Peter Godfrey-Smith, ***Philosophy of Biology.*** Princeton, NJ: Princeton University Press (2014), 200 pp., $29.95.

In *Philosophy of Biology*, Peter Godfrey-Smith provides an introductory overview of some of the most important areas in the field. Each chapter of the book focuses on a major research topic (or cluster of topics) in philosophy of biology. Since most readers here will be interested in the book for teaching purposes, this review will outline the main topics of the book and then briefly discuss its merits as a course text.

Godfrey-Smith begins with a discussion of laws, mechanisms, and models in biology. As he points out, philosophers of biology have largely rejected the idea that biological knowledge is usefully thought of as law-like. It is famously difficult to make broad generalizations about the biological world—exceptions abound.[1] Recent attempts to account for biological knowledge have instead focused on mechanistic explanation (especially in molecular and neurobiology) or on mathematical modeling (especially in evolutionary biology and ecology). Godfrey-Smith seems to support a pluralistic view of biological knowledge where 'resilient' or 'stable' generalizations can take the place of biological laws and where both mechanistic and mathematical analyses can generate genuine biological knowledge.

Godfrey-Smith moves on to discuss evolution by natural selection in chapter 3. He lays out several influential accounts of evolutionary change rather than committing to one. As he points out, any such account that is simple and predictive will struggle with difficult cases, whereas accounts that attempt to cover all interesting cases of change by natural selection will be trivial. Godfrey-Smith's discussion of fitness concepts in this chapter is particularly clear. He distinguishes those that focus on the actual structure of an organism as embodying its fitness and those that are based on offspring count, including both propensity definitions and definitions that simply associate fitness with actual offspring produced. He finishes the chapter with a very brief overview of work on levels of selection and on Darwinian concepts as applied to nonbiological realms.

In chapter 4, Godfrey-Smith discusses adaptation, construction, and function. He begins with the problem of apparent design: How can the complexity and adaptiveness of the biological world be explained without appeal to God? This question leads down two paths. The first focuses on adaptiveness and considers questions like the following: What sorts of adaptationist thinking are being employed by biologists and philosophers? Should organisms be

1. In fact, researchers have just discovered an exception to the central dogma of molecular biology: that codes for amino acid sequences are derived from DNA and RNA (Peter S. Shen, Joseph Park, et al., "Rqc2p and 60S Ribosomal Subunits Mediate mRNA-Independent Elongation of Nascent Chains," *Science* 347, no. 6217 [2015]: 75–78).

thought of as adapting to the environment or as changing the environment to suit themselves? The second path focuses on teleological thinking in biology. Here Godfrey-Smith outlines various positions, distinguishing, for example, between those who think of natural selection as producing genuine purpose and those who think teleological talk in biology is a (potentially useful) fiction.

In chapter 5, Godfrey-Smith focuses on the notion of individuality in biology. This discussion begins with some of the traditional problem cases—genets and ramets, corals, twins, lichens, and bee colonies. Godfrey-Smith then introduces a framework intended to capture the variations between types of biological individuals. This framework is a three-dimensional space where each dimension corresponds to some aspect of individuality (bottlenecking between generations, germ/soma divide, and physiological integration). Various organisms can then be positioned in the space. (For more on this, see Peter Godfrey-Smith, *Darwinian Populations and Natural Selection* [Oxford: Oxford University Press, 2009].) The chapter wraps up with a discussion of the nature of life.

Godfrey-Smith moves on to address genes. He begins with a brief history of the gene concept in biology, from Mendel to molecular genetics. He covers factors that increasingly pushed against the neoclassical gene concept and briefly mentions work on the multiple gene concepts used in biology. Godfrey-Smith then provides a discussion of causation and of genetic causation of phenotypic traits. In doing so, he advocates for the use of difference-making as a causal notion to help think about what genes cause (in cases where environmental variables influence phenotype). The chapter concludes with a discussion of the use of the gene concept in evolutionary theory. Here Godfrey-Smith argues that evolutionary models that include particle-like genes should be thought of as deliberately and significantly idealized.

Chapter 7 discusses the species concept and the tree of life. Godfrey-Smith begins by introducing some of the most influential species concepts including typological, phenetic, genetic, and phlyogenetic views, as well as the biological species concept. For each of these, he rehearses some of the common complaints, making clear that no particular current concept is without its problem cases. This leads Godfrey-Smith to advocate for a deflationary view of species—that although species concepts can be useful, they should not be taken too literally. He concludes the chapter with a nuanced discussion of the tree of life, which, again, Godfrey-Smith thinks of as a useful epistemic tool rather than a literal representation of the history of life on earth.

In chapter 8, Godfrey-Smith discusses the evolution of social behavior, beginning with a history of modeling work on the evolution of altruism and cooperation. He introduces key explanations for the evolution of these traits, including kin selection, group selection, and direct reciprocity. Godfrey-Smith gives a very clear explanation, including a basic model, of the central results of this work—that correlated interaction of prosocial types can lead to the emergence of cooperation, regardless of what mechanism is used to generate this correlation. The remainder of the chapter turns to prosociality in humans, outlining arguments for the importance of social learning, group selection, and cultural evolution to human cooperation.

The book concludes with a discussion of information in biology. After pointing out that information, in the Shannon sense, exists not just in genes, but in rocks, tree rings, and everything else, Godfrey-Smith turns his focus to communication as modeled by the Lewis signaling game. As he points out, one way that information flow can be shaped is through the evolution of behavior in such games. Godfrey-Smith then makes the case for a partial match between signaling games and real world genetic transmission, showing how the genetic system can, to some degree, be thought of as carrying semantic information.

Philosophy of Biology is clear and well written. Godfrey-Smith provides balanced discussions that help clarify standard positions in the literature, while sometimes gently nudging the reader toward viewpoints he espouses.

The book is accessible to beginners and is a good text for an undergraduate course. It is also sufficiently nuanced to act as a guiding document for an introductory graduate seminar. Although Godfrey-Smith presents standard viewpoints in the discipline, however, he does not always outline the main players in debates in philosophy of biology. This choice keeps the book concise and clear but may not meet the needs of students who aim to enter the debate. Another potential complaint is that the book skims, or barely mentions, a number of important debates in philosophy of biology, including new topics in the field. (For example, the book flies by the levels of selection debate.) This is all to say that undergraduate and graduate courses employing this book will benefit from a clear discussion, but will require supplementation.

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