The life & experiences of Sir Henry Enfield Roscoe ... / written by himself.

Contributors

Roscoe, Henry E. 1833-1915.

Publication/Creation

London : Macmillan and co., limited ; New York : The Macmillan company, 1906.

Persistent URL

https://wellcomecollection.org/works/caspu26q

License and attribution

This work has been identified as being free of known restrictions under copyright law, including all related and neighbouring rights and is being made available under the Creative Commons, Public Domain Mark.

You can copy, modify, distribute and perform the work, even for commercial purposes, without asking permission.

wellcome collection

Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
https://wellcomecollection.org

B xxiv. Ros

WELLCOME LIBRARY INSTITUTE

EX BIBLIOTHECA

CAR. I. TABORIS.

22101550068

X41102

WELLCOME
LIBRARY
General Collections
M
8654

Digitized by the Internet Archive
in 2019 with funding from
Wellcome Library

https://archive.org/details/b31347885_0001

THE LIFE AND EXPERIENCES OF SIR HENRY ENFIELD ROSCOE

1833 - 1915

Elliott & Fry Photo

Emery Walker Ph. Sc.

Henry E. Roscoe.
Woodcote 1906.

THE LIFE & EXPERIENCES OF SIR HENRY ENFIELD ROSCOE, D.C.L., LL.D., F.R.S. WRITTEN BY HIMSELF . . .

"*What is the use of health, of life, if not to do some work therewith?*"

CARLYLE, "Sartor Resartus."

LONDON: MACMILLAN AND CO., LIMITED
NEW YORK: THE MACMILLAN COMPANY
1906

All rights reserved

WELLCOME
LIBRARY
INSTITUTE

RICHARD CLAY AND SONS, LIMITED,
BREAD STREET HILL, E.C., AND
BUNGAY, SUFFOLK.

PREFACE

I SHOULD scarcely venture to publish the following memoirs, which were originally written for my family, had it not been for the persuasion of several friends whose opinion I value highly. Amongst those who have thus given me help and advice I must mention the names of Dr. T. E. Thorpe, C.B., F.R.S., and Dr. A. W. Ward, the Master of Peterhouse. To these, and other friends, I offer my best thanks.

H. E. R.

WOODCOTE, *March*, 1906.

CONTENTS

CHAPTER I

CHILDHOOD AND YOUTH

PAGE

Grandfather Roscoe—My Father—My Mother—Dr. Shepherd—Schooldays—Early Taste for Chemistry—Friends of my Youth 1

CHAPTER II

EARLY LIFE IN LONDON

University College, London—Matriculation—Thomas Graham—Alexander Williamson—I become Assistant to Williamson—Stanley Jevons—Brodie 24

CHAPTER III

"HEIDELBERG DU FEINE"

Heidelberg—Bunsen—Fellow-students—Heidelberg Doctorate—Photochemical Researches—German University Life . . 44

CHAPTER IV

"BUNSENIANA" AND HEIDELBERG FRIENDS

Bunsen and Kirchhoff—Spectrum Analysis—Kelvin and Stokes—The 400th Anniversary of Heidelberg University—Bunsen Letters—Kopp–Helmholtz 67

CHAPTER V

PROFESSORSHIP OF CHEMISTRY AT OWENS COLLEGE

Return to London—Appointment at Owens College—Early History of Owens—My Assistants—Growth of the College—Training in Scientific Method—New Building—Japanese Students—British Association, '61—Joule 100

CHAPTER VI

WORK IN MANCHESTER, 1862—72

PAGE

Cotton Famine Recreative Evenings—Penny Science Lectures—Marriage—Public Lectures in London—Faraday—Herschel—Vanadium and other Researches—Oxford Professorship—Literary Work—Macmillan 124

CHAPTER VII

WORK AT MANCHESTER (*continued*), 1872-80

British Association, Liverpool and Dublin—Post at Bart's—Eclipse Expedition, Sicily—Noxious Vapours Commission—Paris Exhibition, 1878—French Men of Science—Owens College—Jubilee of Chemical Society—Society of Chemical Industry—The University of Manchester 156

CHAPTER VIII

TECHNICAL EDUCATION

Royal Commission, 1882-4—Foreign Experiences—Our Report—Addresses on Technical Education—Royal Commission on Secondary Education 187

CHAPTER IX

ORIGINAL RESEARCH

Original Research as a means of Education—University Colleges, Dundee, Liverpool, Birmingham, Sheffield—Scottish Universities Commission—British Association, Montreal—Visit to America—Knighthood—Presidency of British Association at Manchester—Queen's Jubilees—Queen's Funeral—King's Coronation 218

CHAPTER X

CONCLUSION OF WORK IN MANCHESTER

Resignation of Professorship—Member of Parliament for South Manchester—Addresses on Retirement—My Views on the Teaching of Chemistry—Fellow of Eton College . . . 240

CHAPTER XI

POLITICAL LIFE

Entrance to Political Life—My Opinions on Politics—Contested Elections '85, '86, '92, '95—Mr. Gladstone in the Free Trade Hall—Home Rule—Legislative Measures proposed—Committee on Ventilation and Drainage of the Palace of Westminster—Irish Members. 257

CHAPTER XII

POLITICAL LIFE (*continued*)

PAGE

Mr. Gladstone—Committee on the Metrical System of Weights and Measures—Friendships in the House—Reform of Parliamentary Elections—Opening of Museums on Sunday—Committee on Science Collections, South Kensington—Grants to University Colleges—Legislation on the Use of Steam in Weaving Sheds—Adviser to the Metropolitan Board of Works—Sewage Pollution of Rivers—1851 Science Scholarships—Address from Constituents on Retirement 281

CHAPTER XIII

PASTEUR AND PREVENTIVE MEDICINE

Pasteur Commission—Paris Exhibition 1889—Prince of Wales's Visit to Institut Pasteur—Anti-rabic Treatment—Pasteur's Letters—Speech on Anti-vivisection—Pasteur's Character and Work—The Lister Institute—Election to French Academy—Centenary of the Institut de France 314

CHAPTER XIV

UNIVERSITY OF LONDON

Chemical Examiner—Elected Vice-Chancellor—Reorganisation of the University—Medical Education in London—Removal to the Imperial Institute—Addresses on Presentation Day—Address to King on his Accession—Incorporation of University College—Proposals to found an Imperial Technical University—My Jubilee 337

CHAPTER XV

HOME LIFE AND TRAVELS 362

APPENDICES

APPENDIX I.—LECTURE ON JOHN DALTON 395

APPENDIX II.—JUBILEE ADDRESSES AND LETTERS . . . 405

LIST OF ILLUSTRATIONS

Henry E. Roscoe	*Frontispiece*	
William Roscoe	*To face page*	1
Allerton Hall, the seat of William Roscoe	„	2
Thomas Graham	„	34
A. W. Williamson	„	34
Sir Henry Holland	„	41
R. W. Bunsen, G. Kirchhoff, and H. E. Roscoe	„	73
R. W. Bunsen	„	79
H. v. Helmholtz	„	95
The Old Owens College, Manchester	„	102
The New Owens College (Victoria University of Manchester)	„	102
The Roscoe Laboratories.—Quantitative	„	110
John Dalton	„	113
S. Suguira (Japanese Student)	„	114
James P. Joule	„	120
Michael Faraday	„	132
C. Schorlemmer	„	154
The Wreck of H.M. Dispatch Boat *Psyche*	„	160
Roscoe and Bowen "Ready"	„	160
M. Berthelot	„	164
The Quadrangle, Owens College, Manchester	„	182
"A Dream of Toasted Cheese"	„	243

W. E. Gladstone . . . . . *To face page* 281
L. Pasteur . . . . . „ 314
The Lister Institute, Chelsea . . . . . „ 329
A Laboratory at Chelsea . . . . . „ 330
A Laboratory at Queensberry Lodge . . . . . „ 330
"Fisherman" . . . . . „ 363
Woodcote . . . . . „ 386

W. Roscoe

LIFE AND EXPERIENCES

CHAPTER I

CHILDHOOD AND YOUTH

Grandfather Roscoe—My Father—My Mother—Dr. Shepherd—School-days—Early Taste for Chemistry—Friends of my Youth.

It is not given to many men to be mistaken for their own grandfather. This, however, happened to me.

Whilst visiting Egypt in the winter of 1891, with my family, I inspected the Khedival medical school, and was there introduced to an Egyptian professor who was able to speak French. On hearing my name he politely congratulated himself on meeting a distinguished English botanist with whose work he was well acquainted. With some difficulty I recognised that he had mistaken me for my grandfather, William Roscoe, the author of a monograph on the Monandrean Plants, printed by Geo. Smith of Liverpool in 1828. This is now a rare work, quoted in Quaritch's catalogue at £6 6*s*. The plates were hand-coloured and the arrangement was that of the Linnæan system. Mr. Roscoe also made several contributions on botanical subjects to the *Transactions* of the Linnean Society in 1806 and the following years.

My grandfather was born in the year 1753 and died in 1831, so that he lived to a good old age.

He was the first man of real mark Liverpool had so far produced, and it is remarkable that, entirely self-

educated as he was, and in a place at that time wholly devoted to commerce, he should have made for himself a European reputation, and should have laid the foundation of a new era in the history of the Renaissance. He is, of course, best known by his *Lives* of *Lorenzo de' Medici* and *Leo X.* (see portrait, page 1). Yet, singular to say, he never visited Italy, but obtained the necessary information and local colouring by correspondence with a resident who sent him Italian books. He spoke Italian, but with an English pronunciation; and hence Italians who came to visit him could scarcely understand what he said. A few years ago a relative of mine asked me if I knew the number of the house in the street in Florence in which my grandfather lived when he wrote the *Life of Lorenzo*, as a distinguished Catholic prelate was about to visit that city and wished to have a tablet placed on the "Casa Roscoe."

The father of William Roscoe was the landlord of a small inn or public-house standing in Mount Pleasant in Liverpool. There was a market-garden at the back of the house, and I have heard that my grandfather, when a boy, carried potatoes on his head to market for his father. By his energy and perseverance he had in the year 1799 already accumulated sufficient wealth to purchase the Allerton estate, a valuable property lying about six miles from Liverpool. The house was originally built in the reign of James I., but about the middle of the eighteenth century a part of the structure had been taken down and the new handsome stone edifice (see the accompanying plate showing the fine old tulip tree) erected in its place.

The situation was a romantic one, the house being built on the shores of the Mersey with a charming view of the Welsh hills in the distance, and

Allerton Hall, near Liverpool, the seat of William Roscoe.

surrounded by gardens arranged in the old English style and enclosed on either side by ample woods. To this pleasant residence Mr. Roscoe retired to prosecute his literary and botanical pursuits; and here his family enjoyed the delights of a country home for many years, with all the refinements and interests attaching to their father's high position. This idyllic state, however, did not last his lifetime, for in 1816 by the failure in that year of the Liverpool bank in which he was a partner, came the loss of all his fortune and the consequent impoverishment of his family.

His valuable collection of oil paintings was bought by his friends and presented to the Liverpool Royal Institution, which he had founded. A sitting statue of him by Chantrey was also placed, after his death, in the same building. A few years ago the Institution ceased to exist, the pictures were handed over to the Liverpool Municipality, and they now occupy a special room in the magnificent Walker Gallery. The statue, too, was presented to the city of Liverpool, and a site was found for it in the St. George's Hall. But on raising the heavy statue into position in the hall the tackle broke, and the statue fell and was seriously damaged. Fortunately, however, it was found possible to repair the broken parts, and there the statue now occupies a place of honour.

My grandfather had always been an ardent Liberal. At a meeting which took place in Liverpool on the 14th July, 1790, to celebrate the taking of the Bastille, he produced a song, well known at the time, of which the first verse ran:

> Unfold, Father Time! thy long records unfold,
> Of noble achievements accomplished of old,
> When men, by the standard of Liberty led,
> Undauntedly conquer'd or cheerfully bled.

A similar meeting was held the following year. In Birmingham riots took place on the same anniversary, and, perhaps in consequence, the celebration of the day was afterwards discontinued in Liverpool.

Mr. Roscoe's speeches and published addresses all bore testimony to his Liberal and even Radical views, and a medal struck in his honour bears on the reverse the words, "Roscoe the Friend of the People."

In 1806 my grandfather was returned as Member for Liverpool. But he sat only for one Session. He was a determined opponent of slavery, and at that time the slave-owning interest in Liverpool was powerful.

The following extract from the *Globe* newspaper of December 3rd, 1806, reprinted in the same paper for December 4th, 1904, serves to show how Mr. Roscoe's friends celebrated his election :

1806.—CELEBRATION OF MR. ROSCOE'S ELECTION.—Tuesday se'nnight, pursuant to public notice, the friends of Mr. Roscoe dined in the large room at the Golden Lion, Dale Street, Liverpool, to celebrate the election of that gentleman as one of the representatives of that good town in the ensuing Parliament. The dinner was provided by Mr. Henry Forshaw, of the Globe Tavern, and consisted of 38 pots turtle, 12 dishes fish, 12 pieces beef, 12 legs of pork, 6 legs mutton, 12 saddles ditto, 12 roast pigs, 12 tongues, 12 hams, 12 turkeys, 12 geese, 12 hares, 24 fowls, 12 pigeon pies, 6 ornamented raised pies, 100 snipe, 36 partridges, 50 woodcocks, 12 wild ducks, 6 pheasants, 12 moor-game, 48 lobsters, 20 salads, 18 plum puddings, 50 tarts, 60 dishes jelly, 20 blanc-manges, 50 mince pies. After dinner the following toasts were drunk : "The King" (with three times three—duet and chorus, "God Save the King"), "Our Glorious Constitution," "The Prince of Wales" (with three times three), "The Queen and Royal Family," "The Duke of York and the Army" (with three times three—duet and chorus, "Britons Strike Home") ; "The Duke of Clarence and the Navy" (with three times three —song, "Rule Britannia" by the whole company).

On returning from Westminster at the close of the Session, Mr. Roscoe's carriage was met by a mounted company of his friends, who escorted him into the Borough. On passing through Castle Street this procession was attacked by a number of common sailors, possibly incited to this act of violence in consequence of their Member's action in Parliament as a friend of Clarkson and Wilberforce. Mr. Roscoe escaped without injury, but this rough treatment may have contributed to his determination to retire from Parliament and to devote himself to more congenial literary pursuits. In the course of the Session of 1807 he had seconded a motion, proposed by Mr. Samuel Whitbread, which had for its object the establishment of a system of parochial primary schools throughout England. A Bill for the purpose passed the House of Commons, but it was thrown out in the Lords on a motion of Lord Hawkesbury without even a division. To the credit of humanity, however, be it mentioned, there were at that time one or two noble lords who, like Lords Stanhope and Holland, strongly supported the Bill, though the Lord Chancellor and the Archbishop of Canterbury opposed it on the narrowest of grounds. Lord Stanhope spoke out with vigour. He differed from the right reverend prelate on what he called "the abominable principle" that no part of the population of the country ought to receive education unless in the tenets of the Church of England. The schools, Lord Stanhope remarked, were merely to teach reading, writing, and arithmetic; and with far-seeing wisdom he added that "the superiority of workmen with some education over those with none must be sensibly felt by all men in the country."

By a singular coincidence, when I myself sat in the House of Commons in 1889, representing the South

Division of the neighbouring city of Manchester, Mr. Samuel Whitbread, the grandson of my grandfather's friend, was a fellow-Member. During a discussion of the Technical Education Bills I reminded the House of the action which had been taken eighty-two years before by our two grandfathers.

But England had to wait until 1807 became 1870 before a Bill for a national system of education passed into law. It is scarcely possible to realise what would have been the benefit to this country had the earlier measure been placed on the Statute Book.

That my grandfather's opinions on science and education were far in advance of his age is clearly shown in an address which he delivered on the occasion of the foundation of the Liverpool Royal Institution in 1817.[1] An Italian translation of the discourse appeared shortly after its publication in England.

It fell to my lot to distribute prizes at the same Institution in 1881, and I chose for the subject of my address an exposition of my grandfather's ideas of more than sixty years before. With true insight he declared that "imperfect indeed would be the civilisation of that people who, devoted to the accumulation of wealth by industry, should, from an apprehension of expending their means on useless objects, refuse to encourage scientific inquiries." He also asked to what are all the astonishing improvements which have lately been made in mechanics, in chemistry, in manufactures, to be attributed, but to the incessant researches and scientific discoveries of those whose talents have been devoted to extending the boundaries of science. He tried to imagine what would be the consequence if we were to

[1] Printed by Harris and Co., Liverpool and sold by Cadell and Davies, London, 1817.

be deprived of all the advantages derived from scientific discovery, and stated that many of those occupations which, within our recollection, were carried on empirically, without knowledge of cause and effect, are now practised on scientific principles. These have in their turn become the best schools of information and experiment for those now engaged in carrying the improvements of the present day to a still greater extent. He added that education was not only the proper employment of our early years but of our whole lives. Thus, in 1817, William Roscoe struck the chord which has been vibrating ever since, but which has only in these latter days given out its true tone and evoked a response which all may now hear.

I have never been able to ascertain the original birthplace of the Roscoes. The name, although a very uncommon one in the South of England, is not infrequently met with in Lancashire. Thus our family is one of the many who cannot trace back their origin for more than three or four generations. On this subject my grandfather writes: "Amongst my new acquaintances is Sir Isaac Heard, Garter Principal King-at-Arms, who has been extremely civil to me and is desirous of tracing the pedigree of the noble family of the Roscoes, which has hitherto, I find, baffled all his researches. I told him I was a good patriarch and the proper person to begin a family, as I had six sons, &c. Accordingly the whole descent is registered, and the Roscoes and Daulbys may now go on *in sæcula sæculorum*, Amen."[1] My father made the seventh.

The following extract from *The Creevey Papers* (John Murray, 1903), respecting my grandfather,

[1] See *Life of William Roscoe*, by his son, Henry Roscoe (T. Cadell, Strand, 1833), Vol. I, p. 3.

gives a lively picture of Creevey's feelings towards Mr. Roscoe.

Mr. Creevey to Miss Ord (his step-daughter) :[1] —

DENBIES,

July 15th, 1833.

I am in the second volume of poor Roscoe's *Lorenzo de' Medici*. I read his *Leo* three or four years ago with great pleasure, and the present book with increased delight. I can scarcely conceive a greater miracle than Roscoe's history—that a man whose dialect was that of a barbarian, and from whom in years of familiar intercourse I never heard above an average observation, whose parents were servants (I well remember them keeping a public-house), whose profession was that of an attorney, who had never been out of England and scarcely out of Liverpool—that such a man should undertake to write the history of the 14th and 15th centuries, the revival of Italian [illegible]—that such a history should be to the full as polished in style as that of Gibbon, and much more simple and perspicuous—that the facts of this history should all be substantiated by references to authorities in other languages, with frequent and beautiful translations from them by himself—is really *too*! Then the subject is to my mind the most captivating possible; one's only regret is that poor Roscoe, after writing this beautiful history of his brother bankers the Medici, should not have imitated their prudence, and by such means have escaped appearing in that profane literary work, the *Gazette*! Oh dear! what a winding-up for his fame at last!

Roscoe's life was a singularly fruitful and interesting one, and he lived long enough to see the justice of almost all the leading principles he had advocated acknowledged. Thus he was permitted to partake of the triumph which the friends of liberty obtained in the abolition of the slave-trade. He saw the repeal of the Test and Corporation Acts, and of the laws of Roman Catholic disability. His views respecting penal jurisdiction were becoming generally acknowledged; and, lastly, he survived to witness all

[1] *The Creevey Papers*, Vol. II. p. 256.

but the completion of the great work of Parliamentary reform.

The eulogium passed on the character of my grandfather by Washington Irving in his *Sketch-book* speaks for itself:—

> I was told (says Irving) that Roscoe had been unfortunate in business. I could not pity him, as I heard some rich men do. I considered him far above the reach of my pity. Those who live only for the world, and in the world, may be cast down by the frowns of adversity; but a man like Roscoe is not to be overcome by the reverses of fortune. They do but drive him in upon the resources of his own mind. . . . . He lives with antiquity and posterity; with antiquity, in the sweet communion of studious retirement; and with posterity, in the generous aspirings after future renown. . . . . The man of letters who speaks of Liverpool, speaks of it as the residence of Roscoe. The intelligent traveller who visits it inquires where Roscoe is to be seen. He is the literary landmark of the place, indicating its existence to the distant scholar. He is, like Pompey's column at Alexandria, towering alone in classic dignity.

My maternal grandfather, Thomas Fletcher, was a man of quite another stamp. He was a respected Liverpool merchant, though not a slave-owning one, chairman of the West-Indian Committee, and he, too, lost his money by the failure of a Liverpool bank. He lived to a good old age, and I can remember him well. He always wore black broadcloth and a frilled shirt. Though an intelligent and most upright man, he had few literary and no scientific tastes or tendencies, and he always used to remark that the fossil remains of saurians and elephants found in England were merely, as he termed them, "freaks of nature." "How," said he, "is it possible that an elephant can have lived in the valley of the Thames? How could it cross the Channel? The whole thing is ridiculous." I suppose I used to trouble the old gentleman by frequent questions which he was unable to answer. On one occasion he said to

me, "Why do you ask such foolish questions, boy? You might as well ask me why is a cow's tail long and a fox's tail bushy"—a subject about which Darwinians would now perhaps find a reasonable explanation.

I first saw the light at 10, Powis Place, off Great Ormond Street, in London, on January 7th, 1833. Though I did not read the announcement of my birth, I have lived to see that of my death, for a friend in Australia sent me an obituary notice printed in the *Melbourne Journal of Pharmacy*, May 21st, 1888.

My father, Henry Roscoe, was the youngest son of William Roscoe, the Benjamin of the flock, the youngest of seven who were all thrown on their own resources by their father's bankruptcy. My father came to London to seek his fortune at the Bar in the year 1819, and from that time did not cost my grandfather a penny; for he, with many of his brothers, inherited the literary faculty and lived for some years by his pen. He married my mother in 1831. He had retired from the Bar and accepted the post of Judge of the Court of Passage in Liverpool. His health had doubtless suffered much from the hardships which he as a struggling young man had to endure, and he died in 1836. He was a singularly able lawyer and a man of the highest character, and had he lived he would probably have reached a prominent position.[1]

The following appreciation by Henry Chorley, which I here append, gives an idea of my father's character:

> A third piece of good fortune for me was access to Mr. Henry Roscoe, by far the most gifted of the sons of the Italian historian, who had sufficiently distinguished himself at an early age to make his death, ere the prime of life and success were entered on, a heavy and cruel loss to all who were privileged to know him. His accomplishments were many

[1] My father's law books, notably his *Digest*, were for many years after his death standard works.

and real; his solidity of judgment was as great as his quickness of sympathy. Like all first-class persons I have known, his patience with those inferior to himself, patience entirely clear of painful condescension, was great and genuine. Everyone was seen to the best possible advantage when beside him. He could listen and encourage, as well as talk with a natural and flowing brilliancy I have rarely heard equalled, not three times in my life excelled.

Though so rich in every gift which attracts and retains admiration, he was as unhackneyed and as simple in his manners as the veriest schoolboy who rattles away out of the fulness of his high spirits without an idea of producing effect.

In the hour of trouble he was as tender and patient in sympathy as a woman, with such instant justice and strength of decision as belongs to a truthful, acute, and strong man. It was impossible to be afraid or affected in his company. He was one of those whose early departure (whereas so many false and evil people are left to cumber and poison the earth) tempts those left behind to rebellious thoughts and questionings—only to be silenced by the solemn words, "What I do thou knowest not now, but thou shalt know hereafter." It has been my duty to lay leaves on many tombstones, and in writing of the deceased to disregard the adage, "De mortuis, &c.," but of none have I been able to speak in higher and more unqualified terms of admiration than of Henry Roscoe.

We had lived in a fairly large house in Gateacre, near Liverpool. After my father's death my mother with her two children was left with very straitened means. Being a skilful artist, she at once sought to add to her income by teaching painting to the girls at the school of her cousins in Rodney Street, Liverpool. I have in my possession a painting of hers, a copy of Copley Fielding's "View of Snowdon," now hanging in my study at Woodcote, which exhibits her artistic power. She also possessed considerable literary gifts, as shown in her *Life of Vittoria Colonna* (Macmillan and Co., 1868), containing admirable translations of the sonnets of that remarkable woman.

As for my own natural capabilities, I have always

thought I was cut out for a doctor. Indeed, I should have taken to the study of medicine had not my uncle Richard (Dr. Richard Roscoe) strongly dissuaded my mother from allowing me to do so, urging that it was an extremely arduous profession which would probably kill me.

After my father's death we left the large house and went into a small cottage close by. My grandfather Fletcher and his two daughters Harriet and Louisa lived near. The latter kept a boarding-school for girls. Their earliest pupils were the daughters of the first Lord Denman, and I remember well as a small boy playing with them and many others, some of whom I now know as charming old ladies. Close by my aunt's house was "The Nook," the old-fashioned residence of the Unitarian minister of the ancient Presbyterian chapel in Gateacre. I may remark here that my forbears on both sides came of Presbyterian or Unitarian stock, one of my great-grandfathers on my mother's side being Dr. Enfield, the author of the justly famous *Enfield's Speaker*. The incumbent of Gateacre chapel was Dr. William Shepherd, a literary friend of Lord Brougham. He wrote the *Life of Poggio Bracciolini*, a copy of which, presented to my mother by the author, is now in my possession. It attracted much attention at the time. It was translated into German, French, and Italian, but unfortunately the German manuscript, which had been put into the hands of a printer at Berlin, was lost in the confusion which followed upon the conquest of Prussia by Napoleon. Dr. Shepherd kept a school for boys, to which my Roscoe uncles, the Booths, the Thornelys, and a number of the sons of the best Liverpool Nonconformist families were sent. A severe disciplinarian of the old school, he used to tweak the

boys' ears until the blood came, and I have heard the late Mr. James Booth, as well as my uncles, describe the physical pain which he inflicted upon them. He was, however, always very kind to me in his old age.

Shepherd possessed a fund of humour which occasionally had its grim side, and some of his stories were not altogether orthodox. After his death his friends had his marble bust (he was a very ugly man with a desperate squint) stuck up in the middle of the chapel, with a long Latin inscription written by Lord Brougham describing the good qualities of heart and head which his old friend possessed. Dr. Shepherd's methods of discipline sometimes took an informal turn. Thus I remember that in the field behind "The Nook" was an open bath, access to which was strictly forbidden to the boys. It was surrounded by a wooden railing, and between the railing and the bath grew a flourishing bank of nettles. One day the doctor, who was short-sighted, was walking up and down the field reading his Horace, as was his wont, when he heard a commotion in the water. He at once understood that his boys were breaking rules. He said nothing, but gradually drew near to the place. The boys, fearing his displeasure, which was a serious matter, got out of the water and hid themselves among the nettles. The doctor slowly passed up to the side where the boys were ensconced, growling and making a well-known peculiar noise characteristic of his anger; the boys then crept in fear and trembling to the other side, thus hoping to hide themselves. He never inquired which of the boys had committed this grievous offence, thinking, and with good reason, that they had been sufficiently punished for their misdemeanour. Sometimes, however, the boys had their revenge on the doctor. Thus, one day he saw something moving

about in the garden in front of the house, and, being almost blind, he said to the boys, "Turn that ass out of the garden." They looked round and answered, "Please, sir, it's Mrs. Shepherd."

Shepherd had a remarkable old clerk, Turton by name, who was the village saddler. On one occasion a stranger was to preach, and when the doctor returned he said to him, "Well, Turton, what did you think of the sermon last Sunday?" "Well," said he, "I dunno. I yeard a kind o' tuzzlin', but wheer it cum from I cudna' rightly tell."

For a few years I was sent as a day-boarder to Miss Hunt's school at Gateacre. On one occasion my mother and sister went to London for some months, and my cousin Charles Crompton and I became boarders for that time at this establishment. It is only when a boy becomes a boarder that he understands school life and begins to see the unadulterated iniquities of boys. We had rice-pudding at dinner before meat, and on Saturday night there was a general washing of feet in tin foot-pans. It was our firm belief that the watery rice-puddings which we were made to eat were cooked in the foot-pans. There were no games in those days except marbles, and the sports now so common were then almost unknown.

In 1842 my mother moved to Liverpool and I was sent to the High School of the Liverpool Institute. The school was divided into two parts, the higher and the lower—the higher for boys of a better class, and the lower school for tradesmen's sons and boys of the lower middle class. It was one of the first of what are now called modern schools. My mother, a most capable woman, saw that her son would not benefit by the usual classical grind, and that his tendencies were of a different character, and she therefore chose for me a non-classical

school. Even in those days we had a chemical laboratory in which the boys worked, and besides chemistry we learnt drawing, natural philosophy, and French, as well as the stock subjects of English, mathematics, and classics. I did not do much either at classics or at mathematics, but I obtained a knowledge of things in general during my stay of seven years at the school, and I think it served my mother's purpose and my own (if I then had any) fairly well. I came under the hands of masters of many kinds. Balmain, afterwards well known as the discoverer of "Balmain's luminous paint" and of boron nitride, was our teacher in chemistry, and from him I suppose I picked up my love for the subject. Balmain was a genial fellow with whom I afterwards had some dealings. "Now, boys," he said one day, "if working in the laboratory you ever get any acid on your clothes, come to me and I will put some ammonia on and prevent the clothes from getting destroyed." One day a very small boy who still wore a long blouse came to him. "Please, sir," said he, "I have got some acid on my trousers behind—will you put some ammonia on?" And, on lifting his blouse, there were no trousers at all—they had been eaten away by the acid. "Well, my boy, I think if I put on the ammonia you won't like it!" he remarked.

Balmain's method of impressing the nature of a chemical reaction upon the minds of the small boys was as original as it was successful. Thus on one occasion a class of thirty or forty boys was ordered into the laboratory after a lecture on the method of preparing sulphuretted hydrogen. There each boy was provided with a glass containing powdered sulphide of iron and with a second one containing dilute sulphuric acid. "When I give the word of command," said Balmain, "each boy will pour the acid on to the sulphide, and you

must then all run away as fast as your legs can carry you." No sooner said than done! The result was such a fearful stench that each boy will carry down the recollection of that moment to his grave, and will remember to his dying day the formula which Balmain wrote on the blackboard —

$$FeS + HO + SO_3 = FeOSO_3 + HS.$$

Hugo Reid, our teacher of natural philosophy—or physics, as it is now called—was a very remarkable man, and from him we learnt the history of the steam-engine and the properties of gases as well as the rudiments of mechanics and dynamics. He taught us well, and we had to keep accurate notes of the lessons. When I was ten years old I was able to write out a fairly good account of the rise and history of the steam-engine, including the atmospheric engine of Newcomen. One of these engines I actually saw at work in a Cheshire coal-pit in my early days. I recollect quite well that I understood the mechanism of this engine; and I suppose that there are not many people now living who can remember seeing a Newcomen at work.

I also came under the influence of another very genial teacher, W. B. Hodgson, who afterwards became Professor of Political Economy in the University of Edinburgh. He was a singularly interesting man, and I attribute a good deal of any literary facility which I may possess to the practice in essay-writing which he gave us and to the criticisms which he made upon our work. Hodgson was a man of varied and extensive reading. This is evident in his little book, *Errors in the Use of English*, which was published by his widow in 1881. Many of the author's observations on the errors committed by English writers, both great and small, exhibit the kindly

humour which his friends so much appreciated. One of the many amusing cases of faulty language given by Hodgson is an instance of ambiguity in the use of the demonstrative and possessive pronouns, viz. : " Mr. A. presents his compliments to Mr. B. I have got a hat which is not his; if he have got a hat which is not yours no doubt they are the missing one." No reference to authority is given with this quotation. It eventually found its way into *Punch.*

We had to learn a good deal of poetry, most of which I regret I have forgotten. Sight-memory and ear-memory are two totally distinct faculties: I possessed the former, but not the latter to any great extent; and I suppose this former faculty is the more useful to a scientific man. I never forget a face, though I may not at once remember to whom it belongs. This peculiarity is specially valuable to a doctor. I met with a good instance of this some few years ago. When at Braemar I became acquainted with the late Sir Andrew Clark, with whom I was afterwards on more or less intimate terms, and I discussed with him then the question of gout from which I had been suffering, and he gave me some excellent advice. Many years afterwards I happened to be calling on my old friend Sir Joseph Whitworth, who was then living in Great George Street, Westminster. As I came out, Sir Andrew Clark's carriage drove up, and, as was his habit, he jumped out before the horses had stopped, and rushed up to the door, meeting me face to face. He had not seen me for four or five years, as I was then living in Manchester. " Hallo ! " he exclaimed, " how's the gout ? " The sudden sight of me at once recalled to him all the circumstances connected with my case.

I was encouraged in my taste for chemistry by having a room set apart in our house at Liverpool for

a laboratory, in which I spent all my spare moments and, I need scarcely add, also all my spare cash, neither of which was then very plentiful. However, I succeeded in getting together enough apparatus to be able to perform most of the ordinary chemical experiments, and thus to amuse and sometimes to bore my cousins and other friends by giving them illustrated lectures. I used to ask them to mix the contents of various bottles in order that I might analyse them and find out the constituents of the mixtures, and I suppose I was usually successful—doubtless much to the amazement of my young friends. I remember also making gun-cotton soon after its invention by Schönbein in 1846, and, to the astonishment of my boy friends, firing small cannon loaded with it.

Much was done by the authorities of the school to interest the boys in their work (much more than is the case now in many schools), and we had an excellent library. I was a somewhat omnivorous reader, and devoured the novels of Scott, Marryat, Fielding, &c., but my chief enjoyment was working in my laboratory. I do not remember what chemistry books I read. There were not many in those days, though I had Kerr's translation of Lavoisier, which had belonged to my father—for, curiously enough, he was also interested as a boy in making chemical experiments. I have the book now.

Public lectures were also frequently delivered in the large hall of the school during the winter by well-known men on literary and scientific subjects, and I shall never forget the impression made upon me by one of Mr. Pepper's lectures. He afterwards became professor at the Polytechnic in Regent Street, before "Pepper's ghost" was discovered, and

long before the institution fortunately fell into the hands of the philanthropist, the late Mr. Quintin Hogg. "Shall I ever," I thought, "attain to the position of a scientific lecturer and burn phosphorus in oxygen on a large scale before an admiring audience?"

Another of my experimental delights was firework-making under the guidance of my elder cousin, Roscoe Jevons. We used to spend every half-holiday in the summer and autumn preparing our fireworks for the 5th of November. We worked in an old stable which had been converted into a laboratory, near the house of my uncle by marriage, Thomas Jevons, the father of Stanley Jevons. On one occasion we were drying in front of a fire a quantity of rockets, squibs, and Roman candles which had been packed moist in their cases when one of them ignited and set some of the others off. Our presence of mind in throwing the burning ones out of the window saved a catastrophe, for there were several pounds of blasting powder lying uncovered on the table, and if this had ignited the roof would have been blown off and we boys probably sent into eternity.

On the whole I had a very happy boyhood. My cousins the Booths and I were on the most intimate terms. The Booths belonged to an old and respected Liverpool family. Charles Booth, my uncle by marriage, and the father of the Rt. Hon. Charles Booth, the eminent statistician, had built himself a house just outside the Prince's Park on land that belonged to the family. This park had been given to the borough by Mr. Richard Yates. The Yateses were another well-known Liverpool family and are connected with some of my earliest associations. They were great friends of Harriet Martineau, with whom they made the journey to the East. Mr. Yates was a very small

man. Being of a delicate constitution, before proceeding to Egypt he was advised by his doctor to take exercise by skipping on board the *dahabeah*, and every morning before breakfast he used to skip for half an hour at the bows of the boat. The Egyptian sailors looked with awe upon this proceeding and never interrupted him, firmly believing that he was performing his morning devotions.

My mother and her children used to stay during the summer holidays at some seaside place in the neighbourhood. More than once we were invited to spend the summer with our good friends and cousins the John Taylors at Coed Dhu, a charming place in Flintshire, and Mr. Taylor on one occasion drove us in his carriage from his house to Aberystwyth ; and a pleasant drive it was. I was usually seated between the groom and Mr. Taylor, who drove a pair of spanking chestnuts. We put up for a night or two on the way, and at Machynlleth, having dirtied my shoes, I asked the chambermaid if I could have them cleaned, to which she answered she would send the Boots. I said I didn't want any boots, I wanted my shoes cleaned. However, after a while the functionary appeared, and I got what I wanted, and for the first time I began to understand hotel nomenclature. Mr. Taylor was a distinguished mining engineer and director of a large number of mining concerns, especially lead mines in South Wales, and I remember the interest with which I visited Goginnon and a number of other lead mines and observed the methods of stamping and washing the ore. I also collected minerals, of which I had even then a fair number of specimens.

Another pleasant house that we visited was that of my cousin Margaret Sandbach. She was a great

friend of John Gibson the sculptor, and in a sculpture gallery attached to the house the Sandbachs had some of his most valuable works. Gibson was a *protégé* of my grandfather, and it was through the latter that he became acquainted with Mrs. Sandbach. He was originally a Welsh stonemason in Liverpool; his genius was discovered by Mr. Roscoe, who sent him to Rome, where he soon blossomed into a celebrated sculptor. Mrs. Sandbach, who died at a comparatively early age, shared the literary gift of the family, and published several volumes of poetry as well as a tragedy. She was a most accomplished woman and a delightful companion.

We were also intimate with the family of the late Dr. James Martineau, the eminent divine. He was then the Unitarian minister in the old Presbyterian chapel in Paradise Street. Dr. Martineau had built himself a house in Prince's Park. My chief recollection of him at that time is the admirable manner in which he used to read Scott's novels and poetry to the family and friends. He was truly one of England's worthies. A more noble-minded man never breathed, and he is acknowledged by all creeds and all nations to have been a most able theologian and metaphysician. He died at the ripe age of ninety-five years. Shortly before his death I met him at one of the *soirées* of the Royal Society, which he always attended as a guest. I congratulated him on attaining his ninetieth birthday, and he said: "I am working through the letters of congratulation I have received, and by degrees shall answer them all. One of the most remarkable was from a lady, the only person who addressed me as 'dear James.' I had not heard of her since we were boy and girl together in Norwich. She is one of the daughters of

Dr. Rigby, of that city. My friends used to joke me as a young man about Miss Jane Rigby, and I believed her long since dead. She is now also in her ninetieth year."

Another family with whom we were intimate was that of Mr. S. D. Darbishire, of Manchester, who lived in Greenheys. There was then a large garden attached to his house, but the whole is now, alas! covered with small cottages. The third son, Vernon, had suffered, as a boy, from an attack of rheumatic fever, and all his tendons had become so contracted that he could not walk but shuffled about upon the floor. There was practising in Manchester at that time a physician, Dr. Braid, who was one of the first to investigate the subject of mesmerism—or, as it is now called, hypnotism—and one of his patients was Vernon Darbishire. I often witnessed Vernon being put into the cataleptic state, and the phenomena were very similar to those I observed many years afterwards at the Salpétrière under Charcot. The boy was soon put into a condition of insensibility, and then Braid would extend and flex the tendons without any pain to the patient, though in his ordinary state the pain would have been excruciating. This treatment went on for many months, and ended in his recovering to a great extent his powers of locomotion.

During the trance he certainly performed remarkable feats, some of which can be attributed to a heightened sense of touch. For instance, if one took a handful of silver coins with a few gold ones among them, and told him that gold burnt, and then dropped the coins quickly one after the other into his hand (his eyes being, of course, blinded), the moment a sovereign touched his palm he let it drop with a cry of pain. More remarkable, however, was the way in

which he could write when he was blindfolded. Thus, his eyes being covered, a board would be placed, for still further assurance, between himself and his hands which were holding the slate and pencil. He would then be told to write from dictation, and after he had finished a pretty long sentence, which he had written in perfectly straight lines just as if he had seen the slate, he was told to go back and dot his "i's" and cross his "t's": this also he did with precision. These phenomena are similar to those which have been since more carefully investigated by Charcot and others; but the attempt to apply the hypnotic condition (of the existence of which there can be no doubt) to the cure of disease does not seem to have made much progress. With regard to the above powers I would remark—may it not be possible that just as the invisible Röntgen rays pass through a deal board, and by means of a fluorescent screen render visible the key under the board, so in the same way some, as yet unknown, emanation accompanying light passes through the board and affects the eye of the hypnotised patient, whose nervous system, as we know, has been rendered exquisitely sensitive?

CHAPTER II

EARLY LIFE IN LONDON

University College, London—Matriculation—Thomas Graham—Alexander Williamson—I become Assistant to Williamson—Stanley Jevons—Brodie.

UNIVERSITY COLLEGE, LONDON, in the late 'forties and early 'fifties was at the heyday of its usefulness and prosperity. Founded in 1828 by many supporters of free education, including Thomas Campbell the poet, it became, after the rejection by the House of Lords in 1834 of a Bill to admit Dissenters to degrees in Oxford and Cambridge, the chief and indeed the only seat of higher learning and research open freely to men of every religious persuasion. No tests of any description were imposed on either teachers or taught, and the lecture-rooms and laboratories were filled with students from all parts, whose religious tenets prevented their entrance to the older seats of learning. That the professors were men of independent views, each master of his subject, is proved by the fact that among them were De Morgan, Francis Newman, Malden, Sharpey, Graham, Lindley, Williamson, Jenner, and Liston. Their system of instruction was based rather on the German and Scottish methods than on those of Oxford and Cambridge. They were professorial rather than tutorial. Many of the students of my time afterwards made their mark in the world. Lister had just completed his medical studies ;

Herbert New, Langton-Sandford, Farrer-Herschell Bagehot, Jessel, Richard Hutton, Osler, William Caldwell Roscoe, Henry Thompson, and Edward Fry had either taken their degrees in the University of London when I first entered the College in 1848 or did so shortly afterwards.

The abolition of religious tests for degrees at Oxford and Cambridge naturally to some extent affected University College, as many exceptionally brilliant men were drawn away by the superior inducements offered by the older seats of learning. But in spite of this my Alma Mater held her own, and for another half-century was the chief home of the higher liberal education in the metropolis, embracing in her arms Jew and Gentile, bond and free. Now, in 1906, she has entered upon a new phase of existence in which she bids fair to outstrip her former record of usefulness, for she has become an integral part of the newly reconstituted Teaching University of London, and will henceforward bear a leading part in the building up of an educational edifice worthy of the chief city of the Empire.

De Morgan was certainly *facile princeps* among the teachers of mathematics of his day, and he inspired the greatest enthusiasm for the subject in the minds of his pupils. My cousin W. S. Jevons, the eminent economist, wrote of him: "One learns more and more to adore him as an unfathomable fund of mathematics."

But De Morgan was not merely a mathematician and a unique teacher; he was one of the profoundest and subtlest thinkers of the nineteenth century. His was a most original mind, and his method of instruction was quite different from that of the ordinary schoolmaster. The trouble he took with his students was extraordinary. On joining his class one saw at once

the difference between the methods of college or university teaching and those of a school.

The professor was blind of one eye and very stout, and had many peculiarities of voice and manner which often created diversion among the youths who attended his class, and many were the tricks played upon him; for, although generally respected, his peculiarities made him something of a butt to those who were too stupid to understand the value of his admirable instruction. On one occasion a number of sparrows were let loose in the lecture-room and flew about, perching on the blackboard, much to the amusement of the audience, who expected every moment that one would alight on the professor's bald head. After some time his attention was drawn to their presence, and he remarked, resting his nose on his pointer, as was his wont, and surveying the class with his only eye, from behind a very large white choker: "I see nothing to laugh at if a sparrow does come into the room, and I daresay there are many here who have not got the brains of a sparrow." After which the lecture proceeded without interruption.

Francis Newman at this time was professor of Latin, and no doubt I benefited to some extent from contact with this remarkable man; but I fear I did not construe to his satisfaction. I remember he appeared to be of a very chilly nature, and used to sit in a brown poncho with his legs wrapped up in a blanket. Newman's method of teaching was to lay stress rather upon the general features of the text than upon its details, and in this way to interest his class. Unfortunately he had not in those days published his Latin translations of *Hiawatha* and *Robinson Crusoe* (Lat., *Robilius Cruso*), so that our reading was confined to the older classics.

A. J. Scott was the professor of English, and I attended his class, little thinking that in a few years I should be his colleague in Manchester. His subject for that session was Anglo-Saxon, and after explaining to us the construction of the larynx he proceeded to instruct us very fluently in the history of Beowulf, Bede, and others, giving us some illustrations of the Anglo-Saxon language. He was, however, very prosy and lengthy, and the end of the session came before he had finished the Anglo-Saxon period. Next year the course announced was the literature of the Elizabethan era; this I thought would be extremely interesting, and consequently I entered the class, though I was much occupied with other subjects. On the first day, however, Scott looked round the class and said: "I see there are a number of gentlemen present who did not hear my lectures last session on Anglo-Saxon, and as the knowledge of this portion of English literature is necessary for a proper appreciation of subsequent periods, I propose to devote a few lectures to the study of Beowulf." I was somewhat disappointed, but hoped soon to get to Elizabeth. This, however, was not to be, for almost the whole of the session was taken up as before with Anglo-Saxon, and we only got a lecture or two on the Elizabethan people.

A more refined and charming teacher than Malden I have never met. I was, however, but a 'prentice hand at Greek, and had some difficulty in following the subject. Malden would spend half an hour in discussing with philological minuteness the derivation and exact meaning of each word or even particle, so we didn't get through so much reading of Greek texts as I had hoped.

A source of greater satisfaction to me than the

above arts studies was Thomas Graham's course of lectures on chemistry (see portrait). The majority of the class consisted of medical students, the remainder being made up of arts men, for in those days no science faculty or science degree existed. The illustrations to his lectures were prepared and carried out with the greatest possible care, every experiment succeeding; this was chiefly due, however, to an intelligent lecture assistant who was a good manipulator. Graham was a good expositor and we learnt much from his lectures, but he was nothing of an orator nor even a fluent speaker, often failing for want of words, and pointing with both hands without speaking to indicate the result of an experiment. Still it was an entirely new world to me, and I valued it accordingly, and I think I got a silver medal at the end of the session.

Graham could upon occasion show himself a man of firmness. One day a row occurred. Two of the medicals having been expelled by order of the Council of the College, an *émeute* on the part of their fellow-students broke out, and they resolved to stop all the lectures at the medical "end" by way of expostulation. So, armed with all the thigh-bones they could pick up, not only the medical students for the year but the whole number of them, marched in a body into Graham's class-room, of which they took forcible possession. It was well known what was to happen, and a note was placed on the lecturer's desk signed by the "head centres," stating that no disrespect was meant to the professor, but that they were determined, &c. The little man entered the theatre, followed as usual by his two lecture assistants. He was received with a salvo of artillery from the thigh-bones hammered

against the benches. After some time, when order was restored for a minute, Graham very quietly, but in sight of the audience, tore up the note without opening it. This was a signal for a further and more determined salvo of femur gunnery, which lasted for perhaps ten minutes, the professor standing quietly for some time and at last sending for a stool, upon which he sat, showing that he was determined to outface the malcontents. Their muscular energy somewhat exhausted, silence was once more restored, and Graham said in a quiet voice : " At the end of the last lecture, gentlemen, we were studying the properties of hydrochloric acid. I will now proceed with a further description,"—upon which another roar occurred ; and this farce repeated itself many times. At last, wearied out with the vain attempt to carry on his class, but determined not to refer to anything but the business in hand, Graham had to retire, the students celebrating their victory by another salvo of femurs.

