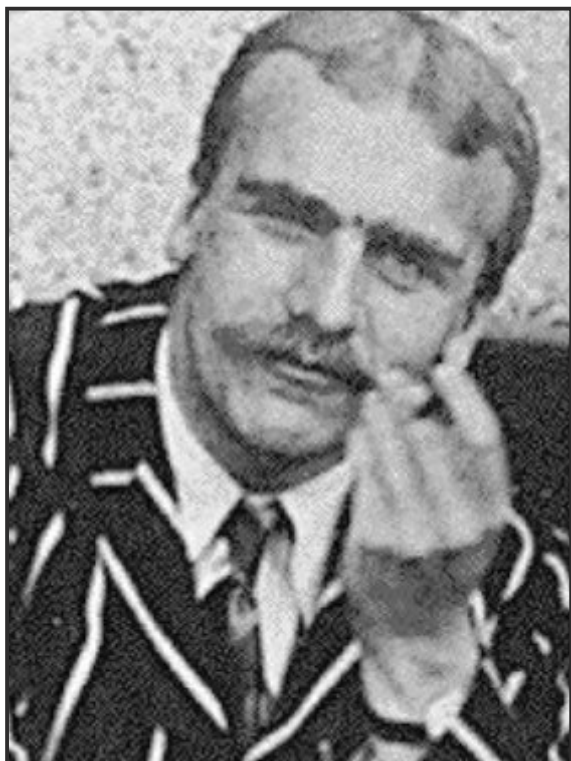


J. B. S. HALDANE

A "GREAT RASCAL OF SCIENCE"

T V Venkateswaran

What made J.B.S. Haldane one of the most respected scientists of the 20th century? At the same time, why was he called a 'great rascal of science'? What are his contributions to science and what kind of a person was he? This article takes us through the remarkable life of one of the most interesting and accomplished scientists of the 20th century.



J.B.S. Haldane, in Oxford UK, 1914.
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Working under intense pressure

It was the 1940s. The world was in the grip of the Second World War. This was no ordinary war. The amassed armies on both sides faced a new generation of weapons, from barbed wire, to rapid fire artillery, to machine guns that spat out 600 rounds a minute – all these changed the very nature of war. Soldiers from all sides slaughtered each other, and the war ravages shattered the very foundations of civilisation. Air raids and submarines were bringing the war to every door step, and for the first time in history, the civilian casualties were far more than the death of uniformed soldiers.

British and allied submarines were facing the dangers of German attack underwater. When a submarine is hit by a mine, the men inside it had no option but to dive out and swim to the surface. Often, they used diving equipment to breathe as they ascended from the depths of the ocean. But, all was not well with these diving equipments. There were many fatalities that resulted from causes ranging from nitrogen narcosis (consequent from increase in the partial pressure of nitrogen) to carbon dioxide poisoning. Oxygen, otherwise necessary for human life, became life threatening under water. Divers were advised not to breathe pure oxygen, and were instructed to

watch out for symptoms of oxygen poisoning; tingling of fingers and toes, twitching of muscles, convulsions followed by unconsciousness, and death.

A rigorous understanding of oxygen toxicity, human limits, and suitable gas mixtures for oxygen tanks, was clearly needed. One man was given the task of tackling these physiological dangers to which divers and other men, trying to escape from submarines, were exposed. That man willingly subjected himself to entering pressure chambers with varied gas mixtures in an effort to discover the true resiliency and limitations of humans when living a "Life Under Pressure", and in the process almost died. He found that exposure to pure oxygen at severe atmospheric pressure led to convulsions within 5 minutes, and helped develop an ideal nitrogen - oxygen mixture, which lowered the risk of both oxygen toxicity and nitrogen narcosis (an alteration in consciousness that occurs while diving at depth). These pioneering studies not only helped save many lives during the war; but also led to the development of safe scuba diving equipment, making it possible for humans to explore the depths of oceans.



Some important books written by J B S Haldane:

1. Daedalus; or, Science and the Future (1924)
2. Possible Worlds and Other Essays
3. The Inequality of Man, and Other Essays (1932)
4. Science and the Supernatural: Correspondence with Arnold Lunn (1935), Sheed & Ward, Inc.
5. Marxist Philosophy and the Sciences (1939)
6. My Friend Mr. Leakey (1937)
7. Everything Has a History (1951)

(The last two books are available as eBooks in Vigyan Prasar Digital library, for free download. See www.vigyanprasar.gov.in).

