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GEORGE FREDERIC BARKER

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A Biographical Memoir by

EDGAR F. SMITH

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WHEN THE WRITER of the following paragraphs began the study of chemistry in 1972, his textbook was *Elementary Chemistry,* then in its tenth edition, written by Professor George F. Barker. At that time the writer never dreamed that it would be his privilege to become a colleague of this distinguished scientist, nor that later he would be called upon to write in memory of this splendid teacher, profound student, and man of noblest character.

The face of Dr. Barker was familiar to men of science, both in this country and abroad, as he made it a point, whenever possible, to meet with his fellows in science. On such occasions by his affability and courtesy he made a wide circle of friends, who in recent years have keenly felt his absence from their meetings, and were indeed shocked when the message of his death was announced. The writer had the opportunity to meet Dr. Barker daily for many years, not so intimately at first, but later with the greatest freedom and in true companionship. The impression made by him, at all times, was that of an earnest student of science, thoroughly conversant with its most recent advances

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and able to render subjects, which were dry and unattractive though important, so simple and so fascinating, that the ordinary layman could comprehend them with ease. His lectures to students were celebrated for their clarity of presentation as well as for their wide scope. He was painstaking in the presentation of his subject, and his constant endeavor was to make his students grasp the problems he placed before them. He spared no pains to make abstruse points clear, and if at times he seemed to demand almost too much and be a bit brusque, yet no earnest student was ever turned away; he was, in a word, the true teacher, whose sole object was the welfare of those whom he taught.

In the lecture room he had rare skill and facility as an experimenter, and one of his chief joys was to illustrate his lectures, as far as possible, with an abundance of attractive and striking experiments. He often presented the most intricate topics before large audiences, reaching sometimes into the thousands, and so uniformly brilliant was his success that he became noted throughout the country as one capable of popularizing science as few could do it. The writer recalls an occasion in his younger days, when the Academy of Music in Philadelphia was filled to its dome with an intensely interested and intelligent audience assembled to listen to his lecture on "Sound," and, while seated in the "sky parlor" of the immense auditorium, enjoying the discomforts peculiar to his position, so intensely absorbing was the lecture and its experiments that at its conclusion it was difficult for him to realize that he had actually sat there more than an hour.

Dr. Barker was much esteemed in the community where he lived by persons of all ranks. For a number of years he served on the board of education in the city of Philadelphia, and there exerted an influence which was entirely for the good, and never to be forgotten. His contributions

to municipal interests included studies of the local water supply, of the quality of illuminating gas, and of the means for protecting public buildings from lightning. At various times he appeared as an expert in scientific matters, and in this field further demonstrated his spirit of careful investigation and absolute integrity and loyalty, as well as [an] ability to be just and fair to all. Many of the cases called for the highest scientific knowledge and accuracy, which were abundantly supplied by him.

By his colleagues on the teaching staff of the University of Pennsylvania he was most highly valued. His services were constantly engaged upon committees, and those who worked with him in such duties entertained but one impression, to wit, that he was capable of handling the most intricate and perplexing problems with fairness, calmness, and the best judgment. Indeed, it was a pleasure to be associated with him in work of this description; his hearty cooperation and his many helpful suggestions in the solution of university problems were appreciated by all his colleagues.

Dr. Barker's early academic training was received in the Boston Public Schools, and at the academy in South Berwick, Maine. He further served an apprenticeship with Joseph Weightman, a maker of scientific instruments, going thence to the Sheffield Scientific School of Yale University, where he received the degree of Bachelor of Philosophy in the year 1858. He was deeply attached to his Alma Mater, and invariably spoke in terms of the highest praise and affection of his early teachers. His serious student days had, however, a bit of the modern in them, for if the writer remembers correctly, he was a member of the varsity crew in the year of his graduation. Some years later, in the autumn of 1869, he became professor of physiological chemistry and toxicology in the Yale Medical School, a chair

created for him. During this period he served as expert for the state in several poison cases, the most noted being the Lydia Sherman case in New Haven.

