OBITUARY NOTICES.

BERNARD SHIRLEY DYER.

1856—1948.

BERNARD DYER died in London at his home on February 12th, 1948, in his ninety-second year, seventy-three years after his election as a Fellow of the Chemical Society, of which he was the oldest member.

He was born in London on February 25th, 1856, the son of J. A. Dyer, a then well-known London journalist. He was educated, during the headmastership of the late Dr. E. A. Abbott, at the City of London School, where chemical lectures had for many years formed a normal part of the curriculum, opportunities being afforded for voluntary practical work on half-holidays. On leaving school at the age of seventeen he became a pupil assistant to Dr. Augustus Voelcker, consulting chemist to the Royal Agricultural Society, in his laboratory in Salisbury Square, Fleet Street, where he was associated with Voelcker's two sons, John and E. W., and with Alfred Smetham. It is a tribute to this early training in Salisbury Square that Dyer, the Voelckers, and Smetham continued in close association throughout their lives, and that each was honoured, in due course, by election to the Presidency of the Society of Public Analysts.

The scope of Bernard Dyer's work during the three years he spent with Voelcker naturally led to a specialisation in agricultural chemistry and doubtless determined the background and pattern of his working life. Possessing an inherited aptitude for journalism, he was soon engaged in writing popular signed articles on elementary agricultural chemistry for various agricultural journals and for the lay press, and this led to an extensive correspondence and friendship with farmers and a fruitful experience of farming operations. In those days the only places of systematic agricultural education in England were the Royal Agricultural College at Cirencester and its offshoot at Downton, in Wiltshire. The average level of knowledge of elementary agricultural science was very low; it was not until the early nineties that, through a fortunate happening (known familiarly as " The Whisky Money "), the Government became suddenly in a position to provide for technical education on a wide scale, and of this aid agriculture received a liberal share. Agricultural education became part of the work of most Universities or Colleges of University standing, and many new provincial Agricultural Colleges and Farm Institutes came into being.

The energy and enthusiasm which Bernard Dyer applied to his daily work must have been extraordinary, for about this time he took the B.Sc. degree of the University of London, was appointed consulting chemist to the Devon County Agricultural Society in 1877, and later to the Essex and Leicestershire Agricultural Societies as well as to various local Farmers' Clubs and Chambers of Agriculture, and in 1880 was appointed Lecturer on the Progress of Agriculture at the City of London College, where for eight years he gave evening lectures attended by farmers, market-gardeners, and others interested in the subject within easy reach of London. To cope with the analytical work arising from these activities he—at the precocious age of twenty-one—established a laboratory at 17 Great Tower Street, London, in premises which he continuously occupied until they were destroyed in an air raid in May, 1941. Here he built up an extensive analytical and consulting practice, specialising particularly in agricultural and food chemistry and in the work which is now recognised as the province of the public analyst.

His first published paper was on field experiments on the growth of turnips at Rusper, Horsham, in the *Journal of the Royal Agricultural Society* in 1884, followed by a further paper on field experiments on cabbages. The latter led to co-operation with the Essex Agricultural Society in systematic field experimental work on the manuring of mangolds, oats, potatoes, and cabbages from 1886 to 1891, the principal outcome of this work being the demonstration that mangolds—an important crop in Essex dairy farming—would repay the application of far larger dressings of nitrogenous fertilisers than was then customary, and that the raising of heavy crops of mangolds by liberal dressings had no deleterious effects on the following grain crop. The continuation of this work was handed over to the Technical Education Committee of the Essex County Council, and developed, in due course, into the now flourishing East Anglian Institute of Agriculture.

