The Tangled Bank: An Introduction to Evolution

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Source: BioScience, 60(3) : 239-241
Published By: American Institute of Biological Sciences
URL: https://doi.org/10.1525/bio.2010.60.3

Dodds appears unfamiliar with landscape ecology, as Bruce Milne and Monica Turner are absent even in the fractal section. If anyone has ecological laws, they do. Diversity, with its "laws," causes the usual problems: It is a measurement still waiting for an idea; it remains a granfalloon (Vonnegut 1963), a group of issues capriciously related, like the chemistry of red things. Dodds's diversity laws (for example, diversity increases with area) often appear trivial: How could diversity go down in a larger area, since a species, once counted, cannot be uncounted in that place? Larger areas are often not more diverse than smaller ones when the comparisons are made in different places, so Dodds's law is either insignificant or full of holes—take your pick.

The book mistakes scale for type throughout. Dodds indicates that his laws apply to the organism, population, community, or ecosystem *scale* when he really means the *type* of entity in the foreground. This issue gets away from the author. The level of analysis, particularly in ecology, includes not just a ranking on scale (as will commonly suffice in physics) but also a ranking on the type of thing at given levels that are ranked by definition not size. The equivalence of organisms required in the definition of "population" is not a statement of size or scale (you are not equivalent to the mites on your body and so do not belong to their population, although you are an organism as are they, and you occupy the same space). Of necessity there are levels of analysis in science in general, but critically, in ecology, the pertinent levels will be different for each new time and place—any law will have lots of exceptions. The organisms that we model often have models of their own for themselves and the other organisms around them. Polanyi (1968) succinctly captured this notion in his classic article "Life's Irreducible Structure." It is the meaning in the models of the subjects and the observers that is irreducible. That "structure" requires recognition by a person observing at one level, and that makes the notion of law quite difficult.

Laws, Theories, and Patterns in Ecology has lots of citations to David Tilman but none to the superior work, with strong empirical backing, by Phil Grime. The omission of Grime is symptomatic, since Grime addresses diversity through strategies that are identified by an experienced observer with a clear level of analysis. Dodds also makes no acknowledgment of Rosen's (1991) modeling relation, which limits the book's sophistication. There is no distinction between formal coded models, such as allometric equations, and analog models, where experimental schemes rescale the phenomenon. Howard Pattee (1978) made some very helpful distinctions between laws and rules. Being a card-carrying physicist, Pattee is far more qualified to sort out the deeper meaning of the concept of law than are ecologists, who often just get befuddled, and will likely remain so, this book notwithstanding.

Most ecologists still defending a modernist view will not share my objections. Many reading this review will say, "What else but discovering reality is the proper reference for science?" My reply is that we have been to Oz and have discovered that the Wizard is in some sense only manipulating perception. In a postmodern world (Allen et al. 2001) it matters that we have data interpreted only through a level of analysis, not access to an essential external reality. Some may feel that all is lost without an approach to reality. Even so, the Lion gets his courage, the Scarecrow gets his brain, and the Tin Man gets his heart anyway. And Dorothy gets to go home, if not to Kansas, to Uncle Fred Clements in Nebraska. So all is not hopeless even if science provides only narratives and simply states powerful points of view. But it is better to face with a robust epistemology the necessity of having a point of view than to deny it. So read Dodds's book with a critical eye; while appreciating in positive terms what it attempts, understand where it fails.

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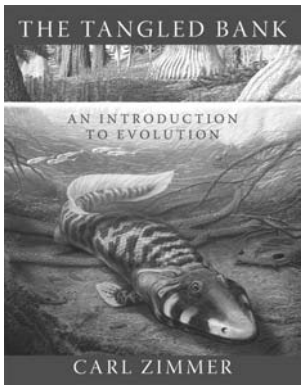
TO SEE THE FOREST THROUGH THE TREES

The Tangled Bank: An Introduction to Evolution. Carl Zimmer. Roberts and Company, 2010. 385pp., $59.95 (ISBN 978-0981519470 cloth).

