crementalism works in the history of science, with the introduction of new tools and new insights, and with fusions of fields leading to a greater understanding of how a science evolves?

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ANIMAL, VEGETABLE, MINERAL?: HOW EIGHTEENTH-CENTURY SCIENCE DISRUPTED THE NATURAL ORDER.

By Susannah Gibson. Oxford and New York: Oxford University Press. $34.95. xv + 215 p.; ill.; index. ISBN: 978-0-19-870513-0. 2015.

The author received her doctorate in 2011 at the University of Cambridge in history and philosophy of science studying 18th-century natural history. In this book she looks into the distinction between the then three kingdoms of matter: animal, vegetable, and mineral. Her volume shows how what once seemed obvious as a classification of three distinct kingdoms crumbled from both philosophic and scientific outlooks. This is a short book intended as a popular work but with a scholar's analysis and insights in the tradition of Schrödinger's *What is Life?: The Physical Aspect of the Living Cell* (1944. Cambridge (U.K.): Cambridge University Press). For those with a vague sense of the history of science, it is filled with surprises as Gibson portrays the participants in the debates and their philosophic approaches. At issue, from the scientific concerns of the times were the troubling instances of minerals that appeared to be alive (corals), animals that appeared to be like plants (sponges, anemones, and polyps), and plants that acted like animals (Venus flytraps).

Gibson begins with Aristotle. He believed all living things had a soul. A dead dog or cat, like a human, is breathing one moment and then dies. The suddenness and stillness of dead animals suggested to him that an animating agent or soul had to be present even in insects and worms. It was Descartes who challenged that view by limiting the soul to humans and arguing that animals and plants were automatons lacking consciousness and all of their behavior could be explained as instincts or mechanical responses to external stimuli. What shattered this dualism were the experiments of Abraham Trembley on hydras. He cut them into pieces and each piece regenerated. This was profound because it implied that souls could be twinned or that the idea of a soul was different from the animating agent or process in living things. Gibson shows the surprise as corals (collected as dried minerals) turned out to have minute flower-like objects poking out of pores. The same was true for sponges. It took another century before the debates on preformation and epigenesis, or of vitalism and mechanism, were resolved. The author points out the roles of experimentation, new tools (microscopes), and new fields of science (cell biology, organic chemistry, evolutionary biology, and genetics) in shifting the debates over the connections between plants and animals or of the living cellular and noncellular (viral) worlds.

Gibson reminds us that scientists differ in cultural experience, religious (or nonreligious) outlooks, social class, and from their past and future generations. Although vitalism or holism might retreat from the organism to the cell or from the cell to some vague protoplasmic dynamism, we have to remind ourselves that life is more complex than our present knowledge of how to interpret it at its most basic level and that we tend to believe we have a more complete picture of life than we actually have. This is a book well worth reading and it will enliven many a classroom lecture.

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GENERAL BIOLOGY

BAYESIAN MODELS: A STATISTICAL PRIMER FOR ECOLOGISTS.

By N. Thompson Hobbs and Mevin B. Hooten. Princeton (New Jersey): Princeton University Press. $49.50. xiv + 299 p.; ill.; index. ISBN: 978-0-691-15928-7. 2015.

This book goes against the current fashion in ecological statistics volumes in at least two ways. For one, the authors refrained from writing a recipe book littered with helpful but necessarily specific code. Second, the scientific method, and along with it, theory, are put into the center of statistical endeavor. After a decade of wading through hugely helpful R code-dominated, how-to volumes, reading *Bayesian Methods* refocuses readers on the "why," rather than the "how." In an old-fashioned and authoritative style, the book aims to make readers understand how to embed ecological theory in a formal mathematical Bayesian framework. It contains few examples, quite a few equations, and no modicum of abstract statistical reasoning—all to the service of comprehension, rather than application, of the Bayesian toolkit in ecology.

This is an addition to a well-stocked, shelfload of Bayesian-statistics-meets-ecological-theory books—Mangel's *The Theoretical Biologist's Toolbox: Quantitative Methods for Ecology and Evolutionary Biology* (2006.

