

each synaesthetic's list of associations is idiosyncratic, with no discernible commonalities even among identical twins. But any one person's associations remain very stable over time. This is the basis of the now-standard 'test for genuineness', which checks the constancy of a subject's associations for a given list of words — non-synaesthetics tend to match fewer than 40% of their previous associations, whereas synaesthetics average more than 90%.

The organization of the book is somewhat frustrating. At times it's structured like an autobiographical narrative, at others it's more like a standard scientific monograph, while in many places it becomes an introductory text in scientific methods. Harrison's pedagogical digressions are sometimes important, but more often baffling. For example, the very brief discussion of neuroimaging data is preceded by more than 20 pages on the general history of neuroimaging. Ultimately, though, he doles out enough fascinating tidbits to keep the reader's interest, and the unanswered questions are tantalizing. I found the book especially good 'afternoon coffee-break' reading — although doubtless some synaesthetics would find that an unconscionable clash of tastes. ■

Ilya Farber is at the Philosophy-Neuroscience-Psychology Program, Washington University of St Louis, One Brookings Drive, St Louis, Missouri 63130, USA.

Creationism by stealth

Icons of Evolution: Science or Myth? Why Much of What We Teach About Evolution is Wrong

by Jonathan Wells

Regnery: 2000. 362 pp. \$27.95

Jerry A. Coyne

Opposition to evolution is found in many corners of the American religious landscape, including the Unification Church. Church founder Sun Myung Moon has frequently condemned darwinism for giving God no role in the history of life. In 1976, Jonathan Wells, a student in Moon's seminary, answered his leader's call. He writes, "Father's [Moon's] words, my studies, and my prayers convinced me that I should devote my life to destroying Darwinism, just as many of my fellow Unificationists had already devoted their lives to destroying Marxism. When Father chose me (along with about a dozen other seminary graduates) to enter a PhD program in 1978, I welcomed the opportunity to prepare myself for battle." The University of California supplied Wells with his weapon, a PhD in biology and, with *Icons of Evolution*, Wells has fired the

latest salvo in the eternal religious assault on Charles Darwin.

This personal history, taken from the Unification Church website (<http://www.tparents.org/Library/Unification/Talks/Wells/0-Toc.htm>), is conspicuously missing from the author's biography in *Icons*. The book, aimed at the non-specialist, masquerades as a scientific critique of classic examples of evolution, but is actually a polemic intelligently designed to please Father Moon. *Icons* is a work of stealth creationism, and strives to debunk darwinism using the familiar rhetoric of biblical creationists, including scientific quotations out of context, incomplete summaries of research, and muddled arguments. But because Wells has scientific credentials, studiously avoids mentioning religion or God (who appears only under the alias "intelligent design"), and presents his book as an objective critique (complete with 70 pages of references and research notes), it is easy for the non-scientist to be taken in. *Icons* has been embraced with glee by anti-evolutionists, who want it included in the American school science curriculum.

Wells's book rests entirely on a flawed syllogism: hence, textbooks illustrate evolution with examples; these examples are sometimes presented in incorrect or misleading ways; therefore evolution is a fiction. The second premise is not generally true, and even if it were, the conclusion would not follow. To compound the absurdity, Wells concludes that a cabal of evil scientists, "the Darwinian establishment", uses fraud and distortion to buttress the crumbling edifice of evolution. Wells's final chapter urges his readers to lobby the US government to eliminate research funding for evolutionary biology.

To see his argument at work, let's look at development, which Wells has referred to elsewhere as "the Achilles' heel of Darwinism". As Darwin first realized, some aspects of vertebrate development — especially transitory features — provide strong evidence for common ancestry and evolution. Embryos of different vertebrates tend to resemble one another in early stages, but diverge as development proceeds, with more closely related species diverging less widely. This conclusion has been supported by 150 years of research.

Wells tries to refute this mountain of work by noting that, in 1891, the German biologist Ernst Haeckel published illustrations of vertebrate embryos that exaggerated their similarity, and that some biology textbooks still display these doctored drawings. This embroidery, however, was first reported by the British zoologist Adam Sedgwick in 1894, and has repeatedly been used to show the failings not of darwinism, but of Haeckel (see, for example, *Nature* **410**, 144; 2001).