The professor of Natural Philosophy was an extraordinary man—an enormous bulky body, with a face like a woman's and a piping voice. His method was that of the Cambridge of that day. His lectures were not experimental, and they were not appreciated by my fellow-students. He generally read from his own book on mechanics, holding it in his hand while he wrote up a formula on the blackboard, and occasionally would become confused, and would pipe out when a mistake was pointed out : " Reading and writing, gentlemen, reading and writing, make a mistake." Times have changed as regards the teaching of physics, nothing less than a revolution having occurred. The question of the dismissal of an undesirable professor is a most difficult one, especially where no retiring pension is allowed. At last, however, the professor

resigned, and a man of a totally different stamp—my friend George Carey Foster, who afterwards became the principal of the College—reigned in his stead with conspicuous success.

In June 1849 I went up for matriculation. The examinations were held in Somerset House. I was pretty safe in all my subjects except Latin, in which I felt somewhat shaky, especially in the grammar; but, as up to that time the translation of the set book was all that was needed, I hoped to scrape through. I remember well being placed first at the top of a long table, at the end of which sat the Latin examiner. When we were all very busy translating the passages from the Æneid, which I fortunately happened to know well, the examiner rose from his seat and said: "Gentlemen, the examiners have decided to ask each candidate a few simple questions in grammar, and I shall begin now in the order in which you are sitting." "The deuce you will!" thought I—"it's all up with me"; and so I stood up and was the first to be cross-examined as to the gender of a noun or the mood and tense of a verb. I am afraid I made rather a hash of it, for the examiner smiled, as some of them do, grimly, and then he said, "Pray, sir, are you any connection of William Roscoe the historian?" "Yes, sir, I am; he was my grandfather." "That'll do, sir." Upon which I said to myself, "Thank goodness, that's the first time my grandfather has been of any use to me personally, though of course I partly owe to him my existence." And I passed in the first division.

My uncle "the doctor," with whom I resided when I first came up to town, was an amusing companion full of old-world stories. One day when he was going his rounds—for in his early days he was

assistant to a country practitioner—he saw the dead body of an old villager, who had met with an accident, being carried into his cottage. He went in to see if he could be of any use. The old wife Betty threw up her hands and said, "Thank God it's no worse!" "Why, Betty," said the doctor, "how could it be worse? Here's John brought home dead on a stretcher." "Why," said she, "he might have been taken ill i' th' autumn, and died i' th' spring."

My mother and sister soon followed me to London, and we occupied a house in Torrington Square, which accommodated not only our family but also my cousins Frank and William Caldwell Roscoe. Later on we lived in Oval Road, Camden Town, and there also two of my cousins resided with us, the late Henry Roscoe, for many years the head of the firm of Field and Roscoe, of Lincoln's Inn Fields, and my cousin Stanley Jevons. Stanley had been at University College School, but soon afterwards attended the classes at the College. I was not long in finding that in him I had to do with a remarkable mind. The first instance of his power was shown by his examining a number of crystallised minerals which I possessed, and giving the crystallographic nomenclature to their faces. I shall have to mention him later.

We were very intimate with our cousins the Cromptons, who first lived in Endsleigh Street, but when my uncle became a judge the family removed to a large corner house in Hyde Park Square. The judge in his early days had been a great friend of my father's, and was indeed almost like a second father to me. He offered to send me to Cambridge with his son Charles, who afterwards came out fourth wrangler and was Fellow of Trinity, but in those days Cambridge offered no such inducements for the

study of science as fortunately it does now, and I told him so, and that my hope was to study in Germany.

The judge was an original man, and his family were all like brothers and sisters to us. For some years he rented a beautiful place in Sussex, near Horsham, called the Nunnery, where we were often invited to stay, and the charming times that we passed there will always remain among the brightest memories of my life. It was in the drawing-room at Hyde Park Square that I first met my wife, then a girl about seventeen years of age.

Whilst Charles Crompton was an undergraduate at Trinity I frequently visited him. On one occasion he invited to meet me a young Scotchman who had, so he said, scientific proclivities. This young man addressed me in very broad Scotch as follows: "Come and see my devil; I've got a devil." So I went. The floor of his room was covered with sheets of white paper; upon these were drawn a most complicated series of curves; from the ceiling was hung a doubly suspended pendulum, the "bob" of which was a heavy weight ending in a point. On placing the point on one of these curves and releasing the weight, the point followed exactly these singular curves running all over the floor in a grotesque manner. This was my first introduction to Clerk Maxwell and his "devil."

Another talented member of our family, who like my father died prematurely, was my cousin William Caldwell Roscoe. When I first came to London he and his youngest brother Frank, who was in an office in the City, lived in South Crescent, near Gower Street. I often used to see them. William was a delightful companion, and of all the grandchildren was the one who possessed most literary power, as his essays and

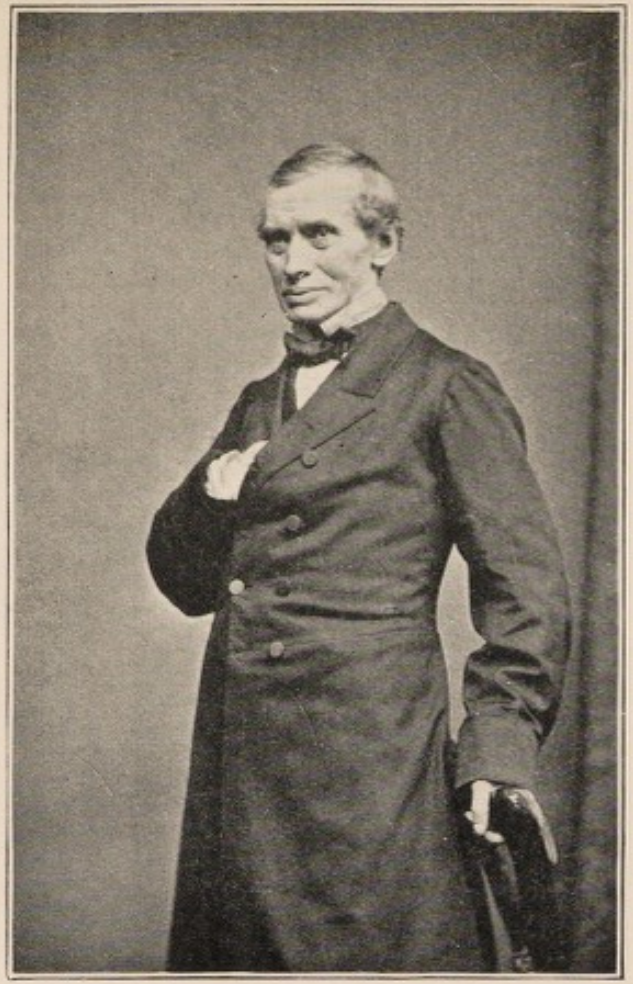
poems, edited after his death by his brother-in-law Richard Hutton, testify. Richard Hutton had married William's sister, Mary Roscoe, and was then the principal of University Hall in Gordon Square. Hutton was attacked by a very serious illness, a lung trouble, and he was told that his only chance of life was to spend some time at St. Thomas, in the West Indies. So he and his wife took passage to St. Thomas in a Liverpool sailing-vessel. A few days after they had left port, news came of the outbreak of a virulent type of yellow fever in the island. As there was then no telegraphic communication with the West Indies, it was not possible to inform the voyagers on their arrival; and the next mail brought word that soon after landing the strong and handsome wife had fallen a victim to the epidemic, whilst the patient had escaped. On hearing of this sad event, William Roscoe, at the risk of his own life, set out for St. Thomas to bring back his brother-in-law, an act of self-forgetfulness which may well be compared to a deed of military heroism. Richard Hutton, a man of great talent and a charming character, was for many years the well-known editor of the *Spectator*. After some time he married another of my cousins. He died in 1897.

To return to my studies. I soon made up my mind to follow chemistry as a profession, much to the astonishment and even dismay of some of my friends and relations, who asked me if I intended to open a shop with red and blue glass bottles in the window. And this was not an extraordinary question, for in the early 'fifties the position of science in public estimation was very different from that which it now holds in England. At the beginning of my second session at University College I entered the Birkbeck Chemical Laboratory, which had just been placed under the

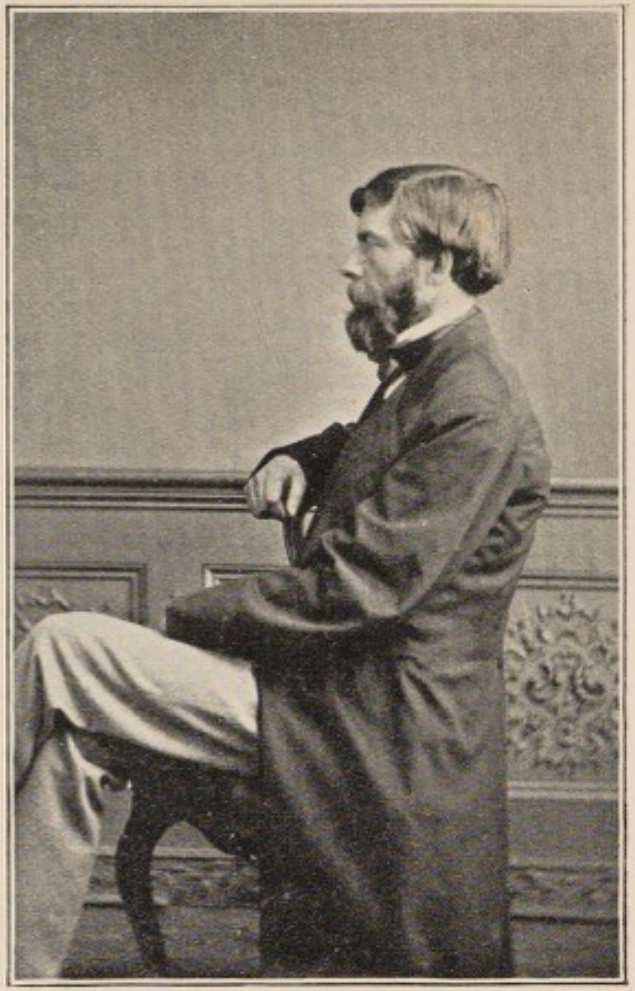
charge of a distinguished young chemist, Alexander W. Williamson (see portrait), who brought fresh life into the study of practical chemistry.

He came direct from the laboratories of Laurent and Gerhardt in Paris, and I found myself in an altogether new and very congenial atmosphere. The chief assistant was Henry Watts, afterwards known as the editor of the great *Dictionary of Chemistry*. He was an admirable teacher and a walking encyclopædia of chemical knowledge, although he had not the original mind of Williamson. I soon got through the ordinary course of chemical analysis, which in those days was not nearly so complete or searching as it afterwards became, and Williamson set me before long (too early I have sometimes thought) to work on original investigation.

I quickly made acquaintances, some of whom have proved to be life-long friends. Dr. W. J. Russell, F.R.S., for many years lecturer on chemistry at Bartholomew's, was one of these; another was William Kenrick, whom I afterwards met as a fellow-member of the House of Commons. Alfred E. Fletcher, who carried off the gold medal one year, somewhat to my chagrin, was another. He afterwards became the Chief Inspector of Alkali Works, which post he filled admirably. There was also a large number of excise-men, who were a queer set—oldish men among a number of youths. These men were set to do original work. Of these Bell, Duffy, and Railton published their results, and afterwards rose high in the service, and there is no doubt that the couple of years which they spent at University College were most useful to them and beneficial to the Inland Revenue Department. This was the beginning of the systematic scientific education of excise officers which was for many years carried on in the Government laboratory



Wm. Graham



Abram W. Venable

under the direction of the Chief Chemist and some of his assistants. After the appointment in 1894 of my friend and former pupil Dr. T. E. Thorpe, C.B., F.R.S., to the office of Government Chemist in succession to Dr. James Bell, C.B., the laboratories were rebuilt on a most complete scale by Dr. Thorpe, on a site provided in Clements Inn and the whole system and service reorganised. Since that time the instruction of the young men destined for appointments in the Scientific Departments of Inland Revenue and Customs has been transferred to the Royal College of Science at South Kensington, where they spend two years in attendance on lectures and in laboratory work.

At the end of the session of laboratory work at University College the professor permitted us to have what may be termed "a chemical saturnalia," by the administration of nitrous oxide (laughing gas) to such of the laboratory inhabitants as desired to take it. I did not inhale the gas, but I remember very well some ludicrous incidents, interesting as showing what varied effects the nitrous oxide intoxication produces upon different individuals. Of course for this purpose the gas must be mixed with air so that it shall not act as an anæsthetic but as an intoxicant. The *famulus* of the laboratory was a Quilp-like creature, Williams by name. When under the influence of the gas he simply sat upon the coal-box and made the most horrible series of grimaces that one could possibly imagine. Watts, on the other hand, when under its influence danced about in a high state of exhilaration, clicking his thumbs in great delight. A student of the name of Fox, a Quaker, and of course a man of peace, became terribly pugnacious and chased us all round the laboratory. I remember fortunately hiding behind one of the doors in the furnace-room, but he caught one of the

excisemen, and, getting the head of the unfortunate man "into chancery," inflicted considerable damage upon his person. It was all over in a few minutes, but it was deadly whilst it lasted ; and the astonishment of the peaceable Quaker, when he recovered, at the results of his onslaught was very amusing to all but the exciseman. I did not observe, however, any of the effects of the gas such as are depicted by Gilray, in his well-known and somewhat coarse caricature of the first public exhibition of the effects of the inhalation of the gas, under Davy's superintendence at the Royal Institution, partially reproduced in Thorpe's *Life of Davy*.

At the time I entered the laboratory, Williamson was engaged in the researches which have made his name a household word to chemists all the world over. His was a mind of great originality, and his personality was a most attractive one. And, despite his physical disabilities—for he lost an eye and the proper use of his left arm in early childhood—he was a diligent and accurate worker. Ardently devoted to his science, he infected all who worked under him with the same feeling. And his pupils willingly own that much of the success that they may have met with in after years was due to his teaching and example. I well remember the feelings of interest he aroused as he each day came down to the laboratory brimful of new ideas. First it was his explanation of the theory of etherification, of which he proved the truth by preparing the mixed ethers, thereby ascertaining the general constitution of alcohols and ethers, and laying one of the foundation-stones of modern chemistry. Next it was his well-known paper on the constitution of salts, in which he enunciated principles which have since been generally adopted. Then came

his views on atomic motion and interchange, the first definite statement of a series of chemical phenomena which in the hands of van't Hoff and others have become of the highest import. All this was the work of very few years. After that he remained silent, but he was nevertheless working on many subjects. Thus he clearly foresaw the principles upon which the modern development of the steam-engine depends, and though he failed for want of constructive skill, he pointed the way which engineers have since followed with conspicuous success.

In my second year he did me the honour to ask me to become his private assistant, and I derived great advantage from working with him. I also acted as his lecture assistant during the first session in which he was appointed to Graham's chair, and prepared the chemical museum for him. As this was my first official position the letter in which the offer was made is not without interest; moreover it indicates the methods of instruction in chemistry which Williamson introduced in those early days :—

3, ARUNDEL TERRACE, BRIGHTON.
July 8th, 1855.

MY DEAR ROSCOE,—

The Council appointed me yesterday afternoon Professor of Chemistry, including Practical Chemistry, and my first act in that capacity is to ask you to give the College the benefit of your services as assistant to the general Chemistry Class. The duties of that office will be laborious enough, especially during the first session, and require a man of scientific acquirements and skill. In fact, they will occupy in all probability the full business time of every day in the week for six months. They will consist of preparing the experiments for the lectures and often assisting me to devise them, in recording the experiments in a journal, and last, though not least, in assisting me in the instruction of the class in the following manner :

I intend giving the students exercises in the most important points taught in the lectures, and shall be anxious to get

the whole class to do them. These will of course have to be corrected; and in many cases it will be desirable to explain to individual students whatever they may have failed to understand in the lectures. Now, the correcting these exercises and conferring with individual students will be one of the most important duties of the assistant, and one which I imagine will be far from disagreeable or unprofitable. I may state that I intend mentioning the assistant's name in the prospectus if, as I trust, no objection is made to my doing so by the Senate. So the engagement I propose to you is for six months, commencing from the 1st October, and as honorarium I would propose the sum of sixty guineas (£63), or it will be better to say from the 15th September to the end of March at the above *rate*, as we shall have a good deal to prepare before the beginning.

I need hardly assure you how pleasant it will be to me personally, and satisfactory officially, to have you with me, and that I should do my best to make the arrangement comfortable to you and conducive to your advancement. But I ought to say at once that I don't think you would under this arrangement have time during the *day* for private work, so that the only kind of work which you could carry on simultaneously with it would be evening work, such as translation. In connection with this latter subject I may mention (*entre nous*) that I am writing to Gerhardt to ask him to prepare an abridgment of his *Chimie Organique* in one small volume, I providing to find a translator into English—of course I should first ask you to undertake it—though I fear he will require to share the profits of the translation with the translator.

Write me as soon as possible your decision—for the sake of the prospectus—and believe me ever

Yours sincerely,

ALEX. W. WILLIAMSON.

P.S.—Remember me to Bunsen and tell him I shall write very soon to tell him all about the result to which he so cordially contributed.

Nearly forty years afterwards, in 1888, I had the pleasure of presenting to University College on behalf of the subscribers the portrait of the Master which now hangs there.

Soon after I commenced my chemical studies,

Stanley Jevons, whom I have before mentioned, entered the laboratory. Graham, who had then become Master of the Mint, sent for me one day and offered me the post of Assayer in the Mint at Sydney, which had just been established. It was worth £600–700 a year, and was a post which many young men would have jumped at. I felt, however, that I could not leave my mother and sister, as they did not wish to go to Australia, so I declined it with thanks, but told him that I knew a young man who was singularly well fitted for the position, and who I believed would accept it. This young man was Stanley Jevons. Graham saw him, was pleased with him, and gave him the appointment. How he fitted himself for the work and how he carried it out is told in the memoir written by his wife. On this point one letter written to me from Australia by Jevons has an interest of a special kind :—

I suppose that you get along famously in your rather responsible place, and accordingly congratulate you on the fact. Would that I had such another berth! I feel an utter distaste for money-making; but, on the contrary, ever become more devoted to my favourite subjects of study. I told you long since that I intended exchanging the physical for the moral and logical sciences, at which my *forte* will really be found to lie. I like and respect most of the physical sciences well enough, but they never really had my affections. I have almost determined to spend a year at college before looking out for any employment in England: it might be worth while to take my B.A. (If I had had this degree before coming to this colony I would vastly have improved my position in, as well as outside, the Mint.) I wish especially to become a good mathematician, without which nothing, I am convinced, can be *thoroughly* done. I daresay it is the general opinion of my friends in England that I am inexcusably imprudent in resigning £630 per ann. I am sure it will grievously offend some of my relations. But, I ask, is everything to be swamped with gold? Because I have a surety of an easy, well-paid post here, am I to sacrifice every-

thing that I really desire, and that will, I think, prove a really useful way of spending my life? I certainly must be excused if I do not consent to throw away my lifetime.

In my early years in London I used to see the late Sir Henry Holland. He frequently invited me to his breakfast parties in Brook Street. One day I found him before breakfast busily engaged in reading an enormous volume, the *Vie de César* presented to him by his friend the Emperor Napoleon with the inscription "From the author, N." On another occasion amongst the party at breakfast was a military-looking gentleman to whom I was introduced, but whose name I have forgotten. On the party rising, Sir Henry Holland came with me into the hall, and then in a low and insinuating voice said, "Oh, my dear Harry"—for he used to call me by my Christian name, having known my family for many years and being in some degree connected with us through his first wife—"would you step into this anteroom for a moment? I will not detain you long." I waited for some ten minutes, after which interval the old gentleman glided in again noiselessly and, with his head on one side and an angelic smile on his face, said, "Well, all I wanted to say to you was good-bye—good-bye and God bless you!" I only surmised what had happened when I learnt some time afterwards that the military gentleman I had seen was a high Court official, and that Prince Albert was trying to find a suitable young man to be the tutor or companion to the Prince of Wales or one of the other Royal princes. I was sent for to be looked over; and no doubt when Sir Henry showed me into the anteroom, he went back and asked the Court official whether I would "do," receiving an answer in the negative, probably to the effect that I was too young or too old, or not a

SIR HENRY HOLLAND.

sufficient classic, or had a Lancashire accent, or that I didn't grow a moustache, and that in short I would not serve his purpose.

I here reproduce a photograph of Sir Henry Holland which I took at the Royal Institution on May 6th, 1864, by the magnesium light.

In 1850 I first made the acquaintance of Brodie, afterwards professor of chemistry at Oxford, by means of a letter of introduction from Lady Coltman, the widow of the judge. Brodie had recently married and lived in Albert Road, and had fitted up the lower part of his house as a laboratory. He was working then on graphitic acid and graphite, and I was much interested in the results of his experiments. He and I became fast friends, and I often visited him in after years at Oxford, where he lived at Cowley House on the banks of the Cherwell, and where I had ample opportunity of admiring his high scientific attainments and his large-hearted and liberal views, especially with regard to university and scientific education—views which are clearly shown in the following letters :—

COWLEY HOUSE, OXFORD.

February 28th, 1872.

MY DEAR ROSCOE,—

I have never thanked you for your beautiful specimens of the compounds of vanadium, which I found in the laboratory on my return here in January, and which you were kind enough to send me. I am much obliged to you for them.

You may know that I am about, before long, to resign my professorship here, of which I find the work, especially in the way of lecturing, to be rather more than I have strength for. It really should be known that this professorship is open to all the world without any limitation whatever, and there is the strongest feeling in the University in favour of the appointment of the most competent person who will come forward for it, irrespective of all other considerations. The professor is appointed by a board, who are pretty certain also to take

CHAPTER III

"HEIDELBERG DU FEINE"

Heidelberg—Bunsen—Fellow-students—Heidelberg Doctorate—Photo-chemical Researches—German University Life.

HAVING taken the degree of Bachelor of Arts in the University of London in 1853, I was able to give my whole attention to the study of the science to which I had determined to devote my life. In the course of my chemical work I had naturally become acquainted with Bunsen's fame as a teacher as well as with many of his researches, and I had a great desire to work under him. I therefore persuaded my mother, who was nothing loth, to accompany my sister and myself to Heidelberg, to which university Bunsen had just been called from Breslau.

The mass of British tourists who pass through Heidelberg each summer to enjoy the charming scenery of that delightful spot know little and perhaps care less about that which really marks this town as one of the most illustrious and ancient seats of learning in the world. They are satisfied to stroll round the ruins of the Heidelberg Schloss, and to wonder at the Gesprengte Turm outside, and at the Grosse Fass inside the Castle. The very existence of the far-famed Ruperto-Carola is to most of these travellers unknown, and it is only if by chance they meet some corps students in gala costume, or hear of some more than

usually serious duel, that it occurs to them that there exists in the town a curious kind of institution called a German university.

Several friends joined us for the tour up the Rhine. We left by the "Baron Osy" one Sunday in August 1853, and on the following morning arrived at Antwerp, a city which from its picturesqueness and individuality was then one of the best that could be chosen for the first visit of an Englishman to the Continent.

We journeyed by boat slowly up the Rhine, stopping at the places which were still old-fashioned, our only alternative to the steamer being the lumbering diligence.

Arrived at Heidelberg and having presented our letters of introduction to Professor von Mohl and others, our first object was to secure a domicile. This we obtained in the house of a typical old South-German woman, Frau Frisch, near the Karlsthor, and here we established ourselves, my mother, my sister, myself, and my cousin Enfield Dowson, a boy of about sixteen, who had come with us to go to school in Heidelberg and learn German. Everything was new to us, and we all entered into the spirit of the thing.

I had time to get up my German before the lectures began, and with the help of an old pedagogue and that of our maid Gretchen, and by attending service in the German church on Sundays (a practice which I did not continue long), I got my ear pretty well accustomed to the language and was able to make myself understood.

The Mohls were a charming family, and the professor a polished man of the world, totally unlike the usual English idea of a German professor. His family consisted of his wife, two daughters, and two sons, with all of whom we became intimate. He had three brothers—Hugo von Mohl, the celebrated professor

increasing number of students, however, made it necessary to enclose the cloisters with glass windows, in front of which a series of working benches were arranged. One of these was given to me, and on one side worked Lothar Meyer, and on the other side Pauli, whilst Russell and Hermann, and Atkinson and Meidinger, occupied neighbouring places. Of course we had neither water nor gas laid on. We used Berzelius spirit-lamps, drew our water from the pump, and threw down our useless precipitates on the tombstones of the old monks under our feet; all our combustions were of course made with charcoal, and the evaporation of the wash-waters of our analyses was carried out over charcoal fires.

Bunsen soon set me at quantitative work, and I first learnt from him what accuracy of manipulation meant. His system of silicate analysis was carried on by almost all the men (each analysis occupying six weeks), and he used the results for verifying the law with regard to the acid and basic silicates, which he first brought forward in his celebrated memoirs on the composition of Icelandic rocks. As soon as I had obtained the requisite amount of facility for work of this kind, he put me through a complete course of gas analysis, for which he was specially celebrated, and thus I learnt a number of manipulative details as well as exact methods of measuring and estimating gas volumes.

Having in these and other ways put me on my mettle, and having thus gained confidence in my powers of accurate and trustworthy manipulation, the Master set me on to original work. The outcome of these, my early flights into unknown regions, were not of striking import, but they served as an introduction to better things to come.

Bunsen was not only a great investigator but a stimulating and inspiring teacher. His lectures were, like everything he touched, marked by originality of treatment. He did not attempt to catch the attention of his audience by brilliancy of style or by "firework" experiments; but his exposition was luminous, and his experiments, always made with his own hands, were exactly illustrative of the matter under discussion. As soon as the lecture was over he went into his laboratory. There he would find about a hundred men waiting for his assistance and advice, and there he spent the whole of his day, superintending the practical work of his students.

To work with Bunsen was a real pleasure. He did not confine his attention merely to those who were engaged in original inquiry; even the beginner had the benefit of seeing how the Master worked, and some of the most elementary operations in analytical chemistry were performed by him at the bench of the pupil. Thus, he taught us not only by precept but by example, and from him we learnt what accurate work meant. We saw how to eliminate errors of experimentation, and to find out where more errors lay. It was this complete devotion to his science and to his students that drew men from all quarters of the globe to study under him; no one who cared to benefit from his teaching was ever sent empty away, and all who had worked in the Heidelberg laboratory looked back upon the time spent there as one of the most fruitful periods of their lives.

It was, however, specially to the advanced students engaged in investigation that Bunsen's heart went out, and to them he gave unstintedly his time and labour. For to these men he knew the future of the science belonged, and that it was they who would hand down,

burning more or less brilliantly, the torch of progress. There would be, perhaps, twenty men thus engaged, not, as in many laboratories, all working on closely cognate subjects, but each one on matters differing widely, and therefore requiring much greater grasp and attention on the part of the teacher, to whom the initiation and often the general conduct of the research was due. This constant presence of the master, this participation by him in the work of the pupils both young and old, bore in on the minds of all the lesson that it is the personal and daily contact with the leader which creates a successful school; and that whilst fine buildings and well-equipped laboratories are good things in their way, they are as tinsel and dross, unless accompanied by the devotion and collaboraton of the teacher.

How, it may well be asked, could Bunsen, thus devoted to supervising the work of others in the laboratory, who had to deliver a lecture every day, and had much perfunctory university business to transact as well—how could he possibly find time to carry on laborious experimental investigations of his own? for he never kept an assistant, as many do, to work at his researches for him, but did all the experimental work with his own deft hands. Well, it is always the busy man who has most time for work—or at least who does most—and so it was with Bunsen. Spending the whole day in the laboratory, he was often able to spare an hour or two to devote to his own work, either of devising and testing some new form of apparatus, of separating the rare earth metals, or of preparing and determining the crystalline form of a series of salts. Then he was an early riser, and when I lived with him, I know that it was his habit to rise often before dawn in the summer, to complete an experi-

ment or to edit a research. And then much original work was done in his vacations.

Before his appointment Bunsen had stipulated with the Government of the Grand-Duchy of Baden that new laboratories should be built for him, and these were shortly completed, and the old monastery pulled down to make way for a new physical institute and a zoological museum.

Up to 1853 Heidelberg had not been supplied with gas, and it was quite an event for the good Heidelbergers when the gas-lamps were first lighted in the town. Of course, Bunsen at once saw the advantage of having gas for heating purposes in the laboratory, and I brought from London a sample of the gas-lamp which we had been using in University College. This consisted of an ordinary argand burner, above which was a cylindrical copper chimney, and on the top of this was fixed a disc of wire gauze. On turning on the gas and applying a light to the top of the wire gauze a non-luminous flame was obtained, which did not, of course, blacken any object upon which it played. As the admixture of air and gas in this arrangement was not exactly regulated, the temperature of the flame was often low, so much so that if the supply of gas were diminished, the flame went out altogether. Bunsen was not satisfied with this, and he said: "I am going to make a lamp in which the mixture of air and gas shall burn without any wire gauze." This, I thought, would be a difficult task, as a mixture containing ten volumes of air and one of gas becomes explosive and the flame would then pass down the tube to the nozzle where the gas escapes, and thus the lamp would be rendered useless. However, Bunsen, nothing daunted, made a large number of experiments on the relative size of the openings for gas and air, and

eventually the "Bunsen burner" came to light. This is now universally employed, not only for chemical but for a great number of other purposes in the arts and manufactures, so that this burner is even more widely known than the zinc-carbon battery which also bears his name.

Another well-known instrument invented by Bunsen (1844) is the photometer, which he devised for measuring the illuminating power of coal-gas. The essential feature of this apparatus is a disc of paper having a grease spot in the centre, a comparison of the luminous intensity being made when by the approximation of the source of light to the illuminated disc the spot becomes invisible. When the instrument was shown and explained to the late Emperor Frederick he remarked, "For the first time in my life I now know the value of a spot of grease."

It is not only his inestimable additions to pure Science, upon which this is not the place to dilate, that mark Bunsen as one of the foremost scientific men of his age; he is no less distinguished by his contributions to its industrial applications. Perhaps the most important of these was the revolution he effected in iron manufacture. He made the first successful attempt to introduce accurate scientific methods and inquiry into this great industry. Up to 1845 the production of cast-iron in the blast-furnace was carried on largely in ignorance of the scientific principles upon which it depends. The waste of fuel was enormous, amounting often to 80 per cent of the whole. Bunsen, by analysing the escaping gases from the blast furnaces at Alfreton, in Derbyshire, showed how this loss could be obviated and the heat of the burning gases utilised; and, in conjunction with the late Lord (then Dr. Lyon)

Playfair, he conducted a series of experiments which have resulted in economies the money value of which may be reckoned by millions of pounds.

Clear light was thrown by these researches in other directions upon the chemistry of the blast-furnace. For example, the formation of cyanogen in the furnace was unknown until it was discovered accidentally, as thus described by Playfair: "Bunsen was engaged below, and I above, passing the gases through water to collect any soluble products, when I was alarmed by being told that my friend had become suddenly ill. I ran down and saw white fumes coming out of a lateral tube, and Bunsen apparently recovering from a fainting condition. I applied my nose to the orifice and smelt the vapour of cyanide of potassium, which gave an entirely new light to the processes of the furnace."

These important results could not have been achieved if Bunsen had not previously elaborated an accurate method of gas analysis. No one before his time could undertake accurate determinations of the several constituents of a gaseous mixture. His book on gasometry—the only book he ever wrote—is a remarkable one. For originality of conception, for success in overcoming difficulties, for ingenuity in the construction of apparatus, and for accurate methods, this book as a record of experimental work is, I believe, unequalled. Many were the physical properties of gases which formed the subject of Bunsen's investigation. He devised new methods of attack; he invented novel instruments for effecting his object, and was thereby able to study with accuracy the phenomena of gaseous diffusion and absorption. All these researches were masterpieces of experimental skill and of accurate and painstaking work.

dance, and we none of us thought that he could manipulate. In this, however, we were soon undeceived, for though as a rule his hand was on the shake, his muscles sometimes had what may be termed lucid intervals, and then he used quickly to make his circuit complete, and arrange his apparatus, and then begin shaking again. He afterwards greatly distinguished himself by working on the alloys, as also by the preparation of the metals of the alkaline earths. He worked also in the physical laboratory, especially on the redetermination of electrical constants. He was remarkable for his intense application in spite of his physical infirmities, and during the winter used frequently to sit up all night in the cold laboratory at a temperature far below freezing point, in order that he might make accurate determinations, which he could not do in the day-time, owing to the vibrations caused by passing vehicles. My friend, the late Dr. Atkinson, used to tell a story which indicates the confidence placed in Matthiessen by the custodian of the physical laboratory. Atkinson, desiring to make use of a particular instrument, asked Matthiessen to give him an introduction to the custodian, which he did, adding: "If you tell him that you are a friend of mine, he will let you unscrew every piece of apparatus in the place." Poor Matthiessen came to a sad end, for he poisoned himself with hydrocyanic acid years afterwards at Bart's, where he became Professor of chemistry and where he was succeeded by Russell. He was scientific up to the last, and drank the poison mixed with soda water, so that death came to him easily as in sleep.

Most of us were soon working at original research, and the number of interesting papers which were published from that laboratory during the first five years of Bunsen's appointment in Heidelberg

was something extraordinary. But, not satisfied with setting all these men to work on different subjects, Bunsen was always engaged on one or two researches of his own, so that the list of memoirs published during those years by Bunsen and his pupils is a long one, and their valuable matter would fill many volumes.

The stories of Bunsen's absent-mindedness, to which I have already alluded, are numerous. One of the best is the following. He was very fond of playing ombre, and one morning, as he was lying in bed, he said to his "Stiefelfuchs"—a man who comes in the morning to black your boots and brush your clothes—"Put out my dress suit, for Frau Geheimräthin Schultz has invited me to an ombre party this evening." Next morning, when Oelhäuser came again, he found the Hofrath's evening clothes exactly where he had placed them. Said he to the professor, "I see, sir, that you have never had your evening clothes on." "Good gracious," said he, "I forgot all about it. Well, never mind," and turning round he lit his cigar, as was his habit, and ruminated on his pillow. And then he remarked to himself, "I know what I'll do." That evening he put on his dress clothes, and went to the lady's house at the appointed time, and walked in as if it were the day upon which he had been invited. The Frau Geheimräthin, much too polite to tell him that he had mistaken the evening, and that the party had taken place on the previous night, sent out to her friends to say Professor Bunsen had arrived unexpectedly, and would they come in to play a rubber again? And so the party was made up. In the course of the evening the conversation turned on absent-mindedness, and Bunsen began to tell them what had happened to him a long time ago—how that he had forgotten an invitation, and how he had made up his mind to go

vacations in the years 1859–62 in working with Bunsen on photometrical measurements; and the results were printed in German in Poggendorf's *Annalen* and in the *Philosophical Transactions* in English. An appreciative reference was made to these researches by Ostwald in an appendix to his reprint in his *Collection of Scientific Classics.*

"The Photo-Chemical researches of Bunsen and Roscoe deserve the name of a classical investigation, as they not only have gathered together all points known hitherto on the subject, but by their wide and thorough experiments have laid the foundation for all further work on the subject. It cannot be doubted that these researches not only serve as *a* classical, but as *the* classical type for all future experimental work on the subject of Physical Chemistry.

"In no other research in this domain of science," he adds, "do we find exhibited such an amount of chemical, physical, and mathematical dexterity, of ability in devising experiments, of patience and perseverance in carrying them out, of attention given to the minutest detail, or of breadth of view as applied to the grander meteorological and cosmical phenomena of nature."

In this connection the following (translated) letter from Bunsen is of interest. It requires a word or two of explanation. On my return to England from Heidelberg for the Christmas holidays, 1855–6, I heard for the first time of Draper's previous work on a chlorine and hydrogen "tithonometer," and, somewhat downcast by this discovery, I wrote to Bunsen on the subject. His wise and encouraging words put new heart into me, and I returned to work at Heidelberg determined to do my best to prove equal to the task that lay before me.

HEIDELBERG, 13*th January*, 1856.

MY DEAR ROSCOE,

I think that Draper's experiments will not require to be repeated by us any more than Witwer's. Independently of much that appears to me to be inexplicable in them, the

pressure to which the luting liquid saturated with H and Cl is subjected constantly changes. I therefore conclude that Draper's instruments will not indicate proportionality, &c., especially as the volume of the isolated gas is so small compared with that of the luting liquid. At any rate I see no grounds for interrupting our experiments; still less do I consider that it is a misfortune that the results which we have obtained should have been to some extent previously described by him. It appears to me that the value of an investigation is not to be measured by whether something is described in it for the first time, but rather by what means and methods a fact is proved beyond doubt or cavil, and in this respect I think that Draper has left plenty for us to do. Do not, therefore, let your discovery of Draper's work disconcert you. I am now busy getting my *Eudiometry*[1] ready for press, and I hope by Easter to have made an end of it. My best greetings to Williamson, in hearty friendship.

Yours,

R. W. BUNSEN.

I naturally enjoyed greatly the close personal relationship with Bunsen which this work brought with it. A special room in the laboratory was assigned to me for carrying it on, and as the apparatus required supervision in the night, a bedroom was set apart for me in his house. It is almost needless for me to remark that without Bunsen's advice, assistance, and co-operation I should never have succeeded in obtaining the results we did; and although I carried out the experimental part of the work, the elaboration of the results was mainly due to him. Only those who have had the pleasure and the benefit of working directly with Bunsen can fully appreciate the value of his teaching and of his example, and this pleasure and benefit I had in abundance. I was usually able to get away from Manchester at the beginning of July and worked steadily in Heidelberg until the middle

[1] Translated into English by myself and published by Taylor and Walton.

or end of August, in the years from 1857 to 1862, when Bunsen and I, accompanied sometimes by Kirchhoff and sometimes by Häuser, the well-known historian, or by both of these intimate friends, made excursions into the Bavarian Highlands, the Tyrol, and Switzerland. I have often regretted that I never made notes of the incidents which occurred on these excursions, and of the humour and wit of my companions, especially of Häuser, which was a never failing source of amusement.

The years I spent at Heidelberg were among the pleasantest as well as the most fruitful of my life. Although I worked hard at my science and permitted no social engagements to interfere with the prosecution of my investigations, I fully appreciated the proverb that "all work and no play makes Jack a dull boy," and took care to enjoy my leisure hours in a variety of ways. I did not, however, join any of the "Studenten Corps," as I thought it poor fun to stand up to have one's face slashed at by a German friend or to try to do the same to him. Nor was I an adept in filling my skin with gallons of "small beer," and therefore did not frequent the "Commers," though I thoroughly enjoyed the "Frühschoppen" after a hard morning's work, and sometimes with a few choice spirits—of a chemical nature—went so far as to drink a "Salamander" to the progress of our researches.

Of exercise, beyond the "Fecht-Boden" of the Hirsch Gasse, the Heidelberg student was altogether innocent. He might walk—though he generally preferred to drive in a droschke—to some neighbouring "Bierlokal" where he imbibed his favourite beverage, and "renomaged" over his pluck when he last went "los"—that is, at his last duel. "Gestern," says one, "habe ich sechs nadeln bekommen." "Ja," replies

his friend, "aber letzte woche habe ich sieben gehabt." This practice of duelling must, I suppose, have its good side, as it is not only prevalent throughout German Universities, but shows few signs of decay, and yet it is to our English ideas a puerile form of assault, as the combatants are so protected by masks and bandages that the worst that can happen is that the cheek is cut open or the nose slashed across. No, much as we may think that our English sports are overdone, there is no shadow of doubt that the qualities of head and heart which are called forth in cricket and football go further in the making of character than does this German system of duelling, which, after all, is only practised by a fraction of the German students. The rest get no games or exercise in common of any kind, though gymnastics (turnen) takes a prominent place in German schools.

The Englishman, however, needs something of the sort to keep him going and out of mischief. So my friend the late Dr. Atkinson and myself bought an English-built skiff, the *Lady Margaret*, and, much to the astonishment of the humdrum Heidelbergers, disported ourselves—"verrückte Engländer" we were called—on the "Green Neckar," strengthening our muscles by pulling up the rapids to Neckar Gemünd, or running down the river to its mouth on the Rhine.

This brings to mind a scene which, though it happened half a century ago, is keenly impressed on my memory. One day, crossing the old bridge—the only one then—over the Neckar, I saw a young man punting up-stream in one of the native flat-bottomed boats. "That man is an Englishman," I at once exclaimed, for no young German gentleman was ever known to put himself to the trouble of punting alone up a rapid. And so it turned out, for the man was

no other than Leslie Stephen, who was staying at Heidelberg to learn the language. Soon I made his acquaintance, and this ripened into friendship which endured to the end of his life. His was a noble character, and it is a privilege, for which I am thankful, to have known such a man. My last sight of him, dying as he was by inches, was one never to be forgotten. We talked of old Heidelberg times and of our pleasant long-ago intercourse, and his eyes brightened and his voice trembled as he recalled some of its incidents.

To return to the German student, I always think that his foibles should be looked upon with an indulgent eye, and should not be allowed to overshadow his excellent qualities. He is a real good fellow and an intelligent. Quite as hard a worker as our Oxford or Cambridge average man, with more "Geist" and a far more thorough training. Whether his nine years of strict "Gymnasium" discipline have gone to make him a better man than our much more lax public-school system does for our boys is a matter about which much may be said. Of one thing I am certain: the average Eton boy could not follow as the German "Fuchs" (first year's man) does the high-class lectures on every conceivable subject, some of which he is bound to attend. This comes of his "Vorbildung" and of his appreciation of scientific method concerning which our undergraduate is, as a rule, altogether his inferior. Then the Germans with their "Lern- und Lehrfreiheit" are on the true University lines, whilst we, hidebound by examinations, are too apt to ignore, in our old system, the essential aim of all University life—the advancement of learning. That brilliant exceptions exist amongst us only proves the rule. It is in spite of, and

not by the help of, our plan of cram almost from birth to maturity, that the innate creative power of the Anglo-Saxon blood comes out. How much more might the race yield if originality were encouraged instead of being repressed and often destroyed by examination grinding, and if the freedom to teach and to study were in vogue with us as in Germany!

The oft-debated question of the tutorial *versus* the professorial system of training is one upon which I do not propose here to enter, save to call to mind that if the Universities throughout the world were asked to vote as to which system is to be preferred, only few hands would be held up for the former method against many for the latter. But, whichever system may be the favourite, one cannot help feeling that the hybrid method as practised at Oxford and Cambridge is an illogical one. Let us have one plan or the other. A friend of mine who took honours in the History Schools at Oxford told me that he never knew throughout his University career that Stubbs (one of England's great historians) lectured on history! Imagine, if you can, a German student of that subject not knowing that Häuser in Heidelberg or Treitschke in Berlin lectured on history.

Another equally intelligent friend supported the existence of University professorships by the argument that they were useful sinecures for distinguished persons!

In Heidelberg in the early 'fifties social festivities were on an old-world footing; now railways and telegraphs have modernised not only the town itself, but the manners and customs of the inhabitants. On one occasion we were invited to spend the evening with the Geheimrat, who was the Professor of Rural Economy, and what might be called a "stock"

German professor, very punctilious and precise. We sat down at table at three o'clock and never moved till ten. We began with tea and biscuits, followed by sponge cake with layers of jam, and went on with several courses and finished up with hot roast venison, the several items being washed down with wine. In those days society in Germany was of a somewhat formal character. Thus at the commencement of the proceedings all the ladies and all the gentlemen were ranged in lines on each side of the salon. An Englishman coming into the room and being presented to the ladies would naturally shake hands. This mode of salutation, however, was considered much too intimate, and in its place he had to institute a stiff bow with the feet placed in the "first position," and this to every lady in turn. The men and the ladies then kept studiously apart until the time for supper arrived.

CHAPTER IV

"BUNSENIANA" AND HEIDELBERG FRIENDS

Bunsen and Kirchhoff—Spectrum Analysis—Kelvin and Stokes—The 400th Anniversary of Heidelberg University—Bunsen Letters—Kopp—Helmholtz.

In the summer of 1855 I visited the first Paris Exhibition in company with one of my German friends. At that time there was no antagonism between the two nations. Later in the same year I attended, for the first time, the meeting of the British Association held in Glasgow. Playfair was President of the Chemical Section, and he proposed me as secretary, and introduced me to the members as a young man of promise, who might some day succeed to the sectional chair. How little at that time did I think that I should be President of the Association in Manchester in the Queen's Jubilee year. In Glasgow I read a paper containing the result of work carried on conjointly by Bunsen and myself on the action of light on chlorine water, for he had invited me to join him in the work. It was afterwards published in the Journal of the Chemical Society and in Liebig's *Annalen*. At this meeting I made the acquaintance of many English chemists, and also had the good fortune to be introduced to Liebig, whom I afterwards visited in Munich on several occasions, and from whom I received a testimonial later on when I was a candidate for the chair of Chemistry at Owens College, Manchester.

During the summer of 1860 a remarkable gathering of chemists was called together at Carlsruhe, chiefly through the instrumentality of Kekulé. This had for its object the discussion of chemical nomenclature, which at that period was in a condition of chaos. The results, though not productive of the general agreement which was hoped for, were still useful, and the meeting marked an era in the progress of scientific chemistry, inasmuch as Cannizzaro here first set forth his system of the atomic weights of the elements which has served as one of the bases of modern chemistry.

Bunsen rarely attended such meetings, and it was only by extreme pressure that he consented to go. The subject under discussion was not one in which he took much interest, and he frequently said that one new chemical fact, even an unimportant one, accurately determined, was worth a whole congress of discussion of matters of theory. I accompanied Bunsen, and we stayed under the hospitable roof of Weltzien, Professor of Chemistry at the Polytechnic School.

The more serious business of the Congress was enlivened by many amusing incidents and by the great hospitality shown by the Carlsruhers. Among the guests was old Professor Despretz, of Paris, who was most anxious, on every occasion, to air his incomplete knowledge of the German tongue. He said to Schoenbein, of Basel, who was well known to all his friends as a "Plaudertasche," or, as we term it, a chatterbox: "Sie sind kein Deutscher; Sie sind ein Schwätzer [for Schweizer]!"