His active scientific career may be said to have commenced about this time. Thus this Journal in 1967 (2, xliii, 252) contains a brief article "Upon the Silvering of Glass," which is a modification of a suggestion of Böttger, consisting in adding to a boiling solution of Rochelle salt a solution of argentic nitrate, after which the boiling was continued for eight or ten minutes, the liquid allowed to cool, and then filtered. A second portion of the original silver solution was treated with ammonium hydroxide until the precipitate formed was almost redissolved, after which water was added and the liquid allowed to cool, and then filtered. A second portion of the original silver solution was treated with ammonium hydroxide until the precipitate formed was almost redissolved, after which water was added and the liquid filtered. To silver glass, equal portions of these two fluids, thoroughly mixed, were poured upon it. After a lapse of about ten minutes, a brilliant layer of metallic silver was deposited. By repeating the process the layer could be thickened to any desired extent. A somewhat earlier article is entitled "Account of the Casting of a Gigantic (Rodman) Gun at Fort Pitt Foundry" (ibid., xxxvii, 296); this contains some important practical suggestions.

An interesting contribution is made by Dr. Barker, in the same Journal (2, xliv, 263, 1867), in support of the view that formic acid is carbonous acid. He believed this to be true because of the ready formation of formic acid by the partial oxidation of carbon, and also because it resulted from the oxidation of carbonic acid. For these reasons he further concluded that formic acid was the acid of bivalent carbon.

In an extended communication "On Normal and De-

rived Acids" (ibid., xliv, 384), he arrived at the following conclusions:

"1. That all the bonds of any simple radical may be saturated by the monad hydryl (OH). 2. That the compounds this formed, being evidently normal, are conveniently designated by the prefix *ortho.* 3. That the equivalence of negative radicals varies through several stages, while that of positive rarely changes, and hence, that there may be a series of ortho-acids from a given negative radical, but only a single base from a positive one. 4. That by the removal of the elements of water from a normal or ortho-acid, a derived acid is produced, which may be indicated by the prefix *meta.* 5. That when there are several such derivatives, the Greek numeral prefixes di, tri, tetra, etc., may be used to indicate the number of molecules of water removed from the ortho-acid to yield the meta-form. 6. That intermediate between the simple ortho- and the meta-acids are others containing more than a single atom of the negative radical; and that these acids may be designated by di, tri, tetra, etc. (according to the number of negative atoms) prefixed to the name of the acid, while the number of molecules of water removed from a multiple of the normal acid to form them is indicated by the same numerals prefixed to the meta. 7. That while the negative atoms in the compounds just mentioned are united by oxygen, there may be other compounds whose negative or positive atoms are united directly; thus producing a fourth class of acids and of bases.

"By classifying thus the substances known as acids and bases—and, of course, the salts derived from them—it is hoped that their relations to each other may be made clearer. And by giving them systematic names, their position in the series may be fixed, and a step taken toward the establishment of a national nomenclature."

In 1870 appeared his textbook of *Elementary Chemistry, Theoretical and Inorganic,* which ran through many editions as well as translations into other languages. This was the first book in our language in which modern chemistry was presented systematically. The style of the book, as so many can testify from its study, is concise and clear. Wolcott Gibbs spoke of it as "a book wholly in the spirit of the most advanced thought in the science."

During his life at New Haven, he contributed a note "On the spectrum of an Aurora which appeared at New Haven, November 9, 1871." This point of particular interest in this observation was the fact that the line of wave-length, 502, was not laid down in any authority accessible to the observer, as having been noted in the spectrum of the aurora. He adds: "Indeed, no previous observer, so far as I know, has seen any auroral line between the Frauenhofer lines *b* and F" (This Journal 3, ii, 465, 1871). Sometime later, he presented a second contribution "On the Spectrum of an Aurora of October 24, 1872." This aurora, like that of 1871, was distinguished by its radiant crimson color, and by its form. Dr. Barker remarks that in the lines that appeared in the spectrum, none was new, though no previous observer had seen all of them at once. Vogel had seen five and four had been seen by Dr. Barker. Two of the lines nearly coincided with the solar lines F and G, but a considerable difference was observed in the spectrum of the aurora of 1871.

Dr. Barker was assistant to Dr. Bacon in the Harvard Medical School from 1859 to 1861; professor of chemistry in Wheaton College, Illinois, 1861; then in the Albany Medical College, where he received the degree of Doctor of Medicine (1862–63), making while there a chemical examination of the viscera of a dead body, the first time it had ever been done in this country; next, in the University of Pittsburgh (1863); he also delivered the lectures on chemistry at Williams College in the years 1868 and 1869; and, after service in his Alma Mater, to which reference has already been made, he became professor of physics in the University of Pennsylvania (1872), where the remainder of his life was spent. At this period he published a contribution of considerable length, with the aid of illustrations, on "A New Vertical Lantern Galvanometer," in which claim is made

for the general principles of construction of the instrument, and the advantages possessed by it in the readiness with which it could be put into use, the brilliancy of the illuminated circle of light which it gave upon the screen, its great range of delicacy by which all experimental requirements might be answered, and, finally, the satisfactory character of its performance as a demonstration galvanometer (Proc. Am. Phil. Soc., xiv, 440). This was followed by a communication "On the Measurement of Electromotive Force (ibid., xx, 649), in which the author states: "Having had occasion to make measurements of electromotive force by the method of comparison, I have been led to devise a form of standard cell, which appears to have advantages over others heretofore used as to justify me in bringing it before the Society."

