DEAN RICHARD BISHOP MOORE

CINCINNATI, OHIO
May 6, 1871

NEW YORK CITY
January 20, 1931

The death, on January 20, 1931, of Richard Bishop Moore, Dean of Science and head of the Department of Chemistry at Purdue University, removed from the ranks of the Indiana Academy of Science one who at two periods of an illustrious career had been an active and efficient member.

Dean Moore was born at Cincinnati on May 6, 1871, the third child and second son of William Thomas Moore and Mary Bishop Moore. His maternal grandfather, for whom he was named, was mayor of Cincinnati in the days of Lincoln and later governor of Ohio. His immediate ancestors were Kentuckians who were descended from migrating Virginians.

William Thomas Moore was a typical example of the humbly-born middle-westerner of uncommon mental energy. He was born in a log cabin in Henry County, Kentucky, lost his father at the age of eight and from that time had to become a support for his mother and her family. At 18 he had no schooling but had learned to read and knew well Shakspere, the Bible and certain books of history which had come to his hand. His ambition for an education led him to study at night by the light of pine cones for he could not afford candles. Ultimately he managed to secure a college education, became a clergyman of the Christian Church (Disciples of Christ) and rose to a position of leadership in the religious world. He became an ardent advocate of Christian Unity, that is, the union of all the religious sects into one great body. To win the support of British Christians for this worthy cause, he resigned in 1878 the pastorate of the Central Christian Church of Cincinnati and took his family to England. Ultimately Dr. W. T. Moore became pastor of a large church in London and editor of a religious weekly newspaper, the Christian Commonwealth, which exerted a wide influence.

The Moores continued to reside in England until 1895, that is from Richard's eighth to his 25th year. It thus came about that his education was chiefly British. He spent one year, 1885-6, at the Institute Keller in Paris. During his school-boy period he became greatly interested in chemistry and in 1886 entered University College, London, that he might be near the famous Ramsay. Here he spent four years, then taught for a few years in British schools. Returning to the United States in 1895 he became an assistant in chemistry at the University of Chicago, completing the requirements for the B.S. degree in 1896.

In 1897 he went to the University of Missouri as an instructor in chemistry and hither came, in 1902, Herman Schlundt. The two young men quickly formed a friendship and scientific partnership which was destined to be lifelong and of the greatest scientific importance. Work on radioactivity was in its infancy and the young men were eager to repeat experiments such as those of Rutherford and Soddy at McGill University which appeared to indicate with astounding probability that atoms disintegrate and form new elements. They had one ounce of

thorium nitrate and they found that it really would act on a photographic plate. That was enough and from that time they spent every moment that could be spared from their long teaching hours and, according to Dr. Schlundt's recollections, several that should not have been, in devising electroscopes and ionization chambers. Hampered as the work was by lack of chemicals and satisfactory apparatus, several important papers were published by the young men. Incidentally they tested the nearby springs and well waters for radio activity.

In 1905 Moore was called to the Chair of Chemistry at Butler College and here he remained until 1911 with the exception of a leave of absence in 1907-8 which he spent in research work with Ramsay at University College. In the summer just preceding this leave he had, with Schlundt, made a survey for radioactive properties of the springs of the Yellowstone National Park in behalf of the U. S. Geological Survey. The object of the government investigation was to find whether the hot springs and geysers were due to localized quantities of radium in the rocks about them. Naturally the result of the investigation failed to support this rather naive idea. However a very pleasant vacation was had by the two young scientists.

During Moore's Sabbatical year with Ramsay he worked upon the separation and purification of krypton and xenon, the least abundant of the rare gases of the atmosphere. By fractionating the heavy residue from 119 tons of liquid aid which had been given by Georges Claude of Paris, some 300 centimeters each of krypton and xenon were obtained in a high state of purity. He determined the physical constants of the two gases and his data still stand in the literature. On his return to Indianapolis he devoted much time to a search for a rare gas, heavier than xenon for which there seemed a place in the periodic table of the elements. Owing to uncertainty as to the number of rare earth elements and the position of these elements in the periodic table, there was at that time no suspicion that radon (radium emanation) was the heaviest member of the inert gases. Many members of the Academy probably have heard Dr. Moore report on this investigation and have seen the complicated and ingenious apparatus which he devised to further the work. All his efforts of course had to be fruitless, but ten years were to elapse before the reason became clear. Meanwhile, he was also continuing his researches on radioactivity and had acquired such reputation in this field that on the opening of the Chemists' Club of New York he was invited to be one of the principal speakers. As a result of the impression he made on this occasion he was invited to the staff of the Bureau of Soils at Washington and resigned his Chair at Butler College to accept this appointment.