The allrounder

That eccentric man was J.B.S. (John Burdon Sanderson) Haldane, a famous British geneticist and evolutionary biologist, and one of the greatest scientists of the 20th century. A gifted mathematician, biologist, socialist, atheist, materialist and superb populariser of science, Haldane was acclaimed as a genius. From human philology to population genetics, his works continue to stimulate and interest scholars. He was the first to suggest in vitro fertilisation ("test tube babies"). Many scientific terms, such as cis, trans, coupling, repulsion, and darwin (as a unit of evolution) were coined by him; and he was the first to use the term "clone", to describe the possibility of creating exact copies of animals. Noting that fossil fuels, like coal, would not last forever, he was also the first to suggest hydrogen-powered renewable sources of energy.

J.B.S. Haldane was born in Oxford, England, on November 5, 1892, to a family of Scottish aristocrats. About his childhood he wrote, "...as a child I was not brought up in tenets of any religion, but in a household where science and philosophy took the place of faith. As a boy I had very free access to contemporary thought, so that I do not today find Einstein unintelligible, or Freud shocking". No wonder then, that he got admission to Eton, and later Oxford, for pursuing higher studies, where from he graduated in 1914 with a MA degree in mathematics, classics and philosophy. From 1914 to 1919, he served as a military officer in World War I. Haldane became a Reader in Biochemistry at Cambridge University (1922-32), and the Professor of Genetics at London University (1933-37). In 1930, he became a Fullerian Professor of Physiology at the Royal Institution, London.

Although he studied mathematics, his interest in genetics was kindled, when he attended a lecture on Mendel's genetic principles in 1901. It was during this time that Mendel's laws were rediscovered, and were considered to be contrary to Darwin's theory of evolution. Haldane, together with R. A. Fisher and Sewell Wright, not only showed that both the theories were compatible, but also developed the theory of population genetics, which still underpins all serious thinking about evolution. In 1912, he published his first paper on genetic linkage, following it with research on the genetics of haemophilia and colour blindness. His book 'The Causes of Evolution' was a landmark in population genetics. Among many scientific firsts, he investigated the

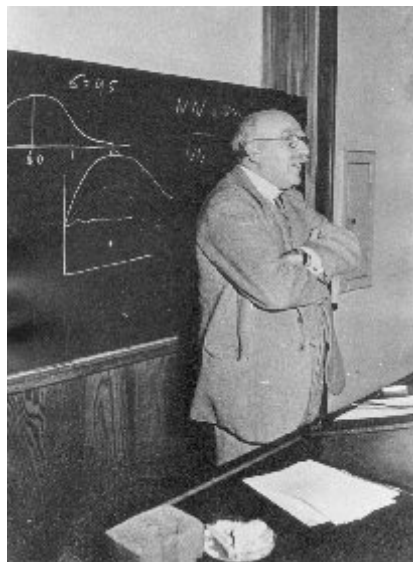
biochemistry of gene action, the genetic control of enzyme reactions, calculated mutation rates for genes, created linkage maps for human chromosomes, and analysed human pedigrees to understand different modes of inheritance. While at Cambridge (1922- 33), he formulated a mathematical model of natural selection.

Through his study of enzymes, and using some elegant mathematics, he calculated the rates at which enzyme reactions take place, and showed (in collaboration with G.E. Briggs) that enzyme reactions obey the laws of thermodynamics. Haldane's work on regulation of blood alkalinity is basic textbook material. Haldane and A.I. Operin independently suggested a plausible mechanism for the origin of life in an anaerobic pre-biotic world.

The socialist

Haldane was not only a flamboyant and productive scientist, but also had deep humanist commitments. As a compassionate humanitarian, J.B.S. Haldane was distressed at the rising unemployment, destitution and squalor all around. During World War I, he became a socialist. In the 1930s, he began reading the work of Vladimir Lenin, becoming a supporter of Marxism, and joining the British Communist Party in 1942. His work "The Marxist Philosophy and the Sciences (1938)", and his preface to the English edition of Engels's "Dialectics of Nature", are considered classics. Haldane wrote, "Had his (Engels) remarks on Darwinism been greatly known, I for one would have been saved a certain amount of muddled thinking". He left the party during the 1950s, but maintained a Marxist philosophy throughout his life.

Haldane stressed on the social responsibilities of science and scientists, and argued that it is the duty of a scientist to render science intelligible to ordinary people. He wrote volumes of essays explaining science to ordinary people. He accepted the position of Chairman of the editorial board of the left-wing 'Daily Worker', wherein he wrote more than 300 articles on scientific themes, often mixed with political comments, conveying complex concepts with clarity and humour.