Cambridge (U.K.): Cambridge University Press), Clark's *Models for Ecological Data: An Introduction* (2007. Princeton (NJ): Princeton University Press), Bolker's *Ecological Models and Data in R* (2008. Princeton (NJ): Princeton University Press), Link and Barker's *Bayesian Inference with Ecological Applications* (2010. London (U.K.): Academic Press), and Kéry and Royle's *Applied Hierarchical Modeling in Ecology: Analysis of Distribution, Abundance and Species Richness in R and BUGS* (2016. London (U.K.): Academic Press). Still, its stance is different. The authors' mantra is that Bayesian analysis has to be understood before it is to be applied: no shortcut, no delegation to software packages, no backdoor. Using examples to illustrate their points is, in principle, great, but Hobbs and Hooten exemplify only the model-construction step, and do not give a single numerical example or result.

Although I sympathize with the authors' intentions, this approach also has its downsides. In real life, there is an implementation gap between a mathematically formulated model and a fitted Bayesian model, and learning *how* reinforces the *why*. When learning Bayes, some problems and details remain obscure until one "does it," goes back, rereads, and thereby iteratively grasps both theory and computation. And it is, in my experience, implementation ambiguity that leads to suboptimal Bayesian analyses: simulation from the model and Bayesian p-values; nonlinear correlation between parameters that make marginal distributions suggest suboptimal estimates; convergence statistics that are dependent on initialization; computation of Bayes factors; dominance of the observation model for small data sets; and improper Jeffreys prior for hyperparameters; all of them being dealt with at best cursorily here.

The volume is a refreshing and solid read for anyone confused or distracted by Bayesian recipe books. Ideally, ecologists should have substantial experience with probability theory *or* have some experience with doing Bayesian analysis. Following the maths *before* knowing what you will do with it is very abstract; finally understanding *why* all the how-to guides suggest one approach or another is more rewarding. The Fundamentals section of the book takes up over half of the pages, while Implementation receives less coverage with around one-third. The final part of the volume, Practice in Model Building, eventually also offers an abstract recipe, which is then detailed in five "problems." The authors' fluent and clear writing style make the book substantially more coherent and balanced than the recently published journal paper "abstract" of this volume (with accompanying R code). Theoretical ecologists will find the statistical background to match models and data in a Bayesian framework.

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PALEONTOLOGY

EXPERIMENTAL APPROACHES TO UNDERSTANDING FOSSIL ORGANISMS: LESSONS FROM THE LIVING. *Based on a topical session held at the Geological Society of America's Annual Meeting, Minneapolis, Minnesota, 11 October 2011. Topics in Geobiology, Volume 41.*

Edited by Daniel I. Hembree, Brian F. Platt, and Jon J. Smith. New York: Springer. $229.00. xvii + 420 p.; ill.; index. ISBN: 978-94-017-8720-8 (hc); 978-94-017-8721-5 (eb). 2014.

It is refreshing when a dedicated volume such as this comes along that so wonderfully illustrates the proliferation of data-driven comparative methods over a previous reliance on qualitative analogs. The development of new methods as well as the application of carefully designed comparative approaches are satisfying to behold here and marks this as an important contribution in paleobiological research. This edited volume consists of 17 chapters organized into three parts: functional morphology, taphonomy and environment, and organism-substrate interaction. A substantial breadth of research covering disparate taxonomic groups, study environments, and novel methodologies is captured, including vertebrate and invertebrate biomechanics, comparative taphonomy of marine near-shore environments, and descriptive neoichnology of vertebrate and invertebrate burrows. Taxa covered include crinoids, bivalves, eurypterids, whales, microbialites, mollusks, worms, urchins, plants, scorpions, fish, salamanders, lizards, elephants, and lemmings. Many chapters are wonderfully illustrated with full color, high-resolution images, figures, and tables. As with many edited volumes, this one occasionally suffers from consistency issues. Some chapters seem like a rehashing of an author's previous work with little by way of new results. Many chapters do contain innovative methods and analytical techniques sure to capture attention and perhaps even inspire further work. Excellent examples include those chapters on fossil cetacean feeding ecology by Cooper et al. (Chapter 5) and multiple neoichnology studies coming from the Hembree laboratory.

Many paleobiologists (and neontologists for that matter) are likely to find something of immediate interest or use in these pages, although certain contributions may be too specific to be directly applicable to their own research. This volume will be of particular use for graduate students and those teaching graduate-level methods courses, where one can examine and compare numerous experimental designs and analytical techniques. Although a few chapters include an appendix of data tables,