It was becoming evident that radium was an important agent for the control or cure of cancer. Its cost at this time was about $120,000 per gram. Most of the carnotite ores of Colorado were being shipped abroad for extraction of their radium content. Moore urged strongly upon responsible government bureau heads the importance of refining the carnotite in this country and the certainty that the cost of radium could thus be very greatly reduced. All the radium produced up to that time constituted a bulk no greater than that of a garden pea. The an-

nual death toll of cancer in the United States alone was in the neighborhood of 75,000. As a result of his urgent pleas Moore was transferred to the Bureau of Mines and put in charge of an experimental bureau at Denver for the investigation of rare minerals. A national radium institute was formed and Drs. Howard Kelley of Baltimore and James Douglas of New York, both interested in the use of radium in hospitals, agreed to contribute $75,000 each for the promotion of radium production and a co-operative arrangement was made for the work to be done by the Bureau of Mines. As a result of improving methods of extraction, 8½ grams of radium element were obtained at a net cost of $345,000. The Great War produced a sudden demand for larger quantities of the rarer metals such as vanadium, molybdenum and tungsten and to the Denver Laboratory was assigned the task of improving processes for obtaining them. As a recognition of the importance of his work for science and its commercial benefit to the State the University of Colorado conferred upon him the Degree of D. Sc. in 1916.

The World War had stimulated search for a non-flammable gas for balloons and dirigibles and the hope of obtaining helium for that purpose was communicated by letter to Dr. Moore by Sir William Ramsay in February, 1915. Apparently the British Admiralty which had enlisted the aid of Sir William Ramsay did not know of the work of Cady and McFarland in 1907 on the natural gas in Kansas which had been found to contain helium in perceptible quantities. In April, 1917, at a meeting of the American Chemical Society in Kansas City, Dr. Moore discussed the occurrence of rare gases in the natural gas of Kansas, announced the interest of the British Admiralty in helium and urged that production in this country was feasible and should be undertaken. In the following month the matter began to be seriously discussed among the government bureaus and ultimately three experimental plants, one under the direct supervision of the Bureau of Mines, were erected in Texas. At the signing of the Armistice the first consignment of 147,000 cubic feet of 93 per cent helium was on the dock for shipment to Europe. Dr. Moore had been placed in charge of this experimental work in Fort Worth in 1918. In 1919 he was transferred to Washington as Chief Chemist of the Bureau of Mines. In this capacity he retained charge of the helium work, organized the Cryogenic Laboratory in Washington and was the civilian member of the Helium Board of the Army and Navy. During the succeeding decade the volume of helium production was steadily increased and the cost as steadily decreased to about 25 cents a cubic foot. Meanwhile explorations conducted by the leading powers disclosed the probability that the United States possessed a monopoly of helium. This at once made apparent Dr. Moore's unusual foresight in urging upon Congress, as he had, the importance of forbidding the export sale of the gas. To him belongs the credit for first clearly visualizing the superiority over hydrogen of this inert gas for lighter-than-air craft; for his energy in convincing the Congress and the Government Bureaus of the importance and feasibility of extracting it from natural gas; and for the technical skill with which he guided the earlier stages of the commercial processes to sure and solid success. It

was an extraordinary feat to lower within a few years the cost of production to a figure not excessively greater than that of hydrogen.

After the production of helium was sufficiently standardized, Dr. Moore withdrew from the Bureau of Mines and joined the Dorr Company of New York City as consulting engineer. Later he was appointed General Manager of the company.

