



On the record

Fish were the inspiration for Ray Troll's witty artworks, which adorned T-shirts in the 1980s. This fascination has taken him deeper into the marine world and its evolution, as shown by the detail of spawning ammonites shown

here. Troll is now a celebrity among palaeontologists, and his art has moved from T-shirts to museum exhibitions. *Rapture of the Deep: The Art of Ray Troll* (University of California Press, \$29.95, £18.95) showcases his work.

air strike. A passing eagle, clutching a tortoise, had seen his head. The best way to open a tortoise, if you are an eagle, is to drop it on a clean shiny surface. Exit the father of tragedy, in the only known case of killing two chelonians with one bird.

Though we can set the climate as we choose, we need to guard the bald top of the world. If you don't want to be struck from the air by an unknown unknown, give this book to a campaigning granny. ■

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Ring theory

The Science of Middle-Earth

by Henry Gee

Cold Spring Press: 2004. 256 pp. \$14. To be published in the UK by Souvenir Press.

Michael A. Goldman

We're living in a society where the average person's knowledge of science is so fragmentary that much of what we take for granted looks a lot like magic. Although it starts out as a well-informed critique of J. R. R. Tolkien's work, Henry Gee's *The Science of Middle-Earth* rapidly moves into a lively collection of science essays united by references to life in Middle-Earth, an exploration of the depths of Tolkien's keen imagination. Tolkien's work had a cult following that escalated with Peter Jackson's stunning films of *The Lord of the Rings*. Gee, an editor of *Nature* and a disciple of Tolkien's classic, is equally at home in the modern research laboratory and in the lands of Middle-Earth.

Gee's attempt to entertain and educate about science using Tolkien's fantasy to capture the public's attention may be just what the MTV generation needs. The tour takes us through ecology, evolutionary theory, metabolic-rate physiology, the scaling of body size, biochemistry and genomics.

How about a chainmail vest that can deflect the sharp blow of an orc? In the analysis that follows, the reader learns about pliability, hardness, brittleness and newly conceived materials yet to be synthesized. How do orcs reproduce? Were they cloned or manufactured? Were they fallen humans, or devolved elves?

Far from mere legend, a dragon is a challenging problem in developmental biology. With four legs and two wings, dragons are an ideal opportunity to explain homeotic mutations. Fire-breathing dragons, the only respectable kind, no doubt do a little chemistry to create something like diethyl ether, which, slightly warmed, would probably ignite on contact with air. Excess vapours would burn off slowly as the dragon fumed between rampages.

The denizens of Middle-Earth have legends and a past of their own. Some societies may have devolved over time, losing their best technology. Readers of *Nature* are now familiar with *Homo floresiensis*, known as the Hobbit, who shared Indonesian islands with humans just 18,000 years ago, and maybe more recently. They might represent a devolved form of *Homo erectus*. Gee tells us that our fairy tales could be poorly preserved accounts of events and technologies we no longer remember or understand. Similarly, "the slow erosion of information into repetitive idiocy resonates with what we know of the evolution of the human genome... time

and chance have made nonsensical drifts of huge swaths of once useful genetic information." Wouldn't mobile phones look like magic to someone from 50 years ago, and wouldn't we think it magic if they worked as they should? As Arthur C. Clarke pointed out, any sufficiently advanced technology is indistinguishable from magic.

Gee is alarmed at what he sees as a decline of science as a college major. While we lament the lack of interest in science, we too often worry about it in terms of the profitable innovations science gives us, rather than the simple pleasure of knowing. We expect people to take certain views of the world as law, discouraging questioning, and asking people to take our word for it. "This aggressive promotion of science is flawed, not least because many of its provisions" are "antithetical to the pursuit of science". No matter how fundamental we think a concept is, we need to explain it patiently, rather than insisting the public take it as given. Gee chides evolutionary biologist Richard Dawkins, saying that "it is a tactical error for those promoting science to impose their view on others, for fear of replacing one kind of religion with another, diminishing the very subversive, questioning quality that is the foundation of science."

