NATIONAL ACADEMY OF SCIENCES

FRANK CLIFFORD WHITMORE

1887—1947

A Biographical Memoir by

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Frank Clifford Whitmore was born in North Attleboro, Massachusetts, on October 1, 1887. He spent his early youth in Atlantic City, New Jersey, and there received his grammar and high school training. His mother was a remarkable woman who found time in a busy, workaday life to interest her son in Shakespeare and classical literature. He retained throughout his life, an interest in literature and a tremendous variety of other subjects.

Whitmore selected the Latin-Scientific course in high school as preparatory for college. But when, at the beginning of his senior year, he chose Harvard as his college, he expected to need a year of Greek for entrance. Characteristically, he persuaded the high school principal to give such a course. Whitmore was the leader of his class in academic work and in athletics. He was captain of the track team and was active in basketball. He achieved unusual skill in the craft of wood carving. He graduated in 1907 as valedictorian of his class and was awarded a scholarship to Harvard University. It was in high school that he acquired the nickname of Rocky Cliff, from his middle name, Clifford. This was later shortened to "Rocky" by which he was known throughout life.

He was proud of having worked his way through Harvard, and showed great ingenuity in finding jobs of various types. He was particularly fond of telling about a job as night telephone operator at the switchboard in the town of Wellesley, Massachusetts some 17 miles from Harvard Square. He travelled between the towns by trolley car and was on duty from 7 p.m. to 7 a.m. daily. He held this job for the balance of his freshman year. He ingeniously contrived a device that rang a bell instead of merely showing the usual light whenever a subscriber lifted his receiver. Thus he was able to do his studying and get his necessary sleep between calls. Fortunately, the exchange was not a busy one.

He took no chemistry as a freshman but did start the study of that subject as a sophomore. Between his junior and senior years, he tried for a place as a college guide and served in that capacity during the summer of 1910. It was during this summer that he decided to make chemistry his life work. In his senior year he took nothing but chemistry—qualitative, quantitative, organic, and physical—and received his A.B. *magna cum laude* in June, 1911, and his A.M. with highest honors June, 1912. He attracted the attention of Professor Charles Loring Jackson and became his laboratory assistant. This was Whitmore's introduction to research. He had to work with unusual independence, for Professor Jackson was about to retire and spent most of his time at his home in Prides Crossing, Massachusetts. Whitmore went there for many conferences on his research problem.

In 1912, after Professor Jackson's retirement, Whitmore shifted his work to Professor T. W. Richards and Professor Kohler. During his graduate work he supported himself as a very active tutor in the famous "Widow's" tutoring school. He was highly successful and commanded what was a very large salary for the times.

While a graduate student he decided definitely on an academic career. However, his income as a tutor was much more than he could expect as an instructor in any college at that time. Consequently, he devoted two years after receiving his Ph.D. degree in 1914 to tutoring in order to accumulate enough money to live on his savings and a university salary thereafter.

In 1914 he married Marion Gertrude Mason of Cambridge. He had met his wife-to-be during his summer as a university guide. She was a student of chemistry at Radcliffe and became a great help to him first in the laboratory and during later years in the writing of his books and papers. They were a very devoted couple throughout their married life, with five children, Frank, Jr., Mason, Harry, Marion, and Patricia Joan (deceased).

It is of interest to note that all four children have turned to scientific careers. Frank, Jr. was trained at Amherst, Pennsylvania State College and Harvard (Ph.D. 1942) in geology

and currently is Chief of the Military Geological Branch of the U. S. Geological Survey. Mason received the M.D. degree from Cornell University and is now resident in radiology at Jefferson Hospital in Philadelphia. Harry was trained as a chemist at Pennsylvania State College and is in the technical sales and service department of Universal Oil Products Company, where he is the expert on food anti-oxidants. Marion has completed her work for the degree in the premedical course at Pennsylvania State College and is now studying with Dr. Pauline Beery Mack in the field of nutrition.

