ago, was among the first to comment on the importance of studying the evolution of gene networks. His book is aimed squarely at professionals. It makes few concessions to naïveté, assuming a fairly extensive background in molecular and developmental biology and a passing familiarity with the evolutionary history of animals.

Davidson's approach, however, is far less mainstream than that of Carroll *et al.* Rather than weaving his narrative around simple lessons drawn from a handful of familiar studies, the author builds his case from the ground up. He is concerned with general principles of genomic information management in embryos, and he emphasizes the reasons why diverse regulatory strategies are used at different times during development and by different kinds of animals. In the last chapter, Davidson directly tackles the *Hox* Paradox. He argues that the diversity of *Hox* gene expression domains among extant animals (in limbs, gut, nervous system, and reproductive organs) makes it difficult to reconstruct the original developmental function of these genes. He presents an ingenious explanation for why homologous genes are sometimes expressed in nonhomologous but functionally analogous structures (such as the eyes of insects and vertebrates).

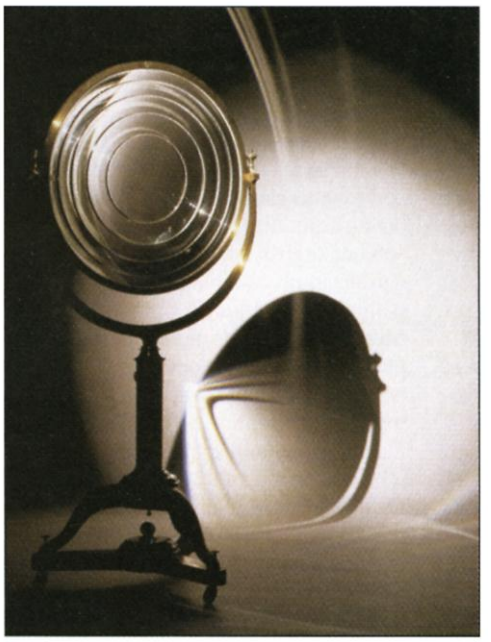
Davidson does not discuss what kinds of mutations are likely to rewire gene networks. This is a surprising omission given his empirical contributions to our understanding of the organization and function of the DNA sequences that regulate transcription. In contrast, Carroll *et al.* raise this important issue in their final chapter. Their largely theoretical discussion is thought-provoking and highlights just how little concrete information exists regarding the evolution of regulatory DNA sequences. Both books make a persuasive case for the need to fill this large gap in our understanding of how genomes evolve.

That these books were written by developmental, as opposed to evolutionary, biologists is clear throughout. One manifestation is the restricted taxonomic focus on model systems, despite a growing body of pertinent information from diverse groups of animals. This is particularly true of Carroll *et al.*'s book, whose title belies an almost exclusive focus on a handful of species in just two phyla. Evolutionary biologists may also wish that population-level variation had received more attention in both books, and they may miss the rigorous phylogenetic argumentation that is now routinely applied to comparative data in their discipline.

These are relatively minor concerns, however, and they do not detract substantively from two outstanding books that should be on the shelf of every aspiring practitioner of "evo-devo." The publication of these books marks an important transition in our thinking about the evolution of developmental gene networks. Just a few years ago, the dominant research agenda was documenting the apparent conservation of regulatory gene function among distantly related taxa; now we know that the situation is considerably more complex. The clear challenge for the future lies in unraveling the genetic basis for anatomical diversity.

CREDIT: MUSÉE DES ARTS ET MÉTIERS DU CNAM, PARIS

BROWSINGS



Light! The Industrial Age 1750–1900. Art & Science, Technology & Society. ***Andreas Blühm and Louise Lippincott.*** **Thames & Hudson, New York, 2001. 272 pp. $55. ISBN 0-500-51029-6.**

The authors survey the changes in artistic perception, depiction, and symbolism of light that occurred as first gas and then electricity revolutionized illumination. Besides discussing representative paintings, they present a selection of the scientific instruments, practical inventions (such as the 1835 example of a Fresnel lens, left), and household articles that transformed human understanding and uses of light. The book accompanies an exhibition Blühm and Lippincott organized for the Van Gogh Museum in Amsterdam and the Carnegie Museum of Art in Pittsburgh, where it continues through 29 July (www.cmoa.org/html/light/light.html).

