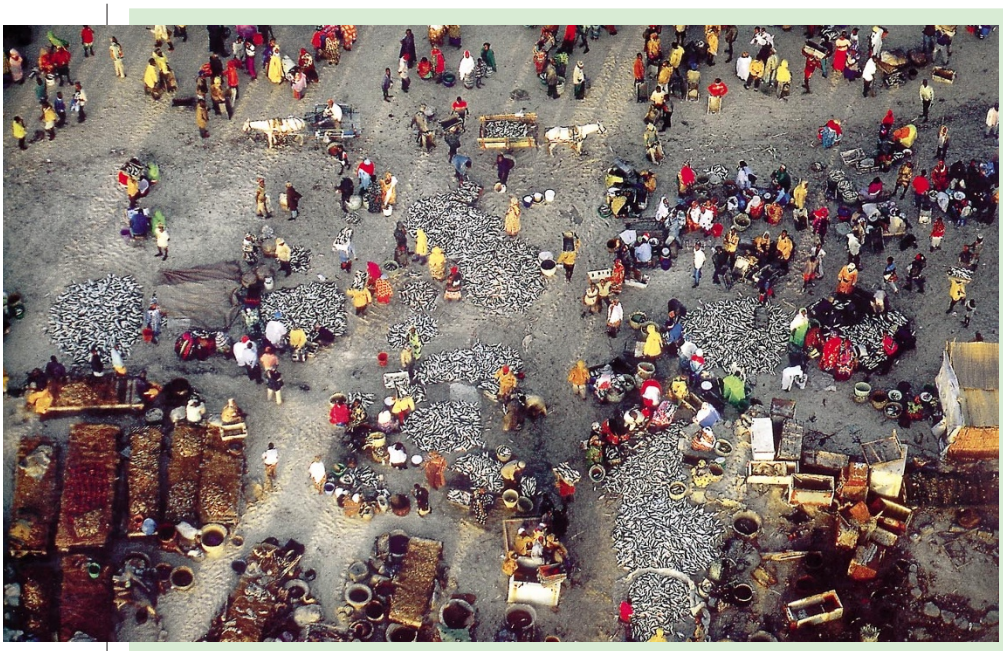

Around the world in 365 days

The vivid colours of a fish market in Saint-Louise, Senegal, one of Yann Arthus-Bertrand's photographs in *The Earth from the Air: 365 Days* (Thames & Hudson, £24.95). His powerful images on many different scales range from the polar wastes to the tropics, giving a new view of natural and human landscapes — from the 'stone forest' of Madagascar to the Rio slums.

experiment that forcefully challenges the assumption that animal pain is intrinsically less important than human pain, and R. G. Frey argues that the same reasoning that justifies experimenting on animals (which he supports) also justifies experimenting on members of our own species.

Regan, on the other hand, is an abolitionist. He does not want to regulate or reform animal experimentation, but to end it altogether. He rejects the utilitarian approach of philosopher Peter Singer. Singer believes that animal testing and experimentation are wrong because the price paid by the animals outweighs the likely benefits to humans. Singer does not contend that animal lives are equal in value to our own or that they have rights. What he does say is that, to act morally, humans must take animal interests into account, giving those interests as much weight as the equivalent interests of humans.

Regan faults utilitarianism for permitting us to sacrifice the interests of some for the benefit of others and, more specifically, for failing to rule out animal experimentation in principle. He believes that some animals are the "subject of a life". By this he means that they "bring the mystery of a unified psychological presence to the world". These animals desire, remember, feel emotion and act intentionally. Taken together, such capacities mean that their lives have innate value. In kantian terminology, these animals are ends in themselves — just as humans are — and, accordingly, they have a right to life, liberty and bodily integrity. More generally, they have a right to be treated with respect.