It has often been remarked that Faraday was Davy's greatest discovery. With almost equal truth it may be said that Bunsen's greatest discovery was Kirchhoff. I had left Heidelberg before the scientific twin brethren

had begun their memorable work on spectrum analysis, but on returning there in the summer of 1860 I soon came into the thick of it, and translated their epoch-making memoir in Poggendorf's *Annalen* for the *Philosophical Magazine*. I shall never forget the impression made upon me by looking through Kirchhoff's magnificent spectroscope, arranged in one of the back rooms of the old building in the Hauptstrasse, which then served for the Physical Institute, as I saw the coincidence of the bright lines in the iron spectrum with the dark Frauenhofer's lines in the solar spectrum. The evidence that iron, such as we know it on this earth, is contained in the solar atmosphere, struck one instantly as conclusive. And yet not more than forty years had elapsed since Comte in his *Système*, arguing that investigators should not waste their time in attempting the impossible, used as an example of what he meant by the impossible that the knowledge of the composition of the sun at a distance of 91 millions of miles must for ever remain unattainable. Now we know the chemical composition of the solar atmosphere almost as well as we know that of our own. But who can say how much more we have yet to learn of both? It was only a day or so ago that no fewer than four elements, hitherto unknown and wholly unexpected, were discovered in the air we breathe.

One of the most successful lectures I ever gave at the Royal Institution was that which I delivered on March 1st, 1861, on "Bunsen and Kirchhoff's Spectrum Observations." It is interesting now to remember that at that time no one in England had been able to project the bright lines of the metals on the screen. I had indeed heard that an optician in Paris, Duboscq by name, had done so with a certain amount of success. I wished, however, to try, and

I asked Faraday if he would allow me the use of the large Grove's battery belonging to the Royal Institution. He sent this down to Manchester, and I remember trying with all my might in the cellars of the old Owens College to throw the image of the spectrum on the screen, but I could not manage it. So I had an accurate reproduction of the drawings which accompanied Bunsen and Kirchhoff's first paper painted on glass. The interesting thing to show was that when a mixture of the salts of the alkali- and of the alkaline-earth metals was placed in the flame, the spectra of the most volatile of these metals made their appearance first; gradually, however, these died out, and then the spectra of the less volatile became visible. This appearance and disappearance I roughly accomplished by means of two lanterns, as in ordinary dissolving views, and the phenomena were thus clearly understood by everyone present.

I may here quote a letter which I received from Sir George Stokes in answer to a question as to his share in the history of Solar Chemistry; it is interesting, as it exhibits the modesty of the man and points out clearly the facts which have since then come to light as to the part played by Stokes and Kelvin in the discovery of the coincidence of the dark solar lines with the bright lines of sodium.

LENSFIELD COTTAGE, CAMBRIDGE,
7 Feby., 1862.

DEAR MR. ROSCOE,

My share in the history of the Solar Chemistry, I look upon it, is simply *nil*; for I never published anything on the subject, and if a man's conversations with his friends are to enter into the history of a subject there is pretty nearly an end of attaching any invention or discovery to any individual.

As well as I recollect what passed between Thomson and myself about the lines was something of this nature. I mentioned to him the repetition by Miller of Cambridge of Frauenhofer's observations of the co-incidence of the dark line *D* of the solar spectrum with the bright line *D* of certain artificial flames, for example a spirit lamp with a salted wick. Miller had used such an extended spectrum that the 2 lines of *D* were seen widely apart, with 6 intermediate lines, and had made the observation with the greatest care, and had found the most perfect co-incidence. Thomson remarked that such a co-incidence could not be fortuitous, and asked me how I accounted for it. I used the mechanical illustration of vibrating strings which I recently published in the *Phil. Mag.* in connection with Foucault's experiment. Knowing that the bright line *D* was specially characteristic of Soda, and knowing too what an almost infinitesimal amount suffices to give the bright line, I always, I think, connected it with soda. I told Thomson I believed there was vapour of Sodium in the sun's atmosphere. What led me to think it was sod*ium* rather than soda, chloride of sodium, &c., was the knowledge that gases that absorb (so far as my experience went) yield solutions that absorb in the same *general* way, but without the *rapid* alternations of transparency and opacity. Now if the absorption were due to vapour of chloride of sodium we should expect that chloride of sodium and its solution would exercise a general absorption of the yellow part of the spectrum, which is not the case. Thomson asked if there were any other instances of the co-incidence of bright and dark lines, and I referred to an observation of Brewster's relative to the co-incidence of certain red lines in the spectrum of burning potassium and the lines of the group *a* of Frauenhofer. I am nearly sure this is in a volume of the reports of the British Association being analogous to but not identical with Brewster's obs^{n} in the report for 1842, pt. 2, p. 15. (Since I wrote this I have looked through the indices of the vols. of the reports of the British Association and do not find it there.) Thomson with his usual eagerness said, oh then we must find what metals produce bright lines agreeing in position with the fixed dark lines of the spectrum, or something to that effect. I was, I believe, rather disposed to rein him in as going too fast, knowing that there were terrestrial lines (seen when the sun is low) which evidently take their origin in terrestrial atmospheric absorption where metals are out of the question, and thinking it probable that a large number of lines in the solar spectrum might owe their

origin to gaseous absorption of a similar character in the solar atmosphere. Even now I think it likely that some of the non-terrestrial lines in the solar spectrum may be of this character, though after what Bunsen and Kirchhoff have done I think it probable they are a minority.

The idea of connecting the bright and dark lines *by the theory of exchanges* had never occurred to me, and I was greatly struck with it when I first saw it, which was in a paper of Balfour Stewart's read before the Royal Society and printed in the Proceedings. I was wrong in saying *lines*, for B. Stewart considers only solids, the spectra of which don't present such abrupt changes. Stewart's paper was independent of, but a little subsequent to, Kirchhoff's, though the same idea with reference to radiant heat occurs in two papers of his printed in the Edin. Phil. Trans. and much anterior to Kirchhoff's paper. These papers I was not acquainted with at the time when Stewart's paper on light came before the R.S.

We can by no means affirm from the theory of exchanges that every dark line in the solar spectrum must be capable of reversion. For it may be due to absorption by a compound gas which is incapable of existing un-decomposed at the temperature requisite for becoming luminous, or which though not decomposed might yet have its mode of absorption completely changed, as we know that even a small elevation of temperature is sufficient materially to alter the absorption of light by NO_4 gas.

As to the mention of the metallic lines in the invisible region, I own to feeling a wish that the subject may be novel when I bring it forward, and yet I can't help feeling that that is mere selfishness and that I have no business to keep it bottled up. When are your lectures to be given? If not for some time perhaps I may draw up a note for the Royal Society for publication in the Proceedings which would of course set you quite free.

Yours very truly,

G. G. STOKES.

In 1862 I induced Bunsen and Kirchhoff to visit England. Kirchhoff had never done so, and Bunsen only some thirty years before, when, as a young man, Playfair took him to Alfreton to analyse, as already stated, the gases of the blast furnaces. I here

Emery Walker, Ph. Sc.

R. W. Bunsen, G. Kirchhoff, and H. E. Roscoe
1862

reproduce a photograph of Bunsen, Kirchhoff and myself, taken in Manchester in the above year.

During their stay in London we visited the Exhibition of that year and saw some of the usual sights of the metropolis, and I remember we attended a garden-party given by Mr. Gassiot, who lived in a large house at Clapham. It was a lovely day, and my two friends were very much struck with the beauty of an English garden; Faraday was there, and I introduced them to him. It was on this occasion that a lady, mistaking the chemist for the Chevalier Bunsen, addressed to him the question: "Pray, sir, have you not yet finished your great work on 'God and History'?" "Alas, no, madam," replied the chemist; "my untimely death prevented me from completing my task."

Of course Sir Charles Wheatstone invited us to visit him, and he talked with his usual emphasis about his own discoveries. Bunsen was much amused, and afterwards, when we were staying at Wastwater, at the Lakes, he fancied he saw a strong resemblance between Mrs. Ritson, the landlady, and Sir Charles, and remembered the place for years, often referring to "Frau Wheatstone" and the tame fox which was kept in the yard.

A characteristic episode occurred at Rugby, where my friends had promised to visit Mr. Charles Arnold, one of the Rugby masters, who had married a Heidelberg lady. Mr. Arnold had arranged for us to stay with him on Saturday night, and we were to go to my house in Manchester on the Sunday, as I had invited Dr. Joule, Professor Clifton, and other scientific friends to meet them. On the Saturday, Mr. Arnold said to me: "Oh, your friends will certainly stop over service to-morrow." I said I didn't know

and would ask them, and upon informing them that they were expected to attend service in the morning, they both expressed great unwillingness to do so, Bunsen saying that he had not been inside a church for seven years, the last time being at the marriage of his niece, and that he really didn't know how to behave! So I told Mr. Arnold that I was afraid we should not be able to manage it, as I had invited people in Manchester to meet my friends. Mr. Arnold, to my dismay, then said: "I have arranged it all; you can get out of chapel before the communion service, and so you will be able to catch your train." I then went to my friends and told them in German that there was no getting out of it, that they would have to attend service in the morning, and that they must make up their minds to it. So next day, to my great amusement, Bunsen appeared in a costume he very seldom indulged in, tail-coat, white tie, &c., &c., and on his hands a large pair of white kid gloves, and thus arrayed he accompanied us to chapel. The sight in the chapel at Rugby of all the boys in surplices is certainly a very interesting one, and my German friends were much impressed, Bunsen saying to Kirchhoff afterwards, "Do you know, I really felt quite devout." "Oh, nonsense," said Kirchhoff; "you were only sleepy."

Kirchhoff was, by common consent, one of the first scientific minds in Germany. He remained at Heidelberg until 1875, when he became Professor of Theoretical Physics in the University of Berlin. For many years he had not been strong, and had to go on crutches for some time in consequence of an injury to his foot. He died at Berlin in October 1886.

Bunsen had an irrepressible dislike to having his portrait painted, though he did not mind being photo-

graphed. Many years afterwards, my friend Dr. Mond was very anxious to have a good oil-painting of Bunsen, and he therefore commissioned Mr. Hans Schadow to go to Heidelberg and see whether he could paint his portrait without a formal sitting and without Bunsen's knowledge; and so the painter went, and, being well known to several of Bunsen's friends, he arranged with them that he should dine at the Grand Hotel at the same table where Bunsen usually had his midday meal. Whilst Bunsen was engaged in lively conversation he narrowly observed him and secretly made sketches on his knee of his various expressions, and from these he painted a likeness of the old man.

From 1857, on my appointment in Manchester, to 1863, the year of my marriage, I invariably spent the long vacation working with Bunsen at Heidelberg; the chief result of such work was the publication of the photo-chemical researches already referred to. I followed up these investigations in subsequent years, describing an automatic arrangement for registering the chemical action of light by the blackening of standard silver paper. A form of the apparatus designed for meteorological purposes was made for me by Horace Darwin, of Cambridge. A description of the method was published in the *Philosophical Transactions* (Bakerian Lecture, 1865); it worked extremely well, but has not yet been generally adopted in observatories, as I had hoped it would be.

In the year 1886 the eighth Jubilee of the foundation of Heidelberg University 400 years before was celebrated, and I was invited to be present and was one of the few to whom an honorary degree (in my case M.D.) was given. The festivities were of an unusually interesting character. Processions illustrating striking events

in the history of the University were got up with characteristic German accuracy. The Castle was, of course, illuminated, and a reception was held in one of the Castle halls by the Grand Duke. To this Bunsen and myself were invited, but he expressed great unwillingness to put on his gala costume with his orders pinned on to his coat, but at my serious insistence he agreed to accompany me. As we walked up to the Castle, as luck would have it, the Royal carriage containing the Grand Duke and Duchess and her brother the Prince Frederic of Prussia could not get through the crowd and came to a stand directly at the point which Bunsen and I had reached. He, of course, was at once recognised and addressed by the Grand-Ducal party, a *rencontre* which my friend especially wished to avoid.

On another day I had the honour of being introduced to the Prince of Prussia and had a long conversation with him in English. He was, as all the world knows, a man of splendid presence and also of great geniality and simplicity. I noticed that his hand was bound up, and on inquiring the cause he replied, "Oh yes, a little accident occurred to me the other day ; a box of matches exploded in my hand and burnt me slightly,"—treating the whole matter as a mere triviality.

Among other incidents which occurred on that occasion I remember that the formal oration was given by Professor Kuno Fischer before the Grand-Ducal party in the large Protestant church in the Hauptstrasse. The temperature being high and the address very long and tedious, the effect upon the audience was, as might be expected, soporific. Bunsen lapsed into a calm state of unconsciousness, but on a more than usually impressive sentence disturbing his rest he

whispered to me, "I was dreaming that I had let a test-tube full of cæsium fall on the floor."

Concerning the preparations for the Jubilee and the invitation to me to take part in it, the following translation of two characteristic letters from Professor Kopp is of interest :—

Our University has had many difficulties over the invitations to this Jubilee to other Universities and Academies, to former Professors of this University and also to high State and Court officials (I have called the Jubilee week August 2–7 the Passion-Week and "I wish it was time to sleep and all was well"), in trying to cut down the number of representatives of these corporations (all are to be guests of honour and are to stay with members of the University), and also in trying to find room for them at the banquet (we have no room in Heidelberg large enough, and there are many reasons for its not taking place in "Noah's Ark"—a huge place which has just been put up as a "hall of ceremonies" on the Neckar, and where many can get light refreshments, though it is unsuitable for the banquet). On these accounts the invitations abroad had to be limited to the smallest number of Universities and Academies—in most cases one for each country. And I hear from the latest reports that the Victoria University will not be included. But you, old Heidelberg student, if you come to the celebrations you will not only give intense pleasure to all your friends here but I will also guarantee all the necessaries of life so that you can encounter the "struggle for existence." Everyone's wants on those days—even those of the inhabitants—will have to be modest; *à la guerre comme à la guerre.* I shall have to manage as best as I can *en garçon*; for my wife will go to Freiburg to our daughter there—I would not have her here at that time on any account.

Bunsen is well, as busy as usual with lectures and in the laboratory, and sends you his love. My wife sends you her kindest regards.

Your devoted

HERMANN KOPP.

Couldn't you come as F.R.S.? So far as I know, this Society will be asked to send one representative. If not come as (I nearly wrote "Good old") Roscoe!

On the same occasion it was proposed by myself and others to honour Bunsen by a dinner given to him by his former students who were present at the Jubilee, an invitation which he was unable to accept.

HEIDELBERG, *June 27th*, 1886.

DEAR FRIEND,

I will not put off answering your letter received yesterday. Bunsen's health is as good as we can expect at his age. With regard to the dinner which his former students intended to give him, he quite understands how much honour, attachment, and thanks they wish to show him, but, owing to the necessary fatigue entailed by the Jubilee week at which he will have constantly to be present, he fears he cannot name a day to set aside for this dinner. If he will feel strong enough after the Jubilee is over to attend the banquet proposed by his pupils, I cannot of course say, but I think it is better for me to explain matters a little. At Bunsen's age, naturally, he often speaks of retiring from his profession, particularly when he is not feeling well or if any difficulties arise. Were he really to carry this out I should deem it not only as very serious for science in general and a calamity for our University but also as very critical for Bunsen himself, for if he no longer had his former employment, old age would creep on much more quickly. By keeping on old occupations one preserves something of one's youth and repulses thereby the march of time. Bunsen will retain his activity all the longer the more regular his life is and the less interruption of any sort he has to undergo. I think you will agree with me in this matter and that it will be best for us to wait until the end of the Jubilee week to see how he is; if then he feels well enough he could have a special gathering of his former students who will be here then.

Your faithful

HERMANN KOPP.

At a later time, after he had retired into private life (1889), I was not infrequently a guest at his house in "Bunsen Strasse," when we fought our battles o'er again and I recounted to him things which had taken place in England. Above all he was interested in murder cases, of which in England we had about that

time some startling examples, and these I would tell him in great detail. The interest which he took in these cases was in no degree due to a morbid seeking after horrors, but entirely to scientific appreciation of the value and trend of evidence. It was in reading trials such as that of Palmer, where conviction was obtained in spite of the fact that no poison was found on the body, or that of Madeleine Smith, where the verdict was given of non-proven although death from antimonial poisoning was ascertained, that Bunsen found relaxation. He was also an omnivorous reader of light literature; his table was loaded with books sent in on approbation from the "Museum" Library, and he easily judged of their contents without cutting them open.

Although he was, in his latter years, unable to walk far, as had been his habit formerly, he enjoyed the beauties of mountain and forest as keenly as ever, driving through the chestnut woods which extend to the Königsstuhl.

Gradually failing in strength and health, but always, as he once wrote to me, "able to enjoy the humour of life," he peacefully breathed his last on August 16th, 1899. A singularly touching portrait of Bunsen in his later life faces this page.

The obituary notices which appeared in the Press did him, I think, justice both as an investigator and as a true and noble-hearted man. It naturally fell to my lot to write some of them; and in the *Times* on the morning following his death, and in *Nature* of August 31st, 1899, I was able to give sketches of the man and his work. I wrote similar notices for the Royal Society; and, lastly, I gave a more complete account of him in a Memorial Lecture read before the Chemical Society, of which he had

long been a Foreign Member. In this memoir I endeavoured to give not only an account of his scientific achievements, but to picture the man as he lived and worked; and I venture to think that my endeavour to honour the memory of my great friend was not unsuccessful, as the memoir was not only reprinted in America by the Smithsonian Institute and by this means widely circulated, but was translated into German by Professor Ostwald, and then placed as a preface to the collection of the works of the great master which was published by the Society in Germany founded in his honour and called "Deutsche Bunsen-Gesellschaft für Angewandte Physikalische Chemie."

During the long period over which our friendship extended, I received from Bunsen a large number of letters containing not merely matters relating to our investigations, but to incidents in connection with his own. Especially touching to me were the constant expressions of esteem and affection which they contained. I quote only five of the 126 letters which he sent me.

Feeling that these letters ought in some way to be carefully preserved, and knowing that Bunsen had expressed objection to the publication of his correspondence, I offered them to the President of the Bunsen-Gesellschaft for safe keeping. This offer was thankfully received. I had the letters carefully bound, through the kindness of Sir Edward Maunde Thompson, by the binders of the British Museum, and a very handsome volume they made. Thus the letters will be preserved for ever by the Society which honours itself by taking Bunsen's name.

The letter of which the following is a translation was printed in facsimile in my Bunsen Memorial

Lecture given before the Chemical Society. It is of special interest as it is the first communication of the discovery of spectrum analysis by Bunsen and Kirchhoff. It also gives an idea of the way in which he and I worked together in our photo-chemical researches.

HEIDELBERG,

November 13th, 1869.

My best thanks, dear Roscoe, for your last letter. Your induction experiments appear to me to be very important and interesting. From our former experiments I consider it certain that considerable induction takes place with our rotating disc, and from further experiments which I have made since then I have obtained the same results by exposing the paper on its reverse side; whilst according to my last experiment the duration of the insolation as compared with that when the light is cut off lasts frequently from $\frac{1}{500}$ to 20 seconds. If we assume that the induction in the case of the chloride of silver paper passes off very quickly, this would not be noticed in your experiments, whilst with the rotating disc it would become visible. A new apparatus about which I wrote to you will do all that we hoped. Unfortunately the weather is not favourable for me to make experiments; but I hope at Christmas or Easter to have obtained results for which we have so long striven. At the moment I am occupied by an investigation with Kirchhoff which does not allow us to sleep. Kirchhoff has made a totally unexpected discovery, inasmuch as he has found out the cause for the dark lines in the solar spectrum and can produce these lines artificially intensified both in the solar spectrum and in the continuous spectrum of a flame, their position being identical with that of Frauenhofer's lines. Hence the path is opened for the determination of the chemical composition of the sun and the fixed stars with the same certainty that we can detect chloride of strontium, &c., by our ordinary reagents. By this method the chemical elements occurring upon the earth may also be detected and separated with the same degree of accuracy as upon the sun; for example:—In 20 grams of sea-water the presence of lithium can be shown. In the detection of many elements this method is to be preferred to all previously known processes. A mixture contains Li Ka Na Ba Sr Ca; all that is necessary is to bring a milligram of this mixture into

our apparatus in order at once, by help of a telescope, to read off the presence of all these bodies by a simple observation. Certain of these reactions are of a marvellous degree of delicacy; thus, for example, one can detect $\frac{5}{1000}$ part of a milligram of lithium with the greatest ease. I have myself observed the presence of this body in almost all specimens of potash.

Your

R. W. BUNSEN.

The following letters describe two most unfortunate events. The first refers to an explosion by which Bunsen was seriously burnt; the second gives an account of a singular incident which befell him, reminding one of the well-known accident which happened to Isaac Newton, only in this case it was the sun's rays shining through a globular water-bottle instead of the dog Diamond that brought it about. The first accident was the occasion of a remarkable outburst of enthusiasm on the part of the Heidelberg students. It was reported that Bunsen had lost his eyesight. Next morning the whole of the Wrede Platz in front of the house of their beloved teacher was crammed with an anxious crowd awaiting the report of the doctor, and when he appeared on the balcony and stated that no serious damage had been done, the shout of joy which rent the air was one not to be forgotten. In the evening the "boys" gave Bunsen a "Fackel-Zug" and sang "Gaudeamus Igitur" under his window.

HEIDELBERG,

May 24th, 1869.

MY DEAR ROSCOE,

It is still rather difficult for me to write as my hands are not quite healed, but I cannot delay any longer my answer to your friendly sympathetic letter, as I do not wish you to be uneasy about me. The cause of the explosion is to me still quite inexplicable. I had prepared

about a pound of a mixture of metallic rhodium and iridium by reduction with zinc according to a method which I have described, and dried it on a water-bath to 100° C. On lightly touching the finely divided metals, not yet quite cold, with my finger, the whole mass exploded as rammed-in powder does; and this is all the more puzzling, as I have often rubbed the same sort of powder violently in a mortar in similar quantities from other platinum residues entirely without danger, and heated similar preparations of this kind red-hot in vacuo without any gas being given out, and certainly no hydrogen gas. My left hand, with the first finger of which I touched the mass, saved my eyes, as my face and eyes were only superficially burned by the flames which penetrated through my fingers. My eyes are now unhurt, with the exception of singed eyebrows and eyelashes, and so the whole explosion will leave no serious results behind. I have begun my lectures again.

I have not read anything for a long time with so much pleasure and satisfaction as your interesting lectures, and I am looking forward very much to the continuation and to the whole, which you are going to send to me and Kirchhoff—who, by the way, sends kind remembrances. I am convinced that the Vieweg translation will shortly be out of print. Kirchhoff was very much pleased with the new and astonishing sun observations. When you come in the summer—and we are delighted at the idea of seeing you—you must give us more detailed information verbally about these interesting discoveries.

Heartily yours,

R. W. BUNSEN.

HEIDELBERG,

June 3rd, 1874.

MY DEAR ROSCOE,

You have good cause to be very angry with me, *i.e.* for only answering your friendly and sympathetic letter; but I have lately not dared to think of anything which would remind me of the loss of my burnt researches, and was under the impression that I had written to you and thanked you for your sympathy, when in fact your friendly letter lay still unanswered underneath my papers.

I was about to collate experiments on which I had been working for nearly three years, before despatching the fair copy to Poggendorf for publication. On my return after a

short absence, I found all these papers, which had caught fire, a glowing heap of ashes. The photographs of the apparatus, and the drawings of all the spark-spectra, namely, those of the rarer earths, to separate which had cost me untold trouble —all, all burnt!

Yours ever,
R. W. BUNSEN.

To conclude the subject of Bunsen, I am pleased to be able to add the following picturesque description by my friend Thorpe of his introduction to the master :—

MY DEAR ROSCOE,

You are good enough to ask me to tell the story of my first acquaintance with Bunsen. I well remember the circumstances. Indeed, thanks to your good offices, I look back upon the years I spent in the Heidelberg laboratory, in close association with that great man, as one of the most precious memories of my life. You may remember you sent me to Heidelberg with a scholarship awarded on your recommendation by the trustees of the old place in Quay Street, and for which I can never be sufficiently grateful, for it meant everything to me at that time. I had tried my 'prentice hand at a little bit of research—carbonic acid in sea-air—and you had the temerity to believe that with encouragement and assistance I might do better. Years afterwards I learned from our old friend Mr. Aston, the legal adviser of the College, that the award of that scholarship settled a constitutional question: it brought the Atlantic Ocean within the purview and jurisdiction of the Council.

Well, in the autumn of '67 I set out for Germany, fortified with much good advice, and the bearer of sundry presents from you and yours to Bunsen—among them a copy of the *Times* containing an account of a "horrid murder" (you remember the dear old man's amiable weakness for "horrid murders"), a small consignment—I think from Mrs. Roscoe, your mother—of potted shrimps (another amiable weakness), and above all some magnificent specimens of potassium and sodium (calculated to go straight to his heart) from Mather's works at Patricroft. Sonstadt had worked out Caron's process for the manufacture of magnesium, and there was what we then considered a great demand for the metals of the alkalis.[1]

[1] Sodium is now manufactured electrolytically to the amount of many thousands of tons annually.—(H.E.R.)

After a leisurely journey up the Rhine—I remember seeing the white-coated Croats in garrison at Mayence—I found myself in Heidelberg and lost no time in presenting myself to Bunsen, armed with the copy of the *Times*, the potted shrimps, and the precious box containing the alkali metals. Although it was still vacation time Bunsen had returned to work. I was ushered into the little room you know so well overlooking the Wrede Platz. The great man—great physically as well as intellectually—rose from the table at which he was writing—I see him now—and motioned me to the sofa. He evidently was not unprepared for my coming—I suppose you must have informed him. I duly presented your letter of introduction and, after answering his many tender inquiries concerning you, moved up my heavy battalions. I received a momentary check, however, for, owing partly to his slight deafness but much more to my imperfect knowledge of German, he moved across to the sofa the better to hear me, and sat down on my hat! I at once brought the *Times*, the potted shrimps, and the alkali metals into action. The "horrid murder" he would read at bedtime: the potted shrimps would certainly be appreciated in the morning: and we prepared ourselves for the alkali metals. The servant was called to unpack the box, when to my consternation he produced a bottle—I remember it was an old pickle-bottle—partially filled with naphtha, at the bottom of which were a few tablespoonfuls of a bright shining and rather mobile fluid. I had given the Geheimrath such a glowing account of the size of the sticks of the two metals that I was simply speechless with astonishment and felt indeed rather like an impostor. I had never realised so vividly before the possibility of the transmutation of metals. "Well," I said at last, "potassium and sodium were certainly put into the bottle before I left home, but what is there now is uncommonly like quicksilver." "No," said Bunsen, who was holding the bottle, "it is not quicksilver. Feel the weight of it!" The fact was that our old friend Heywood, who had been ordered by you to pack the specimens at the time in separate bottles, perceiving that both could be got into one bottle, had, with the charitable idea of not encumbering me with too bulky a package, placed the two metals together with the untoward result I have indicated. Chemical combination between solids is not of very frequent occurrence, but that it is possible under certain circumstances has never been forgotten by me. I had no knowledge at the time of the existence of this fluid alloy—nor had Bunsen—which, perhaps,

is not very creditable to us since it is actually mentioned by Davy. As an historical fact I believe the first so-called potassium isolated by Davy was fluid at ordinary temperatures owing to the amount of soda in the electrolysed potash. I still recall Bunsen tilting the bottle back and fro to observe the flow of the shining mobile fluid. (A few days afterwards he told me all that was then known of this fluid alloy and referred me to Gmelin's *Handbuch*.) I assure you I felt a little limp at the moment—more limp, indeed, than my crushed hat—and, the conversation flagging, he suggested that he should show me the place where he intended that I should work. It was in his own little laboratory, a couple of benches away from him, and where I had as companions Victor Meyer and an American—Gideon Moore—a man of extraordinary ability, who had the misfortune to be stone-deaf but who taught himself German and spoke it fluently without having heard a sound of the language.

We then passed into the lecture-theatre, and, stepping across the room, he pointed to a picture on the walls. It was a plate from the *Phil. Trans.*—the curves of the chemical intensity of daylight, which I had measured for you in Portugal, or in the Brazils—I forget which. This he had caused to be framed, and placed in the lecture-room. I felt that after all I had not lived in vain.

I could run on interminably with my reminiscences of "Papa" Bunsen, as we affectionately termed him. How affectionately we, and not only his own students but the whole University, regarded him may be illustrated by the following incident of which I was witness. It was during my time in Heidelberg that Bunsen experienced the explosion which nearly cost him the sight of his remaining eye. It occurred at night time when he was alone in the laboratory, and was probably due to the escape of occluded hydrogen from a large quantity of reduced mixed platinum metals over which he incautiously held a lighted taper. Next morning the rumour ran round the town that Bunsen was blinded, and the Wrede Platz was packed with students and burghers anxiously inquiring if the news were true. No certain information could be gained, and the crowd swayed backwards and forwards throughout the day waiting for tidings. It was late in the afternoon before a proper examination could be made, when it was discovered that the eye was safe. Friedrich, the surgeon, promptly stepped out on to the balcony to announce the fact, when the air was simply rent with huzzas, caps went up, men embraced each other, women wept. Such a scene I

never witnessed before, nor have I seen the like of it since. If the cheers reached the darkened room in which the dear old man was sitting—as indeed they must, for the noise was terrific—he must have gathered how strong was the hold he had on the affections of the whole place.

Working literally side by side with Bunsen, I naturally saw much of him. Although our teacher, he was to all intents and purposes as much a student as the merest tyro. He had no more bench-room than anybody else, and was subject to the same disciplinary rules as the others, paying up his kreutzers with an affectation of dismay when caught wasting the gas, or leaving the balance case open, or committing any other of the one-and-twenty cardinal sins by which, when discovered, we supported the library.

Of his almost paternal interest and kindness to me I could give many instances, but one must suffice. The day came when I was to be indoctrinated into the art and mystery of gasometric analysis—Bunsen's gasometric analysis—and by Bunsen himself. It was a red-letter day, and I determined to mark it by purchasing the finest eudiometer Desaga stocked. With his help I picked out the longest, straightest, and widest in the shop, and returned in triumph with it to the laboratory. As I passed through the swing door I came upon Bunsen, who asked me what I had got. I showed him the instrument: it met with his approval, but, taking my hand, he showed me to his own amusement but to my consternation and disgust that my thumb could not possibly close it. He then proved to me with what ease he himself could close it: his right thumb indeed by constant use was like a pad, and to my astonishment much larger and wider than that of the left hand. I am afraid I must have looked, as I felt, rather foolish and chap-fallen as I gazed on my incompetent digit. But he sought to cheer me with the remark: "Sie mussen recht viel arbeiten und es wird grosser werden." I regret to say, however, that I never succeeded in closing that eudiometer as Desaga sold it to me.

On another occasion I had a *rencontre* with Bunsen in which I scored a little better. It was at the time of my examination for the doctorate. As was his habit, he led off with some simple easy question. He asked me how many oxides of nitrogen there were. I have a nebulous sort of notion that I fancied at the time such a question was almost an insult to my intelligence. I promptly gave him the number. He demurred to there being five. I felt at a loss what to say until, glancing at Kopp sitting in the rectorial chair—

in which, by the way, he seemed to be but faintly visible—I got an encouraging nod. I reiterated my belief as to the number. I was then called upon to name them. When I came to the last, Bunsen expressed his incredulity as to its existence. Something in my look must have impressed Kopp, for when I looked again at him the nods were more emphatic than ever. You know how in moments of peril one's senses are quickened and the faculty of recollection is sharpened. Such a moment had come to me, and luckily I was equal to it. Some time before I left for Heidelberg you had expressed a wish to repeat Deville's work on nitrogen pentoxide—I don't think we called it nitrogen pentoxide in those days—and bade me get the subject up, which I did. Although I had not seen the paper for some years, the whole matter now came back to me with perfect distinctness. I could visualise the pages in the *Annales de Chimie* where the memoir was. I seemed to see the title and the number of lines below it, and I mentally unfolded the plate on which the apparatus needed is figured. I quickly got to work, and I think it was soon evident to the rest of the Faculty, most of whom—Kopp excepted—probably knew nothing whatever about the matter, that I had good reason for the faith that was in me. Bunsen appeared to be genuinely interested, and when I had finished, amidst a shower of approving nods from the dear old Pro-Rector, he wound up by asking who was the discoverer of the wonderful compound I had described. "Henri Etienne Saint-Claire Deville," I answered. "Oh! a Frenchman!" he cried. Whereupon the whole Faculty laughed in chorus, Bunsen included. Although I seemed to myself to "romp in" apparently an easy winner, I had and still have a suspicion that the shrewd old man, with artful simplicity, was "pulling my leg" all the time.

The last occasion I saw Bunsen was after a visit to Stockholm, where Pettersson and Arrhenius had shown me the laboratory of Berzelius, restored as far as practicable by the pious care of the librarian of the Academy. It was most interesting to me to look over the specimens—a sample of Wöhler's synthetic urea, racemic acid, the vanadium specimens, bits of selenium, &c., and to see the old apparatus. Bunsen had then retired, and I found him a cheerless, solitary man, unable to read, and physically very feeble. I gave him an account of what I had seen. "But the place was only a kitchen!" he exclaimed. "Yes, but such a kitchen! There was never a kitchen like it,"—with which

he agreed. And then I told him I had discovered a water-colour drawing of Old Anna in a curiosity shop in Stockholm, which Arrhenius forbade me, for the honour of his country, to take away. Whereat he smiled. And then he began to talk of old times. We had had, or were about to have, the Jubilee dinner of the Presidents of the Chemical Society, and he spoke of Playfair, and of the first Mrs. Playfair—a memory I did not probe—and seemed tickled with the picture he conjured up of the little Red Lyon in a very big wig. He apparently imagined that the Chairman of Committees is arrayed in all the Speaker's glory. We had a delightful half-hour, and it was pleasant to see how he seemed to glow once more with the old bright smile that we know so well. I rose to go, and, expressing my pleasure at finding him as he was, said I hoped to see him again before very long. He took my hand between his. "No," he said, "you will see me no more." And so it proved. I had looked upon him for the last time.

Yours very truly,

T. E. THORPE.

On looking back upon the life and interests I had in Heidelberg, I do not think that such a time existed there before, or has done since. Such distinguished friends as Helmholtz, Bunsen, Kirchhoff, Kœnigsberger, and Quincke as men of science, and I may add Haüser and Vangerow as men of letters, besides eminent representatives of other professions, will never meet together again.

Amongst these great men the figure of Helmholtz stands out pre-eminent. To use the words with which as President I welcomed him as Faraday Lecturer to the Chemical Society, "eminent as an anatomist, as a physiologist, as a physicist, as a mathematician, and as a philosopher, we chemists are now about to claim him as our own."

The title of the lecture was "On the Modern Development of Faraday's Conception of Electricity" and the lecture may truly be said to have been a

turning-point in the history of the subject and to have laid the foundation of our present ideas of the theory of electrolysis.

The following letters (translated) from Helmholtz indicate the great amount of trouble which he took in connection with this lecture :—

November 21st, 1880.

HONOURED FRIEND,

I am quite ready to give the Faraday Lecture for 1881 if it can be arranged to take place between the 15th March and the 22nd April. Of late I have been working partly upon electrolysis and partly upon electro-dynamics, more or less on Faraday's lines, and I will try how much of this I can make suitable for chemists without becoming too abstract.

I saw our old friend in Heidelberg in September. He was well and happy, although he speaks about wishing to retire.

My kindest regards to your wife.

Yours,

H. HELMHOLTZ.

January 3rd, 1881.

HONOURED FRIEND,

If the Council of the Chemical Society already wish to publish the title of my Faraday Lecture, I think of calling it something like this : "The Modern Development of Faraday's Ideas on Electricity." Can you think of a better English expression for it? (*Die neuere Entwickelung von Faraday's Vorstellungen vom Wesen der Elektricität*). If so, please suggest it. I will write my address in English. If you will then kindly take the trouble to read it through and correct all that does not please you, I should be very grateful to you. I do not as yet know how far I dare attempt to perform experiments. In a strange place with strange apparatus it is always risky. Besides that, Professor Tyndall writes me that there will only be an hour between the closing of the last lecture and the beginning of mine, and therefore that would give but little time for preparation. The phenomena of which I shall have to speak are undoubtedly known to most chemists, and I shall probably only have to set out the apparatus in order to explain what I mean shortly and quickly.

Many thanks for your friendly invitation to stop with you. I accept for myself with great pleasure; my wife has not quite decided yet what she will do.

With kindest regards to your wife,

Yours,

H. HELMHOLTZ.

PARIS (undated).

HONOURED FRIEND,

I have come safely through my expedition in England, Ireland, and Scotland, given my lecture in Dublin, spoken at the Royal Society of Edinburgh, and ended up by staying with Sir W. Thomson. Every moment of this entire time was so filled up that I was quite unable to write the short notices necessary for the completion of the Faraday Lecture for publication. To-morrow night we go to Berlin, and will get there on Monday evening. Meanwhile the Editor of the *Journal of the Chemical Society* has sent me a copy of the present text with the request that I should revise it speedily. In any case I will send it off from Berlin if I do not find a quiet moment here to finish it off. Should it be necessary to get it through very quickly in order to insert it in the June number, I beg you to send me a post-card to Berlin to that effect. My time has been so occupied ever since my lecture at the R.I., what with preparing my next lecture and making appointments to see people, that I have had no time to get through this revision.

Once more, many and hearty thanks from my wife and myself to you both for our delightful stay with you, and for the great sacrifice of time you gave on my behalf.

In true friendship,

Yours,

H. HELMHOLTZ.

In 1861, Helmholtz married our friend Anna von Mohl, and their house in Heidelberg became the resort of all that was best and intellectual, not only there, but from all the world over. Helmholtz was certainly, taking him altogether, the most wonderful man I ever knew, and his character was as charming and simple and his heart as kind as his intellect was great. He was not merely an eminent *savant*, but a polished man

of the world, as much at home among princes and grand-dukes as he was in his laboratory among his students. Our two families became intimate, for the Helmholtzes frequently came to England and stayed either at my sister Mrs. Enfield's house in London, or with us in Manchester. Frau von Helmholtz was as charming in her way as he in his. She outlived her husband by a few years, and died on December 1st, 1899. A beautiful notice was written shortly after her death by Marie von Bunsen, grand-daughter of the Chevalier, which contains the following appreciation: "A man leaves his mark on the world by works and deeds, but a woman who neither courts publicity nor attempts authorship cannot acquire fame, and yet Anna von Helmholtz may truly be said to be one of the most remarkable of German women."

Frau von Helmholtz had a highly sensitive and active temperament. I remember that on the morning of the day on which he was to deliver the Faraday Lecture she came down to breakfast and amused us by saying that she had been so nervous about the success of his lecture that she felt in the night as if she should die; upon which he remarked in his calm, equable manner, "Ach, dass geht nicht so schnell."

Helmholtz was a very temperate man; he never smoked, and I remember his saying that he found that the smallest quantity of alcohol dispelled from his mind "all his good ideas," as he used to express it, by which he meant that if any great problem had to be thought out, this was only possible when his brain was free from alcoholic taint.

Apropos of this, one of the most interesting facts about the human body is its power of accommodation as well as its sensitiveness to stimulant. Think of the quantity of laudanum De Quincey used to take

with impunity; and on the other hand Bunsen, who was a great smoker, could not drink tea. He used to say that if he drank a cup of tea even at breakfast, and certainly in the evening, it would keep him awake during the whole night. Again, one has seen many men who would be completely upset by smoking a cigar, who yet, like Johnson, would drink any number of cups of strong tea at night and sleep well afterwards.

Another instance of the accommodating power of the human body occurred to me many years ago (1861). I investigated the question of the alleged power exhibited by the Styrian peasants to eat arsenic. This was laughed to scorn by Dr. Alfred Taylor in his well known book on Toxicology, but it turned out to be perfectly true. I obtained evidence through my friend Pebal, who was professor at Gratz, which not only satisfied me, but everyone who took the trouble to go into the question, that the peasants in Styria are able to swallow with impunity four times the amount of what is usually a fatal dose of white arsenic. I obtained a sample of the materials used by these peasants—they call it "Hidrach," which is a corruption of "Hüttenrauch," thus showing the origin of the material—and it turned out to be pure arsenious oxide. The object of their taking arsenic is said to be to preserve their wind in carrying loads up the mountains. Whether it did so or not I do not know, but any doctor who prescribed four grains of arsenic would very soon be brought up for manslaughter if not for murder; and yet those peasants took that quantity with impunity.[1]

[1] Micro-organisms can also, like macro-organisms, be gradually accustomed to doses which are absolutely bactericidal to the same species when not so acclimatised, and the ready acclimatisation of bacteria to poisons is now generally admitted (Metchnikoff).

To return to Helmholtz. When I was last in Heidelberg I had an interesting conversation about him with Koenigsberger, the well-known Professor of Mathematics. They had been on most intimate terms. Koenigsberger had just written a most valuable and elaborate *nécrologe* of his great colleague. In a letter to me, he remarks that it was always interesting to listen to Bunsen and Kirchhoff dispute about some mathematical, scientific, or philosophical subject. Still more interesting was it, however, to watch, when he was present, the incomparable Helmholtz looking silently on from his calm Olympian heights with an appreciative and meaning smile as the discussion proceeded. He also spoke to me about the very great admiration which Helmholtz had felt for Clerk Maxwell's work. He said that he (Helmholtz) considered Maxwell superior to himself as a physicist, and often spoke of him as if he were inspired.

Perhaps the most striking example of Helmholtz's many-sidedness was shown on the anniversary of his seventieth birthday, when deputations, not only from all the German universities, but from a great number of distinguished persons from the Emperor downwards, and from scientific and other associations of various kinds, presented addresses of congratulation to him. To each one of these he replied, apparently without effort, and certainly without preparation, in the most varied and appropriate language, alluding in the case of each deputation to the special points of most interest to them. To his scientific labours I do not intend to refer: those who are interested will find them mentioned in Koenigsberger's excellent *Life of Helmholtz* published by Vieweg; or in the touching and able Memorial Lecture delivered before the

H. v. Helmholtz

Chemical Society in January 1896 by my distinguished and lamented friend Professor FitzGerald of Dublin University.

Helmholtz and his wife suffered a similar loss to ourselves in the death of their eldest son. Robert von Helmholtz was from birth a cripple, and it was only by the very greatest care and by the most rigid surgical and medical treatment that he survived his childhood. He became, however, a distinguished mathematician; indeed I have heard his father say that he considered his son's mathematical brain superior to his own, and if his life had been spared he too would have done great things.

Full of honours and esteemed by the whole world, Helmholtz breathed his last on September 8th, 1894. An excellent likeness of Helmholtz faces this page.

I first met the eminent Belgian chemist Stas at Heidelberg, where he had come on a visit to Bunsen. I afterwards called upon him several times at his laboratory in Brussels, and also met him in Paris more than once. He was a very small, refined, delicate man. "Ah, *mon ami*," he used to say, "*je suis très-malade*." His experimental work, as all chemists know, was the acme of accuracy, and only those who have endeavoured to follow in his footsteps can form a conception of the labour he bestowed upon his atomic weight determinations. It is interesting to remember that whilst Stas's classical researches gave to chemists the proof that Prout's law does not hold good, his earlier work with Dumas was undertaken with the view of ascertaining its truth. He was far from being a rich man, and was held in high esteem in his own country as well as by chemists all the world over. When I visited him in Brussels he resided in a small house

which he had almost entirely given up to his chemical work. He was a bachelor, and lived entirely for science. There is an interesting *éloge* of Stas in the *Mémoires* of the French Academy, and also in the *Series of Memorial Lectures of the Chemical Society* by Professor J. W. Mallet, of Virginia, in 1892. He was a grand example of unselfish devotion to purely scientific work, and all who knew him must have recognised his charming simplicity of character, his affectionate disposition, and his unostentatious life.[1]

Among the most distinguished and gifted of Bunsen's friends was Hermann Kopp. His was a singular personality and in some respects the ideal type of the old German professor. His fame will rest upon his work as an historian rather than as an experimentalist, and his books on the history of chemistry will always hold a high place in the literature of the science.

It was amusing to see Kopp, who was a very small man, walking down the Anlage with his friend—I almost would have said protector—Bunsen, for the small person trotting by the side of his tall and dignified companion reminded one of Landseer's picture of "Dignity and Impudence," though this latter term is scarcely fitting, for Kopp was one of the most modest of men though bubbling over with humour, often with more than a touch of pathos, and crammed full of knowledge.

Apropos of this friendship I am reminded of a grim joke played upon a younger colleague by Bunsen, who in answer to a question remarked: "Yes, a

[1] An interesting experimental criticism of Stas's atomic weight determinations has recently been made by Theodore Richards, of Harvard. He has shown, by methods which rival those of Stas in care and accuracy, that the Belgian chemist was not infallible, and he has pointed out sources of error in Stas's work. *Humanum est errare.*

little chemist of the name of Kopp used to live here. I knew him well for thirty years, but I never understood a word he said." Kopp talked the Hanau dialect of German, Bunsen pure Hanoverian.

My friend Thorpe has done full justice to Kopp's memory in his lecture before the Chemical Society. Several of Kopp's letters lie beside me, of which the following indicates his humour and kind heart, and illustrates his intimate relations with Bunsen, to whose Jubilee it refers.

HEIDELBERG, *Jan. 9th*, 1882.

HONOURED FRIEND,

At present I am working very hard. For some time I was not at all well, but now I am all right again.

We really expected you here for Bunsen's Jubilee. B. has hidden himself with a few chosen friends at Zugenheim in the Bergstrasse; in case you came I had written where we were to be found, in a note which my wife was keeping for you. B. bore the unavoidable with dignity and not without pleasure. He is very well and happy, suffers slightly from chronic bronchial-catarrh, grumbles a great deal, and is therefore thoroughly normal. He sends you hearty greeting; that is to say, he and I have joint authority to do this to mutual absent friends (when I was with him this afternoon as usual, I did not know that I should be writing to you, but I find I have half-an-hour to spare before midnight). He is thinking of going to Italy in the Easter holidays with Quincke. I shall stay here this time and work.

But now good-night. My best wishes to you and yours for the newly-started year.

Your devoted,

HERMANN KOPP.

My knowledge of the Germans and Germany has led me to love the Fatherland, and, I venture to think, to understand as well as to respect and admire the nation. As to any feelings antagonistic to England and the English existing in the minds of the many Germans with whom I became intimate I never found

a trace, for Treitschke I did not know. All with whom I ever came in contact expressed a feeling that England was the old home of freedom, that she had led the van in securing that freedom by gradual and peaceable measures, and, in short, that the path in which the Englishman trod was that in which they wished to follow. "We cannot," my friends said to me, "express our opinion on political matters with the freedom to which you in England are accustomed. How indeed can this be otherwise, when we are governed by an autocratic power which believes in the divine right of kings, and have to submit to a condition of things in which summary punishment for "Majestätsbeleidigung' is possible?"