In 1926 he was asked to become Head of the Department of Chemistry and Dean of the School of Science at Purdue University, positions which had become vacant through the death of Dr. Percy N. Evans and the retirement of Dean Stanley Coulter. Thus after a lapse of twenty-five years he returned to his old associates in Indiana. During the summer of 1930 evidences of failing health became a cause of concern to his friends. No apparent cause of trouble could be found but his condition rapidly grew worse. In November he went to the Mayo Clinic where his disease was diagnosed as tumor of the brain. He was removed to the Memorial Hospital in New York City that he might be treated with that very radium which he had been instrumental in producing. Before the effect of the treatment could be fully determined, he was stricken by pneumonia and died on January 20.

Dr. Moore was a man of many sides and many attainments. As a scientist he represented a very near approach to the ideal type. He was thoroughly imbued with the spirit of research, of discovering new truths. He did not know what it was to be daunted by lack of tools. Probably his early training in Ramsay's laboratory had taught him how much could be done with limited resources for it is evident that the great Ramsay worked for most of his life under financial handicap. When Dr. Moore was planning to return to Ramsay's laboratory for the sabbatical year 1907-08, Ramsay wrote him: "I should be very glad to see you an inmate of my laboratory; but you will find a much overcrowded building with extemporized appliances. We have a lot of small rooms, convenient enough for fitting up apparatus, though somewhat underground. I think, however, that you might profitably spend some months here, for some of our dodges are not to be learned by reading, but out of hand. I think you would find this place permeated by a spirit of research—under difficulties." These were apparently just the conditions under which Moore was used to working at Butler College where, of course he had no great financial support, and he and Schlundt at Missouri had become accustomed to constructing apparatus out of old scraps. This sort of training had taught him that much could be done with little and no prospect of protracted and excessive labor deterred him from an investigation which he wished to pursue. It is to be remembered that Moore returned to America in 1895, one year before Becquerel discovered radio-activity and three years before the Curies discovered radium. The work in radio-activity which Moore and Schlundt did at the University of Missouri was due to their own initiative and not at all to any influence which Ramsay had exerted on Moore. Dr. S. C. Lind, one of Dr. Moore's most intimate friends, has expressed his belief that in 1907 Moore took with him to Ramsay's laboratory a technique of radio-active measurement which enabled him to give far more than he received in that particular field. Again in the production of

radium it required rather uncommon courage to undertake as a commercial proposition the working up of some 200 tons of carnotite ore to produce a gram of radium. The same dauntless pioneering courage was again required to venture a commercial recovery of helium from natural gas, of which it forms at the maximum 1 to 1.5% and to foresee the means by which the cost of its recovery should ultimately be reduced to a reasonable figure.

He combined in a quite unusual way the skill, patience and persistence of the investigator in pure science with the business grasp and foresight of the commercial executive. The investigation on the physical properties of xenon and krypton and many of the papers on radioactivity represent the highest type of pure and presumably financially fruitless research. On the other hand, when research clearly promised enormous benefit to mankind, as in the case of radium, or to the country, as in the case of helium, he was able to combine the unselfishness of the pure scientist with the shrewd and calculating foresight of the business executive. It was undoubtedly this unusual combination which caused him to advance rapidly to the very forefront of his profession and to attain a reputation not only in his own country but in all lands where research is diligently pursued. The esteem in which he was held by his colleagues of the chemical profession was signified when he was awarded the Perkin Medal for the year 1926. This Medal is the most coveted distinction open to American chemists. Before that he had been awarded the Longstreth and the Potts Medals by the Franklin Institute of Philadelphia.

His gift of clear, persuasive argumentation was shown in the organization of both the radium and the helium investigations. Only a very few pioneers of the medical profession had yet become convinced of the therapeutic value of radium. It was a scientific curiosity for which a fabulous price was asked. A very high degree of skill was required to secure the financial co-operation of the medical profession and of the government before large scale production could be considered. The situation with regard to helium was similar in many respects. Lighter-than-air craft had received little attention in this country and the Departments of War and Navy were not actively interested in them. Very clear and far-sighted vision was required to foresee the importance of such craft and, when that had been demonstrated, to convince not only the Departments but also the Congress of the importance of non-flammable gas for lifting them. When the monopoly of helium possessed by the United States became evident, it again required vision and persuasion to convince the Congress of the wisdom of foregoing the large profits from the sale of helium to other countries. Dr. Moore was entitled to the highest praise for the enthusiasm and the skill with which he brought these two great activities to complete and financially successful fruition. It is scarcely too much to stay that the sole credit for the inception of these enterprises belongs to him.

