

Edmund Albert Letts (1852-1918) – A Pioneer Environmental Analytical Chemist and his Association with Official Analytical Posts in Ulster

D. Thorburn Burns^a and Michael J. Walker^b

a Institute for Global Food Security, The Queen's University of Belfast, Belfast BT9 5HN, Northern Ireland, UK

b Michael Walker Consulting Ltd, 29 Dorchester Drive, Newtownabbey, BT36 5WP, Northern Ireland, UK

Summary

The life and contributions of Edmund Albert Letts, Professor of Chemistry in the Queen's College, Belfast for 38 years are reviewed along with a brief history of Northern Ireland Public Analysts stemming from Letts' teaching.

Introduction

Letts is one of the less well-known and under-valued chemists who practiced in Ireland in the late Victorian period due to his being in the shadow of Thomas Andrews, his famous predecessor, in the Belfast chair of chemistry. His diligent tuition in both theoretical and practical analytical chemistry led to several of his students succeeding to official appointments including those as Public Analysts.

Education and Career prior to Appointment to Queen's College, Belfast

Letts was born at Clare Lodge, Sydenham, Kent in 1852¹⁻⁷. His education began at Bishop Stortford School from which he went to King's College, London. Further studies were made at the Universities of Vienna and Berlin. In 1872 he was appointed chief assistant to Professor Crum Brown in Edinburgh. Four years later, Letts became the first Professor of Chemistry in University College, Bristol. In 1879, he was appointed to the Chair of Chemistry in the Queen's College, Belfast, a post held for 38 years, until retirement in 1917.

He was in addition, Lecturer in Sanitary Science in the Medical School, 1896-1909. He was chosen for the Queen's Chair of Chemistry on Andrews' advice from a short list containing William Ramsay and WA Tilden. A retrospective view by Cecil Wilson, suggested that Ramsay might have been the better choice⁸. However, to sustain such a view requires both the gifts of fore and hindsight in combination, and additionally, that Ramsay's work was, or would have been, independent of his environment. Edmund Albert Letts, FRSE in 1874, was appointed in Queen's with an excellent pedigree as indicated by his winning the Royal

Society of Edinburgh's *Keith Prize*, 1887-89, which at the time was their senior award. He was active in the Institute of Chemistry and its Vice-President in 1904-1907. Wilson was also wrong about the numbers of Letts' publications and that the bulk appeared before Letts was appointed to Queen's.



Figure 1 – Portrait of Professor Edmund Albert Letts, taken in 1906 (reproduced with the permission of the archives of The Queen's University of Belfast)

Scientific Work

Letts' scientific work can be divided into three main sections:

- i Up to 1890, in organic chemistry
- ii From 1895-1902, on the accurate determination of carbon dioxide in air and in water
- iii From 1900-, on the analyses of estuarine and tidal waters⁹

(i) Organic Chemistry

Letts' research up to 1890 was concerned with a wide range of organic compounds. His most important contribution being that on benzyl phosphines and their derivatives¹⁰, for which he was awarded the *Keith Prize* of the Royal Society of Edinburgh. About which it was stated, "*the work was difficult [due to the spontaneous inflammability of most phosphine derivatives], very thoroughly done, and the results are of great interest and that he had overcome the difficult analytical problem of determining the compounds' phosphorus contents*"¹¹.

The basis of the method, refined in Belfast, was oxidation of the phosphine compounds with black copper oxide¹². He first purified his copper by electrolysis prior to formation of copper nitrate from which to prepare the pure copper oxide. The residual oxide and the phosphate were then dissolved in nitric acid and the phosphorus precipitated as magnesium ammonium phosphate hexahydrate and weighed after ignition as magnesium pyrophosphate.

382 *Proceedings of Royal Society of Edinburgh.* [SESS.

A New Method for Determining Phosphorus in Organic Phosphorus Compounds. By Prof. E. A. Letts and R. F. Blake, Esq., *Queen's College, Belfast.*

Read July 21, 1889.

In the phosphines and their derivatives, which we have investigated from time to time, considerable uncertainty has always attended the determinations of phosphorus by the ordinary methods recommended for the purpose. In fact, we never felt any confidence in the result, for no matter how carefully the determinations were made, duplicate analyses led to different numbers.