It is, however, necessary to remember that a change which may indeed be said to be revolutionary has occurred in Germany. When I first went there, now more than fifty years ago, the population of what subsequently constituted the Empire was under forty millions; at the present time it numbers over sixty. In the second place, half a century ago, oversea commerce and manufacturing industry (Welthandel), such as we in England have enjoyed for generations, was practically non-existent. There was no means of livelihood for the increasing population but agriculture or manual industry (Handarbeit); consequently millions of stalwart men and women of Teutonic blood found their way to the New World, where free scope for employment and improvement lay open to them. Their children, however, soon ceased to be Germans; they no longer looked back on the Fatherland as their home, but threw themselves with ardour into the lap of the Republic, and thus ceased to give power and strength to their old nationality. How different is the present condition of things! The unification of

Germany not only made her great politically, but by fostering her commerce and industry made her a formidable rival to our trade. This being the state of the case, can one wonder that their rulers should seek in other countries an outlet for their teeming population and for their increasing commerce, countries in which the future populations would look back to the "Vaterland" with similar feelings of loyalty and love to those with which our colonists regard the "Mother Country." Can one marvel that they see with envious eyes the steps which we English have taken to secure for ourselves in our lands beyond the sea that for which they so ardently long?

Whether the expressed determination of Germany to become a first-class sea-power may be intended to wrest from us some of our possessions, or whether it is for the simple purpose of protecting their trade, we cannot tell. The mere chance of the first of these happening is sufficiently serious to warrant our determination that, come what may, the English sea-power *must* remain supreme.

At any rate all well-wishers of peace and progress in both countries must deplore the continual attacks made by certain organs of an irresponsible Press on both sides on the good feeling which ought on all hands to prevail. It would be an outrage to civilisation if two countries so closely allied in blood and intellectual development should ever come to blows.

CHAPTER V

PROFESSORSHIP OF CHEMISTRY AT OWENS COLLEGE

Return to London—Appointment at Owens College—Early History of Owens—My Assistants—Growth of the College—Training in Scientific Method—New Building—Japanese Students—British Association, '61—Joule.

HAVING acted to my advantage as assistant to Professor Williamson at University College in the winter session of 1855–6, and having completed as far as was then possible my research work in Heidelberg, I returned to London in the autumn of 1856, for the purpose of beginning life on my own account. The funds at my disposal were of small amount, but I had kind friends who gave me a helping hand to fit up a private laboratory, where, with the help of my friend Dittmar, who came over from Germany to assist me to carry on research work, I hoped to make a beginning as a consulting chemist. My mother and I set up housekeeping in London, and I began my experience as an independent teacher by lecturing to an army school at Eltham, and as a consultant, by an investigation on ventilation for a departmental committee of which Dr. Lyon Playfair was a member and the late Mr. J. F. Campbell, of Islay, was secretary. For this committee I examined the air of the soldiers' sleeping-rooms in Wellington Barracks when the men were in bed. I also visited many schoolrooms, as well as artisans' dwelling-houses, and determined the amount of carbonic

acid contained in the air of a crowded theatre. The results of these investigations were published in a Blue-book, and also communicated by me to the Chemical Society and appeared in the "Journal." One result of my experiments was to prove that the statements made by Dr. Neill Arnott as to the ventilation of dwelling-rooms are erroneous. According to his theory, little children breathing the air below the level of the fireplace (which acted as a ventilator) were healthy, while the nursemaids were unhealthy owing to the fact that they inhaled a large amount of carbonic acid gas, which collected in great quantities in the upper part of the room. He maintained that the nursery could only become healthy for both children and adults if his patent ventilators were placed in the wall above the fireplace. My investigations proved that the amount of carbonic acid at the top of the room and below the level of the fireplace was exactly the same in all cases.

In the summer of 1857 an advertisement appeared in the newspapers, stating that the chair of Chemistry at the college recently founded in Manchester by John Owens was vacant through the resignation of Professor (afterwards Sir Edward) Frankland. I determined to apply for the post, and obtained the usual testimonials of efficiency from Bunsen, Liebig, Williamson, Graham, and others. In course of time I was informed that I was one of the selected candidates, and I was requested by the secretary of the trust to come down to be trotted out before the trustees. On arriving in Manchester at the office of Mr. Aston (the secretary of the trustees), I was received by an old gentleman whom I could barely understand, as he had no roof to his mouth. I was then interviewed. In the same room I met the late Dr. Crace Calvert and the

late Dr. Angus Smith, both well-known Manchester men, who were candidates for the post.

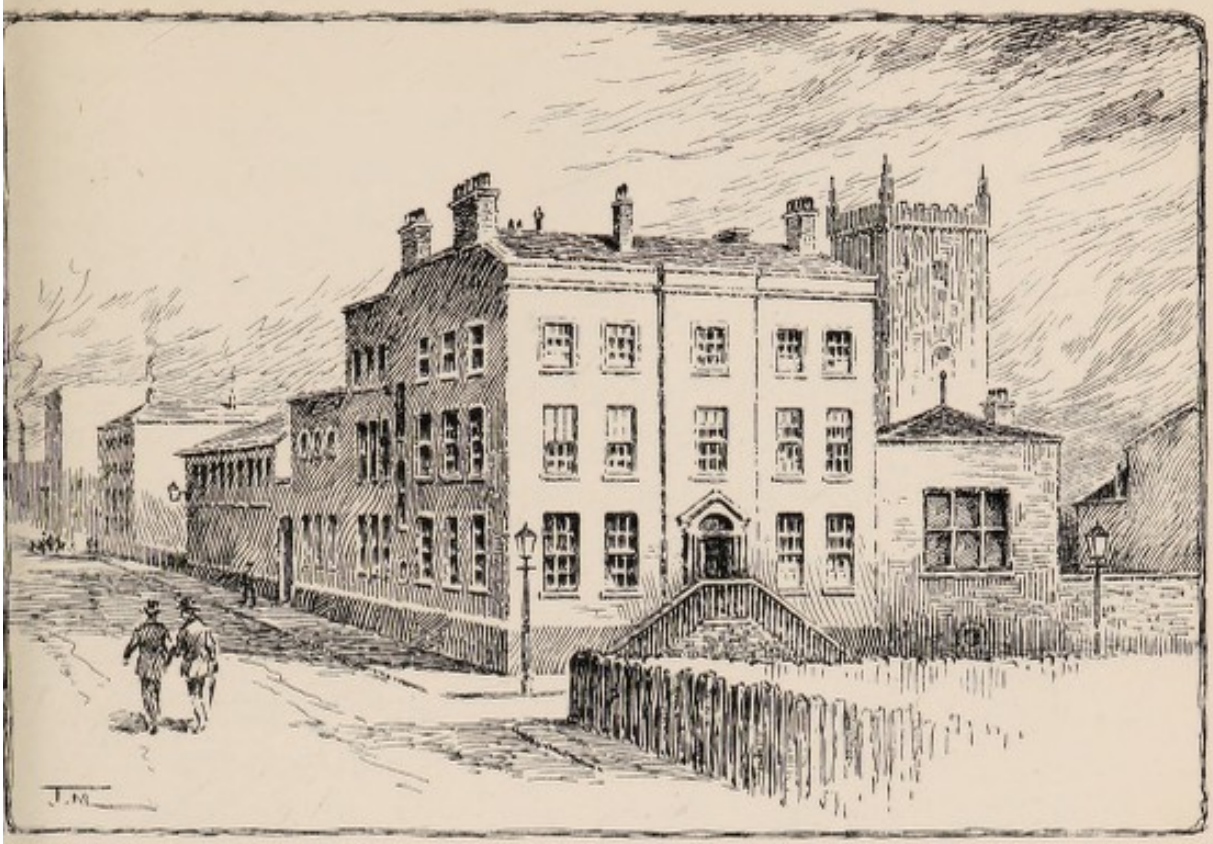
I suppose the trustees were satisfied with my appearance and with what I could say for myself, because a few days afterwards I was informed by Mr. Aston that I had been appointed to the vacant chair. I therefore had to give up my London laboratory and make arrangements for settling down in Manchester.

At that time the college had been founded about six years. My colleagues were: A. J. Scott, Principal; J. G. Greenwood, Professor of Classics; Archibald Sandeman, Professor of Mathematics and Natural Philosophy; W. C. Williamson, Professor of Natural History; and R. C. Christie, Professor of Law and History. There were in the college at the time about thirty-five students, of whom fifteen were working in the laboratory, which had been fitted up by my predecessor, Frankland.

The history of the foundation and remarkable rise of Owens College has been written by my friend Mr. Alderman Thompson,[1] a Manchester manufacturer of about my own age, who had entered the college and was working in the laboratory. I need not therefore enter into detail in regard to this except to say that the college was first established in a private house in Quay Street which had formerly been the residence of Richard Cobden (see drawing facing this page).

The institution was at that time nearly in a state of collapse, and this fact had impressed itself even on the professors. I was standing one evening, preparing myself for my lecture by smoking a cigar at the back gate of the building, when a tramp accosted me and asked me if this was the Manchester Night Asylum. I replied that it was not, but that if he would call again

[1] *The Owens College: Its Foundation and Growth*, by Joseph Thompson; published by J. E. Cornish, Manchester, 1886.



THE OLD OWENS COLLEGE, QUAY STREET, MANCHESTER.

THE VICTORIA UNIVERSITY OF MANCHESTER.
(Owens College New Buildings, Oxford Street, Manchester.)

in six months he might find lodgings there! That this opinion as to the future of the college was also generally prevalent is shown by the fact that the tenancy of a house in Dover Street was actually refused to me when the landlord learnt that I was a professor in that institution.

Public opinion in Manchester at that time did not appreciate the value of the higher education, and it was not understood that science could be made an efficient instrument of education, and that such an education was absolutely necessary for an industrial career. To make a school of chemistry worthy of the great manufacturing district of South Lancashire was my ambition, and after thirty years of work I think it must be admitted that this was, to some extent at least, realised, for there were, I believe, few engaged in that district in any large way of business in which chemistry plays a part who did not show their appreciation of the value of scientific education by sending their sons or their managers to learn chemistry at Owens College.

The deed of the founder specified that the instruction to be given in his institution should be similar to that given in the English Universities, but that no restriction as to religious belief was to be placed either on the teachers or the taught, and that no instruction was to be given that could in any way be offensive to the religious susceptibilities of parents or guardians. Its secular character placed the college in opposition to the prevalent views of the orthodox, and possibly it was in order to allay the feeling of hostility that the Principal was in the habit of delivering a series of lectures on "The Influence of Religion on the Life of the Scholar." These were given in the chemistry lecture theatre and were open to the general public, and were, of course, mainly attended by ladies, who were much impressed by the rhetoric of the Principal.

Scott was a man of remarkable power, and his influence upon those who came into personal contact with him was profound. It was to his memory that George Macdonald dedicated his novel *Robert Falconer*. "To the man who stands highest in the oratory of my memory, Alexander John Scott, I, daring, presume to dedicate this book." He was, however, wanting in business habits, and he did not understand how to raise up a university college in the Manchester of those early days. Soon after my appointment he resigned his office, and Dr. Greenwood became Principal. He was exactly the man for the post. A scholar and classic, he had wide sympathies, and understood that if the college was to succeed it must be on modern lines. He had the satisfaction of seeing his handiwork prosper, but always acknowledged that this prosperity was greatly due to the help he received from his colleagues.

On taking up my duties at the college as the Professor of Chemistry I found my old friend Frederic Guthrie installed as the sole assistant, and Joseph Heywood as the famulus. Dittmar continued to act as my private assistant, and we worked together on various subjects in physical chemistry, especially on the solubility of gases in water and on the composition of the aqueous acids, the results of which have found their due place in the structure of modern chemistry. I also encouraged research among the older students, and before long my laboratory became known as one where a man could get a training in research methods, with the result that in those early years a considerable number of original communications were contributed to the scientific societies.

An American professor once said that the task of an investigator requires for its success the toughness

of a soldier, the temper of a saint, and the training of a scholar, and he therefore cautions mere enthusiasts from attempting to carry on so serious a business.

The need of caution in these matters, though in a somewhat different sense from the above, came home to me in a singular way in my early years as a teacher. As I have said, I was anxious to promote original work, and I therefore accepted the proposal made to me by a young man, by name Pearson, who had previously gone through a scientific training elsewhere, to undertake the revision of the atomic weight of uranium, a matter upon which chemists were then in doubt. After a time I observed that, although his method of manipulation was inaccurate, his numerical results tallied in a suspicious manner with his preconceived notions. In short, I came to the conclusion that he was "cooking" his results. So I determined to catch him, and catch him I did, to my own satisfaction and that of my assistant, who witnessed the operation. I need not detail the methods I employed or the precautions I took; suffice it to say that the proof of guilt was complete. On being accused of the offence, which, of course, is the gravest a worker in science can commit, he indignantly denied the charge. But, on pressure being brought to bear, he after a while confessed his guilt. Now came my mistake. I let him off with a severe reprimand. I refused, of course, to allow him to stay with me, but I got no written confession. This was, however, only the beginning of a "strange eventful history." He turned parson, and after some time blossomed out into a vigorous and popular preacher, and ingratiated himself with the late Dr. Parker, of City Temple renown, then living in Manchester. Soon reports of strange doings on Pearson's part alarmed the Congregationalist body, and an investigation was

called for. This took place in Manchester with the late Dr. Binney as President. I was requested to inform the Court what had happened years before at Owens College, so I appeared before the Reverend Commissioners and stated the case. Of course none there comprehended what I meant, and those who believed Pearson to be an injured innocent, and they were not a few, thought that I had treated the man badly, some freely expressing that opinion. The trial ended by a verdict of "non-proven." But there was more to come. Pearson, after this inquiry, was appointed minister at a Nonconformist chapel near Manchester. In the neighbouring town he had, it seems, struck up an intimacy with a servant girl, and one night, appearing at the house where she was employed, he gagged her and rifled the house of its portable contents. Cleverly eluding the police, he escaped to America, and there he ended his career by being lynched for horse-stealing! To Dr. Parker's credit, I must add that on hearing of these events he wrote to me apologising for his former conduct, and adding that he had been deceived by Pearson's "Satan-like character." I am also amused to remember that Pearson was clever enough to palm off upon me a prize essay cribbed from the Bridgewater Treatises and Dr. Chalmers' sermons, and deceived the editors of a journal called *The Chemist*, who printed it in full, and also published a concocted research in Pearson's name, on a supposed new method of analysis, the falsehood of which was, I believe, exposed by Fresenius.

Guthrie soon afterwards received the appointment of Professor of Chemistry at the Royal College in the Mauritius, and Dittmar succeeded him. The

latter was a most accurate and careful worker, and took infinite pains with the students. He was a man with an original mind and had an extensive knowledge of his science, which won for him later a high position among chemists. When he accepted the college demonstratorship he advised me to ask a young German friend of his, Schorlemmer, to take his place as my private assistant, and, accepting my invitation, Schorlemmer came to Manchester, and continued much of the work which Dittmar and I had begun. I soon found that Schorlemmer was a man of great ability. He remained with me for thirty years; indeed, to the end of his life. Throughout that period we were much attached to each other; indeed, I do not think during the whole of that time we ever had a disagreement. We worked on the boiling-point of acids, a subject which has proved to be of considerable theoretical importance.

Schorlemmer was born at Darmstadt, the birthplace of many distinguished chemists. He came of poor parents, but by economy and hard work he secured an education which enabled him to attain a high position in the ranks of Science. He was neither an eloquent lecturer nor a neat manipulator, but his lectures were as full of sound matter as an egg is full of meat, and his experimental investigations were fruitful of good results. As an historian of the science, Schorlemmer was only second to Kopp, for his knowledge of both branches of chemistry was wide and accurate, whilst his sustained power of work, whether literary or experimental, was truly Teutonic.

His researches on the hydrocarbons rank as chemical classics, and his successful controversy with Frankland as to the constitution of the so-called alcohol radicals and of their hydrides forms an interest-

ing and important episode in the history of chemical theory. I am glad that his name is associated with one of the laboratories at Owens, where he did his work. That originality does receive its meed in England is shown by the fact that Schorlemmer, a quiet retiring man, personally known to few, was elected a Fellow of the Royal Society on his first application—a rare event.

During the whole thirty years of my work in Manchester, I am thankful to say that there were very few serious accidents either to pupils or to myself. On one occasion, however, I had been working on perchloric acid, and I had prepared some perchloric ether, which I was anxious to analyse, as this had never been done. It was well known to be an excessively explosive substance, and as I was filtering a few cubic centimetres of the liquid into a test-tube, the whole thing exploded, the bottom of the test-tube bored a hole, an inch in diameter, almost through the hard wood of the filter-stand, whilst the glass was shivered into many thousand fragments in my left hand, from which I afterwards picked out some 200 pieces. If I had had my hand under the test-tube it would have bored a hole in it just as it did in the filter-stand. This accident happened to me the day before I had to give a lecture at the Royal Institution in London, and I appeared at the lecture table there with my hand wrapped up and my arm in a sling.

Our numbers in the laboratory soon increased, until at last we had to divide the benches and cram the students into all sorts of holes and corners, and my lecture class rose from fifteen or twenty to something like 200.

Knowing from my German experience what a course of experimental physics should be, and as there was

no such course in the college, I had perforce, at first, to give a good deal of elementary physics in my own lectures. So I brought before my colleagues, and through the new Principal, Greenwood, before the trustees, the necessity for the appointment of a Professor of Physics. Professor Sandeman was the purest of pure mathematicians, and had not the slightest idea of experimentation, though he was by title Professor of Natural Philosophy. He wrote a book called *Pelicotetics*, which I believe consisted of an attempt to prove why two and two made four and not five! This was the subject upon which he delighted to lecture to the untutored youth who then attended the college. After a time R. B. Clifton, then a distinguished young Cambridge man, was appointed as Professor of Physics, and this was the first step towards the expansion of the college in a scientific direction. Clifton soon became most popular, his lectures were admirable, and enabled me to dispense with teaching any portion of his subject. Too soon Owens had to part with him to Oxford, a University which he still adorns. On Clifton's departure, his place was filled by my lifelong friend William Jack, and on his resignation by Balfour Stewart, a man of original mind and of high position in the world of science.

The gradual increase of the number of students, and the general recognition by the public of the work done by the Owens College, led to the determination among us to place the institution on a more satisfactory footing both as regards building and endowment. For this purpose we formed a Committee, consisting of Manchester men of position, whom we had interested in the rebuilding of the Owens College, on a prominent site in the city, and they had so far completed their work that the foundation stone of the

new college buildings in the Oxford Road, designed by Mr. Alfred Waterhouse, was laid, on the 23rd of September, 1870, by the Duke of Devonshire.

In addition to the ordinary work of my professorship I was much engaged in executive work connected with the new building committee, especially in designing the laboratories. Principal Greenwood and I had visited a large number of the University laboratories abroad, during the summer vacation of 1869, for the purpose of obtaining ideas respecting the building, and the results of our visit were communicated to the committee and to the late Mr. Alfred Waterhouse, R.A., who adopted such of them as were found feasible. And here I must bear testimony to the abilities of my late distinguished friend as an architect for buildings for scientific purposes. He at once understood the special requirements of a laboratory, and as a result those which he built in Manchester, Liverpool, and Leeds are, each of its kind, a model of what such buildings should be. In my own case, those which I designed for Owens College[1] (see photograph), were copied far and wide not only in this country but abroad, and especially at Munich, where Baeyer (Liebig's successor) based his new buildings on the plans which I sent to him. But plans and elevations do not convey to some minds any idea of how the building when complete will turn out. This was the case with Sir Joseph Whitworth, a generous contributor to the funds of the college, and it was only when a model to scale of the proposed building was made that he gave his consent to its erection.

To speak of the development of Owens College without mentioning Thomas Ashton, of Manchester,

[1] I am indebted for this illustration to my friend, Mr. P. J. Hartog, the editor of the history of the Owens College, published by J. E. Cornish, Manchester, 1900.

[*Photo Frith & Co.*

THE ROSCOE LABORATORIES.—QUANTITATIVE.

would almost amount to a crime. Of all business men of high distinction whom I have known, his name in my mind stands out pre-eminent. A man of strong common sense, of great business capacity and powerful will, Thomas Ashton was one of those clear, straightforward men whom to meet was a satisfaction and whom to know was not only to respect but to love. He was fortunately an intimate friend of ours, and in the early days of Owens College, when we were struggling for existence and when the only hope of our ever making our way out of the narrow ruts into which we had fallen was to secure the co-operation and sympathy of some of the generous and far-seeing men in Manchester, I walked up to Ashton's house in Didsbury one Sunday and said to him: "You must help us in placing this college of ours on a footing worthy of the city." To this he objected, with the remark that the Governors of the private Trust were strong Churchmen and mainly Tories, with whom he had little sympathy. The place, he said, was moribund, and he did not like to undertake the task of resuscitation. I knew that I should not succeed at once, and that when Ashton had once put his foot down it was not easy to make him move it; but at length I won, not only his co-operation, but his ardent enthusiasm, and it was mainly owing to his exertions and his powerful advocacy that we succeeded in getting the ear of the Manchester public, which also meant its pocket. I was always glad to show honour to my friend, especially because he would never attempt to gain honour for himself. No statue, not even a portrait, of Thomas Ashton adorns the walls of the college for which he did so much, for against every kind of post-mortem distinction he set his face irrevocably. All the more, therefore, did I value any

opportunity of indicating my sense of the debt which Manchester owes to that man, and this I was able to do on more than one occasion, notably at the opening of the new buildings of the college by the late Duke of Devonshire. I rejoice to think that during his lifetime he received the greatest honour which Manchester could give, that of its freedom.

No sooner had I set foot in Manchester than I was elected a member of the Philosophical Society of that city, the oldest, best-known, and most important of provincial scientific societies. Its hero, of course, was John Dalton, who served as its president for many years, and scarcely second to him was another great Manchester man, James Prescott Joule, who also, after Dalton's decease, occupied the presidential chair. For many years I served as secretary to the society and spent many pleasant hours in scientific converse, for those meetings brought together all those in the city and neighbourhood who felt interest or took part in the prosecution of science. In later years I had the satisfaction of unearthing a number of Dalton's manuscript laboratory note-books, which had hitherto escaped attention, and where I found some most interesting historical data which, in my opinion, altered the views up to that time prevalent respecting the origin of the atomic theory. These views were published by Dr. Harden and myself in a volume entitled *A New View of the Origin of Dalton's Atomic Theory* (Macmillan and Co., 1896).

In due course I also became president of the society from 1882 to 1883, and in recognition of my efforts to elucidate Dalton's work, and also of the services which I had rendered the society, I was, in February, 1900, awarded their first Dalton medal. In acknowledging this honour, I said that the first

John Dalton.

Engraved by C. H. Jeens from a Daguerreotype.

London, Published by Macmillan & Co.

original research which I undertook in coming to Manchester was a revision and an extension of Dalton's well-known laws of the absorption of gases in water.

The house in George Street, still occupied by the society, is where John Dalton carried on his researches. There, too, are collected together the apparatus of various kinds which he used. They were of the simplest character and almost all made by himself. With these simple means he accomplished great things. He ascertained the laws which affect chemical combination and upon which he founded the atomic theory of chemistry. Upstairs is the old-fashioned "Meeting" room, where Dalton as president used to take the chair at the meetings of the society, and where, when a very prosy communication was being made to the society, he at times would lean over the raised platform, and in a loud *sotto voce* address the secretaries: "Well, this is a very interesting paper for those that take any interest in it." Facing this page is a fine portrait of Dalton when an old man, engraved by Jeans from a Daguerreotype taken about the year 1840.

At a later date I wrote a popular account of the life and labours of John Dalton for the Century series of Scientific Men published by Cassell and Co., in 1901, called, *John Dalton and the Rise of Modern Chemistry.*

During the years immediately following the Japanese revolution many promising students were sent to the universities and colleges in Europe and America to learn scientific method. Several came to Owens College, and I became intimate with those studying chemistry under me. They were one and all extraordinarily persevering, painstaking men. They had learnt English before coming over, and very soon were able to follow

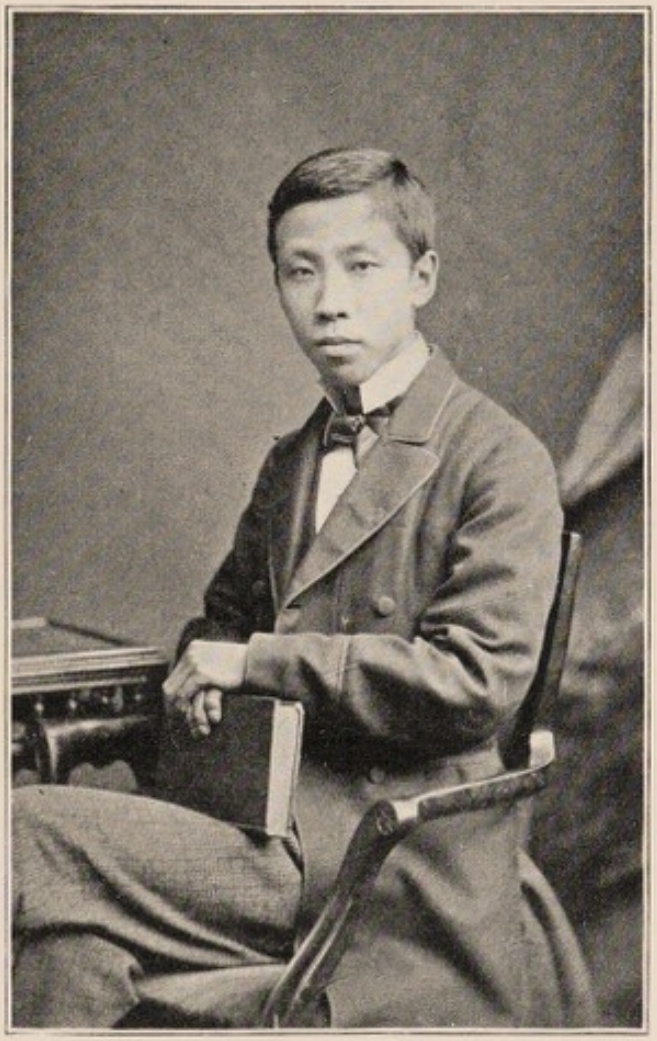
the lectures perfectly, and, moreover, showed their talent in manipulation. Indeed, as students, they exhibited a capacity for mastering the details of a subject certainly not inferior to that of the best of our own countrymen. One of them, Suguira by name (his portrait faces this page), carried off the first prize in my junior lecture class, consisting of from 150 to 200 students. He had come to stay at the college for three years. At the end of the second session Suguira was placed second on the list of the senior class at the sessional examination, the first being an Englishman. Some little time afterwards I learnt that he was leaving, when I sent for him, and said that I understood that he was to stay with us for three years. "Had he," I asked, "been sent for; if not, what other reason had he for leaving?" "No," he said, "I am leaving at my own desire." And after much pressing I found that he considered himself disgraced by not having taken the first place in the senior class, and that he could not stand being confronted with his fellow-students.

Since that time I have had several letters from my Japanese friends and pupils, some of which are interesting.

TECHNICAL INSTITUTE, ASAKUSA,
TOKIO, JAPAN.

MY DEAR SIR,

I fear I can but blame myself if you have thought hardly of me for never having written to you since my return to Japan. But do not, Sir, imagine that I have let the memory of those happy days at Owens College be effaced, or even in the slightest degree dimmed by time. Your teaching and your noble example to all students of science are ever before my eyes with all the freshness of the College days. Believe me, here in Japan, there is at least one heart that watches your career with intense interest and feels himself honoured by the honours conferred on you. . . . Prizing as I do the high distinction of having been your pupil, I determined to deserve it by performing some serious and earnest scientific



S. Suguira.

work. I waited patiently until the establishment by the Ministry of Public Instruction of a Technical Institute, when I was called to the chair of Technical Chemistry. I devoted myself especially to the chemistry of dyeing, and, being convinced of the unscientific nature of the process in vogue, I set myself to write a standard work on the subject for the guidance of our dyers. This I have accomplished, and hasten with a boyish joy to beg your acceptance of a copy of this my maiden work, hoping to show thereby that, unworthy as I am to be ranked among your distinguished pupils, it has not been for the want of the wish or will.

Wishing you all honour and prosperity,

I remain, dear Sir,

Your affectionate Pupil,

Y. KIRAGA

(formerly known as SADAM TAKIMATSU).

October 1st, 1886.

It is not often that a professor of chemistry is consulted by an unknown correspondent upon a question of international policy, but the following letter is of interest as bearing upon contemporary history :—

NORDAL BRUNSGADE 6, CHRISTIANIA
(NORWAY).

7/4, '92.

Professor HENRY E. ROSCOE,
London.

I thank you cordially for your kind letter, which I keep carefully as a dear token of you. Indeed you must excuse me that I trouble you once more with my writing, but your great kindness to me encourages me. With all my heart I should namely like to know your opinion of a matter which of late has been very much discussed here in Norway. It turns upon the claim of the Liberal party that Norway no longer shall have its Ministry of Foreign Affairs together with Sweden, but that each country shall have its own. I have read a good deal about it, but having been written so much both for and against it, I have not been able to arrive at an absolute conclusion. Therefore it would give me immense interest to know your view of this matter, to know whether

you think it possible for two peoples, otherwise entirely united, each to have its own diplomacy. I do not know anybody in the world to whose words I attach such importance as to yours. This letter is however very pretentious and so audacious, that by no means I have a reason of expecting an answer; I seem to see, how you, frowning over my audacity, throw my letter far away; but—on the other hand—if you knew my interest in the matter and my admiration to you, then I feel sure you would forgive me.

At all events I heartily beg you to excuse my pretentiousness.

Your

Devoted Norwegian admirer

OLAF HALVORSEN
(19 years old).

Referring to singular communications, I have received two from Spain which beat anything I have ever had from any other country.

DANIEL GRANT, Négociant, achat et vente de valeurs cotés dans les Bourses de Paris et Londres.—Adresse télégraphique: Grant, Barcelona.

BARCELONA (ESPAGNE),
Le 3 *Octobre*, 1895.

MONSIEUR,—

Je viens de me quereller avec l'ancien correspondant que jusqu'à présent j'avais eu dans ce Chambre; ayant admiré plusieurs fois votre talent et compétence dans la politique anglaise, j'ai l'honneur de vous offre dit charge.

Comme je possède des grosses sommes en valeur anglaise, j'ai besoin d'un habile correspondant auquel j'adresse, une ou deux fois par mois, mes consultations sur la future marche de la politique intérieure et extérieure d'Angleterre.

Sans doute vous n'ignoriez pas l'influence que possède politique sur la cote des valeurs en Bourse; et pourtant je veux être orienté.

Vos appointements seront de £1,200 annuellement, à payer d'avance £300 chaque trois mois, par traité de change ou cheque; outre cela, aussitôt arrivée l'époque des élections je payerai la moitié des frais pour votre réélection.

Dans l'attente de votre acceptation pour ultimer l'arrangement, agréez, monsieur, l'assurance de ma considération la plus distinguée.

DANIEL GRANT.

This was too good a joke to pass over, and I at once accepted, fully believing that my reply would be delivered to the writer in the municipal madhouse, and, of course, I have never again heard from him.

I received other letters from the same locality, but from another individual, of almost as original a character. Again I thought I would give the Barcelona madmen a chance, and I said it would greatly gratify me and my family to receive the handsome present which their club proposed to send me, but, alas! the promised work of the goldsmith's art never arrived, and I have reluctantly come to the conclusion that the greater part of the population of Barcelona is demented.

In 1861 the meeting of the British Association was held in Manchester, and I was one of the local secretaries, Sir William Fairbairn being President. Having held both offices, I can say that the anxiety and labour accompanying the office of local secretary are far greater than those which fall to the lot of president. My colleagues in 1861 were Mr. Alfred Neild, Mr. R. D. Darbishire, Professor Clifton, F.R.S., and Dr. Arthur Ransome, F.R.S., all of whom, with the exception of Mr. Neild, I am glad to say, are still (1906) alive.

That public lecturers should be able to make their voices heard to a large audience is sometimes not realised by scientific men. I have always remembered this fact, and have urged the advisability of appointing for such purposes men who are not only distinguished in science but who have also good lungs. Fairbairn, who was one of Nature's noblemen, a charming old gentleman, most suave and agreeable, was fortunate in possessing a powerful voice. He made an excellent President and spoke out like a man, having had to shout at the men in his boiler-shops.

These meetings are occasionally attended by a certain number of persons who are eccentric, to put it mildly. Sir George Airy was president of Section A, and during the discussion of some interesting mathematical question a man in the audience rose from his seat and, holding up his watch, addressed the President in a loud voice as follows: "Mr. President, if you will kindly look at this instrument you will see plainly indicated on it the pulsations of the universe." Upon which Sir George Airy, who never lost his presence of mind, quietly remarked: "Very good, sir; pray sit down just now, we will consider the matter later on,"—and then sent one of the secretaries to the unfortunate man, who was persuaded to retire. On that occasion Manchester seems to have been rather flooded with persons of this sort, for during the meeting one of these men came to the President, who sent him on to me as a local secretary to deal with. At that time, as will be remembered, Lancashire was suffering from the cotton famine, to which I shall again refer. This man came to me with a parcel under his arm, and stated that he wished to bring before the Association a discovery he had made relating to a new textile raw material which in his opinion would altogether supersede the use of cotton, and he wished to know to which of the sections his communication should be addressed. I then asked him as to the nature of his discovery, and to describe the material. "Well," said he, "it is one of very general occurrence; in fact, it is the human hair! I have found a means of stimulating the growth of the human hair to an altogether unprecedented extent; and I have here," he added, unfolding his parcel, "a piece of cloth manufactured from the hair of my sister, from whom I have succeeded in obtaining this year two large crops!" I told him that I thought the subject was more suited to

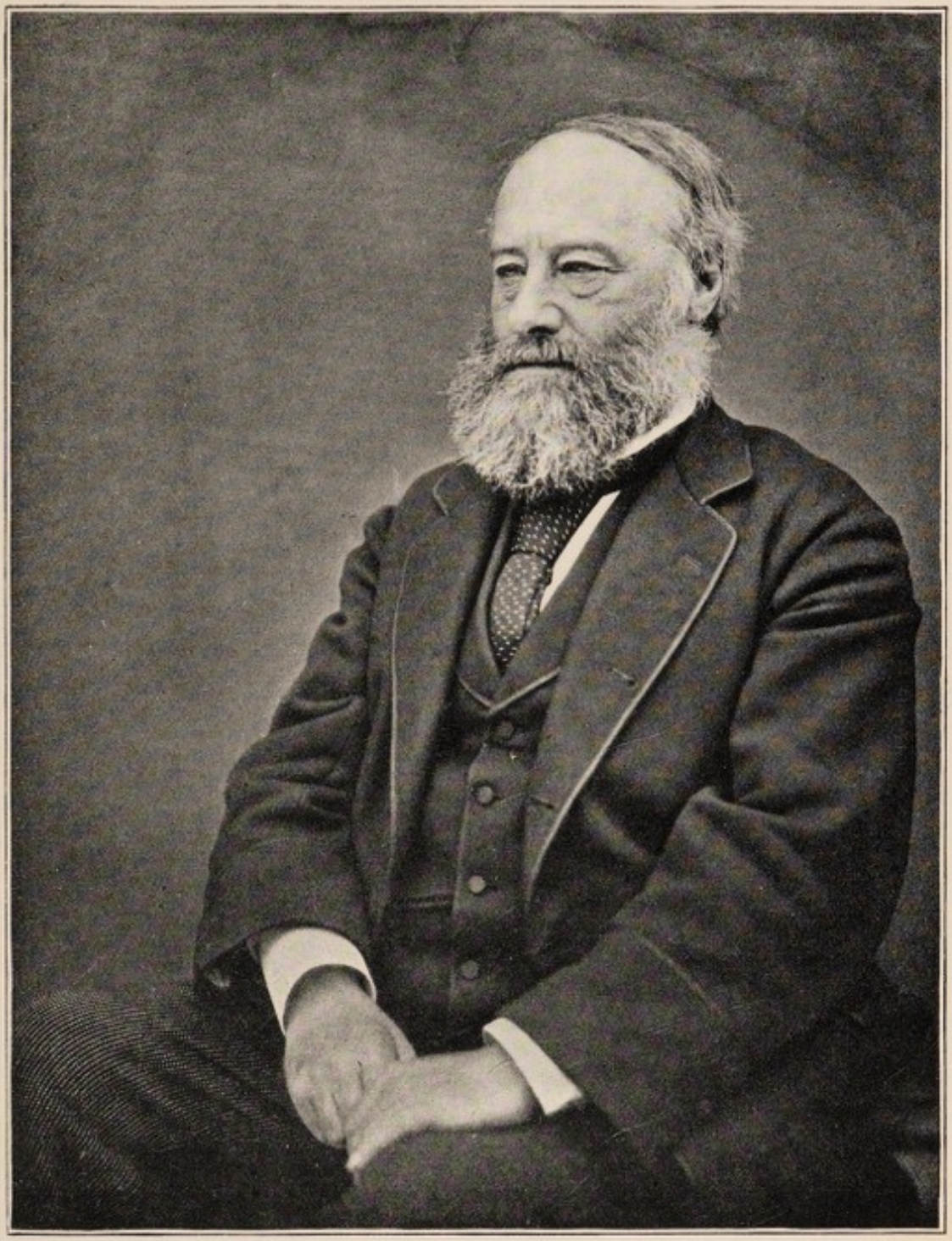
the biological section than to the chemical one, which I more or less represented, and I handed him over to the secretary of that section, giving him, however, as my opinion that if what he stated were true he would put to confusion all other inventors of hair specifics.

A third madman appeared on the scene. He informed the President that he had made a discovery by which the rainfall of any country could be satisfactorily regulated. He intended, he said, to confine his attention in the first instance to the British Isles. His propositions were the following: (1) The rain falls from the clouds. (2) The clouds always form over the sea. If, therefore, we can prevent the clouds from passing over the land, we can also prevent the rain falling. If, on the other hand, rain is needed, the clouds must be allowed to pass over the land and there deposit their moisture. His plan therefore was to erect round the coast of our islands a series of posts between which sail-cloths were to be drawn. If rain was wanted, these sail-cloths would be drawn up to the posts, and the clouds would pass over the land. If, on the contrary, the land was suffering from an excess of moisture it would only be necessary to draw these curtains tight, and all the rain would be deposited on them and flow harmlessly into the sea. Fairbairn heard the man out and then said, "Have you made any calculation as to the height to which your posts must extend?" "No," he replied; he did not think it was important. "Well," said Fairbairn, "what do you say to making the posts two miles high?" "Oh," said the man, "I see no difficulty in that." After which confession the President politely bowed the poor man out, but to which section he referred him I have forgotten.

The introductory lecture which I gave on entering

upon my professorship in the autumn of 1857 contained a popular statement of the work of the great Manchester physicist and experimentalist Joule, in so far as it related to the determination of the mechanical equivalent of heat.[1] One of the chief pleasures to which I looked forward in coming to Manchester was that I should have Joule as a friend, and I think there were few persons, with the exception perhaps of Sir William Thomson (Lord Kelvin) and the late Dr. Schunck, who were more intimate with Joule than I had the good fortune to become. Owing to his extreme shyness and reserve, I suppose, not many men came into close relation with him, and the reverses of fortune he met with rendered him still more of a recluse. He frequently dined with me, and once he came to stay with us in the summer when we lived at the Lakes. I much desired that the Owens College should have the honour of enrolling his name on its staff of professors, but on approaching him with this object in view I found he was unwilling to accept even an honorary position on the staff. He became, however, a member of the court and council, but he never took a very active part in the management of the institution. In his latter days, like his contemporary Faraday, Joule suffered from mental weakness, and I remember a somewhat pathetic meeting between him and Helmholtz. The latter, who was staying with us in Victoria Park with his wife, expressed a great desire to see Joule, whom he had never met. So I drove him over to Sale, where Joule then lived, and where a bust to his memory has lately been placed. It was in no sense a satisfactory interview, and Helmholtz expressed his sorrow at Joule's inability to talk on scientific subjects.

[1] See portrait-photograph by Lady Roscoe.



James P. Joule

About the year 1877 I was glad to be of service in bringing forward the claims of Joule for national recognition. The proposal was to obtain for him a Government pension. A memorial drawn up by Professor Tyndall was signed by almost every scientific man of position in the country, and I had much correspondence with Tyndall and Huxley and Hooker on this subject. The result was a pension of £200 a year.

Many letters from Joule are in my possession. The following one was in answer to a letter I had written to him urging him to accept a nomination as President of the British Association at the Bradford meeting for the year 1873. It is interesting as showing that he was not at all averse to the appointment of eminent noblemen who are not especially scientific as presidents, an opinion which is not now generally held, it being felt that the first requisite for the President is a distinguished scientific position, whether he be a nobleman or a commoner.

5, CLIFF POINT, BROUGHTON,

March 4th, 1872.

DEAR ROSCOE,

I thank you much indeed for your kind note; and if anything could have helped me into the office it would have been such encouragement. But it cannot be; I am not strong enough for it, and must be content to go on in my present quiet way. I see that since the Prince Consort there has been only one nobleman (the Duke of Buccleuch) appointed. At the commencement of the Association there were about even numbers of peers and commoners. It seems to me a most desirable thing to get at the sympathy and influence of the upper ten. There is Lord Derby and your President D. of Devonshire, both most eminently fitted. I could not well suggest this in my letter, but if you chance to agree with me and see a convenient opportunity of urging it, it might be

useful. I fear we are losing rather than gaining in parliamentary and political influence, and every opportunity should be seized to keep at any rate what is already held.

Yours very truly,

JAMES P. JOULE.

I not only took an interest in the proposal to erect a statue to Dr. Joule in Manchester, but also in the foundation of an international Joule memorial which should indicate the feeling of indebtedness which men of science of all countries share concerning the transcendent value of his work. In connection with this I addressed a letter to the *Times*, and as a result a general committee was formed and the sum of £1,500 was raised, the whole of which was handed over to the Royal Society for the foundation of an international scholarship for the encouragement of research especially among younger men in those branches of physical science more intimately connected with Joule's work.

It was also decided that a memorial to Joule should, if possible, be placed in Westminster Abbey, and as the honorary secretary to the committee I consulted on several occasions the Dean of Westminster, Dr. Bradley. Of course he was very polite, but he was unacquainted with Joule's work and brought forward the difficulty, which no doubt was a real one, of finding space anywhere in the Abbey. As I saw that my assertions as to the world-wide importance of Joule's researches did not appear to bring conviction to the Dean's mind, I enlisted the good offices of the President of the Royal Society, Lord Kelvin, and we made a joint attack upon the reverend gentleman. We succeeded in convincing him that Joule's name was as well known on the Continent as that of Newton, and at last, with our aid, he discovered an area of

about two square feet in a dark corner, the only one which he could place at our disposal in the English Walhalla to commemorate Joule's work. And so a simple tablet is inserted in one of the side walls just below the effigy of Charles Darwin ; and thus within a foot or two of one another are placed the simple and unattractive acknowledgments of work done, the like of which hath not been seen and the importance of which cannot be reckoned. The ridiculous, if it were not the pathetic, position thus accorded to two men who have conferred inestimable benefits not only on our own country but on the world at large, when compared with the grandiose monuments to political, naval, and military nonenities, is, it must be confessed, a somewhat humiliating reflection on the lack of appreciation of science shown in the English Temple of Fame. But, after all, this is of little moment, for the names of Darwin and Joule will live for ever in the minds and hearts of all those who appreciate scientific worth.

A statue of Joule by Gilbert was unveiled by Lord Kelvin in Manchester on December 9th, 1893. Kelvin had been Joule's most intimate scientific friend, and may be said to have discovered him. I moved a vote of thanks for the address, saying that when I first came to Manchester the work, and even the name of Joule, were scarcely known there, and contrasting this with the honour now paid to him.

CHAPTER VI

WORK IN MANCHESTER, 1862—1872

Cotton Famine Recreative Evenings—Penny Science Lectures—Marriage — Public Lectures in London — Faraday — Herschel — Vanadium and other Researches — Oxford Professorship — Literary Work — Macmillan.

In the winter of 1862 the Cotton Famine was at its height in Lancashire, and thousands of mill-hands, both male and female, were thrown out of work through no fault of their own. It was felt by some friends and myself that whilst the behaviour of the people in these most trying circumstances was in the highest degree creditable to them, yet there was some danger of a depression of spirits occurring, which might lead to serious results if the attention of the unemployed was not turned in some new direction. Hence a committee, of which my late friend Dr. John Morgan and myself were the secretaries, was formed with the object of providing recreation in the evenings for these unemployed operatives. We hired some disused mills and other large rooms and started a series of entertainments of various kinds. I see from a circular which we issued that during the four winter months of the above year more than one hundred recreation evenings were given to audiences averaging upwards of 4,000 a week.

The attention and demeanour of the operatives were throughout in the highest degree satisfactory.

These evenings included musical, scientific, geographical and other subjects, and the cost of them amounted only to £55 for the winter. I find in the *Manchester Examiner and Times* for March 31st, 1863, this report of the last of the lectures which I gave to the unemployed :—

> Mr. Hewitt, the master of the school (the Guardian schools Gaythorn, where the lecture was given), having addressed a few words to the men, and a vote of thanks to Professor Roscoe having been moved and seconded, Mr. H. J. Leppoc (vice-chairman of the Board of Guardians) said : "I have attended this interesting lecture as one of the guardians of the poor, and rise to support the resolution just proposed not only to Professor Roscoe, but to all the gentlemen who have joined him, and who, during the last four months, have so kindly come forward, at a great sacrifice of time and expense, to deliver lectures on various subjects interesting to the working classes. It is, indeed, a pleasure and gratification to see that every class in this vast community has striven to lighten the burden so patiently borne by their poorer brethren ; and I beg to assure the gentlemen that we, the guardians, are as much indebted to them as you can be, for it has always been our aim to provide for you in these painful times every little recreation and that instruction for which in better times you have been able to pay yourselves."

The *Manchester Guardian* for December 27th, 1862, contains an announcement signed by the Rev. William Gaskell, Dr. Arthur Ransome, and myself, giving a list of the arrangements. Among these I see that Mr. Charles Hallé and some members of the Manchester Liedertafel gave an instrumental and vocal concert to the unemployed attending the schools. I myself lectured on the "Chemistry of a Candle," with numerous experiments ; my friend F. C. Calvert, on "A Few Words on Chemistry" ; Arthur Ransome, on "Air and Water, the Great

Purifiers"; Professor Greenwood, on "A Tour in Switzerland," illustrated with a magic lantern; the Rev. H. Cottam, on "Pompeii, Past and Present." Dr. Morgan gave readings from Hood, Dickens, and other authors; Professor Clifton gave a lecture on "Heat," illustrated by numerous experiments. The conductors of several tonic sol-fa choirs gave their aid on numerous occasions.

In consequence partly of the success which attended these recreation evenings, and partly of the appreciation of science which was shown when the subject was treated popularly, and also because I felt it to be of great importance to create a more general interest in scientific matters than had hitherto been possible, I determined to institute a series of penny science lectures. The first of these was delivered in a large hall in a poor part of Manchester in the spring of 1866. These lectures were extremely well attended, and were repeated on a more extensive scale in the autumn of the same year. They were published by John Heywood, and largely sold at a penny each. Three lectures were given on elementary chemistry, classes being held at the close of each lecture; upwards of fifty men attended the class in the spring course, and a very successful one it was. In the following winter a similar class was held, the charge being 2*s.* 6*d.* for a course of thirteen lectures extending over a quarter of a year. The success which attended these lectures and classes led, in the first place, to the establishment of science lectures for the people on a more permanent footing, which were carried on by me for eleven consecutive winters. They also led to the foundation of the Working Men's College in Manchester, in which I taught for some time, assisted by my colleagues of

the Owens College and others interested in the education of the working man. These classes lasted for some time, but after a while they were merged into the evening classes instituted in the Owens College.