About this time the question of the value of soil analysis as a means of assessing the availability of the mineral elements of soil as plant foods was receiving considerable attention. It had long been recognised that the quantities of phosphoric acid and potash extractable from soil by mineral acids afforded no reliable information in this connection. For some years Bernard Dyer had been pondering over the problem, and had been attracted by the generally accepted assumption, based on observations by Sachs, that plants extracted their mineral food from the soil by the solvent action of root sap exuded from their " root hairs ". It seemed to him necessary, however, that more precise information about the actual acidity of root sap must be obtained before any real step forward in this direction could be made. Accordingly in 1889 he set to work in his own laboratory and determined the root acidity of some 100 plants, comprising sixty-seven species or varieties and ranging over twenty-two natural orders. He found that the average acidity was equal to that of a 0·9% solution of citric acid. This was so strikingly in line with an earlier suggestion of Tollen and Stutzer for the use of a 1% solution of citric acid for the assessment of the " availability " of phosphatic fertilisers that Dyer was encouraged to undertake the work of further systematic investigation, and, after consultation with and assistance from Sir John Lawes and Sir Henry Gilbert, he proceeded to the task of determining the amounts of phosphoric acid and potash, both total and soluble in 1% citric acid solution, in samples of twenty-two barley soils taken from plots in Hoos Field, Rothamsted—plots grown continuously under barley for forty years with complete records of their manuring and cropping. The general outcome of the investigation seemed to justify the usefulness of the 1% citric acid solution for the purpose of assessing the " availability " of phosphoric acid and potash in soil and, in fact, it was generally accepted and widely used. Although a different view of the *modus operandi* of root absorption is now in favour, the " Dyer citric acid method " is still in use in many agricultural laboratories. For this investigation the University of London granted him the D.Sc. in 1892, and the results were recorded in a paper read before the Chemical Society and published in the *Journal* in 1894.

Doubtless Sir John Lawes recognised the merit and potential value to agricultural science of this work, for he then suggested to Bernard Dyer the larger task of examining the soils of the world-famous Broadbalk wheat field. This field had recently (1893) been sampled to three depths, 1—9, 10—18, and 19—27 inches, corresponding with samples still then in existence which had been drawn in 1865 and in 1891, and all these samples were placed at his disposal and examined in his laboratory. The analytical work took some years to complete, but when completed there yet remained the absorbingly interesting task of correlating the results with the estimates obtained by mathematical computation from the complete records which had been kept of the quantities of phosphoric acid and potash added by manuring and removed by cropping. (Some of the plots in the field had been continuously unmanured for fifty years, and some continually dressed with farm-yard manure or artificial fertilisers during the same period.) The results were published in 1901 in the *Philosophical Transactions of the Royal Society* just after the death of Sir John Lawes, to whom the inspiration of the work had been due, and only shortly before the death of Sir Henry Gilbert.

A little earlier (in 1900) Bernard Dyer delivered the then triennial Course of Rothamsted American Lectures at Newhaven, U.S.A., before the Association of Agricultural Colleges and Experimental Stations. These lectures were published by the United States Department of Agriculture in 1902, under the title of " Results of Investigations of the Rothamsted Soils ", and aimed at giving in collective form an account of all the chemical work hitherto carried out in this direction by Gilbert and his various co-workers.

In 1893 Bernard Dyer wrote a little book on " Fertilisers and Feeding Stuffs ", and in 1894, in co-operation with F. W. E. Shrivell, of Golden Green, Hadlow, Kent, he began a course of field experiments on the manuring of vegetables and fruits, on which very little work had previously been done. The investigation, which continued over twenty years and dealt with twenty-seven varieties of vegetables and nine varieties of fruit crops, was carried out with the aid of an annual grant from the Chilean Nitrate Committee; results were recorded in the *Journal of the Royal Horticultural Society* and the *Journal of the Ministry of Agriculture* in 1903, and as a separate publication in 1924 on " The Manuring of Market Garden Crops ".

Despite the immense amount of work of an agricultural nature rehearsed above—work which by itself would seem sufficient for any one man when of necessity it must have been largely carried out personally in such time as could be spared from the business of earning his living—Bernard Dyer did much original work in food chemistry, and kept abreast of scientific progress by a close working association with the members of various learned Societies, and regular attendance at their meetings.

He became a Fellow of the Chemical Society in 1875, and served on the Council during 1893—97 and 1904—08. To the *Journal* he contributed the results of his original agricultural investigations, and also, in 1895, a study of the Kjeldahl method for the determination of nitrogen—a paper of outstanding importance on a subject on which he was, in Great Britain, a pioneer.

