



## Nonlinear Physics of Ecosystems, by Ehud Meron

K. Alan Shore

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## BOOK REVIEW

**Nonlinear Physics of Ecosystems**, by Ehud Meron, Boca Raton, FL, USA, CRC Press, 2015, 359 pp., £57.99 (hardback), ISBN 978-1-4398-2631-7. Scope: monograph. Level: specialist, early career researchers.

Nonlinear dynamics has been studied at least since the time of Poincaré but has grown significantly in both scope and methodologies relatively recently with an explosion of interest in chaotic dynamics. Although the weather-forecasting studies of Lorenz are seen as pivotal in that development, it may be that a wider awareness of nonlinear dynamics and chaos was occasioned by a Nature paper due to Robert (now Lord) May. The context for that work was biological: the use of the quadratic map to describe the growth and decline of biological populations.

Subsequently, chaos was found theoretically and experimentally in a wide variety of physical systems and notably in laser systems. As contributions to the field grew, the mathematical tools for studying nonlinear phenomena became both more sophisticated and better known to physicists, engineers and economists (amongst others). In turn, that led to a broadening of horizons with the emergence of a general discipline of complexity. Whilst all that was in process biological systems were still behaving in their nonlinear fashion presenting challenging problems for elucidation.

A particular feature of natural systems is their manifestation of a variety of patterns: some simple (e.g. stripes on a zebra) and some more complex. The focus of this present work is the latter. The author cogently advances the case that a new scientific discipline is emerging at the interface between spatial ecology and pattern formation. This book then is directed at providing a firm foundation on which to erect that new scientific discipline or more specifically ‘to assimilate the concepts and methods of pattern formation theory into ecological research’. The author provides a pictorial representation of pattern formation in ecosystems as an interaction between biodiversity, ecosystem function and the environment. The book then seeks to explore the various linkages between those elements which lead to pattern formation.

It should be made clear that this is not a formal mathematical approach but one very much rooted in real examples including patterns of vegetation, loss of biodiversity and the extreme desertification. It is really remarkable that such issues can now be treated with

some precision. Naturally, in order to produce a tractable text the author has needed to omit some topics but those wishing to gain an appreciation of this emerging field will have plenty to keep themselves occupied in digesting the contents of this book.

Prior to getting into the detail the author offers an overview of the discipline with succinct introductions to spatial self-organisation, spatial ecology and the modelling of ecosystems. This is termed by the author as an elementary introduction to the new discipline. The second part of the book, indicated as being the advanced introduction to the field, gives a detailed yet accessible exposition of pattern formation theory in four chapters. The book then changes gear and moves to considering applications of pattern formation theory in ecology. The diversity of the topics treated here shows the scope of the work: ‘Modelling water-limited vegetation; ‘Vegetation pattern formation; ‘Regime shifts and desertification ‘and’ Species co-existence and diversity in plant communities’.

The approach taken by the author is simultaneously rigorous and relevant. If one were not careful to avoid an obvious pun, one might say that the reader will always see the wood despite the trees. More directly one would say that the mathematical structures erected are built on firm applications foundations. In a word, the approach is well motivated and accessible. A useful feature at the end of each chapter is a summary of its contents. The chapters have good diagrams and other illustration which add to the accessibility of the material.

This book easily reaches the objectives set for it by its author and is thus strongly recommended to its target audience. There is though one slight niggles of doubt in this reviewer’s mind whether the title chosen for the book will necessarily attract the expect readers. Perhaps, something more explicit concerning pattern formation in spatial ecology could have been considered? It is hoped that this book does indeed reach its intended audience. One anticipates that then that audience will grow super-linearly as this new discipline attracts greater attention.

K. Alan Shore

*School of Electronic Engineering, Bangor University  
Bangor, UK*

*k.a.shore@bangor.ac.uk*

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