Obituary

Jeff Schell (1935–2003)

What can we learn from a soil bacterium that induces tumours in plants? This was the question that Jeff Schell set out to tackle when, in 1967, he became an associate professor of genetics at what was then called the Rijksuniversiteit Gent. Schell died on 17 April 2003. In the intervening quarter-century, the lessons that he and others extracted from work with the bacterium concerned, *Agrobacterium tumefaciens*, were to provide the basis for the plant biotechnology industry.

In the mid-1960s, it had just become generally accepted that some viruses cause tumours, as was acknowledged with the award of a 1966 Nobel prize to Peyton Rous. But bacteria capable of inducing tumours in animals were unheard of. And although there had long been an awareness of plant tumours called 'crown galls', they generated only minor research interest. Schell, however, wanted to explore at the molecular level what, 20 years previously, Armin Braun had dubbed "tumour-inducing property": the ability of *Agrobacterium* to induce crown galls.

Schell had been trained in Gent as a bacterial taxonomist, and had then had the good fortune to do postdoctoral work with Bill Hayes, the father of bacterial genetics, at Hammersmith Hospital in London. Later, with Lou Siminovitch in Toronto, he discovered the fascinating world of bacteriophage — viruses that infect bacteria. Along with this grounding in bacterial and phage genetics, he had an especial talent for formulating hypotheses and designing experiments to test them. All of this was the perfect background for solving the crown gall puzzle.

Jeff and I had both been active in the same student movements. When he became a professor, his lab was next to mine, and we decided to join forces. A good collection of oncogenic and non-oncogenic strains of *Agrobacterium* was available to us at the taxonomy laboratory where he had done his PhD, and we set to work comparing the strains. We found that tumour-inducing strains of *Agrobacterium* harboured a large element, which we called the Ti-plasmid. And we proposed that some DNA of this Ti-plasmid might become integrated into the genome of its host and induce the crown gall. This hypothesis met with scepticism from most plant physiologists as a seemingly wild and untestable idea — of course, molecular biology was then only just coming into existence.

SCHELL FAMILY

Pioneer of plant genetic engineering

It was not long, however, before the appropriate techniques were developed. With the advent of gene cloning and DNA hybridization by Southern blots, proof came fast that a copy of a segment on the Ti-plasmid was preferentially inserted in expressed DNA sequences of the plant. But why were genes in a bacterium active only in a plant cell?

The answer stemmed from work by Georges Morel and Jacques Tempé, who had shown that the Ti-plasmid causes a plant to produce certain unique amino-acid-derived molecules. From this, Schell developed the concept of 'genetic colonization', according to which the whole *raison d'être* of the Ti-plasmid is making plant cells secrete these molecules, which constitute a source of carbon and nitrogen that only *Agrobacterium* can use. Crown galls, then, constitute a unique ecological niche for the microbe.

The implication of these findings was clear: if DNA was being transferred by *Agrobacterium*, it should be possible to replace the tumour-inducing genes by others that conveyed new traits to plants. The race to turn *Agrobacterium* into a reliable gene vector was on, with fierce competition from Gene Nester at the University of Washington in Seattle, and Mary-Dell Chilton at Washington University and Monsanto in St Louis. Schell was a keen sportsman, with a particular interest in sailing, and he relished competition (especially when he felt he could win). Nonetheless, this was a scientific race conducted on amicable terms, with information being exchanged and synchronized publication of many of the notable papers.

In 1978, Schell had become director of the Max Planck Institute for Plant Breeding Research in Cologne, Germany. This he turned into an international leader in plant research, nurturing generations of students and young scientists from around the world. He continued co-directing the team in Gent, however, and our work culminated in 1983 with the announcement, simultaneously with Chilton and Monsanto, of the *Agrobacterium*-mediated creation of the first genetically modified plants that expressed a new trait.

With this development, plant molecular biology had a key tool with which to flourish: from then on, transgenes and gene regulatory sequences could be routinely transferred into plants. Financiers and agrochemical companies became keen to invest in the new discipline of plant biotechnology through start-up companies focusing on crop improvement. Schell was instrumental in helping many of these industrial initiatives to integrate the findings of fundamental research into their activities. Throughout his career he was concerned about injustice and suffering; he was particularly alarmed by environmental problems, and was convinced that this new technology would be instrumental in achieving more sustainable agricultural practices. He believed that, for all their good intentions, those who wish to ban genetic modification in crops, or who argue that developing countries should reject food-aid with a genetically modified component, are profoundly misguided.

Even though Schell was suffering from a neurodegenerative disease, right up to his death he continued to put the case for the need to apply plant biotechnology to help farmers in developing countries. He was also particularly active in promoting German–Israeli cooperation in the plant sciences, through the Otto Warburg Minerva Center in Jerusalem, which runs joint programmes with the Weizmann Institute and the Hebrew University.

Jeff Schell was not only a thoughtful and innovative scientist, but also an outstanding speaker and a charismatic mentor. And in one sense, the best may be yet to come, for the enduring influence of his work is likely to be seen in many of the advances in agriculture in the decades ahead.

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