He was admitted into the newly formed Society of Public Analysts at its first meeting in 1875, became a member of Council in 1880, then (jointly with Otto Hehner) Honorary Secretary from 1883 to 1896, when he was elected President in succession to Sir Thomas Stevenson. He contributed a number of papers to *The Analyst,* dealing with analytical methods and with natural variations in composition of food-stuffs, based, in some instances, on the accumulated records of analysis made over long periods. As late as 1932 he was responsible, in collaboration with the late Dr. C. A. Mitchell, for the compilation of a history of the first fifty years of the Society. But valuable as these contributions were to the Society they could scarcely compare in value with the worth of the personal association and the administrative and executive help which he rendered, officially and unofficially, during more than seventy years of membership. For of all the Societies to which he belonged none was more beloved by Bernard Dyer than the Society of Public Analysts.

He was elected an Associate of the Institute of Chemistry in the year of its formation (1878), and became a Fellow in 1880; he served on the Council for various periods between 1889 and 1929, including two years (1908—10) as Vice-President, and acted as Examiner during 1899—1903 and 1915—25. He was an original member of the Society of Chemical Industry, and acted as Chairman of its London Section in 1923 and 1924.

He held appointments as Agricultural Analyst under the Fertiliser and Feeding Stuffs Act, and as Public Analyst under the Food and Drugs Act for many Counties and Boroughs, and was official Analyst to the London Corn Trade Association.

He married twice, first Alice Collett, and secondly in 1890 Edith Steel, who survives with two of their three daughters.

Tributes to the personality of Bernard Dyer, to his charm and kindliness, to his comradeship, and to his peaceful outlook on life, will be paid in the living memories of many of us in the years to come. But of Bernard Dyer in his younger days we can only learn from the printed page, for a grand old age must inevitably be lonely with the loss of youthful friends. A little glimpse is afforded in his own history of the Society of Public Analysts where he tells of the early days of the Society when " the bow of Apollo was slackened " and he formed one of the group of members who regularly repaired after the monthly meetings, in the earlier period to a secluded corner of the well-known bar of the Criterion Restaurant, and later to an equally well known West End " Bier-Halle ", and there " by the pleasant friction of brains over beer and tobacco ", thrashed many and diverse matters of discussion, usually until midnight. Indeed, " these meetings continued until the world was turned upside down in 1914 ". As Bernard Dyer was then, so he remained always, essentially a clubable man; it is this side of his character, particularly by its antithesis to the austerity of his scientific work, which helps to paint the picture of his life.

For in his work he had a tenacity of purpose, a scrupulous exactitude, and an uncanny power of straight reasoning that almost compelled the successful issue of any problem which he tackled. He believed that synthesis proved the truth of analysis, and expressed this belief in his favourite command : " now let's get down to real herrings ! " although usually long before he got to the herrings his analytical skill had anticipated the difficulties or seen the errors in the analysis.

Another outstanding characteristic was his sense of humour; he loved the odd and bizarre. A faithful Dickensian, he was always alert for the Pickwicks, the Mrs. Harris's, the Silas Weggs, and the others who are constantly passing by or just slipping round the corner. This humour was always peeping out in the wonderful fund of reminiscences with which occasionally—but only occasionally—he could be persuaded to delight a few friends. He delighted in the architecturally beautiful and the historically interesting, and he possessed Sam Weller's knowledge of London.

He thought it well that the right hand should not know what the left hand did, and it is only now, when many tributes are being paid to the help which he ungrudgingly and often voluntarily gave to others, particularly to the young and struggling, that we can even vaguely appreciate how often throughout his life he extended a helping hand.

His life was too full for any serious hobbies or recreations, but he was a moderate violinist in his young days, and he played a good game of chess; always he enjoyed fly-fishing and occasionally a little golf in a club handicap match.

As to each his epitaph, so to Bernard Dyer—he fought a good fight; he finished the course; he kept the faith.

George Taylor.

ERNALD GEORGE JUSTINIAN HARTLEY.

1875—1947.

ERNALD GEORGE JUSTINIAN, the only son of George Thompson Hartley, Esq., of Wheaton Aston Hall, Staffordshire, was born on May 1st, 1875. He came of a long-established family, and his unusual Christian name Ernald was borne by an ancestor who was knighted for his services to the crown in Plantagenet times. He was educated at Harrow and Christ Church, Oxford, where he studied under Harcourt and was placed in the first class in the School of Natural Science (Chemistry) in 1897. During the next three years he remained in Oxford as a demonstrator in the Christ Church laboratory, carrying out at the same time research in collaboration with Professor (afterwards Sir Henry) Miers, and publishing several papers on the composition and constitution of mineral phosphates and arsenates. These early papers in which Hartley was responsible for the chemical work already showed his ability in precise quantitative analysis to which he returned with zest and marked success later in life as a teacher in the Oxford chemical school.

