OBITUARIES

Prof. T. Thunberg

WITH the death of Torsten Thunberg on December 4, 1952, there passed an investigator whose name was known to generations of physiologists and biochemists, and whose 'Thunberg tube' has served a valuable purpose in the study of dehydrogenase reactions. It was undoubtedly as a biochemist that Thunberg made his major contributions to science.

Born in 1873, Thunberg, after training in medicine, became a demonstrator for one year in the Institute of Physiological Chemistry at Uppsala under Olof Hammarsten, and for two years under Frithiof Holmgren, in the Institute of Physiology. In 1897 he was appointed temporarily as reader in physiology at Uppsala, in which post he was confirmed in 1901 at the early age of twenty-eight. After the death of Magnus Blix in 1904, Thunberg became the temporary occupant of the chair of physiology and embryology at Lund, and in the following year he was appointed substantively to the chair of physiology, a post which he retained until his retirement in 1938. On his retirement he was appointed professor emeritus, and he continued to make contributions until the time of his death, his last paper being published early this year.

Although in his early years Thunberg's researches extended as far as the physiology of the senses, including colour blindness, it was for his investigations on dehydrogenases, and on the metabolic significance of citric acid, that he is best known. When he began his studies on intermediary metabolism, little was known about the mechanism of oxidation within the cells. In 1885 Paul Ehrlich's book, "Das Sauerstoffbedürfnis des Organismus", described the staining of tissues by the *intra vitam* injection of dyes such as methylene blue, and stated that some tissues could reduce suitable injected dyes to colourless leuco-bases; but little came of these observations at the time. In 1912 Wieland showed that organic substances can be oxidized by the removal of hydrogen in the presence of a catalyst, and that the hydrogen could be taken up by suitable acceptors, such as methylene blue, which were thus reduced to the colourless leuco-base. Thus, the oxidation of ethanol to acetic acid could be formulated in terms of the activation and removal of hydrogen atoms. In his own studies, Thunberg had investigated the capacity of animal tissues to oxidize acids such as acetic, propionic, oxalic, malic, succinic and citric acids, and it was perhaps intuition which led him to choose, from all those available, acids such as succinic and citric, the especial importance of which in metabolism is now clearly recognized.

In 1910 Thunberg found that the addition of succinate to minced muscle resulted in an increase in oxygen uptake, and later integrated his own with Wieland's discoveries in propounding the idea of a specific hydrogen-activating, chain-forming enzyme system in the oxidation of succinate. A dehydrogenase, such as succinic dehydrogenase, could activate hydrogen atoms in its substrate to bring about a reaction which otherwise could not be observed, namely, the reduction of methylene blue to the colourless leuco-base; this colourless leuco-base could in turn be reoxidized to methylene blue by atmospheric oxygen. The introduction of the terms 'hydrogen donator' and 'hydrogen acceptor' in this connexion were of the widest significance, and

opened up the possibility of the existence of a multitude of hitherto unsuspected dehydrogenases. The ideas that developed from this work appeared to be contrary to that of Warburg's 'respiratory enzyme' in some respects; but later Warburg's own 'yellow enzyme', a hydrogen-carrying flavo-protein, helped to bridge the gap, and to-day Thunberg's concept of hydrogen transport from one system to another lies at the root of modern views on oxidative metabolism.

In 1910 Thunberg suggested that citric acid represented a normal intermediary in metabolism and he was afterwards able to map out the occurrence of citric acid in animals and man. The recent development of the citric acid cycle, first through the researches of Szent-Györgyi on the catalytic significance of succinic acid in biological oxidation, and then through the addition of tricarboxylic acids to complete the cycle, which was the work of Krebs, bears witness to the far-sightedness and soundness of Thunberg's ideas. With Thunberg's death biochemistry has lost one whose contributions are securely placed within the foundations of modern views on intermediary metabolism in general and of the mechanism of cellular oxidation in particular.

Vol. 30, Supp. 111, of *Acta Physiologica Scandinavica* contains an obituary notice of Thunberg with a bibliography of his papers. F. G. YOUNG

Mr. L. St. L. Pendred, C.B.E.

THE news of the death on November 20 at Twickenham of Loughnan St. Lawrence Pendred, for forty years the editor of *The Engineer*, will be read with regret by engineers all over the world. Together with *Engineering*, *The Engineer* is read wherever engineers congregate, both journals being known for their high professional standard and the sense of responsibility shown by a succession of able editors. Founded in 1856 by Edward Healey, *The Engineer* was edited for a short time by the brilliant but eccentric American engineer Zerah Colburn (1832-70), who in 1866 founded *Engineering*. Colburn was a nephew of the famous American 'calculating boy', Zerah Colburn (1804-40), and is sometimes confused with him. Colburn's connexion with *The Engineer* ceased in 1864, and shortly afterwards Vaughan Pendred (1836-1912) was appointed editor. A native of Barraderry, Co. Wicklow, Vaughan Pendred in 1862 had married Marian Loughnan, of Crohill, Co. Kilkenny, and a year or two later had settled in England, obtaining through Colburn an appointment in a works in Staffordshire. A classical scholar, a lover of mechanics and a born journalist, he became first the editor of the *Mechanic's Magazine*, and then in 1865 editor of *The Engineer*, a position he held until his retirement in 1905.

Loughnan Pendred was one of Vaughan Pendred's three sons. Born on November 23, 1870, he received his technical education at the Central Institution, South Kensington, and Finsbury Technical College, where he came under the influence of Silvanus Thompson, John Perry and H. E. Armstrong. Leaving college, he served an apprenticeship with Davey, Paxman and Co., of Colchester, and gained further experience in Belgium and France, and during 1893-96 he worked in the ordnance department of Armstrong's great works at Elswick. In 1896 he joined the staff of *The Engineer*, and nine years later succeeded his father as editor. Long a member of the Institution of Mechanical Engineers, he was president during 1930-31 and represented the

Institution at the jubilee meetings of the American Society of Mechanical Engineers. In 1934 he delivered the Thomas Lowe Gray Lecture of the Institution, taking as his subject "A Survey of Ships and Engines".

