HERMAN AUGUSTUS SPOEHR
1885–1954

Herman Augustus Spoehr was born in Chicago, Illinois, on June 18 1885. He was the son of Charles A. and Frida Baeuerlen Spoehr. Although both his parents were natives of Goeppingen, Wuerttemberg, they met in America.

Spoehr's father came to Chicago about 1868, just before the Chicago Fire which deprived him of most of his worldly possessions. After the fire, he established a candy manufacturing business which grew successfully, along with the great burgeoning mid-west metropolis, to become one of the outstanding enterprises of its kind in the country. The interests of the candy business were logically expanded into the manufacture of sugar and chocolate, the latter of which Spoehr's father pioneered in this country.

Spoehr received most of his early schooling at private schools in Chicago. His secondary-school training was obtained at Lewis Institute, and his college work was taken at the University of Chicago, from which he received his baccalaureate degree in 1906. The year after graduation from college was spent in Europe studying with the two most noted European carbohydrate chemists of his time, Emil Fischer of Berlin and L. Maquenne of Paris. Following his sojourn in Europe, he returned to his Alma Mater for further training; there he received his Doctor of Philosophy degree in 1909. At Chicago he worked with another eminent carbohydrate chemist, John Ulric Nef—one of the great company of scholars which had been attracted to the newly founded university.

One could hardly be interested in sugar chemistry without wondering about the origin of sugar in nature. In order to prepare himself to satisfy this curiosity, Spoehr elected botany as his secondary subject and studied Plant Physiology with Charles Reid Barnes. According to Mrs. Spoehr, he "encountered considerable disparagement from some of the chemistry faculty for such an 'impossible' combination." But it was this "impossible combination" which formed the foundation for most of Spoehr's scientific work.

In a fashion characteristic of his forebears, Spoehr left the familiar surroundings of his youth to pioneer untried fields in a strange land. In 1910 he and his bride left the mid-west metropolis to establish their home in the small frontier town of Tucson, Territory of Arizona, he to be Chemical Plant Physiologist at the recently established Desert Laboratory of the fledgling Carnegie Institution of Washington. The ten years which he spent in the Arizona desert profoundly affected his scientific thought.

Except for the year 1930–1931, when he served as Director of Natural Sciences of the Rockefeller Foundation, Spoehr was an active member of the Carnegie Institution's staff from 1910 until he retired in 1950, being Chair-

man of the Division of Plant Biology from 1928 to 1947. Even after retirement he remained closely associated with the Department of Plant Biology until his death on June 21, 1954. Those of his immediate family who survive him are his widow, Florence Mann Spoehr, a son, Dr. Alexander Spoehr, and a daughter, Mrs. Horace P. Miller. The scientific pioneering so distinctive of the father is being continued by the son who is Director of the Bernice P. Bishop Museum of Honolulu.

Spoehr's scientific contributions were numerous and significant. They centered about one theme—photosynthesis. It is difficult now to realize the state of photosynthesis research at the time Spoehr began. No other laboratories in America were engaged in such research. In Europe, the classic work of Willstaetter and his collaborators, especially Stoll, was just getting under way. And in his early years Spoehr was possibly the sole link between this country and Europe in this important field.

Since he had a lively interest in carbohydrate chemistry and because carbohydrates are the principal products of photosynthesis, a large portion of his personal research was concerned with seeking to understand their reactions as they pertained to photosynthesis.

While at Tucson, Spoehr investigated the carbohydrates of the cacti and their transformations relative to the extreme changes encountered in the desert environment. This work culminated in a notable monograph, *The Carbohydrate Economy of the Cacti.* The diurnal fluctuations of the organic acids of the cactus plant and their reciprocal relation to the sugars also engaged his attention. An examination of the products obtained from the photolysis of these acids *in vitro* provided a partial explanation of the changes observed in the living plant. He identified formaldehyde among the photolysis products of the pure acids. Consequently, the presence of formaldehyde in leaves could no longer be considered sure evidence for the Baeyer formaldehyde theory of photosynthesis. This observation, in conjunction with his meticulous experiments on the photoreduction of carbon dioxide to formaldehyde which failed to substantiate the affirmative claims of others, greatly hastened the abandonment of the Baeyer theory.