Hartley left Oxford in 1900 and became chemist to a colliery company in his native county. Commercial work of this type soon, however, proved uncongenial, and the methods of work not consonant with the high standards he always set himself. He therefore gladly availed himself of an opportunity to return to pure research. The Earl of Berkeley had recently retired from service in the Royal Navy and resolved to devote himself to scientific research. His intention was to become a member of Christ Church and to work for an Oxford research degree at his private laboratory at Foxcombe, some five miles outside the city. It was most unfortunate that the rigidity of the University statutes rendered this scheme impossible, for it produced an estrangement between Lord Berkeley and Oxford, to the detriment of both, which was only broken down many years later. However, during the short time that Lord Berkeley spent in the Christ Church laboratory he met Hartley, and, when the laboratory at Foxcombe came into operation, invited him to join him as a colleague in a programme of research on the osmotic properties of solutions. So began the collaboration which during the next thirteen years was to add so much to our knowledge in this field. It is not possible to arrive at an exact apportionment of credit in so intimate a partnership, but it is fair to say that Lord Berkeley's imagination and instinctive engineering skill were fairly matched by the critical ability of Hartley, his patient and accurate experimental work, and his judgment in detecting and overcoming sources of error.

Although the foundations of the theory of solutions had been brilliantly laid and the fundamental importance of osmotic pressure demonstrated by van't Hoff nearly twenty years before, the experimental basis in Pfeiffer's experiments was by no means adequate even to establish the dilute solution law. Berkeley and Hartley accordingly first undertook a critical examination of the errors involved in Pfeiffer's experiments. Morse and Fraser in America worked on the problem at about the same time. Both teams of investigators devoted much attention to the preparation of copper ferrocyanide membranes of great perfection, capable of allowing the passage of water but impeding absolutely the passage of the dissolved substance. Both were well aware of a fundamental difficulty in the Pfeiffer method in which osmotic equilibrium is set up by the entry of the solvent through the membrane producing changes of concentration. But while the American investigators were content to improve the Pfeiffer method and to allow for the dilution of the cell contents by calculation, Berkeley and Hartley felt that the slowness of diffusion of sugars, which at that time were the only solutes for which membranes were truly semi-permeable, made the equalisation of concentration practically unattainable, especially in more concentrated solutions. They were accordingly led to devise a new method of osmotic pressure determination in which a measured hydrostatic pressure was applied to the solution so as to prevent the entrance of water. This method was described in their first paper in 1904, and the apparatus was finally perfected until it was able to give accurate osmotic pressures up to values of 130 atmospheres. The results obtained with various sugars showed that van't Hoff's dilute solution law was strictly true in the limiting case of infinite dilution, while concentrated solutions invariably had osmotic pressures much in excess of $\boldsymbol{R}Tc$.

The limitations of the copper ferrocyanide membrane confined the direct measurement of osmotic pressure to a small and limited class of solutes, and Berkeley and Hartley next turned to the indirect method of vapour pressures. Here again critical examination of existing methods led to the perfecting of an apparatus in which very precise measurements could be made. With the aid of C. V. Burton who had jointed the Foxcombe team, the accurate conversion of vapour pressures to osmotic pressures for any degree of concentration was accomplished by the use of the thermodynamical work of A. W. Porter. With the same solutes as in direct determinations a very close degree of concordance was obtained, so that the vapour pressure method could be relied on as a precise method of exploring concentrated solutions of other substances.