Despite Wells's arguments, one does not need Haeckel's wishful pencil to draw copious evidence for evolution from develop-

mental biology. Human embryos, for example, have pharyngeal pouches, a tail and six aortic arches — all features found in embryonic fish. But our pouches become glands and ducts instead of gill slits, our tail disappears, and our aortic arches (which remain six in some fish) either disappear or are transformed into carotid, systemic and pulmonary arteries. In our first trimester we develop the lanugo, a coat of hair that is shed before birth.

Are these patterns mere whims of the Intelligent Designer, or evidence of our common ancestry with fish and furry primates? Embryos of whales and some snakes develop hindlimb buds that regress before birth; embryos of baleen whales possess teeth that later disappear; and horse embryos have three well-developed toes, with the outer two shrinking to leave the single-digit hoof. Such examples abound, but you won't find them in *Icons*.

Wells also notes that the earliest vertebrate embryos (mere balls of cells) are often less similar to one another than they are at subsequent stages when they possess more complex features. According to Wells, this counts as evidence against biological evolution, which supposedly predicts that the similarities among groups will be strongest at the very first stages of development. But darwinism makes no such prediction. Darwin himself noted that embryos must adapt to the conditions of their existence, and the earliest stages of vertebrate embryos show adaptation to widely varying amounts of yolk in their eggs. Wells repeatedly fails to grasp the evidential value of phenomena that can be understood only as the result of a historical process, even if the results were not predictable. Perhaps an observer in the early Cenozoic could not have predicted that a lineage of ungulates would lose their hindlimbs as they became aquatic, but the development of the hindlimb in embryonic whales can be understood only as a result of descent with modification from a four-legged ancestor.

When discussing other 'icons', Wells uses the same tactic of selective omission to distort a body of literature he pretends to review. Nowhere is this more visible than in his chapter on human evolution. Faced with a series of hominid fossils showing transitions from ape-like to modern human traits over 4 million years, Wells can only mumble about the Piltdown Man hoax, and imply that the vigorous scientific debate about the course of human evolution proves that humans did not evolve.

It is telling that, although Wells repeatedly attacks evolution, he gives no hint of his own ideas about the origin and development of life. There is good reason for this. As one learns from his website sermon, *Evolution by Design*, Wells believes that "the human species was planned before life began, and that the history of life is the record of how this

plan was implemented". To Wells, the fossil record does not represent a continuum of ancestry, but a succession of creations by the Intelligent Designer, with each species carefully devised to nurture the next product of creation up to the final goal, humans.

But this argument is blasphemous, for its logical consequence is that the pinnacle of evolution is not *Homo sapiens* but our ectoparasite *Pediculus humanus*, the body louse. It also turns the Great Designer into a Great Deceiver, who, in the manner of Satan, put fossils in the rocks — and tails on embryos — to mislead biologists of the future.

Finally, Wells's main theme about the collusion of evolutionary biologists is simply wrong. Authors of some biology texts may occasionally be sloppy, or slow to incorporate new research, but they are not duplicitous. And, far from representing a conspiracy, it is invariably evolutionists (including myself) who have noted problems with some classic icons of evolution. Wells has it backwards. It is creationists like him who are conspiring to purge evolution from American education. They hide their own differences about issues such as the fossil record and the age of the Earth, they pretend to be disinterested seekers after truth, they fail to do their own scientific research, and, like Wells, they avoid at all costs revealing their own theories about the history of life. *Icons* is exactly as even-handed and intellectually honest as one would expect from someone whose "prayers convinced me that I should devote my life to destroying Darwinism". ■

Jerry A. Coyne is in the Department of Ecology and Evolution, University of Chicago, Chicago, Illinois 60637, USA.

A pillar of molecular biology

Ahead of the Curve: David Baltimore's Life in Science

by Shane Crotty

University of California Press: 2001. 372 pp. \$29.95, £19.95

Robert Bazell

Many of his peers regard David Baltimore as the most important living figure in biology. His co-discovery in 1970 of the enzyme reverse transcriptase, which makes DNA from an RNA template, opened the way for, among other things, recombinant DNA, the modern understanding of cancer and most of what is known about HIV. All too often, a scientist's significant research ends with such a seminal Nobel prizewinning discovery. But not only has Baltimore's productivity continued unabated, his work has left "a lasting impact on virtually every realm of modern biology", according to one colleague. His dis-