The uncertainty depends partly upon the difficulty of oxidising the phosphorus in such compounds to phosphoric acid. For, as a rule, in any *dry* combustion process which may be employed, volatile oxidation products, containing phosphorus, are formed of great stability, which frequently pass over the red-hot oxidising mixture almost unchanged. Moreover, the glass of the tube is attacked by the oxidising mixture, and this undoubtedly leads to inaccuracies, probably of considerable magnitude.

If any *moist* combustion process is resorted to, only a part of the phosphorus is converted into phosphoric acid. A more certain and trustworthy process than any of those which are in general use was therefore desirable, and in some of our investigations, where everything depended upon a correct estimation of the phosphorus, it was essential. It occurred to one of us that the difficulty in finding such a process ought not to be so great after all, for by burning a substance in the ordinary way with oxide of copper, the phosphorus ought to be completely oxidised, and should be found at the end of the operation as phosphate of copper, in which it could be estimated without much difficulty by the molybdate method. In addition to the simplicity of such a method, it should also possess the great advantage of permitting the simultaneous determination of carbon and hydrogen.

Our anticipations have been fully realised, and the new process, based on the above principle, if somewhat tedious, we believe to be accurate, of general application, and easily carried out. We shall describe it with the necessary detail, and then give some of our results obtained with it.

Figure 2 – Method for Determining Phosphorus in Organic Compounds

(ii) Accurate Determination of Carbon Dioxide

Letts then studied, with the assistance of RF Blake, later Public Analyst for Antrim, the determination of carbon dioxide in great detail¹³. This study was initiated by a request to determine carbon dioxide in the insalubrious air of a Belfast linen weaving shed. As the initial sets of results were not reproducible, they investigated the source of the variability. The resultant paper started with a quotation from Dr. Black's Lectures on the reaction of lime water with carbonic anhydride. The paper was in effect a monograph, of 163 pages, including 2 appendices: (a) On ground air and its relationship to atmospheric carbon dioxide, and (b) Verification by comparison of the Pettenkorfer's original method and that of the Letts and Blake and on the errors incidental to Pettenkorfer's method, [30% positive error]. This study was carried out independently by William Caldwell, Honorary Demonstrator of Chemistry in Queen's College, Belfast.