Carl Zimmer takes the title of his book, *The Tangled Bank: An Introduction to Evolution*, from the last paragraph of Darwin's *Origin*: "It is interesting to contemplate a tangled bank…and to reflect that these elaborately constructed forms…have all been produced by laws acting around us." Like Darwin, Zimmer chooses to write in a style that is understandable for any educated reader. What better way is there to inform the general reader of Darwin's theory than to provide a lucid

explanation supported by compelling current evidence?

Zimmer is a popular science writer with a special interest in evolution. Among his previous books are *Evolution, the Triumph of an Idea* and *At the Water's Edge*. He is a frequent contributor to the *New York Times*, *Discover*, *Popular Science*, and *Scientific American*. One expects that his writing will be clear, concise, and engaging and that the science will be correct. Zimmer does not disappoint.



In the introduction, Zimmer writes, "the book is intended for those who are not planning to be biologists—in other words, most people." That is a big target, but can it be hit? The first four chapters suggest his aim is right on. Zimmer chooses whales—the Jonah fish—as the hook for introducing evolution in the first chapter. In the very first paragraph we meet a contemporary scientist on the cutting edge of research on whale evolution. Zimmer uses this technique throughout the book, and is effective at putting real faces on scientists employing all the tools of modern science to test evolutionary hypotheses.

Zimmer then steps back to make some basic points about "descent with modification." Traits are inherited through DNA, mutations change DNA, and evolution results from mutations becoming more or less common in the population. Furthermore, these changes can be used to construct a tree illustrating genetic relationships among organisms. Zimmer also makes some key points up front: Evolution is not directed; adaptations do not result in perfection; evolution builds by modifying existing traits; and there are always trade-offs, because every mutation can have multiple effects. Then, after discussing evidence and illustrating that evolution, like many "hard" sciences, can use both experimental and inferential evidence to test hypotheses, Zimmer brings us back to the whales and the multiple lines of evidence used to document their evolution from an ancestor shared with hippos. Zimmer's engaging style and prose are the two greatest strengths of the book.

This chapter also provides a clue to two more of the book's strengths, the illustration program and references. The extensively illustrated book makes use of well-designed graphics and images, both original and reproduced. Reproduced illustrations are documented in a thorough, chapter-by-chapter credits section at the end of the book. Also arranged by chapter is a salient references section at the end that gives pertinent general references to appropriate books as well as specific references to cited articles, frequently from *Science*, *Nature,* or the *Proceedings of the National Academy of Sciences*. The majority of the references are from the past decade, including into 2009. The references and credits alone are invaluable resources for anyone teaching a course in evolution.

The second chapter is a good story, and is one to be expected at the beginning of a book on evolution—Darwin and the status of natural history in his day. In keeping with a marine theme, Zimmer begins with Nicholas Steno and the discovery of fossilized sharks' teeth. Readers are introduced not only to the usual cast of characters, Linnaeus and Lamarck, but also to Buffon and Cuvier, William Smith, and James Hutton. Smith's work, resulting in the geological map of England, Scotland, and Wales, was the first to recognize the extent of fossil-bearing strata and is beautifully illustrated in the text. *The Voyage of the Beagle* and evidence supporting the theory of natural selection are summarized in the second half of the chapter. It is an engaging overview, but there are a few minor errors that in sum are disconcerting. For instance, Zimmer notes that the HMS *Beagle* experienced an earthquake while surveying the coast of Chile, but the "centimeters" of shoreline lift were actually meters (Darwin 1860). Similarly, Zimmer attributes Darwin's observations of the Galápagos finches as being pivotal to his thinking—but the mockingbirds, not finches, get later mention in *On the Origin of Species* (Sulloway 1982).

This chapter also provides the first example of Zimmer's use of text boxes to address some of the major misconceptions about science. For instance, the first box elaborates on the 2008 National Academy definition of science (NAS 2008). Zimmer focuses on the use of multiple lines of indirect evidence to support explanations and predictions. He draws on familiar examples from physics and geology before mentioning how epidemiologists track the evolution of viruses using these same techniques. Other boxes in the text address radioactive clocks, how evolution makes testable predictions, facts and theories in science, how scientists study evolution, and how not to study evolution.