After moving to the Carnegie Institution's Coastal Laboratory at Carmel, California, in 1920, Spoehr in collaboration with a number of co-workers continued his experiments on various phases of carbohydrate chemistry and photosynthesis. His study of the transformation of the sugars by purely chemical means fully demonstrated various interconversions of the trioses and hexoses among themselves and among each other under conditions of temperature and alkalinity (phosphate and carbonate buffers) commonly existent in biological systems.

The monograph, *Studies in Plant Respiration and Photosynthesis,* published jointly by Spoehr and J. M. McGee, emphasized the possible connection between these two processes and revealed new interrelationships between the sugars and amino acids in them. Spoehr was much interested in the mechanism of the biological oxidation of sugars. To study this, he invented

a catalytic procedure which simulated the biological process in that it could oxidize sugars to carbon dioxide with air at body temperature and at physiological pH values. The active catalyst in this process was sodium ferropyrophosphate.

Considerable effort was expended to find the "substance on to which carbon dioxide . . . can be added" in photosynthesis. The first experiments showed the carbon dioxide uptake to be predominantly ionic in nature, but some years later, through the use of radioactive carbon, C^{11}, an organic acceptor was demonstrated to exist in the leaf which took up relatively small quantities of this gas.

While still at Carmel, the series of researches on the pigment systems in photosynthetic organisms was begun. Initially, the work was limited to the structural relations of certain carotenoids. But this work, in the hands of H. H. Strain, was soon expanded to include a survey of the carotenoids and chlorophylls of a large number of plants. This survey demonstrated the complexity and diversity of the photosynthetic apparatus among the different groups of plants. It uncovered a host of hitherto unknown carotenoids and, most surprisingly, some new chlorophylls.

One of the most notable achievements of Spoehr in the years spent in Carmel was the completion and publication of his book, *Photosynthesis*. This was an authoritative account of what was known about the subject at the time. The book marked its author as the distinguished writer, scientist, and scholar that he was. It became the bible for a generation of workers in this field and had much to do with exciting the present general interest in this subject.

In 1928 various groups of plant scientists operating within the Carnegie Institution were combined for administrative purposes into the newly created Division of Plant Biology with Spoehr as chairman. During 1928 plans were perfected for a new central laboratory of the Division to be built on the campus of Stanford University, and in 1929 this building was occupied. Although Spoehr's administrative load reduced his own research activities, he always had experimental work of his own in progress. This work was devoted to the study of the complex carbohydrates in leaves—starch, cellulose, and uronic acids; the conditions required for the activity of leaf enzymes, particularly the amylases; the organic nutrition of albino plants by which he brought them to maturity; and the mass culture of algae. With H. W. Milner he demonstrated the determinative influence of culture conditions on the internal composition of algae. During World War II he, with his associates, obtained antibiotics from autotrophic organisms, particularly from Chlorella. Even though some of these researches were carried on in collaboration with others, Spoehr participated personnally
mental work in all of them.

In 1947, three years before retirement, Spoehr resigned the chairmanship of the Division of Plant Biology, to which position C. Stacy French was appointed. During the three years previous to retirement and the four

years following, he continued his work on the carbohydrates of photosynthetic organs, isolating and purifying substances whose occurrence had only been postulated by indirect evidence gained by methods which were oftentimes of doubtful validity. During this time, several publications came from his hand. Most of these dealt with some aspect of the large-scale culture of algae—a process of industrialized agriculture which in time may bring new types of practices into agriculture.

Besides his scientific papers, Spoehr published a series of philosophical essays which treated, in the main, various aspects of the relation between science and society.

In addition to his regular duties, he performed many useful services to science. He counseled wisely and his advice was sought by many leaders in science, industry, philanthropy, education, and government. Spoehr was accorded many honors and was placed in numerous positions of responsibility and trust. It is not the purpose of this tribute to review these, since they have been enumerated in other places. Only his relations and contributions to Annual Reviews, Inc. will be elaborated here.