In 1916-17 Whitmore was instructor at Williams College and in 1917-18 he taught at Rice Institute. He worked at Rice Institute on toxic gases for the Chemical Warfare Service. He went to the University of Minnesota as Assistant Professor in 1918 and remained two years. He next was called to Northwestern University as Professor in 1920. Here he was associated with Professor W. Lee Lewis. When Lewis left the University, Whitmore was made Head of the Department. At Northwestern, Whitmore began to have graduate students working with him and soon his scientific work began to attract attention. He obtained a grant from the Interdepartmental Social Hygiene Board and began intensive work on the organic mercurials. His first book, a comprehensive treatise on organic mercury compounds, appeared in 1921. He concentrated his researches in this field during his stay at Northwestern

Whitmore was an extremely vigorous person and a prodigious worker. He not only carried his duties as Head of the Department at Northwestern and conducted an aggressive research program, but was able to serve as a consultant to the Bureau of Chemistry and Soils of the Department of Agriculture and to the Chemical Warfare research group, as a member of the editorial board of *Organic Syntheses,* as editor of the *Chemical Bulletin,* in many capacities for the National Research Council (Chairman, 1927-28) and in all elective offices of the American Chemical Society, including five years as Secretary of the Organic division. While at Northwestern he again demonstrated that he could do with little sleep compared with most men. He got up as early as 3:00 a.m. and went to work in his

office. Then at normal times for rising he returned home to be with his family for a few hours before returning to his regular office schedule.

In 1929 he moved from Northwestern to the Pennsylvania State College as Dean of the School of Chemistry and Physics and Research Professor of Organic Chemistry where he remained for the rest of his life. He raised the standards in chemistry to give Pennsylvania State College a high place in chemistry and chemical engineering education. While he was Dean there, the graduate enrollment in chemistry increased from 18 to over 100 and the College awarded 871 Bachelor's, 383 Master's, and 215 Doctor's degrees in chemistry and chemical engineering. In spite of heavy administrative duties, he managed to remain an inspiring and thorough teacher, increased his output of fundamental research in many fields of organic chemistry, and at the same time carried on his service to the American Chemical Society as a director, president, and associate editor of its journal. While president of the American Chemical Society he visited and talked before each of its over one hundred sections.

During World War II, he was especially active in a wide variety of Government projects. For the National Defense Research Committee, he served as chairman of the subdivision of the chemistry section dealing with organic explosives during the critical early years of that program. He served as consultant to the War Manpower Commission, War Production Board, Office of Production Research and Development, and Office of the Quartermaster General. In addition, he supervised war research at Pennsylvania State College dealing with aviation fuels, lubricants, explosives, antimalarials, synthetic rubber, penicillin, and silicones. He was particularly active in his support of the efforts to keep the Selective Service System selective so that the highly trained personnel in chemistry, chemical engineering, and physics could be used where they would be of greatest service to the country. It can be said with truth that Whitmore was a war casualty, for the heavy drain on his vitality that all of these activities required resulted in his physical decline and led to his sudden death. For his con-

tribution to the war he was awarded the President's Certificate of Merit, posthumously.

Whitmore was an unusually productive man in the field of fundamental organic research. As was mentioned, his first independent work was in the field of organic mercurials. His monograph in that field published in 1921 is still the standard reference text. He not only devised many new mercurials but in particular he developed better methods for the production of many types of mercurials and showed how these materials could be used to advantage for the synthesis of many other types of organic compounds.

Perhaps his best known work was in the field of molecular rearrangements. His electronic conception of rearrangements has become generally accepted by all organic chemists, although when first proposed many were skeptical of its ultimate usefulness. In establishing this conception of rearrangements on a firm experimental basis, Whitmore directed his researches into nearly every phase of synthetic aliphatic chemistry. He prepared hundreds of new and complex alcohols and studied their dehydration products. In the synthesis of the needed alcohols he improved old procedures and developed new ones. In particular he added to our knowledge of the Grignard reaction as a source for ketones from acid chlorides, for the preparation of tertiary hydrocarbons, and as a reducing agent. He devised improved procedures for the ozonolysis of unsaturated hydrocarbons in order to elucidate the structure of his rearrangement products. He developed the unusual chemistry of the neopentyl system which was essentially unknown before his researches in that field. He synthesized pure hydrocarbons, both saturated and unsaturated, to confirm their properties and structures. He related the rearrangements of olefins in acid solution to the rearrangement involved in the dehydrogenation of alcohols by various agents, and the rearrangements which occur in such reactions as the Hofmann degradation of amides, the Chugaev reaction, the transformation of tertiary halides, the pinacol and semi-pinacol rearrangements, action of nitrous acid on amines, the cationic polymerization of olefins and other similar transformations.

