ecologies

MDPI

Book Review

Book Review: Hui, C.; Richardson, D. *Invading Ecological Networks*; Cambridge University Press: Cambridge, UK, 2022; ISBN: 9781108778374

Marco Favretti

Dipartimento di Matematica Tullio Levi-Civita, Università degli Studi di Padova, 35121 Padova, Italy; favretti@math.unipd.it

The book addresses the problem of describing the dynamics of the interaction of alien species with an ecosystem using modern network theory. The classical approach was to focus only on the fate of the invader, following the steps of introduction, establishment or extinction. The more modern view presented in the book is to consider the network of interactions between resident species and invaders and to study the network dynamics, in particular the change in network topology and complexity, the effect on stability of equilibria and on the complexity–stability relationship.

Invasion Science is a recent discipline aiming at describing the effect of the introduction of alien species (the invaders) in an ecosystem at equilibrium. Globalization has enormously increased the effect of human-mediated transfer of species in terms of quantity, distance and speed, determining an overwhelming record of new established non-native species. Scientists risk to be left behind by the pace of the induced transformations of the biosphere, without control on the cascade of effects observed at the global scale on climate, biodiversity, agriculture and economy, to cite a few.

In the book, the many facets of this complex and urgent problem are dealt with using a multitude of notions mainly derived from modern network theory and, even more importantly, by reshaping the classical theory of deterministic models (predator–prey Lotka-Volterra systems) in a new, more complex tool with increased predicting power and flexibility (see Chapter 2).

This step is akin to the shift from classical equilibrium thermodynamics of closed systems to the more modern non-equilibrium thermodynamics of an open system in a stationary non-equilibrium state: instead of a closed ecological system with a fixed number of species, the book considers an open adaptive system where the number of species is changing due to the introduction of alien species, the interaction strengths are changing (randomly or deterministically) due to different strategies or mutations in trait and the role-switching between partner species (rewiring) is allowed.

Let us cite two main consequences of this change of perspective. First, the notion of equilibrium points and of (linear or nonlinear) stability for systems described by ODEs is updated to the open adaptive systems scenario, where the system dimension is changing and diverse factors at different space and time scales influencing species co-existence need to be taken into account. This is discussed at length in Chapter 4 through the concepts of demographic and structural stability, self-organized criticality, bifurcations and change in network topology, and complexity-stability relationship. The parameters that drive the possible dynamic bifurcations are the interaction strength between species, the traits if mutations are allowed and the adaptive switching if the players in the networks are allowed to change their strategies.

Secondly, the need of a shift of paradigm from a species-centric description to a picture of the different interactions as a mobile, self-organized network is motivated because the outcome of invasion depends not only on the invader's own strategy, but also on the response of resident species.

Citation: Favretti, M. Book Review: Hui, C.; Richardson, D. *Invading Ecological Networks*; Cambridge University Press: Cambridge, UK, 2022; ISBN: 9781108778374. *Ecologies* **2022**, *3*, 508–509. https://doi.org/10.3390/ecologies3040036

Academic Editor: Valery E. Forbes

Received: 14 October 2022
Accepted: 19 October 2022
Published: 21 October 2022

The prominent characteristics of a network are: non-centralized or distributed control, connectivity and co-evolution, sensitivity and emergent order, and openness. Chapter 3 contains a gentle but effective review of basic concepts of network topology and architecture with applications to ecology (mutualistic and antagonistic networks, food webs) with a touch of game theory (adaptive interaction switching, optimal foraging strategies).

The book discourse unfolds from the emergence of network complexity and architecture to how invading species modify and break the complexity–stability relationships of the network and push the system towards instability.

The above outlined features are the shared concern of many modern, mathematically oriented books of ecology in a wide sense, and also including social sciences. What is peculiar of this book is the constant commitment to manipulate this matter to offer an effective, quantitative and testable theory of invasion.

The final part of the book (see Chapter 7) opens on the newly introduced concepts of invasibility of an ecological system or invasiveness of an invader, then moves to discuss invader strategies and finally address the delicate and currently crucial point of invasion control and management and early warning signals determination.

One can not help but admire the commitment and devotion of the authors to understand such a complex and rapidly changing aspect of our interconnected world whose consequences for our everyday life are still to be appreciated. Both of the authors are leading scientists in the field.

Funding: This research received no external funding

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The author declares no conflict of interest.