OBITUARY

FREDERIC SCHILLER LEE

FREDERIC SCHILLER LEE was born at Canton, N. Y., on June 16, 1859, son of the Reverend John Stebbins Lee, president of St. Lawrence University. He received his A.B. degree at St. Lawrence in 1878 and his master's degree three years later. He then became a graduate student at the Johns Hopkins University, where he received the degree of Ph.D. in 1885.

The year 1885–86 he spent in Ludwig's laboratory at Leipzig among a group of students, many of whom became distinguished physiologists. Perhaps the best known of this group was the late Ivan P. Pavlov. It was in Ludwig's laboratory that Lee investigated the progressive increase in strength of contraction of an isolated muscle under constant stimulus during the first few contractions and showed this to be an effect of the same chemical substances which ultimately in higher concentration lead to the phenomenon of fatigue. Here also he become interested in electrophysiology and in the functions of the labyrinth.

Returning to America, he was instructor in biology at St. Lawrence for a year and then went to Bryn Mawr as instructor in histology and physiology.

In 1891 John G. Curtis, then professor of physiology at Columbia University, College of Physicians and Surgeons, brought Dr. Lee to Columbia as demonstrator in physiology. At that time the teaching of physiology in America had been by lecture and demonstration alone except at Johns Hopkins. With equipment which had been purchased in Leipzig by Dr. Curtis, supplemented by the work of the laboratory mechanician, Dr. Lee inaugurated a course of practical laboratory instruction for students. He became adjunct professor in 1895, professor in 1904 and Dalton professor and executive officer of the department in 1911. Resigning the latter post in 1920, he was research professor until 1928 and professor from 1928 to June 30, 1938, when he retired. He became professor emeritus on the following day, July 1, 1938.

Dr. Lee's major activity has been the study of fatigue. He developed a beautiful technique for this work, and his published curves are models of technical perfection in this field. His interest in the special problem of fatigue in isolated muscle led to studies in the general problem of fatigue, and he was a guiding spirit and active participant in the extensive investigations of the New York Commission on Ventilation. During the World War he was active in studies of the relation of working conditions and fatigue to production in industry. From 1917 to 1919 he was consulting physiologist to the U. S. Public Health Service. From 1919 to 1924 he was senior physiologist to the U. S. Public Health Service with special mission to investigate industrial conditions in Europe.

In 1911 Dr. Lee delivered the Morris K. Jesup Lectures at Columbia and in 1918 he was Cutter Lecturer at Harvard. He was secretary and treasurer of the American Physiological Society for ten years and president from 1917 to 1919. Besides membership in many professional societies, Dr. Lee's extra-mural activities covered a wide field. He was a member of the board of managers of the New York Botanical Garden for twenty-four years, vice-president for two years and president for four years. He was a member of the board of directors of the Desert Sanatorium at Tucson, Arizona, and trustee of the Columbia University Press.

For a number of years prior to the beginning of the long illness which terminated his life, Dr. Lee had been at work on a monograph covering the history of the study of fatigue from the most ancient records available to the present time. It is unfortunate that this work could not have been completed.

His knowledge of the literature of physiology was broad, and he could usually provide references to any important work from his unaided memory with sufficient precision to enable an inquirer to locate the work without delay.

His intimate friends will remember him as a genial and polished gentleman who derived exceptional pleasure from those social occasions in which the delightfully human side of his personality could manifest itself. His death, which occurred on December 14, 1939, followed an illness of several years. He was buried at Woodstock, Vermont, where for a long time he had made his home during the summer.

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ALFRED GEORGE JACQUES

A PROMISING career was terminated by the drowning of Alfred George Jacques in Bermuda on February 20, 1939. He is survived by his wife, Mrs. Hazel Lewis Jacques, and daughter, Fleur Frances Jacques.

He was born in Sutton, Surrey, England, on April 18, 1896. He attended the University of Western Ontario, Queens University, Lafayette College, the University of Manitoba and Harvard University, from which he received the degree of Ph.D. in chemistry in 1931. He was assistant in general physiology in the Rockefeller Institute for Medical Research from 1926 to the time of his death. From 1926 to 1933 he worked at the laboratory maintained by the Rockefeller Institute in Bermuda, and in subsequent years he made annual visits to the Bermuda Biological Station to continue his investigations.