Molecular biology, formally introduced in chapter 5, is the foundation for understanding the next five chapters. This is when most undergraduates' eyes will begin to glaze over, and where even the scientifically literate lay person will have to read more carefully, but Zimmer does a remarkable job of providing just enough depth to explain key concepts without bogging down in details. A few terms slip in without definition, for example, "codon" (p. 106), "fixed" (p. 113), "*Hox* genes" (p. 165), and "genetic distance" (p. 197), but overall, this is the level and approach I'd like to see in all nonmajors' textbooks. Given

doi:10.1525/bio.2010.60.3.11

the prevalence of "intelligent design," I particularly appreciated the pages spent explaining the evo-devo basis of our understanding of the molecular evolution of physiology and the structure of light-sensitive organs in animals. My only serious complaint is an incorrect diagram of sexual reproduction in figure 5.5. Meiosis is correctly illustrated but the chromosomes of the sperm and egg do not fuse as a result of fertilization.

The last five chapters are back to easier reading, especially given Zimmer's flowing style. Extinctions and radiations, symbiotic associations, and sexual selection are topics found in every evolution text and are particularly interesting to scientists. Most readers, however, will engage with the final two chapters, "Evolutionary Medicine" and "Minds and Microbes: The Evolution of Behavior." Readers will recognize the medical examples from recent news media, but Zimmer goes far beyond typical media coverage in providing the necessary background to understanding the often-predictable evolutionary basis of these diseases. And unlike the news media, he asks the reader to think of him or herself as a human Petri dish in which these evolutionary battles between microbes and human cells are played out.

Perhaps not surprisingly, the last chapter is the longest in the book. Behavior, particularly human behavior, is a biological topic of widespread interest to everyone—the author's target audience. As Zimmer notes at the end of the chapter: "We are only at the beginning of this particular chapter in the history of science…. But we can be excused for being especially interested in it. Evolution helps show us who we are, and how we got this way."

After turning the last page I had to stop and reconsider, who really should read this book? I teach a graduate/upper-level undergraduate course in evolution, and this is not the book I would use as a text. However, reading it for this review was a quick refresher outline of the major concepts I will be teaching next semester, and I made notes of examples and applications I will want to use. Those of you specializing in other areas of biology will find this to be a satisfying introduction to current evolutionary thought. But Zimmer specifically targets those *not* going on in biology. How does it fit that audience? In the best of all worlds, every educated American could and should read this book, and as a result, would have a much richer understanding of evolution as a force directly affecting our lives. My hope is that a great number of us who teach in colleges and universities will focus our introductory-level biology course for preservice teachers on evolution. After all, "Nothing in biology makes sense except in the light of evolution" (Dobzhansky 1973). *The Tangled Bank* would be an excellent textbook for such a course.

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A LEVEL-HEADED DAMAGE ASSESSMENT

Extinction in Our Times: Global Amphibian Decline. James P. Collins and Martha. L. Crump. Oxford University Press, 2009. 273 pp., illus. $29.95 (ISBN 9780195316940 cloth).

This book, intended for both a scientific and informed lay audience, summarizes the big picture of scientific understanding of amphibian population decline and its probable causes. Both Collins, a professor at Arizona State University, and Crump, an adjunct professor at Northern Arizona University, have published extensively on amphibian biology and the enormous challenge posed by the decline of so many amphibian species.

Because I know the passion that the authors have for the subject, I was impressed first with the organization of the book, and then with the level line of logic that they followed. Facts and data, supported with citations (even though in a rather obtuse format) and emphasized with bulleted lists, current scientific opinion, and cogent syntheses, were standard. The many kinds of hyperbole that could have crept into such a discourse found no place in this book, and the authors analyzed information without lapsing into undue scientific terminology. Their style was surely intentional, and it certainly was the only one that would allow a variety of readers with inherent biases to read the book productively.

The font style and size of this sturdy book worked well with my old eyes, and the organization served to introduce, present, and summarize the complicated problem at hand. Some of the punctuation seemed odd, and I smiled when I noticed that one of the authors had pointed out a verb-subject disagreement in a

doi:10.1525/bio.2010.60.3.12