The man who knew power

A look at one of the key figures in the development of the atomic bomb.

Edward Teller: the Real Dr Strangelove
by Peter Goodchild
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Don't look back: Edward Teller denied having been in favour of dropping the bomb on Hiroshima.

More than twenty years ago, Peter Goodchild, a television producer at the BBC, wrote a book about J. Robert Oppenheimer, father of the atomic bomb. Now he turns his attention to the man who became Oppenheimer's foe, the nuclear-weapons physicist and policy adviser Edward Teller, who died last year. The book on Teller is a useful, although error-prone, popular history that should help to guide the writing of more scholarly, probing, careful and better volumes. In the interim, this engaging biography will stand as the best single book on Teller's whole life.

The book is largely fluent, often gripping, sometimes insightful and occasionally poignant — in short, it is a good read. However, it sometimes understates its dependence on other published works, notably Gregg Herken's *Brotherhood of the Bomb* (Henry Holt, 2002), which devotes about 100 pages to Teller.

One of the most controversial US scientists of the post-war years, Teller was a Hungarian emigré of Jewish descent who went to the United States in 1935. He is best known to the public and much of the science world not for his formal contributions to theoretical physics, but for his efforts on, and disputes about, nuclear weapons and nuclear policy. These included his campaign for the hydrogen bomb, his negative testimony in 1954 when Oppenheimer was accused of disloyalty, his opposition to the test-ban treaty, and his crusades for civilian nuclear power and for the US Strategic Defence Initiative (SDI), or 'star wars' programme.

Despite the book's possibly polemical subtitle, Goodchild usually weaves a path between the views of Teller's admirers and his enemies, though tilting more to the side of unfriendly critics. He does not directly challenge Teller's sincerity, but occasionally laments his pursuit of power and the compromises, in Goodchild's view, that such a quest presumably propelled Teller to make.

Many studies of Teller note the troubling discrepancies between the archival (and sometimes public) record and Teller's own claims about major issues and events. Among others, these include Teller's different attitudes before and after Hiroshima on the use of the atomic bomb, his many dealings with Oppenheimer, his testimony in the Oppenheimer loyalty hearing, and his excessively optimistic reports about the SDI. But unlike most analysts, Goodchild avoids making firm judgements on whether these discrepancies have their roots in lies or self-deception, or perhaps some other kind of innocent error.

While discussing these discrepancies, Goodchild quotes his recent interview with Edward Teller's son, Paul, a philosophy professor at the University of California, Davis. Paul Teller says his father was the most honest man he knows, and concludes that the emotional quality of some disputes distorted his father's recollections, producing honestly held, but possibly inaccurate, memories. Edward Teller's foes would obviously be less charitable, and some quoted interviews in the book point in that direction.

The book deals uneasily with the troubling issue of Teller's pre-Hiroshima attitude about using the atomic bomb on Japan in 1945. He actually supported combat use of the bomb, apparently without a prior non-combat demonstration to warn Japan of its power. Unfortunately, because of inadequate research, Goodchild does not recognize how greatly Teller struggled in the aftermath of Hiroshima and Nagasaki to rewrite his own pre-Hiroshima past on the bomb's use.

To help understand Teller generally, Goodchild uses pieces of Teller's frequently fascinating correspondence in the 1940s and 1950s with physicist Maria Goeppert Mayer, who won a Nobel Prize in 1963 for discoveries concerning nuclear shell structure. Quoting from those sometimes obliquely flirtatious letters, Goodchild skilfully captures arresting glimpses of the self-doubting, argumentative, spirited, brooding, wary and embattled Teller. With Maria, he often played the role of the wayward imp and made her the adult scold.

Goodchild, despite missing some important themes and evidence, stresses how much Teller was injured by his testimony against Oppenheimer in the 1954 disloyalty case when fellow scientists learned of his harsh words. Goodchild poignantly describes the deep depression into which Teller fell. According to Goodchild, Nobel laureate Enrico Fermi feared that Teller might be close to suicide in 1954 after the backlash to his testimony.

Teller's support for the SDI occupies a few chapters, which often lean heavily on the writings of journalist William Broad. Some of Goodchild's interviews provide previously little-known details about the SDI but otherwise leave the story largely unchanged.

Teller survived to the age of 95, outliving nearly all his scientific contemporaries. Becoming heavily dependent upon others in illness and old age, he hired students to read to him. Some of them, in a matter apparently undiscovered by Goodchild, had no inkling of who Edward Teller was. To them he was simply an old man, nearly blind and in poor health, who paid them to read aloud, even though he sometimes fell asleep during the session.

