model of the solar system. Add to that the cryptic titles of the tales and one becomes downright dizzy. Dawkins has written another wonderful book, but the manuscript would have benefited from a good, firm edit. Had the text been reduced by a third and the marginal notes either incorporated in the main text or eliminated, *The Ancestor's Tale* could have become a true classic. It should also be noted that Dawkins is an entertaining author precisely because he is not afraid to express opinions. However one might feel about the particulars, at times these opinions become downright caustic, and they trivialize the tales in which they appear. Conservative readers might risk an aneurysm.

The taxonomic scope of *The Ancestor's Tale* is strongly affected by the author's understandable decision to follow human ancestry. We are animals, so this is fundamentally a book about animals (i.e., metazoans). In the one chapter on plants, Dawkins comments, "I ended a previous tale by remarking what delight it is to be a zoologist at such a time. I could have said the same about being a botanist. What a pleasure it would be to demonstrate Deep Green [(*2*)] to Joseph Hooker—in the company of his close friend Charles Darwin. I almost weep to think about it." Nonetheless, in practice Dawkins seems to follow another great philosopher of science, Tom Weller, who said, "The evolution of plants is an important chapter in the history of life. However, it's a pretty dull chapter, so we'll skip it." (*3*) Furthermore, to my astonishment, the Archaea—a third of all life—are not allotted a single tale.

But so be it. Dawkins is an enormously talented author, and *The Ancestor's Tale* is expansive, current, and authoritative. There are, of course, technical errors and dubious assertions to be found. Few texts of such scope are without them. These flaws, however, are mostly minor, and the book avoids many pitfalls that have trapped other authors. It would be an excellent choice for an undergraduate honors seminar in zoology and could serve a graduate student well in preparation for oral exams. It is also entertaining, witty, and—at least in the "Pilgrimage to the Dawn of Life" version—beautifully illustrated. If it still leaves room for the botanists and microbiologists of the world to present their perspective on the tree of life, who am I to complain?

References and Notes

1. R. Dawkins, *The Selfish Gene* (Oxford Univ. Press, Oxford, 1976).
2. "Deep Green" refers to a project to reconstruct the phylogeny of green plants and to a hyperbolic visualization of that phylogenetic tree, available at http://ucjeps.berkeley.edu/map2.html.
3. T. Weller, *Science Made Stupid* (Houghton Mifflin, Boston, 1985).

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EVOLUTION

Seeing the Forest for the Trees

Scott J. Steppan

Assembling the Tree of Life presents a preliminary view of one of the grand enterprises of modern science, resolving the phylogeny of all life. Imagine a vast tree whose myriad branches lead to millions of leaves. Each leaf, itself composed of innumerable parts, represents an individual species in the history of life, and the tree stands billions of years tall. Revealing that tree is the shared vision of the world's systematists, but for now it remains a dream. We do not know what the whole "Tree of Life" looks like. We can only see parts of it, and our situation is worse than that of the proverbial three blind men trying to describe an elephant. Thousands of us work on particular branches, which are hidden from one another in a mist. This volume, the product of a 2002 symposium by the same name held at the American Museum of Natural History (AMNH) in New York, seeks to blow away the mist and reveal the structure of the whole Tree and, in doing so, galvanize the systematics community toward unifying its goals.

Assembling the Tree of Life
Joel Cracraft and Michael J. Donoghue, Eds.
Oxford University Press, New York, 2004. 592 pp. $59.95, £36.50. ISBN 0-19-517234-5.

A complete Tree of Life (hereafter "Tree") holds enormous promise for many fields of science, but the task of revealing it is an enormous undertaking—one that requires more data than the Human Genome Project (just one leaf on the Tree) and orders of magnitude more computation. Even small parts are difficult; as Michael Whiting notes, "A child can tell a beetle from a wasp from a butterfly, but even the entomologically erudite is left pondering which two insects are most closely related." The volume, edited by leading systematists Joel Cracraft (AMNH) and Michael Donoghue (Yale University), begins with three chapters that explain why assembling the Tree is important to science and society. Most of the reasons offered will be familiar to biologists, as the revolution in systematics has penetrated many different fields. Unfortunately, nearly all refer to the benefits of knowing the phylogeny for a particular group and say little about those benefits that can only come from assembling the entire Tree. In addition to revealing common patterns or coordinated evolution among clades, having the whole Tree should lead to more important but as yet unanticipated insights. For example, would Wegener have imagined continental drift if he had only a collection of road maps and no global map to work with? We biologists need our own globe.

Following the introductory section, 26 chapters by authorities on major branches (clades) summarize the state of our phylogenetic knowledge. These begin at the base of the Tree, where contributors highlight, for example, the recent recognition that the earliest branchings split life into three domains: the bacteria, archaea, and eukaryotes. The chapters then proceed up the Tree through smaller branches and less inclusive groups (e.g., green plants, animals, and arthropods) to consider such "crown" groups as flowering plants, annelid worms, and birds. In each chapter, the authors summarize the constituent subgroups and typically describe supporting evidence, regions of uncertain relationship, and definitive morphological features. Afterward, Donoghue and three other leading evolutionary biologists (Edward Wilson, David Wake, and David Hillis) offer short summary perspectives. In the final chapter, the editors tie everything together by assembling a 138-taxon synoptic tree.

