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A Scientific Entrepreneur

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George Beadle: An Uncommon Farmer. The Emergence of Genetics in the 20th Century. Paul Berg and Maxine Singer. x + 383 pages. Cold Spring Harbor Laboratory Press, 2003. $35.

When leading scientists, with the greater part of their career behind them, embark on writing a biography of a hero in their own discipline, professional historians of science are usually skeptical, and rightly so. Such narratives almost invariably follow the "standing on the shoulders of giants" trope and as a result tend to be hagiographic (the taller the subject, the higher the author stands), Whiggish (the subject's role in history is to pave the way to the author's work) and unreliable (colleagues' memories have never made good historical scholarship). But in *George Beadle,* by Paul Berg and Maxine Singer, we have something very different: a meticulously investigated, historically contextualized and finely written biography of one of the central figures of 20th-century genetics.

George Beadle was born in 1903 on a farm in Nebraska. After attending the University of Nebraska's College of Agriculture in Lincoln, the young Beadle went to graduate school at Cornell University. There he became attracted by Rollins Emerson's genetics group, which included Barbara McClintock, who was working with maize, exploring the new approaches of cytogenetics. Beadle developed strong ties with McClintock and took up research on mutations associated with sterility of corn plants.

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After earning his Ph.D., Beadle moved to the California Institute of Technology, where he joined Thomas Hunt Morgan's *Drosophila* group. There, most of the genetic research concerned the mechanisms of gene transmission. The mode of expression of genes, on the other hand, and their role in controlling embryonic development, remained obscure. Beadle decided to join forces with the French embryologist Boris Ephrussi (who visited Caltech in 1934) and to spend a year in Paris to address those questions. The complementary skills of the two researchers allowed them to show that an eye-color mutation in *Drosophila* could in some cases be overcome by transplanting tiny embryonic eye buds from one mutant larva to another. This suggested that genes specified a necessary step for the metabolism of diffusible substances responsible for the eye pigments.

Beadle's failure to determine the chemical nature of those substances brought him to adopt a new strategy: As a professor at Stanford he took the fungus *Neurospora* as his model organism and decided to reverse the experimental approach he had used up until that point. Instead of starting with a mutation and then searching for the affected chemical reaction, why not search for mutations affecting known chemical reactions? Taking this approach, Beadle and the biochemist Edward Tatum were able to isolate a number of nutritional-deficiency mutants and identify the responsible genes. This led them to suggest the famous "one gene—one enzyme" hypothesis, which posited that each gene specifies the production of a single enzyme.

Throughout the war, Beadle continued research in that direction. In 1946, however, he became chairman of the division of biology at Caltech, a position Morgan had occupied earlier. Together with Linus Pauling, who chaired the division of chemistry, he developed grandiose plans for the

institution, trying to capitalize on the postwar expansion of funds available for research. In 1958, Beadle was awarded the Nobel Prize, together with Tatum and Joshua Lederberg. By that point he was a full-time science administrator, with no time left for his own research.

In 1961, Beadle became even more remote from the laboratory when he was appointed president of the University of Chicago. He was gifted at raising not only corn, flies and fungus, but also money, and he succeeded in finding $160 million for the university. He retired in 1967, just after having faced the beginning of turmoil and sit-ins on campus. Only then did he return to research on the origin of corn, which he continued almost until his death in 1989.

Berg and Singer have used an impressive amount of archival material and conducted numerous interviews with persons who knew Beadle. The authors have also relied on previous historical scholarship, notably the important contributions of Lily Kay, Robert Kohler and Garland Allen. However, the research of others, such as Susan Lindee, Nicolas Rasmussen and Michel Morange, is curiously absent from the bibliography; this work should have been mentioned in the text, too, because it covers some of the same ground as Berg and Singer. With a bit more careful editing, some inaccuracies could have been avoided (Max Delbrück was awarded the Nobel Prize not in 1975, but in 1969), as well as several repetitions. Except for these small flaws, the book is a most valuable contribution to our understanding, not only of Beadle's life, but also of the transformation of genetics in the 20th century.

The treatment of the one gene—one enzyme hypothesis is particularly illuminating. It is usually described simply as a "discovery" published in 1941, but Berg and Singer give a much more complex picture of what was initially a simplifying and heuristic hypothesis rather than a description of how things were really supposed to be. Resistance to this simplification was strong and lasted for more than a decade. However, the book's greatest strength lies elsewhere, in the light it sheds on the genesis of experimental procedures and the broader context in which science is done.

Beadle worked with three completely different model organisms in less than 20 years. The move from one to the next proved crucial to each of his intellectual contributions, and Berg and Singer appropriately underline the importance of these transitions and their practical consequences. They also describe the very peculiar style of interactive and collaborative research prevalent in Morgan's fly community at Columbia and then Caltech, in Emerson's corn group at Cornell, and later in the *Neurospora* community at Stanford. This way of depersonalizing the source of ideas proved to be particularly productive in each of these different fields. It opens the question of the mode of cultural transmission of these research styles, which, as the authors rightly stress, have played a large role in the rise of molecular biology—as was the case, for example, for the phage group gathered around Max Delbrück at Caltech.

Berg and Singer nicely describe the "competitive collaboration" between Ephrussi in Paris and Beadle at Stanford, and the different ways scientific collaboration was understood on both sides of the Atlantic. This perspective could have benefited from a further comparison with a similar study recently published by historian of science Jean-Paul Gaudillière on a similar "competitive collaboration" between Lederberg and Jacques Monod in the immediate postwar years. These contrasting ways of dealing with scientific collaboration are very revealing of cultural heterogeneities. Finally, Beadle's career also highlights how productive research can be at the interface of different fields: cytology and genetics with maize, embryology and genetics with *Drosophila* and biochemistry and genetics with *Neurospora*.

This biography also illuminates the figure of Beadle as a scientific entrepreneur involved in the management of research and the politics of science. Particularly fascinating is how, for example, Beadle was able to make his nutritional deficiency studies relevant to the war effort, negotiating the boundaries between pure and applied science. Berg and Singer also describe how, during the McCarthy era, Beadle was confronted with loyalty and security issues. In one of the most interesting chapters, they describe Beadle's consultancy with the Atomic Energy Commission and his participation on official committees studying the biological effects of atomic radiation. The authors make a very welcome contribution to the growing evidence on the links between the

postwar "Atomic Age" and the rise of genetics and molecular sciences. The tremendous interest, and fear, surrounding the promises of atomic energy opened new professional opportunities for those who could, for example, assess the short- and long-term health risks posed by this technology. Geneticists like Beadle were ideally positioned to seize these chances.

This biography of Beadle thus represents an essential contribution to the history of science. It should be a good read for anyone interested in the development of genetics in the 20th century.

Reviewer Information

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