Some of his popular essays were published in the anthology, Possible Worlds (1927). In the essay "On Being One's Own Rabbit," he describes the experience of running tests on himself in lab experiments. Noting the clarity one gets from mathematics he said "An ounce of algebra is worth a ton of verbal argument". Elsewhere (Fact and Faith 1934), he wrote "my practice as a scientist is atheistic. That is to say, when I set up an experiment I assume that no god, angel, or devil is going to interfere with its course; and this assumption has been justified by such

success as I have achieved in my professional career. I should therefore be intellectually dishonest if I were not also atheistic in the affairs of the world". He argued that "the main objection to religious myths is that, once made, they are so difficult to destroy. Chemistry is not haunted by the phlogiston theory as Christianity is haunted by the theory of a God with a craving for bloody sacrifices.Chemists believe that when a chemical reaction occurs, the weight of the reactants is unchanged. If this is not very nearly true, most of chemical theory is nonsense. But experiments are constantly being made to disprove it. It obviously cannot be proved, for, however accurately we weigh, the error may still be too small for us to observe. Chemists welcome such experiments and do not regard them as impious or even futile".

The right size

"On Being the Right Size", published in 1928, is one of Haldane's most appreciated essays. In it, he asks why mice are small and whales are big. More generally, he asks, is size an accident, or is there a good reason? "You can drop a mouse down a thousand-yard mine shaft; and on arriving at the bottom, it gets a slight shock and walks away. A rat would probably be killed, though it can fall safely from the eleventh story of a building; a man is killed, a horse splashes." Why aren't there any giant insects? He wrote "Insects don't have lungs. Instead, they have a system of holes and tubes that allow oxygen to reach the cells inside their bodies. But this passive system doesn't work for anything much larger than the size of today's

Galileo, in his book, 'Dialogues Concerning Two New Sciences', noted this, and explained why objects cannot have arbitrary sizes. When an object is scaled up, its area increases only by the square of the multiplier, while the volume increases by the cube of the multiplier. Thus, for example, if there are two cubes A & B, such that each of the sides of B is ten times that of corresponding sides of A, then, while the surface area of B will only be 100 times that of A, its volume will be 1000 times that of A.

insects. They've gotten about as big as they can, and we can sleep without fear that a two-hundred pound ant will someday come crashing through the door". In Haldane's words, "The higher animals are not larger than the lower because they are more complicated. They are more complicated because they are larger". Further, Haldane explains why birds are the size of birds, why small animals can't live in frozen regions, and why large animals don't have enormous eyes. Many of his examples in this book are based on the **square-cube law**, although he does not use that terminology.

Serving science-in life and death

At the age of 65, in 1957, Haldane and his wife, Helen Spurway (an accomplished geneticist herself), were disturbed at the imperialist Suez invasion of Anglo-French forces, and in protest they immigrated to India. Initially he joined

Indian Statistical Institute (ISI), Calcutta, at the invitation of P.C. Mahalanobis, and subsequently established an Institute for Biology and Genetics, at Bhubaneswar. Haldane had a deep appreciation of Indian culture, was deeply engrossed in Indian Philosophy, and had a good knowledge of Sanskrit. In April 1961, he became an Indian citizen. He attended international science conferences sporting a kurta and pyjama, identifying with independent India; and invited scientists across the world to collaborate with developing countries.

Like life, he faced his death with wit and bravery. He wrote "I am a part of nature, and, like other natural objects, from a lightning flash to a mountain range, I shall last out my time and then finish. This prospect does not worry me, because some of my work will not die when I do so". Afflicted with cancer, lying in the hospital bed, he wrote an outrageous comic poem, mocking his own incurable disease:

"... I know that cancer often kills,
But so do cars and sleeping pills;
And it can hurt one till one sweats,
So can bad teeth and unpaid debts.
A spot of laughter, I am sure,
Often accelerates one's cure;
So let us patients do our bit
To help the surgeons make us fit."

He passed away on December 1, 1964. As per his will, his body was sent to the Rangaraya Medical College, Kakinada for scientific use. "My body has been used for both purposes during my lifetime", Haldane wrote in his will, "and after my death, whether I continue to exist or not, I shall have no further use for it, and desire that it shall be used by others". No wonder that Richard Milner, aptly, said "J. B. S. Haldane was one of the great rascals of science; independent, nasty, brilliant, funny and totally one of a kind".



T V Venkateswaran, Scientist with Vigyan Prasar, Department of Science and Technology, New Delhi, is a prolific science writer with more than 25 popular science books and 300 science articles to his credit. He conducts science TV shows, resource person for training programmes, and writes for periodicals. His research interest includes history of popular science in Tamil, and in particular the modern Indian astronomer Chintamani Ragoonathacharry. Says that he is lucky to have his passion as his vocation - he could read books, watch movies and interact with children, teachers - call it 'work' and get paid for it! He likes to travel, listen to Carnatic music and cook exotic dishes. One of his secret vices is to read spy thrillers and detective novels. The author can be contacted at tvv123@gmail.com.