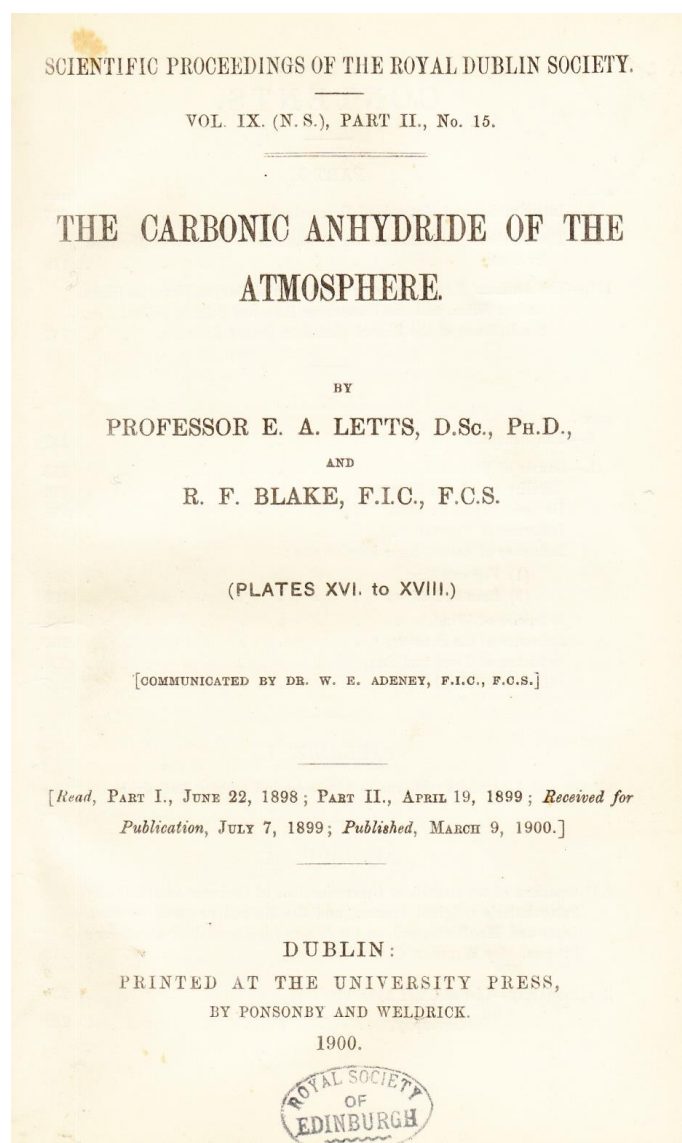


Figure 3 – The Determination of Carbon Dioxide in the Atmosphere

The paper concluded with a detailed bibliography, 38 pages; 304 references to original publications, with all re-publications and abstracts in other journals. Before the publication of *Chemical Abstracts*, (or *Scifinder*, as it is currently called), journals drew attention with short reviews or abstracts to key papers in other journals on topics of interest to their readers. Letts and Blake were so thorough in that they also included titles and summaries of lectures in the *Reports of the Annual Meetings of the British Association for Science*.

The procedure used baryta water (a solution of barium hydroxide) to absorb the carbon dioxide, the excess was titrated with hydrochloric acid using phenolphthalein as indicator. They studied the random and systematic errors meticulously until satisfied they had a method able to produce accurate and precise results. The main problem found was that baryta water reacted with the glass vessels and that the dissolved silica affected the titre in a time dependent manner. This was solved by coating the inner surface of his receiving and storage vessels with paraffin wax. They were careful to guard against access of carbon dioxide during experiments. The overall procedure was lengthy and complex to carry out. In Watson's 5 page review publication it was described as a very valuable paper¹⁴.

Letts was then asked to devise methods for application on the first Scott Antarctic Expedition¹⁵ and developed the use of sealed glass ampoules to store the standard alkali solution for use on such expeditions.

The use of the ampoules on board the ship *Discovery*, on voyage to the Cape and thence to New Zealand was described in Letts' paper to the 1902 British Association Meeting in Belfast. Unfortunately for this paper no abstract was provided, he also presented 3 other papers at that meeting.

The annual BA meetings were at the time, the showcase for scientific research in the UK; Letts presented 3 papers in 1900, 2 in 1901, and as noted 4 in 1902 and 2 in 1903.

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ON SOME PROBLEMS

CONNECTED WITH

ATMOSPHERIC CARBONIC ANHYDRIDE,

AND ON

A NEW AND ACCURATE METHOD FOR DETERMINING ITS AMOUNT
SUITABLE FOR SCIENTIFIC EXPEDITIONS.

BY

PROFESSOR E. A. LETTS, D.Sc., Ph.D.,

AND

R. F. BLAKE, F.I.C., F.C.S.,

QUEEN'S COLLEGE, BELFAST.

[COMMUNICATED BY DR. W. E. ADENEY, F.I.C., F.C.S.]

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Figure 4 – The Determination of Carbon Dioxide on Scientific Expeditions

(iii) Analyses of Estuarine and Tidal Waters

Letts was probably best known as an authority on questions connected with the pollution of rivers, especially estuarine and tidal waters. He was initially concerned with the increased

growth of the seaweed *ulva latissima*, “sea lettuce”, which caused problems after it was washed ashore in Belfast Lough¹⁶. Banks of the weed, several feet thick, extended for miles in Belfast Lough and also in Dublin Bay. The *ulva* decomposed in warm weather giving rise to an overpowering smell. Over the years the various nutrient and decomposition parameters were studied and appropriate analytical methods devised¹⁷⁻²².

At the request of the Royal Commission on Sewage Disposal, Letts, an authority on the subject, was asked along with WE Adney to make extensive studies of the important estuaries round the British Isles. The 5th report of the Commission in 1908 was 442 pages long²¹, the 7th in 1911, a mere 142 pages²². As for carbon dioxide, Letts with colleagues made a detailed and through study.

