

# How many more eureka's in the bath?

## What Remains To Be Discovered: Mapping the Secrets of the Universe, the Origins of Life, and the Future of the Human Race

by John Maddox

Free Press/Macmillan: 1998. 433 pp. \$26, £20

Carl Zimmer

One can only imagine how annoyed John Maddox must have become in 1996. He had retired from *Nature* a year earlier, after an impressive 23-year stint as its editor. Having successfully guided this journal into the age of space-based telescopes and genome projects, he decided it was a good time to write a book. There he would lay out the most important questions still left unanswered by scientists. And then, just as he was getting elbow-deep in the project, everyone suddenly started talking about another book on what the future will bring: John Horgan's *The End of Science* (Helix, 1996).

Horgan, a journalist, had interviewed leading scientists and strung profiles of them together into an argument that science as we've known it in the past few centuries — unveiling the Universe's fundamental secrets — is coming to a close. Much of the important stuff, such as relativity and DNA, has already been discovered, and the things that haven't, Horgan claimed, are either minor details or dreamy notions beyond our powers to verify. Many scientists loathed the book, and Maddox himself wrote in a review that it was "intelligent but perverse".

Now, two years later, we have *What Remains To Be Discovered*. Nowhere does Maddox mention Horgan by name, and yet Maddox often addresses him implicitly. When Maddox writes, "Who, now, dares say that the days of surprise are over?" it is hard not to imagine Horgan lurking in his mind.

Maddox's book, I suspect, is all the better for it. He has done an excellent job of showing just how many surprises we may have in store. He divides his book into surveys of physics, cosmology, evolution, cell biology, consciousness, mathematics, and what could be called the science of calamity — global warming and other threats to humanity's future. He runs through the histories of these fields, often with great clarity. (Now at last I understand how virtual photons transmit forces between particles.) Then Maddox dives into the gaps still left after all those centuries of work. The biography of the Universe is still a shambles, despite all that's been learned since Edwin Hubble saw stars fleeing away from us. Physics still awaits the union of gravity and quantum mechanics. No one has yet truly described thought.

Although a physicist by education, Maddox is a great intellectual omnivore, and he

can recognize how different fields face similar challenges. Biologists who are trying to use genes to assign dates to the origin of humans and other lineages are like cosmologists searching for standard candles to measure the distance to stars and galaxies. Cell biologists won't be able to transcend the heaps of data they've collected until they follow the example of atmospheric scientists, who are learning how to model the world's climate on computers.

I was disappointed, though, that some important subjects warranted little or no space. I looked in vain for what remains to be discovered by ecologists (the role of species diversity in ecosystems, for example, or the control exercised on food webs from the top or the bottom). The atmosphere and the oceans only turn up in Maddox's discussion of global warming, which is a bit like saying that physics is only interesting in connection with radioactive waste.

When Maddox talks about evolution, he skips over the ongoing revolution in phylogenetic systematics. He is rightly sceptical about the claims of evolutionary psychology, but his interest in the evolution of animal behaviour seems to stop with William Hamilton's work in the 1960s. In fact, it is now a burgeoning field, with many questions still unanswered.

And Maddox never quite vanquishes his tacit foe. Horgan's book doesn't work as a coherent argument because he sets up the rules of the game so that he can't lose. If an old scientist declares that he and his generation solved all the great problems 50 years ago, Horgan wins. If another says that the ultimate answers will always remain just out of reach of the latest theory, Horgan wins. If another says that his field has ground to a halt because he and his colleagues can't figure out

how to proceed, Horgan wins. But, although it may fail as an argument, Horgan's book is interesting as a collection of questions about the nature of science. Can a science run its course, and then run out? Are there some things we can't know? What then?

Maddox hardly addresses the possibility that there are practical and theoretical limits to science. A long list of unanswered questions isn't sufficient. Most of the ones that Maddox presents won't supplant current paradigms in the way that relativity engulfed Newton's laws of motion. On the other hand, the union of quantum mechanics and gravity could indeed change the way we view the Universe but, if it requires atom smashers the size of galaxies to be tested, will it be anything more than a thought experiment?

Instead of confronting these matters head on, Maddox simply asserts that science is like a set of *matryoshka*, those nested Russian dolls, with another doll always hidden inside waiting to be unscrewed. He believes this because in the past there has always been another doll. But when I unscrew a set of *matryoshka*, I know that history isn't a guarantee that the future will be like the past. I may twist one open and find nothing inside, or simply be unable to twist it because it's too small for my fingers.

I won't dare to guess whether Maddox's dolls will keep coming unscrewed or not, but I suspect that, even if they don't, science will go on with a long happy life. Natural selection doesn't automatically predict mastodons and flying fish. Quantum mechanics doesn't automatically put the Moon in the sky. There's a lot in between, and a lot to keep future editors of *Nature* working late into the night. □

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## Hubble vision

The star Eta Carinae exploded 150 years ago, since when its impressive gas nebula (right) has been expanding. This photo is from *Hubble Revisited: New Images from the Discovery Machine* by Daniel Fischer and Hilmar Duerbeck (Springer, \$40, £24.50). The book, a sequel to *Hubble: A New Window to the Universe*, contains many of the latest images from the space telescope.

