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SAMUEL WILLIAM JOHNSON.

Samuel William Johnson was born in Kingsboro, New York, July 3, 1830, the fourth child of Abner Adolphus and Annah Wells (Gilbert) Johnson. His ancestry traces back in every line to early colonial settlers in Connecticut. He studied in the district schools and the academy at Lowville, New York. He then alternately taught and studied in this country, Germany, and England until 1855, when he began his active service of forty years as a member of the faculty of the Yale (now the Sheffield) Scientific School. He was director of the Connecticut Agricultural Experiment Station from 1877 to 1900. He was early a member of the American Association for the Advancement of Science, and was chairman of its subsection on chemistry in 1875. In 1866 he was elected a member of the National Academy of Sciences. He was an associate fellow of the American Academy of Arts and Sciences. He was long a member of the American Chemical Society and was its president in 1878. He was one of the original members of the American Association of Official Agricultural Chemists, was its president in 1888, and was also president of the American Association of Agricultural Colleges and Experiment Stations in 1896. He died at his home in New Haven July 21, 1909.

Professor Johnson's life was a striking example of the power of a dominant purpose conceived in boyhood and consistently followed to old age.

The Experiment Station Record, in an editorial, said that

> his name will be intimately linked with the early history and the development of agricultural science in this country, as it will be with the establishment of the agricultural experiment station as an American institution. He was a pioneer of pioneers, a leader of thought, the disciple of a new idea of science. He gave not only results, but an intelligent understanding of their meaning and application; and in the early days of the new work he aroused an interest and confidence in it which went far toward making possible its spread and development. The career of this man is a monument to industry and to untiring devotion in behalf of a cause which appealed to him from his youth. As a teacher of agricultural teachers, as a leader in agricultural science, and as a

father and promoter of the movement to bring the sciences to the aid of the farmer through the experiment stations, he rendered signal service to the cause of agricultural advancement, and has left a name to be remembered with great honor.

Although Professor Johnson's childhood was spent on a farm far removed from any scientific influences, he early acquired a keen interest in the scientific side of the processes of plant and animal life, by means of which all with whom he was associated were gaining support for their families. He thus as a child became impressed with the importance and dignity of agriculture, to the promotion of which he devoted the whole of a long and active life, contributing by his lectures and publications concerning the fundamental principles of agriculture not only to the development of the art, but also to the intellectual life of the farmer.

His attention seems to have been first directed to such subjects by his father, to whom, as his "earliest and best instructor," he dedicated his first book. Although his father had no scientific training he had an inquiring mind, which led him to think about and to discuss the wonders of life in such a way as to impress profoundly the child who was his constant companion. The interest thus awakened was soon directed into purely scientific lines by the influence of David Mayhew, one of his first teachers at the Lowville Academy, to which he was taken when only ten years old by his older brother. Mayhew, who was a man of more than ordinary ability and scientific training for that time, soon excited in the boy a strong interest in chemistry, which he at once began to study with energy and to apply to the solution of agricultural problems.

That he was destined to become a teacher of agricultural science, and especially of agricultural chemistry, is shown by his first paper, entitled "Fixing ammonia," which was published when he was but seventeen years old. This paper is remarkable, as it shows the purpose which dominated his whole after life and the character of the education which he had acquired under what would now be regarded as unfavorable conditions, and is not only characteristic of his later writings but interesting as one of the early contributions to American agricultural science.

During his school days he was not content with the facilities provided by the academy for acquiring a knowledge of chemistry, and at the age of sixteen he fitted up a room in a wing of his father's house as a laboratory. Here he prepared the reagents necessary for qualitative analysis, according to the direction given in an edition of Fresenius which his teacher had presented to him. He thus gained experience in conducting chemical work without the assistance of instructors, developing a degree of self-reliance which had a marked influence on all of his later life. An interesting picture of the work that he did in this laboratory is given by his first note book, which contains an account of successes and failures in the many processes which he conducted. The entries in this book show that it was no boy's work which he had undertaken, for the experiments described were intelligently planned to supplement the instruction that he received at the academy.

After teaching school for two or three years he determined to continue his study of chemistry with the intention of devoting himself to its application to agriculture. Unlike other students of his time he made his choice of instructors in the spirit of the modern university student. He did not seek an institution where he could follow a prescribed course and obtain a degree, but applied himself to getting information as to the men who would give him the most of what he sought for.