In carrying on the science lectures for the people, which still continued to flourish, I was assisted by some of the most eminent scientific men of the day. Thus, for instance, Huxley gave lectures on "Yeast," on "Coral and Coral Reefs," and on "The Circulation of the Blood"; W. B. Carpenter, on "The Unconscious Action of the Brain"; Tyndall, on "Crystalline Molecular Forces." I may here add the names of some other lecturers with the subjects introduced by them:—Huggins, on "The Transit of Venus"; Avebury, on "Modern Savages"; Abel, on "Gun-cotton"; Stanley Jevons, on "Coal"; Clifford, on "Atoms"; Thorpe, on "Priestley"; Spottiswoode, on "The Polarisation of Light"; and many by myself.

In connection with these Science Lectures I here quote two letters I had on the subject from Huxley:

24, ABBEY PLACE, N.W.
Oct. 30, 1870.

MY DEAR ROSCOE,

I shall be very happy to allow my lecture to be reported and printed and will correct it so that you shall have it ready for the second Friday evening.

I don't think my respectability will stand having anything more to do with Bishops—People will say of me "noscitur a sociis"!

Do what you think best for the interests of the undertaking; but if my whims may be gratified without injury to them, I would say, let none but working men in, and ask our friend Mr. Ashton to take the chair.

I am sorry I have no slides.

Ever yours faithfully,
T. H. HUXLEY.

4, MARLBOROUGH PLACE, N.W.
June 7, 1878.

MY DEAR ROSCOE,

I had not begun to think about the title of my preachment —November being a long way off.

If you think that *Harvey and the Discovery of the Circulation of the Blood* would do, it would suit me excellently well.

I suppose my auditors will not be likely to have read the *Fortnightly* and find out that I am giving them an old story.

The advantage of the subject is that one can make it interesting and deal with it in a speech more than a lecture. With your big audiences this is a great practical advantage.

Ever yours, very sincerely,
T. H. HUXLEY.

Most of the lectures were given in the Hulme Town Hall, but some were delivered in the large Free Trade Hall, which was always crammed. They were attended by thousands of people of all sorts and conditions, and as published they have been sold for a penny all over the world. They have also served as models for popular but truly scientific lectures delivered in other cities and other countries. Many of these I started, especially those in Glasgow, when in 1879 I gave a lecture on the "Chemical Action of Light" to the Glasgow Science Lectures Association.

In the course of the years which have passed since those lectures were given, I have frequently met persons, some of them occupying a high and responsible position in commerce and industry, who informed me that they were indebted to these lectures for their first interest in science, and have added that their whole subsequent career was altered and influenced by attending them. One of these was Mr. Thomas Parker, of whom the following notice appeared in the *Westminster Gazette* of February 4th, 1893:

Mr. Thomas Parker, the works director of the large electrical company at Bushbury, contractors for the Liverpool Overhead Railway, has had a remarkable career. He is a man whom Smiles would love to portray. He is distinctly a self-made man, being born in Shropshire of humble parentage about fifty years ago. He had little schooling, for at the age of nine he was put to work at the Coalbrookdale Foundry. Leaving Shropshire he went to work in the Potteries, and subsequently at Manchester. Professor (now Sir Henry) Roscoe was then in the habit of lecturing at the Hulme Town Hall, and young Parker, attending these lectures, acquired much electrical knowledge. In course of time he was appointed to an important post in the old works at Coalbrookdale, and whilst there, he invented the Parker-Weston steam pump. In 1882 he entered into partnership with a manufacturer of tips and horse-shoes, and the now well-known firm of Elwell Parker was established. At the commencement of the partnership Elwell-Parker employed but three individuals; business, however, increased so rapidly that a large electrical company was formed, and Mr. Parker became manager of its extensive works at Bushbury, Wolverhampton.

Of all the popular scientific lecturers of the time, Huxley and Tyndall were certainly the most distinguished, both being great but in different ways. Huxley's lucid method and finished style are familiar to all the world. Tyndall was no less taking as a popular writer and speaker, and to illustrate his method of adapting himself to all ages and classes I quote the introductory passages of his lecture on "Crystalline and Molecular Forces," which he gave at the Penny Science Lectures. His great endeavour was at the outset to rivet the attention of the audience by some story or some striking experiment before he entered into the subject matter of his discourse. On the occasion I refer to there were 3,700 people present. Tyndall began his lecture by saying:

A few years ago I paid a visit to a large school in the country, and was asked by the Principal to give a lesson to one of his classes. I agreed to do so provided he would let me have the youngest boys in his school. To this he willingly

assented, and, after casting about in my mind as to what could be said to the little fellows, I went to a village hard by and bought a quantity of sugar-candy. This was my only teaching apparatus. When the time for assembling the class arrived I began by describing the way in which sugar-candy and other artificial crystals were formed, and tried to place vividly before their young minds the architectural process by which the crystals were built up. They listened to me with the most eager interest. I examined the crystal before them, and when they found that in a certain direction it could be split into thin laminæ with shining surfaces of cleavage, their joy was at its height. They had no notion that the thing they had been crunching and sucking all their lives embraced so many hidden points of beauty. At the end of the lesson I emptied my pockets among the class, and permitted them to experiment upon the sugar-candy in the usual way.

When asked to come here and lend a helping hand in what I believe to be a truly good work (though hard pressed by other duties), I could not refuse the invitation.

I know not whether this great assembly will deem it an impertinence on my part if I seek to instruct them for an hour or so on the subject chosen for my little boys. In doing so, I run the imminent risk of being wearisome as well as impertinent, while labouring under the further disadvantage of not being able to make matters pleasant at the conclusion of the lecture by the process adopted at the end of my lesson to the boys.

With regard to the foregoing lecture I received the following characteristic note :

17th Oct., 1874.

MY DEAR ROSCOE,

I shall always be glad to see my friend Sir Joseph Whitworth.

Dare I ask you to give me a glass of good dry champagne at dinner? I would not trouble you with the request were it not important for the well-being of my brain during the lecture.

The parsons do not "bother" me save through the trouble of opening the various letters and other communications which my sins have brought upon me. My faith is great [1]

[1] This refers to his well-known address which he had just given at the meeting of the British Association at Belfast, and which called forth the wrath of the orthodox.

that time will justify me and put the parsons in the wrong.

Have you a good large screen, or will it be necessary for me to send one down?

Can I address the audience from the side of the Hall? it looked a long way to the end when I heard Huxley.

I hardly think he was heard at the end.

Yours truly,

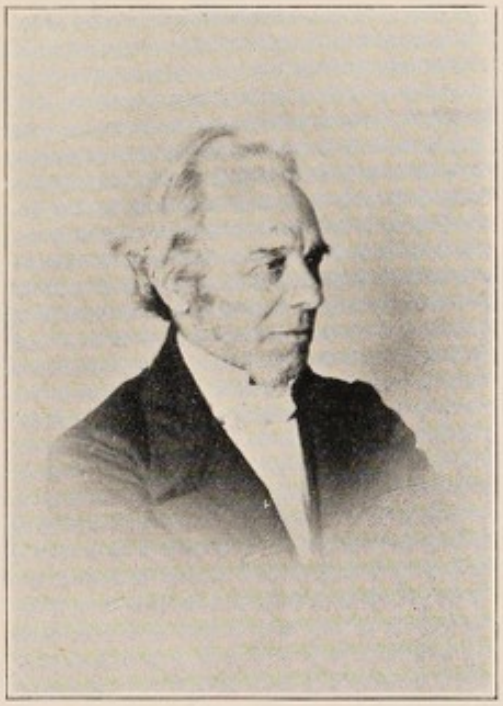
JOHN TYNDALL.

On July 4th, 1863, I married Lucy, youngest daughter of Edmund Potter, Esq., F.R.S., of Camfield Place, Herts, for many years M.P. for Carlisle. This was indeed for me "The Glorious Fourth"! Through joy and sorrow, the common lot of mankind, she has now for more than forty years been to me a true and faithful friend, a loving presence in all our halcyon days and a tower of strength in times of trouble.

The same year brought me another privilege, which, though less vital, was still a welcome one, the Fellowship of the Royal Society.

My first Friday evening discourse at the Royal Institution was given on April 4th, 1856, on the "Chemical Action of Light," at the suggestion of my friend Brodie (afterwards Sir Benjamin), who was at that time connected with the Institution. I was very young, being only twenty-three, and my topic, I am afraid, was not one of much general interest. The subject of my next lecture, on March 1st, 1861, was one which, however, had aroused the attention of the civilised world, *i.e.*, "Bunsen's and Kirchhoff's Discoveries in Spectrum Analysis." In 1862 I gave a course of three lectures on "Spectrum Analysis" at the Royal Institution, which I repeated at the London Institution in 1864. On Friday, May 22nd, 1863, I gave a further lecture on the direct measurement of the chemical action of

light, which was more successful than the former one on the same subject, because I was able to illustrate it by novel and striking experiments as well as to give the results of further investigation. I found that it was possible to seal up in a glass bulb the sensitive mixture of equal volumes of chlorine and hydrogen, and that the mixture contained in these hermetically sealed bulbs could be preserved in the dark for any length of time, and these lent themselves to a large number of striking experiments. One of the best of these consisted in enclosing one of these bulbs in a lantern, one side of which was glazed by a pane of red glass, another by a pane of blue, a third by a pane of yellow, and a fourth by a colourless pane. On firing in front of the red glass a mixture of chlorate of potash and magnesium powder no effect was produced, as the red glass cut off all chemically active rays. This also occurred with the yellow glass, but on firing the mixture in front of the blue glass a loud explosion took place, combination having been brought about by the more refrangible rays. On May 6th, 1864, I gave a lecture describing some recent discoveries by means of spectrum analysis, especially that of indium, and also discussed the application of spectrum analysis to the manufacture of steel. I had investigated this subject at Brown's Atlas Works in Sheffield, with the result that the chemical changes which occurred in the Bessemer process could be accurately noted, and the point at which it was necessary to cut off the blast of air was ascertained with a greater precision than was possible with the unassisted eye. On this occasion I also made use, for the first time, of the light of burning magnesium wire for photographic purposes, and photographed Faraday (here reproduced) during the lecture, having also done the same previously



with the chairman, Sir Henry Holland (see p. 41), and with old Sergeant Anderson, Faraday's laboratory assistant.[1] Mr. Brothers, of Manchester, who was the first photographer to use the magnesium light for portraiture, helped me.

In the autumn of 1864, I delivered the first of the public lectures at the meeting of the British Association at Bath on the "Chemical Action of Light," Sir Charles Lyell being the President of the Association; I also photographed him by means of burning magnesium. My lecture was on the Friday evening, and a singular incident occurred to me. Just before my lecture, I was collecting my thoughts and soothing my nerves by smoking a cigar at the stage-door of the theatre in which the lecture was to be delivered, when up came a military-looking man, and was for pushing past me. I said: "You cannot come in this way; you must pass in by the ordinary entrance." He replied: "Who are you?" I said: "Well, I'm the lecturer." "Oh, I daresay," he continued; "come, clear out." To which I replied: "It is you that will have to clear out." "Sir," said he, "do you mean to insult me?" "I have no such intention," I added; "but one thing is certain—you don't come in here"; and not being the bigger man he did not attempt to force his way in, but looking daggers at me said: "You perhaps don't

[1] Anderson was the sole assistant to Faraday, and, of course, was utterly uneducated in scientific matters; but he could obey orders, which is not always a characteristic of an educated man. One day Anderson was told by Faraday to keep stirring a pot containing some chemicals over a fire until he returned, Faraday being in the habit of going upstairs to tea in his rooms and coming down directly afterwards to work in the laboratory during the evening. For some reason he was prevented from coming down again and forgot that he had told Anderson to watch the pot. On coming down the next morning he found Anderson still stirring the pot, having been at it the whole night and thus carrying out the order which was given him.

know, sir, that I am Captain Snooks, of the Royal Dragoons, and I shall send my friend to call upon you in the morning, for I consider that my honour demands reparation." I said: "You can do as you like, and I wish you a very good evening." I think that the case of a man receiving a challenge from an officer just previous to his delivering a lecture to 2,000 people is perhaps unique. I do not know, however, that it affected my nerves, and I suppose my military friend thought better of it, for I never heard from him again.

The second public lecture was delivered on the Monday by Dr. Livingstone, and an amusing incident occurred at its commencement. Of course Sir Roderick Murchison, being present, introduced the eminent lecturer, and also as a matter of course Sir Roderick had had a good dinner with a bottle of port to follow, and when he came forward to introduce Livingstone he said with his accustomed *empressement*: "Ladies and gentlemen, I have the honour to introduce to you my distinguished friend Dr. Livingstone, who, as you know, has just returned from his celebrated travels in Asia." At which the whole audience roared with laughter. Sir Roderick at once pulled himself together and said: "I beg your pardon, ladies and gentlemen. The fact is we have been all the morning in the geographical section exploring all parts of the known and the unknown world, and for the moment I absolutely forgot where my distinguished friend had been. Of course I meant to say that he had just returned from his wonderful explorations in Africa."

The following letter from Lyell with regard to his address contains interesting reference to the subject then occupying many minds.

53, HARLEY STREET, LONDON, W.
17th Jan., 1864.

MY DEAR SIR,

I should like much to make a passing allusion in my Address to the British Association to Bunsen's discovery of cæsium and rubidium when I am alluding to the mineral waters of Bath. I shall only have room for a sentence on the subject, and should be much obliged to you if you would have the kindness to tell me in what year Bunsen discovered cæsium, and in the waters of what spring, and whether they were thermal waters, as are those of Bath, and what were the principal mineral ingredients in the spring.

Would you give me the same information in regard to rubidium?

If I mistake not, thallium is the only other metal brought to light by spectrum analysis? but not, I think, originally in the waters of a mineral spring. But for this I may look over Mr. Crookes' paper which I must have in the *Phil. Trans.*, so I need not trouble you.

I shall have no space for the history of spectrum analysis as a method, but I should like if I can to put our friend Bunsen's name in my address.

Iron, I see, is the only metal of which a minute quantity occurs in the Bath waters, just enough to be perceptible to the taste, while they retain their heat, but I suppose I may safely say of this or any thermal mineral water not yet experimented upon, that we know not what contents may not be revealed by spectrum analysis[1] when applied by such an investigator as Bunsen.

Believe me,
My dear Sir,
Very truly yrs.,
CHAS. LYELL.

P.S.—Was not the proportion of cæsium in the spring waters very infinitesimal? such as could never have been detected by any other method? Could I give any popular expression to the extreme minuteness of the quantity, such as a millionth part of the proportions actually borne by some of those ingredients that were previously recognised in mineral waters as occurring in the most minute quantities?

May I not say that it was by solar light that Bunsen discovered cæsium and rubidium?

[1] This prediction has been fulfilled by the discovery of radium, argon and helium in the Bath waters.

Has electric or other light also been used in the application of the principle of spectrum analysis to mineral waters? or their contents?

In the lecture which I gave at the Royal Institution on the "Opalescence of the Atmosphere" on June 1, 1866, I explained the action of finely divided matter in absorbing and scattering different rays of light, occasioning red sunsets, and the orange-coloured sun seen through a fog, &c. I wished on this occasion to illustrate my subject by Faraday's researches on the colour of gold films, in which he showed that finely divided gold imparts magnificent purple and green colours, as seen by transmitted light, to the medium, whether liquid or solid, through which it is diffused. I found in the laboratory of the Institution the bottles containing the finely divided gold suspended in water, in which, though the vessels had been standing for years, the heavy gold had not been deposited. I did not, however, find in the laboratory any of the gold films which he had prepared with gelatine, and I went up into his rooms at the top of the Institution, to ask him if he would be good enough to lend me some of these which he had preserved in watch-glasses, and put away in a box.

His mind was then failing, and it was quite sad to see that he hardly understood what I was asking for. Mrs. Faraday, who stood close by, tried to recall the facts to his mind and said to him: "Don't you remember those beautiful gold experiments that you made?" To which he replied in a feeble voice: "Oh, yes, beautiful gold, beautiful gold," and that was all he would say. Mrs. Faraday found the box, and I showed the specimens in the evening, and projected the image of the coloured films on the screen.

After the lecture was over I went to an evening

party at Mr. Hardcastle's, who was then Member for Bury St. Edmunds, and a connection by marriage of the Herschels, to meet Sir John Herschel, whom I had never seen. I found the great astronomer, who was only a year younger than Faraday (Herschel was born in 1792, Faraday in 1791), in perfect possession of his faculties, and the contrast between the two intellects, the one dying out, and the other still in full vigour, was brought home to me still further by a conversation which I had with Herschel. I mentioned to him a fact I had just learnt, which I knew would interest him. This was, that a day or two before our interview, my friend Joseph Baxendell, the well-known Manchester astronomer, had observed that a new star near the Greenwich variable No. 1773 of the 12 year Catalogue (1864)[1] had suddenly burst out and become a star of the first or second magnitude. Herschel was very much interested, of course, in this observation of the nova, which was new to him, and remarked: "Do you know that when I was at the Cape, I observed a similar phenomenon?" Then, considering for a while, "Yes, it was in the year 1835," and again after a pause, "On August the 16th, at one o'clock in the morning."

To say that Faraday was kindness itself to me, when as a young man I was lecturing at the Institution, is only to express what everyone experienced who came in contact with him. I remember so well how he used to come down with his cheerful face and manner, dangling his spectacles in his hand, to inspect the lecture table upon which I was making preparations for my lecture, and say: "Now, are you quite sure that all your experiments will go? Because, you know, if you are not, and if there is one which you

[1] *Manchester Literary and Philosophical Society Proceedings*, vol. iv. p. 22.

have some little doubt about, just omit it—they will never find it out!" He was most careful himself in the preparation of his experiments, even to the extent of trying the stoppers of all his reagent bottles beforehand. This method and precision Faraday carried out in all his doings. Each sample of gold-film on the watch-glass was carefully marked and every bottle in the laboratory in use was labelled by himself with his monogram MF.

Here are two letters I had from him, which exhibit his delicate thoughtfulness even on so small a matter as the return of a photograph.

21 *February*, 1857,
ROYAL INSTITUTION,
ALBEMARLE ST., W.

MY DEAR SIR,

Last night I placed the portrait of Bunsen in the Library, and that led me to get a friend to read the inscription beneath; and considering the case I am persuaded that I came to a false conclusion about it. Somehow I imagined that it came from Bunsen himself, but then I do not know him personally and the inscription tells me that it is a valued personal testimony to some one in particular, and I doubt not it is you. Now I should send it back to you at once by the carrier, but am not quite sure that I have your town address, so I use this letter as a means of knowing really where you are and with many thanks for your kind intention of showing it to us here, beg your pardon for my mistake and oblige,

Ever, my dear Sir,
Yours Very Truly,
M. FARADAY.

— Roscoe, Esq.,
&c., &c.

25 *February*, 1857,
ROYAL INSTITUTION,
ALBEMARLE ST., W.

MY DEAR MR. ROSCOE,

Your letter is very kind and I would on no account wish to offend you. But I know the value of a personal remembrance and I think the portrait ought to be in its right

place with you.—I think so of those which I have and should never allow a mistake to cause the displacement of the least of them. I would send the portrait back at once, but fear to annoy you in some way and so shall wait until I see you face to face and then—

Ever Yours Truly,

M. FARADAY.

H. E. Roscoe, Esq.,
&c., &c.

Everybody who has lectured frequently on the Friday evenings at the Royal Institution knows that the audience is a very peculiar one. It consists of ladies and gentlemen who for the most part have no knowledge whatever of the subject of the discourse. The lecturer must not only make his subject as plain as possible to the uninitiated, but must be able to give a scientific presentation to his colleagues and others of the "Fach" who honour him by their presence. I remember on one occasion, when I was explaining the origin and properties of some of the remarkable colours extracted from coal products, that a lady who had been an attentive listener came up, as is their wont, at the conclusion of the lecture, and said that she was particularly obliged to me for the information I had given her, for it had explained to her in a most satisfactory manner a question about which she had long sought for a solution, and that was concerning the colours of natural flowers. I replied that I was much pleased, but that I did not quite understand how my lecture had given her this information. "Why," she said, "it's quite clear: you have explained how these beautiful artificial colours are obtained from coal; coal, as you tell us, is present in the earth, and of course it is from the coal in the earth that the flowers obtain their various tints."

I once met at a ball a young lady friend who had

been attending Tyndall's lectures on light. We were dancing the quadrille when she was good enough to say that it was a great pleasure to her to meet me, because there were one or two points with regard to the polarisation of light which she did not fully understand, and she was sure I should be able to explain her difficulties before the end of the set.

In connection with these lecture amenities I am reminded of a story told by Huxley, who when delivering a lecture on the "Brain" at the Royal Institution thought that the mass of his audience were, so to say, entirely at sea, but that one lady followed him closely with appreciative glances. At any rate, thought he, there is one among my audience who understands me; and from that time forward he directed his observations specially to this lady. At the conclusion of the lecture the lady came up to him and begged leave to ask him only one question: "I did not quite understand," said she, "whether you said the cerebellum is inside or outside the skull."

One more amusing story comes into my mind. Sir Robert Ball, as we all know, is a most taking popular lecturer on astronomical subjects, and on one occasion, after delivering a lecture on "Sun-spots and Solar Chemistry," he met a young lady who expressed her regret that she had missed hearing him on the previous evening. "Well, you see," he said, "I don't know that it would have interested you particularly, as it was all about sun-spots." "Why," she replied, "it would have interested me extremely, for I have been a martyr to freckles all my life."

In 1869 I published the six lectures on Spectrum Analysis delivered before the Society of Apothecaries. This book met with a favourable reception. A new edition was called for within a few months, and in the

third edition I was assisted by my friend Professor Schuster in describing the newest developments of this fascinating branch of science.

I have always tried to make the illustrations in my books worthy of the subject. This was especially the case with the *Spectrum Analysis* and with the *Treatise*. In the latter I not only endeavoured to obtain the best drawings of the most modern plant used in chemical industries, but I also took photographs of the actual apparatus used in my own lectures. These were admirably engraved by Messrs. Vieweg and appeared both in the English and in the German editions. With regard to the book on Spectrum Analysis I received the following letter from Sir John Herschel:

COLLINGWOOD, *May 28th*, 1869.

MY DEAR SIR,

Accept my very best thanks for your exceedingly beautiful book, and not less interesting than it is beautiful. There was wanted just such a work to embody the vast mass of new experiment discovery and speculation which "Spectrum Analysis" is grown into and the whole scientific world is under a real obligation to you for its production. I have only dipped here and there into it, but enough to perceive that it is a real treasury of information. (Among things perfectly new to me those curious properties of Erbium and Didymium on p. 176 are peculiarly striking.) The list of Memoirs, &c., at the end is also most valuable, and it is really astonishing to see so assembled such a mass of laborious research on a subject so very new.

Once more expressing my thanks for this kindness, believe me,

My dear Sir,

Yours very faithfully,

J. F. W. HERSCHEL.

In the year 1865 I was asked to visit the copper mines at Mottram, near Alderley Edge, in Cheshire. Copper occurs there together with a large number of

other metals, notably cobalt, in the Keuper sandstone, each grain of sand being surrounded by a coating of copper carbonate and oxide of cobalt. The process of extraction consists in treating the ore with hydrochloric acid, the copper being afterwards precipitated by metallic iron or zinc. On my visit the manager showed me a dark blue solution which he believed to be a concentrated solution of a copper salt in a peculiar condition, inasmuch as it was not precipitable by zinc. I at once saw that this could not be copper, but that the blue colour was probably due to the presence of the very rare metal vanadium. I asked him to send me some of the solution to test, and found my suspicions confirmed. I inquired in what portion of the ore or residues he found this substance, and after a while obtained from him several tons of a lime precipitate containing this hitherto rare metal. I then worked it up so as to obtain a considerable quantity of the oxide of vanadium, and proceeded to examine the properties of this substance, repeating in the first place the experiments made by the Swedish chemist Berzelius, who had investigated its properties about the year 1838. In working at this subject I found certain discrepancies between my results and those of the great Swede, and after a very considerable time I came to the conclusion that he had been mistaken in the composition of the oxides, and therefore in the atomic weight of the metal. I remember very well it was in the summer of 1867, when we were staying at Roddam, in Northumberland, and I was making the calculation of my analyses that the true explanation of the difference between Berzelius' results and my own flashed upon me. The investigation, when completed, was published in the *Transactions* of the Royal Society, and also in Liebig's *Annalen* and the French

Annales de Chimie. The upshot was that vanadium, which had hitherto been wandering among the elements like a stray goddess (Vanadis being the Scandinavian name for Venus), was brought home to her relations and placed in an assured position among the elements. This is certainly the best piece of scientific work I ever did, and I do not know that I ever enjoyed anything of an intellectual kind more thoroughly. I may mention that I was assisted in the work at first by Dr. Thorpe, who made some of the important preliminary determinations, and afterwards by a young Hungarian, Mr. Oelhofer, and by Dr. Finkelstein, who all showed great ability. I believe a good deal of my subsequent ill-health was due to working on this subject in the old laboratory. I was obliged to use rooms which were not intended for such purposes, and breathing the bad air due to the presence of products of combustion, chlorine, and other horrors had certainly a deleterious effect upon me. The subject aroused very general attention throughout the scientific world, and my view concerning the relationships of the metal was universally adopted. Those who wish to understand this matter more fully can read the papers in the *Philosophical Transactions* (Bakerian Lecture, 1868), and also several lectures on the subject which I gave at the Royal Institution.

One further point of interest I may refer to without becoming too specially chemical. The explanation of the close resemblance between vanadium on the one hand, and phosphorus and arsenic on the other, is the chief outcome of this work. These three elements replace one another in all proportions, and minerals containing vanadium crystallise in the same form as, or are isomorphous with, those containing phosphorus and

arsenic. The researches of Berzelius gave results which, as I have said, stood in contradiction to these facts, and vanadium was isolated from its brethren until its true relationships were recognised. It is remarkable that whilst vanadium and phosphorus are so closely allied, a small admixture of the latter body changes altogether the properties of the former. Thus, if phosphoric acid is added to vanadic acid, the splendid crystals of the latter are changed into a dark, pitch-like, non-crystalline mass. This Berzelius was not aware of, although his vanadic acid contained plenty of phosphoric acid. This I know because I happened to find in the laboratory of the Royal Institution, on the occasion of a Friday evening lecture, a specimen in a bottle labelled "Vanadic Acid, from Berzelius." Of this I was permitted to take a few grains, and I found it to contain notable quantities of phosphorus.

When in Stockholm a few summers ago I made a pilgrimage to the Berzelius Museum, with the contents of which I was greatly interested. Minute tubes—by the hundred—containing the materials, from the whole range of inorganic, and from a good part of organic chemistry—which he had analysed, and many of which compounds he was the first to determine the composition, lay in a drawer. In looking over these precious relics of the work done by that "Viking" of science, I metaphorically bared my head in presence of the Master.

Berzelius lived and worked in the simplest possible manner. All these wonderful analyses were made, all his books and reports were written, in a two-roomed cottage. The kitchen was his only laboratory; the cook, Anna, his only assistant. "What is your master?" asked one of her neighbours. "Oh, he

is a chemist." "What's that? what does he do?" "Well, I will tell you: he has something in a big bottle, then he pours it into a smaller one, and then again into quite a tiny bottle." "Well, and what then happens to it?" "Oh, then I throw it away."

I think it may here be well to mention a few points of scientific interest which attracted my attention during my last few years in Manchester. I became possessed, through a friend in South Africa, of a considerable quantity of Kimberley diamonds. These all had a yellowish tint, and it would be worth much if this colour could be discharged and a diamond of pure water obtained. I daresay that it is known to many that if such yellow diamonds are immersed in powdered charcoal and then heated to a white heat and allowed to cool in absence of air, the yellow tint disappears, but unfortunately on exposing them again to light the yellow colour returns. I do not know any explanation of this, and I doubt whether either Sir William Crookes or M. Moissan can at present account for it.

The diamond which was burnt in a current of oxygen by Dumas and Stas in 1841 was, I believe, a Brazilian stone; at any rate it was not South African; and it became a matter of interest to note whether the South African diamond consisted of carbon giving an atomic weight identical with that yielded by the Brazilian stones. Strange things have occurred in chemistry, and it would be possible, at any rate, that the Kimberley diamond was something different from those obtained from other sources, so I burnt a quantity of the diamonds and obtained numbers closely agreeing with those of Dumas and Stas. So far so good. Still, we chemists know of elementary bodies possessing identical or nearly identical atomic

weights which are yet essentially different substances. To clinch matters, it was therefore necessary to show that the gas obtained by the combustion of the Kimberley diamonds gave the well-known spectrum obtained by burning diamonds from other sources and other forms of carbon. This Schuster and I accomplished; the spectrum of the South African carbon dioxide was identical with that yielded by other varieties of carbon.

I do not know that much of my other experimental work is of more than purely chemical interest. I may, however, say that I determined the vapour densities of the chlorides of thallium and lead, proving that each of these compounds contained one atom of the metal. I also discovered the existence of two chlorides of the metals tungsten and uranium, which had theoretically no business to exist; but they insisted upon it, and WCl_5 and UCl_5, though of anomalous composition, still maintain their individuality. Besides proving the existence of compounds which have no right to be there, I succeeded in disproving the existence of a so-called element. This was termed phillippium, and was the only one which at that time had no place in the periodic system, and I showed that it was a mixture of two others, terbium and yttrium.

The accurate determination of the spectrum of these rarer earth elements was a matter of importance, and Schuster and I mapped that of the pure terbium salts which I had prepared in the foregoing experiments.

During this period my students were also active, and many researches in their names appeared in the scientific journals of those years.

On October 9th, 1872, I distributed the prizes to the Liverpool Operatives' Science Classes, my subject being the scientific education of the working man.

By this term I did not mean to specify one particular class, for every man who supports his position or who gains a higher one than that in which he was originally placed, is a working man ; he who labours with the brain, by an expenditure of nervous energy, is as much a working man as he who labours solely by the force of his muscles. I said that the popular interest in scientific matters was only just beginning. I felt confident that before long there would be a means whereby anyone who had the requisite intellectual strength and perseverance might step from the bottom of the ladder up to the top. Such a system ought to be organised, and I believed firmly that this would be the case before my hearers were ten years older, and this prediction may be said to have been verified by the passing of the Technical Instruction Acts, and by the establishment of centres for science-teaching throughout the country.

In March, 1872, I had a letter from an Oxford tutor, and also one from Professor Clifton, suggesting that I should become a candidate for the vacant chair of Chemistry in the University ; they stated that, should I consent to stand, and should I be elected, a fellowship would be attached to the professorship. That I might be Brodie's successor was a tempting suggestion, but after some deliberation I decided not to accept the invitation, feeling that I had a wider scope and more useful life in building up the Chemical School in the Owens College.

On this subject I may quote letters I received from Professor Huxley and Sir William Fairbairn.

MY DEAR ROSCOE,

Many thanks for your kind letter of welcome. My long rest has completely restored me—as my doctor told me, I was sound, wind and limb, and had merely worn myself out

—I am not going to do that again—and you see that I have got out of the School Board. It was an awful incubus! Oddly enough, I met the Ashtons in the Vatican and heard about your perplexities touching Oxford—I should have advised you to do as you have done. I think that you have a great piece of work at Owens College and that you will do it. If you had gone to Oxford you would have sacrificed all the momentum you have gained in Manchester; and would have had to begin *de novo*, among conditions which, I imagine, it is very hard for a non-University man to appreciate and adjust himself to.

I like the look of the "Primers" (of which Macmillan has sent me copies to-day) very much and shall buckle to at mine as soon as possible—I am very glad you did not wait for me. I remained in a very shady condition up to the middle of March and could do nothing.

Ever yours very faithfully,

T. H. HUXLEY.

24, ABBEY PLACE,
April 16th, 1872.

MANCHESTER, *May 5th*, 1872.

MY DEAR MR. ROSCOE,

I was highly gratified to hear from Principal Greenwood last night that you had declined an offer of the chair of Chemistry from the University of Oxford, and that you were content to remain where you are and where you think you can render the greatest service to a profession which I entertain hope of your becoming a distinguished leader.

I am the more convinced that this will be the case from the circumstance that it is a much higher position to be a distinguished chemist in Manchester, where you are surrounded by so many practical workers, than to be locked up and end your days as an old Don at either Oxford or Cambridge.

I may be wrong, but I am clearly of opinion that there is a wide and open field before you in this district for attaining eminence in the profession as a successor to my late old friend Dalton. Allow me therefore to congratulate you on the choice you have made, and in wishing you a long and distinguished career of usefulness,

I am ever sincerely and truly yours,

WM. FAIRBAIRN.

In 1866 the first edition of my *Lessons in Elementary Chemistry* appeared. A fair copy for press of the whole book was written out by my wife. I had already done some small amount of work for Macmillan, but this was the first book of any importance. It seems it was published at the right time and suited the public, for edition after edition was called for, and up to the present year (1906) the number of copies sold is 211,000. I spared no pains to keep the book up to the level of the science of the day, and the publishers also grudged no expense in reprinting in order that this might be done. That the book should be so successful in England was more than I expected, but much greater was my astonishment that it should be received with favour in other countries. I sent a copy to my friend Prof. Lothar Meyer at Tübingen, and he urged me to have it translated into German, adding that he was sure it was just the book that was wanted for the German schools. I agreed; my friend Schorlemmer translated it, and it was published by the great scientific publishers in Germany, Frederick Vieweg and Son. I had always been accustomed to think that the Germans wrote scientific books for the rest of the world, but I suppose there is something in the expository powers of Englishmen which is to some degree wanting in the Germans. However this may be, the fact remains that the book at once found its way into the German schools and colleges, and that it has passed through so many German editions that the total number sold in that country from 1867–98 has been 57,500. At the present moment it is still largely in demand, in spite of the fact that whereas, in 1866, when it first appeared, there were scarcely any books of the kind in existence, thirty years afterwards their name was legion. I granted

many applications from other countries for translations, although, as we have no copyright agreements with them, I never received a farthing for any of the translations except from Messrs. Vieweg, who most punctually paid what we had agreed upon. Translations of the book appeared in Russian, in Italian, in Hungarian, in Polish, in Swedish, in modern Greek, in Japanese, and even in one of the Indian vernaculars, Urdu. Connected with this latter there is an amusing incident. The book was not printed but lithographed, and the page, instead of being small octavo, was nearly twice the size, and the illustrations of apparatus, &c., were magnified correspondingly. On page 24 of my book a description is given of the metrical system, and to enable the reader to understand it is a drawing showing the length of a decimetre, divided into centimetres and millimetres. In the Indian edition this drawing is also magnified!

The following letter from the translator, Amir Shah, accompanied his book, which he sent me:

LAHORE, *Dec.*, 1879.

SIR,

I am extremely obliged by your kind note of the 6th October last.

I hope the bound copy of my translation of your Elementary Lessons on Chemistry has safely reached you by this time and that it has met with your kind approbation.

I have done my best to make your book as popular and useful among the purely vernacular students here as it is among the Anglo-Vernacular students, both by translating it into easy idiomatic Urdu style, as well as by illustrative plates as are given in the original, and in conclusion beg to add that any addition or alteration which you may think desirable to suggest regarding the book will be most thankfully acknowledged by

Yours most obediently,

AMIR SHAH,
Assistant Surgeon McCleod Kapurthala,
Natural Science Fellow. P.W. College.

In the year 1870 Mr. Macmillan asked me to join Huxley and Balfour Stewart as editors of a series of science primers. Huxley wrote the introductory volume, to which reference has been made. This seemed to me more difficult than the subsequent ones, and more fitted for reading after the special primers had been studied than before. I wrote the Chemistry, Balfour Stewart the Physics, Geikie the Geology, Jevons the Logic, Hooker the Botany, &c. The Chemistry primer appears to have met a want. It was written from the purely objective point of view, and was intended to serve as the first step in chemistry for young boys in schools. The experiments described were of an exceedingly simple nature, and of such a character that they could be made by the boys themselves. The total number sold up to the present year (1906) amounts to 355,000. Translations have appeared in Icelandic, Polish, German, Italian, Japanese (1874, published by the Educational Department of the Japanese Government), in Bengali (Calcutta, Thacker and Co., 1876), in Turkish (J. R. Alexander, American Mission Training College, Assiout, 1892), in Malayalam (Krishnan Pandalay of the Presidency College, Madras, 1893), in Tamil (T. P. Masilamany Pallai, Jaffna, 1903).

The following characteristic letters, hitherto unpublished, were written by Clerk Maxwell to my colleague Balfour Stewart with reference to the primers :

GLENLAER, DALBEATTIE,
June 25, 1871.

DEAR STEWART,

I was very glad to see your handwriting again. I hope you are now quite strong again. I have written my name on the sheet you sent me. I have endeavoured to do so in a consciencious [*sic*] manner, but I have failed entirely, as the

composition, though tolerably grammatical, did not touch my conscience (as the French say) and signed. Stuart's lectures in Liverpool seem to have done no harm, rather otherwise. I do not myself believe in Science of any kind as the principal pabulum of the half-cultivated mind ; crude notions in Science are about as unwholesome as Lemprière's dictionary in a slightly different way. They appear as if they would satisfy the love of the marvellous, but they soon get stale for want of human interest. For beginners the best mental pabulum is some kind of history about people, expressed in good style. These things remain in the mind ; and if it is the practice for everybody to learn the same thing, then when they meet in after life they associate upon a common understanding. The Greek knew his Homer, the Jew knew his Bible and so did the Britisher until of late, the M.P. used to know his Horace, &c. And even in Science it is when we take some interest in the great discoverers and their lives that it becomes endurable, and only when we begin to trace the development of ideas that it becomes fascinating.

Yours truly,

J. CLERK MAXWELL.

11, SCROOP TERRACE, CAMBRIDGE,

5th Feb., 1873.

DEAR STEWART,

Many thanks for the three primers. I have not much time on my hands, but it is possible I might do geometrical optics if such a book were wanted. The mechanics, that is to say the doctrines of matter and motion stated simply, is the most important, but at the same time the most difficult subject of all. The thing to remember with beginners is that it is as easy for them to learn right notions as wrong ones, and that precise language is as intelligible as loose language. Above all things, never argue against any prejudice which they have not had time to imbibe as if they were already (like ourselves say, when boys) imbued with it, for by the diffusion of Science, its paradoxes are transformed into truisms.

This is not criticism of the primers, it is criticism "at large."

Magnetism is a very good subject for beginners to experiment on, but I think optics still better. The experiments succeed so much better than in most other subjects.

I would arrange the subject in the order which I think best also for Nature students—begin with experiments on lenses and mirrors, and show how to use them so as to produce

desired results, and afterwards go on to the laws of reflection and refraction, the composition of light, its velocity, its alternations.

Then comes a statement about wave propagation and wave surfaces (not including double refraction as yet) and the explanation of reflection, refraction, interference, &c.

Then if it can be done in the space the simpler parts of polarisation, which are by no means as simply done in books as they ought to be. I see I have an optical disciple, Sig. Casorati, who has adopted my plan of doing optical instruments, but has restored all the things which I purposely cut out of the theory in order not to confuse the student.

Yours very truly,

J. CLERK MAXWELL.

N.B.—I can do nothing till June, and am not sure of my time even then.

On visiting one of our large public schools I was informed by one of the masters that my book was used in the school. I said, "I suppose you use my Lessons in Elementary Chemistry?" "No," said he; "we use your shilling primer." I added, "Of course for the small boys. What book do you use for the higher classes?" He replied, "We only teach chemistry to the elder boys and we use your primer." I hope this cannot be taken as a type of the science-teaching in our secondary schools. Here were boys from sixteen to eighteen years of age, the sons of well-to-do persons, who were being taught chemistry out of a book which I wrote, so to speak, for little boys out of the street.

A much more serious business than the writing of these small books was the preparation and publication of the *Treatise on Chemistry*. In the writing of this I had the advantage of the co-operation of my friend and colleague Schorlemmer, to whose power of work and knowledge of the science, especially the historical portion of it, I have already alluded.

Reviews of the first volume of this book were very favourable, and the opinion expressed that it was destined to take rank as *the* English treatise on chemistry has, I may say, without egotism, since been fully borne out. Schorlemmer at once translated it into German; it was published in 1880 by Vieweg; and the reception it met with in Germany, both from the reviewers and the public, was even more favourable than was the case in England.

From time to time fresh editions of the book were called for in both countries. Owing to Schorlemmer's untimely death in 1892 (see portrait), the English Organic part, for which he was specially responsible, has not been finished, and I fear it never will be. The task of writing a complete work on organic chemistry is an extremely difficult one, inasmuch as this portion of the science is not only constantly receiving enormous additions, but also undergoing changes which are truly revolutionary. Hence before the end of the subject is reached, the earlier volumes are already antiquated. In the last few years the inorganic volumes have been re-written, and I have been aided in this by my friends and former pupils Drs. Colman and Harden, so that at any rate the two volumes of the inorganic portion will be complete and up-to-date. A new German edition has recently been published under the editing care of Professor Classen in Aachen, and is largely used in the colleges and technical schools in Germany, whilst the organic portion of the work has now been completed in German, thanks to the labours of many contributors, especially of Professor Brühl of Heidelberg.

Before closing this account of my literary work I wish to add a few words about the late Mr. Alexander

Warwick Brookes Photo. Walker & Boutall, Ph. Sc.

C. Schorlemmer

Macmillan, the founder, together with his brother, the late Mr. Daniel Macmillan, of the firm of my English publishers. He was a good and valued friend. His success in life—and it was great—was in my opinion mainly due to his knowledge of men, and especially of young men. He knew the kind of man who could produce a book that would sell and he got him to write it. If the list of "Mac's" books of fifty and even sixty years ago were looked through, one would be astonished at the number of authors whom he backed to write good books and who succeeded in doing so. But he was successful not only in drawing good men and true to his counter, but to himself. He was thoroughly upright and straightforward in his dealings, possessed an intelligent interest in topics of the most diverse kind, and had a racy Scottish humour which made him an excellent companion and a charming host. I have dealt with the firm—father, son, nephews, and Craik—for fifty years, they have treated me liberally, and it is a pleasure to see the continued success of their eminent house.

CHAPTER VII

WORK AT MANCHESTER (*continued*), 1872–80

British Association, Liverpool and Dublin—Post at Bart's—Eclipse Expedition, Sicily—Noxious Vapours Commission—Paris Exhibition, 1878—French Men of Science—Owens College—Jubilee of Chemical Society—Society of Chemical Industry—The University of Manchester.

THE autumn of 1870 was rendered scientifically memorable by the fact that Huxley held the post of Commander-in-Chief of the Army of British Science at the Association meeting in Liverpool. His presidential address concerning the mighty actions of the infinitely small is an example of what such a discourse should be. I acted as one of his general staff and presided over the Section of Chemistry. In my address I referred to the outbreak of the Franco-German War, into which the two most scientific nations of the Continent were then plunged, and in which even the professors of chemistry and their pupils took a humane part. I called attention to the influence which the brotherly intercourse of those interested in the progress of science and its applications all the world over exerts in appeasing animosities so fatal to the welfare of humanity such as those of which we were then the spectators.

About the same time I put forward a proposal to form a National Science Union, which should have for its object to secure the common action both of men

of science and those anxious to promote its progress in obtaining more adequate recognition of the importance of science to the public welfare and in urging the necessity of some well-considered measures of State action.

History here repeats itself, for the matter has been taken up (1905) by other scientific men, particularly by Sir Norman Lockyer, who has inaugurated a movement of a similar kind which I hope will meet with general approval, my efforts in this direction having apparently been premature.

On October 12th, 1870, I received the following letter from the late Mr. George W. Callender, the well-known surgeon, offering me the post of lecturer on chemistry at St. Bartholomew's Hospital.

47, QUEEN ANNE STREET,
Oct. 12th, 1870.

DEAR SIR,

Odling has written to you respecting the vacancy at St. Bartholomew's which has occurred by reason of the unhappy death of Dr. Mathiessen. I need not say how pleased we should be to welcome you among us, and I venture to hope you may think it worth your while to take the matter into your consideration. Odling has, I believe, represented to you the general position of the affair; but I shall further be very pleased to give you any information in my power respecting the duties and emoluments of our chair of Chemistry. I believe it is considered that our laboratories are in excellent order; in fact, poor Mathiessen was left to order and to arrange for just what he liked, and he was quite satisfied with the result.

With kind regards I am always yours faithfully,

GEORGE W. CALLENDER.

This invitation I felt obliged to decline.

In December, 1870, I went to Sicily with a number of scientific friends, on a Government expedition to

witness the total eclipse of the sun which was to take place that month. The party consisted of some thirty or forty persons more or less cognisant of astronomy and spectrum analysis. Among them were Mr. Vignolles, C.E., and his son ; Sir Norman Lockyer and his wife and niece ; the late Professor Clifford ; Mr. Brothers, the photographer, of Manchester ; Sir George Darwin, Dr. Thorpe, and the late Mr. Bowen, of Harrow, who acted as my assistant ; Mr. Seabroke, of Rugby, and myself. We had special carriages run through to Naples, over the Brenner, and a luggage van with our telescopes and other apparatus. We stayed twenty-four hours in Rome, and saw the breach in the wall through which the Italian troops had entered only three months before. On passing the gates of the Castle of St. Angelo, I was amused to notice on the one side a Papal Zouave as sentry, whilst opposite him keeping guard was a soldier of the Italian army. Upon inquiring why this was so, I was told that the Roman populace had so bullied and insulted the Papal soldier when he was alone, that an Italian sentinel was placed at his side to protect him. At that time it will be remembered the Leonine city was Papal.

