# LEAPS IN THE DARK

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# PREFACE

In 2002, Oxford University Press published my book *Fabulous Science: Fact and Fiction in the History of Scientific Discovery*. Its chief aim was to make cutting-edge research undertaken by historians of science much more widely accessible. The central theme of the book was that science, like other highly regarded spheres of human activity, has a tendency to create foundation myths. On close inspection, much of the received history of science, that vivid tapestry of Eureka moments, farseeing geniuses, jealous rivals, and bigoted clerics, turns out to have little basis in historical fact. Some of the most famous stories of scientific discovery are not much more than tribal tales, packed with inspirational value but extremely unreliable as accounts of the past.

As in this book, in *Fabulous Science* I employed a series of separate case studies to contrast fact with myth. Covering a wide range of fields, from physics to medicine, from Darwinism to management theory, and from epidemiology to genetics, it also sought to make a more general point: that our understanding of the history of science has been skewed by something called presentism, our tendency for judging past ideas solely by how closely they approximate to current orthodoxies. In this follow-up volume I've given greater prominence to case studies showing that those scientists who were eventually proven wrong were rarely the dullards or envious mediocrities of the standard histories. History's also-rans, often pressed into the role of fool or bigot, were often competent scientists, and their theories were perfectly good efforts for their times.

The following case studies try to cut through the layers of myth to tell more nuanced stories about the scientific enterprise. They also explore why certain individuals have achieved heroic status and how certain myths have proven so incredibly long-lasting. Once again, however, the book's main thrust is that the history of scientific discovery needs to be contextualized if we're to have any chance of understanding how we came to know so much about the world around us.

John Waller
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# THE PAST REALLY IS ANOTHER COUNTRY

Life is lived forwards, but understood backwards.

Attributed to Søren Kierkegaard

This collection of ten essays has a consistent theme: that in the history of science nothing is straightforward. Few cutting-edge experiments are ever actually decisive. Only occasionally do truths about nature reveal themselves in sudden moments of thrilling clarity. One cannot even identify a single approach that's guaranteed to keep scientists from falling into error. And although we often talk of the 'scientific method' as a unitary thing, a set of hard and fast rules that ensures progress so long as we're looking in the right direction, it really isn't like this. The early phase of developing a scientific theory entails pursuing hunches and preconceptions even in the face of unpromising experimental data. If the idea turns out to be credible then the discoverer is fêted for his or her profound intuition; if it's rejected they're likely to be condemned for overenthusiasm.

As this suggests, we're usually not terribly fair to those later judged to have got it wrong. We tend to forget how hard it is to prove a new theory and so, if they're remembered at all, we condemn the also-rans with unflinching severity. By the same token, we're often too misty-eyed about those who came up with ideas approximating to what we now believe. We overlook the fact that our heroes didn't always arrive at their ideas by a route we'd consider either rational or direct. Moreover, in many cases their evidence was anything but decisive, and their rivals absolutely correct to carry on the fight even years after what we now consider to be the truth had actually emerged. In other cases, those celebrated today as 'father figures' of one or other discipline didn't actually say what we're taught they did. Indeed, some heroic reputations are almost entirely the product of myth-makers. Occasionally, they're the result of self-aggrandizement.

Science may be the only reliable approach for making sense of the world we live in. But as these few lines suggest (and most scientists freely acknowledge),

the process of discovery is a convoluted and long-drawn-out affair. Behind the trusty formula of the far-seeing hero and the story of triumph over adversity there is usually a much subtler but no less gripping reality of flawed geniuses, inadequate experiments, stabs in the dark, blind alleys, and, above all, a natural world of such treacherous complexity that brilliant men and women have been at least as likely to get it wrong as to get it right.

Unfortunately, however, the rich ambiguities of scientific research are often obscured by the way the history of scientific discovery gets told. In particular, there's a strong predilection among science writers for squeezing episodes of scientific discovery into a predictable but not very realistic three-act drama. The cast, theme, and time-scale vary, but the plot could hardly be more familiar: the hero arrives at a new idea (Act I), suffers the wrath of jealousy, conservatism, and clerical bigotry (Act II), and is then triumphantly vindicated (Act III). It's undoubtedly uplifting, but in most cases sadly lacking in accuracy.