At the behest of the Belfast Public Health Committee, Letts along with L Smith and later by W Mair²³ undertook respectively the chemical and bacteriological studies of an experimental sewage treatment plant which resulted in the design of a new sprinkler based system²⁴⁻²⁶.

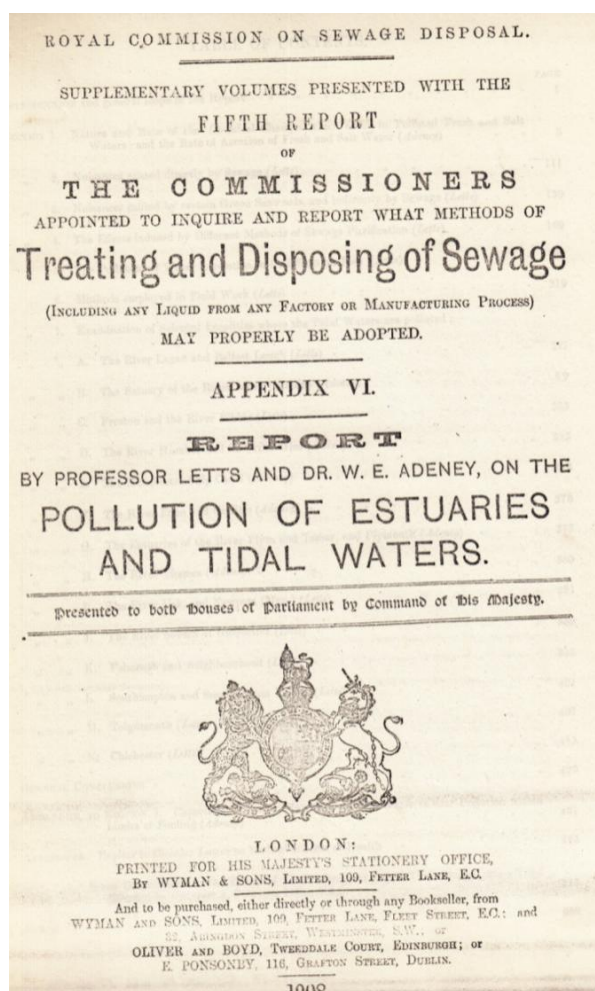


Figure 5 – Report on the Pollution of Estuaries and Tidal Waters

Letts' Research Collaborators and the Holders of Official Analytical Posts in Ulster

Letts was assisted in his applied chemistry researches by junior academic staff and former students, Robert Frederick Blake (1867-1944) [Chemistry Demonstrator, 1897-1908]²⁷, Joseph Harold Totton (1881-1937) [BA 1902, BSc 1904, Chemistry Honorary Demonstrator, 1902-1904]²⁸ and John Hawthorne (1875-1958) [BA 1898]²⁹, who all in due time held official analytical posts in Northern Ireland²⁷, and by Florence Williamson Rea [BA 1907, BSc 1909, MSc 1915, Chemistry Assistant, 1908 and 1911-1916], with whom he wrote his last four papers⁷.

Both Blake and Hawthorne were members of the "The Irish Association of Analysts" set up in 1910, under the chairmanship of Sir Charles Cameron to further and protect the interests of those holding official posts in analytical chemistry in Ireland³⁰. The easiest way to follow occupants of these posts in Ulster, is via *The List of Official Chemical Appointments held in Great Britain and Ireland, India and the Colonies*, by RB Pilcher, Registrar and Secretary of the Institute of Chemistry, first edition, 1906, the 9th and last edition of which appeared in 1937.

In 1906 Blake was listed as a recognised Medical Analyst to the Poor Law Unions. In 1912, Blake was recorded as Public Analyst for Antrim and as agricultural analyst for Antrim and for Tyrone. Blake was born in York and received his early education at University College School in London, subsequently at University College, Nottingham under Clowes and Colman. In 1888 he became assistant to Professor Letts, over years he was a co-author with Letts on 10 papers. His Record Books are held by the Public Record Office of NI and give details of the analyses he conducted for dispensaries and the constabularies²⁷.

