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Book Review

M.A. Davis (2009). **Invasion Biology. Oxford University Press, Oxford, UK.** 288 pp. Paperback US$55.00. ISBN13: 9780199218769.

Defining and re-defining invasion biology.

At the start of the millennium research in invasion biology was surging. Some worried it was becoming ''a glutted field,'' as countless new and established ecologists busily worked on the vast theoretical, economic, and management issues surrounding invasive species. Thus, Mark Davis sets himself an impressive task in attempting to cover the field over the past 10 years in his new book, *Invasion Biology*. His stated goal is to provide the first single-author update of the discipline since Willamson's well-cited *Biological Invasions* (Williamson 1996). The book succeeds in providing both a fresh and comprehensive review of the vast ecological literature of invasions: it is coherent, easy to read, while hitting most of the high points and advances over the past 10 years. It is also a manifesto of sorts on the need to redefine invasion biology, and perhaps kill it along the way.

The book is targeted at established researchers and graduate students, and could easily be the base text for a graduate-level course in invasion biology. Davis prefaces the book with a discussion of terminology and the myriad issues surrounding the oft-sounding militaristic terms of invasion biology, and closes with a discussion of the responsibilities of invasion biologists, especially its research-focused community. The chapters are neatly organized and approachable, but lacking numerous section headings or in-text bolding of key points that would make the book feel as though it were simply a textbook. Three generally excellent indexes are provided, one each for geographic, taxonomic and subject terms. Davis divides his book into three unequal sections: process (I), impacts and management (II) and reflections (III); by the far the most substantial section in content and depth is the first.

This first ''process'' section focuses on ecological theory, nicely integrating examples from myriad ecosystems and organisms. It works to cover a vast literature by tracing the underlying process that allows a species to invade a new habitat, establish, and increase in abundance. The reference list to the first section is impressive, and the text leads the reader coherently from one key advance to another. Davis has gone out of his way to cover recent literature, especially literature by a new generation of ecologists; the result is a text that is often brightly cutting-edge, but feels well-integrated with established work and classical references that he also includes. The section touches along the way on such key areas as lag effects (between establishment and spread), the enemy-release hypothesis and the role of disturbance and system variability in invasions. In particular, the fluctuating resource theory of invisibility – perhaps Davis's most famous work and by far his most cited – receives special attention. The theory posits that pulses of available resources may be highly important to the establishment and success of invasive species and thus, that environments with more temporally or spatially variable resources may be most invasible. Although he aptly works to carefully credit the theories and studies of others appropriately, it is perhaps inevitable that Davis writes of his own hypothesis rather more favorably than he writes of several other ideas and theories.

One area of research that is more coolly examined is the role of niche theory in invasion biology. Testing whether invasive species tend to occupy vacant niches has lead to an abundance of research, and formed the basis for the well-studied invasibility-diversity debate (Fridley et al. 2007). Davis puts less emphasis on theories regarding how species may co-exist via niche-partitioning that occurs in the same space and at the same time than theories which use variability in space and time to promote coexistence. I think Davis misses opportunities to link the various flavors of species co-existence theory – and their roles in invasion biology – with each other. For example, the theory of fluctuating resources, in its simplest form, predicts species partition resources through time or space, and that invasive species may gain a foothold in new environments by exploiting what could de described as a temporally vacant niche. A more nuanced discussion of such links could have lead to a more comprehensive review of niche theory and naturally elevated the importance of the theory of fluctuating resources in a world where humans have altered space (Soulé et al. 1992), time (Walther et al. 2005), and system variability (Carpenter & Brock 2006).