After a careful canvass he determined to place himself under the instruction of J. P. Norton, then professor of scientific agriculture in Yale College. Accordingly, in the winter of 1849-1850, he went to New Haven, where he studied during the following two years. There he came under the influence not only of Norton but of the Sillimans, father and son, J. D. Dana and others, by all of whom he was appreciated and encouraged.

His life in New Haven was a busy one, for in addition to his study he was compelled to devote some time to commercial analytical work in order to meet his necessary expenses, as his father was at first inclined to do but little to help him.

In the spring of 1853, with the approval and assistance of his father, he went to Leipzig, where he worked with Erdmann and Neumann for nearly a year, chiefly at organic and inor-

ganic analysis. He then went to Munich, where he spent the next year in Liebig's laboratory, receiving instruction in organic chemistry, especially in its relations to plant and animal life. He also attended the lectures of Pettenkofer and Von Kobel on physiological chemistry. Von Kobel and Liebig contributed much to his social and literary development. He was a frequent visitor in their houses, where he learned the habits of German society, and during his later years he often recalled with pleasure the social evenings he thus spent with their families and friends, and many of the habits of manner and speech which he then acquired were retained throughout his life.

After a brief stay in Paris, where he visited the laboratories of prominent chemists, he went to England to work in Frankland's laboratory for a few months in order to learn the methods of gas analysis.

Having visited the experimental farms of Lawes and Gilbert and other places of agricultural interest, he hurried back to New Haven to take charge of the Yale Analytical Laboratory. While in Europe his efforts were directed to qualifying himself for a teacher of agricultural science, and his hopes were centered in plans for establishing at some place in this country an institution where instruction in the principles of this art should be taught. In connection with such plans he had extensive correspondence and many interviews with Evan Pugh, who was then studying with the same objects in view and who later became head of the College of Agriculture of Pennsylvania.

These plans were changed by his appointment as first assistant in charge of the Yale Analytical Laboratory, but the purpose of his life was not altered thereby. The next year he was made professor of analytical chemistry and the year after professor of analytical and agricultural chemistry in the Yale Scientific School. Having thus at last obtained a position in his chosen field, he set himself at work to develop a popular interest in scientific agriculture by means of essays and lectures. For many years he made frequent and regular visitations all over New England and at times into New York State, attending meetings of agricultural societies and farmers' clubs.

He was the apostle of a cause, and his earnestness, sincerity, and clearness as a lecturer rendered him and his subject popular among his hearers and secured for him the confidence of the agricultural community.

He was appointed chemist to the Connecticut State Agricultural Society in 1856 and made his first report in 1857. This report is of much interest, as it was the first agricultural publication of its kind issued in this country. In it he employed many of the methods which are still used in similar reports issued by the agricultural experiment stations of the United States. Thus he placed a money value on the commercial fertilizers which he analyzed, based on the cost of their essential elements as derived from the market value of such substances in their cheapest form available for agricultural purposes. He also discussed the manurial value of the several fertilizers from a scientific standpoint in so simple and concise a manner that all farmers of ordinary intelligence could easily understand their value in practice and the principles involved in their economical application.

This report was much more than a chemist's statement of analytical results and has had a lasting influence. It instructed the farmer in many things of great practical importance to the proper conduct of his business and set a standard for those who have since been engaged in the application of science to agriculture. One cannot fail to recognize in this report the beginning of the movement which later led to the establishment in every State of the agricultural experiment stations, which are now filling such an important place in the development of American agriculture. We can fairly say that Professor Johnson was himself the first agricultural experiment station in this country.

The work that he thus began he continued with untiring persistence until the outbreak of the Civil War, in spite of the many official duties which his college teaching involved. Lack of funds and diversion of public interest brought the activities of the Connecticut Agricultural Society to a close, and consequently his efforts in this direction ceased for the time being.