Taken individually, the chapters are useful summaries of our current understanding, but they seem like disconnected limbs. Nonetheless, the Tree will start to assemble itself—an emergent property of the disconnected parts—in the minds of those readers who take the time to read far enough. In that indirect way, the editors have met their goal. In addition, even the most broadly trained comparative biologists will discover unap-

Iconic metaphor.

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BROWSINGS

The Elements. Earth, Air, Fire, and Water. *Art Wolfe, text by Craig Childs.* Sasquatch, Seattle, WA, 2004. 176 pp. $45. ISBN 1-57061-405-9.

In ancient Greece, philosophers held that the physical world around them was derived from four elements: earth, air, fire, and water. Wolfe presents a collection of his color landscape and nature photographs that explores the diversity of forms these substances take. There are sheer rock walls of the Karakoram Range, Pakistan, and loose sediments of the Colorado River's subaerial delta plain, Baja California (left); morning mists and midday clouds; volcanic eruptions and flaming forests; Hawaiian breakers and Antarctic ice. The four elements are also used as background for portraits of wildlife, flowers, and trees. Many of the images are carefully composed to capture patterns of light and contrast. In four short essays, Childs offers his impressions of the effects the elements have on humans and the natural world.

preciated diversity in less familiar groups and the kind of fascinating organisms that inspired many of us to become biologists. These benefits would have been even easier to appreciate if the material was presented in the more dynamic and immersive experience of the volume's Web analog, the Tree of Life project (http://tolweb.org/tree/). (It is a shame that updatable, peer-reviewed Web pages still lack the professional status of static book chapters.)

Most authors have taken their charge very seriously and have written unbiased, synthetic, and useful accounts. Particularly readable chapters include those on Holometabola (insects characterized by complete metamorphosis), land plants, and chordates (vertebrates, hagfish, lancelets, and tunicates). A minority of the contributors have yielded to provincialism, focusing on their own work or dismissing information (e.g., molecular) that they distrust. The most extreme position appears in the mammal chapter, whose authors eschew the summary format in favor of lecturing on their preferred systematic procedures. Only a handful of conflicting conclusions appear; one is the description of the Holometabola as a group whose monophyly is either routinely supported by both morphology and molecules (Whiting) or never supported in any molecular data (Rainer Willmann).

The volume's principal utility stems from its revelation of the patterns among diverse clades. Many authors cite the explosion of molecular data as the reason for the revolution in phylogenetics, especially for the field's transformation since the previous symposium that attempted to view phylogenetics across all of life (*1*), held in 1988. The most publicized cases of conflict between molecules and morphology are not representative of that revolution: The tidal surge of molecular data seems to have confirmed numerous old hypotheses while rejecting a few but, most importantly, resolving many branches that morphological evidence did not. One is struck by the great reliance on a single gene—the small subunit (SSU) of the ribosomal DNA, also known as 18S—for most resolution deep in the Tree, even within phyla. Elsewhere, despite frequent accolades to molecular data, the recognition of many clades (especially among chordates) continues to rely on morphology.

The other broad impression the volume leaves is that of an imbalance toward authors who favor parsimony for phylogenetic analysis over model-based or statistical methods such as likelihood. Individually, this imbalance is not very important because all chapters include authoritative authors. The reviews of findings by other researchers are generally fair, although occasionally conflicting model-based results are brushed aside—as in the treatment of the debate over the effects of long-branch attraction on analyses of the relationship between the fly orders Strepsiptera and Diptera (*2*). A more pervasive and subtle, yet profound, consequence of this methodological bias is omission from most chapters of fundamental aspects of evolutionary history, like timing of events and rates of diversification. The emphasis in the volume is entirely on the sequence of branching. (Branch lengths are not important in parsimony analysis, and their estimates are generally unreliable. In contrast, they are integral to model-based methods.) As a result, the tempo and mode of evolution (*3*) are lost, and we cannot see whether the Tree looks like a spreading oak, a willow, or a bamboo grove—we have little sense of its gestalt. The lack of resolution in some parts of the Tree is therefore attributed to a lack of data rather than to the much more interesting possibility of rapid diversification. Branch lengths—as indicators of time or amount of evolution—are important to almost every aspect of comparative biology, and the volume would have benefited from the more nuanced vision their consideration would have offered.

The summary chapters praise the progress and promise more to come. I would have preferred a more critical analysis of the overall state of this resource-limited field. Where are the biggest holes? Should we focus on broad taxonomic coverage of a few universal genes, overlapping sets of many genes, or perhaps new initiatives to train morphologists? But in the end, the big picture emerges from the details, and we gain a better appreciation of how the branches fit together and where some of the bigger questions remain. The vision Cracraft and Donoghue articulate in their introduction does emerge from the mist, incomplete though it may appear. *Assembling the Tree of Life* should also meet the editors' larger goal. It will help the systematic community aspire toward a common goal, identify priorities for future coordinated work, and mobilize our resources.

References and Notes

1. B. Fernholm, K. Bremer, H. Jörnvall, Eds., *The Hierarchy of Life: Molecules and Morphology in Phylogenetic Analysis (Nobel Symposium 70,* Elsevier, Amsterdam, 1989).
2. J. P. Huelsenbeck, *Syst. Biol.* **46**, 69 (1997).
3. G. G. Simpson, *Tempo and Mode in Evolution* (Columbia Univ. Press, New York, 1944).

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CREDIT: ART WOLFE FROM *THE ELEMENTS*