In 1880, before the American Association for the Advancement of Science, at its Boston meeting, Dr. Barker, as retiring president, delivered an address upon "Some Modern Aspects of the Life-Question," from which the following paragraphs are introduced:

"As Preston has suggested, if we regard this ether as a gas, defined by the kinetic theory that its molecules move in straight lines, but with an enormous length of free path, it is obvious that this ether may be clearly conceived of as the source of all the motions of ordinary matter. It is an enormous storehouse of energy, which is continually passing to and from ordinary matter, precisely as we know it to do in the case of radiant transmission. When potential energy becomes kinetic, the ether loses and the matter gains motion. When kinetic energy becomes potential, the lost energy of the matter is the motion gained by the ether. Before so simple a connection as this, both potential energy and action at a distance are easily given up. All energy is kinetic energy, the energy of motion. Giving now to the ether its storehouse of tremendous power, and giving to it the ability to transfer this power to ordinary matter upon opportunity, and we have an environment compared with which the strongest steel is but the breath of the summer air. In presence of such tremendous power do we act. Is it

a wonder that out of such a reservoir the power by which we live should irresistibly rush into the organism and develop the transmitted energy which we recognize in the phenomena of life? Truly, as Spinoza has put it, 'Those who fondly think they act with free will, dream with their eyes open.'

"Such are now the facts and theories to be found in the science of today considering the phenomena of life. Physiologically considered, life has no mysterious passages, no sacred precincts into which the unhallowed foot of science may not enter. Research has steadily diminished day by day the phenomena supposed vital. Physiology is daily assuming more and more the character of an applied science. Every action performed by the living body is sooner or later, apparently, to be pronounced chemical or physical. And when the last vestige of the vital principle as an independent entity shall disappear from the terminology of science, the word 'Life,' if it remain at all, will remain only to signify, as a collective term, the sum of the phenomena exhibited by an active organized or organic being."

In following the career of our friend there is plainly seen a versatility on his part, as well as a keen interest for other branches of science than that one to which he gave the best years of his life. Thus, he is found a member of an expedition to Rawlings, Wyoming, for the purpose of reporting "On the Total Solar Eclipse of July 29, 1878"; his particular duty being to observe with an analyzing spectroscope the presence, either of light, or of dark (Fraunhofer), lines in the spectrum of the corona. (See Proc. Am. Phil. Soc., xviii, 1880.) Again, in connection with Professor Rowland, he reported "On the Efficiency of Edison's Electric Light." See this Journal 3, xix, 337.

Dr. Barker was the first person to exhibit radium in this country (1894) after its isolation by Madame Curie in Paris. Radioactivity appealed so strongly to him, that it is not surprising to find a paper of his on "Radio-activity of Thorium Minerals" in this Journal (4, xvi, 161, 1903). In this communication, the author introduces a number of original contributions. He repeated the experiments of Hofmann and Zerban, relative to the radioactivity of Brazilian

monazite, which contains no uranium, and confirmed the results of these observers, to wit: that the thorium from this monazite is probably radioactive. From a series of experiments, he further concluded that thorium emanation rapidly decays, falling to one-half its value in one minute, while that of the radium emanation retains its active properties for several weeks. On the other hand, the excited radioactivity produced by the former emanation is much more prominent than [that] produced by the latter. Since excited radioactivity can be produced on bodies if the emanation be present, even in the absence of a radioactive substance, and since the amount of emanation, it follows, first, that the production of excited radioactivity is a property of the emanation, and, therefore, is also produced in bodies where the radioactive emanations from thorium and radium are present: and second, that uranium and polonium, which do not give forth any emanation, do not possess the power of exciting radioactivity. In the present view of science, therefore, it would not be probable that the radioactivity of thorium is a secondary or excited radioactivity due to the uranium associated with it in the minerals previously named.