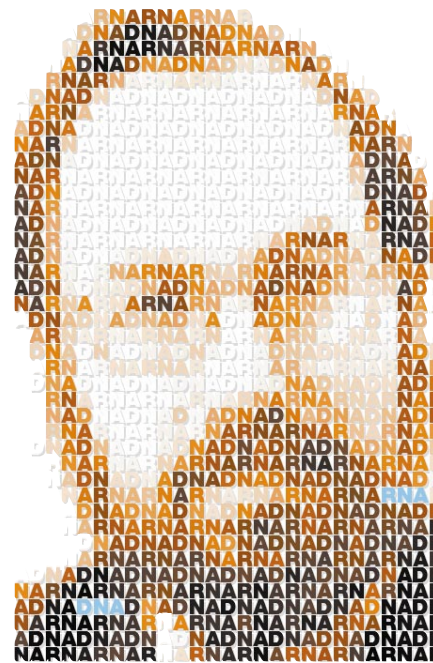
tinctive teaching style — a combination of frightening confrontation and passionate loyalty — has attracted and trained a large and elite corps of scientists who are now leaders in many areas.

And Baltimore's achievements extend beyond the research bench. He has served as president of two of the world's leading research universities: Rockefeller University, from which he was forced to resign, and the California Institute of Technology, where he now presides. He started and effectively ran the Whitehead Institute for Biomedical Research in Cambridge, Massachusetts, one of the most productive and innovative models for public-private research cooperation. He was involved in most of the prominent science-policy issues of the past 30 years, including the US government's declaration of a 'war' on cancer, the initial perceived dangers of genetic engineering, the response to the AIDS epidemic and, of course, the most famous and protracted allegation of scientific fraud ever — the Imanishi-Kari affair or, as it is often called, 'the Baltimore case', in which the researcher Thereza Imanishi-Kari was accused of falsifying data for a paper co-authored with Baltimore and published in *Cell* in 1986.

Because of that case, or perhaps because some people use it as an excuse for other agendas, Baltimore — to put it mildly — faces detractors every bit as fervent as his supporters. James Watson, the co-discoverer of the structure of DNA and the embodiment of biology for the US public, actually campaigned to have Baltimore's Nobel prize rescinded and to have him expelled from the National Academy of Sciences. Others who were once considered Baltimore's close friends have behaved with only slightly less rancour.

Reading Shane Crotty's excellent book, we do not necessarily understand such horrid behaviour but we come to appreciate the context. Baltimore embodies molecular biology over the past 35 years, during which it evolved rapidly from an observational science to the Messiah of medicine, capable of delivering us from deadly degenerative diseases. It has become a magnet for so much money that even those marginally involved, not to mention the leaders, routinely make sizeable fortunes. This makes it fertile ground for monumental egos, and, much to the dismay of many of his contemporaries, Baltimore's powerful intellect and supreme, often abrasive self-confidence remained intact during the most trying times.

"Brilliant, eloquent and personable, Baltimore is a man whom even his closer friends refer to as arrogant and ruthless," Crotty, a postdoctoral fellow at the University of California, San Francisco, tells us early on. Unfortunately, we get little sense of the origins of Baltimore's personality. This is not a psychological biography. We learn that Balti-



DAVID NEWTON

more adored his mother, but she, along with his father, is not even named in the book. The mother pushed David into biology by suggesting a high-school summer programme at the Jackson Laboratories in Bar Harbor, Maine. Throughout his training, Baltimore seldom attached himself to one mentor for long, possessing a keen appreciation of those who could teach him something and great disdain for those who could not. From his earliest days as a graduate student he was "a pain in the ass", one teacher recalls.

But the reader will find few personal anecdotes here. At one point Crotty quotes Baltimore about his time as a graduate student at Rockefeller University: "I'd go to the movies occasionally, had some love affairs and things, but — I did an awful lot of lab work. Loved it!" That's as juicy as it gets. Baltimore's first marriage and divorce, and his subsequent marriage to the prominent virologist Alice Huang, merit only a few lines. Because of this lack of personal detail, the reader gets little insight into Baltimore's emotions during the many vicissitudes of his career.

What the book does offer is fine science writing. From Baltimore's first experiments with mouse genetics during his high-school summer to recent efforts to accelerate the development of an effective AIDS vaccine, Crotty describes clearly the underpinnings of each stage of Baltimore's career in language accessible to the educated layman, but not condescending to the practising scientist. As a result, we understand not only the research, but also the policy issues and personality conflicts it generated. By the time we are told about Baltimore's discovery of reverse transcriptase, we can thoroughly grasp its importance and the reason for the excitement. When Crotty details the experiences in Stanford biologist Paul Berg's lab with the animal tumour virus SV40, it is easy