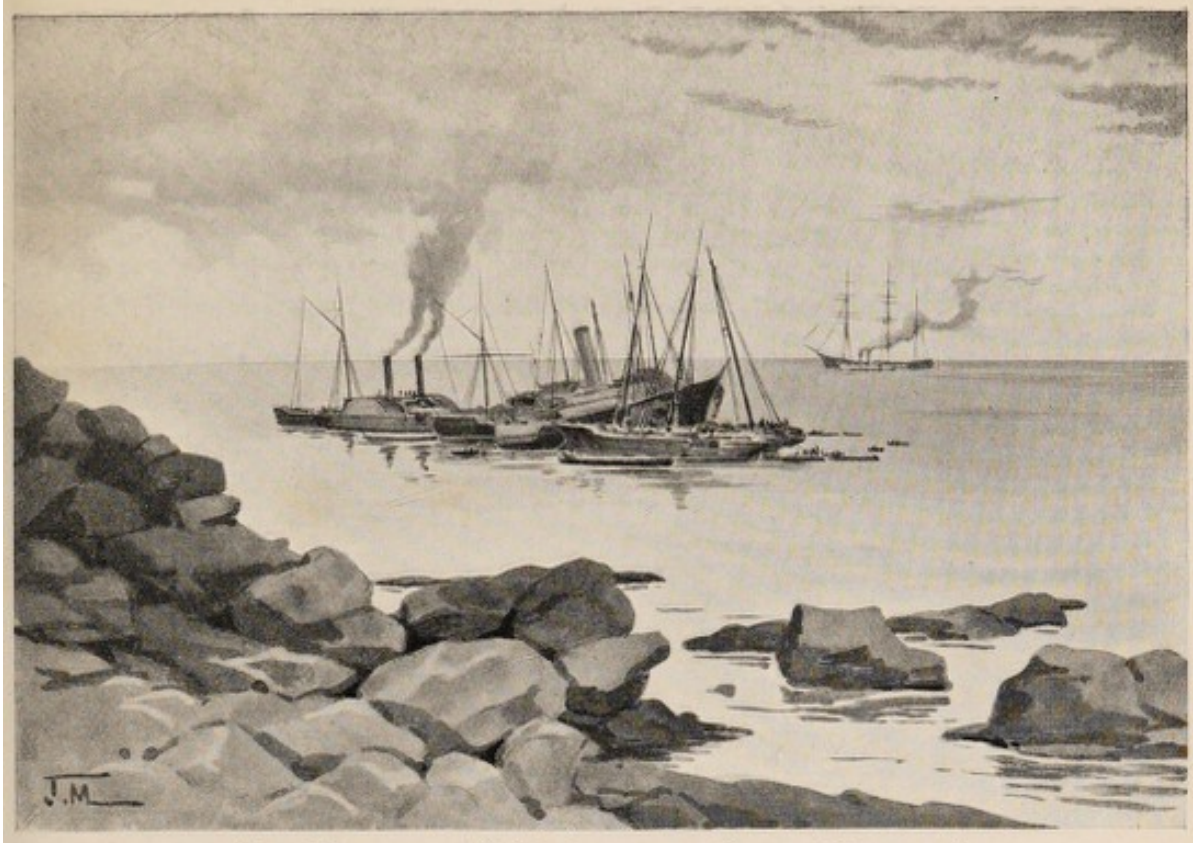
At Naples we embarked in H.M. despatch boat *Psyche*, which had been told off for the service, and in it we proceeded to Sicily. Passing through the Straits of Messina the ship was steered near land so that we might enjoy the coast scenery. About noon, with a calm sea and bright sunshine, we were approaching Catania, and passing about a mile and a half to the north of the celebrated Cyclopean rocks, when Captain Fellowes went below with Mr. Lockyer to arrange about the discharge of some of our apparatus at Catania. Some of us were

standing on the bridge enjoying the scene, when we noticed some Sicilian fishermen in their boats close in front of our steamer gesticulating violently, and in a few seconds the ship ran on a pointed submerged rock near Cape Molino. We were thrown down by the concussion, the vessel shivered from stem to stern, with a grating noise like that of a bandbox being ripped up. She came to a dead stop, and settled down at the stern.

It was soon found that the rock had penetrated the ship, and fortunately she stuck fast; otherwise she might have slipped off into the deep water on either side, and many of us would doubtless have been drowned; as it happened, the captain, rushing on deck, finding that the ship was fast on the rock, at once assured us that we and all our apparatus would be put safely on shore, but he added, "I am a ruined man." The behaviour of the officers and crew was admirable; and all our party were quickly landed upon the neighbouring rocks, below the village of Aci Reale. I was asked by the captain to take charge of the party on land, and of our apparatus, which soon followed us, together with the ship's books and plate. The inhabitants began to arrive in shoals, and I ordered a guard of marines to form a cordon above the rocks to keep the people from pillaging our effects. When we were preparing to leave the ship someone asked where was Mr. Vignolles. He was not to be seen, and Dr. Thorpe went to look for him in the cabin, and found the old gentleman quietly seated writing his diary. It was only after some expostulation that he could be induced to pack up his writing materials and take his place in one of the boats, when he immediately proceeded to light a cigar. After all our gear was put ashore, the boats were again manned, the cases containing the telescopes

and other apparatus were placed in them, and the blue-jackets rowed us safely into the harbour of Catania, a distance of some ten or twelve miles. It was certainly a well-ordered shipwreck, for no one even wet their shoes.

We stayed some little time at Catania, an old monastery, from which the monks had only recently been expelled, having been placed at our disposal for our scientific preparations. It was arranged that I should take charge of an expedition on Etna. The party consisted of Bowen, Darwin, Seabroke, and myself, and we were accompanied by the late Professor Silvestri, of the University of Catania, whose acquaintance with the district was of great service to us. After some labour we reached the Casa del Bosco, at a height of about 5,000 feet, and therefore about half-way up the mountain. The site was an admirable one for our purpose. There we spent the night, having unpacked all our apparatus. The morning broke bright and clear, and we congratulated ourselves on being in a perfectly transparent atmosphere, whilst mist obscured the vision of those who remained below. All our preparations were made (see illustration) and we were in high spirits, expecting that we should have a splendid view of the eclipse, when, much to our chagrin, shortly before the first contact clouds were seen on the horizon. These gradually shut out the landscape, snow began to fall, and in a few minutes we were in the midst of a heavy snowstorm, and the sun was completely hidden. During totality we were of course left in gloom, so that we did not obtain a glimpse of the corona. Still more provokingly, the last contact had scarcely occurred before the clouds blew over, and we were again in brilliant sunshine. I had brought some champagne to celebrate our victory,



THE WRECK OF H.M. DISPATCH BOAT "PSYCHE."

ROSCOE AND BOWEN "READY."

and I felt that it was more needed even in the circumstances of our failure than it would have been had our expedition proved successful.

As it turned out, those who were at a lower elevation, especially the party under Mr. Brothers at Syracuse, saw the eclipse perfectly, and brought home some most interesting photographs of the appearance of the sun at totality; whilst Dr. Thorpe at Catania obtained some valuable curves expressing the diminution of the sun's light during the progress of the eclipse as measured by the darkening effect by the solar rays on normal chloride-of-silver paper.

As soon as the news reached Malta that H.M.S. *Psyche* had been lost, the admiral ordered the whole of the fleet to repair to the spot to endeavour to recover the vessel (see illustration). All efforts were unsuccessful, and the admiral, fearing that a storm was rising and knowing the dangerous character of the neighbourhood from sunken rocks, decided to leave the *Psyche* to her fate, and an advertisement appeared in the papers a few days afterwards that the wreck would be sold by auction. I believe the boat was sold for £100, having cost the nation £30,000. It was an unfortunate error of judgment. We had no business to be so near the shore, and instead of altering the course when we approached Cape Molino, which jutted out, the navigating lieutenant, in the absence of the captain, who, as I have said, was below looking after our effects, ran straight upon the submerged rock. One thing that could be said in favour of the officers was that the rock was not shown on the chart which they were using. This chart was an old French one, and no other was forthcoming, although a complete survey of this dangerous volcanic coast had been made by the British Navy

a few years before, the results of which were carefully docketed in a pigeon-hole at the Admiralty!

In June, 1876, I received a letter from Mr. Cross, the Home Secretary, asking to be allowed to submit my name to the Queen for appointment on the Noxious Vapours Commission. I accepted the nomination, and was engaged for some time with my colleagues, in visiting the alkali and copper works in various parts of the country, and in framing a report and recommendations. Lord Aberdare was chairman and Mr. Fitzgerald secretary. Many of our recommendations are now embodied in the amended Alkali Acts of 1891 and 1892. In the first place, the amended Acts extended the schedule of works in which the escape of acid fumes could be regulated; secondly, they provided for an apportionment of damages amongst the various contributors thereto; and thirdly, provided that all acid drainage must be kept apart from the alkaline drainage of the waste heaps, thus preventing a serious nuisance from the escape of sulphuretted hydrogen.

The escape of noxious vapours cannot in all cases be prevented without seriously interfering with trade. For instance, in glass works an enormous quantity of salt cake (sulphate of soda) is employed, the sulphuric oxide being given off in the process of fritting the materials. No one has yet proposed a method by which these acid fumes could be collected or absorbed without greatly damaging the industry by reason of the costliness of such a process. There is, however, no doubt that our recommendations were of great value in extending the operation of the Acts and in rendering their provisions more effective.

In the autumn of 1877 the British Association held its meeting in Dublin, Allen Thomson being

President, and among other members I was selected for the honour of a degree. I was unable to be present at the time, but I went over to Dublin the following year, and on January 21st, 1878, the late Earl of Dufferin, the Earl of Rosse, and I were the three recipients of the honorary LL.D. The translation of the Latin address to me written by the Senior Proctor is as follows:

PROFESSOR ROSCOE

Right Hon. Vice-Chancellor and all the University (and you especially, you young men, who are shouting so loud), lend me your ears! This college, according to her wont, desires as a mark of honour to enroll among her graduates three men, already overwhelmed with other honours. I therefore present to you first a distinguished professor, Henry Roscoe, a *savant* who has devoted himself completely to chemistry, and who in that science has won the highest honours. He, in the analysis of the sun, has shed on the sun itself the light of science. Casting aside the false images of Democritus, he has grasped the true images of things. He has verified what with Lucretius was an empty boast,

"Sunt igitur jam formarum vestigia certa
Quae volgo volitant subtili praedita filo."

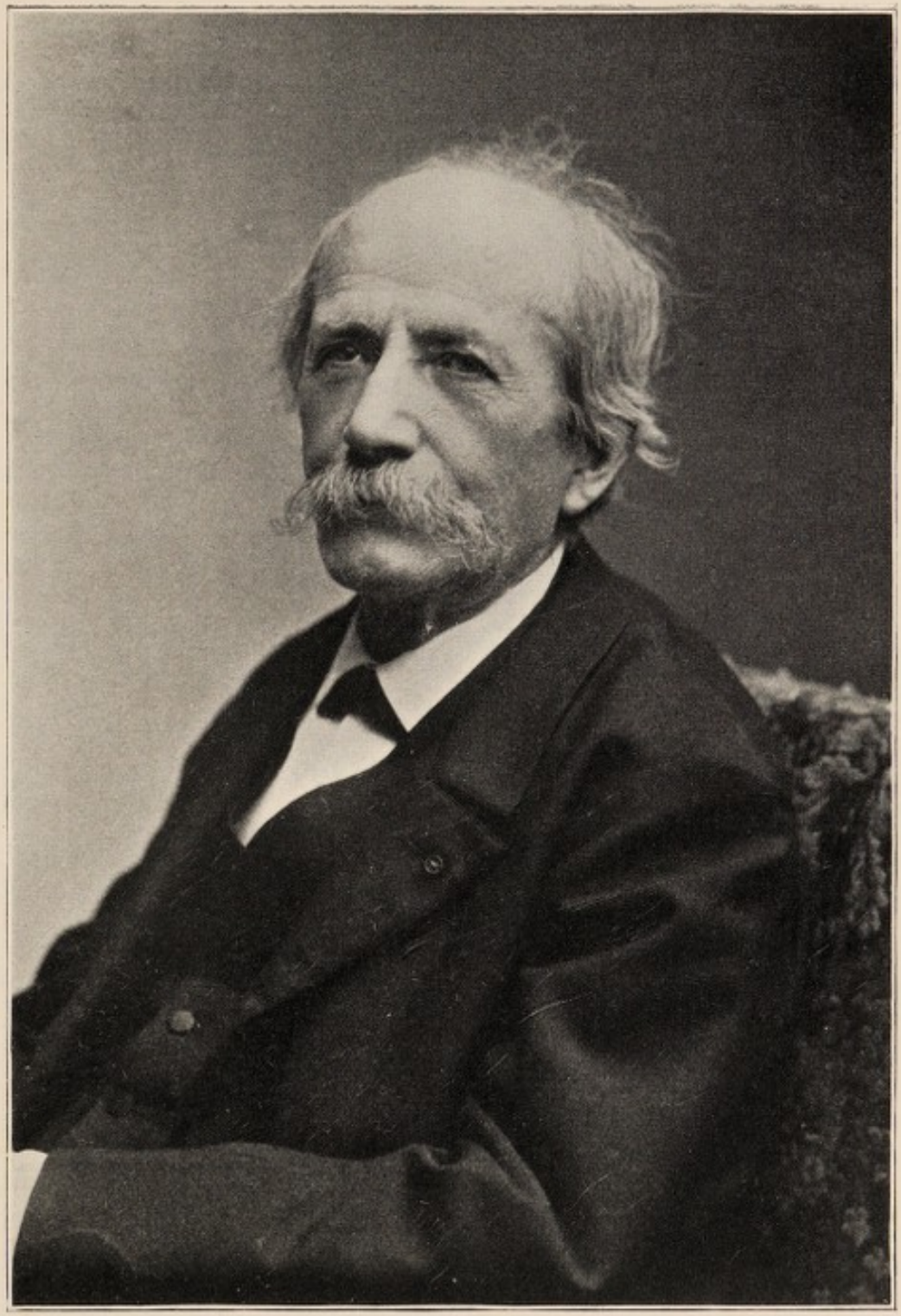
Irish humour is proverbial, and Trinity College was in this respect then fully represented. Sam Haughton at one end of the table and Machaffy at the other in the Combination Room drew each other out and a brisk time we had of it. The one reverend gentleman asked the other to relate how he operated on the young lions in the Zoological Gardens. "Is it the lions of the Association you mane? If so, bring them along and I will operate at once," was the reply.

In June, 1878, I received an invitation from the Prince of Wales, as President of the Royal Commission for the English Section of the French Exhibition of that year, to act as member of the jury for chemical products. So in the autumn of that year, accompanied

by my wife, my son, and my nephew, Edmund Potter, I spent some time in Paris. It was on this occasion that I became acquainted with the celebrated chemist Dumas, then the *doyen* of French science. I dined with him, and after dinner he led me to a sofa and, smoking his cigar, said: "I have seen many phases of life; I have moved in Imperial circles, I have been Minister of State; but if I had to live my life again, I would always remain in my laboratory, for the greatest joy of my life has been to accomplish original scientific work and, next to that, to lecture to a set of intelligent students." Dumas was quite the *grand seigneur*, an impressive personality. He came over to London to deliver the first Faraday lecture and charmed his audience by his eloquence.

The work on the jury was somewhat fatiguing, but I think that on the whole our awards gave satisfaction. The heat in Paris was intense, and the relief from that high temperature when crossing the Channel was a thing to be remembered.

My frequent visits to Paris gave opportunity for meeting many eminent French scientific men. First and foremost among these I put Würtz, both as a friend and as a man of science. I often visited him both at home and in his laboratory in the old Ecole de Médecine, long since demolished. He, like many distinguished Frenchmen, was an Alsatian—in fact, a German—by birth. His family name was Wirtz, but this is unpronounceable in the mouth of a Frenchman, and so he was re-christened Würtz. His mother, he told me, could not speak a word of French. He was as great an expositor as he was an experimentalist, and those who heard his Faraday lecture will long remember the striking play of voice and feature so characteristic of French oratory.



M Berthelot

Then I knew Henri St. Claire Deville, of aluminium fame; Balard, the discoverer of bromine; Friedel, a great mineralogist, as well as a distinguished chemist and the most lovable of men. These have all joined the majority, but their names will be remembered as those of men who did much to uphold the high standard of French science. One of my friends of that day remains, Marcelin Berthelot, the permanent Secretary of the Institut. I met him first in 1857 in Heidelberg, and since then have often enjoyed seeing him in Paris. He is not only an indefatigable worker but a voluminous writer, and as an historian of early chemistry is unequalled. Then he is a statesman, having acted both as Minister of Education and of Foreign Affairs. A Frenchman *par excellence*, he played an active part during the siege of Paris. A life-like portrait of Berthelot at the present day will be found facing p. 164.

Of Pasteur I shall have much to say in a subsequent chapter.

On October 7th, 1878, I distributed the prizes at the Liverpool Science and Art Classes, and endeavoured to explain my view of the difference between modern scientific training and the kind of education which the world had known for generations. It seemed to me that they differed chiefly in this, that the old system was one in which the information or knowledge was crammed down the pupils' throats, and was therefore essentially one of learning by rote, a system which I designated as the "*as in presenti*" system;—the Latin grammar was set before an unfortunate boy, and a certain number of pages had to be committed to memory, whether the boy understood or not. The scientific system, on the other hand, was one of inquiry; it was an inquisitive system; the word

"why" must be constantly on their lips; they did not accept a statement without some kind of proof; the proof might be in some degree incomplete or even erroneous, but at any rate it was the best they could get at the time. Science was nothing but systematised common sense. I added that it would ill become me speaking in Liverpool, to decry in any way the benefit both of historical and literary studies, but at the same time I believed that all education ought not to be purely literary, and that it was a mistake that scholarship was the only road to culture. In speaking of the science classes I said that Government had been perfectly right in beginning this system of spreading wide the knowledge of and interest in scientific subjects; that it had been well said that Faraday, the bookbinder's apprentice, was the greatest of Sir Humphry Davy's discoveries; and that if in the course of a generation they succeeded in rescuing one Faraday, the country would be amply repaid, not only for all the work but for all the money that the nation had spent upon him.

It is to be remembered that at that time such classes as these were the only means of a scientific education in Liverpool, and many years elapsed before the foundation in that city of a university college which has since become a university.

The benefaction of £100,000 by a comparatively unknown Manchester merchant, John Owens, in the year of grace 1848, for the foundation of a college in that great city of manufacturing industry, but then of little intellectual activity, was a most remarkable occurrence. It was the beginning of a movement for the higher education of a university type among the masses which has led to results of a national importance that cannot be overrated and of which the end

is not yet. For no sooner had Owens College risen to a point of eminence after years of struggle, than the interests of Liverpool were aroused, and through the liberality and open-handedness of its citizens, a college second only to that of Owens was founded. A like action was taken by Leeds, Birmingham, Bristol, Sheffield, Wales, and Nottingham. All these provincial university colleges were established and long entirely maintained by private effort. It took years for the Government to understand that these were essentially national institutions, upon the development of which the prosperity of the country depends, but at the present day £100,000 a year is voted by Parliament towards their support. After a while the several communities also became aware that their individual progress was intimately connected with that of their colleges, and municipal aid is now freely voted. With many of these university colleges I have had the honour to be connected as a member of the Governing Body. That of Liverpool had, of course, a special interest for me from the connection of my family with that city. A chair of Modern History (Civil and Literary) was founded in memory of my grandfather, William Roscoe, and it is also of interest to remember that a lectureship in Italian was established concerning which Mr. Gladstone wrote the following letter :

HAWARDEN, *October* 31, 1891.

DEAR SIR,

Special obligations under which I have come to this place oblige me, as a general rule, to decline all local contributions, which are numerous. Nevertheless, I cannot avoid sending you a small sum in token—for it is only a token—of the lively pleasure with which I have read your letter, and learned that an Italian professorship is to be founded in the Liverpool University College. At the present period, when

fashion, which governs so much, has set its face against the general teaching of Italian in this country, and when, in consequence, it has come to be confined within the narrowest limits, I think it a real and very high honour to the town of Liverpool that it (and, for all I know, it alone) should have made this effort, and brought it so nearly to success may be both speedy and permanent, and that in that great community you may be enabled to bring back the days of Roscoe and Shepherd.—I am, dear Sir,

Your very faithful and obliged,

W. E. GLADSTONE.

Professor E. Londini.

As time went on, and the importance of these colleges was more fully recognised, they blossomed into Universities, and now Manchester, Liverpool, Leeds, Birmingham, and Sheffield have each received a University Charter, whilst Wales boasts also of a University containing three university colleges. And this great movement, certainly one of the greatest educational movements of our time, received its first impulse from John Owens' gift.

The difficulties which are met with in delivering experimental lectures at a distance from his own laboratory are only fully realised by the lecturer himself. Probably these difficulties were never more acutely felt than by myself in giving lectures on spectrum analysis. For these lectures my friend and assistant, Joseph Heywood, and I had to carry about with us a whole paraphernalia of batteries, acids, electric lamps, Rhumkorff coils, and a host of minor breakable articles, for this was before electricity could be had by pressing a button. It frequently happened there was no convenient place where I could set up the battery of some forty or fifty Grove cells which was needed. If it was placed near the lecture-room, the smell from the fumes was something unbearable; if it

was put up outside, it frequently rained and all sorts of difficulties would arise. Sometimes the zincs in some of the cells were not properly amalgamated and they were corroded very rapidly, or, what was worse, sometimes the porous cells had been injured in transit and the nitric acid got at the zinc, and then there was a nice mess, and the battery had to be taken to pieces and cleaned.

The responsibility of making all the experiments succeed is no light matter, and no one but those who have gone through the experience can understand the excitement and worry which such lectures entail. The lecturer has to assume a confident air, and yet he cannot be certain that at the last moment he will be able to perform what he has promised. Where merely drawings have to be exhibited or slides shown the thing is entirely different. To carry out a lecture on spectrum analysis at that time without help of the dynamo required all one's presence of mind and skill. Nothing detracts more from the effect of a lecture than when a certain result is anticipated and explained beforehand, as it is necessary to do, the thing does not come off. It does not mend matters when the lecturer says, "Oh, well, this is not very important; we will go on to the next."

I did not, as a rule, allow my public lecturing to interfere with my college work, and I have often, after packing up all my apparatus, a matter of no slight difficulty, travelled late at night in order to meet my class at nine o'clock the next morning. I remember on one occasion I had to give a lecture in Birmingham. I met my class at Owens College in the morning; I packed all my apparatus after the lecture, took the train to Birmingham, arrived there about three o'clock, worked for three or four hours in preparing the lecture,

delivered it from eight to nine o'clock, packed up my traps, caught the night mail at twelve, got home at three a.m., and lectured to my class at nine in the morning. But with all this I enjoyed lecturing very much.

The packages of apparatus which I had to take about were often of portentous size and strange appearance. On one occasion, after a lecture at Hull, my assistant Heywood and I, encumbered by many packages, arrived at the station as our train was on the point of departure, to be greeted by an excited porter: "Now, you Punch and Judy men, take your seats at once."

I used to order glass apparatus for my laboratory from Vienna, and it generally arrived in many large cases before the beginning of the session. One year the things did not turn up, although they had been despatched in proper time. After a while an indignant carter arrived at the college with the goods. "Does Bosco live here? I have been all over the place seeking him." Bosco was a celebrated conjurer who had recently visited Manchester, and these packages were supposed to contain some of his tricks.

In the autumn of 1879 I was invited by the Borough Council of Liverpool to give a course of public lectures in the concert room of the St. George's Hall. These were very largely attended, and appear to have been appreciated by the audience. I afterward received a copy of a resolution of thanks passed at a meeting of the Borough Council.

In December of that year I was elected, together with Marignac, of Geneva, an honorary member of the German Chemical Society. This I greatly value, as the number of honorary members is a very restricted one.

In the year 1880 I was elected a member of the Philosophical Club of the Royal Society, and in 1881 I was nominated as President of the Chemical Society. This involved my attendance in London at the meetings of the council, as well as of the society, every fortnight for two years, and also my being present at many gatherings of a social character in London.

The Chemical Society of London is an institution which has exercised a most beneficial influence on the progress of British science. My election as Fellow dates from 1855, but I was not an original member of the society. It was inaugurated a generation before me, by men whose names are watchwords in British chemistry. The society has for its main object the encouragement of original chemical research, and its influence on the extension of such work has been most marked. It now numbers nearly 3,000 Fellows, and its monthly Journal contains not only a full statement of the original work of British chemists, but also abstracts of that done in other countries. At the meetings, papers are read and their results discussed, whilst valuable annual reports on the general progress of the various branches of the science are published. Moreover, funds are appropriated in aid of scientific research, and medals are awarded for its successful prosecution. It was my good fortune as President to present on the part of the council the first Longstaff Medal to my friend and distinguished pupil Dr. Thorpe, for his important investigations published during the three previous years.

The society celebrated its Jubilee in February, 1891. My friend William Russell was President, and amongst other functions naturally came a dinner.

The chief guest of the evening was the late Lord Salisbury, who delivered a masterly speech on the intellectual pleasure to be derived from the pursuit of science for its own sake. No less eloquent was the recognition by the ever-lamented chemist of Heidelberg, Victor Meyer, of the part played by the society in the development of the science. I responded to the toast of "Science and Industry," proposed by Sir Richard Webster (now Lord Alverstone).

To reply to this sentiment might entail a discourse on the progress of civilisation during the last fifty years. For has not science during that time remodelled entirely every condition of life, while man himself remains much as he was? We read that Horace, when advised by his physician to take the waters of Clusium (as any dyspeptic might be advised to-day by his physician to go to Bath), wrote to ask about the water supply of the place, and having, I presume, received satisfactory information, went to the baths, as we do now. How insignificant do political changes appear compared with the changes which science has wrought in the world! Look where we will, in every department of human knowledge and activity, in all climes, and throughout all classes of society, we see the beneficent action of science. There is not an industry which does not owe its success, nay, even its existence, to the application of scientific principles. But how is this union of science and industry, of theory and practice, to be made more fruitful? Only by the appreciation by all classes that practice without science and without theory is unpractical, and that industrial progress without science is impossible. England has happily become at length aware of this great fact. The word technical instruction has become world-wide, and we see the necessity of scientific education, in order that we may preserve our national supremacy. But public attention has yet to be awakened to the importance and necessity of fostering and stimulating provision for the higher teaching of science. It is to the master rather than to the man that we must look for those improvements and discoveries by which alone industry can be rendered permanent. It is the pride of such societies as our own to develop this higher scientific training by the encouragement of original investigation. To enlarge the boundaries of our knowledge of Nature is

the first step towards rendering the appreciation of that knowledge available for the practical benefit of mankind and of our country. Where would chemical industry now stand if it had not been for the labours of Dalton? If he had not pointed out the laws which affect chemical combination, if Liebig had not laid clearly before us the principles on which organic chemistry is founded, could Perkin have established the coal-tar industry? Could Graebe and Liebermann have discovered alizarin, Baeyer artificial indigo, or Fischer prepared sugar in his laboratory, unless the ground had been thus prepared for them?

The Society of Chemical Industry was founded in 1880. It originated with a few men interested in the Lancashire chemical trade, notably Eustace Carey, Ludwig Mond, and Edmund Muspratt. It was originally proposed that the society should be a local one, the object being to bring together purely scientific men and those practically engaged in chemical industry in the Lancashire district. I felt strongly the importance of such a proposal, but I thought that if the thing were worth doing at all it should be a national and not a local institution. I gradually obtained adherents to this view, and the society was founded on these lines. The first list showed that we had obtained already 360 members; at the present moment the numbers are over 4,000. The history of the society during the quarter of a century which it has existed has been one of constant progress and success, and its influence is felt not only in this country and our Colonies (Canada and Australia), but also in America, where we have one section in New York and another in Boston.

I was elected the first President, and many distinguished chemists, both scientific and industrial, have succeeded me in the presidential chair. The work which the council has done in publishing a Journal under the able editorship of my old pupil

Mr. Watson Smith has been beyond praise. Besides original communications it contains an abstract of patents; in short, a *résumé* of what is doing all the world over. There is no doubt that this society has greatly stimulated the study of chemical science among manufacturers, and the meetings have always been successful and interesting. Two citizens of the United States, eminent chemists, have already been elected Presidents of the society, which is thus shown to be an international one. The general meeting for 1904 was held in New York under the presidency of Sir William Ramsay, while that of 1905, in London, was presided over by Dr. W. H. Nichols, of New York, whose address on the planning and organisation of a chemical works forms very interesting reading.

As its first President I look back with pride on its achievements, and especially rejoice in the fact that it is an American as well as a British institution, and helps to strengthen the intimacy and good feeling which happily exists between the two nations.

One feature of the annual meeting is the dinner. My lamented friend Walter Weldon was one of the most active members of this society as well as our poet. The following is one of the verses of his song, sung to the tune of *The Leather Bottel*:

> As I survey this room around,
> And note the faces which here are found,
> And see so many men, like me,
> Who live by chemical industry,
> Who often in trade compete and fight,
> But have dined together like lambs to-night;
> I pray that all blessings his may be
> Who founded our Society.

Concerning the foundation of the society I received the following letter from Professor Hofmann:

BERLIN, 24 *June*, 1881.

MY DEAR PROFESSOR ROSCOE,

I have heard with much pleasure of the formation of the Society of Chemical Industry under your auspices. I need not tell you how much I sympathise with this movement. Having had the privilege, in early life, of associating with many of the leading representatives of chemical industry in Great Britain, remembering as I do, with feelings of sincere gratitude, how often and how effectually my scientific labours have been furthered by their liberal assistance, deeply impressed, moreover, with the conviction of the material advantages which are likely to accrue from their alliance, not only to industry and science, but to the progress of mankind, I consider it both a duty and a pleasure to join the Society which you have just started, and which, I have no doubt, will soon become a worthy sister of our Chemical Society of London.

Will you be so good as to insert my name in the list of members, and to convey to the Fellows the expression of my heartfelt wishes for the rapid success of the Association?

I remain,

My dear Professor Roscoe,

Yours very sincerely,

A. W. HOFMANN.

THE UNIVERSITY OF MANCHESTER

The history of the foundation of a new English University is a matter of interest to all who have the progress of the country at heart. And as I had much to do with the creation of the Victoria University of Manchester, I need not apologise for introducing the subject, showing how, from a comparatively insignificant local institution, Owens College rose to the dignity of an important national University. But first let me describe the incident which led to the proposal to convert the college into a University.

The fame of the Manchester Penny Science Lectures for the People reached what the Scots term "the second city of the Empire," and I was invited to give

the opening lecture of a similar series which a committee in Glasgow had established. My lecture on "The Chemical Action of Light" was given in 1878, in the large St. Andrew's Hall, before a crowded audience. After it was over Sir William Thomson (Lord Kelvin), who had presided at the lecture, remarked to me, "Why do not you make Owens College into a University?" I said that we had often talked about it, but that we thought the time had not yet arrived for so momentous a proposal. He replied: "You are quite mistaken. The time *has* arrived; you have quite attained a University position, and you ought to make it the University of Manchester." Thinking the matter over, I came to the conclusion that he was right, and on returning home consulted my friend Dr. Ward, now Master of Peterhouse, who was then our Professor of History, on the subject. He at once fell in with the suggestion, and after some time we convinced our Principal, Dr. Greenwood, who was of a cautious disposition, that we ought to make the attempt to found a new English University.

The official beginning of the movement was, however, the drafting of a statement which Dr. Ward laid before the Senate, and which was also largely circulated among a number of eminent men, containing the arguments in favour of the foundation of a University for Manchester.

To place, in a clear light, before the Lancashire public the value of the possession of a University in its midst was a task which we set ourselves to accomplish, for without the support of public opinion nothing could be done. For this purpose I drew up a statement which appeared in the local Press, the arguments from which I append.

The proposal to found a new University in the North

of England was one the value of which was then hardly appreciated by many of those whom such a foundation would benefit. It was said that it was not clear how the establishment of such an institution would affect the great middle classes of the community. It is true that everyone was sufficiently well aware of the importance of the spread of primary education, and even of the necessity for a higher training, especially in those branches of science which have a direct bearing on our staple trades and manufactures; but how the establishment of a new national degree-giving University could touch the masses of our northern population was not so evident. And yet, if the proposal had anything of life in it, if it had any *raison d'être* at all, it could only be in so far as it supplied a want keenly felt by the workers in these great hives of industry. It must be the "University of the Busy," as distinguished from the old Universities of Oxford and Cambridge, which are still and will probably remain the "Universities of the Wealthy."

Though the idea of a University was a new one to the bulk of the population of Lancashire, it was neither a new nor a strange one to the sons of the Scotch peasants or the sons of the shopkeepers or farmers in or near Glasgow or Aberdeen. We had only to look at Scotland to find the boon of a popular University life and culture properly appreciated. Did anyone doubt the blessings which the Scottish Universities have, for many generations, conferred upon the middle and poorer classes of their country? Let such a one learn how the poor students in Edinburgh, Glasgow, and Aberdeen work in a garret and live on oatmeal porridge during the winter months, attending the University classes, to go back again to the plough or to the counter in the summer to enable them to attend next winter session.

Such a boon the Privy Council had been memorialised to advise the Queen (to whom the prerogative belonged) to bestow upon Manchester. Surely our community with its multitude of densely populated manufacturing towns was as fully entitled to the advantages of a University as the cities over the Border. Surely, too, the time for demanding such an increase in our educational facilities had fully arrived. What tenable ground then could there be for hesitation on the part of the Government in granting the prayer of the memorialists who, in such unprecedented force and numbers, appeared before the Lord President? In the Colonies, in India, in Ireland many Universities had been founded. Had we been 2,000 miles distant from London instead of 200, we should have had a University long ago. The proposal to found a new *English* University seemed, however, to some otherwise apparently well-balanced minds to savour almost of sacrilege. We were told by some that the great institutions of Oxford and Cambridge with their great wealth can do all that England could legitimately require in the way of the highest academic culture. Others, again, affirmed that a new University would lack all that prestige which the old institutions alone could enjoy. Some expressed a fear that what they were pleased to term our new-fangled degrees could never compete with the older and more refined and less provincial seats of learning, and that to multiply Universities was simply to lower the tone of the higher education. We were kindly advised to tack ourselves on to those great old institutions as poor and rather vulgar country-cousins, or admonished that we must altogether give up our hopes of doing more than we did at present. But we in Lancashire knew perfectly well that thousands among us had

sons who were well qualified for and desirous of receiving University training, but who could not afford to go to Oxford or Cambridge. Moreover, there is a great deal in the *genius loci*. We knew, or we thought we knew, what we wanted in this busy North of England, and we were not quite so sure whether the Dons of Oxford and Cambridge knew it as well as we did ourselves. Our type of University culture must, whilst providing in the fullest sense for a liberal education, bear the impress of our local life and requirements, and no one but ourselves could efficiently direct or control that culture. This control is what we asked for: we simply wished to work out our own salvation in our own way. We were, we claimed, to all intents and purposes, a University already; our students were University students both in age and education; our courses of instruction and our class examinations were fully up to the University standard; and as regards numbers we did not compare unfavourably with many Universities of high standing in our own and in other countries.

The full details of a story unparalleled in the annals of English education will be found in Alderman Thompson's volume on the history of Owens College, to which reference has already been made.

To go back to still more ancient history, it is not generally known that long ago unsuccessful proposals to form a University in Manchester were made. Thus, as early as 1640 Henry Fairfax wrote to his brother Fernandino, the second Lord Fairfax, enclosing a memorial from the public of Manchester praying the Long Parliament to grant a Charter to a Northern University, adding, "Posterity may bless you and the work will speak for itself that the like hath not been in England (if Cambridge be the last) not of two

thousand years." The Knights of the Shires for Lancashire and Cheshire being consulted by Fairfax on the matter, "he found them hopeless of having it. The way to effect it must be by Bill, which will be a charge of 100 marks at least [£66 13*s.* 4*d.*], and therefore I think it fittest to let that rest, and let none come to solicit it in this troublesome time, when all business of the commonweal is at a stay, my Lord Strafford still keeping us in play." Troublesome times pass over, but these are not the only difficulties which beset the founding of new institutions; for when Cromwell had leisure to propose a Member of Parliament for Manchester, and to give ear to the other desires of the town, rival claims sprang up in York, the Wars of the Roses were again waged, this time on educational grounds, the upshot being that Cromwell gave to neither the University which each desired, but by sequestrating the funds of the Dean and Chapter he founded the University of Durham. In 1798, and again in 1836, similar proposals were made; but the citizens of Manchester had to wait for the accomplishment of their wishes until the Victorian era (1880), when a Royal Charter constituting the Victoria University was granted by her Majesty.

This Charter did not give a University to Manchester alone, as was originally proposed by the Owens College authorities. That institution was joined with two other teaching bodies in the North, namely, the University College of Liverpool and the Yorkshire College at Leeds, and a form of Federal University consisting of these three constituent colleges was established. Under this Charter the Victoria University proved to be an undoubted success; the high character of its degrees was acknowledged by all, and its growth and prestige were remarkable. In conse-

quence of this very success each college at length felt that it was strong enough to become a local University, and at last this came about. Manchester has now its own University with the name of Victoria attached to it, while Liverpool, Birmingham, Leeds, and Sheffield have each received a Charter of Incorporation, so that each of these cities has its own University complete in its various faculties.

When the subject of applying for the original Charter was under consideration, I received the following three letters, the first from Lord Kelvin, and the others from Professor Sir Benjamin Brodie.

April 1st, 1877,

THE UNIVERSITY, GLASGOW.

DEAR ROSCOE,

I was very glad to receive your note telling me that Owens College is now thoroughly resolved to apply for a University Charter. I hope you will be successful. Indeed, I cannot doubt, considering the strength of your claim, that you will be so. I do not believe that any existing University in our country deserves better to be a University than does Owens College. And I believe that Owens College being made a University will be beneficial, not only to itself, but to education throughout England, and generally to the cause of Universities and University education. I return the memorial, which came to me when I was on the point of writing in reply to your previous note.

Yours very truly,

W. THOMSON.

June 2, 1876,

BROCKHAM WARREN, REIGATE.

MY DEAR ROSCOE,

I enclose to you a letter giving my views about the foundation of a Manchester University. As I entertain a very decided opinion on the question, and am much interested in it, I have thought it well to give some of the reasons on which my opinion rests. If you were simply going to do over again what is already done at Oxford I should care less about

the matter, but I hope you will do something different and something better.

You are at liberty to publish the letter in part or otherwise, as you may think expedient.

I should have replied to Mr. Ward before now, but I have been much out of sorts, and have only just recovered the power to do or write anything at all.

With kind remembrances to Mrs. Roscoe, I am,

Sincerely yours,

B. C. BRODIE.

Sept. 7, 1876,

BROCKHAM WARREN, REIGATE.

MY DEAR ROSCOE,

I enclose to you a note which I have received from Lord Selborne, which you may like to see. He has kept your letter, which is well. Please return to me Lord Selborne's note when you have done with it.

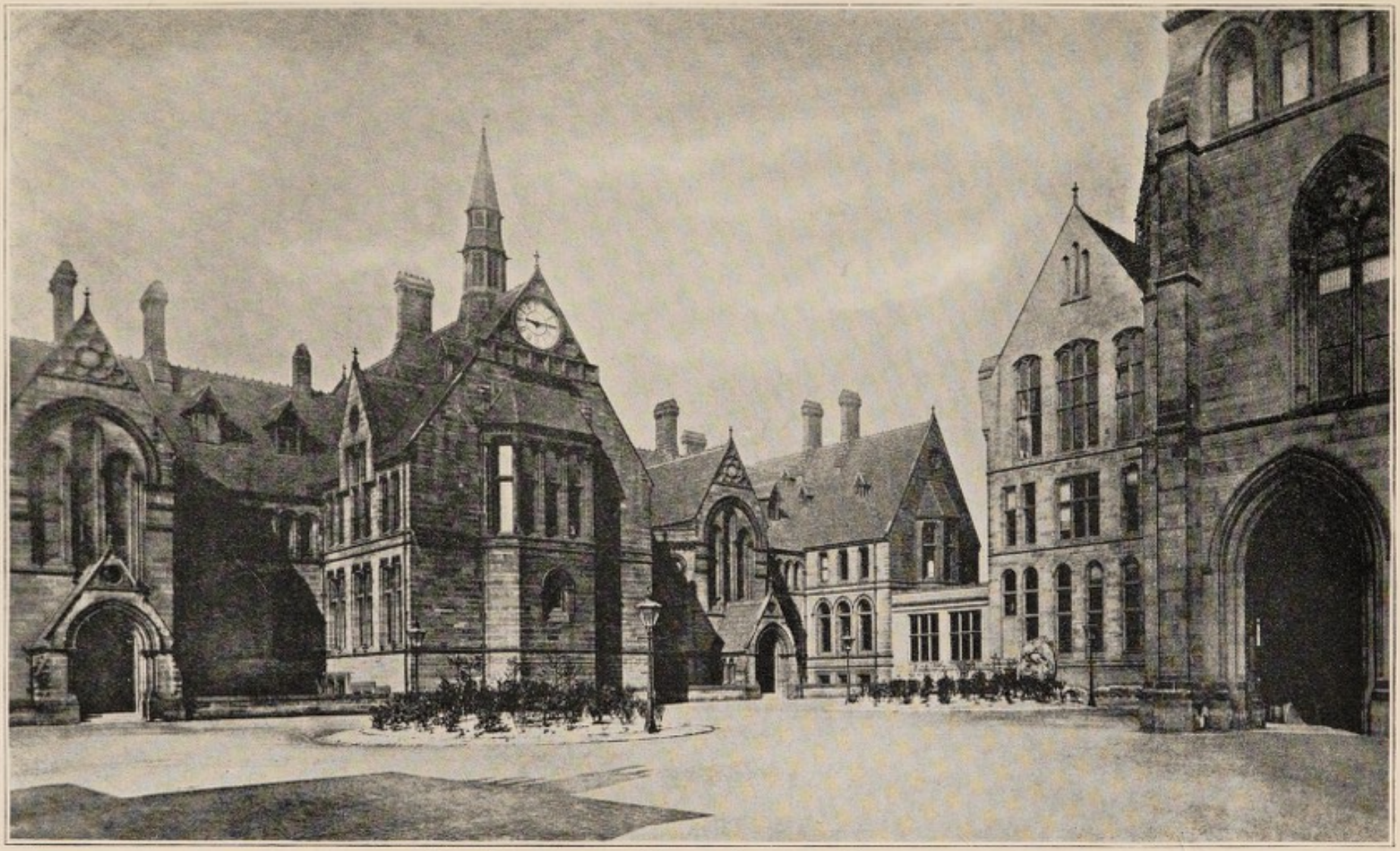
I see from the letter in the *Daily News* that a good deal of opposition will be made to the foundation of the "Manchester University." This is no reason for not prosecuting the movement, but rather the reverse, for your opponents are showing how weak their hand is. Henry Smith,[1] who was here on Sunday, and with whom I spoke on the matter, said that he did not anticipate that any opposition to it would arise in Oxford. Indeed, why should it arise? for there is nothing in the principles on which your University would be based of which they would disapprove—your line would mainly be the same as theirs—whereas to the principles of a mere examining University like the University of London they are much opposed. University College and King's College have by no means been successful, except in their schools, and I fear have no inclination to support the upward movement of others.

It appears to me desirable for you to get up a powerful North of England movement, if you can, with an address to the Prime Minister—but I would back this up by an address of a more limited character to be signed by scientific men and others, who desire the establishment of the University, not merely from local motives but in the interest of knowledge itself.

Sincerely yours,

B. C. BRODIE.

[1] The late eminent Professor of Geometry in Oxford.



THE QUADRANGLE, OWENS COLLEGE, MANCHESTER.

The great event of the year 1880 was the inauguration of the Victoria University (some of the buildings of which, as they stand to-day, are shown in the photograph) by the Chancellor, the late Duke of Devonshire. A *soirée* was given at the Owens College on the 13th of July, and a banquet in the Town Hall on the following day.

An accident occurred at this *soirée* which might have had serious results. I was lecturing on spectrum analysis, illustrated by the use of a dynamo which had been presented to the college by Dr. Henry Wilde. The chemical theatre was packed with distinguished people, both ladies and gentlemen, and I was in the middle of my short lecture, when by some mischance, in handling the electric lantern, the alternating current passed through my body, and my hands became fixed to the two brass pillars of the lamp. I suffered great pain, but without showing it, I called to Heywood, my assistant, who saw what was the matter and cut off the current. If I had not remained perfectly quiet, or if I had attempted to remove my hands, a fearful explosion would have occurred, for near the electric lantern were several large prisms filled with that most volatile and combustible substance, bisulphide of carbon, placed on a somewhat rickety stand, and many gas flames were near. If I had attempted, as I have said, to withdraw my hands, I should have pulled the whole thing over, the bisulphide of carbon prisms would have fallen and broken, and the vapour would certainly have caught fire. What might then have ensued is almost too dreadful to contemplate, as the audience could only have escaped from the room with difficulty, and there is no doubt many lives would have been sacrificed. I may add that as soon as I was released I went on with the lecture, and few, if any, of the audience knew what had happened.

In April, 1881, the first meeting of the Court of Governors of the Victoria University was held. The labour connected with the arrangement of the curricula for the degrees was no light one. Indeed, it is only by those to whom the task had been assigned of initiating the first new English University that the difficulties of drawing up a scheme which should be at once of high academic character and yet in accord with the requirements of the locality can be fully appreciated. Among those to whom the University was in this respect most indebted must first be mentioned the name of Professor A. W. Ward, afterwards Principal of Owens College and Vice-Chancellor of the Victoria University, and now Master of Peterhouse. Dr. Ward brought to bear on the question, not only a full appreciation of the requirements of a University situated in a great centre of industrial and commercial life, but a complete knowledge of the older University systems of England, Scotland, and Germany, and a devotion to the cause and a clear- and fair-mindedness which were in themselves a guarantee of success.

Among the many others who worked for the foundation of the University, the names of Joseph Gouge Greenwood, our first Vice-Chancellor, and Principal of the college, and Richard Copley Christie, who gave to the University his magnificent library, and to whose munificence we owe the Whitworth Hall, will never be forgotten.

Other members of the college staff with whom I worked for thirty years in perfect harmony, and who also aided in one way or another in the great work, were the late Augustus Wilkins, the classic ; the late William Crawford Williamson, the authority on the flora of the coal measures ; Boyd Dawkins, still the

distinguished Professor of Geology in the University; Professor Arthur Schuster, now one of the foremost of English physicists; and last, but not least, my eminent friend Osborne Reynolds, *facile princeps* among scientific engineers of the day.

At the first meeting of the University Court, the most interesting question which was debated was whether Latin and Greek should be made compulsory for all degrees. It was proposed by the Board of Studies, consisting of the professors and teachers in the constituent colleges, and supported by the University Council, that for candidates for Science degrees an examination in modern languages should be allowed in the place of that in Latin and Greek, but on this stubborn question of ancient versus modern languages the final resolution could not be passed without the test of a division. A report in *The Times* of April 15th, 1881, of this matter, adds that perhaps the argument most decisive with the Court on this question was given in the words of Professor Roscoe, who said "that they had to consider the large number of persons who came to the Owens College for special instruction, more especially for engineering and mathematics, but who had never been at any school where Latin was taught. These were the men who carried off the best engineering prizes, and for them it was that this door had wisely been kept open. They must not be guided by what Oxford and Cambridge had done, but by what was good for their own district, and by what was advisable at the present moment. Let them remember how large was the number of men such as he had described in their neighbourhood, and how flourishing were the mathematical schools. And then let them say whether they could cut off these schools and scholars from

University education." Finally the Duke of Devonshire, while conscious of the dangers of the experiment, was unable to shut his eyes to what had been said as to the requirements of classical knowledge excluding a large proportion of those who were likely to take advantage of the new University. On a division, the resolution to exclude classics from the Science degree curriculum was carried by eleven to five; that is to say, by a majority of more than two to one. A leading article on the subject appeared in *The Times* of the 16th of April, in which the following passage occurs: "Thus, though a new feature has been introduced into English academical education, it is not such as to alarm or startle reasonable minds, nor will there be room for the somewhat illiberal prejudices entertained as to the degrees conferred by the new University. The proficient in engineering or in science will not be a Bachelor of Arts, but a Bachelor of Science. This provision, it may be hoped, dispels the fear that the prestige of the older Universities has been impaired by an influx of degrees bearing the time-honoured names, but covering a host of upstart plebeian accomplishments. Perhaps the strangest feature in the objections to dispensing with Latin and Greek in the Victoria University is the quarter from which they proceeded. Apparently the men who might have been chiefly expected to entertain a healthy disregard for worn-out educational superstitions were the very men who wished to retain them. The possessors of academical honours, on the other hand, deprecated the continuance of a curriculum which they saw to be unsuitable to the local genius, and of which they had witnessed even in their Universities the disadvantages as well as the benefits."