A very instructive address upon "Radio-activity in Chemistry" was delivered by Dr. Barker before the Chemical Society of Columbia University; it appeared in full in the School of Mines Quarterly (xxiv, 267). It has historical value, and will prove helpful to all wishing to familiarize themselves with the subject. It is accomplished with bibliographies covering ninety titles by the most prominent investigators in this particular field of research. In 1889, Harper and Bros. issued a small volume of seventy-five octavo pages on "Röntgen Rays," in which are incorporated memoirs by Röntgen, Stokes, and J. J. Thomson, translated and edited by Dr. Barker.

On the 27th of May, 1893, the American Philosophical Society celebrated the 150th anniversary of its foundation, on which occasion Dr. Barker offered a paper on "Electrical Progress since 1743." This paper is a review of the advances in physics since that early date, emphasizing in particular the contributions to electrical science by such persons as the immortal founder of the Society, Benjamin Franklin, and by Kinnersley, Robert Hare, Joseph Henry, Joseph Saxton, David Rittenhouse, and Alexander D. Bache. "The labors of these men have mightily contributed to advance the development of scientific thought throughout the world, and so to bring about that exceptional evolution of electrical facts and theories which is the distinguishing feature of the science of the nineteenth century." This little brochure is indeed worthy of study by every student of the physical sciences.

Still other communications of Dr. Barker are "On the Henry Draper Memorial Photographs of Stellar Spectra" (Am. Phil. Soc., ssiv, p. 166), "On the Use of Carbon Bisulphide in Prisms" (this Journal 3, xxix, 269), in which communication there is presented to the public the observations of his friend, Dr. Henry Draper, taken from the notes of the latter after his death; and "The Microphone of Hughes" (ibid. 3, xvi, 60), in which Dr. Barker takes occasion to say that the results obtained by Hughes had been clearly anticipated by more than a year by those of Edison.

Biographical memoirs of Frederick Augustus Genth, of Henry Draper, of John William Draper, and of M. Carey Lea were written for the National Academy by Dr. Barker, and he also prepared for the Smithsonian Institution annual reports upon physics from the year 1881 to 1885, inclusive. These amount to 253 pages and represent the most recent advances in the science during these years.

From 1868 to 1900 he was associate editor of this Jour-

nal, and the abstracts of chemical and physical papers which he contributed regularly during this period are remarkable for their clearness and accuracy. In 1874–75 he was editor of the journal of the Franklin Institute.

In 1892 appeared his "Physics, Advanced Course" from the press of Henry Holt & Company, which immediately met with a most hearty reception and became a standard among the textbooks on this important subject.

It follows naturally that to one so active in the scientific world there should have been awarded numerous honors. Thus, in 1881, Dr. Barker was United States Commissioner to the Paris Electrical Exhibit, a delegate to the Electrical Congress, and vice president of the Jury of Awards, receiving the decoration of Commander of the Legion of Honor in France; in 1884, he was U. S. Commissioner to the Electrical Exhibit in Philadelphia; and in 1893, a member of the Jury of Awards of the World's Columbian Exposition. He was an active member of the National Academy of Sciences, serving on many of its important committees, and also of the American Association for the Advancement of Science, of which he was vice president twice, delivering on one of these occasions an address on "The Molecule and the Atom," a most valuable contribution to theoretical chemistry, and president in 1879; his presidential address in 1880 has already been referred to. He was a corresponding member of the British Association. He was president of the American Chemical Society (1891), the subject of his presidential address being "The Borderland between Physics and Chemistry." He was secretary and later vice president of the American Philosophical Society from 1899 until 1909. He was a member of the Physical Society and of the Deutsche Chemische Gesellschaft. In 1899 he became an honorary member of the Royal Institute of Great Britain. He was the recipient of the following academic

honors: Doctor of Science from the University of Pennsylvania in 1898; LL.D. from Allegheny College in 1898; and LL.D. from McGill University in 1900.

He became Emeritus Professor of Physics in the University of Pennsylvania in 1900. He was a member of the Century Club of New York and the University Club of Washington.

In 1861, Dr. Barker was married to Mary M. Treadway of New Haven, Connecticut, who with three daughters survive this devoted and loving husband and father.

Dr. Barker was born at Charlestown, Massachusetts, July 14, 1835, and died at Philadelphia on May 24, 1910. His was a beautiful life, so full of service to his fellow men and so rich in its achievements that it will ever remain a most precious memory to his many friends.