During the fall of 1859 he delivered at the Smithsonian Institution in Washington a series of lectures on agricultural

chemistry, which attracted wide attention among those interested in the subject, and served as the basis of his most successful book, "How Crops Grow," which was published eight years later. During these eight years he contributed many articles to agricultural journals and numerous scientific papers to the American Journal of Science and Arts. He translated and edited Fresenius' Qualitative Analysis, wrote "How Crops Grow," and discharged his duties as professor of analytical and agricultural chemistry in the Sheffield Scientific School, into which the Yale Chemical Laboratory had been merged.

The war being over and public attention again turned to the pursuits of business, he, with others who had been active members of the Connecticut Agricultural Society, succeeded in establishing a board of agriculture under the authority of the State. By this board he was appointed chemist, and at once resumed the work he had formerly done for the Agricultural Society.

This work he continued for the next ten years, and thereby demonstrated, in a practical manner, what an experiment station could do for the agricultural community. In the conduct of this work he devoted himself largely to practical questions rather than to purely scientific problems, as he hoped thereby to gain the interest and support of the community to the end that the State should establish and suitably endow an independent institution, which should furnish the farmer with such scientific information and investigations as he required for the successful conduct of his farm.

A step in this direction was taken in 1875, when the legislature of Connecticut appropriated $2,800 annually for two years for experiments in agriculture to be carried on in laboratories which Wesleyan University offered to furnish free of charge. This work was done under the direction of W. O. Atwater, a former assistant of Professor Johnson, who was then professor of chemistry at that place. Thus through the continued efforts and as the direct outcome of Professor Johnson's work the first experiment station in the United States was established in his adopted State.

Two years later it was decided to place the work of the station on a permanent and established basis, and accordingly

the legislature incorporated the Connecticut Agricultural Experiment Station as an independent institution under the management of a board of control representing the agricultural and scientific interests of the State. Professor Johnson was at once appointed its director and remained in this position until he resigned, twenty-three years later.

In his conduct of this institution he accomplished a work of national importance, for the influence of his learning and high ideals was all-controlling in the development of the similar institutions which were later established throughout the country.

Under him were trained in experiment station work many younger men who have carried out plans and ideas which Professor Johnson evolved in his administration as director. His high standard of scientific work in its application to practice and his keen sense of fair dealing as between the farmers and those from whom they bought supplies have done much to shape the policies of all similar institutions and to win for them the respect of the entire community.

To the development of the analytical methods employed in the chemical work of experiment stations he contributed much, both in respect to their accuracy and rapidity of execution. His deep knowledge of chemistry and wide personal experience in almost every branch of chemical analysis rendered him especially fitted to develop this part of the work and, in connection with his profound interest in agriculture and his marked ability as a lecturer and teacher, made him an ideal director of a new institution which stood in need, not only of new and proper methods of work, but of the support and confidence of those whom it was designed to help.

Of the work which he thus accomplished his colleagues have written: *

> It has been said that the most substantial contribution of the United States to applied science has been in using chemistry for the improvement of agriculture. Of this movement Professor Johnson was the leader. The whole system of agricultural experiment stations may well be regarded as his monument.

* Report of the President of Yale University for 1910.

And again:*

> Professor Johnson's broad and keen grasp of chemical problems, added to his farsighted appreciation of the many advantages to be gained by a judicious application of the science of chemistry to agriculture, made him a power in his generation, and his services counted for much in the development of agricultural chemistry and the inauguration of the Agricultural Experiment Station, which today is a recognized feature of practically every State in the Union.
>
> In the early years of the Sheffield Scientific School he was a pillar of strength, an example of the highest type of productive scholar, and a forceful illustration of the power which a scientific man can wield for the good of the community. The life of Samuel William Johnson and the work he accomplished constitute a suggestive example of a form of high public service which the man of scientific training can render his country and humanity.

Professor Johnson's most important work was in his chosen field of agricultural chemistry, but he accomplished much in other directions. When he came to New Haven as first assistant in the analytical laboratory, opportunities for instruction in scientific subjects were limited, but soon after the large gifts of Joseph E. Sheffield led to the organization of the Sheffield Scientific School. In the development of this school Professor Johnson took an active part, especially in the department of chemistry, in which he gave instruction first in analytical and agricultural chemistry and later in theoretical and organic chemistry. As a teacher and lecturer in these subjects he exerted a strong influence on his students, among whom were many who later achieved distinction in science and who remembered him as an inspiring teacher.

