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Two Men Who Invented Genetics

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Review

TWO MEN WHO INVENTED GENETICS

Oren Solomon Harman, *The Man Who Invented the Chromosome: A Life of Cyril Darlington* (Cambridge, MA: Harvard University Press, 2004), 342 pp., ISBN 0-674-01333-6, $49.95

Paul Berg and Maxine Singer, *George Beadle, an Uncommon Farmer: The Emergence of Genetics in the 20th Century* (Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, 2003), ix + 383 pp., ISBN 0-87969-688-5, $35.00

The historiography of genetics is dominated by tales: of Gregor Mendel's rediscovery, of the 'Golden Age of the Theory of the Gene', as articulated by Thomas Hunt Morgan and his *Drosophila* researchers; and of the molecular revolution ushered in by James Watson and Francis Crick. Although appealing to the general reader, these narratives do not come close to capturing the complexity of their subject. Indeed, scholars know that genetics before the Second World War was not limited to fly rooms, or to Morgan's ideas. On the contrary, gene action and evolution were actively debated in laboratories across the world. Thanks to these new biographies of Darlington and Beadle, we see something of the scale and scope of this activity, through the lives of men who profoundly influenced the conceptual, methodological, and material development of genetics in the twentieth century.

Cyril Darlington was hailed as the 'Newton of cytology'. Yet his major work was initially labelled 'poison for students'. The reasons for this remarkable combination of praise and scorn are masterfully captured in Harman's biography. Born into a middle-class English family in 1903, Darlington attended Wye Agricultural College before landing a position at the John Innes Horticultural Institution in 1923. There, he decided to do research on the chromosomal basis of genetics. He received little supervision from the Director – the great geneticist, William Bateson – but much

from J.B.S. Haldane (a senior colleague after 1928). With Haldane's encouragement, he applied theory to the painstakingly-empirical world of cytology. In so doing, Darlington ushered in a revolution.

Darlington began by asking how and why chromosomes pair; and then applied the same questioning approach to problems of breakage, crossing over, and recombination. This culminated in his *Recent Advances in Cytology* (1933), a groundbreaking work that attempted to unify cytogenetics. Harman highlights Darlington's willingness to postulate generalizations about chromosomal behaviour as products of evolution, and gives a nuanced account of the crucial, yet ambiguous place of chromosomes in the history of evolutionary theory. By depicting chromosomes as evolved systems, Darlington brought evolution back into cytology, and set an agenda for future research.

Regrettably, the reception of his work by cytologists and geneticists was openly hostile, especially in the USA. Harman expertly dissects the American criticism as partly cytological (revolving around debates about chiasmata, crossing-over, and chromosomal pairing); partly methodological (concerning the role of conjecture in cytology); and partly institutional because Darlington appeared to challenge the dominance of T.H. Morgan's theory of the gene and the role of population genetics in the study of evolution.

However, Darlington was undeterred. His second book, *Recent Advances with the Evolution of Genetic Systems* (1939) expanded on its predecessor in advocating a significant role for cytogenetics in evolutionary biology. As a contribution to a 'new' neo-Darwinian synthesis, his work slowly gained supporters, and influenced evolutionary geneticists such as Theodosius Dobzhanksy and G. Ledyard Stebbins. His research won him praise. Between 1939 and 1943, he became Director of the John Innes Horticultural Institution, a Fellow of the Royal Society, and President of the Genetical Society. In 1946, he was awarded the Royal Society's Darwin Medal.

After the war, Darlington turned his interests in cytoplasmic inheritance towards the interplay between science and politics. These elements came together in his comments on Lysenkoism. Darlington was sympathetic to aspects of Lysenko's research, but he unreservedly condemned – in *The Conflict of Science and Society* (1948) – the persecution of Soviet geneticists. In the 1950s, Darlington turned to the promotion of 'social genetics'.

His interest in racial differences was first expressed in *The Facts of Life* (1953), and later in *The Evolution of Man and Society*

(1969). Although he acknowledged the variability and adaptability of groups, Darlington was at heart a genetic determinist who believed in race as a meaningful set of biological categories. Such views inspired hostility at a time when eugenics was being absorbed into human genetics. Darlington's intellectual opposition to UNESCO's official position that there was no scientific basis for race, set him against most of his fellow geneticists. His determinism and 'racism' came together in his last book, *The Little Universe of Man* (1978). By the end of his career, what were generally taken as his conservative scientific and political views had pushed him to the margins of his profession.

