BOOKS & ARTS

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In the balance: the intensive use of pesticides has benefited agriculture but caused wider environmental damage.

For better or for worse

Science must be applied carefully if we are to reap the benefits but minimize the risks.

Times of Triumph, Times of Doubt: Science and the Battle for Public Trust
by Elof Axel Carlson
Cold Spring Harbor Laboratory Press: 2006. 227 pp. $39

Ian Wilmut

Scientific research and the associated technical applications have transformed our lifespan and way of life, at least in the West. Public health has been enhanced greatly by good sanitation and by the provision of clean water and adequate food. Immunization and the use of antibiotics have banished diseases that just a few decades ago haunted our grandparents. Neonatal mortality has been dramatically reduced. The benefits arising from biomedicine alone are enormous, and other disciplines have also led to improvements, such as greater opportunities to travel and to communicate. So why do many people view science and innovations with anxiety and concern?

Elof Axel Carlson is a geneticist by training who has taught biology to non-science students for many years. In his thought-provoking book *Times of Triumph, Times of Doubt*, he asks why many of his young students who have turned away from careers in science feel that "science has let them down through its bad outcomes". In making his analysis he includes in the scientific community not only researchers but also those responsible for the commercialization and regulation of science, such as business executives, ethicists, theologians, legislators, lawyers and journalists.

Carlson has selected a number of areas in which there has been either public controversy or actual harm associated with the application of scientific ideas, and considers how the unfortunate outcome arose, in the hope that the risk of similar outcomes might in future be reduced. He casts his net wide in selecting incidents from which science emerges with less than a perfect reputation. Some are very recent, whereas others began in the nineteenth century. They include eugenics, weapons of mass destruction (in particular the atomic bomb), pesticides, methods of assisted reproduction, and the oversight of procedures for the introduction of new medicines.

It may come as a surprise to many younger readers of this book to find that the scientific community is held responsible for the worst excesses of the Holocaust, but some of the ideas of genetic superiority had their origins in academic genetic research. By a nice twist of history, one of the major centres of this activity was Cold Spring Harbor Laboratory, New York, where the publishers of this book are based. The laboratory is now distinguished for its research in molecular genetics. But in the early twentieth century, its director, Charles Davenport, developed policies for eugenic protection and the enhancement of our species. Europeans have no cause for complacency because other groups developed similar ideas in Britain, Sweden, Norway, Denmark, Finland and Switzerland. Germany may be the only country that systematically murdered its citizens, but in other countries people were sterilized without consent as a result of policies that had no sound scientific justification and would be judged ethically unacceptable today.

However, the misuse of pesticides seems to me to be a far more representative example of the way knowledge has been used without due care. The intensive use of chemicals that became available in large quantities after the Second World War made it possible for the first time to eliminate insects and weeds. There were medical benefits in some cases, for example in the control of malaria. However, the widespread and sometimes careless use of chemicals in agriculture and domestic

gardens damaged the ecosystem and put people's health at risk.

This danger was first made clear to the public by Rachel Carson in her book *Silent Spring* (Houghton Mifflin, 1962), in which she described the changes in the natural world brought about by the use of chemicals. Since then, in part as a result of Carson's book, there has been a very slow change in our priorities, although many people argue that much more needs to be done to restore an ecosystem in which humans and other species are in a stable relationship. In a few years it may seem obvious to everyone that our pollution of the atmosphere by the consumption of hydrocarbon energy sources was even more reckless than our use of pesticides.

The use of new knowledge, then, is a double-edged sword. Pesticides led to real benefits, but their careless use was harmful. This is surely the situation in many cases, such as atomic energy and dynamite. It was even the case when a sharp stone was first stuck on a stick to make an axe that could be used to kill animals or chop sticks for firewood, or to kill people.

Carlson ends the book with the interesting suggestion that legal proceedings should be possible in cases of science or technology being misused. He draws on a comparison with the Wall Street crash in 1929, which led to greater regulation of the financial world. In some of the scientific cases he discusses, surely legal redress would already be available if inaccurate information was provided. However, this would not be the position at present if someone merely argued a case in a book or scientific paper, as was the case in the development of eugenic policies.

Everyone in the scientific community has a responsibility to assess the value of our work realistically and to broadcast both the risks and the benefits, argues Carlson. In determining our attitude to scientific and technological advances, perhaps even more important than the effect of any failures is our tendency to take new things for granted very rapidly. Research has contributed a great deal to our way of life, and none of the sceptics would wish to go back even to the nineteenth century. But it can also do great harm. Let us have ambitious research, but cautious application. ■

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Painting the whole picture?

Visions of Nature: The Art and Science of Ernst Haeckel
by Olaf Breidbach
Prestel: 2006. 304 pp. $100, £55

Philip Ball

When *Nature*'s centenary issue of 1900 listed the most important scientists of the age, only one German biologist was included: Ernst Haeckel, professor of zoology at the University of Jena. Reckoned to have been instrumental to the introduction of darwinism to Germany, Haeckel has also inspired generations of scientists with his stunning drawings of the natural world. He is perhaps most widely known now as the author and illustrator of *Art Forms in Nature*, a series of plates published between 1899 and 1904 that showed the marvellous forms and symmetries of creatures ranging from radiolarians to antelopes.

Few scientists of his time were more complicated. He was the archetypal German Romantic, who toyed with the idea of becoming a landscape painter and venerated Goethe. He promoted a kind of historical determinism, akin to that of the philosopher G. W. F. Hegel, that sat uncomfortably with Darwin's pragmatic rule of contingency. Haeckel's view of evolution was a search for order, systematization and hierarchy that would reveal far more logic and purpose in life than a mere struggle for survival. His most famous scientific theory, the 'biogenetic law', which argued that organisms retrace evolutionary history as they develop from an egg ('ontogeny recapitulates phylogeny'), was an attempt to extract such a unifying scheme from the natural world.

It can be argued that this kind of visionary mindset, with its strong preconceptions about how the world ought to be, does not serve science well. Haeckel supplies a case study in the collision between Romanticism and science, and that tension is played out in his illustrated works. This is something that Olaf Breidbach's lovingly produced book *Visions of Nature* never really gets to grips with. Indeed, the book has a curiously nineteenth-century flavour itself, declining to grapple with the difficult aspects of Haeckel's life and work.

For example, historian Daniel Gasman and others have proposed that Ernst Haeckel's influence on German culture at the turn of the century was pernicious in its promotion of a 'scientific' racist ideology that fed directly into Nazism. However, Breidbach goes no further than to admit that Haeckel became a "biological chauvinist" during the First World War, and that "sometimes the tone of his writing was overtly racist". Breidbach admits that his book is not a biography as such, more an examination of Haeckel's visual heritage. Yet one could argue that Haeckel's dark side was as much a natural consequence of his world view as was *Art Forms in Nature*.

Ernst Haeckel's images portrayed his preconceived view of the world.

The claim that Haeckel doctored images to make them fit with his preconceived notions of biology is harder to ignore in this context. He was even accused of this in his own time, particularly by his rival Wilhelm His, and to my eye the evidence looks pretty strong (see *Nature* 410, 144; 2001 and *Science* 277, 1435; 1997). But Breidbach skates over this issue, alluding to the allegations only to suggest that the illustrations "instructed the reader how to interpret the shapes of nature properly".

On the whole, Breidbach simply explains Haeckel's reliance on image without assessing it. Haeckel's extraordinary drawings were not made to support his arguments about evolution and morphogenesis; rather, they actually were the arguments. He believed that these truths should be apparent not by analysing the images in depth but simply by