Needless to say, not all popular accounts of scientific discovery ignore the complexities involved in doing science. Some popular science writers (one thinks particularly of the late Stephen Jay Gould) have explored with great eloquence the subtleties of the great scientific endeavour. But consider the spate of recent books with subtitles along the lines of 'The Invention that Changed the World', 'The Man who Invented Time', 'How One Man Changed the Way We See the World', and 'The Story of One Man's War Against the Establishment, Ignorance and the Deadly Scurvy'. Each is the story of, to quote from a best-selling example, 'just one man, doing it all by himself, imagining the unimaginable' and facing down 'purblind churchly certainty' and the ignorant criticism of 'dreamily unscientific' opponents. For all the many merits of these books in other respects, in each case a complex story has been shoe-horned into a single, ready-made schema. The result is that the messiness of reality is written out of existence and the ambiguities that make science so interesting are left behind.

This fondness for Great Man histories of science is regrettable because heroic dramas tell us little about how science progresses or about what scientists are up against in trying to advance our knowledge of the natural world. The aim of this book is to show, from several different angles, how misleading the notion of the lone embattled genius can be. The first three chapters look at three of history's villains or also-rans, men who advanced ideas often characterized today as irrational, pre-scientific, or just downright silly. In each case I aim to show that, given the limitations

of knowledge at the time, all three formulated perfectly rational and persuasive theories. With hindsight we can see that they were misguided, but it was not through any deficiencies in reason or investigative flair that they drifted into error. Those deemed right in the long run, I will argue, have rarely had a monopoly over reason and good sense.

The next three chapters explore that staple of romantic histories, the world-changing experiment or demonstration. Examining celebrated moments in the lives of Isaac Newton, James Lind, and Ignaz Semmelweis, I attempt to demonstrate that no matter how obvious an idea might seem to us, those who come up with new theories rarely have the ability to prove them correct straight away. In most cases, it requires the development of new approaches or the refinement of old concepts, tools, and apparatus before a hunch supported by partial data can be turned into a well-attested scientific theory. Sometimes, bold new claims can only be substantiated after the originator's death. This is usually the basis for making them into far-seeing heroes spurned by inferior contemporaries. But what it really tells us, in most instances, is that our heroes weren't always sure-footed and their opponents were very often right to stick with what they'd been taught, at least until more compelling evidence was presented.

The final chapters shift the focus to the construction of heroic scientific reputations. All four subjects are revered as father figures of their disciplines, credited with opening up whole new vistas of knowledge in the fields of psychiatry, medicine, and physics. On closer inspection, however, it becomes clear that two of our quartet simply didn't say or do what most textbook accounts assert. The remaining pair *were* involved in important discoveries or developments, but they're singled out today mostly because they embellished their roles, attaching to their own names contributions actually made by others.

The main contention of this book is that we need to be very suspicious of any historical account of scientific discovery involving the romantic cliché of the man or woman before their rightful time. It's not that there haven't been individuals of exceptional ability or cases of great minds being frustrated by ignorant and mean-spirited opposition. The problem lies in our tendency to romanticize the past. There is now hardly a significant idea in the realm of science that isn't associated with a Eureka moment or a chance observation leading to an earth-shattering realization. A few of these stories are genuine, yet most are flawed to varying degrees, and many have no basis at all.

There are many reasons why the myths looked at in this book arose and were

then successfully propagated. Among the most important is what historians call 'presentism', a major pitfall in writing about the past, defined by Stephen Jay Gould as the 'mistaken use of present criteria to judge a distant and different past'. In history of science scholarship this trait has produced some pretty major distortions, and is in one way or another relevant to each of the following stories. Most obviously, presentism leads historians to focus only upon scientific ideas that have come to inform modern scientific paradigms. Historians must, of course, seek to explain how the present came to be as it is. But rather than trying to reconstruct how our forebears saw the world, presentist historians, professional or amateur, plunder past world-views for anything that sounds even vaguely like something we believe in today, and cast everything else aside as unimportant.

Studying the past in this way is rather like trying to write an accurate account of our planet's evolutionary past by looking only at lineages with descendants alive today. We can't hope to gain a true appreciation of the scientific enterprise unless we investigate those ideas now thought to be wrong, as well as the tiny fraction now judged to have been correct. It would be unreasonable to expect scholars to give equal time to the losers but I think it's a mistake to assume that only scientists on the winning side are worthy of our attention.