CHAPTER VIII

TECHNICAL EDUCATION

Royal Commission, 1883–4—Foreign Experiences—Our Report—Addresses on Technical Education—Royal Commission on Secondary Education.

DURING the summer of 1883 I was standing with the other members of the Royal Commission on Technical Instruction in the streets of Amiens, and I called the attention of my colleagues to the fact that the walls were placarded with notices, signed by the Mayor of the town, stating that the Municipal Schools in Amiens would be opened on a certain date. "How long will it be," I said to my companions, "before we in England see an announcement like this? And how many years shall we have to wait until our country is roused to feel the necessity, long foreseen in France, of establishing a national system of technical education?"

But the unexpected often happens. What then seemed almost an impossibility soon turned out a reality. Thanks to the influence brought to bear upon public opinion—mainly by the Report of our Commission—England awakened, and, what is more, England made up its mind that the thing had got to be done, and Parliament showed this in the most forcible manner possible, by finding the money to do it. Not only do we now see notices like those in France posted

up in all our large towns—calling attention to the opening of municipal technical schools and classes—but on almost every gate-post throughout rural England similar notices may be found of county council classes, not only in agricultural matters, such as dairying and butter- and cheese-making, but in the great variety of useful subjects permissible under the Education Acts.

The object of the Commission was especially to bring before the English public the extent to which foreign countries, particularly Switzerland and Germany, were ahead of us as regards this kind of education, upon which it was felt the future progress and position of England as a manufacturing and commercial nation depend, and how far the flourishing industries in these countries had been stimulated and supported by the technical education which had there been developed. By that is meant education in the principles of the arts and sciences underlying industry and commerce.

No one whose opinion is of value pretends that the technical school can supplant the workshop or the factory. To be an adept in any handicraft the experience of long continuous work in the shop or at the loom is, of course, essential. The school teaches the principles, scientific, mechanical, or artistic, upon which the industry is based. The workshop puts those principles into practice. The school does not consider economy of production ; at any rate it cannot carry out economy in detail ; whilst in practice economy, that is, the proper relations between production and expenditure and between quality and quantity, is an essential condition of successful work.

Respecting this difference between the teaching in a technical school and the information as to manu-

facturing processes gained in the factory, the following story may be cited. A cotton operative—a minder—came to the Principal of the Municipal Technical School in Manchester, and said: "Mr. Reynolds, I have come to see if you will allow me to attend the class on cotton manufacture, even if only occasionally, for I want to see the various kinds of cotton machinery." Mr. Reynolds asked, "What is your special need?" "I want to see," the man answered, "what sort of a thing a carding machine is. I cannot get into the carding-room in our mill—the boss once allowed me to have a look in at the machine on the payment to him of 4*s.*—so I have come to the school in order that I may have a good many looks at it both inside and out, so as to see how it works, and become acquainted with its principles." My friend admitted this man, and he made good use of his opportunities. In the mill the hand is kept to one job, and probably not allowed to see any other department than that in which he works. In the school he can examine the various methods of manufacture from the raw material to the finished product; he sees all the machinery at work, and he thus obtains a general view of the whole nature of the manufacture and the principles upon which it is based.

Even at that time the subject did not fail to attract attention from the public, and *The Times* of March 13th, 1882, in a leader says: "The cause of Technical Education in this country will not fail for want of illustrious patronage and earnest endeavour. To-day the Prince of Wales will preside at a meeting of the Governors of the City and Guilds of London Institute, at which will be presented the second report of the Council. . . . Last August a Royal Commission was appointed to inquire how far the current opinion

(*i.e.*, that foreign industries are surpassing English ones) is borne out by the facts. The names of Mr. Bernhard Samuelson, Dr. Henry Roscoe, and Mr. Slagg among its members will show its competence."

The Commission was a singular one, inasmuch as each Commissioner had to pay his own expenses, the Government being responsible only for the secretarial expenditure and cost of printing. From my knowledge of Germany, and of what was being done in the way of science-teaching in that country and generally on the Continent, I was willing to undertake this responsibility, and the result proved to be not only interesting, but, as I venture to think, important in the industrial history of the country.

My colleagues were Mr. (the late Rt. Hon. Sir) Bernhard Samuelson, the great iron-master, a man of varied commercial experience, intimately cognisant of the industrial conditions on the Continent, as well as at home, and, moreover, perfectly acquainted both with French and German; the late Mr. John Slagg, M.P., whose knowledge of the cotton trade in general was very complete; Mr. (now Sir) Swire Smith, who represented the great woollen trade of Yorkshire, and had taken much interest in educational matters; Mr. (now Sir Philip) Magnus, who represented the London Guilds; and the late Mr. William Woodall, M.P., who was well acquainted with the pottery district and the important industries in that neighbourhood. Our secretary was Mr. Gilbert Redgrave, of South Kensington, who brought to bear on his duties great knowledge, great enthusiasm, and complete devotion to the cause.

Our journeys abroad, as well as those in this country, were of a most interesting and successful character. As they are fully indicated in the report, I will not

attempt to describe them here at any length. Everywhere we were received with the greatest hospitality and kindness ; we were scarcely ever denied access or refused information, though our inquiries extended not only to the schools and educational institutions, but also to the industrial establishments in the various commercial and manufacturing centres both at home and abroad, our object being to ascertain how far the systematic education given to the workmen, to the overseers or foremen, and to the masters abroad, and the comparative lack of a system at home, told in favour of the industrial progress of continental nations and against that progress with us. The evidence we gathered from all quarters abroad, from manufacturers and workmen alike, showed us that the beneficial effect of technical-school training upon industry was universally admitted; and our visits proved that the sums of money voted by both State and municipality were far in excess of what were then applied to British education.

In proof of this a few instances will suffice. In Switzerland, for example, the sums of money spent on education appeared to us in those days to be something extraordinary when measured by the standards at home. Thus, an elementary school in the Lindischer Platz in Zurich cost £43,000, which amounts to £66 per head of the children instructed. We think £12 per head in England an excessive price! Irregularity of attendance among the children there is practically unknown; they all learn one foreign language; they are all taught drawing, and they have object lessons in natural history. In the higher classes they are instructed in the rudiments of chemistry and physics. Great pains are taken to place before the children well-arranged specimens contained in the school museum.

These museums form very noteworthy objects in the Zurich schools. Among the objects we found there were simple chemical and physical apparatus, chemical specimens, geographical relief maps showing the Alps and their glaciers, typical collections of commonly occurring and useful rocks and minerals, excellent botanical models, as well as collections of insects, carefully labelled, a complete herbarium, zoological and anatomical specimens and models; the collection, in fact, serving as a type of what such a school museum should be. Many of the specimens were collected and arranged by the teachers.

All the school subjects were taught intelligently and well. We were specially struck by the clean and tidy appearance of the boys, and there was difficulty in realising that the school consisted mainly of children of the lower classes of the population. Indeed, so struck was I that on one occasion I said to the master, "These are surely children of the upper classes?" To which he replied, pointing to the two first children on the front bench: "That is the son of a chimney sweep, and his neighbour is the son of a road scraper."

In the Canton of Zurich by far the larger proportion of the taxes is spent on education, and on asking a local manufacturer how it came about that the tax-paying classes were satisfied with the system by which they paid for the whole of the education of the poorer classes—for these latter are not taxed *at all*—he replied: "Education is our only remedy against socialistic action and the only safeguard which capitalists have in this country. The poorer classes take education as a boon, and we provide it as an insurance against revolution."

The following is another instance of the value

attached by the Swiss to educational efficiency. The Federal Polytechnic school at Zurich, one of the largest and most important of these institutions on the Continent, needed a new chemical laboratory, and the Swiss Minister of Education proposed to the Chamber a vote of £50,000 for this purpose. Objection was raised, but the Minister was able to prove that the new industries created on Swiss soil, especially at Basle, by the young men, chemists and engineers, who had been trained at the Polytechnic, had already amounted to many times the sum asked for, and the amount was at once voted, and a splendidly equipped laboratory now stands as a monument to the foresight of Swiss educationists. In Germany remarks to the same effect were made to us by manufacturers respecting the large sums spent in that country on technical education. "We are a poor nation," they said; "we cannot afford to throw away our money; but we are quite convinced that not only is the money well spent on technical instruction and education, but that it repays the country tenfold."

As an example of the influence which German schools have exerted on German industries the case of Crefeld stands out conspicuously. There we found—it must be remembered I speak of more than twenty years ago—the most complete textile school in the world. On all hands the testimony was forthcoming that this school was the mainspring of the wonderful development of the local silk industry. Whilst this manufacture had almost sickened unto death in the old centres in England, especially in Spitalfields and Coventry, and had languished in France at Lyons and St. Etienne, it had established itself and flourished most vigorously at Crefeld, to such an extent, indeed, that the exports of silk manufactures from this town

of 83,000 inhabitants greatly exceeded the entire export of silk from the United Kingdom. Our informant insisted that the chief motive power in all this development had been the Weaving School, and that its influence had been chiefly felt in two important branches in which the factory is most liable to fall behind, viz., designing and dyeing. It was shrewdly remarked by one of the manufacturers, "The day has gone when I can make money without effort; to exist I must move on; my neighbour compels me." We were further told that employers are constantly on the look-out for students who have attended the school.

We were much struck by the fact that the members of the Council of the Chamber of Commerce, with one or two exceptions, all spoke English fluently; they had all visited England frequently, as their trade was mainly with this country. At a luncheon which was given us, toasts were proposed and speeches made in English, and we often asked each other, "Where in any town in Britain could a deputation of Germans or Frenchmen find a Chamber of Commerce, or indeed representatives of any public body, all able and willing to address the foreigners in their tongue?"

All this is now, one is thankful to think, to a great extent a matter of ancient history. The textile schools in Manchester, Leeds, Bradford, and other places, in equipment and staff, are now, to say the least of it, equal to any of the continental textile schools, whilst the results thus effected upon the trade of those districts by the introduction of new methods and the perfection of old ones is a matter of notoriety.

We not only devoted our attention to the great manufacturing centres, and assured ourselves of the enormous influence which technical schools have exerted on every branch of what may be called the

larger industries, but inquired as to the apprenticeship schools established in Germany and Austria for the encouragement of cottage industries and petty manufactures, such as clock-making, straw-plaiting, lace-making, wood-carving, &c. For all these crafts we found elementary technical schools provided. The local authorities find the buildings, the State pays for teachers and supplies models, examples, and tools. We contrasted the taste and ingenuity of the wood-carving done in the districts where these schools were established with the lack of the same quality noticeable in Irish wood-carving where the artistic power of the peasant had not been called forth by instruction. In the case of Irish lace and embroidery, which is now carried on to so large an extent by the Irish peasantry, the taste in these matters has been fostered and developed through the action mainly of private individuals.

The condition of the Irish cottage industries of that date may be compared with those in Germany in the following picture of Thuringia:

> If the neighbourhood through which we passed is fairly representative of the forest country of Thuringia, it is impossible to overrate the importance, in a material point of view, of these home industries. The cottages were pretty and well kept; most of the windows contained flowers beautifully grown in pots, and many of the houses had gardens attached to them. The people were well-dressed, and had the air of being well-fed and contented. They are evidently a most industrious race, and their success may depend as much upon their natural disposition and temperament as on the fact that they have been trained for generations in these various occupations. Still, whatever may be cause of their success in home industries, we think it is impossible to doubt that the influence for good of such work is of vast importance. We found populous and thriving villages, filled with busy workers, in districts remote from railways and where carriage and transport must be matter of extreme difficulty, and in parts

of the country, moreover, where agricultural work would in many cases be wholly insufficient to provide support for more than a small proportion of the present population. It is in such cases as these that the provision of suitable employment for the masses of the people is so important, and the question of the mode in which such industries are introduced, and the way in which they are fostered, is surely one which deserves the most careful attention of the economist.

It must not, however, be imagined from this somewhat *couleur de rose* view of the German peasant that we found no black spots abroad. Indeed, when we consider the general conditions of labour in continental countries, the wages of the operatives, their hours of work, and the provision made for their health and safety, we are driven to the conclusion that they were far behind the workers of the same class in this country. Some facts that we came across in the North of Italy revealed a condition of things such as probably never existed here even in those far-off times, nearly a century ago, before factory laws were instituted. English tourists, as they wander with so much pleasure through some of the loveliest districts of Northern Italy, little suspect that amid so many outward signs of fruitfulness and plenty, the struggle for existence in the factories is so keen, and that the conditions under which the poor workers exist are almost intolerable.

In the silk-reeling mills of the Italian Lake district we found that there were no Factory Acts, and consequently the hours of work were excessive and the hygienic conditions of the poorest. Children from eight years old were employed during the winter months, together with grown women, from 5 a.m. till 10 p.m., with slight pauses for food, but making a total of $15\frac{3}{4}$ hours of work per diem. The pay was

very small for such long hours, the women getting 1*s.* 2*d.* per day, the children 5*d.*, though the masters provided soup for the hands at midday. They only worked at the mills during the winter; in the summer they returned to their homes, generally farms, in the neighbourhood, where they worked in the fields, harvesting the corn, maize, and fruit for the winter food of the people, and also superintending the rearing and feeding the silkworms which is carried on at their own homes.

The atmosphere of the rooms in which these people worked at the mill was hot and very moist, as the cocoons are treated in boiling water. The temperature is seldom lower than 80° F. In spite of this, the appearance of the hands was distinctly healthy, they seemed bright and happy, and there were always plenty of workers, and we were told they were fond of their work. Still, we felt convinced that they were so healthy on account of the outdoor life they lead in summer; it would surely be most injurious to the physique and general health of the neighbourhood were the operatives shut up in these unhealthy surroundings all the year round. As for the education of the little children employed, they sometimes went to school during the summer, and in some cases the mills provided instruction in the dinner hour; possibly one in ten of the hands can read and write a little. Education is not by any means esteemed among the poor, and compulsory education would be very unpopular.

The foregoing picture shows the abuse of the work in factories when it is without the necessary accompanying legislation. But in England, Germany, &c., where the Factory Acts are in force, the effect of the replacement of home labour, such as hand-loom

weaving, by the factory system, has been greatly to the advantage of the population. I well remember in visiting Lyons, where the greater part of the silk-weaving is done in the dwelling-rooms of the workers, that the hours of labour are excessive, and that the conditions under which the work is carried out are far more injurious to the health of the people than factory work where the hours are fixed and the hygienic conditions are much more favourable.

In the apprenticeship and trade schools in Germany, Belgium, Switzerland, Holland, and France, we found that drawing was made the basis of all the technical teaching, and is regarded as the universal language. The lessons follow a graduated course, from chalk drawing on the blackboard to the study of projection and ornament, industrial and machine drawing for special trades, and original designing.

Among many interesting interviews which we had with teachers and manufacturers I may quote the following. It has often been said that the success of the German arms in the Franco-German War depended upon the German schoolmasters. That this was the opinion in France was illustrated when, on visiting the Ecole Professionnelle of Rouen, the headmaster asked me to inspect the school museum. Among the usual objects I noticed with surprise a Prussian soldier's helmet. On being asked why he placed it there, the schoolmaster stated that it was picked up in the streets of Rouen during the German invasion. And he added that it was of great service to him, for when the scholars did not attend to their work he used to bring this down and put it on his desk, and pointing to it say : " Now, if you do not make progress and learn properly, this will happen to you again. The surest way to bring it upon you is to neglect your studies and grow

up in ignorance, and to become inferior in intellectual training." "The display of that helmet," said the Director, "never fails to bring the blush of shame to the cheeks of my students, and to rouse their patriotism and their zeal for their studies."

This story was at the time widely circulated, and often served to "point a moral and adorn a tale." My friend and colleague on the Commission, Sir Swire Smith, who perhaps has been more constant than anyone else in successfully preaching on the subject of educational progress in England, has often quoted this story to assemblies of students in this country. "Could not you," he asked on one occasion, "draw from it a moral for yourselves? You may be spared the humiliation of a warlike invasion, but it depends upon you whether we may not have to face an invasion even more serious than that of armed forces, if by ignorance, idleness, and lack of scientific training we fall behind our foreign competitors in the arts of peace. I cannot show you German helmets picked up in your streets, but I can go to your shop windows and stores and gather together electrical appliances, dye-wares, and piles of articles 'made in Germany'; silks, cashmeres, gloves, works of art from France; butter and cheese from Denmark; and I could say as truly as was said by the French schoolmaster, it has been in consequence of the greater scientific and artistic knowledge and more systematic technical training of your industrial rivals that these commodities, representing many, many millions sterling annually, find their way to this country, and that it is only by intellectual training and industrial efficiency equal to theirs that this foreign invasion can be stayed."

No sight witnessed by us in our tours of inspection abroad was more striking than that of the crowded

evening Art Classes in Paris, for in them we found an explanation of the well-known superiority of the French taste in all branches of art, not only in textiles, but in metal-work, in bronzes, furniture, and every description of decorative work.

The following picture of what we saw twenty years ago is still of interest, although the strictures upon our English methods of teaching drawing are probably not so cogent now as they were then. In one of the Paris schools of design, situated in the tenth arrondissement, we found no less than 300 adult pupils, all of whom had been hard at work at their various trades for twelve hours before they entered the school, for there is no fifty-six hours Act in Paris. There, in one room, we saw engravers, textile designers, stonemasons, carpenters, decorators, and other tradesmen, to the number of forty or fifty, all drawing from the living model. In another room was a large mechanical drawing-class, where we found an ordinary stonecutter making a scale drawing of a skew bridge, a task which very few working masons in England could accomplish. In a third room was a class of thirty men engaged in modelling in clay from a classic figure; and three or four other rooms were crammed full of artisans working hard at their art studies, and these same men came in every night in the week. This is only one of thirty or forty such schools in Paris, all crowded with zealous and diligent students, and when we compare this with our sparsely attended schools of design, it is evident that teaching has much to do with the prominence into which French taste and French fashions have forced themselves on the markets of the world.

The method of teaching drawing in the French elementary schools is also founded on rational

principles. In place of drawing pictures of old tubs and besoms, broken-down cottages, or equally valueless objects, as was too often the case in our schoolrooms, the French boy begins at once to draw from the round—a simple cast of a leaf for example. He has then some tool or simple piece of machinery placed on his desk. This he has first to sketch, then he accurately measures all the parts, and noting these he afterwards has to construct a sectional drawing to scale of the object. Problems of constantly increasing complexity are thus placed before him, and the objects which he has to draw are such as are of everyday use and of practical value, and the result is that the little French or German boy out of the street is able to draw, and draw accurately, in a way which is absolutely astounding to an Englishman conversant only with the work of an ordinary primary English school. He is thereby fitted to receive the advanced instruction in art designing which he finds supplied gratuitously in the evening classes in such abundance and perfection. Since those days, however, matters are much improved in England, in great measure owing to Mr. Ablett's fine system.

The Report of the Commission created more general interest than usually falls to the lot of such documents. Long and appreciative notices appeared in the Press, and abstracts and extracts from the Report were widely read. The following kind letter from our chairman must find a place here :

HOUSE OF COMMONS LIBRARY,
May 17th, 1884.

MY DEAR ROSCOE,

I find the Report was too late for post last night.

I cannot refrain from telling you once more, now that our work is before the public, how much I feel myself indebted to you for its satisfactory accomplishment. When Mundella

who are not up to very much good in the battle of life. Now, I think we are beginning to acknowledge that theory is only a systematic practice—and practice without theory is very often poor practice—and we recognise that science is but ordered knowledge, and that if we are to succeed in the great endeavours which we as a nation have to make, if we are to keep abreast of the progress which other countries are making, and are to preserve the position of superiority for our manufactures and trade we have enjoyed in the past, every effort must be made to put our educational house in order and to see that the sciences upon which the manufactures and industries of this country are based are taught to the people of every class from top to bottom.

Of course I frequently took occasion to hold forth on the efforts made by the German Government to encourage scientific training. I quoted the well-known case of Strassburg, where a University was founded at great cost as soon as the war was concluded; £700,000 being set aside for building and a subsidy of £43,000 per annum as income.

Touching the fact that in many towns in England both masters and men engaged in industrial pursuits had not yet freed themselves from a rule of thumb practice, and did not appreciate the value of the application of scientific method to their work, I congratulated the population of Sheffield on the steps they had taken to endeavour to remedy this defect. I pointed out that the Sheffield people know what they want better than anybody else, and their Technical School supplies that want. It contains as complete a metallurgical department as exists in the country. It has an excellent staff of teachers, and the students are intelligent and industrious. But, I asked, is everything done that might

be and ought to be done? Are the great mass of the Sheffield "blades," whether masters or men, yet fully alive to the greatness of the issues? Do they see that their future trade, their profits, and their wages depend upon the skill and the technical knowledge which they severally bring to bear on their industries? I said I feared that the iron had not yet entered into their souls; and their interest was in too many cases only skin deep. They were satisfied with little, and did not see that much deeper knowledge and training are needed. As an example of what may be done by scientific work I quoted the story of Thomas and Gilchrist. Two young students, not more gifted, probably, than many others, studied their subjects with care and attention. They were good chemists and good engineers. The iron-masters were unable to make steel from cheap Middlesbrough pig, because it contained phosphorus, and in the ordinary Bessemer process this substance remained in the steel and rendered it useless. Ulverston flourished because their hematite, though more expensive, contained no phosphorus. Suddenly a change comes. These two young men, scientifically equipped, win a great victory. Why, they asked themselves, is the phosphorus not left with the slag in the ordinary Bessemer process? Because, they replied, the phosphorus cannot combine with the silicious or acid lining of the converter. If, instead of using an acid lining, we were to use a basic lining—one composed of lime and magnesia—then the phosphorus would be taken out of the steel as phosphoric acid, and would be found in the slag. And this turned out to be so. This application of a simple chemical principle has revolutionised the iron trade. It has rendered the commonest and cheapest Middlesbrough pig available for steel-making, equally with the best Cumberland hema-

tite iron. But this is not quite the end of the story, for the material which was previously so harmful as well as useless, namely, the phosphoric acid now contained in the slag, is available as a valuable manure, so that not only do the iron-masters obtain a pure steel from impure ore, but they sell the impurity for good money.

My predictions of twenty years ago have now been fully realised. The Sheffield University with its Technical School stands now, with regard to metallurgy and engineering, equal in rank to the best of similar seats of learning, both at home and abroad; and it is fitting that a great technical school for the study of the metallurgy of iron and steel should be established in a locality which is the chief focus of that industry. This has been accomplished, thanks mainly to the labours of Arnold and Ripper.

On December 17th, 1889, I distributed the prizes and certificates to the City and Guilds of London Institute at Goldsmiths' Hall, when I pointed out that the newly founded metropolitan polytechnic institutions could not give the highest kind of education such as is carried out on the Continent. There institutions exist which bear the same name, but which are analogous rather to the scientific departments of our Universities, and to those of the metropolitan and local university colleges, to the Royal School of Science, and to the Central Institution founded by the Guilds. I then suggested that this latter might with advantage become a Government School for Applied Science, as the Royal College of Science is at the present moment one for pure science. The proposal to form a Central College for Applied Science at South Kensington has since been widely

discussed, and is now about to be carried out so as to form a "School" of the reorganised University of London.

On the 13th of January, 1893, I gave an address at the request of the Technical Instruction Committee of the Essex County Council at Chelmsford on Technical Instruction in Agricultural Counties with special reference to Science-teaching. In this address I pointed out a fact which has both before and since been endorsed, that after all education is the only, or at any rate the most potent, factor in the cure of agricultural depression in the country. One of the speakers at the meeting, a clergyman, expressed dissatisfaction, saying that they wanted an immediate cure. I suppose he meant a proposal such as the impost of a duty on foreign corn. This, of course, I could not advocate, as I believe that Free Trade is a blessing to this country, and that in other countries the higher they extend the duties on imports the more they suffer.

I frequently expressed the opinion of the necessity of the appointment of a Minister of Education, of Cabinet rank. We have recently seen the appointment of a Minister of Agriculture, who has a seat in the Cabinet. Surely the subject of the education of the people is not a less important one than that of the improvement ot our crops and herds, and the presence in the Cabinet of a real educationist is the only means of securing that attention to education which we feel is bestowed upon it in all other civilised countries in the world. That such a step has been taken (1906) by the appointment of Mr. Birrell as Minister of Education with a seat in the Cabinet will be welcomed by all supporters of educational progress.

Secondary Education

In 1896 a great deal of correspondence appeared in *The Times* on the burning question of education. I stated my views on the subject in the following short letter on November 6th, 1896:

To the Editor of "The Times"

SIR,—Permit me to endorse with one observation the admirable remarks in your columns of to-day on the prospects of legislation both for primary and secondary education. What is required for the one is not and cannot properly be suited to the other. Thus the object of primary education is to bring up the level throughout the country to the same height. The children in Dorsetshire and those in Manchester ought to be served alike. Secondary education, on the other hand, is a totally different affair, and specialised education is needed. The children of the Dorset peasant and of the Manchester mechanic require different treatment, and here specialisation and local requirements come in. Hence it is that, whilst decentralisation and local authority are the watchwords for secondary, a uniform system and centralised authority are the principles upon which our primary education has rested and ought still to rest. This points to the severance of legislative action. "To organise our secondary schools," following the recommendations of the late Commission, is a necessary and is certainly a much easier course for the Government to pursue than to attempt joint legislation on the lines of the late Bill. Surely after the experience of last session, the Government would do wisely to take the path of least resistance, and at any rate put our secondary education on a systematic basis.

One of the most important steps which have been taken since the publication of the Report of the Commissioners was the establishment, under the Presidency of Lord Hartington (now the Duke of Devonshire) of the National Association for the Promotion of Technical Education, for the purpose of embodying the views of the Commissioners in suitable legislation. It is not too much to say that the Association and its Executive

Committee have been the means of initiating action and of securing progress of such a character as few voluntary bodies can claim. In addition to their propagandist work, the Executive Committee promptly brought their objects before the Legislature by the introduction of certain measures into the House of Commons. Under the title of "The Technical Education Bill" two measures were introduced by me (as hon. secretary of the National Association) in February, 1888, and in February, 1889, respectively; while in March of the last-named year the Right Hon. Arthur H. D. Acland, M.P. (at that time one of the secretaries of the Association), brought forward "The Technical Schools (Local Authorities) Bill." None of these measures was placed upon the statute book, but in the year 1889—only two years after the establishment of the Association—the Government passed the Technical Instruction Act. Although this Act was not altogether in accord with the views I had put forward, I gladly accepted the measure as a satisfactory instalment. In this connection I feel I ought to mention the special services rendered by the Right Hon. Sir W. Hart-Dyke, Bart., M.P., by Sir William Mather, M.P., and by the Rt. Hon. W. H. Smith, M.P., then Leader of the House.

In the following year I brought forward a Bill "intended to clear up any doubt as to the legality of the provision of a technical and manual instruction in public elementary schools"—a Bill which did not pass.

It may be of interest to refer to the first appropriation of Government funds for technical and secondary education, which was made on July 21st, 1890, when Mr. Goschen announced that the sum intended for the extinction of licences (now known as "Whisky Money") would be handed over to the County and

County Borough Councils for the purpose of the Technical Instruction Act, coupled with an intimation that charges might in the future be placed upon them for secondary education. On August 1st in the same year Mr. Arthur Acland moved an amendment to the effect that a county or county borough might contribute half of the new grant for technical education, and might apply the rest, under the Endowed Schools Act, to purposes of secondary education. The Government accepted the first part of Mr. Acland's amendment, but opposed the second, which was withdrawn on the understanding that the whole and not only a moiety of the residue should be applicable to technical education.

The educational importance of the Act of 1889 can hardly be over-estimated, inasmuch as it provided the machinery by which the local authorities were enabled to utilise the large sum of money under the Local Taxation (Customs and Excise) Act of 1890, which, as I have explained, became available for the purposes of technical instruction. The very fact of the allocation by Parliament of a sum of about three-quarters of a million to technical education—an event unparalleled in our financial history—is of itself a proof of the real appreciation of the necessity of promoting the industrial equipment of our people. A further proof of this appreciation is shown by the way in which the local authorities at once availed themselves of the opportunities thus presented, for although the application of the funds to educational purposes was not obligatory, yet it was only in a few cases that the money was used for the relief of rates. No sooner, however, had the local authorities got to work, than it became clear that the Act of 1889 was deficient in several particulars. Of these the most important were,

first, that none of the grant could be spent in awarding scholarships ; secondly, that the areas over which the authorities had control were unnecessarily limited ; and thirdly, that the regulations for allocating the funds were of too inelastic a character. So the National Association entrusted me with a Bill to remove these deficiencies, and this was one of the few private Bills which during the session of 1891 became law. That the provisions of this Act were much needed is clearly shown by the facts that at least one million sterling is now spent by County and County Borough Councils upon scholarships alone, and that the other clauses of the Act have proved to be of an equally beneficial character.

These Acts paved the way for the systematic development of secondary education which is now quickly taking place under the Education Act of 1902. This latter Act constituted one local authority for the purposes of all forms of education in administrative counties and county boroughs. But it is to be borne in mind that, whilst the Act repealed the Technical Instruction Act of 1889, it nevertheless included provisions which covered even a wider field. For instance, it enabled the local authorities to deal with higher education as a whole and not simply technical instruction. But, what was of even greater importance, it secured the permanent appropriation to education of the "Whisky Money" which had so long been allowed to remain at the option of the local authorities.

The Association is still in full activity under the careful superintendence of our respected secretary, Mr. Frederick Oldman. It not only watches with scrupulous care the action of the Government in educational matters, but it acts as a consultative agent to all interested in the subject. It publishes a quarterly record of the action and proposals of local

education authorities, and includes special articles of educational interest. The value of its work is fully appreciated both by the Board of Education and by the authorities throughout the length and breadth of the land.

One's labours in the cause of technical instruction were sometimes brightened by amusing incidents which occurred in the course of inquiry. A class was held by some well-intentioned people for the purpose of endeavouring to stimulate and improve the education of a number of railway navvies, who, by the way, call themselves "excavators." A reverend gentleman was dilating to a number of these men on the importance of self-improvement, and said to them: "You men who do this heavy work ought to try to raise yourselves to something better. Here you see your contractor, who superintends the work, carrying about a set of plans under his arm and giving directions; now if only you men had got some technical training, you would have been carrying the plans." To which one of the navvies replied: "Aye, aye; but if we are to be 'uggin' plans, who's to wheel th' barrows?"

The second story is related of a farriery class held in Manchester, where a number of shoeing-smiths were being instructed in the art of horse-shoeing. The lecturer, in commencing the class, told his hearers that they must bring note-books with them the next time. At the second meeting of the class he saw that most of the men had thus provided themselves, but one rough diamond had failed to do so, and he called his attention to the fact, upon which the man inquired, "What was the use of them?" The teacher replied, "Why, to take notes of what I tell you." "What then," he answered, "is the use of my blooming head?"

In spite of the facts of which I have given a very brief account respecting the influence of technical education upon the industries abroad, the Royal Commissioners on Technical Instruction came to the conclusion that, as a whole, "our people still maintain their position at the head of the industrial world." We also pointed out "that the machinery employed in manufactures had been either invented or perfected in this country in the past, and it is not too much to say that most of the prominent new industrial departures of modern times are due to the inventive powers and practical skill of our countrymen. Among these are the great invention of Bessemer for the production of steel in enormous quantities, by which alone, or with its modification by Thomas and Gilchrist, enabling the commonest description of iron to be used for the purpose, steel is now obtainable at one-tenth of the price of twenty years ago; the Weldon, Hargreaves, and Deacon processes, which have revolutionised the alkali trade; the manufacture of aniline colours by Perkin; the new processes in the production of silk fabrics by Lister; the numerous applications of water pressure to industrial purposes by Armstrong; the Nasmyth steam-hammer; the compound steam-engine, as a source of great economy in fuel; and the practical application of electricity to land and submarine telegraphy by Cooke, Wheatstone, Thomson, and others."

Again, we found that "in those textile manufactures in which other nations have hitherto excelled, as in soft all-wool goods, we are gaining ground. We saw at Bradford merinos manufactured and finished in this country, which would bear comparison in texture and in colour with the best of those of the French looms and dye-houses, and in the delicate fabrics of Notting-

ham and Macclesfield (thanks in great measure to their local Schools of Art) we no longer rely on France for designs."

From a Report which has lately been issued as the result of an inquiry into the present condition of French chemical industries, it would appear that the position of the French manufacturers as regards the appreciation of scientific education is, to say the least of it, no further advanced than is the case in England, and it also appears that the progress in France is much behind that of Germany.

A writer in *Nature* who signs himself "W. R." on this point remarks: "To add insult to injury, the red trousers, so conspicuous in the French army, were designed originally to encourage the cultivation of the madder plant; the plant is commercially as extinct as the dodo, and the trousers are now dyed with artificial alizarin supplied from Germany! *Sacré nom de tonnerre!*"

The effect of the publication of the Report of the Commission was largely to stimulate public interest in the question of technical instruction as affecting the progress of British industries. Numerous visits have since that time been paid by industrial and educational experts both to America and the Continent, and these have chronicled the great changes which have taken place in the last twenty years. More remarkable probably than the European progress is that made in the United States, which since my visit in 1884 has undergone what may be called a revolution. The results of this progress have been satisfactorily dealt with by many inquiries, but by none more efficiently than by the Commissions organised by Mr. Mosely.

From these recent inquiries it is clear that, in spite of what has already been done, much remains for us in

England to accomplish in the organisation of our secondary and scientific training, in which our competitors are before us, and of which the importance and the effects are well summed up in the following opinion of an eminent German manufacturer: "We in Germany do not care whether you in England are free-traders or protectionists, but what we are afraid of is that some day your people will wake up to the necessity of having a complete system of technical and scientific education, and then with your energetic population, with your insular position, and with your stores of raw material it will be difficult, or it may be impossible, for us to compete."

Secondary Education

In the spring of 1894 a Royal Commission on Secondary Education was appointed. It was composed of seventeen gentlemen (including myself) and three ladies; my friend the Rt. Hon. James Bryce, M.P., acted as chairman. The Commission sat for a considerable number of months and issued a Report which exerted great influence in pointing out the position of secondary education in England compared with that in other countries, and which suggested remedies which ought to be applied to place this subject on a proper footing.

In November, 1896, I introduced a large and representative deputation to urge upon the Lord President of the Council (the Duke of Devonshire) the desirability of taking steps to enforce the recommendations of that Commission. I pointed out that the deputation, representing the National Association for the Promotion of Technical and Secondary Education, the Association of Directors and Organising

Secretaries for Technical and Secondary Education in Counties and County Boroughs, the Incorporated Association of Head-Masters of Secondary Schools, and other bodies, desired to urge the national question of immediate legislation for secondary education in England. The Report of the late Royal Commission and the recommendations which that Commission had made had been received with remarkable unanimity by the educational public, including all political parties. It was especially with regard to the importance of scientific and technical education of the country that action was urged. Little could, however, be hoped for in the way of systematic and advanced technical instruction until the basis of secondary education, such as had long existed in continental countries, had been here established. I then pointed out that the most important recommendations of the Royal Commission were, in the first place, the establishment of local authorities, consisting of not smaller areas than counties and county boroughs, and, in the second place, of a central authority chiefly of an advisory character.

In reply the Duke said that it was the intention of the Government to deal with the better organisation of our secondary schools; and there is no doubt that the result of this deputation was to stimulate the Government to take steps in the matter which culminated in the Education Act of 1902.

"Every litttle helps," so I hammered away at the old story when I distributed the prizes at the Royal Technical Institute at Salford in October, 1901, and my speech was, like the utterances of all other educational experts, a plea for a well-considered Secondary Education Bill. The local authorities throughout the country have been erecting large and

well-equipped technical schools, only to discover that a great proportion of their would-be pupils coming from secondary schools of all kinds are not adequately educated so as to profit by the advanced teaching of the technical schools. This is a striking proof of the inadequacy of the existing secondary schools. But matters will not improve until the various schools of this type are brought under the supervision of the local authority, organised in relation to one another and to the needs of the district, and assisted by public money. Happily the dawn of this long-desired improvement has now come. The public mind has at last become impressed with the necessity for organising our secondary education in its entirety. Throughout the length and breadth of the country, large sums of money are being devoted to the erection, maintenance, and reorganisation of various types of secondary schools. Local authorities are not only devoting funds from the "Whisky Money," but they are also rating their areas and borrowing money on the security of the rates for these purposes. It is not easy even to estimate the amount thus applied, but it certainly runs into millions —apart from the numerous benefactions which are now everywhere forthcoming.

CHAPTER IX

ORIGINAL RESEARCH

Original Research as a means of Education—University Colleges, Dundee, Liverpool, Birmingham, Sheffield—Scottish Universities Commission—British Association, Montreal—Visit to America—Knighthood—Presidency of British Association at Manchester—Queen's Jubilees—Queen's Funeral—King's Coronation.

For the last quarter of a century I have, without cessation, been preaching the doctrine of the importance of our manufacturers understanding, not only the value of original research, but its absolute necessity, if we are successfully to withstand the attacks upon our commerce and industries made by continental nations. In 1874 I published an essay in a volume of *Owens College Memoirs* entitled "Original Research as a Means of Education," in which I summed up by showing that if freedom of inquiry, independence of thought, disinterested and steadfast labour, habits of exact and truthful observation, and of clear perception, are things to be desired as tending to the higher intellectual development of mankind, then original research ought to be encouraged as one of the most valuable means of education; and that on this ground alone, and independent of the enormous material benefits such studies confer on the nation, it is the bounden duty, not only of the Government, but of every educational establishment, and of every citizen

of this country who has the progress of humanity at heart, to promote and stimulate the growth of original research among us.

Although as the years roll on the appreciation of the value of research from all points of view is gradually becoming acknowledged, much yet remains to be done. At the meeting of the British Association in 1896, I read a paper on "Chemical Education in this Country and Abroad," in which I had to reiterate the opinion that the value of research is not taken sufficiently to heart by our countrymen, and I there stated my opinion that, if in the early 'fifties our great chemical manufacturers had been able at all to look into the future, there was no reason, for we "had the men and had the money too," why the great colour industry, worth millions of money, should not have been a British instead of a German trade.

Of all recent discoveries in synthetic chemistry, that of the artificial production of indigo by Baeyer is perhaps the most interesting and important—interesting because it points the way to the manufacture of valuable products which hitherto have only been found in vegetable or animal organisms; important from a national point of view because it has already placed the Indian indigo industry in a precarious position. Artificial indigo, like so many other manufactured colouring matters, is prepared from coal-tar. This is not the occasion to enter into a description of the refined and difficult chemical process by which the raw material is made to yield these finished articles. But perhaps a short statement of the case made by me on a Friday evening at the Royal Institution in 1881 may not be out of place. To Englishmen it is a somewhat mortifying reflection that, whilst the raw material from which all these coal-tar colours are made are produced

in our country, the finished and valuable colours are nearly all manufactured in Germany. The crude and inexpensive materials are, therefore, exported by us abroad, to be there converted into colours having many hundred times the value ; and these expensive colours have again to be bought by the English dyers and calico-printers for use in our staple industries. The total annual value of manufactured coal-tar colours amounts to about three and a half millions ; and as England herself, though furnishing the raw material, makes only a small fraction of this quantity, but buys a large fraction, it is clear that she loses the profit of the manufacture. The causes of this fact, which we must acknowledge, viz., that Germany has driven England out of the field in this important branch of chemical manufacture, are probably various. In the first place, there is no doubt that much of the German success is due to the long-continued attention which their numerous Universities have paid to the cultivation of organic chemistry as a pure science. For this is carried out with a degree of completeness and to an extent to which we in England are as yet strangers.[1] Secondly, much again is to be attributed to the far more general recognition among German men of business of the value, from a merely mercantile point of view, of high scientific training. In proof of this, it may be mentioned that the number of scientific chemists employed at the colour works at Höchst is now a hundred. The other day I heard that at these works one research chemist who was paid £1,000 a

[1] It is a satisfaction to me, however, on this point to remember that my late friend Schorlemmer was at my suggestion appointed to a special chair of Organic Chemistry at Owens College, the only chair of this kind in the country, and also that his successor, Professor Perkin, is continuing on even a more extended scale and with greater means at his disposal in the new Schorlemmer Laboratory the teaching of organic chemistry to the most advanced point, and that young men are being turned out as fully equipped in this department as from any of the German schools.

year had worked for five years without result, but that at last he succeeded in making a discovery which has not only repaid the company his salary, but has brought them in a sum of money reckoned at half a million. A third cause which doubtless exerts a great influence in this matter is the English law of patents. This, in the special case of colouring matters at least, offers no protection to English patentees against foreign infringement, for when these colours are once on the goods they cannot be identified. Foreign infringers can thus lower the price so that only the patentee, if skilful, can compete against them, and no English licences of the patent can exist. This may to some extent account for the reluctance which English capitalists feel in embarking in the manufacture of artificial colouring matters. That England possesses, both in the scientific and practical direction, ability equal to the occasion none can doubt. But, be that as it may, the whole honour of the discovery of artificial indigo belongs to Germany and to the distinguished chemist, Professor Adolf von Baeyer, whilst towards the solution of the difficult problem of its economic manufacture the first successful steps have been taken by Dr. Caro and his colleagues at the Baden Aniline and Soda Works at Ludwigshafen.

In reference to the above I may add that a further and more important step in strengthening the hold which the Germans possess on the manufacture of artificial colouring matters for the whole world has lately (1905) been taken in the amalgamation of the three great colour-manufacturing companies at Höchst, Ludwigshafen, and Elberfeld for common action. This will probably result in cheapening the manufacture of artificial indigo to the point which may render the production of natural indigo impossible.

During the quarter of a century which has elapsed since the date of my lecture on Indigo much has been done in England to make up the leeway. Technical schools, polytechnics, university colleges, and new Universities have sprung up throughout the length and breadth of the land, and are rapidly doing away with the notions which were prevalent twenty years ago, that a man must go to Germany to get his scientific education. From my position at Owens College I was often consulted as to the steps to be taken in the foundation of such new institutions, and frequently took part in their government.

As an example of this I may mention the connection I had with the foundation of the University College in Dundee in 1881. A Dundee gentleman informed me of the munificent bequest which had been made by Miss Baxter for the endowment of a university college in that town, and requested me to draw up a scheme for the allotment of the income arising from her gift of £100,000. This I did, and my suggestions were practically adopted by the Governing Body.

I proposed that the teaching of the physical sciences and mathematics should form an important part of the curriculum; but, whilst arranged on a scientific basis, the application of such science-teaching to the wants of the district should be attended to. I also pointed out that literature, especially the modern languages, must on no account be excluded, and therefore suggested the following chairs:

(1) Professor of Natural Philosophy and Mathematics.
(2) Professor of Chemistry.
(3) Professor of Engineering and Drawing.
(4) Professor of Classics and History.
(5) Professor of English Literature and Language.
(6) Professor of French and German.

The success of the scientific side of the Dundee College was greatly due to the work of my distinguished and much-to-be-lamented pupil and friend Dr. Carnelley, who afterwards became professor in Aberdeen and enriched science with much important work. I am glad to remember that since its foundation Dundee College, passing through many difficult times, has now become an integral part of the neighbouring University of St. Andrews, and that its influence in its district is great and constantly increasing. And I am also pleased to think that I had a hand in this matter as a member of the Scottish Universities Commission.

Other institutions of a similar but even of a more important character were founded about this time. The first of these was the Liverpool University College, to which I have before made reference, which has, after a most wonderfully successful career, now blossomed out into the University of Liverpool. As a member of an old Liverpool family, I was much gratified to be nominated by the Duke of Devonshire, who was then Chancellor of the Victoria University, to a governorship of the Liverpool College. And here I must express my admiration, which must be shared by all interested in the higher education, of the open-handed generosity of the Liverpool people, who have now founded a University which in its whole equipment is second only to that of its neighbour in Manchester, and which indeed in some respects it probably transcends.

I was present at the laying of the foundation stone of Firth College, which has now become the University of Sheffield, by the late lamented Prince Leopold, and admired his unostentatious bearing and the sound sense which characterised his address on that occasion.

For many years I had a seat on the Council of this college, and advised them on many points with regard to their Science curriculum.

I was also present at the inauguration of the Mason College, Birmingham, which has, thanks mainly to the public spirit of Mr. Chamberlain, also received its Charter of incorporation as the University of Birmingham, and has been fortunate enough to secure the services of my friend Sir Oliver Lodge as its first Principal and Vice-Chancellor.

It was perhaps natural in those early days that the munificent founders of such institutions as Firth and Mason College should have failed to appreciate the full significance of the work which they initiated. Thus, I remember that, after the foundation of his college, Mr. Mark Firth visited the chemical laboratories which I had built in Manchester, and he at once confessed that if he had been aware of the extent and completeness of my department he would have erected very different buildings at Sheffield. Josiah Mason at Birmingham also had restricted views with regard to his foundation, as his notions did not rise above the idea of a technical school to be made useful for the advancement of Birmingham industries.

A fourth institution with which I was in some degree connected was the Nottingham University College, to which I have already referred. Though it has not attained University proportions it also is doing excellent work for the higher education of its district, the chemical department being highly successful under the direction of my former pupil Professor Kipping, F.R.S.

In May, 1888, I received a letter from the late Lord Lothian, then Secretary for Scotland, inviting me to

become a member of a Royal Commission to act as an executive body to carry out the provisions of the "Scottish Universities Act." This proved to be a most agreeable duty; I met on the Commission a number of gentlemen whose acquaintance and friendship I made, and the work was of a most interesting character, whilst the ordinances which we issued were far-reaching and important, in many respects revolutionising the existing system of the Scottish Universities both as regards curricula and finance. It does not always happen that the changes introduced by an Executive Commission are carried out to the satisfaction of the interested parties, but in our case it was so, for the ordinances which we felt it our duty to make were loyally accepted by the staff and Governing Bodies of the four Universities, and certainly led to the liberalisation of the hitherto somewhat narrow system which had been long in vogue. Thus, for example, whilst up to that time a system of enforced attendance at classes for the degree examinations had been limited to three or four subjects, the Commission opened out new avenues to the degrees, a change which was of the greatest importance, especially for scientific education. No one can value the existence in Scotland of four distinct high schools of learning and research open to all comers, both rich and poor, more than I do. The University and parish school systems have made Scotland what it is, the most remarkable country of four millions of people on the face of the globe. Climate and blood have also played their part in the high position which Scotsmen have taken in every branch of commerce, industry, literature, and science, but this would not have been sufficient had not the love of education and the power to get it been

existent. What England might have been, had we, like Scotland, had similar schools and similar popular Universities planted throughout the land for many generations, it is hard to say.