If all subjects of a life have these basic rights, and if, as Regan believes, many non-humans are subjects of a life, then experimenting on these animals is morally impermissible. To point to the costs of forgoing such experimentation, as *Why Animal Experimentation Matters* does, misses the point. But is Regan's reasoning sound? Regan argued his case at length in his 1983 book, *The Case for Animal Rights* (University of California Press). In several of the essays collected in *Defending Animals Rights*, he restates his position and addresses his critics. But the philosophical debate is bound to rage on. ■

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Biotechnology retrospective

The Green Phoenix: A History of Genetically Modified Plants
by Paul F. Lurquin
Columbia University Press: 2001. 240 pp. $50, £33.50 (hbk), $25, £17 (pbk)

F. C. Botha

Ask any student of biotechnology today when the first foreign DNA was transferred to plants, and the answer will invariably be 1984. Very few will recall that it all started with the innovative and tenacious work in Lucien Ledoux's laboratory in Belgium in the late 1960s. And it would be interesting to know how many plant molecular biologists have read the two pioneering publications of Ledoux and Huart, which claimed to report the integration of foreign DNA into the genome of barley. Paul Lurquin's book appropriately reminds us of the major difference between the theory of the scientific method and the way it translates into practice. Certainly, it is not as simple as formulating a hypothesis and then automatically verifying it. All those many failures — and often erroneous interpretations — are seldom told to newcomers to the field.

In the late 1960s, the concept of horizontal DNA transfer — the transfer of genes between species — was inconceivable, as this violated the accepted idea of slow, mutation-driven evolution constrained by sexual barriers. Without good models or detection systems, the early pioneers in this field had to persuade a highly sceptical scientific community of the merits of their hypotheses. It is almost unimaginable that they had to rely on a very basic technique, density centrifugation, to demonstrate gene transfer in plants. Today's students have the benefit of sensitive modern techniques, and yet often fail to obtain good evidence for the stable integration of foreign DNA into plant genomes. They will certainly appreciate the enormous task that early researchers faced in convincing others of this phenomenon.

In the very early days of plant genetic engineering, the small flowering plant *Arabidopsis* was already the laboratory workhorse for the Ledoux team. In 1974, they stated that they had achieved the successful complementation (restoration to normal function) of a vitamin B1 mutation by the transference of genetic material from bacteria. In the same period, D. Hess in Germany claimed to have engineered a change in flower colour through horizontal gene transfer. Both pieces of research were heavily criticized and their accuracy was questioned. But a major turning point came with the discovery in Germany and the USA that genes from the bacterium *Agrobacterium* can transfer naturally to plants. The book accurately describes the very rapid developments that followed this discovery, culminating in the conclusive demonstration of horizontal gene transfer to plants in 1984.

Looking back at the turbulent first two decades of plant genetic engineering, it is difficult to understand how the researchers involved persisted with their ideas. It is inspiring to read how a few individuals, driven by curiosity and faced with strong opposition and criticism, eventually had such a huge impact on science. Yet again, this history illustrates how major breakthroughs, with enormous potential applications and

financial reward, often flow from very basic research. The book makes the point well that good research is driven by new ideas and not by technology. In reality, the technologies available are often inadequate for testing new hypotheses accurately. Thus, it remains puzzling that the private sector remains so reluctant to fund basic research. How many of those who today are reaping the benefits of biotechnology would have been prepared to support this early research financially, especially when controversy reigned in the field? There is probably a lesson to be learned from the fact that Monsanto initiated research on plant genetic engineering in the early 1970s, a decade before the phenomenon was reliably demonstrated.

Plant genetic engineering is a highly controversial topic, and will probably long remain so. Whether the technology will deliver its promise of a better life for all, only time will tell. With the negative impacts of the first Green Revolution still fresh in our minds, many are concerned that the new technology will have an equally negative impact on the environment, and increase the gap between rich and poor still further. Most of the advances in biotechnology are in the hands of major companies in the developed world, and the question is rightly asked whether those most in need will ever be able to afford the technology. It is a pity that the book fails to mention the several instances where it has already significantly improved the living standards of small-scale growers, and the broader community, in the developing world.

Often ignored is the very important role of plant genetic engineering in advancing our understanding of plant metabolism and plant defence mechanisms. As Lurquin points out, many more basic questions regarding collateral gene damage during integration of the new gene into the genome and the control of gene expression must be answered before the technology's potential can be fully realized.

