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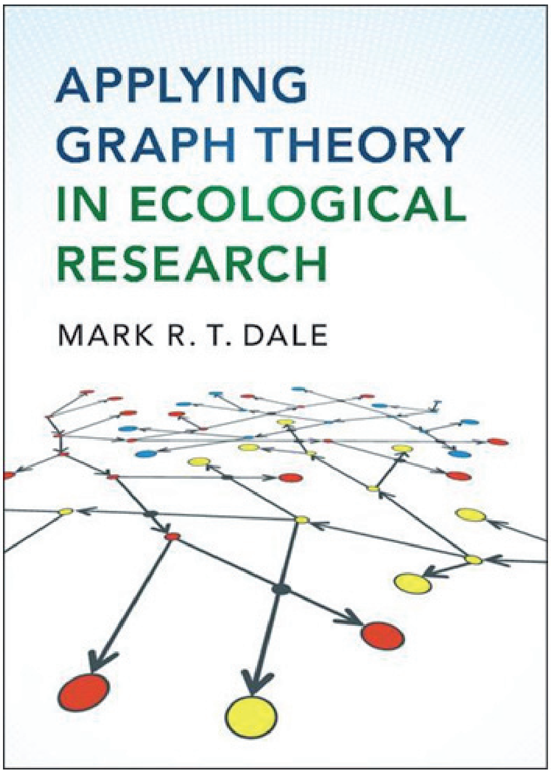
Book review

Mark R. T. Dale. 2017. **Applying Graph Theory in Ecological Research.** Cambridge University Press, Cambridge. ISBN: 978-1-107-46097-3. Kindle $45.72; Hardcover $89.99; Paperback $40.62.



What a beautiful work! The monograph of Professor Dale (University of Northern British Columbia) is an attempt to show the „smart things ecologists can do with graph theory". It overviews the concepts and methods used in network analysis in ecology - but at the end of the day it also shows how the network perspective can unify the various branches of ecology! Since ecology is the very science of coexistence and interactions, it is not very surprising. But so nice to see.

Chapter 1 is about the basic concepts of graph theory, written with exactly as much mathematics as needed, in order to be both precise and digestible (even for students). Classical concepts (e.g. paths, subgraphs) are presented and the main kinds of applications are already indicated (e.g. space, time, dynamics). The way how to use graph models to generate testable hypotheses is discussed and also the kind of data needed for doing this. General issues, like randomization and sampling are briefly mentioned, really just to create a nice set-up for the rest of the book. Then Chapter 2 elaborates some key features of network topology, including trees, triangles and acyclic graphs.

In Chapter 3, species interaction networks are discussed in general terms, providing examples for several systems (e.g. plants and pollinators, food webs) and presenting several important network properties (e.g. motifs, clusters, nestedness, centrality). The main generative models (e.g. scale-free) are then presented, keeping a delicate and very functional balance between theory and data, problems and solutions. This is a key characteristics for the whole book.

Chapter 4 is focused on trophic networks, discussing the evergreen problem of aggregation, mentioning the classical but often neglected concept of interval graphs, presenting the key issues of trophic hierarchy, keystone species and indirect effects. Again, biology and mathematics go hand in hand in a charming way.

Chapter 5 is about associations, discussing novel systems (animal social networks) and bringing new methods to the table (e.g., balance). The integrative, synthesizing nature of the book becomes stronger and stronger after this chapter. Chapter 6 is focused on competition, hierarchies and tournaments, while Chapter 7 is on mutualism and parasitism, going into the details on bipartite graphs, nestedness and modularity.

Chapters 8, 9 and 10 discuss temporal, spatial and spatio-temporal networks, respectively. The part on temporal networks is outstandingly important and gives many examples in many systems, ranging from disease spread to animal social networks and plant-pollinator networks. Classical (e.g. centralities) and quite novel (e.g. burstiness) concepts are discussed, as well as randomization techniques. The part on spatial networks is focused on connectivity, but also the evident but often neglected issue of planarity is discussed. As a currently emerging topic, dendritic networks make this chapter totally up-to-date. Spatio-temporal networks, again, are illustrated by several examples (including lightning strikes, forest stands, disease spread, and, of course, metacommunities). This part is concluded by discussing the ecological memory of landscapes.

Chapter 11 uses graphlets in order to richly present and discuss the relationship between network topology (structure) and dynamics (functioning). This is a stepping stone towards the last and concluding Chapter 12 on synthesis and future directions, emphasizing the perspectives on comparative studies, more data, more methods and novel applications.

A great Glossary, some 600 References and a useful Index helps the Reader to navigate better inside and outside the book. The single-page Appendix hangs already on my wall.

This book is a journey across methods and systems, providing a network-based integartion of ecology. Mathematics and biology go hand in hand, and the clarity of the book is supported also by a large number of excellent little graphs, illustrating most concepts and presenting many systems.

On the flipside, I would mention only two things. First, I am not sure that the „graphlet" concept is very useful. It is clear in the book but somewhat redundant with the already used concepts like „motif" and „module". Second, several concepts appear in many parts of the book (this is no problem) but it is not always immediately clear to the Reader which is the actual place where they are „first and best" defined (like centrality on p.67 and p.115, graphlet on p.60 and p.252, nestedness on p.63 and p.147).

All in all, this book is a beauty. Very smart, clear and highly useful for students and researchers who want to understand either the details (using a book like a handbook) or the Big Picture (sitting back and reading the book just to understand ecology).

Ferenc Jordán
Danube Research Institute
MTA Centre for Ecological Research
Budapest, Hungary