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DUNCAN ARTHUR MACINNES, FOREMOST AMERICAN ELECTROCHEMIST

Joseph A. Schufle
Professor of Chemistry (Emeritus)
New Mexico Highlands University
Las, Vegas, New Mexico USA
87701

ABSTRACT

Duncan Arthur MacInnes, one of the world's outstanding electrochemists was born in Salt Lake City, Utah on March 31, 1885 and died on September 23, 1965. He graduated from the University of Utah with a bachelor of science degree in chemical engineering in 1907 and obtained a Ph.D. degree in chemistry from the University of Illinois in 1911. He held positions mainly at M.I.T and the Rockefeller Institute for Medical Research. His most important contributions deal with the determination of transference numbers by the moving boundary method, development of the glass electrode and experimental confirmation of the Debye-Hückel Theory.

RESUMO

Duncan Arthur MacInnes, um eletroquímico mundialmente reconhecido, nasceu em Salt Lake City, Utah, USA em 31 de Março de 1885 e faleceu em 23 de Setembro de 1965. Formou-se como engenheiro químico na Universidade do Utah em 1907 e obteve o grau de Ph.D. em Química da Universidade de Illinois em 1911. Trabalhou principalmente no Instituto de Tecnologia do Massachusetts e no Instituto Rockefeller de Pesquisas Médicas. As suas contribuições mais importantes incluem a determinação de números de transferência usando o método da fronteira móvel, o desenvolvimento do eletrodo de vidro e a confirmação experimental da Teoria Debye-Hückel.

One of the world's outstanding chemists, Duncan Arthur MacInnes published over a hundred scientific papers in his special field, electrochemistry, and "Principles Of Electrochemistry", a textbook that was widely adopted for classes in this subject. His scientific work extended over an active period of nearly half a century.

He was born on March 31, 1885, to Duncan MacInnes and his wife, Frances Charlotte (Sayers) MacInnes, in Salt Lake City, Utah. He suffered a nearly fatal accident in a streetcar that resulted in a badly injured leg and the loss of two fingers from his left hand, when he was only thirteen years old, which made it impossible for him to engage in any activity such as sports for a few years. He was not discouraged however by this disability, and perhaps because of it, he undertook a typical life-long program of exercise which eventually resulted in his becoming skilled in hiking, skiing, and mountain climbing.

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While a student at a preparatory school of the University of Utah at the age of sixteen he boarded at the same boarding house as Solomon Farley Acree, who was later to become the chief of a division of the National Bureau of Standards in Washington, D.C. Acree, ten years older than MacInnes, was then an active research chemist, having received his B.S. and M.S. degrees from the University of Texas, and his Ph.D. from the University of Chicago in 1902, and had done postgraduate work at the University of Berlin in Germany. Acree was an assistant professor of chemistry at the University of Utah from 1901 until 1904, and undoubtedly encouraged the young MacInnes to enroll there, which he did in 1903 at the age of eighteen. His first class in chemistry was conducted by an excellent teacher, Dr. William C. Ebaugh. Four years later he was graduated from the University of Utah with a bachelor of science degree in chemical engineering.

Because the country was in the depths of another depression at the time MacInnes was graduated from the University of Utah, he had trouble finding a job locally, and he finally took a job with the Phelps-Stokes Company (forerunner of the Phelps-Dodge Copper Company) in Berlin, Nevada. This job did not suit him however, so by 1908 he was back with his parents in Utah, where his father was in business in American Falls.

MacInnes had applied for a fellowship at a number of eastern universities, and in 1908 he received an offer from the University of Illinois where William A. Noyes was professor of chemistry and director of the chemical laboratories from 1907 to 1926. He studied and did research with Dr. Edward Wight Washburn, who had received his Ph.D. in chemistry from the Massachusetts Institute of Technology (M.I.T.) in 1908. Thus MacInnes was one of Washburn's first research students. He wrote a thesis on "The Laws of 'Concentrated' Solutions. The Ionization and Hydration Relations of Electrolytes in Aqueous Solutions at Zero Degrees", for which he was awarded the degree of doctor of philosophy in chemistry in 1911. After graduation he accepted a position as instructor at Illinois, teaching physical chemistry. He became active in research immediately, and published five papers on electrochemistry at Illinois. Arthur A. Noyes, director of the Research Laboratory in Physical Chemistry at M.I.T., invited MacInnes to join him there in 1917, and MacInnes did outstanding work there in electrochemistry, with the collaboration of other well-known scientists such as A.A. Noyes, Theodore Shedlovsky, James A. Beattie, and Edgar Reynolds Smith, publishing fourteen papers in electrochemistry, and also several in the field of x-rays.

Among MacInnes' most important contributions to science was his work, with Edgar R. Smith, on the determination of transference numbers by the moving boundary method, a spectacular method still described in some laboratory manuals for physical chemistry. Other work of his included that on the development of the glass electrode, work in potentiometric methods of chemical analysis, measurement of acidity (pH) (his early friend Acree was chief of the Division of pH Standards of the National Bureau of Standards), and the determination of ionization constants and activity coefficients.

He took a sabbatical leave from M.I.T. in Paris in 1925 devoted to study and travel in Europe. He wanted to work with Peter Debye, whose theory of interionic attraction had been published with Walter Huckel, but Debye was in the U.S. in 1925. In Paris he visited museums and improved his abilities in the French language. He also visited Holland, Switzerland and Italy, and made his most extended visit to England, about two months. In England he visited Dr. Frederick George Donnan, F.R.S., who proposed the theory of the Donnan Membrane Equilibrium, as well as other workers in physical chemistry.

On his return to M.I.T. he was asked to teach a course in colloid chemistry, which he considered an imprecise field, and his lack of enthusiasm for this topic may have led to his decision to move to the Rockefeller Institute for Medical Research in New York City in 1926 where he did research for the rest of his life, becoming a member in 1940, and Emeritus Member in 1950. MacInnes said that he considered his experiments to confirm the interionic attraction theory of Peter Debye, sometimes called the Debye-Huckel Theory, to be his most important work. He was convinced that strong electrolytes in aqueous solution were completely ionized and that Debye's theory offered the best explanation of their behavior.

The New York Academy of Sciences elected him its president in 1944. He played an important role in starting the Academy's Conferences at Rams Head Inn, Shelter Island, Long Island, New York. These were to be small conferences on topics in which actual work was in progress and that participants were to be limited to investigators who were actively working in the fields under consideration. In MacInnes' view these conferences were needed because the meetings of regular scientific societies, such as the American Chemical Society, had become so large that workers in a specific field were having difficulty getting together for serious discussions about their work.

The Electrochemical Society awarded him its Acheson Medal in 1948, and elected him its president in 1935. MacInnes worked for the Chemical Warfare Service, U.S. Army, in World War II, as director of a group at the Rockefeller

Institute working on topics of interest to the war effort, and was awarded the President's Certificate of Merit for this work in 1948. He was awarded the Nichols Medal by the American Chemical Society's New York Section in 1942, which indicated that his chemical interests included areas of physical chemistry other than electrochemistry. He was elected to the National Academy of Sciences in 1937, and the American Philosophical Society in 1942.

MacInnes became somewhat skilled as a mountain climber, and on one occasion these skills helped him save his party from a serious accident. He was a member of the American Alpine Club and the Appalachian Mountain Club, and was considered to have made significant contributions to the preservation of the environment and the national park system. He died on September 23, 1965.

REFERENCES

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Note:

(This biography is an example of the 18,000 entries being prepared for the "American National Biography", sponsored by the American Council of Learned Societies, and to be published in October 1998, by the Oxford University Press.)