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Book Review

Experimental Evolution. Concepts, methods, and applications of selection experiments, Theodore Garland, Michael Rose (Eds.), University of California Press, 2009, (752 pp.), ISBN: 9780520261808

Garland and Rose's book is an excellent introduction to experimental evolution written by a distinguished selection of authors. By presenting such a solid review of the field, the book dispels two common misconceptions about evolutionary biology. First, it dismisses the misconception that evolutionary biology is exclusively a historical science, a concept taken for granted by people from other fields. There is also a general perception that historical sciences are inferior when compared with experimental sciences, even though there is no definitive philosophical justification for this judgment. Nevertheless, no scientist would disagree on the power of experiments that allow Popperian falsification of hypotheses, and the strength of replication and controls. The book leaves no doubt about the power of experiments in understanding the mechanisms of evolution. And in so doing, it clearly breaks this misconception.

The second misconception is introduced by Garland and Rose as Darwin's *other* mistake. The *first* Darwin mistake is an obvious one: he got the mechanism of heredity wrong. Darwin believed in blending inheritance, and he was unaware of Mendel's work. Most of the earlier critiques of Darwin's theory of natural selection were based on this mistake. It took a few decades until the modern synthesis reconciled Mendelian genetics with natural selection. Darwin's *other* mistake is the idea that natural selection is an extremely slow process that acts over thousands of generations, and therefore natural selection is not suitable for experimentation. Influenced by the work of the gradualist geologist Charles Lyell, Darwin understood natural selection as a slow process, practically imperceptible at each generation, and just capable of producing large changes over thousands of generations. In this way, Darwin did not attempt to study natural selection, and the closest he got was to use artificial selection information from breeders. Garland and Rose's book clearly proves Darwin wrong in this aspect.

The book summarizes experiments in a diverse group of organisms, but it, unfortunately, excludes studies on plants. The editors present a reasonable excuse for the exclusion; it would make the already 700+ page book even more gigantic. The book includes non-plant organisms from viruses to several insects, as well as bacteria, algae, fungi, copepods and vertebrates. The diversity of topics included is even more remarkable. Chapter topics include the different levels of biological organization, from evolution of biochemical mechanisms to evolution of behavior and altruism, from genome structure to experimental phylogenetics. There are also chapters on speciation, adaptive radiation, evolution of domestication, reverse evolution, population processes, life-history, physiological performance, animal morphology, aging, and adaptation to laboratory conditions. The book also does an excellent job showing the diversity of different methods and the multidisciplinary nature of the field. The authors employ a variety of approaches, including mathematical models, genomic technologies, field experiments, and, inevitably, laboratory experiments. The authors also integrate, for example, biochemistry, physiology, demography, neurobiology, morphology and microbiology.

Several chapters include helpful practical suggestions and guidelines for future research. For example, Roff and Fairbairn describe individual-based models that can be extremely useful for experiment design criteria, such as decisions on sample sizes and experiment duration. Irschick and Reznick provide a practical guide for designing evolutionary experiments in the field. Fry provides detailed suggestions for future experiments in speciation. The book also includes important critiques to some approaches in experimental evolution. For example, Oakley presents an interesting critique to the field of experimental phylogenetics, by comparing it to computer simulations. Finally, the book ends with an honest critique to laboratory natural selection experiments by Huey and Rosenzweig. They describe the usefulness of these experiments in answering many questions in evolutionary biology, but they recognize their limitations and problems. These limitations can be especially problematic when laboratory natural selection experiments are used to simulate natural selection in the wild. Huey and Rosenzweig provide guidelines to overcome some of these limitations. They conclude that researchers should always consider that despite the usefulness of laboratory natural selection experiments in answering evolutionary questions, the limitations of the approach may result in conclusions with uncertain validity.

The editors have chosen a remarkable group of authors that have been building the field of experimental evolution for the last decades. The chapters are stimulating and inspiring, and the book will definitely define the field. The book is suitable for beginners in the field, and would be perfect as a seminar for graduate students. More advanced researchers would also benefit by broadening their perspective in the different approaches and topics covered.

Garland and Rose's book clearly presents the importance of experiments in evolutionary biology, and that evolutionary biology is not exclusively an historical science. The book also shows that natural selection can be much faster than Darwin originally proposed. Additionally, the book shows that current research in experimental evolution continues to use Darwin's approach to science. Darwin's work was characterized by the use of an integrative approach, using evidence from different disciplines, and the use of a huge diversity of organisms to understand the natural world. One hundred and fifty years after the first publication of the Origin of Species, if Darwin was alive to read Garland and Rose's book; he would be amazed by how evolutionary biology has developed. He would likely agree that the mechanism of inheritance and the speed of natural selection are different from what he originally proposed. Nevertheless, I imagine he would be pleased with how his students have assimilated his approach to science, and how experimental evolutionary biology has emerged as an integrative field that combines so many different approaches and disciplines.

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