Who was Theodore William Richards?

by M.S. Simon (Adapted from The NUCLEUS, 1996 (3) 4 ff)

The first award of what, at that time, was known as the Theodore William Richards Gold Medal (the medal is still gold, with a silver replica for informal display) was made to Arthur Amos Noyes in 1932. The Section Chairman, William Ryan, introduced the occasion with the following quotation by Henry Watterson:

A mound of earth a little higher graded Perhaps upon a stone a chiselled name, A daub of printer's ink soon blurred and faded And then — oblivion. That — that is fame.

Ryan went to point out that Watterson, as an observer in national politics, had developed a cynical attitude toward selfseeking politicians, and Ryan contrasts the impermanence of reputation of such with the seekers of truth for truth's sake for whom true fame is imperishable. With reference to Richards he said, *"True fame ... lives on, not merely to perpetuate the name of the individual and his accomplishments, but rather to inspire and encourage others who are serving similar ends."*

But in our age, when only "fifteen minutes" of fame are allowed, it behooves us to keep alive the names and accomplishments of our predecessors in chemistry. The Northeastern Section has many great chemists, but the earliest of the internationally renowned was Theodore William Richards. His Nobel Prize in Chemistry, awarded in 1914, was the first given an American chemist.

He was born in Germantown in 1868, was educated at home by his mother, a poet, and his father, a marine artist. He became interested in science at the age of six when he was shown the rings of Saturn through a four-inch telescope by Professor Josiah Parsons Cooke, Jr. of Harvard while the family was at Newport, R.I.

At ten he was making Pharaoh's Serpents with mercuric thiocyanate and coloring flames with various salts. He obtained money to set up a chemistry laboratory when he was 13 by printing on a hand press, copywriting, and selling an edition of his mother's sonnets.

He was allowed to attend chemistry lectures at the University of Pennsylvania, and at 14 entered and studied chemistry at Haverford. He received the Bachelor of Science at 17. He went to Harvard to study under Cooke and received a Bachelor of Arts and, at 20, after a year of very difficult research in which he demonstrated exceptional experimental skills in determining the atomic weight ratio of oxygen to hydrogen in water, earned the

Ph.D. degree. A year in Europe gave him the opportunity of studying analytical techniques at Göttingen and visiting important laboratories in Germany, France, England, and Switzerland.

He returned to Harvard in 1889 as an assistant and remained there for the rest of his years. When Cooke died, in 1892, Richards, already an assistant professor, was sent to Ostwald at Leipzig and Nernst at Göttingen to prepare himself to become the instructor in physical chemistry. His rise to full professorship at Harvard in 1901 came quickly, when Göttingen attempted to recruit him.

His early work centered one what at the time was one of the major scientific problems, that of determining exact atomic weights. He explained his choice, *"not merely because I felt more competent in that direction than in any other, but also because atomic weights seemed to be one of the primal mysteries of the universe. They are values which no man by taking thought can change. They seem to be independent of place and time. They are silent witnesses of the very beginnings of the universe, and the half-hidden, half-disclosed symmetry of the periodic system of the elements only enhances one's curiosity about them. Moreover, among the many properties possessed by an element, the atomic weight seems one of the most definite and precise. Hence, in trying to satisfy a desire which had as its object the discovery of more knowledge concerning the fundamental nature of things, one naturally assigns to the atomic weights an important place."*

In the following years Richards and his students (if we include independent work of Baxter and Hönigschmid, who had been trained by him) determined the atomic weight of 55 of the 92 known elements, in many cases in parts per ten thousand, in some, parts per hundred thousand. All of the elements whose atomic weights were the basis for determining the atomic weights of other elements were determined. His work on lead from uranium and from non-radioactive sources advanced acceptance of the theory of isotopes, the only conclusive evidence until the development of the mass spectrograph.

He was always respectful to those on whose shoulders he was standing, J.J. Berzelius and J.S. Stas, pioneers in atomic weight determination, but when his superior methods showed that the Stas values had to be revised, he took the mantle on his own shoulders. A modest man, only after searching diligently for his own possible errors would he conclude that the Stas work had to be superseded.

He was guided to success by *"his ability to foresee all sources of error and possible calamities which the average investigator would have overlooked completely,"* reported his son-in-law, James B. Conant.

Richards put it thus, *"Every substance must be assumed to be impure, every reaction must be assumed to be incomplete, every method of measurement must be assumed to contain some constant error, until proof to the contrary can be obtained. As little as possible must be taken for granted."*

It is illuminating to consider that much of his work was conducted in Boylston Hall, where his laboratory had been a stockroom, where the iron sashes of the fume hood rained rust, and a flood on the floor above caused the ceiling to collapse on him; where fumes from elsewhere in the building could ruin his experiments. Finally, the Wolcott Gibbs Memorial Laboratory, a gift of Dr. Morris Loeb, was built in 1912 and Richards had the facilities his work deserved.

The concentration on atomic weights suggests that Richards was solely an analytical chemist. Indeed, he was a superb analytical experimentalist, but his work in other areas of physical chemistry formed an important part of the total picture. His work began at the period when physical chemistry was aborning; van't Hoff, Arrhenius, Ostwald, Nernst were the new names and the Zeitschrift für Physikalische Chemie was founded in 1887. Richards' first student in physical chemistry was G.N. Lewis, to whom he assigned the study of the electrochemistry and thermochemistry of amalgam cells. Richards rejected the belief of that day that atoms were incompressible, developed evidence that atomic volumes change, and, according to Lewis, very nearly discovered the third law of thermodynamics in his studies of the relationship of changes in free energy and total energy accompanying a reaction.

His invention (with G.S. Forbes and L.J. Henderson) of an adiabatic calorimeter led to studies of specific heats of acids, bases and salts, heats of solution and dilution, heats of neutralization and the thermochemistry of organic compounds.

His laboratory attracted students from many other countries to learn the methods of the Harvard school. His ability to devise methods which could give superb results in the hands of students led to volumes of published research. The list of his students includes many of the most capable physical chemists of the first half of the twentieth century.

At his death in 1928 the Northeastern Section appealed for funds to set up a memorial and, with 'gratifying response', raised a sum of ten thousand dollars in a few months. The Theodore William Richards Gold Medal was designed by Cyrus Dallin, a distinguished sculptor and friend of Richards.

A more complete account of the career of Richards may be found in a lecture delivered by Sir Harold Hartley and recorded in the Journal of the Chemical Society (London), 1930, 1930-1968, from which much of this article was taken. Other sources include the *Encyclopedia Britannica* and *The NUCLEUS*. *The Scientific Work of Theodore William Richards* is the title of a Ph.D. dissertation by Sheldon J. Kopperl, U. Wisconsin, Madison, 1970, 333-359.