The search for other solutes which might be used with the copper ferrocyanide membrane had only brought to light a single one, calcium ferrocyanide, when Lord Berkeley suggested to Hartley that he should attempt the preparation of tetramethyl ferrocyanide. This was eventually accomplished and the " ester," which turned out to be freely soluble in water, was suitable for osmotic measurements. Hartley's work in its preparation, which was described in a series of papers in the *Transactions*, opened up an interesting field of chemistry which is worthy of special note. The methylation of silver ferrocyanide by methyl sulphate under pressure gave rise not to the expected product but to a complex mixture from which Hartley isolated substances which gave analyses corresponding to compounds of tetramethyl ferrocyanide with either methyl sulphate or methyl hydrogen sulphate [$(CH_3)_4Fe(CN)_6,(CH_3)_2SO_4$ and $(CH_3)_4Fe(CN)_6$ $2CH_3{\cdot}HSO_4$]. These substances did not behave as loose compounds, however, but were shown to be salts of a strong diacid base, hexamethyl ferrocyanogen hydroxide. By preparing the chloride by means of barium chloride and decomposing it by heating it in a vacuum, Hartley finally obtained tetramethyl ferrocyanide, of which two forms were found to exist, differing in solubility and crystalline form, which were named α and β.

Decomposition of this series of compounds with concentrated sulphuric acid gave an important clue to their composition, for Hartley found that the reaction product from all the hexamethyl compounds treated with platinic chloride gave only the platinichloride of methylamine, while the two isomers of the tetramethyl compound gave mixtures of methylamine and ammonium platinichloride. It was therefore proved that all the nitrogen atoms in the hexamethyl compound, and presumably also four nitrogens in the tetramethyl compounds, were combined with methyl groups: *i.e.*, they were *iso*cyanides and not normal cyanides. Hartley endeavoured to account for these compounds on the basis of the current theories of the structure of ferrocyanides, but afterwards fully accepted their formulation as co-ordination compounds of ferrous iron with methyl *iso*cyanide as suggested by Glasstone. Thus the hexamethyl compounds are the salts of the fully co-ordinated hexamethyl*iso*cyanide ferrous ion, $[Fe(CH_3{\cdot}NC)_6]^{++}$, while the tetramethyl compounds are obtained by the replacement of two of the methyl *iso*cyanide groups by *iso*cyanide radicals which in accordance with Werner principles leads to an un-ionised compound, $[Fe(CH_3{\cdot}NC)_4(NC)_2]$, as was proved by the osmotic measurements. The isomerism of the tetramethyl compound was now easily understood, being of the *cis-trans* type of which many other examples occur in 6-co-ordination. In a later publication with Powell, Hartley clinched the matter finally by showing that the tetramethyl compound could be alkylated by alkyl iodide in presence of mercuric iodide. By methyl iodide the α- and β-tetramethyl compounds gave the same hexamethyl compound, while alkylation of the isomers with ethyl iodide gave isomeric tetramethyldiethyl compounds which formed different compounds with mercuric iodide. Hartley also investigated the alkylation of cobalticyanides and obtained similar isomeric methylated compounds, $[Co(CH_3{\cdot}NC)_3(NC)_3]$.

In the 1914—1918 war, Hartley joined the Special Brigade, R.E., and saw service in France as Assistant Chemical Adviser to the First Army. In 1917 he returned to England owing to the serious illness of his eldest daughter to whom he was greatly attached, and after her death was posted to Gas Services Home (Research) Section under Lieut.-Colonel Harrison at University College, London. Dr. B. Lambert, who was in close touch with his activities both in the field and at home, writes that Hartley was " of tremendous help in perfecting the first respirator to deal successfully with particulate clouds." Lambert, who afterwards was to enjoy many years' collaboration with Hartley in University work, adds: " He was universally loved and respected both at First Army Headquarters and at University College. He was one of the straightest and most trustworthy men with whom I have had to deal, and I had a great affection for him." After leaving the Army in 1919 with the rank of Major, Hartley returned to university work, becoming a university demonstrator in the Inorganic Chemistry Department at Oxford. His main responsibility was for teaching quantitative analysis, where his experience, knowledge, and unusual skill were greatly appreciated. He was a most gifted teacher, instilling almost imperceptibly his own passion for precision and his love of a job well done into generations of students who looked back to him with affection and admiration. He was highly esteemed by his colleagues for his single-minded and entirely unselfish service. No word of criticism was ever levelled against him, unless indeed it were for the excess of modesty which, as many thought, prevented him from attaining a more prominent place in the world of chemists. He neither sought nor appeared to desire distinction. He never read papers at meetings or took part in public discussions, and disliked any kind of publicity. Even the discussions round the blackboard of Foxcombe, where Lord Berkeley loved to gather the team around him to thrash out some aspect of the work, would usually find Hartley missing. He would be discovered where he preferred to be, carrying out some practical operation in the laboratory.