He had an uncommon ability to arouse the highest degree of cooperative emulation in subordinates and to combine their individual efforts into an effective whole. Lind has referred to this as Moore's outstanding qualification. This quality is very evident in the rapid

progress of the radium work in Colorado, in the equally rapid increase of efficiency in the processes for separating helium, and in the reorganization of scientific work at Purdue which he accomplished in his four years there. He was a master in the art of imparting enthusiasm to others and in winning their willing and enthusiastic co-operation.

To the members of the Indiana Academy of Science who knew Dr. Moore during his two periods in Indiana, it is unnecessary to recall his genial and friendly disposition, his enthusiasm for the scientific work of colleagues in other fields, his willingness to support any worthy cause and to spare himself no labor in its promotion. Indiana members of the American Chemical Society recall the vast energy and labor which he put into the plans for the National Meeting of the Society in Indianapolis in 1911. That this meeting was long regarded as outstanding among the semi-annual gatherings of the A. C. S. was very largely due to Moore's enthusiasm and unremitted effort.

One of his cherished possessions was a volume of letters to which practically all his professional colleagues in the State contributed upon the occasion of his leaving Butler College to go to the Department of Agriculture. The writer recently had the privilege of looking over this collection of letters. It was interesting to note the variety of personal qualities and talents which the writers had recognized and admired in Professor Moore. As an educator his interests were not confined to chemistry but he was equally interested and conversant with all the varied phases of campus life and activity. It is recorded that during his years at Butler he made a very real contribution to the welfare of the college through his active interest in athletics and his efforts to have athletic matters placed upon a sound and healthy basis. During his few years at Purdue he became increasingly occupied as personal advisor of students and it was evident that he was remarkably successful in winning their confidence and trust. In spite of the incessant demands upon his time he gave himself gladly to these consultations with students.

He had many research plans which he was eager to prosecute, social and outside professional demands were heavy, and it was imperative that the plans for the new chemical laboratory of which the University stood in urgent need, should be completed as rapidly as possible. These plans absorbed much time for laboratories in all parts of the country had to be scrutinized minutely and the excellencies and defects of each carefully weighed. While the details of the new laboratory were taken over, so far as possible, by Dr. M. G. Mellon, there still remained numerous decisions for Dr. Moore's consideration. The amount of detailed work accomplished during these last four years is by no means the least eloquent testimonial to his varied abilities and even more to his uncommon will power and self-control.

He possessed talents and had avocations of which only his more intimate friends were aware. He had a rather marked talent for drawing and painting. Although he had received no more than elementary instruction in the former, he had the artist's eye for form and color and in his few spare hours had picked up some acquaintance with the technique of painting. At various times he produced a fair number of distinctly interesting pictures and studies in oil. While he made no

pretence to musicianship, he had a very real comprehension of, and appreciation for, good music and he missed few opportunities to enjoy it. He inherited probably, or at least acquired, a gift of writing very good verse of which a considerable amount was found among his papers. This includes not only amusing jingle written for festive occasions, but also many examples of genuine poetic feeling and command of form.

The untimely passing of Dr. Moore was a loss to the science he so ably represented, for important projects were left which he had hoped to complete. It was keenly felt by Purdue University which had hoped to benefit for many years from his varied experience. It was even more a personal bereavement to the many friends who valued him no less for his scientific achievements yet even more for his genial and friendly personality and his readiness to devote himself unselfishly to the causes of his friends.

Dr. Moore was twice married; in 1902 to Calthea Pemberton who died in 1918, in 1924 to Georgia Dowell of Dallas, Texas, who, with an adopted daughter, survives him.

A. R. MIDDLETON, Purdue University.

RICHARD BISHOP MOORE

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