BOOKS: STATE OF SCIENCE

Far From the Finish

David L. Goodstein

Two years ago, in his book *The End of Science*, John Horgan put forth the thesis that the heroic age of scientific discovery is finished. John Maddox clearly thinks otherwise. "The purpose of this book," he says, "is to demonstrate that science, far from being at an end, has a long agenda ahead of it." He goes on, "The 500 years of modern science are a good beginning, but only a beginning." So much for *The End of Science*. (Maddox never mentions Horgan or his book by name, but the publisher convinced Horgan to write something politely noncommittal for the dust jacket.)

What Remains to Be Discovered
by John Maddox
Free Press, New York, 1998. 448 pp. $26. ISBN 0-684-82292-X.

Maddox, who was for many years the editor of *Nature*, sets out here to survey the broad expanse of the scientific frontier, to show us where we've been, and to point out to us how much farther we have to go. The truly impressive thing about this book is the fact that Maddox seems able to write with equal authority about particle physics and cell biology, cosmology and genetics, pure mathematics and global warming, and much more. He does all this in a style that seems to be reserved to certain barons of English science—the physicist Sir James Jeans writing about music comes to mind. The style is by turns pompous and charming, off-handedly skillful, and always sublimely confident, even when he doesn't know what he's talking about (which is not very often). Maddox definitely belongs to the club (he was knighted in 1994).

Above all, he is always opinionated (this is part of the charm). Of the people pursuing a Theory of Everything—TOE in physics-speak, almost the same as a Grand Unified Theory (GUT)—he says, "They have reckoned without the simple truth that the recent pell-mell pace of discovery has left them intellectually breathless, without a true understanding of what they are talking about." He also doesn't much like string theory, he predicts that the search for enough dark matter to keep the universe from expanding forever will turn out to be a "wild goose chase," and he is deeply skeptical of the big bang. But it is by no means only physicists that are the objects of his wrath. "[M]uch of contemporary cell biology is but high level botanizing," he says (botanizing is the pejorative term today's biologists use for what 19th century naturalists did). "The central problem of cell biology now," he tells us, "is not so much the gathering of information, but the comprehension of it." He thinks that cell biologists should be working out comprehensive models of cell function, rather like the general circulation models of Earth's climate. But they won't do that because modeling would be an affront to the pristine quality of biology. "If cell biology becomes a part of physics," he thunders, "it will have only itself to blame."

One of Maddox's favorite metaphors is "the river of discovery." But his river is not the one known to those of us trying to navigate it, full of dams and damns, islands and eddies, rapids and long lazy stretches where nothing seems to be happening. To Maddox, the history of science is a seamless flow from one intellectual triumph to the next. Maybe that is the way it looked from his lofty perch at *Nature*.

He also makes an occasional technical goof. For example, shock waves do not travel ahead of a supersonic aircraft, as he asserts at one point, and his account of Fermat's last theorem neglects to point out that it doesn't apply to the integer powers one and two. But these are minor slips; in general, his technical mastery is splendid.

Maddox is certainly capable of butchering a sentence, as when writing of quantum electrodynamics, "...attempts to calculate real physical quantities, such as many of the quantities appearing in the theory turn out to be infinite." On the other hand, his discussions can be so deft that the reader barely realizes that a difficult scientific point has been explained: "...telling whether a hydrogen atom belongs to *this* molecule or *that* is exactly like the difficulty of telling whether an electron is *here* or *there*. The result is that water molecules are held together more strongly than would be expected, by what are called 'hydrogen bonds.' Exactly the same mechanism comes into play when other simple molecules are immersed in water, which explains why substances such as alcohol and sugar are without restraint mixable with water. (In each case, hydrogen atoms attached to oxygen atoms mimic half a water molecule.)"

Near the end of the book, Maddox regales us with tales of calamities that might befall us, and from which only science can save us. Global warming could shear off the West Antarctic ice shelf, raising sea level 5 meters, and sinking Los Angeles beneath the waves (I presume Pasadena would be spared). An errant asteroid could lead to a new extinction. An inherent instability in the human genome (such as inherited systematic errors in the DNA-replication machinery) could lead to an extinction of a different kind. It is the duty of governments, he sternly lectures, to nurture the sort of research that would anticipate such events. Few readers of *Science* would disagree.

It takes courage to write a book like this. Horgan's book may seem silly in a few years; this book, like any book of predictions, surely will. Nevertheless, there's a certain grandeur about the enterprise. To survey all the frontiers of human knowledge, pointing the way fearlessly (and sometimes wrong-headedly) to the future—now that's a job that really takes GUTs.

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BROWSINGS

Color for Science, Art and Technology. *Kurt Nassau, Ed.* Elsevier, Amsterdam, 1998. 509 pp. $142. ISBN 0-444-89846-8.

Measurement, perception, philosophy, therapeutic effects, and the reproduction of color are among the spectrum of topics sampled in this eclectic set of 15 chapters.

The Man Who Loved Only Numbers. The Story of Paul Erdös and the Search for Mathematical Truth. *Paul Hoffman.* Hyperion, New York, 1998. 312 pp. $22.95. ISBN 0-7868-6362-5.

This friendly biography of the exceedingly prolific, peripatetic, and eccentric Erdös provides a fine introduction to number theory as well as a fascinating collection of mathematicians and the problems that intrigue them.

A Natural History of Vision. *Nicholas J. Wade.* MIT Press, Cambridge, MA, 1998. 484 pp. $55. ISBN 0-262-23194-8.

In this unconventional chronicle of the study of vision prior to the development of experimental approaches (circa 1840), Wade presents descriptions of visual phenomena as reported by natural philosophers. The original accounts are organized by topics such as light, color, motion, space, and visual illusions.

The Shoot Apical Meristem. Its Growth and Development. *Robert F. Lyndon.* Cambridge University Press, Cambridge, 1998. 293 pp. $90. ISBN 0-521-40457-6.

The tiny shoot apex gives rise to nearly all of the aerial structures we see and recognize as plants, including leaves and flowers. To explain how it functions, Lyndon marshals findings from cellular, biochemical, genetic, and molecular investigations.