Trends in Ecology & Evolution

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Book Review

Defining Theories in Evolution

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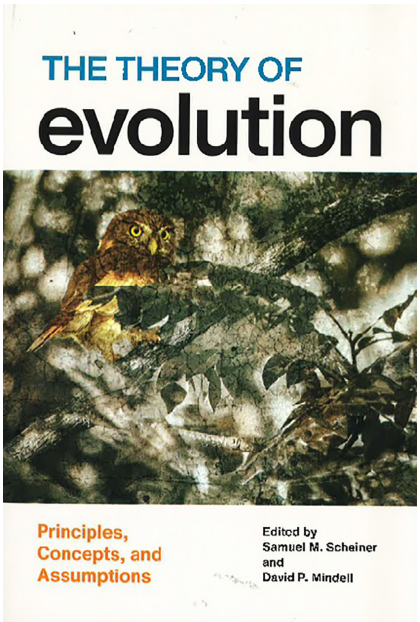

The field of evolution was initially dominated by theory. This includes both verbal models, such as the very definition of evolution by natural selection [1], and mathematical and statistical models, such as the impressive foundations of population genetics laid out almost a century ago [2]. Moreover, in evolutionary biology, mathematical models have a unique history of being used as a proof-of-concept of verbal models that, due to the timescale of evolution and the complexity of interacting forces in nature, cannot be tested empirically [3]. With recent advances in experimental and technological approaches, evaluation of both classical and new models of various degrees of complexity has become feasible [4]. At the same time, other scientific areas such as medicine or conservation biology increasingly recognize the importance of considering genetic and phenotypic variation and the possibility of (rapid) evolutionary change [5,6].

The Theory of Evolution: Principles, Concepts, and Assumptions provides a philosophical and historical account of foundational theories, concepts, and controversies in evolutionary biology. Edited by Samuel Scheiner and David Mindell, the chapters are contributed by both philosophers and biologists, which promotes a diversity of writing styles and viewpoints. The first part of the book raises 'Overarching Issues', often of a semantic and philosophical kind. For example, one chapter highlights the different ways in which theory manifests itself in evolution and another tackles the difficulty of defining species. The second part presents nine 'constitutive theories' within the greater field of theory of evolution. Each of these is characterized by a table of 'propositions' on which the respective theory rests. These can be seen as the least common denominator of rules and potential model ingredients that most researchers in the respective field would probably agree on, and they are likely to be useful for readers new to the field to know 'what they are getting into'. Many of the constitutive theories are situated on the interface of evolution and ecology, with a major focus on selection. Sadly, no constitutive theories are presented regarding the evolutionary forces of mutation and genetic drift.

This book can aid new graduate students in identifying the historical and philosophical context of their research topic or help senior graduate students add an overarching perspective to their thesis. It complements review papers by focusing on the classical literature and a discussion of the history of the field including illustrations of controversies and open questions; for example, the implications of the simultaneous phenotypic long-term stability and genomic instability of prokaryotic lineages for the study of phylogenetics (Chapter 7). Moreover, the book is of interest for anyone (with some biology knowledge) who would like to take a closer look at semantic challenges of evolutionary biology. The book draws attention to blurry definitions and complications that arise from these, sometimes digging deep into philosophical questions.

The nontheoretical reader should not be afraid of drowning in equations and also not expect to 'learn theory' from this book (to learn theory, see [7]): as the subtitle states, most chapters rely on a discussion of concepts and approaches rather than on presenting mathematical formulae. The few equations are simple and used to illustrate important features of the theory. One such example reveals the deep connection between quantitative and population genetics, where a quantitative genetic equation describing genetic variation in a population can be reformulated to give an important formula in population genetics, the change in frequency of an individual allele (Chapter 9, see p. 178). Unfortunately, equation typesetting issues sometimes complicate the understanding of the mathematical arguments (especially in Chapter 4).

Being clear about definitions and assumptions is an essential component of good research. *The Theory of Evolution* encourages thinking about the cornerstone assumptions of one's research area, which are often left unmentioned. Especially in an era of increasingly interdisciplinary work, we could profit from jointly and precisely defining (or updating) the underlying propositions of a focal research area regularly to aid collaboration and to avoid misunderstandings.

The Theory of Evolution: Principles, Concepts, and Assumptions edited by Samuel M. Scheiner and David P. Mindell, University of Chicago Press, 2020. 9780226671161, US$45.00/£36.00

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