One of the reasons why some writers simplify the process of scientific discovery is that, with the benefit of hindsight, current orthodoxies and the quickest ways of getting to them can seem so obvious that we're led to assume that this must have been the route taken. Thus blind alleys, false scents, dead ends, and the circuitous and circular routes along which scientists actually travelled before arriving at their ideas about nature are overlooked. It's striking that this way of thinking about the path to discovery is even embedded in the genre of the scientific article. The Nobel Prize-winning biologist Sir Peter Medawar argued that all scientific papers are in a sense fraudulent because they deliberately smooth out the route to the conclusions they present. '[T]he scientific paper in its orthodox form,' he observed, 'does embody a totally mistaken conception, even a travesty, of the nature of scientific thought.' As Medawar himself appreciated, the path of scientific progress is rarely 'broad and straight'. By failing to acknowledge either wrong turns or the meandering routes taken, we end up with a crudely triumphalist account that does scant justice to the complexities of scientific advance.

Many of the errors associated with presentism are embodied in the way that the expression 'scientific discovery' is normally used. In most usages, the term elides three quite different things: the birth of a new idea (we might call this its *genesis*);

the accumulation of data suggesting that the idea has merit, often referred to as the stage of *verification*; and the juncture at which fair-minded peers recognize that the case has indeed been proven, or the point of *acceptance*. In old-fashioned histories, the first two steps, genesis and verification, are usually telescoped into a single instant of rationality when the clouds parted and the truth was revealed. We've already touched on some of the problems with telling the history of science in this manner. In reality, the way an important new idea is put forward may be anything but rational. Some of the most powerful concepts and organizing principles of modern science originated from obscure sources and were backed up with arguments that would today be considered absurd. As this implies, just because someone comes up with an idea that's later vindicated isn't to say that everyone ought to have downed tools and come running.

Nicolaus Copernicus' 1534 claim that the Earth revolves around the Sun provides an excellent example. We now know that in most important respects Copernicus was right. But even if his suggestion did lead to a simpler way of plotting the movements of the celestial spheres, it's hardly surprising that most of his contemporaries preferred to go on as before. Because Copernicus had no idea that the planets move in ellipses, not perfect circles, his version of heliocentrism failed to fit with the observed movements of the planets. In contrast, the long-established Aristotelian system seemed to explain every single movement of every single thing in the Universe. Copernicans were expecting people to abandon a very plausible theory of everything in exchange for an imperfect theory of just one thing. Not surprisingly, there weren't many takers.

Presentism masks these ambiguities. Having scoured history for precursors, the historian will often cast as a far-seeing hero anyone who described the world in a way even broadly in line with current knowledge. They do not always stop to consider how good their hero's evidence was at the time or how he came up with his 'great' idea. Wrongly assuming that scientific 'truth' can arise only from the most rational enquiry and that alternative theories were obviously based on sloppy research and loose conjecture, presentist historians conflate the emergence of the new concept with its becoming sufficiently credible to be worthy of wider notice. This is what gives rise to many of those canonical narratives in which a new scientific theory is said to have been devised and confirmed almost simultaneously, but then had to endure years of neglect due to the ignoble hostility of lesser minds. As several chapters in this book suggest, it's rather more common for the real hiatus to come not between the stages of verification and acceptance but between those of

genesis and verification. Doubtless, many critics of new ideas have mixed motives. But the evidence so far suggests that a credible scientific theory will usually gain acceptance once a decent empirical case has been made.

Aside from their being inaccurate and unhelpful, to my mind there are three main problems with the preponderance of presentist myths in the history of science. First, in order to make a few individuals seem like gods among men, too many of history's scientists, and for that matter clerics, have been unjustly demonized. The first three chapters of this book are at least in part intended as a defence of the also-rans. Second, by asserting that most radical scientific ideas have to weather storms of ignorant and bigoted opposition, we undervalue the scientific community's impulse to criticize, correct, and dampen overenthusiasm. This is what makes it such a successful enterprise. Last, and I think most important, by disguising the true difficulties of doing science, our myths often prevent us from realizing just how impressive it is that scientists have managed to accomplish what they have. In this sense, demythologizing the history of science can only enhance our respect for scientists, both those of the present and those in the past.