His output of research during his Oxford period was not large, though he continued working on the alkylation of cyanides, and the important paper with Powell, which has already been mentioned, dates from this time. His love of country life led him to reside at Frilford House, some eight miles outside Oxford, which involved a considerable journey and limited his laboratory hours. He also preferred to devote himself entirely to practical teaching, avoiding lecturing, examining, and other distractions which beset university teachers. Naturally enough he was called upon to give long hours to demonstrating, and accordingly the fruit of his labours in Oxford is to be found in the men he helped rather than in the papers he published. He reached the retiring age in 1940, but stayed on to help the Department in the emergency of war until 1945, when failing health and the increasing difficulty of his daily journey from Frilford led to his retirement.

He interested himself in local affairs and was a member of the Parish Council, and he and Mrs. Hartley and their family worked untiringly to develop and foster the cultural life of the community. The Hartleys all cared for the arts, and their home was a charming centre of culture and gracious hospitality. Hartley himself was a talented clarinet player and played for many years in the Oxford orchestra. In music and in his garden he found his chief pleasures. New duties came to him with the outbreak of war and were cheerfully and conscientiously performed. He undertook, for example, the thankless and onerous task of billeting officer for evacuees for the district, which his singular charm, tact, and humour well fitted him to perform. He was also a member of the Home Guard.

The end came just before Christmas in a sudden seizure which ended in a few hours his life of service. He died on December 22nd, 1947, at his home at Frilford. He married in 1902 Mary Frances, the only daughter of Laurence Wedgwood, Esq., of Barlaston, Staffordshire, who survives him with a son and two daughters. To them sympathy will be extended by all his colleagues, friends, and pupils, who will gratefully remember his work and his modest charm.

M. P. APPLEBEY.

PHILIP JOSEPH HARTOG.

1864—1947.

By the death of Sir Philip Hartog in his eighty-fourth year on June 27th, 1947, a well-known figure passed from the ranks of British chemists; for, although he had distinguished himself in later life in other fields, his first study, chemistry, always remained one of his living interests.

Philip Joseph Hartog was born in London on March 2nd, 1864, the third son of Alphonse Hartog, a teacher of French. His mother, Marion Moss, was one of the earliest Anglo-Jewish women writers. His eldest brother was Senior Wrangler in 1869, and his other brother, Marcus, was for many years Professor of Zoology in Cork. A sister married the French scholar, Arsène Darmesteter, professor in the Sorbonne, who with his brother James, a distinguished orientalist, had great influence over Hartog in his formative years and must have largely inspired the breadth of interest and passion for accuracy characteristic of his work. In 1875 Hartog entered University College School, proceeding in 1880 to the Owens College, Manchester, where he graduated B.Sc.(Vict.) in 1882, his teachers including Roscoe, Schorlemmer, Balfour Stewart, and Schuster. For the next two years he lived with his sister in Paris, and studied under Friedel, Lippmann, and Wurtz at the Sorbonne, where he graduated Licencié-ès-Sciences physiques, being placed first in the list. The results, according to custom, were announced in full session to the assembled candidates with their relatives and guests. Hartog paid no attention to the first few names, among which he did not expect to find his own, and after listening to the end expressed his disappointment to his brother-in-law, who had accompanied him, only to be told " Mais, tu es le premier ".

After Paris came Heidelberg in 1884. Here Hartog spent a year working in the laboratory of Bunsen, of whom he had many happy reminiscences. In 1885 he graduated B.Sc. in the University of London with Honours in Chemistry. From 1885 to 1889 he passed four fruitful years on research in " chemical physics " as a pupil of Marcelin Berthelot in the Collège de France.

