https://doi.org/10.1038/s41477-023-01534-6

Data before dogma

Forty years ago, Barbara McClintock – an exceptional plant scientist – was awarded the Nobel Prize for Physiology or Medicine; only the third woman to win a Nobel prize without collaborators.

The beginning of October in the scientific calendar is Nobel Prize time, but it is a safe bet that none of the 2023 laureates will be plant biologists. Nobel prizes have been awarded to plant biologists on no more than four occasions and there is room to debate whether all of those really count. Given that the Nobel prizes are officially for "those who, during the preceding year, have conferred the greatest benefit to humankind" in physics, chemistry, physiology or medicine, literature and peace, this may not be too surprising. But the study of plants on many occasions has illuminated processes that take place across the kingdoms of life, including animals and even humans.

This year marks the 40th anniversary of a 'plant' Nobel prize, which was awarded to Barbara McClintock for "her discovery of mobile genetic elements" – that is, the phenomenon of transposition and the transposable elements that move and copy themselves throughout an organism's genome. She was 81 at the time, having been born in June 1902 in Hartford, Connecticut, and the prize had been quite a long time coming; the original experimental work behind it was mainly performed in the 1940s and 1950s.

McClintock began her scientific career at Cornell University, where she was introduced to her lifelong research companion – the maize plant. While there, she made discoveries that have proved fundamental to our knowledge of genetics. It could be argued that the award of only a single Nobel prize is undervaluing her importance. For example, she was the first person to observe the crossing over of chromosomes during meiosis, which is the principal mechanism for the recombination of genetic material[1]. She also identified 'ring chromosomes', which form by the joining together of the ends of chromosomes after irradiation[2]. This led her to hypothesize that chromosome ends were protected by a specialist structure, an idea that was not confirmed until decades later with the discovery of telomeres. While at Cornell she also studied a number of other chromosomes structures, such as the nucleolus organizing centre.

Dr Barbara McClintock at Cold Spring Harbor Laboratory.

In 1941, after a five-year stint at the University of Missouri, McClintock moved to Cold Spring Harbor Laboratory, where she lived and worked for the rest of her life. There she continued her studies on chromosome breakage and repair. By observing this at the cytological level and comparing it with changes in the characteristics of maize kernels, she identified two loci (*dissociations* and *activator*) that could change their position within the maize genome and found that insertion of these loci could lead to mutations that would be reversed following subsequent movement of the elements from the mutated genes[3]. The first transposons, or 'jumping genes', had been identified.

McClintock was able to comprehend what was happening at the genetic level on the basis of the gross anatomy of chromosomes and changing colours of corn kernels well before the structure of DNA was solved and the physical reality of genes was determined; the majority of geneticists were not able to follow her logic as the concept of transposition did not fit with existing understandings of essentially Mendelian genetics. Her work was largely ignored, to the point that she stopped publishing her findings in scientific journals and simply documented her results in the annual reports to the Carnegie Institution of Washington (which financed the research). This lack of recognition did not worry McClintock unduly. In her banquet speech following acceptance of her Nobel prize she recalls that "Instead of causing personal difficulties, this long interval [of obscurity] proved to be a delight. It allowed complete freedom to continue investigations without interruption, and for the pure joy they provided" (ref. 4). It was not until the 1970s and the development of molecular techniques, which led to the identification of transposons in other organisms and the realization of their essential ubiquity, that McClintock's work began to receive the prominence that it deserved.

Personally, Barbara McClintock was generous and kind and had a well-developed sense of fun. Those who knew and worked with her tell stories of her long and wide-ranging discussion fuelled by tea and homemade brownies with black walnuts, walnuts that she cracked by driving her car over them[5]. Of having the gift of a bouquet of variegated carnations immediately dissected with a scalpel to show how the colouration pattern was created. And of how, when finally being told that she had been awarded the Nobel prize (she was hard to find as she was out collecting walnuts in the grounds of Cold Spring Harbor Laboratory), she "stopped for a second, smiled, and said, 'That's nice.'" (ref. 5). Later that day she attended the press conference about her win incognito, wearing a Groucho Marx mask as a disguise.

Barbara McClintock was an exceptional scientist and human being with a clarity of understanding that allowed her to trust her data above all things – however unpopular the conclusions. Hopefully this year's laureates are similarly endowed, whether plant scientists or not.

Published online: 18 September 2023

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