These investigations dealt with certain large multinucleate plant cells which offer special advantages for studying the entrance and exit of substances and ascertaining the nature of the protoplasmic surface. They include the marine plants *Valonia* and *Halicystis* and the fresh-water *Nitella*. They consist of a thin layer of protoplasm, outside which is a cellulose wall and inside which is a clear watery sap which can be obtained with little or no contamination in sufficient quantity for chemical analysis.

In earlier papers he collaborated in showing that the inner and outer surfaces of the thin layer of protoplasm are quite different electrically and in their resistance to poisons, and that the protoplasm as a whole is very permeable to carbon dioxide and to hydrogen sulfide.

He found later that the passage of sodium iodide through the protoplasm was a million times slower than through an aqueous layer of the same thickness. This appears to be due to the non-aqueous layers at the inner and outer surfaces of the protoplasm. These are too thin to be visible, but nevertheless they succeed in delaying the entrance of certain electrolytes to an extraordinary degree, apparently owing to the very slight solubility of these substances in the non-aqueous material forming the surface layers.

Such differences in solubility might explain why potassium is absorbed much more rapidly than sodium in *Valonia*. It had been suggested that these substances enter chiefly as hydrates by combining with an acid HX produced by the protoplasm and a mathematical treatment of absorption had been developed along these lines. This was carried further by Jacques, who showed, on theoretical grounds, that the effect of external pH on absorption may be large or small, depending on the dissociation constant of HX.

This may account for the fact that in *Nitella* the entrance of potassium is not increased by raising the external pH. Here the rate of entrance is not affected by light. This would be expected if light acts chiefly by raising the external pH through photosynthesis. In *Valonia* where higher external pH increases, the entrance of potassium light also increases it.

In view of the avidity with which potassium is taken up by *Valonia* it may seem surprising that it can be driven out of the cell by ammonia without causing injury. The behavior of ammonia was extensively studied by Jacques and subjected to mathematical analysis. On theoretical grounds he was able to offer an explanation for the fact that the undissociated ammonia in the sap remains less than in the external solution. He showed that the accumulated ammonia can be removed from the cell, but that this process involves a considerable latent period since the ammonia does not begin to come out at once when the cell is placed in ammonia-free sea water. Both the intake and exit of ammonia are hastened by light.

Cells from which the ammonia has been removed can take it up and again lose it under suitable conditions.

He also found accumulation of certain anions. In both *Valonia* and *Halicystis* iodide is taken up from the sea water and appears as iodide in the sap. This is of interest in connection with the function of the thyroid. The internal concentration of iodide exceeds the external 1,000 times in *Halicystis* and 40 times in *Valonia*. Likewise the internal concentration of nitrate exceeds the external 500 times in *Halicystis* and 2,000 times in *Valonia*.

His most recent experiments were of a novel nature. It seemed possible that the growth of plant cells is inhibited by the cellulose wall which must be stretched by the entering water before the volume of the cell can increase. If this inhibition could be removed the cell might expand more rapidly. He was able to bring this about by impaling cells of *Valonia* and *Halicystis* on glass capillaries on which they live for weeks.

As the entrance of water is no longer hindered by the cellulose wall the volume of the sap increases 10 to 20 times as fast as in normal cells. The entrance of electrolyte keeps pace with that of water so that the composition of the sap remains approximately constant.

The entrance of water proceeds faster in light, and in *Halicystis* it is not affected by changes in external pH.

The entrance of water into impaled cells of *Halicystis* increases proportionally as the sea water is diluted, and the protoplasm does not appear to be injured until the amount of added water equals that of the sea water.

In all his work he was chiefly concerned with the kinetics of absorption, and he developed a mathematical treatment dealing with all the details of the process.

In connection with his studies on the absorption of potassium he became interested in its isotopes. Samples of *Valonia* sap and of sea water were sent to Dr. A. Keith Brewer, who reported that the protoplasm of *Valonia* is able to distinguish between the isotopes in that it takes up K^{41} in preference to K^{39}.

This brief, incomplete account makes it evident that his interest lay in fundamental questions. These he attacked in thorough and critical fashion. Technical difficulties were overcome with surprising ease. Chemical and biological problems were equally stimulating to his imagination. He represented a rare synthesis of both disciplines. His contributions have abiding value.

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