In 1889, after this wide experience under many of the leading chemists of the day, Hartog returned as Bishop Berkeley Fellow in Chemical Physics to the Owens College, where in 1891 he was appointed Assistant Lecturer and Demonstrator in Chemistry. He had already published some researches on the sulphites (*Compt. rend.*, 1887, **104**, 1793; 1889, **109**, 179, 221, 244, 436; *B.A. Report*, 1889, 549). Other contributions soon followed: with T. Ewan, the posthumous calculation and publication of Hoskyns Abrahall's determination of the atomic weight of boron (*J.*, 1892, **61**, 650); with J. A. Harker, on a sensitive calorimeter (*B.A. Report*, 1892, 662) and on the latent heat of steam (*Nature*, 1893, **49**, 5; *Mem. Manchester Lit. Phil. Soc.*, 1894, **8**, 37); with G. J. Fowler on silver alloys (*J. Soc. Chem. Ind.*, 1895, **14**, 243) and on iron nitride (*Proc.*, 1900, **16**, 210); and critical historical studies on the Periodic Law (*Nature*, 1890, **41**, 186), the word "eudiometer" (*ibid.*, 1893, **48**, 127), and the Berthollet–Proust controversy (*ibid.*, 1894, **50**, 149).

Hartog's future seemed to be cast for chemistry, but other interests were claiming him. He helped to organise the University Extension Lectures, and in 1894 he was appointed Secretary to the University Extension Scheme of the Victoria University, in conjunction with his assistant-lectureship in Chemistry. This step more clearly marked out his future course, and his interest in educational administration was stimulated by his friendship with Michael Sadler. In 1902—1903 he acted as Secretary to the Alfred Mosely Commission of Educational Inquiry. In 1903 he was appointed Academic Registrar of the University of London, the appointment marking his final severance from experimental research. Many important changes and reforms were carried out in the University of London during his seventeen years of office as Academic Registrar.

Hartog played an outstanding part in the establishment of the School of Oriental Studies, now the School of Oriental and African studies, serving as secretary, first to the Treasury Committee (1907—1909) under Lord Reay as Chairman, and then to Lord Cromer's India Office Committee (1910—1917), which planned the School. He was appointed a representative of the Crown on the Governing Body at its formation in 1916, and continued to be an active member, except when in India, until 1946. His doughty championship of the School's right to remain in its quarters, when threatened with eviction by two Government departments in the course of the war of 1939—1945, led to Parliamentary action against an officialdom blind to the importance of the work of the School to an empire engaged on a war in the Far East. His services in the foundation of the School were recognised by the award of the C.I.E.

In 1917 Hartog served under Sir Michael Sadler as a member of the Viceroy's commission on the University of Calcutta (1917—1919). The report of the commission appeared in 1919, recommending extensive reforms, including the institution of the new University of Dacca (1920), for which Hartog was chosen as the first Vice-Chancellor. At Dacca he spent five years and built up the corporate tradition of a residential University in Eastern Bengal; and, in face of a popular demand for purely scientific and technical training, he made Dacca a cultural centre where learning and science flourished together and where both Muslims and Hindus shared in the life and activities of the University.

On the conclusion of his term of office in Dacca, he served as a member of the Indian Public Service Commission (1926—1930) and of the Begum of Bhopal's Commission of Inquiry on the Muslim University of Aligarh (1927), and then as Chairman of the Auxiliary Committee on Education of the Indian Statutory (Simon) Commission (1928—1929). In recognition of his great services to India, he was knighted in 1926 and created K.B.E. in 1930.

Hartog loved the English language as an instrument for the clear expression of facts and ideas. At Manchester in his spare time he made experiments in the difficult business of teaching the writing of essays to pupils in schools and to classes of working men. He attacked the system which still asked pupils as recently as 1939 and 1940, in the School Certificate Examination, to write in an hour an "English Essay" on such subjects as Sugar, Spies, Etiquette, the North Sea, or Beasts of Burden. This was the reason why the average English boy could not write English; for he was not told to write for a particular audience and with a particular object in view, but was expected to address the civilized world in the consecrated form of the traditional essay after the models of the great masters of our prose literature, Dryden, Swift, Addison, Pope, Steele, and Johnson. The boy, or girl, might as well be told to "write anything about something for anybody". Lessons in grammar and in punctuation had their place, and so had dictation. But writing had a purpose, a reader, an audience. It was either a record for oneself or a message for someone else. And with this distinction between "record" and "message" Hartog taught his experimental classes to write with a purpose. The results were judged not only by the teacher, but also by the class in a discussion in which all took part, the pupils thereby learning to decide for themselves whether or no the aim of the writer had been achieved. A critical spirit was thus called into play, and here Hartog saw democracy's remedy against the hypnotising magic influence of the printed word and of unsound propaganda. His work became widely known, but it still needs far greater application in our schools. Hartog expounded his teaching in many articles, addresses, and reports; and his first book on the subject, " The Writing of English ", was published in 1907. Much of the substance of this book was embodied in his last and posthumous work, " Words in Action " (1947), which bore the sub-title, " The Teaching of the Mother Tongue for the Training of Citizens in a Democracy ". It is a book that every student of science may read with great profit.