In the field of antimalarials, he synthesized a wide variety of heterocyclic bases in the pyridine, pyrimidine, quinoline and triazine series. His wartime studies of the organosilicon compounds led to many new synthetic procedures and in particular he discovered the unusual activity of β-substituted organosilicon derivatives. In the development of processes, he contributed to the processing of penicillin, the production of benzyl chloride by the chloromethylation of benezene, and a pilot plant study of the production of benzyl benzoate. He also conducted pilot plant studies on the preparation of RDX which were used as the basis for one of the first plants built for the production of this explosive. The first hundred pounds of RDX were made in Whitmore's laboratory. In addition to these particular studies in the fields of his greatest interests, Whitmore contributed to nearly every field of organic chemistry.

The investigation of organosilicon compounds interested him so much that at the time of his death he was planning a twenty-year research program in this field. It was his intention that the silicon studies should constitute the third major phase of his research career after the mercurial and hydrocarbon work.

In 1937 his textbook "Organic Chemistry" was published. He characterized it as a one-volume "Beilstein" and directed it toward the advanced group of students and practicing organic chemists. This treatise reflected current industrial interest in the aliphatic and alicyclic series of compounds since nearly three-fourths of its pages were devoted to these topics. The book has had a wide acceptance and is another of Whitmore's important contributions to organic chemistry. A second edition was in preparation at the time of his death, and this has now been completed and made available to all through the efforts of his family.

His researches were recognized by many honors conferred by his fellow chemists. He was awarded the William H. Nichols Medal by the New York section of the American Chemical Society in 1937; was elected in 1938 to the Presidency of the American Chemical Society and to honorary membership in the professional chemical fraternity, Phi Lambda Upsilon; was elected to the American Philosophical Society in 1943; was

awarded the Willard Gibbs Medal by the Chicago Section of the American Chemical Society in 1945. He was elected to the National Academy of Sciences in 1946. He was granted honorary Doctor of Science degrees by Franklin and Marshall College and by the University of Delaware in 1937, and by Allegheny College in 1938.

Although he was awarded most of the honors that can come to a scientist, Whitmore was much more willing to discuss his less spectacular successes, such as being a member of the Atlantic City High School relay team that won a first place in the 1906 Penn Relays, of his skill in bicycle races on the lot where now stands the Claridge Hotel in Atlantic City, and of his activities in the Webster-Haines Debating Society in high school days.

He was always the modestly human man who liked people and who liked chemistry. His recognition as a scientist came naturally because of these interests and not because he sought honors.

He found time in the midst of his many duties to advise industry on its difficult problems. He kept in touch with his students and was always willing to advise them on technical and personal problems. He was always eager to see his "boys" advanced to make best use of their talents. His loyalty to his family extended to those who were his students and his friends. He never was too busy to help any one of those associated with him. He was always cheerful, inspiring, even-tempered, enthusiastic and full of energy. Dean Whitmore's career was ended by his sudden death at his home on June 24, 1947. The tribute paid him by the Directors of the American Chemical Society describes him as "a scholar, teacher, original investigator, dean, eminent scientist, and inspirational leader . . . a great man who gave himself freely to the welfare and advancement of his fellow men and to the advancement of chemistry".

KEY TO ABBREVIATIONS USED IN BIBLIOGRAPHY

Ber.=Berichte der deutschen chemischen Gesellschaft
Chem. Bull.=Chemical Bulletin
Chem. Eng. News=Chemical and Engineering News
Chem. Ind.=Chemical Industry
Ind. Eng. Chem.=Industrial and Engineering Chemistry
J. Am. Chem. Soc.=Journal of the American Chemical Society
J. Chem. Ed.=Journal of Chemical Education
Org. Syn.=Organic Syntheses
Rec. trav. chim.=Recueil des travaux chimiques des Pays-Bas et de la Belgique
Sci. Mo.=Scientific Monthly
Sci. Petro.=The Science of Petroleum

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