Mendelian inheritance

The bicentenary of the birth of Mendel is an opportunity to explore the origins of genetics and to confront some of its difficult subsequent history.

Few scientists have a detailed scholarly knowledge of the history of science — after all, it is a specialist discipline in its own right. But most biologists have a general appreciation of the key stories in the founding of our field. Two stories that spring to mind are: Darwin being hesitant to publish his theory of evolution for decades until he was spurred on by Wallace who had arrived at the same conclusions; and Mendel and his laws of inheritance, which spent 35 years in obscurity before being rediscovered posthumously at the beginning of the twentieth century. The relationship, or lack thereof, between the two scientists is also well appreciated. Mendel, like most scientists in the years following 1859, was well aware of Darwin's work and the furore that surrounded it, although what he actually thought about it is a matter of conjecture (*Heredity* **124**, 263–273; 2020). Darwin, on the other hand, was almost certainly unaware of Mendel's work, even though both of them corresponded simultaneously from 1867 with botanist Carl Wilhelm von Nägeli. Following the rediscovery of Mendel's work, it then took several decades of debate about how the continuous variation seen in nature could arise from discrete mutations before the modern synthesis established firmly that genetics, as instigated by Mendel (albeit without him having used the term), is not only compatible with evolution, but provides its essential basis.

On the two-hundredth anniversary of his birth, it is worth probing a bit further into the life and work of Gregor Mendel, and how it echoes down the ages (see *The Monk in the Garden* by Robin Marantz Henig). Mendel was born on 20 July 1822 in part of the Austrian Empire that is now Czechia. He spent almost his entire adult life as a monk in the Augustinian monastery in Brno (then Brünn), serving as abbot for the last 17 years of his life. Although probably a shy individual, he was not the reclusive monk of popular imagination. Augustinian friars, unlike some other Catholic monastic orders, participated in civic life. Mendel was not only an active teacher but was also involved in the local scientific society and was even, as a result of being abbot, a director of the regional bank. His academic career was relatively unsuccessful, with two failed attempts to pass his formal teaching exams, but monastery life offered him the time and the space to pursue his scientific interests. These were not without some interference — it is thanks to the disapproval of the bishop that he switched his attention from breeding mice to breeding peas, which may have been crucial in allowing him to deduce his laws of inheritance.

During the late 1850s and early 1860s, Mendel conducted a series of now legendary crosses between different strains of *Pisum sativum*, which allowed him to tease apart how dominant and recessive traits are inherited. There are no surviving notebooks from these experiments, just the detailed description in his famous 1866 manuscript. For this reason, we will probably never know to what extent it was luck or the use of exploratory results that led to his focus on single-gene unlinked traits with simple dominance, without which he would have been unlikely to be able to draw the conclusions that he did. Although he reported his results formally in the local scientific society's journal and distributed several reprints to notable scientists, he did not have the easy access to the network of elite scientists that Darwin had, which allowed Darwin's and Wallace's results to be reported to the Linnean Society. This probably largely explains Mendel's work being overlooked until after his death, and we are left to speculate on what could have been had someone like Darwin become aware of it. Darwin famously proposed an unsatisfactory theory of blending inheritance, insufficient to serve as the basis for natural selection. Yet, it is not at all obvious that the implications of what might have seemed niche results in horticultural breeding would have been clear to Darwin or contemporary evolutionists. It is also worth noting that a year after his paper was published, Mendel became his monastery's abbot and no longer had time for his scientific work. Instead, he spent much of his final years engaged in a dispute with the local authorities over the taxation of monasteries. As a result, he did not engage in the refinement and promotion of his ideas that most scientists need for their work to garner acceptance.

The interconnected fields of evolution and genetics, both of which trace their origins to Darwin and Mendel, form the backbone of modern biology. But they have also been invoked to justify racism and some of this period's worst atrocities including mass sterilisation and genocide, largely through ideas associated with eugenics. We should resist the urge to excuse this involvement by arguing that eugenics and related ideas were merely misappropriated versions of genetics and evolution. Yes, they were twisted, but there has always been a social responsibility that comes with research in behaviour and heredity to be proactive in contextualising results and anticipating misuse (see *Nature* **606**, 434; 2022 for recent *Nature* Portfolio advice on harm that can arise from research). It is difficult to pin much blame on a man who almost exclusively conducted plant breeding experiments and made no known attempt to connect them with human behavioural variation. That said, the fact that he had previously worked with mice suggests that he must have, to some extent, contemplated the relevance of heredity across the tree of life.

These are difficult historical and ethical questions that will continue to be debated. Perhaps the best thing we can say with certainty is that we should be vigilant of the implications of all scientific results, however unlikely they seem at the time. The ability of a result to open up undreamt-of new directions is both the beauty and the danger of science. ❐

Published online: 7 July 2022
https://doi.org/10.1038/s41559-022-01834-8