Lurquin's book is the first to describe accurately the history of plant genetic engineering. For students labouring at the bench and getting frustrated at the lack of reproducibility of their experiments, reading this work will provide reassurance. Even scientists who are no longer at the bench, and are now mostly preoccupied with administrative and teaching duties, will find it an important reminder that research is a demanding task, with much disappointment and controversy, and few successes. ■

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More on plant biotechnology

Lords of the harvest: Biotech, Big Money and the Future of Food
by Daniel Charles
Perseus Publishing, $27

Science in culture

Seemingly scientific

Oliver Marsden's abstract paintings.

Martin Kemp

There is an increasing range of imagery in non-figurative or wholly abstract art that is unthinkable without the imaging techniques of recent science. And yet the works themselves tend not to illustrate science, and do not even draw specifically on one kind of scientific image. The beguiling and technically impeccable paintings by the young British artist Oliver Marsden are spectacular cases in point.

A graduate of the Edinburgh College of Art, Marsden is rapidly marking out a distinctive territory for himself. At the tender age of 28, he has already exhibited internationally, including shows at the Spencer Brownstone Gallery in New York. At first sight, his enticing images, on canvases generally more than a metre square, look as if they are taken from science: from cellular and microbiological formations in the earlier works, or from the undulating surfaces of materials viewed in electron microscopes in recent paintings. But they have acquired their scientific 'look' through Marsden's absorption of the vocabulary of those types of images, rather than because they depict specific substances or phenomena.

The old masters selectively remade specific kinds of natural effect rather than imitating what was in front of them (as they obviously had to do when painting a *Crucifixion* or *Rape of Europa*). Similarly, Marsden uses his understanding of the nature of visual effects in scientific imaging to create forms that speak of, and transform, the visual repertoires of contemporary science.

In particular, his paradoxical forms — which appear real and suggestively solid but tend towards physical impossibility and are ultimately nebulous — are in keeping with the problems that indeterminacy of position and state cause for representation in modern physics.

Marsden's latest exhibition, "Waveform 1 2001", is characteristic of recent work in that it has its origin in manipulated three-dimensional shapes on a computer screen. The results are then photographed as 'sketches' for the paintings. Using a combination of conventional brushes and airbrush sprays on immaculately prepared surfaces, the stunning finish of the images results from an interplay between meticulous control and serendipitous process. Marsden relies on what he calls "balanced chaos".

That his pictures are actually painted and not computer-generated matters greatly to Marsden. Their materiality and the traditional connotations of paint on canvas are integral to their effect and to their dialogue with science. Marsden is also aware that the technique of a hand-made artefact evokes the spectator's awe in a way that computer art still tends not to do.

OLIVER MARSDEN/BLUE GALLERY

***WaveForm 1* plays tricks with visual grammar.**

WaveForm 1 looks as if it is the depiction of something tangible. Yet the sharp, contrasted contours of some forms, which lead us to expect that we are dealing with hard, reflective surfaces, melt into the soft convexities and concavities of particulate clouds. Like the 'pictures' generated by a scanning tunnelling electron microscope, his images obey some of the grammar of things seen within our normal visual compass. But they fail to deliver the full range of internally consistent information about the interplay of light and shade and colour and texture to which we have become accustomed in naturalistic pictures, no less than in nature itself.

Marsden is a keen student of the writings of the nuclear physicist David Bohm, whose notion of 'implicate order' has proved particularly suggestive for artists and non-scientists. Bohm's intuition that there may be a level of order that is inevitably inaccessible to our means of scrutiny is suggestively invoked by the fluidity and ambiguities of Marsden's visual conundrums. The artist brings the time-honoured alchemy of pigment on a flat surface into dialogue with the most advanced techniques of imaging in the physical sciences. It is specifically in the tension between the hand-made and the instrumentally generated that an important facet of the fascination of his paintings lies. ■

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Oliver Marsden's "Waveform 1 2001" is on show at the Blue Gallery, 28/29 Great Sutton Street, London EC1, UK, until 1 December 2001.

Visualizations: The Nature Book of Art and Science *is a collection of essays edited by Martin Kemp (published by Oxford University Press and the University of California Press; £20, $35).*