevertheless, I would be remiss to not mention the low diversity among the authors (only ~10% chapters first authored by women, and ~20% women authors overall; most authors from North America and Europe). The chapters represent a clear 'state of the art' of where we are in SAR theory and anyone interested in biodiversity should find this consolidation highly valuable.

At the same time, there remains much to do. Twenty years ago, Sam Scheiner pointed out a severe problem with SAR investigation, and he and others have repeatedly published on this problem. There is not one type of SAR, but in fact many. There are nested SARs and island SARS., and many types of SARs in between. Likewise, there are dozens of ways to measure them, analyze them and think about them. These many ways are well-recognized by the editors and authors of this book. However, I felt that an opportunity was missed to try to do a bit more to 'tame' the SAR beast by more explicitly acknowledging these different types of SARs, and perhaps even trying to find ways to organize and think about them. Or better yet, find a unified view. But this is a challenge, especially for an edited volume.

In short, this edited volume points towards what is known and what is possible to be known. Most biodiversity scientists will find it useful to read and reference. And all of the ingredients for a more unified SAR theory are there. Basic and applied. Theoretical, statistical and empirical. My ultimate wish would be that a chef, or perhaps several chefs, will be able to take those ingredients and combine them into a more synthetic whole over the next decade. This book will help them to get there.

Maybe that chef will be you?

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