Spoehr's actual association with Annual Reviews began in 1933 with his article *Chemical Aspects of Photosynthesis* in volume II. In 1940 he was elected to the Editorial Board of *Annual Review of Biochemistry* and to the Board of Directors of Annual Reviews, Inc. In 1946 he was elected president of the latter board, which office he held until his retirement from the board in December, 1952. He was happy to accept these appointments and to do whatever he could to promote the aims of Annual Reviews for he felt that this was "one of the thoroughly worth-while undertakings in science." How certainly the aims of Annual Reviews harmonized with his conception of what publication had accomplished in science can be seen in a passage from his essay *The Nature of Progress in Science:*

> Without the careful recording of experiences, their correlation, examination in the light of what is already known, sifting the essential from the irrelevant, etc., knowledge would not grow. This organization of its experiences and constant re-examination of the groundwork on which it is building has been an essential element of scientific endeavor. As a consequence it has built up a body of knowledge which has been of inestimable value for its further development. This body of knowledge is contained in a system of written records which . . . considering the staggering number of individual and minute observations and conclusions which it contains is remarkably simple and couched in a language which for the scientific workers is practically universal. . . . The rapid development of science would have been utterly impossible if it had not so organized its body of knowledge that the experiences of one were made available to all . . . that the great mass of experience of an army of workers [was] summarized, generalized and organized, and for all time made available for the guidance of succeeding generations.[1]

There are few men whose background, training, and experience could

[1] "The Nature of Progress in Science," *Elihu Root Lecture of Carnegie Institution of Washington*, p. 48 (1935).

have fitted them so well for this appointment as those of Spoehr. His business and administrative experience, his familiarity with Europe, acquired as a youth and graduate student there, his personal acquaintance with a large number of European scientists, and his first-hand knowledge of their work, gained through his investigation of European silviculture during 1926 and his year as Director of Natural Sciences of the Rockefeller Foundation, all were of great value to Annual Reviews.

Many of the years he served on these boards were decisive ones. The number of Annual Reviews increased from two to eight. This expansion required many critical decisions to be made. The launching of new Reviews created problems concerning publicity and finance, delineation of boundaries between Reviews covering overlapping fields, selection of editors and editorial boards, and a host of minor matters relating to policy and operation.

World War II and the reconstruction period which followed imposed great strain upon an organization such as Annual Reviews which operates on an international scale and in an international atmosphere. With half the world beyond reach, the broad base of authorship on which Reviews depends was greatly curtailed. Even more serious was the restricted access to much of the research being done both in Europe and in America.

Business decisions were also numerous and burdensome. Many foreign outlets for the Reviews were temporarily stopped. With the cessation of hostilities would come a flood of requests to fill the gap caused by the war—but how many volumes would be wanted and how long must the extra inventory be kept? In the reconstruction period the need for these Reviews was great but the money to pay was limited. In how far could the largess of Annual Reviews be stretched? To solve these problems and to answer these questions successfully required thought, experience, and good judgment.

An appreciation of Spoehr's contribution to the successful handling of these matters is given by the editor of this Review in his letter regretting Spoehr's retirement from the board: "You have been with the enterprise for many years, during most of which you steered the ship and brought us safely around some of the treacherous shoals which had to be navigated. I sincerely hope that we may continue to have your advice from time to time on matters that call for your own good judgment and experience."

In his contacts with scientists from home and abroad during his service as scientific consultant to the Secretary of State in 1950, Spoehr was gratified by the frequent mention of Annual Reviews. He was impressed by what a powerful instrument these Reviews could become for cultivating international good will and understanding.

Spoehr's accomplishments as an eminent scientist, writer, and administrator give only a fragmentary picture of the full life he lived. Outside his professional activities, he had varied and deep interests in business, civic, and cultural affairs. Acquaintance with the real warmth of his personality, his charitableness, generosity, and magnanimity came only gradually

through long and friendly association with him. He was a lover of beauty wherever it was found: in art, literature, music, science, nature, nobleness of character, or in social relationships. He sought always to surround himself with it in his home, his garden, and his laboratory.

Perhaps no better way to close this tribute to our valued colleague and friend could be found than to quote the verse he himself used when relinquishing the chairmanship of the Division of Plant Biology:

> "The race of man is as the race of leaves:
> Of leaves, one generation by the wind
> Is scattered on the earth; another soon
> In spring's luxuriant verdure bursts to light.
> So with our race; these flourish, those decay."[2]

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[2] *Homer's Iliad*, Book VI, Line 171 (Edward Earl of Derby, Trans.).