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EDITORIAL: REFLECTIONS ON *THE PLANT CELL* CLASSICS

Auxin and Organogenesis: Initiation of Organs and Nurturing a Scientific Spirit

When I was in college, we were taught that auxin positions new organs at the shoot apex. My instructors at the University of Guelph were giving us cutting edge information: this hypothesis was first reported by Reinhardt, Mandel, and Kuhlemeier in *The Plant Cell* in 2000 **(Reinhardt et al., 2000**) when I was halfway through my degree. I remember the elegance of the paper: the beautiful experiments across tomato and Arabidopsis, the fine technical expertise, and the gorgeous scanning electron micrographs. And to this day I use the paper to teach and in my own seminars, as I am sure many others do. It also formed the basis of much of my own work during my postdoctoral tenure in the Kuhlemeier lab and that of many of my colleagues.

At the time, there weren't many phyllotaxis mutants that altered pattern but there was Arabidopsis *pinformed1*; in *The Plant Cell* in 1991 Okada, Ueda, Komaki, Bell, and Shimura reported on the similarity between the naked inflorescence 'pin' in *pin1* and the phenotype of plants treated with auxin transport inhibitors (**Okada et al., 1991**). Based upon these observations, the Kuhlemeier lab decided to take a more chemical approach to perturbing phyllotaxis, jokingly referred to as 'The Sigma Approach' in house. It was considered quite old fashioned, during the heyday of Arabidopsis developmental genetics, to apply chemicals and inhibitors to plants to determine function. However, this approach had previously yielded another seminal paper in the field: in 1997 Fleming, McQueen-Mason, Mandel and Kuhlemeier demonstrated that application of an EXPANSIN protein could trigger organ formation from a tomato shoot apex (Fleming et al., 1997). This was followed by another paper in *The Plant Cell* in 1998 by Reinhardt, Wittwer, Mandel and Kuhlemeier showing that *EXPANSIN* gene expression marked sites of organ initiation in tomato (**Reinhardt et al., 1998**). And so it was that the lab identified auxin as the positioning molecule both sufficient and necessary for organ initiation from the shoot apex.

Looking back, with all of the information we have now on PIN proteins and their role in auxin transport and patterning, auxin biosynthesis in the meristem, and other hormone involvement, one thing is still obvious: if the Kuhlemeier lab had waited for a mutant to reveal the role of auxin in organ initiation we would likely still be waiting. It was their 'old fashioned' approach that catapulted the field forward. But we shouldn't be lulled into thinking that publication of the story was easy! The very things that *The Student Me* found elegant were troublesome: a mix of species and chemicals instead of mutants. But in the end, the data spoke for itself and the paper has stood the test of time while inspiring a plethora of research avenues.

I am quite certain that Cris Kuhlemeier wouldn't see himself as a maverick, but that is exactly how he has always appeared to me and how he has encouraged his trainees to conduct science. Not recklessly, but fearlessly. To be careful and meticulous and in the end the data will support itself. That spirit has been exemplified by the work of Theres Mandel, the meticulous and prolific technician that the Kuhlemeier lab was blessed with. It was passed to Didier Reinhardt (Freiburg, CH) and Andy Fleming (Sheffield, UK) who continue to push forward plant developmental biology. It morphed into a new era of plant computational biology through collaboration with Przemyslaw Prusinkiewicz (Calgary, CA) and the emergence of Richard Smith (Cologne, DE) and Pierre-Barbier de Reuille (Google, UK).

Beyond these impacts is something more personal and phenomenal to me. Looking forward, I am hopeful, because that maverick spirit was passed to a generation of women scientists that passed through the Kuhlemeier lab: Soazig Guyomarc'h (Montpellier, FR), Emanuelle Bayer (Bordeaux, FR), Naomi Nakayama (Edinburgh, UK), Saiko Yoshida (Wageningen, NE), Anne-Lise Routier (Montreal, CA), Sarah Robinson (Cambridge, UK), and myself (Los Angeles, US). Each of these scientists has pushed forward their fields through scientific and technical achievements in spite of the myriad challenges that have been thrown their way. And each of them will hopefully continue to do so well into the future, and pass their spirit onto their trainees. So in the end, while this is the story of a beautiful and elegant paper that jump-started a field, it is also the story of a maverick scientific spirit that moves between generations to stimulate scientific discovery. And I am left equally grateful for the science and the mentorship.

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*References highlighted for the 30th anniversary of *The Plant Cell*.