Goodchild's book, like Herken's, ends rather evocatively and provocatively. In 1987, Teller, dissenting from Oppenheimer's 1940s statement that the physicists after the dropping of the atomic bomb had known sin, concluded that they have instead

"known power". Was Teller driven, and corrupted, by the quest for power? Goodchild suggests that he was.

Despite such a tantalizing but generally underdeveloped theme, the book only rarely probes beneath the surface of Teller's political and personal life. It frequently relies too heavily on interviews to illuminate much earlier events and ignores many archival materials and some relevant secondary literature. There are also numerous errors (I spotted more than 50) in discussing events and quoting materials, describing people's careers and spelling names, and citing titles and authors.

Vigorously scrubbed and with full sourcing, including explicit reliance on other scholarship, this readable biography would deserve the significant audience it may well gain among those who want an inviting survey of Teller's life. It tells a story of Teller's personal and policy battles, with notable defeats and memorable victories. ■

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A question of size: can biases in mutation rate alter the direction of evolution in different animals?

Gentle biases

Biased Embryos and Evolution
by Wallace Arthur
Cambridge University Press: 2004. 248 pp. £50, $85 (hbk); £18.95, $32 (pbk)

Armand M. Leroi

This book is an introduction to the principles of 'evo-devo' — evolutionary developmental biology. It is written with exemplary clarity and charm, and is clearly intended for the general reader or undergraduate. Beginning with a balanced account of the various strands of modern evolutionary thought, it goes on to outline the fossil history of animals, fruitfly developmental genetics, phenotypic plasticity, phylogenies and the various ways in which genes and ontogenies can change over evolutionary time.

So far, so conventional, even boring. But make no mistake. The author is Wallace Arthur and, as with all his books, there is a whiff of sulphur about this one. It comes on page 13 when he discusses orthogenesis, the notion that lineages have an intrinsic drive to evolve in particular directions. "Orthogeneticists were seen by many as mystics," Arthur writes. "But, even though I have no time for mysticism, I have to admit some sympathy for their cause."

These are brave words. Orthogenesis has been a cause without mainstream sympathizers for at least 60 years. The reason for this is that no one has provided a mechanism by which it might work. Most biologists believe that the evolutionary direction of lineages is largely determined by natural selection; a minority make great play of contingency (the non-selective effects of meteor strikes and the like). So what is going on? Has Arthur discovered a new principle of evolution?

Not really, no. The fuel in his orthogenetic engine is 'mutation bias'. Mutation produces novel phenotypes, but it does not produce all novel phenotypes in equal frequency in a given population. For example, mutations that cause an animal to become smaller than normal might be more common than those that cause it to become larger. This bias is the result of the way body size is specified in development — a bias that might influence the direction that evolution takes, causing small animals to evolve more often than large ones.

To epitomize Arthur's position, there is "a bias in the production of variant phenotypes or a limitation on phenotypic variability caused by the structure, character, composition or dynamics of the developmental system". The quote isn't from his book, it is from John Maynard Smith's famous position paper (*Q. Rev. Biol.* **60,** 265–287; 1985) defining what most of us call 'developmental constraints' — it's just that Arthur doesn't like the term. Many, perhaps most, evolutionary biologists accept that developmental constraints exist. If they aren't a major topic of study — and they should be — it is because distributions of mutational effects are very hard to measure.

Mutation bias is not enough to produce orthogenesis, however. If there is a single fitness optimum, or if the population is sufficiently large to ensure that all possible mutations are always present, then the direction of evolution will be dictated by natural selection alone. But if the landscape is rugged and population sizes small, the particular peak climbed by a population could depend on what mutations happen to be available. This is not orthogenesis of old — which posited a force independent of, or even capable of opposing, natural selection — but a reassignment of influence over evolutionary trajectories from natural selection to the kind of genetic variation available for it to work on.

If 'mutation bias' turns out to be a new term for an old idea, the same seems to be true for another unusual term: 'internal selection'. This is the idea that as one part of an organism evolves, it exerts selective pressure on other parts to change as well. Suppose a mutation increasing the length of an animal becomes fixed in a population. This might cause the subsequent fixation of another mutation that increases the animal's width, so restoring an original, harmonious, proportion. Arthur makes great play of this, but I think the interaction at the heart of this process is well known to population geneticists as 'fitness epistasis' and has often been experimentally demonstrated.

Evolutionary biologists will not be convinced by Arthur's arguments, for they are quite free of both data and maths. But some formal theory (for example, L. Y. Yampolsky and A. Stoltzfus *Evol. Dev.* **3,** 73–83; 2001) does underpin his claims, and it should force us to consider the relative influence of mutation and natural selection on evolution more carefully than we might have done. But this book is ultimately meant for general readers. They will find it a gentle and engaging account of how modern developmental genetics is beginning to affect the neodarwinian agenda. ■

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