BOOKS: EVOLUTION

Fatally Flawed Iconoclasm

Eugenie C. Scott

If someone were to charge that textbooks present atomic theory using evidence that is erroneous, misleading, and even fraudulent, and that we should therefore question whether matter is composed of atoms, eyebrows would be raised—at least at the accuser. If someone further claimed that distinguished physicists crassly participate in this fraud to keep the research dollars rolling in or to promote a materialist philosophical agenda, scientists would be angry at the attempt to besmirch the reputations of respected scholars. And if the same person proposed that citizens should encourage local school boards to insert anti-atomic theory disclaimers in science textbooks, discourage Congress from funding research in atomic theory, and lobby state legislatures to restrict its teaching, it is doubtful that such exhortations would receive much attention.

Such would be the fate of Jonathan Wells's call to arms in *Icons of Evolution*, if biological evolution were not substituted for atomic theory in the above scenario. But rather than being ignored, Wells's book has already inspired attacks on textbooks and at least one lawsuit against a local school board (*1*). Unlike atomic theory, evolution has obvious theological implications, and thus it has been the target of concerted opposition, even though the inference of common ancestry of living things is as basic to biology as atoms are to physics.

Icons of Evolution Science or Myth? Why Much of What We Teach About Evolution is Wrong
by Jonathan Wells
Regnery, Washington, DC, 2000. 352 pp. $27.95. ISBN 0-89526-276-2.

Wells claims "students and the public are being systematically misinformed about the evidence for evolution" because high school and college textbooks rely on invalid or misleadingly interpreted "icons": the peppered moth, the Miller-Urey experiment, vertebrate limb homology, Haeckel's embryos, *Archaeopteryx*, Darwin's finches, the tree of life, four-winged fruit flies, fos-

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sil horses, and the familiar fossils-to-modern-humans series of striding men. These are well-known and frequently repeated examples of principles or mechanisms of evolution, or episodes from the history of the field. Textbooks use them because they communicate these basics clearly to uninformed students. But Wells's premise that textbook examples are the best evidence for evolution is wrong; evolution does not stand or fall on whether a high school book simplifies an example of natural selection.

I examined the books reviewed by Wells and found that things are not always as he portrays them. For example, textbooks don't uncritically rely upon Haeckel or his drawings in their discussions of embryology. Only two of the ten books reproduce Haeckel's embryo drawings, although all of them present, in varying degrees of detail, the scientifically accepted inference that comparative embryology reflects common ancestry. Some of the other "icons" don't occur in most of his sample, and even when they do, they are often accorded only a few paragraphs (*2*).

Textbooks are, alas, far from perfect, but authors and publishers would do little to improve their wares by altering their texts to suit Wells. This is because Wells presents a systematically misleading view of evolution. Individual sentences in *Icons* are usually technically correct, but they are artfully strung together to take the reader off the path of real evolutionary biology and into a thicket of misunderstanding. The Cambrian explosion is supposed to be a "serious challenge to Darwinian evolution" because "phyla and classes appear right at the start." Wells is wrong to claim that the Cambrian appearance of major body plans supposedly puts paleontologists into a tizzy; actually, they regard it simply as a phenomenon yet to be explained. Unexplained is not unexplainable. More misleading to nonscientists is the implication that most modern phyla and classes occur in the Cambrian, which doesn't hold true for either animals or plants. Wells neglects to mention that insects, amphibians, reptiles, birds, and mammals are all post-Cambrian (and even Cambrian "fish" are problematic). Wells correctly notes that chordates appear in the Cambrian, and he correctly describes chordates as "tunicates, lancets, vertebrates." But a layman hearing "vertebrates" is more likely to think of lions and tigers and bears than of the very primitive, worm-like Cambrian chordate *Pikaia*. Here, and with the other "icons," what Wells leaves out of his discussion is often critical.

The author's discussion of the admittedly complex changes in populations of the peppered moth is both incomplete and incorrect. He excoriates textbooks for showing "fraudulent" photos of light and dark moths glued to lichen-covered tree trunks. Wells argues that moths don't rest on tree trunks and that lichens are not associated with moth color changes. But he ignores research showing that moths rest on all parts of trees (including the trunks) and that the color of the surface upon which moths alight is what counts in predation. Dark moths against light backgrounds get nabbed, whether or not lichens form those backgrounds. Textbooks show staged photos of moths affixed to trees to illustrate crypsis of dark and light moths against dark or light backgrounds; not unreasonably, photographers didn't sit patiently by waiting for the right combinations of moths and backgrounds. Researchers glued moths to trees to test whether birds differentially prey upon moths that contrasted against their surface, an experiment necessary to test the hypothesis of bird predation. This is not fraud, it's research.

