INVASION BIOLOGY AND ECOLOGICAL THEORY

Insights from a Continent in Transformation

EDITED BY Herbert H. T. Prins
and Iain J. Gordon

With a foreword by Charles J. Krebs

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Many conservationists argue that invasive species form one of the most important threats to ecosystems the world over, often spreading quickly through their new environments and jeopardising the conservation of native species. As such, it is important that reliable predictions can be made regarding the effects of new species on particular habitats and ecosystems.

This book provides a critical appraisal of ecological theory using case studies of biological invasions in Australasia. Each chapter is built around a set of 11 central hypotheses from community ecology, which were mainly developed in North American or European contexts. The authors examine the hypotheses in the light of evidence from their particular species, testing their power in explaining the success or failure of invasion, and accepting or rejecting each hypothesis as appropriate. The conclusions have far-reaching consequences for the utility of community ecology, suggesting a rejection of its predictive powers and a positive reappraisal of natural history.

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Foreword

Alas, the poor ecologist who is expected to follow the laws of scientific inference that have arisen from physics and chemistry. Erect hypotheses, make predictions, see if they are supported by evidence obtained by observations or manipulative experiments. Perhaps it would be easier if, instead of 30 million species, we had only 118 elements in the periodic table to study or only a few forces in physics to design hypotheses around. So how do we cope? We can deal with autecology or the ecology of individual organisms because we have a strong base in physiology and simple things like metabolic rates are constrained by how evolution has proceeded. We can deal with populations because they typically have a restricted nexus of interactions, as Andrewartha and Birch (1984) told us. But things are getting more complicated since the interactions can involve competition, predation, disease, food supplies, climate, and social effects. Perhaps we can cope with this amount of complexity, but it is certainly complex enough to allow many ecologists to argue extensively about the factors causing populations to rise or fall. In principle we can sort out these arguments at the population level by field or laboratory experiments, and this approach will often work to provide evidence-based explanations. But when we move up to community and ecosystem ecology problems multiply if only because experimental manipulations become more difficult and certainly more expensive. It is partly a reflection of why aquatic community ecology has progressed more than terrestrial community ecology – large-scale experiments in rivers and lakes are more prevalent than they are in terrestrial ecosystems. But it may also be partly a reflection of hypotheses that are not operational.

In an ideal universe we might be able to work out some of these problems but the arrival of human influences has added yet more complexity. Invasion biology is now one of the leading fields of community ecology both because of its intrinsic interest as a test case of how much we understand community interactions and even more because many species invasions have consequences written very large in dollars and cents.

The complexities of community and ecosystem ecology have spawned a number of approaches to ecology that have been less helpful than we might have thought 60 years ago. Simple ideas – diversity promotes stability – have morphed into widely accepted hypotheses that weigh heavily on how the terms involved are defined and measured. If there are really 70 different stability concepts (Grimm and Wissel 1997) and at least a dozen different measurements of diversity, it is small wonder there is confusion mixed with controversy over attempts to test this kind of hypothesis. Much of this confusion has been augmented by mathematical models that make assumptions about ecological concepts that differ in important ways from their mathematical parameterisation.

Enter this book – a bold attempt by Herbert Prins and Iain Gordon to formulate a set of 11 hypotheses that can be tested with empirical examples from Australasia. They have brought together 34 scientists with solid field experience to write 18 chapters on specific examples of invasions with the explicit demand to test the 11 hypotheses in each example if possible. They have used both ancient and modern invaders to broaden the dataset. The results are spectacularly interesting for those of us who are interested in natural history, but they also provide a strong warning for ecologists who think time's arrow always points in the direction of theoretical progress and more precise generalisation.

But relax. If you do not like the conclusions reached here, you have the well-utilised rationalisation that we cannot expect ecological examples from Australasia to apply to theories that are designed to be applied to important parts of the globe (i.e. England). Of course I jest, but evolution is the biggest jester of all in our search for ecological wisdom, as illustrated so well in Darwin's two-creators comments. We do not know the breadth of ecological generalisation.

But we press on. Theory must continually be revised on the basis of evidence from field studies, and this book is a good example of how this change can be driven by specialist knowledge from diverse fields. How much we will be able to understand invasions by defining the niche of a species is just one of the open questions addressed here. As I was reading the evaluation of Hypothesis 3 in Chapter 22, I remembered a conversation I had with Robert MacArthur in 1969. He told me that he had abandoned the concept of the niche because it was not measurable by any realistic set of parameters.

Where next? If the arguments made by the authors of this book are accepted, we should be much more careful about giving predictions of what invasions associated with climate change will do to communities and ecosystems. Predictions about invasive species seem to be successful only after the fact, and the operational message ought to be simply to use every measure possible to restrict the human transport of organisms from one part of the world to another. There are many practical management issues we can, as ecologists, recommend about invasive species, but we should not pretend to have the wisdom that exists only in the closed systems of mathematics. Walk slowly, we have much to do.

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