Touring Tolkien's fantasy world, he asks with the curiosity of a child: "How does this work?" Aside from the fact that the world isn't real, the approach is fully analogous to the science he is trying to portray. He proposes explanations, brings in relevant data, discards a hypothesis and moves on to another. Still, the One Ring remains unexplained, after several laborious pages. "To a scientist, the existence of the inexplicable is a challenge, and a reminder that science always

has more to achieve." More than any morsel of fact we'll take home, we stand to gain from Gee's piercing observations about science education for the third millennium. ■

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Smart underwear for time travellers

How to Clone the Perfect Blonde: Using Science to Make Your Wildest Dreams Come True

by Sue Nelson & Richard Hollingham
Quirk Books/Ebury Press: 2004. 272 pp.
\$16.95/£7.99

Paul Davies

The challenge facing authors addressing politically sensitive issues such as stem-cell research, cloning and robotics lies less with the technicalities and more with the emotion and prejudice surrounding these subjects. Cloning especially revolts many people who lack the foggiest idea of what is actually involved. The authors of *How to Clone the Perfect Blonde* manage to tackle this topic head-on and non-judgmentally by adopting a mixture of fast-paced exposition and gentle humour. That they manage to do this without either patronizing the reader or trivializing the subject is a tribute to their skill. And the formula works equally well with speculative and popular, but technically difficult, topics, such as quantum teleportation and time travel.

Teleportation technology has leapt from the screenplay of *Star Trek*, where it was motivated primarily by the need for a cheap special effect, to the real world of quantum engineering. One of the key properties of quantum particles such as photons is that they may be put into an 'entangled' state. Two entangled photons, even when far apart, remain linked by what Einstein called "spooky action-at-a-distance". Although entangled states cannot be used to send information faster than light, they can be used to reconstruct replicas-at-a-distance. So far, this has been restricted to single particle states a kilometre or so apart, but that has not stopped some enthusiasts imagining scanning a human body, atom by atom, and reconstructing it on Mars, say. Despite the wackiness of this notion, the physics of quantum information is a hot topic, bearing on practical developments such as quantum cryptography and the race to build a code-breaking quantum computer.

And therein lies the value of this book. By addressing a wild and engaging speculation, the authors use it as a peg to cover much valuable science. In the chapter on time travel

we learn the basics of the theory of relativity and some of its more advanced ramifications, such as black holes and wormholes. No matter that unrestricted time travel may be a pipe dream, it's a fun topic that we can all identify with, and it involves some interesting mainstream physics and astronomy that might seem dull in a more prosaic context.

My favourite fantasy, which comes near the end of the book, is the idea of uploading the contents of my brain on to a super-computer, to serve both as a back-up in case something horrible happens to the original and as a gateway to a universe of simulated reality, offering potentially limitless fun. Although technically challenging, to say the least, it is hard to see any obstacles of principle to this procedure, and it raises the unsettling question of how I can be sure that the reality I experience is the 'real' reality or just a simulation. Or indeed, whether there is any meaningful distinction between them.

The reader taking a random walk through this speculative playground will learn some surprising facts to help with future quiz nights. I was particularly intrigued to learn about a slime mould able to find its way through a maze, and the disembodied lamprey brain stem that can control a remote robot by responding to light signals. First prize for inventiveness, however, must go to the smart underwear designed to control the temperature of the room the wearer is in.

As the saying goes, there is something for everybody here, not least for scientists at the sharp end of research, who may be in danger of taking themselves too seriously. ■

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Swimming beneath solid seas

Under Antarctic Ice: The Photographs of Norbert Wu

by Norbert Wu & Jim Mastro
University of California Press: 2004. 176 pp.
£26.95, \$39.95

Frozen Oceans

by David Thomas
Natural History Museum Publishing: 2004.
224 pp. £22

Lloyd Peck

The frozen ends of our planet are among the most captivating and least known places on Earth. What takes them beyond our comprehension is ice. The Antarctic ice sheet is kilometres thick and covers an area bigger than Europe. Ice also means that much of the polar oceans are beyond our experience: some 15–20 million square kilometres of the oceans are ice-bound. This environment drives ocean currents, reflects large amounts of heat from the Sun, and is party to the greatest seasonal changes of any seas.

Possibly the most bizarre aspect of the pack ice in the polar seas is the life that inhabits its under-surfaces, and the communities that depend on the productivity of this system. Algae are eaten by protists and invertebrates, such as amphipods and krill; at the top of the food web, fish make their lives on the frozen ledges and tunnels in the ice. Even some of the top predators, such as whales and seals, depend on the productivity of the sea ice and the ice edge. Climate-change predictions suggest that this is a threatened landscape, with both Arctic and Antarctic sea



Star performers: seastars such as *Odontaster validus*, seen here attacking the larger *Acodontaster conspicuus*, thrive in Antarctic waters where anchor ice scours the sea bed.

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