Having guided the fortunes of *The Engineer* during two world wars and the great depression of the '30s, Pendred resigned his editorship in 1946 and was succeeded by his second son, Benjamin Pendred, who had joined the staff in 1931. During the First World War, Pendred was editor of *The Ministry of Munitions Journal*, and for this and other services to engineering, in 1934 was created C.B.E. The Institution of Mechanical Engineers also made him an honorary member.

Always interested in the history of engineering, Loughnan Pendred played an important part in the inauguration in 1920 of the Newcomen Society, and it was at a dinner given by him to some of its founders, at the Savage Club, then housed in the Adelphi, that the name of Thomas Newcomen was adopted for the new Society. Pendred was one of the original members of council and during 1922-24 and 1928-30 served as president; on October 26, 1923, delivering a stimulating address on "The Value of Technological History". Among his other contributions to the *Transactions* of the Society was a scholarly address given in Dartford Parish Church on the occasion of the commemoration on April 23, 1933, of the centenary of Richard Trevithick. Other societies with which he was connected include the Iron and Steel Institute, the Junior Institution of Engineers, of which he was an honorary member, and the Institution of Engineers-in-Charge, of which he served as president. In an appreciation of Pendred when he retired, Mr. G. E. Chadwyck-Healey, a grandson of Edward Healey, wrote: "I count myself fortunate in having had so kindly, wise and steadfast a friend". There are others who will feel the same.

EDGAR C. SMITH

Mr. A. B. Broughton-Edge, M.B.E.

MR. ARTHUR BROUGHTON BROUGHTON-EDGE, who died on October 8 after an illness which dated from 1940, was a man of very wide interests, demonstrated by his membership of the Institution of Mining and Metallurgy, the Chemical Society, the Mineralogical Society, the Geological Society and the Geologists' Association. His main concern, however, was in geology and the use of geophysical methods in the search for minerals, and in this latter branch he was one of the early pioneers. Born on March 16, 1895, and educated at Bradfield College, Berks, he joined the University and Public Schools Corps at the outbreak of the First World War. Later, commissioned in the Royal Artillery, he saw active service in France, Salonika, etc., with an Indian Mountain Battery. He was invalided to England after an injury in Greece and spent the last part of the War investigating poisonous gases and, as a result, himself suffered from their effects. This phase of his career, for which he was made M.B.E., may well reflect his early interest in chemistry.

In 1918, however, Mr. Broughton-Edge entered the Royal School of Mines and studied geology, in particular the geology of mineral deposits, under Prof. C. G. Cullis, obtaining an A.R.S.M. in 1921 and a B.Sc. in 1922. As a student he visited Cyprus and was a joint author with Prof. Cullis of an authoritative work on "The Cupriferous Deposits of Cyprus", ultimately published in 1926. Although he

studied numerous types of mineral deposits in many parts of the world and was active in the examination of old mineral fields of Great Britain, he will be mainly remembered for his early investigations into the use of geophysical prospecting methods in the search for minerals. In 1925 he was experimenting in Africa with electrical methods, and this valuable experience naturally led in 1928 to his appointment as director of the Imperial Geophysical Experimental Survey in Australia. The report of this survey, which was jointly financed by the Empire Marketing Board and the Australian Government, did much to remove the mystery which surrounded the procedures at that time and placed them on a sound scientific basis.

In 1935 he married Muriel Docea Pullman, who nursed him devotedly during his illness until her untimely death in 1947. Mr. Edge's fortitude during this period was outstanding and, despite his obvious handicaps, he investigated the uses of the microscope for special mineralogical problems, the results of which will be published posthumously.

Mr. Robert Donaldson

THE sudden death on November 5 of Robert Donaldson has deprived physical optics of one of its well-known workers. Born in 1904, he obtained a first in his M.A. in the University of Edinburgh and, after two years as demonstrator in the Department of Natural Philosophy there, went to the National Physical Laboratory in 1928. He was, in those days, as much a mathematician as a physicist and was specially fitted for the post of assistant to John Guild, then conducting his classical researches in the measurement of colour. This early work set the pattern for all that followed for, except during the war years, when he participated in the general work of the Light Division of the Laboratory, Donaldson was primarily occupied with the field of colorimetry, heterochromatic photometry and spectrophotometry.

In 1933 he became head of the colorimetry section of the Division and made outstanding contributions to the subject by the design of instruments and the development of new techniques; by investigating problems arising from the commercial introduction of new illuminants and colorants, for example, fluorescent lamps and paints; by providing the experimental data, apparatus and methods for new applications of colour in the medical field, such as colorimetric haemoglobinometry and spectrophotometric tests for vitamins; and by the improvement of the standardizing procedures called for by the many specifications now governing the supply of lights and filters for rail and road signalling, marine and aerial navigation, aerodrome lighting, etc. Donaldson had a special aptitude for getting to the roots of a research problem, and this is well shown by a few examples of some of the instruments which bear his name.

The first trichromatic colorimeter designed at the National Physical Laboratory was intended primarily for the researches in the Laboratory which led to the establishment of the present international system of colour standardization. It required a supply of direct current and so proved inconvenient for use in industrial laboratories, many of which had only a public supply of alternating current available. Donaldson designed a colorimeter in which the blending of the trichromatic stimuli is effected by an integrating sphere, and which can be used with either A.C. or D.C. supply. This instrument is now the most widely