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EDITORIAL

The Bradman class

Don Bradman, the Australian batsman, who died in February at the age of 93, was a cricketing legend. Although he played his last Test innings over half a century ago in England, an occasion on which he was dramatically dismissed by the second ball he faced, Bradman's exploits on the cricket field were to remain forever imprinted on followers of the game. There have been many spectacular achievements in sporting arenas. Jesse Owens' four athletic gold medals in the 1936 Berlin Olympics, obtained before a stadium packed with adherents of Adolf Hitler's theories of racial superority, Muhammed Ali's remarkable run in boxing rings around the globe; Rod Laver's Grand slams achieved on tennis courts of three continents; Pele's magical runs across the soccer fields of successive World Cups, are all amazing examples of achievement. But, in the years that followed, successive generations of performers would set new standards. Carl Lewis was to have a dream run in the Olympics matching Owens. Bjorn Borg and Pete Sampras have contributed to tennis folklore. Diego Maradona, despite his many troubles, for a while wove a magic on the soccer fields that matched Pele's. But, in cricket, the Bradman legend only grew as time passed after his retirement; in a game dominated by statistics, it soon became clear that his batting averages, a tribute to his amazingly consistent, high level of performance, are unlikely to be matched in the forseeable future. In a career that spanned the period 1928–1948, interrupted by the long years of the Second World War, Bradman set new standards of performance on the cricket field. In reading the deluge of obituaries and essays that followed Bradman's passing, I was reminded that the mathematician G. H. Hardy, a diehard cricket enthusiast, was fond of categorizing his colleagues. For a while in the 1920s, Hardy's highest praise for pure mathematicians (he had a healthy dislike for applications), was to describe them as in the 'Hobbs class'. Here the allusion was to the English batsman Jack Hobbs, who for a while was acknowledged as the finest exponent of his craft. But, that was before Bradman first appeared on the playing fields of England. C. P. Snow recollects a postcard that he received from Hardy in 1938: 'Bradman is a whole class above any batsman who has ever lived: if Archimedes, Newton and Gauss remain in the Hobbs class, I have to admit the possibility of a class above them, which I find difficult to imagine. They had better be moved from now on into the Bradman class.' (C. P. Snow, *Variety of Men*, Penguin, 1969, p. 37). Ramanujan, who according to Hardy, ranked with Gauss and Euler for natural mathematical genius, was clearly in the Bradman class.

In many fields, the hindsight of history allows us to recognize those who have scaled the ultimate heights of achievement. From the 18th and 19th centuries Newton, Faraday, Darwin and Pasteur would undoubtedly win Hardy's unquestioned approbation. But, Science's roll call of honour is long and the standard for elevation to the Bradman class must be extraordinarily stringent. The 20th century (indeed the final decades of the 19th century too) presents a formidable task for the assessors of science. The explosion of scientific activity and the unbridled expansion of science makes it extraordinarily difficult to draw up lists of accomplishment. How can we choose members of the Bradman class? In some fields there are scientists who have achieved iconic status. Albert Einstein, whose remarkable year in 1905 is unlikely to be matched for a long time to come (for cricket aficionados this is comparable to Bradman's march through England in 1930), would be at the top of everyone's list. Who, then, would we choose for our physics list from the remarkable cast of characters who engineered the quantum revolution and ushered in the atomic age; Rutherford, Bohr, Schrödinger, Heisenberg, Dirac, Fermi? Where would we place Richard Feynmann? What of Subrahmanyam Chandrasekhar and Stephen Hawking? Physics in many ways is close to mathematics; connoiseurs may be able to judge and rank practitioners, using the combined yardsticks of intellectual ability and achievement.

In many other fields, most notably those where experimental success depends considerably on managerial and organizational skills, judgements are more difficult. Many areas of modern science are so dependent on group activity that individual contributions are well hidden. There are also major discoveries made by scientists whose intellectual influence on their fields is limited. The polymerase chain reaction (PCR) won for its discoverer, Kary Mullis, a Nobel prize in record time and is probably the most widely used technique in modern biology. But, one would hardly raise Mullis to the

Bradman class. While the DNA double helix will undoubtedly remain one of the most enduring images of 20th century science, would James Watson and Francis Crick qualify easily for the Bradman class? Nobel prizes and major discoveries may be necessary but not sufficient requirements for scientific immortality in the case of 20th century scientists.

Chemistry is an area sandwiched between the more glamorous fields of physics and biology. The former held sway till the 1970s, but the latter has a definite edge at present. Chemists, in search of fame and fortune, have often moved towards their sister subjects; interdisciplinary areas after providing a happy hunting ground for discovery. In assessing chemists (and chemistry) I was struck by a device adopted by the magazine *Chemical and Engineering News*, published by the American Chemical Society. In celebrating the 75th year of its publication in 1998, the journal decided to conduct a poll of its readers, who were asked to send in a list of 20 names of 'chemists', whom they considered had contributed maximally to the discipline, in the years of the journal's existence. Democracy was at work in classifying scientists. The results showed that four chemists outran the rest of the field by a substantial margin; Linus Pauling, Robert Woodward, Glenn Seaborg and Wallace Carothers (*Chem. Engg News*, 12 January 1998). Seaborg, one of the codiscoverers of plutonium and nine other transuranic elements was a major figure in the US atomic energy programs. Carothers, less widely known, was the discoverer of neoprene and nylon at Du Pont. But, what struck me most was that this survey clearly identified chemistry's contribution to the Bradman class, Pauling and Woodward.

The centenary of Linus Pauling's birth was celebrated a few weeks ago. In a career that spanned almost seven decades, Pauling introduced quantum mechanics into chemistry, transformed forever chemical concepts of bonding in molecules, laid the foundations of molecular and structural biology and over fifty years ago introduced the idea of 'molecular disease' in a seminal paper on sickle cell anaemia. In an adulatory 'millennium essay', Gautam Desiraju ranks Pauling 'with Galileo, DaVinci, Shakespeare, Newton, Bach, Faraday, Freud and Einstein as one of the great thinkers and visionaries of the millennium' (*Nature*, 2000, **408**, 407). Desiraju asks provocatively: 'Does chemistry lack the high drama of physics and the glamour of biology because they were appropriated by one larger than life individual?' While Pauling hunted comfortably on the borders of physics and biology, Woodward straddled the heart of chemistry, chemical synthesis. The primary purpose of chemistry for over a century and a half has been the synthesis of molecules. No practitioner of the art of synthesis had greater influence than Woodward, who brought formidable intellectual skills and a deep understanding of chemical theory to an area that was experimentally, intensely demanding. In the span of three decades, from the mid-1940s to the mid-1970s, Woodward completely transformed a field; an intellectual synthesis that will remain far more important than the many molecules he conquered. What marks both Pauling and Woodward is the fact that they became legends in their own lifetimes. This, indeed, is a true indicator of the Bradman class.

But, returning to my original theme; polls may indeed be a good way of identifying the Bradmans amongst scientists. While assessing the impact of science and scientists is a difficult task, at the highest level there may be a fair degree of consensus. Finally, even as Bradman passes into the pages of sporting history, his name will forever be associated with a level of excellence, that the greatest achievers strive for in their chosen fields.

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