Of the part that he took in the work of the school his colleagues have said:*

> As occasion demanded, he taught the different branches, analytical, agricultural, theoretical, and organic chemistry, and in all of these subjects he displayed profound knowledge and great familiarity with the literature. His teaching was clear, concise, and philosophical, and he was successful in imparting much of his own enthusiasm for science to his students. * * * His connection with the School added much to its reputation. He was prominent in chemistry, and he became famous from his writings and lectures upon agricultural science.

* Report of the Director of the Sheffield Scientific School for 1910.

As a student of chemistry he had few equals in his day. A born lover of books, he was an incessant reader of the works of others and his library was filled with books on every branch of science, all of which he had read with an interest and care that made him a master of many subjects. His love of reading was not confined to scientific subjects; he enjoyed poetry and general literature with equal intensity. From the day he left home to begin his life work to the day of his death he was a constant buyer of books. When he returned from Germany he brought with him a library of chemical journals and standard treatises such as few chemists now feel that they can afford to own. Although his means were always limited, he was never too poor to buy books, and all his life denied himself many pleasures that he might have at hand the books he wanted. In his later years, when feeble health and failing sight made much reading impossible, his greatest sorrow was his inability to keep in touch with the enormously increased chemical literature.

As an author he made an impression, not only on his fellow scientists, but on the general public, by a clear and concise style which was not the result of cultivation and training, for his first paper, published when he was but seventeen, was written in the same simple and finished style that was characteristic of all his later writings.

For more than fifty years he was a constant contributor to agricultural and scientific journals. Although his publications were numerous he wrote few books. Two of these, however, were very successful, namely, "How Crops Grow," published in 1868, and "How Crops Feed," published in 1870. These books were the first printed in this country which brought together the data scattered through the literature relating to the composition and physiology of plants. They furnished a new basis for instruction in agriculture and were more widely read than any books before published on agricultural chemistry. They were translated into German, Russian, Swedish, and Japanese, and the former into Italian and French also.

In 1891 he prepared a new edition of "How Crops Grow," and even today the sale of both these books is not inconsiderable. In 1864 he edited Fresenius' Manual of Qualitative

Chemical Analysis, a second edition in 1875, and a third edition in 1883. In 1868 he published a book entitled Peat and its uses as Fertilizer and Fuel, and in 1870 he edited Fresenius' System of Instruction in Quantitative Analysis.

Of his influence as an author one of his colleagues has written that:*

> He was a teacher through the written word. He understood well how to make effective the work and writings of others, as well as his own, and this gave to his writings a breadth of view which was especially valuable at the time.

As an investigator his name does not appear prominently in the literature, for his chief efforts were directed to securing the means through which investigations have since been made by others. His many duties and limited resources afforded him scant opportunity for purely research work; nevertheless he found time for not a little work along these lines, and under his direction and with his aid much work of this kind was carried out by his students and assistants, to whom he generously granted the privilege of publishing under their own names. In the conduct of such work he was more interested in the training and development of the younger men than in securing credit for himself, and therefore his practice was to make his associates feel that the work which he assigned to them was their own, and that the responsibility for its success rested on them. It thus happened that many problems which he might fairly have claimed for his own study he assigned to others, in order that they might learn the methods of scientific research by assuming the responsibility for the conduct of details. During the progress of such work he was always eager to aid by suggestion and criticism, but patiently refrained from interference unless called on for advice. His part in the progress of research is, in fact, much greater than appears on the record, and many younger men owe much to him for the start he gave them in their scientific careers. His desire was to train men to be investigators rather than to appear as one himself.

* Experiment Station Record, Vol. 21, 1909, p. 206.

As an expert in many important cases in court he showed great ability and won a high reputation among the legal profession. The profound knowledge which he brought to bear on these cases, the care and accuracy with which he performed the analytical work involved, the thoroughness with which he prepared every detail, and the clear and logical way in which he set forth his conclusions, have many times been recounted to the writer by leaders of the bar, and have always been accompanied with expressions of the highest admiration and respect for the ability he displayed.

As a man Professor Johnson had a most attractive personality which endeared him to all who were intimately associated with him. His kindly interest in his students and assistants and his many generous and helpful deeds in their behalf will long be remembered by those who had the good fortune to work with him.

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