In 1910 Totton, a Queen's graduate, was recorded as Public Analyst for Armagh; his obituary states he held the post from 1907, upon his return to Ireland after working with CE Cassall, the Public Analyst for Kensington. The lease for the 4th Floor of 16, Donegal Square South, in the centre of Belfast and the site of his and the successor Public Analysts in that City, dates from 1907. Totton held the corresponding posts for the City of Belfast and County Londonderry from 1910 and County Antrim in 1923. He is described as, "*never ruffled in the laboratory and with a charm of manner that endeared him to all with whom he worked*". He was active in masonic circles. At the time of his death, 1937, he was the senior partner of the firm, Totton and Hawthorne.

John Hawthorne, after graduation at Queen's University Belfast and study abroad, taught for some time at Queen's then continued study in Paris and Jena²⁹. He was appointed to Queen's College Cork in 1904 and then, Head of Chemistry at the Municipal Technical College, Belfast in 1906. He left this post in 1910 to take up analytical work with Totton and soon entered into partnership with him. In 1937 he was listed as being Public Analyst and Official Agricultural Analyst for the Counties of Antrim, Armagh and Down, Londonderry City and the County Borough.

Sometime after Totton's death Henry Kenneth Lawton (1903-1983), a Liverpool graduate and holder of a Branch E Certificate joined Hawthorne as "Additional Public Analyst" and in due course they formed the firm, Hawthorne and Lawton. Lawton was the sole appointee as Public Analyst to the counties of Northern Ireland and to the Cities of Belfast and Londonderry in 1971 when his practice was bought by the Chester firm, Ruddock and Sherratt. The Public Analysts Ronald Sinar, George Frederick Hooke and Eric Charles Conchie, (with Derek Pover, their Laboratory Manager) commuted from Chester to Belfast on a rota basis, 3-5 days at a time, until a local chemist, Michael John Walker, qualified M.Chem.A., became a partner in the practice, and in 1984/5 was appointed Public Analyst to the 26 NI Local Authorities. Walker left the practice in 2004 to become head of Forensic Science Northern Ireland and Conchie continued his appointments joined by Ronald Ennion, also based in Chester. In 2006 Walker became Referee Analyst in the Laboratory of the Government Chemist.

In 2005 the firm, Ruddock and Sherratt was acquired by Eurofins which subsequently set up a wholly owned subsidiary, Public Analysts Scientific Services Ltd. In 2014 they ceased to hold the Public Analyst appointments in Northern Ireland after a consortium comprising the private firm, Minton, Treharne and Davis Group and the public sector operation, Worcestershire Scientific Services won the appointments in an open competition to a tender let by the NI local authorities. A local PA laboratory in Belfast was not continued thus ending 107 years of local scientific provision through two world wars and 30 years of "the Troubles". The current non-resident NI Public Analysts are John Robinson and Susanne Brookes (MTD) and Paul Hancock (Worcs). PAAS Ltd retain the Agricultural Analyst appointment to the NI Department of Agriculture and Rural Development, DARD. A non-resident NI Public Analyst is not a new situation; it arose, as noted in the minutes of the Irish Association of Analysts for 30 November, 1912, concerning the appointment W. Hodgson, Public Analyst for Blackpool, with a laboratory in Manchester to the post of Public Analyst for Antrim, vacated by Blake due to low fee levels.

The Public Analyst firms in Belfast, resident in 16, Donegal Square South, Belfast, were as follows:

- 1 Totton, 1907-1911
- 2 Totton and Hawthorne, 1911-1937
- 3 Hawthorne, 1937-1938
- 4 Hawthorne and Lawton, 1938-1958
- 5 Hawthorne and Lawton (Lawton was latterly in sole practice), 1958-1971
- 6 Ruddock and Sherratt, 1972-2005
- 7 Eurofins, subsequently Public Analysts Scientific Services Ltd, 2005-2014

Letts the Teacher and Head of Department

Letts was known to irreverent students as Teddy. It is reported that he was the only Professor in the Faculty at the time who could keep order in his classes. His method of entry to lectures has come down in legend. Entering in his gown he strode to the lecture desk, called the

register and then, with due ceremony, his gown was removed by the lecture attendant before Letts commenced the lecture proper. He was well regarded as a lecturer and interested in student affairs taking a large part in establishing the Students Union in Belfast⁵. FG Donnan, one of Letts more famous students of the *Donnan Membrane Phenomenon* fame, stated,

*"I owe him a great debt of gratitude for his splendid course of lectures, which were most inspiring and gave many generations of fascinated students an insight into the real meaning and nature of chemical science"*⁸.