It is tempting to write off the later Darlington as a crank, especially when confronted with his extreme statements and the reactions they inspired. However, Harman's biography makes such a dismissal impossible. For, without becoming an apologist, Harman helps us to understand why Darlington held these views and defended them so strongly. By analysing the reception of Darlington's work, his personality, and his networks, Harman helps us keep Darlington's world view in perspective. This balance transforms a good biography into a remarkable work of scholarship.

Where Darlington comes across as brash and rebellious, George Beadle is portrayed by Paul Berg and Maxine Singer as a solid citizen – good-humoured, hard-working, and even-tempered. Best known for his Nobel Prize-winning work in biochemical genetics, Beadle also made important contributions to developmental and maize genetics. Moreover, he built up the biology departments at the California Institute of Technology (CalTech) and the University of Chicago, where he became President. In their thoughtful account, Berg and Singer have done their subject justice, tracing Beadle's growth as a scientist and his role in the history of biology.

Born in Nebraska, and educated at the University of Nebraska and Cornell, Beadle began his career (as he would end it) in maize genetics. His research earned him a place as a research associate at CalTech in the 1930s, where – under Thomas Hunt Morgan – he sought to understand the connection between biological development and genetics. Berg and Singer beautifully describe the scientific and social context of this early work. The Fly Group at CalTech was large and exciting. Beadle was drawn into the *Drosophilists*' social network, and soon began his own fly research. In collaboration with Boris Ephrussi, he performed a series of painstaking transplantation experiments that established the

biochemical basis of *Drosophila's* eye colour. Berg and Singer clearly appreciate both the difficulty of these experiments, and their importance in directing Beadle's later interests.

In 1936, after Morgan failed to obtain funding to keep him at CalTech, Beadle went to Harvard. This he found 'too formal for a Wahoo farm boy' (p. 116), and a year later, he was hired by Stanford. There he brought in a young biochemist, Edward Tatum. Beadle and Tatum were scooped in the chemistry of eye-colour pigments by the German biochemist Adolf Butenandt, but – inspired by Tatum's lectures – Beadle decided to switch organisms, from fruit flies to moulds. In so doing, he exchanged a familiar genetic system for a well-known biochemical system. Their joint research resulted in the 'one gene/one enzyme' hypothesis, which claimed that each enzymatic catalyst in any given step in a metabolic pathway corresponds to a single gene. This genetic dissection of metabolism became an important milestone in the rise of molecular biology.

Beadle's achievements as an institution builder were no less remarkable. After the Second World War, he was lured from Stanford back to CalTech, thanks to the efforts of Linus Pauling. Between them, Beadle and Pauling secured the funding, talent, and facilities that put CalTech at the cutting edge of molecular biology. In 1954, Beadle became President of the American Association for the Advancement of Science, and in 1958 (with Edward Tatum and Joshua Lederberg), won the Nobel Prize. Three years later, he became President of the University of Chicago, where he remained until 1968. Charged with restoring the University's reputation, Beadle immediately threw himself into fundraising, recruitment, and improving links with the community. Under Beadle's guidance, the University's prestige rose, and survived the student unrest of the time.

Beadle retired in 1968 when he turned sixty-five. In his 'retirement', he returned to the study of maize, and engaged in heated debates on its origins. As early as 1939, he had proposed that *teosinte* – a hardy perennial grass – was similar to the ancestor of cultivated corn. Between 1939 and 1968, Paul Mangelsdorf, a Harvard biologist, had argued that cultivated corn preceded the appearance of *teosinte*. In collaboration with scientists in the USA and Mexico, Beadle tested these ideas with experiments and 'mutant hunts' involving tens of thousands of corn plants. His debate with Mangelsdorf was never resolved, but advances in molecular biology eventually made it possible to close the controversy in Beadle's

favour. Beadle died in 1989, after a nine-year battle with Alzheimer's disease.

With the help of archives and interviews, Singer and Berg give an admirably-balanced presentation of Beadle's life. However, their work would have been enriched by reference to the now extensive literature in the history of genetics. For example, Beadle's own account of his contribution to biochemical genetics singles out Archibald Garrod as the field's neglected originator. This type of 'neglect story' is well known in the history of genetics.[1] In this case, however, the Beadle-Garrod narrative overlooks a large body of work in physiological and developmental genetics, which occurred in the years between Garrod's research and the 'one gene/one enzyme' hypothesis, including Beadle's earlier work with Ephrussi. A more critical account of why Beadle offered this kind of narrative – and whether it reflected Beadle's own intellectual trajectory – would have helped to settle the issue.

Nevertheless, Singer and Berg offer readers a deep appreciation of Beadle's life. They, with Harman, reveal some of the complex trajectories that helped shape the transformation of biology into a molecular science.

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[1] Jann Sapp, *Genesis: The Evolution of Biology* (Oxford: Oxford University Press, 2003).