Evolution is covered in one chapter tucked towards the end of the book's process section. The choice to separate evolution into its own chapter has benefits: showcasing it as a topic worthy of its own careful coverage. However, it also places evolution outside of the many steps of the process of invasion it has been shown to affect. Evolution clearly plays a role in the lag of many species invasions, and can be critical to how invasive species interact with native species and communities. Importantly, community phylogenetics is almost entirely skipped in the text, mentioned only in passing a couple times, and does not even appear in the otherwise admirable index. A major current and certainly future issue of invasion biology is dealing with the inherent lack of independence in tests that compare suites of invasive species with non-invasive species. This same data from phylogenetic trees that can allow

researchers to control for taxanomic relatedness among species, has also provided a major new way to test niche theory – if traits covary with phylogenetic relatedness then, under niche theory, less related species should be most successful because their differences allow them occupy unused niches (Strauss et al. 2006). Further, phylogeny also allows a test of the alternative hypothesis – that species are filtered based on their fit to the environment, which predicts that invaders should be closely related to native species. Such hypotheses link nicely with basic community ecology theory, because they exactly parallel phylogenetic predictions for communities structured via competition (predicts species in a community are phylogentically overdispersed) versus filtering (predicts species are underdispersed). These ideas have produced a number of studies attempting to use phylogenetics to support hypotheses and it is an important rising field of study, with many issues to resolve. Additionally, phylogenetics may be a tool to predict which exotic and native species will become invasive in the future (Willis et al. 2008), providing one framework to integrate invasion biology with work on range expansions. Thus, Davis's quick coverage of it – though understandable considering the subfield is still developing – may provide one main area for a graduate level course to supplement the book with cutting-edge reviews and research papers.

The second section (II) of the book targets impacts and management. Because it is the impacts of invasive species that managers are attempting to mitigate, treating both impacts and management in one section may provide insight. However, working outside of the process framework of the first section and its thematic, mechanism-based approach, Davis's treatment of impacts reads much like a list of possible outcomes that invasive species managers may need to deal with. This organized list provides a brief yet useful summary before his chapter on management, which reviews the possible ways to handle invasive species (from eradication attempts to the "LTL" approach – *learn to like 'em*) and covers current needs to advance management. The chapter is approachable and diverse and provides a knowledge baseline of the issues and opportunities managers face in dealing with invasive species targeted toward invasion biology researchers.

The last section (III) of the book centers on the philosophy of science, and of invasion biology in particular. Davis is refreshingly upfront that some people detest such philosophical discussions, but he doesn't. Here he uses "I" with disarming effect – creating the impression of a reflectory dialogue with both the individual reader and the discipline of invasion biology itself. The section serves as a call to action for the discipline to consciously and purposefully re-integrate with basic (or as he terms it "mainstream") ecology, especially with community ecology. Such a call is not new (e.g., Cadotte et al. 2006), but adding it within what is effectively a modified textbook format raises the issue in a new light. And he goes further than most by suggesting that "the participants of [invasion biology] abolish their discipline." Davis's first chapter here gives evidence from the literature on how "disassociated" invasion biology has become, and on this basis he moves to outline what he sees as the major disciplinary challenges (pluralism, authority and the effect of paradigms, especially niche-based paradigms). And concludes with a list of research priorities, a brief review of adaptive management and a discussion of possible new terms for invasion biology.

Davis suggest ecologists rename the discipline SPRED ecology – SPecies REDistribution – making sure this research area includes current and future range expansions of many species under climate change, and has strong ties to biogeography. I personally don't want to work in a field called SPRED ecology because the term does not resonate with me, and also because the term "invasion biology" has ties to one of the most basic questions of ecology, "when can a species invade a community?" – a question that underpins some of the most well-studied and "mainstream" theories in ecology including most coexistence theories (Tilman's R^*, Sale's lottery model, Chesson's storage effect etc.). However I do find Davis's call for re-integration and re-organization of invasion biology timely and critical for the discipline. Climate change has now clearly shifted the range and abundances of many species (Walther et al. 2005) and ecologists have begun to grapple with what to call and how to study such "native invasive" species. Integrating more local species shifts into the field of invasion biology provides the opportunity and, hopefully, the momentum to reintegrate the field with basic ecology and cast it in a broader light.

For a discipline as sprawling, research-rich, and in many ways still inchoate as invasion biology, Davis's concluding section – and the entire book itself – does a good job of highlighting what has worked and what needs further discussion, in a way that is efficient and approachable enough for many in the field to read. In the past 5 years publications in invasion biology have topped 1,000 a year and the field, though perhaps not "glutted," clearly is overwhelmed by theories, hypotheses, and research. Davis' book provides a much-needed head-on address of how and why ecologists should redefine the field.

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