On his return from India to London, Hartog resumed his critical study of the examination system about which he had already published his opinions in 1911 and in 1918. When the International Institute Examinations Enquiry was established by the Carnegie Corporation in 1932, he became its Director and moving spirit in this country. The first report was published in 1935 as " An Examination of Examinations " in the joint names of Hartog and E. C. Rhodes. Its startling factual evidence revealed the weaknesses and failures of the current examination system, which were confirmed in two further studies, " The Marks of Examiners " (1936, with a memorandum by Professor, now Sir, Cyril Burt) and " The Marking of English Essays " (1941, with a statistical report by Professor Ebblewhite Smith). To carry on further research the Carnegie Corporation offered a final grant if it could be matched in England. The Leverhulme Trustees at Hartog's suggestion made a donation of £1000. Thus £2000 was handed over to the Institute of Education, University of London, in 1940; and in 1945 the new body thus brought into being became the National Foundation for Educational Research in England and Wales.

In 1938 Hartog had advocated the formation of a Central Register, and, when this was formed, he was invited to become Chairman of the Linguists Committee under the Ministry of Labour. This work took much of his time during the years of war.

In his early days in Manchester Hartog had become deeply interested in the history of chemistry, an interest possibly to be traced to the influence of Marcelin Berthelot, whose researches into the chemistry of the Alexandrian and Arabic periods have become classic. At Manchester too Hartog had written many biographies of chemists for the " Dictionary of National Biography " marked by that exact and careful scholarship that counts no labour too heavy and no detail too trifling in the interests of accuracy. On his return from India, he was able to resume his studies of the work of Priestley and Lavoisier. In conversation he seemed to have an almost day-to-day knowledge of that great period in chemical philosophy in which Priestley's experimental discoveries and Lavoisier's theoretical speculations advanced together towards the foundation of modern chemistry. Hartog's study of Priestley (*Proc. Roy. Inst.*, 1931, **26**, 395) and his address to the Chemical Society on the bicentenary of Priestley's birth (*J.*, 1933, 896) signalised the beginnings of a better and closer appreciation of Priestley's remarkable experimental gifts. His " Newer Views of Priestley and Lavoisier " (*Ann. Sci.*, 1941, **5**, 1), the substance of two lectures given at University College, London, in May, 1939, under the Scheme of Advanced Lectures of the University of London, made a classic contribution to the history of chemistry in its most striking phase.

Hartog's other writings include a history of the Owens College, Manchester (1900), contributions to the Special Reports of the Board of Education, " Some Aspects of Indian Education " (1939), essays on Pascal, Kultur, Poetry and Verse, and many articles on education and scientific articles and reviews in the " Manchester Guardian ", to which he was a frequent contributor, and in " The Times Educational Supplement ".

Throughout a long and busy life Hartog found time to serve his own community. At the beginning of the century he was associated with Zangwill in the attempt to find a territory for the settlement of Jews from Russia. He served for many years on the Council of the Liberal Jewish Synagogue, and was also a member of the Council of the Anglo-Jewish Association and of the Jewish Board of Deputies. In 1933 he went to Palestine as Chairman of a Committee concerned with the organisation of the Hebrew University. After Hitler's accession to power he became Chairman of the Jewish Professional Committee to assist refugees, and was untiring in his efforts in this and other ways to relieve the sufferers from Nazi persecution.

He married in 1915 Mabel Hélène, daughter of H. J. Kisch. Lady Hartog is the author of " Living India " (1935) and " India in Outline " (1944). There are three sons of the marriage.

Hartog was always ready to give sympathy and active help to " all sorts and conditions of men ". He had the gift of friendship and a generosity and tolerance towards the opinions and actions of others. As Marcelin Berthelot said of him more than half a century ago, he was " un savant soigneux, consciencieux, exact dans ses analyses et très laborieux ".

D. McKie.