Letts was a first class practical worker and keen to pass on his skills, but his analytical interest was so strong that the students often ran the risk of being starved of practical work. When demonstrating to students Letts was inclined to take over and complete the tasks himself.

His *Qualitative Analysis* ran to two editions, 1893 and 1905³¹. In addition to the usual inorganic reactions and separations, it contained procedures for the detection of alkaloids, the examination of urine, calculi and stomach contents, topics needed by medical students at the time, which Letts also taught. It is clear from the book's preface of Letts concern to teach his students good practical skills within the time available. Successive NI Public Analysts (including one of the authors) continued to examine stomach contents for drugs and poisons by the Stas-Otto method³².

His other monograph, *Some Fundamental Problems of Chemistry, Old and New*, was based on his advanced lectures³³. The *older chemistry* chapters dealt with nature of matter and energy, atomic weights and theory and the periodic law; the *newer chemistry* concerned electrical discharge in gases, radioactivity the question of inorganic evolution and solar spectroscopy. Overall this text shows a mind alert to the importance of the new physics and radiochemistry upon chemical science.

Letts was also concerned with the dissemination of modern science to the general public, and a prominent member of the Belfast Natural History Society, being its President 1886-89. The list of the titles of his lectures to the Society illustrate his wide interests in chemistry and its philosophy, topics such as recently discovered dyes, the diamond, spectroscopes and their uses, fermentation, Pasteur's life and researches, sanitation, alchemy and the alchemists⁵.

Letts was active in the affairs of the University and for the well-being of his Department. From 1888 he demonstrated the tenacity of purpose equal to that shown in his researches to what was almost a second career, that of pleading, cajoling or bludgeoning the Lord Lieutenant, the Treasury, all bodies and individuals that he and the Principal, Thomas Hamilton, thought might listen to the pressing need for a new building for chemistry³⁴. In the end they won the battle, a new building was provided but in stages which can be followed via the *Book of the Fair 1894*³⁵ which shows photographs of parts of the new, but not completed, building. The Fair was run to provide funds for the Students Union Society which had been established in 1892. Letts was one of the Secretaries to the Fund Committee.

In 1905 a saviour appeared, in the form of Sir David Currie (a Scottish ship builder), who offered the college £20,000 provided that an equal sum was raised elsewhere before Christmas that year, it was. The *Book of the Fete 1907*³⁶ shows the half completed building and the interior of the new laboratories, named in honour of their patron. The fete was held to provide the college with a properly equipped athletic ground. The building, with subsequent expansions, remained in use until Chemistry moved to its present home in the David Keir Building in 1959.

Retirement

When Letts retired in 1917 he left an excellent tradition of scientific endeavor, a cadre of chemists capable of assuming public service as Analysts, and a list of significant contributions to applied science, including a new sewage purification scheme for Belfast and the expanded facilities for the Department. He died on February 19, 1918, shortly after retirement, following a bicycle accident on the Isle of White at about 7.30 pm on the 18th when he lost control of his machine coming down a hill and crashing into a wall. Several obituaries record his unfailing kindness to new and younger colleagues. He had complete trust in his staff and showed unfeigned pleasure in the research output of his department whether it was his own or carried out by others, for he had not a spark of that jealousy which sometimes prevents a senior appreciating the work of a colleague. He was one of that almost extinct species, “*a fine old English gentleman*”.

His permanent memorial within the University is the Letts Chemical Research Studentship, set up by his will dated, 24 October 1914, which left everything to his wife but with £2100 entailed, to be paid after her death, to found a scholarship for chemical research¹. Mrs. Letts died in 1934. Wisely, Letts had agreed the terms of the studentship with the then Vice-Chancellor, although regrettably for financial reasons they are not currently being followed exactly as Letts intended.

The link between Queen’s University and Public Analysts did not end with Letts and his students, as the authorship of this paper demonstrates.

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