Space limits a full treatment of the book's errors and misdirections, but as a physical anthropologist I must mention that Wells cites science writer Henry Gee on the paucity of human fossils from 5 to 10 million years ago. Yet he leaves out the abundance of such fossils over the last 5 million years, which is when humans evolved. Combining this deflection with a 20-year-old citation from another journalist about the scarcity of human remains, the lay reader may incorrectly conclude that the human fossil record is unusually weak. Wells also ignores the many significant discoveries of the past two decades.

Even more misleading, however, is Wells's steady drumbeat of accusation of fraud, misconduct, deception, and incompetence against evolutionary biologists and his claim that evolution is shoddy science maintained by ideology rather than evidence. Although his targets have treated the book with derision, *Icons of Evolution* has high potential to mislead the nonscientific public, and scientists should be prepared to respond.

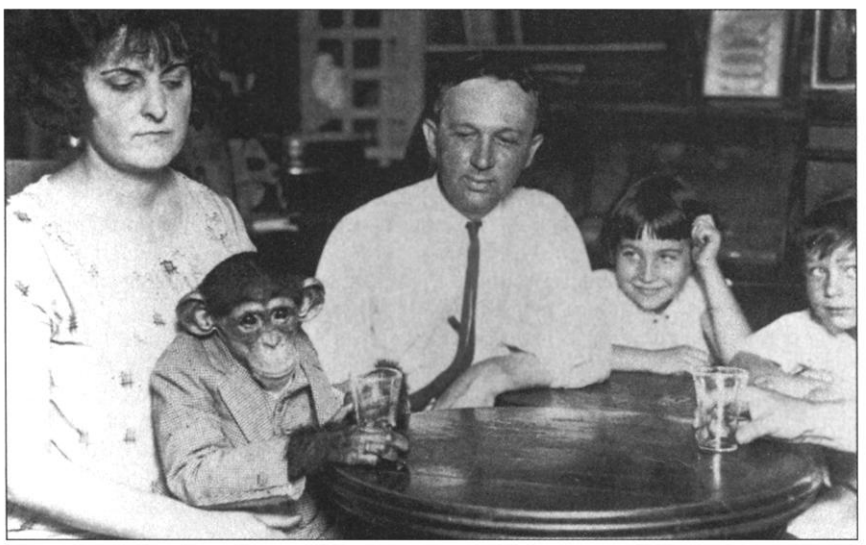
Notes

1. Arkansas legislation HB 2548 (2001) would ban textbooks which included the icons. Patty Pulliam, a West Virginia parent, listed the "icons" in her lawsuit against Kanawha County concerning alleged textbook inaccuracies. Joe Baker, a senior at a Perkasie, PA, high school, is lobbying his school board to insert icons disclaimers into the textbooks.
2. The set reviewed by Wells is a miscellany of ten high school and college biology books, which curiously omits some best-selling texts and other titles with comprehensive treatments of evolution. It is unclear whether his results can be generalized. Wells's critique is discussed further in A. Gishlick and E. C. Scott, "Do textbooks mislead students about evolution? A look at *Icons of Evolution*," *Reports of the NCSE*, in press.

BROWSINGS

The Scopes Trial. A Photographic History. *Edward Caudill, Edward Larson, and Jesse Fox Mayshark.* University of Tennessee Press, Knoxville, 2000. 96 pp. $45. ISBN 1-57233-080-5. Paper, $18.95. ISBN 1-57233-081-3.

This selection of images from the special collections of the University of Tennessee was compiled to mark the 75th anniversary of the "monkey trial." The photographs depict Dayton and its citizens, high school teacher John Scopes, the prosecution and defense teams (including the national figures William Jennings Bryan and Clarence Darrow), courtroom scenes, and the carnival atmosphere that surrounded the case. Fred Robinson, the head of the county board of education, arranged for this well-dressed chimpanzee to greet customers at his drugstore—the place where the trial had been contrived in order to promote the local economy.



CREDIT: UNIVERSITY OF TENNESSEE SPECIAL COLLECTIONS