In the spring of 1882 I received an intimation from the Vice-Chancellor that the University of Cambridge proposed to offer to me the honorary degree of LL.D., and the degree was conferred on me on the 13th of July, 1883, the ceremony having been postponed in consequence of the dreadful death of Lord Frederic Cavendish.

In November, 1883, I received a letter from Professor Bonney, the General Secretary of the British Association, informing me that the Council had nominated me as President of Section B—Chemistry—at the Montreal meeting of the British Association, to take place the following year, and of which Lord Rayleigh was to be the President, and shortly after I received the following letter from Mr. Augustus Lowell, of Boston:

BOSTON, *8th January*, 84.

Professor HENRY E. ROSCOE.

MY DEAR SIR,

As it is definitely arranged that the British Association shall meet in Montreal next autumn, may I not hope that your long-deferred visit to this country will be made; and that in the month of November you will be able to give a course of lectures before the Lowell Institute in this city?

I mention November because with that month usually begin our courses of lectures for the winter, and because before that time and after the meeting in Montreal there would be time to travel and to see as much of the country as you would probably care to do.

I think I can promise you as intelligent and appreciative an audience as you can desire, and one fully able to enjoy the best effort you can make in their behalf—far above a Royal Academy [Royal Institution] audience in previous knowledge and the habit of seeking instruction in this form—and I am

sure that I can engage that you will both give and receive a great deal of pleasure from the visit.

Hoping for a favourable reply and the promise of a full course,

I am, yours faithfully,

AUGUSTUS LOWELL.

I very much regretted that I was unable to accept this invitation.

The meeting at Montreal, the first one held out of the British Isles, was a conspicuous success. We were received with open arms by our Canadian colleagues and by our American friends, who attended in large numbers, and hospitality of the most lavish kind was showered upon us.

On visiting the United States we were hospitably entertained at Cambridge by my old friends Professors Cooke and Loring Jackson, also visiting the one at Newport where we met Wolcott Gibbs, and the other at his country-house at Beverley Farm. At this latter place I had also the great pleasure of calling on the author of *The Autocrat of the Breakfast Table*, Oliver Wendell Holmes. We were delighted with the simplicity of his manner and the charming family life by which he was surrounded. It reminded me much more of the life of the German professors than that of our English colleagues. It is remarkable that, in the press and hurry for wealth and the position which wealth brings, one should find among the really intellectual circles of America a disregard of all that is usually considered to be characteristic of American life, and to see that the *élite* of the people had the power of acting up to an ideal of "plain living and high thinking,"

In June, 1884, I received the following letters from Mr. Mundella and Mr. Gladstone :—

Confidential.]

HOUSE OF COMMONS,
30*th June* 1884.

MY DEAR ROSCOE,

It is possible that before you receive this note Mr. Gladstone may have written to you to inform you that H.M. the Queen proposes to confer upon you the honour of knighthood in recognition of your distinguished services to science and education—more especially in connection with your great and valuable services on the Technical Commission.

Now, my dear Roscoe, I beg you will accept my warm and hearty congratulations. Let nothing deter you from accepting at once the offer which is, or is about to be, made to you. It will place you in your right position in Manchester and throughout the country. It will crown your services and show the value that is set upon your work. It will encourage and delight men of science, Huxley especially, who has written an excellent letter on your work and on the way that such work has hitherto failed to be recognised. It will be especially gratifying to the writer, who has all along been determined upon such a recognition. And if it does not please Lady Roscoe, then tell her to pocket the affront and revenge herself on me next Sunday.

Always faithfully yours,
A. J. MUNDELLA.

10, DOWNING STREET,
WHITEHALL,
30*th June* 1884.

DEAR SIR,

I am permitted by Her Majesty to propose that you should receive the honour of knighthood in acknowledgment of your distinguished service on the Technical Education Commission.

It gives me much pleasure to make this proposal, which I hope will be agreeable to you.

I have the honour to be, dear Sir,
Your very faithful and obedient
W. E. GLADSTONE.

Professor Roscoe, F.R.S.

When this became known I received a very large number of letters of congratulation, and among them the following characteristic one from Huxley :—

SCIENCE AND ART DEPARTMENT, S.K.,
July 7, 1884.

MY DEAR ROSCOE,

I am very glad to see that the Government has had the grace to make some acknowledgment of their obligation to you, and I wish you and "my lady" long enjoyment of your honours. I don't know if you are gazetted yet, so I don't indicate them outside.

Ever yours faithfully,

T. H. HUXLEY.

P.S.—Shall I tell you what your great affliction henceforward will be? It will be to hear yourself called "S'enery Roscoe" by the flunkies who announce you.

Her ladyship will please take note of this crumpled rose-leaf—I am sure of its annoying her.

BRITISH ASSOCIATION—MANCHESTER, 1887.

Among the various scientific honours which have been conferred upon me there is none I prize more highly than that of the Presidency of the British Association. I value this the more, inasmuch as I was elected to hold the post in the city where I had resided for so many years, and in the Jubilee year of the Queen's accession.

The meeting was notable as being the largest ever held since the foundation of the Association, and because in the same year the Royal Jubilee Exhibition was opened in Manchester. Owing to the illness of Sir William Dawson, the retiring President, my old colleague Williamson, of Owens College, moved me into the chair at the inaugural meeting in the Free Trade Hall, stating kindly what he thought I had done

towards assisting the progress of science and the cause of higher education in Manchester, and adding that he never remembered at any meeting of the Association the attendance of so many eminent men and so many coming from foreign countries to do honour to its President.

I opened my address with the following words :—

" Manchester, distinguished as the birthplace of two of the greatest discoveries of modern science, heartily welcomes to-day, for the third time, the members and friends of the British Association for the Advancement of Science. On the occasion of the first meeting in this city, in the year 1842, the President, Lord Francis Egerton, commenced his address with a touching allusion to the veteran of science, John Dalton, the great chemist, the discoverer of the laws of chemical combination, the framer of the atomic theory, upon which the modern science of chemistry may truly be said to be based. Lord Francis Egerton said : ' Manchester is still the residence of one whose name is uttered with respect wherever science is cultivated, who is here to-night to enjoy the honours due to a long career of persevering devotion to knowledge, and to receive from myself, if he will condescend to do so, the expression of my own deep personal regret that increase of years, which to him up to this hour has been but increase of wisdom, should have rendered him in respect of mere bodily strength unable to fill on this occasion an office which in his case would have received more honour than it could confer. I do regret that any cause should have prevented the present meeting in his native town from being associated with the name'—and here I must ask you to allow me to exchange the name of Dalton in 1842 for that of Joule in 1887, and to add again, in the words of

the President of the former year, that I would gladly have served as doorkeeper in any house where Joule, the father of science in Manchester, was enjoying his just pre-eminence.

"For it is indeed true that the mantle of John Dalton has fallen on the shoulders of one well worthy to wear it, one to whom science owes a debt of gratitude not less than that which it willingly pays to the memory of the originator of the atomic theory. James Prescott Joule it was, who, in his determination of the mechanical equivalent of heat, about the year of our first Manchester meeting, gave to the world of science the results of experiments which placed beyond reach of doubt or cavil the greatest and most far-reaching scientific principle of modern times, namely, that of the conservation of energy. This, to use the words of Tyndall, 'is indeed a generalisation of conspicuous grandeur, fit to take rank with the principle of gravitation—more momentous, if that be possible—combining as it does the energies of the material universe into an organic whole, and enabling the eye of science to follow the flying shuttles of the universal power as it weaves what the Erdgeist in "Faust" calls "the living garment of God".'

"It is well, therefore, for us to remember, in the midst of the turmoil of our active industrial and commercial life, that Manchester not only well represents the energy of England in these practical directions, but that it possesses even higher claims to our regard and respect as being the seat of discoveries of which the value not only to pure science is momentous, but which also lie at the foundation of all our material progress and all our industrial success. For without a knowledge of the laws of chemical combination all the marvellous results with which modern industrial

chemistry has astonished the world could not have been achieved, whilst the knowledge of the quantitative relations existing between the several forms of energy, and the possibility of expressing their amount in terms of ordinary mechanics, are matters which now constitute the life-breath of every branch of applied science. For example, before Dalton's discovery, every manufacturer of oil of vitriol—a substance now made each week in thousands of tons within a few miles of this spot—every manufacturer had his own notions of the quantity of sulphur which he ought to burn in order to make a certain weight of sulphuric acid, but he had no idea that only a given weight of sulphur can unite with a certain quantity of oxygen and of water to form the acid, and that an excess of any one of the component parts was not only useless but harmful. Thus, and in tens of thousands of other instances, Dalton replaced rule of thumb by scientific principle. In like manner the applications of Joule's determination of the mechanical equivalent of heat are even more general; the increase and measurement of the efficiency of our steam-engines and the power of our dynamos are only two of the numerous examples which might be adduced of the practical value of Joule's work.

"If the place calls up these thoughts, the time of our meeting also awakens memories of no less interest, in the recollection that this year we celebrate the Jubilee of Her Most Gracious Majesty's accession to the throne. It is right that the members of the British Association for the Advancement of Science should do so with heart and voice; for although science requires and demands no royal patronage, we thereby express the feeling which must be uppermost in the hearts of all men of science, the feeling of thankfulness that we have lived

in an age which has witnessed an advance in our knowledge of nature, and a consequent improvement in the physical and, let us trust, also in the moral and intellectual well-being of the people hitherto unknown; an age with which the name of Victoria will ever be associated."

My address concluded with the welcoming of the foreign guests and expressing the hope that the meeting might be "the commencement of an international scientific organisation. But, whether this hope be realised or not, we all unite in that one great object, the search after truth for its own sake, and we all, therefore, may join in re-echoing the words of Lessing: 'The worth of man lies not in the truth which he possesses, or believes that he possesses, but in the honest endeavour he puts forth to secure that truth; for not by the possession of truth, but by the search after it, are the faculties of man enlarged, and in this alone consists his ever-growing perfection. Possession fosters content, indolence, and pride. If God should hold in His right hand all truth, and in His left hand the ever-active desire to seek truth though with the condition of perpetual error, I should humbly ask for the contents of the left hand, saying, 'Father, give me this; pure truth is only for Thee.'"

At the close of my address the Mayor, Sir John Harwood, moved a vote of thanks to me, who, as he kindly said, was not only known but endeared to the people of Manchester. The most interesting speech was that made by Professor Asa Gray, of Harvard, which was as follows:—

For the very great honour of being called upon to second the motion for a vote of thanks to your illustrious President, I am mainly indebted to that deference which is naturally accorded to advancing years, a deference which sometimes—as in the present case—takes one unawares.

In looking back over the list of corresponding members of the British Association, I find myself, much to my surprise, nearly, if not quite, the oldest survivor.

I recognise, therefore, a certain fitness, on this score, in the call upon me to be the spokesman of those, your brethren from other lands, who have been invited to this auspicious gathering, and to the privilege of listening to the very thoughtful, well-timed, and most instructive address of your President.

As guests, we desire, Mr. Mayor, heartily to thank the city of Manchester and the officers of the Association for inviting us; we wish to thank you, Sir Henry, for the gratification your address has afforded us.

Convened at Manchester, and coming myself by way of Liverpool, I would say personally that there are two names which memory calls up from the distant past with unusual distinctness; both names familiar to this audience and well known over the world, but which now rise to my mind in a very significant way. For I am old enough to have taken my earliest lessons in chemistry just at the time when the atomic theory of Dalton was propounded, and was taught in the text-books as the latest new thing in science.

Some years earlier, Washington Irving in his *Sketch-book* had hallowed to our youthful minds the name of Roscoe, making it the type of all that was liberal, wise, and gracious. And when I came to know something of botany I found that this exemplar, as well as patron, of good learning had by his illustrations of Monadrian plants taken rank among the *Patres Conscripti* of the botany of that day.

The name so highly honoured then we now honour in the grandson. And I am confident that I express the sentiments of your foreign guests, whom I represent, when I simply copy the words of your President in 1842, now reproduced in the opening paragraph of the address of the President of 1887, transferring, as we fitly may, the application from the earlier to the later Manchester chemist: "Manchester is still the residence of one whose name is uttered with respect wherever science is cultivated, who is here to-night to enjoy the honours due to a long career of persevering devotion to knowledge."

I cannot continue the quotation without material change. "That increase of years to him has been but increase of wisdom" may indeed be said of Roscoe no less than of Dalton; but we are happy to know that we are now contemplating, not the diminished strength of the close, but the

manly vigour of the mid-course, of a distinguished career. Long and prosperously may it grow from strength to strength.

In general, praise of the address which we have had the pleasure of hearing would not be particularly becoming from one whose chemistry nearly ended as well as began with the simple atomic theory of Dalton. But there is one topic which I may properly speak of, standing as I do as a representative of those favoured individuals whom your programme —for lack of a better distinguishing word—calls foreigners. I refer to the urgently expressed "hope that this meeting may be the commencement of an international scientific organisation." For this we thank you, Mr. President, most heartily. This is, indeed, a consummation devoutly to be wished, and confidently to be hoped for, by all of us, especially by those for whom I am speaking. Not only we Americans, who are of British descent, and who never forget that blood is thicker than water, but as well our Continental associates on this platform, of the various strains of blood which interfused have produced the English race and fitted it for its noble issues—we, each and all, I repeat, accept this name of foreigners only in the conventional sense which the imperfection of the language imposes. In the forum of science we ignore it altogether. One purpose unifies and animates every scientific mind with "one divine intent," and that by no means the "far-off intent" of which the poet sings, but one very near and pervading. So we took to heart the closing words of your President's most pertinent and timely address. Indeed, we had taken them to heart in anticipation. And we have come to this meeting one hundred strong or more (in place of the ordinary score) fully bent upon making this Manchester meeting international.

Far back in my youthful days there was a strong-willed President of the United States, of military antecedents, who once drew up and promulgated an official order which somewhat astounded his Cabinet officers. "Why, Mr. President!" they said, "you can't do that." "Can't do it," replied General Jackson, "don't you see that I have done it?" And so we internationals have come and done it. I am the unworthy spokesman of such a numerous and such a distinguished array of scientific foreigners as have never been assembled before.

Next year, if you will, you shall have as many more. When you, too, are ready to cross the Channel or the North Sea, we shall compose only a larger scientific brotherhood.

And when you cross again the Atlantic, the brotherhood of science will be the more increased, and its usefulness in proportion.

On behalf of your foreign guests, I heartily second the motion.

The above speech turned out to be the last of the public utterances of our dear friend, as he died shortly afterwards, on returning home to the States.

A conversazione was given by the Executive Committee of the Jubilee Exhibition, on which occasion an address was read by the Chairman, Sir Joseph Lee, to the President and members of the Association, welcoming them to the Exhibition. In this he said:—"Your distinguished President of this year is one of our citizens, and we are proud to think that in the present, as in the past, we have as a city contributed our full share, not less to the advancement and spread of scientific knowledge than to its application in the processes of manufacture, industry, and exchange."

In reply I remarked that I deemed it a great honour, as President of the British Association, to return to Sir Joseph Lee and members of the Executive Committee, on the part of the members, sincere thanks for the address of welcome and for the hospitable reception which had been accorded to them in that wonderful building. No more fitting tribute in honour of her Majesty's reign was raised throughout her dominions than the Royal Jubilee Exhibition in Manchester. It was one of which the utility and influence far exceeded that of any temporary pageant, for the sights and sounds which had already there met the eyes and ears of nearly three millions of our people were of a character not merely to allure and please, but to interest and instruct. For that exhibition

contained illustrations of the most important and interesting productions of the human intellect and human ingenuity, and the contemplation of these achievements could not fail to impress our people with the results of our industrial enterprise, and to encourage them to renewed effort.

At a banquet given to the Association by the Corporation of Manchester on the 7th of September I had to respond, as President, to the toast of the British Association proposed by the Mayor.

The meeting was certainly a great success. To a certain extent this was due to the untiring personal exertions of my late distinguished colleague and friend Professor Milnes Marshall, F.R.S., whose untimely death by an accident on Scawfell Pike science and his friends have had to deplore.

On the occasion of the Queen's Jubilee in 1887, together with the other members of the House of Commons and their ladies, my wife and I had places assigned to us in the Abbey. The magnificent ceremonial has been fully described by other pens. No ceremony of the kind was ever so rich in associations or so beautiful in its effect. In the first place, no monarch ever reigned for so long a time in any part of the world with the trust and love of so many millions of human beings. In the second place, our Sovereign was a woman, with all the noblest attributes of her sex. In the third place, it was not a mere martial show, but the expression of the feeling of a nation devoted to its Sovereign as the upholder of peaceful progress. In the magnificent procession of princes and foreign potentates who came to honour our Gracious Queen stood pre-eminent the splendid form of her son-in-law, Prince Frederick of Prussia, afterwards, alas! for so short a time, the

Emperor of Germany ; conspicuous among all, he stood forth as an embodiment of majestic manhood. Sad it is, indeed, to think of what civilisation and liberty lost in his untimely death. What that loss was to Germany one may judge by the touching and high-minded proclamation with which he inaugurated his brief reign as Kaiser.

The Diamond Jubilee celebration of 1897 was of a different character. Of this I was also a witness. The Queen, accompanied by a whole number of Royal and illustrious personages, passed through the crowded streets from Buckingham Palace to St. Paul's.

On the occasion of the funeral of Queen Victoria I received an invitation, as Vice-Chancellor of the University, to be present in St. George's Chapel, Windsor. This again was a heart-stirring ceremony, and when the coffin entered the Chapel borne on the shoulders of her gallant soldiers, a feeling of thankfulness must have been uppermost in the breasts of all that we had lived in the Victorian era, under the beneficent rule of our great and good Queen. It was a singular circumstance that even the small Chapel was not filled with mourners. Undoubtedly "someone had blundered." On entering the Chapel I was placed in a somewhat remote position, the lower seats being reserved for the great people who never came, so that just before the entrance of the procession I and others were requested to come down and take up the vacant seats. On this occasion the most interesting figure, next to that of our own King, was that of the son of the man of whom I have been speaking, namely, the Emperor William, whose devoted affection to his grandmother was one of the most touching circumstances in a sorrowful time.

"*La Reine est morte, vive le Roi!*" Once more I

was invited to be present in Westminster Abbey for a joyful occasion, that of the Coronation of his Majesty King Edward VII. As all the world knows, this ceremony was postponed owing to the King's serious illness, which, happily for the country and the world at large, and thanks to the progress made by scientific surgery, had a happy conclusion. And here I may mention that Lord Lister, to whom suffering humanity owes so much in the application of the aseptic method of surgery, and who, as Sergeant-Surgeon to the King, was consulted, was told by his Majesty, "If it had not been for you I should not have been here now." A similar case occurring fifty years ago would probably have baffled the efforts of the most eminent surgeons of that time, not in consequence of their lack of surgical skill, but because of their want of knowledge of the existence and of the effects of the poisonous germs which might render their work abortive, and whose attacks now, thanks to Lister, can be averted.

CHAPTER X

CONCLUSION OF WORK IN MANCHESTER

Resignation of Professorship—Member of Parliament for South Manchester—Addresses on Retirement—My Views on the Teaching of Chemistry—Fellow of Eton College.

In consequence of my election as Member of Parliament for the Southern Division of Manchester in the autumn of 1885, I resigned the professorship of chemistry in the Owens College, which I had held since October, 1857. On the occasion of my retirement I received the following resolution passed by the Council of the College :—

At a meeting of the Council held at the College on Friday the 18th December, 1885, the resignation of Sir Henry E. Roscoe, Professor of Chemistry, was considered, and it was resolved, that the Council, while offering to Sir Henry Roscoe its congratulations on his attainment of the honour of election to a seat in Parliament, accepts with very deep regret the consequent resignation by him of the offices of Professor of Chemistry and Director of the Chemical Laboratories in the Owens College, and invites him to confer with a Committee of the Council as to the time at which the resignation shall take effect, and as to the arrangements which it may be desirable to adopt for the future conduct and organisation of the department.

That the Council desires to place on record its strong sense of the eminent services, which through a period of nearly thirty years Professor Roscoe has rendered to the College, and its conviction that to his great attainments as a man of science, his skill and success as a teacher and

organiser, his widespread reputation, and his high personal qualities it is in great measure due both that the College enjoys so high a rank as a place of education, and that its Chemistry Department in particular has long held a position second to that of no other academic institution in the United Kingdom.

The Council expresses its cordial wishes for Sir H. E. Roscoe's prosperity and happiness, and assures him that it will regard with pride and warm interest the honourable career on which he is now entering.

I need hardly say that I left the College, especially the Laboratory, and my colleagues and pupils, with whom and for whom I had worked nearly thirty years, with the greatest regret. I had some hope at one time that an arrangement might have been come to by which I might still have remained in Manchester, taking the full duties of the professorship during the first and busiest term of the year and handing over to some colleague, and I knew I could have secured one, the duties of carrying on the work whilst I was absent in London during the sitting of Parliament. The Council, however, wisely perhaps, thought otherwise, and did not make any overtures to me with this view. But that my work in Manchester was appreciated by those engaged in the chemical and cognate industries in the district may be measured by the fact that a memorial was sent to the Council, signed by upwards of 300 of the chief manufacturing firms in the neighbourhood, desiring that my connection with the College should not be altogether broken. The local Press, as well as that in other parts of the country, expressed a similar desire. Thus the editor of the *Lancet*, noticing my resignation, made the following remarks, which I can only accept *cum grano salis*:—

The Victoria University, Manchester, sustained a great misfortune in the resignation of Sir Henry Roscoe. For many years Sir Henry has been recognised all over the

civilised world as one of the greatest scientific men of our age. His researches have added chapters to the history of chemistry, his writings have adorned it, and his teaching has equipped a host of brilliant and useful scientific workers and successful teachers. His uniform courtesy, and the ready help he has afforded to all who sought it, have procured him high esteem among men, and when he was elected to a seat in Parliament all lovers of science rejoiced.

Shortly after my resignation, my friends desired that my portrait should be placed in the Professors' Common Room at the Owens College, and for this purpose I sat to Burgess. In presenting the portrait, Principal Greenwood, in graceful terms, alluded to my long connection with the College, to the distinctions won by my pupils, to the value of the original investigations made in my laboratories, and also to the work which I had done in obtaining a charter for the University of Manchester. He ended by congratulating me on my election to the House of Commons, at the same time regretting the consequent severing of the ties which had bound us so long and so affectionately together.

If possible, a still more gratifying testimonial was at a later date presented to my wife by my pupils, in the form of another portrait for which I sat to Herkomer. It was accompanied by the following address to myself:—

We the undersigned students of Owens College who have had the privilege of being your pupils, desire at the close of your active work as a teacher to offer you some recognition of the value of the services you have rendered to our College during the time you have laboured as one of its professors. For upwards of thirty years you have had the control and direction of the Chemical Department of Owens College. You leave it in 1887 the best organised and best equipped school of chemistry in the kingdom, numbering its students by hundreds, and the acknowledged

NH_3

"The peculiar pungent smell of this compound is noticed if we heat a bit of CHEESE in a test-tube."

Roscoe and Lant

HBP Dec 99

model of many similar institutions which the success of your own school has called into existence. No place of chemical instruction has exercised so profound an influence as that of which you have been the moving and directing force, and with which your name will always be connected. The influence on the industrial welfare of the community is seen from the number of important posts held by your students in the district. As a centre of chemical research you have made Owens College known all the world over, and your published books on chemical science form the standard works not only in this but in many countries. Whilst we have viewed with regret the severance of your active connection with the institution for which you have done so much, we trust that you may be long spared to continue in the wider sphere of political and public life those efforts which have contributed so largely to the intellectual advancement of the people of this country. We beg your acceptance of the portrait which accompanies this address as a token of our affectionate respect, and in grateful recollection of the many kindly acts which have endeared you to us all.

It was especially a great wrench to leave my well-fitted laboratory, and to cut myself more or less off from scientific work. So strongly did I feel this that I determined to start a private laboratory in London, and with the help of Messrs. Lunt and Scudder I worked on various subjects, especially on a new and accurate method of estimating the dissolved oxygen in water, and on an examination of some of the micro-organisms present in sewage. This latter piece of work was published in the Philosophical Transactions, and was one of the first memoirs containing really good photo-micrographs of the pure cultures. Together with Mr. Lunt I also wrote a *First Step in Chemistry* which has had a large sale. With reference to this little book, I here insert a reproduction of a coloured drawing by my niece, Miss Beatrix Potter, as original as it is humorous, which was presented to me by the artist on the publication of the work. After a while I found that I could not give time to

laboratory work. Mr. Lunt became an astronomer, and got a place under Sir David Gill at Capetown ; Mr. Scudder removed to Manchester to do work for me in connection with river pollution, and my chances of further original laboratory work came to an end.

On resigning the professorship in the Owens College in 1885, I printed for private circulation a statement of my views as to the teaching of chemistry, together with a record of work done in the department during the thirty years in which I had charge, and upon which, now, in my closing years, I look back as having been the chief work of my life.

In the first place, I recalled the position of the college in 1857. The total number of students was thirty-four, and of these fifteen worked in the Chemical Laboratory, whilst in 1887 the number had reached 118. The institution in the outset of its career had not gained the confidence of the public, and to acquire it it had to fight many a stiff uphill battle. It was only gradually that the idea was grasped that science could be made an efficient instrument of education, and that such an education was not only compatible with, but absolutely necessary for, a successful industrial career. Nor was it altogether an easy task to convince the Trustees of the College that a mere repetition, on an insignificant scale, of the old university system could not be expected to succeed in Manchester ; or to bring home to them that unless the institution was to sink down to the level of a school (as many advocated), or die out altogether, some new line had to be struck out, and that the only possible one was that of the encouragement and development of the teaching of physical science. To make this a reality, so far as chemistry and the allied sciences were concerned, was my ambition ; and after thirty years of

work this was, to some extent at least, realised, for there were few engaged in the district in any large way of business in which chemistry plays a part who had not shown their appreciation of the value of scientific education by sending their sons or their managers to learn chemistry at Owens College. It is a pleasure to me to add that since my time the success of the Owens School of Chemistry has not merely been maintained, but has been greatly developed, both as regards numbers and amount of original work, under the able superintendence of Professors Dixon and Perkin.

The public recognition of the value and meaning of a scientific education is shown by the fact of the growing willingness of parents to permit, and of young men themselves to wish to devote a sufficient amount of time to their studies to enable them to derive real benefit therefrom. In the earlier years the prevailing notion of the majority of the manufacturers (though amongst them there were notable exceptions) was that if his son stayed at college for six months he could be "put up" to all the necessary information to enable him to apply chemistry to his business. The fathers frequently used to come with a story of this kind:—"I am a calico printer (or a dyer, or a brewer), and I want you to teach my son chemistry so far, and only so far, as it is at once applicable to my trade," and when informed that chemistry as a science must be taught before its applications could be understood, and that his son could not for two or three years at least begin to work upon the subjects directly bearing on his trade, he too often replied that if that were the system he could not afford time for his son to learn on this plan, and that if he could not be taught at once to test his drugs, he should prefer to leave him in the works, where he

and his father before him had made a great many commercial successes with no scientific knowledge, and where he saw no reason to doubt that his son would do the same.

The change that has come over our manufacturers during the last five-and-twenty years has been remarkable, and now all are, I believe, fully awake to the necessities of their position, and are most desirous of improving the scientific knowledge, not only of themselves and of their sons, but of their managers, foremen, and workpeople. That this is so may be proved by the fact that whereas formerly it was difficult to keep our students for more than one session, our senior laboratories are now well stocked with men in their third, fourth, and even fifth years, graduates of the University, who are working at advanced subjects and at original research, and becoming "Chemists" in the highest and best sense of the word. In order to bring about this state of things it was necessary to establish a thorough course of theoretical and practical instruction, for both these must go together to make the teaching a reality. The gradual increase in the number of men studying chemistry from the year 1857 onwards shows how far my efforts have succeeded, seconded as they have always been by my colleagues, and by the able demonstrators and assistant-lecturers[1] with whom it was my great good fortune to work.

This result, like everything that is worth doing, was not accomplished without years of labour. The personal and individual attention of the professor is the true secret of success; it is absolutely

[1] Among these are found the following names of well-known chemists :— Guthrie, Dittmar, Schorlemmer, Thorpe, Smithells, Bedson, Cohen, Carnelley, Sydney Young, Williams, Baker, Watson Smith, and Bailey.

essential that he should know and take an interest in the work of every man in his laboratory, whether at the beginning or at the finish of his course. The professor who merely condescends to walk through his laboratory once a day, but who does not give his time to showing each man in his turn how to manipulate, how to overcome some difficulty, or where he has made a mistake, but leaves all this to be done by the demonstrator, is unfit for his office, and will assuredly not build up a school. It is in the laboratory, and there alone, that chemistry, like every other experimental science, can be properly learnt, and it is by the peripatetic teaching of the professor and his demonstrators that the student benefits most.

As regards elementary laboratory teaching my idea is that, to be of any use, it must inculcate method and accuracy both in theory and practice. The student must be put on the right track, and made to understand what he is doing, and why he does it. Moreover, he must gradually gain the power of exact observation, and of logical inference. All these faculties are exercised and developed in a properly organised and thorough course of qualitative chemical analysis. The objections which have been urged by some against this system as "mere test-tubing" indicate to my mind a want of knowledge on the part of the critic of how to teach, and what can be taught; on the contrary, I venture to assert that no elementary course of practical scientific work is more useful, either in training the hand or the head, than a properly conducted course of qualitative analysis. This, however, presupposes that the exposition of the theory accompanies the practice of qualitative analysis, and that a course of demonstrations, in which the reactions and methods of separation are

systematically explained and discussed, is attended as well as the general course on theoretical chemistry.

Having in the first year's course of qualitative analysis and preparative chemistry obtained a knowledge of the principles of the science, and a certain amount of facility of manipulation and reliance on his own powers of experimentation and observation, the student on entering upon his second year's course commences quantitative analytical work. In this he learns by degrees what scientific accuracy means, how exact results can be obtained by careful quantitative work, and thus gains in confidence and certainty. Here, too, constant personal supervision on the part of the professor and of his demonstrators is absolutely requisite, as everything depends on the care with which the various operations are carried on. The main object of this course is not only to give the pupil reliance on his own power of exact work, but to make him aware of the sources of experimental error, and to enable him to estimate their amount. This can be accomplished as well by accurate volumetric as by gravimetric work. All the analyses thus made by the pupil must be carefully entered up in a general log-book, as well as in his private note-book, so that at any time reference can be made to the extent and accuracy of his work.

On this firm foundation of a competent theoretical knowledge of inorganic chemistry, and of a thorough practical acquaintance with qualitative and quantitative inorganic analysis, including the preparation of chemical compounds in a pure state, and on this alone, can, I have always been convinced, the proper and higher education of the chemist, whether for purely scientific or for technical purposes, be based, and upon this view I consistently acted. Thus I always set my face

against the pupil "practising" the rough and ready methods used in works before he has learnt to appreciate the exacter processes, and it was my constant endeavour to supplant the often crude and incorrect trade tests by a more precise, though perhaps somewhat more lengthy, system. Having, however, once obtained a satisfactory judgment as to the capability of the several methods, the student may be allowed to occupy himself, according to his taste or necessities, with the determination and valuation of pure and impure products according to the most approved commercial processes.

Having thus gained a practical acquaintance with quantitative methods, and having attended a course of experimental lectures on both elementary and advanced theoretical inorganic chemistry, the pupil is now in a position to begin the study of the carbon compounds or organic chemistry.

The history of the growth of the department of organic chemistry in the Owens College is of interest. When, in 1859, Mr. Dittmar, F.R.S. (afterwards Professor at Anderson's College in Glasgow), resigning my private assistantship, was appointed to the sole demonstratorship in the laboratory *vice* Dr. Guthrie, he was succeeded by Mr. C. Schorlemmer, a young chemist of Darmstadt. In due course Schorlemmer showed his mettle, succeeding Mr. Dittmar as College Demonstrator in 1861, and whilst continuing to discharge the duties of Senior Demonstrator for no less than thirteen years, he won for himself by his original investigations the position of one of the first organic chemists of the day. During the growth of our system of teaching, and whilst greater demands for a higher and more developed range of instruction arose, and whilst at the same time the boundaries of our science

extended themselves enormously, it became plain that the work of properly professing the whole of the science had become too great for one individual, and at my request Mr. Schorlemmer, F.R.S., was appointed Professor of Organic Chemistry in 1874.[1] He was then the only professor of organic chemistry in the country ; for at that time in no other institution in the kingdom had it been thought worth while to encourage the study of the organic branch of our science, or to mark its great importance and extent by giving to it a distinct position.

Although, as I have already remarked, I am convinced of the essential importance of laboratory practice as bringing the student face to face with Nature, I would by no means depreciate the value of attendance on a thorough course of experimental lectures. In this way the principles and the important facts of the science are brought before the student in a consecutive and systematic manner, and illustrated by experiment, preparation, and diagram in a way impossible for the pupil himself to accomplish. The delivery of my lectures to both day and evening students was a constant pleasure to me ; the devising of new experimental illustration is always a matter of interest, whilst the introduction of recent discoveries gives zest to both lecturer and audience. I likewise made it a practice to obtain courses on special subjects from some of our assistant lecturers or from our Berkeley Fellows. These proved of signal value to both teachers and taught, and were fully appreciated by the senior men.

Having secured thorough and advanced teaching in both the inorganic and organic branches of the

[1] The work done by Schorlemmer has been properly acknowledged by the erection of a special organic laboratory named after him, where original work in that branch of the science is now (1906) most successfully carried on by his successor, Professor Perkin, F.R.S.

science, it became necessary to see how far it was possible to introduce lectures and practical instruction in some special branches of applied chemistry. I have always held that the application can only be properly and thoroughly learnt in the factory or works, just as a trade cannot be taught in a school unless, indeed, the school becomes a shop. This is, however, no reason why the scientific principles of the various industrial processes and even of their details should not be brought in orderly fashion before the pupil who is intended afterwards to conduct such processes. I am of opinion that, provided a secure scientific basis is laid, such lectures, given by a teacher who has had practical as well as theoretical experience are of great value to the technical student, and this view I endeavoured to carry out.

One of the chief functions of a school of chemistry is to train teachers, and its highest aim is to guide students in the methods of original scientific investigation, and thus fit them for extending the boundaries of the science. That this had to be done, if the school is to be in any degree successful, I had learnt (amongst much of other invaluable experience) from my venerated teacher Professor Bunsen; and the names of T. H. Sims, William Dancer, William Marshall Watts, Arthur McDougall, and T. E. Thorpe are associated with original experimental investigations which were published from our laboratory in the 'fifties and early 'sixties. The foundation of the Dalton Scholarship in 1856 for aiding original chemical research assisted most materially the progress of our school in early days; indeed, it has done so ever since. We had a goodly list of twenty-two Dalton scholars, most of whom have made or are making for themselves distinguished careers, either as

teachers and investigators or as industrial chemists, and who, one and all, will, I know, acknowledge that the first and most important step in that career was the original work done for the Dalton Scholarship.

The stimulus to original work must be given by the teacher, and it is he only whose head, hand, and heart are thus occupied who can induce others to follow the same difficult though delightful path. In short, the spirit of research must be felt in the atmosphere of the laboratory, and in this respect there ought to be no difference between pure science and its applications. To prosecute either one or the other with success the methods of research must be learnt and followed.

This training in one science, however complete in itself, is insufficient to educate a chemist whether for theory or practice. For each of these branches of the science a much fuller training and a much wider scientific outlook are nowadays indispensable. The chemist must know his mathematics; his acquaintance with physics must be sound and extensive; engineering in some of its branches must be studied, whilst a knowledge of French and German is now absolutely necessary to follow the progress of science abroad. At every turn in his chemical work he meets with points for the decision of which it is necessary for him to be well versed in subjects which some years ago were considered quite foreign to his scientific outfit. Thus, if the new and important subjects of physiological and pathological chemistry are to be followed, a study of the biological sciences is necessary. Hence it is that colleges and universities which set out to train men in science have formulated a strict and properly graduated series of courses, giving the student an opportunity of acquiring a knowledge of the collateral subjects with which he may afterwards be called upon to deal.

But the student cannot appreciate or even understand the matters which are thus brought before him in the college or university unless these courses have been preceded by a sound secondary school education. This is at present our difficulty. A secondary education system is non-existent with us. Much progress in an unsystematic way has, indeed, been lately made, but much more remains to be done. Our great public schools lag behind in adopting the new ideas called forth by the changing conditions of society, and consequently the best blood of the rising generation fails, as a rule, to secure that training in scientific method which is an essential element in national progress.

To illustrate my meaning I may refer to my experiences with Eton, a noble institution, which I admire and love almost as if she had been my Alma Mater, but whose strength and power do not, I hope, altogether blind me to her faults.

In 1889 I was nominated by the Council of the Royal Society, at the instance of my friend Sir James Paget, as its representative on the governing body of Eton College in succession to Huxley, who had retired from active work. And here I remember that Huxley said to me that if he had *carte blanche* to make such changes at Eton as he pleased he did not know what he should do. The function of the Royal Society's representative on the governing body of Eton is to do what in him lies to further the cause of scientific education in the school, and I have endeavoured to the best of my ability to carry out this duty. Nobody who is unacquainted with the very peculiar and complicated system of Eton life and work can fully appreciate the difficulties which a representative anxious to introduce modern educational methods has to contend with.

Not because of opposition from the Head-master, nor, in any degree, from the want of sympathy in these subjects felt by the Provost and Fellows, but because of the enormous inertia of this ancient machine. However, I have succeeded in obtaining new buildings for chemistry and physics, and have also enabled boys to take up modern languages and science in place of classics at an earlier age than was hitherto possible. The upholders of the classical system are fond of talking about "specialisation," a term they use when a boy is allowed to give more time to modern subjects. They seem to forget that the boy has been made to "specialise" in Latin and Greek ever since he was seven years old at the rate of ten or twelve hours a week.[1] Classics, in the opinion of some schoolmasters, is the "be all and end all" of a boy's education. The modern subjects are only introduced as a sop to a world wanting in "culture," not to strengthen the character or the intellect. How soon a scientific method will be introduced into the teaching of all subjects is a matter which the future alone will show. The signs of the times, however, seem to point to a new development in our English public schools, for even those most wedded to a classical education are beginning to see that the conditions of life are altered, and that therefore, if we are to succeed in the preparation of our boys for these changed conditions, our type of education must also be changed.

I am fully alive to the value of literature and the humanities as a part of education, but, then, these subjects, like all others, must be intelligently taught. The old idea of putting boys through a grind, and

[1] At Eton the amount of time spent by boys from twelve to fourteen years of age on Latin and Greek alone actually exceeds twenty hours a week, and the question naturally arises, "with what result?"

setting them a task without reason or interest, is only equalled by the still more ancient and barbarous plan of the birch-rod system of instilling the classics. The whole question of English public school education is too large to be fully discussed here. I must say, however, that unless all masters find out how to arouse the interest of the boys in their studies no radical improvement can be expected. Probably much of this state of things is due to the apathy of parents, who are quite satisfied if the boys' reports are favourable.

With regard to scientific teaching very false notions exist. In the first place, many suppose that the end and aim is to get a smattering of so-called "Nature knowledge." A great Don once asked me, "How do you do an air-pump?" The real educational value of science is not to know how a pump works or how to test for sulphuric acid. The value lies in the formation of an orderly, observant, and accurate habit of mind. Science teaching tends to encourage this habit; and for this reason we value it as an educational instrument, and because mere book-learning does not encourage this habit we rate it accordingly.

I once heard a description from an eye-witness of a lesson in chemistry given in one of the larger schools. One of the Latin masters took chemistry. The book used (no laboratory work was thought of) was my *Elementary Lessons*. Magister (*loquitur*): "Now, boys, have you all got your Roscoe?" Boys: "Yes, sir." M.: "Well, pages 42 to 54." Then he proceeds to correct the Latin exercises. Bell rings. M.: "Well, have you read your Roscoe?" B.: "Yes, sir." M.: "Then you can go." This is a true picture of the science teaching at schools some years ago. Thank goodness, it is no longer so, for

laboratories and practical science teaching are spread over the land, and not merely in the secondary, but also in the primary schools. So that unless our great public schools push boldly forward, as they are to some extent doing, they will be overtaken.

Much may be done to stimulate interest out of school by public lectures and demonstrations. I have given several lectures to the boys at Eton, which I believe have given as much pleasure to them as they have given me (see Appendix I).

CHAPTER XI

POLITICAL LIFE

Entrance to Political Life—My Opinions on Politics—Contested Elections '85, '86, '92, '95—Mr. Gladstone in the Free Trade Hall—Home Rule—Legislative Measures proposed—Commission on Ventilation and Drainage of the Palace of Westminster—Irish Members.

My introduction to political life began in a somewhat singular manner. In May, 1885, I was requested to take the chair at a political meeting held in the new division of South Manchester. The object was to secure the candidature of a friend as the representative of the division, and although I had never taken any part in politics, I felt that I could scarcely refuse the invitation. After the preliminaries had been discussed, I remarked that we had now come to the real business of the evening, and, as I had been requested to do, I called upon a gentleman of position in the neighbourhood to propose my friend's name. Much to my astonishment, he declined to do this, and added that his friend Mr. So-and-So would continue the business of the evening, upon which the second gentleman rose and there and then proposed my name as their representative in Parliament. For this, I need scarcely say, I was totally unprepared. I should add that this proposition was seconded and carried unanimously. I then stated that I had come

there upon a totally different errand, that of supporting the question of the invitation to be sent to my friend, and without the slightest idea that my name would be mentioned in the matter. "But," I added, "the question is one for you, gentlemen, to determine. I leave the matter in your hands. It would be evidently impossible for me to give you an answer or to say anything more now. You must be the judges of your own action, and I therefore beg very respectfully to withdraw from the meeting."

The position between my friend and myself might have been a very unpleasant one. I at once informed him of what had taken place, assuring him that I had not the slightest idea when I went to the meeting of what was about to occur, and he very handsomely wrote to say that he could not allow himself to be put in nomination in opposition to myself, and that to be of any service in the furtherance of my candidature he would be very happy.

Some few days afterwards, on May 8th, an adjourned meeting of the Liberal Association for South Manchester was held in the Rusholme Public Hall, at which it was unanimously resolved to invite me officially to contest the division in the Liberal interest at the next election.

On May 13th I appeared at a meeting of the General Council of the Liberal Association for the division in the Chorlton Town Hall, when I said that after the kind way in which they had received me, and the extremely gratifying invitation they had given me, I felt I could not do otherwise than accept. One great reason which had determined me to take this step was that I believed, if strength were given me and my candidature was a success, I might do something in the House of Commons which other people, per-

chance, were not so well qualified to do. Certain great questions must come forward, even in spite of still more pressing ones of a general character—the great questions connected with our social condition, and especially of education—and on these I might be able to speak and perhaps be of assistance to the community. It was not because I cared really about having "M.P." after my name, and it was not because I thought there were not plenty of able men who could represent a Manchester constituency in many ways better than I myself could. I was not a commercial man. I did not pretend to understand many of the questions which at any rate were most important in this district; and the fact that they had conferred this honour upon one who was out of the ordinary lines of political life had given me great satisfaction, and had been an incentive to me to accede to the request that I should contest the division. Putting aside altogether the personal view of the question, I could not but think it was really a very satisfactory conclusion to which a great commercial community had arrived when it proposed to have for its Parliamentary representative a man who was somewhat different from the men who usually represented such a constituency.

I may also mention that a deputation waited upon me from the Liberal electorate of the Eccles division of South-East Lancashire, requesting to know whether I would undertake to become a candidate for their division. About the same time a letter reached me from a member of the Liberal Committee of the Liberal Association of the University of Edinburgh, asking me whether I would agree to become a candidate for the University seat. I replied to both that I had already accepted a nomination from South Manchester.

It may be well to say at this point that the South is in area the largest of all the six divisions of Manchester, being one-third of the total, whilst the population is about one-sixth of the whole population of the city. One remarkable fact about it is that it contains hardly any factories or works. There was not a single engine used for power throughout the division. The constituency is largely composed of the middle and upper class, rather than of work-people. It is really a Liberal seat, as has been proved by the return of a Liberal (1906) by a majority of no less than 4,232. The number of Welsh electors is very large, and these are all enthusiastic Liberals. The Irish vote is only a small one, but the Catholic vote is not a negligible quantity.

My determination to enter upon political life was not formed without much deliberation and doubt. Our family circumstances at the time were perhaps the greatest inducement for me to change my occupation and our residence, for I felt that it would be good for us to do so (see Chap. XVI), even if the acceptance of the invitation of the constituency should mean the resignation of my professorship and my severance from active teaching work in Manchester. I addressed the electors frequently in the course of the summer, and in consequence made new and valued friendships, many of which remained lifelong.

Amongst these I must specially mention the names of Mr. Edward Donner, the first chairman of our Liberal Association, Mr. Alderman Sir James Hoy, the late Alderman Guthrie, the late Mr. J. A. Beith, and Mr. Reuben Spencer. Among my supporters I was glad to claim the late Venerable Archdeacon of Manchester, the Rector of St. James's, Birch.

Though a strong Churchman, he was throughout a consistent Liberal, and when the split of the Liberal party came, he consistently supported me in all my elections. On the first occasion I was also warmly supported by most of my colleagues, Dr. Williamson, Dr. Wilkins, Dr. Leech, and others.

For some time no candidate appeared on the Conservative side, and, indeed, I think there was some difficulty in obtaining one. At last Dr. Peter Royle, a local medical man with an extensive practice as a club doctor, came forward. On a fly-sheet printed by Dr. Royle's committee it was stated that for forty years he had been member and past officer of the "National Independent Order of Oddfellows," and for a similar period a "Dryad," an "Ancient Forester," and a "Shepherd." It also stated that as a Freemason he had obtained provincial honours in the craft, and in the "Royal Arch"; further, that he had held high rank as a "Knight of St. John," a "Knight of Malta," and "P.M.W.S. Rougecroix," and had been the "Grand Standard-bearer of England." His membership, it was added, was of the "thirtieth degree." It will, perhaps, be wondered why, when a gentleman possessing such titles and uniting the offices of a local club doctor with that of the Grand Standard-bearer of England came forward, I did not at once retire in his favour. But Fate—in other words, my constituents—willed it otherwise, and the result of the election (1885) was that I was returned by a majority of 670.

I shall never forget the scene in the large room in the Reform Club in Manchester on the evening of the election. I was the only Liberal Member returned for Manchester, and when I had to stand on the table in the midst of a roaring and excited audience and acknowledge their greeting, I felt com-

pletely overpowered. All my friends on the Liberal side had been rejected. Sir William Houldsworth had beaten Mr. John Slagg; Mr. James Hutton had beaten Mr. Charles Schwann; Sir James Fergusson had defeated Mr. Ponsonby Blennerhassett; Mr. Arthur Balfour had been victorious over Mr. Alfred Hopkinson; and even that stalwart member of the Liberal party, Jacob Bright, who had held the division next to mine for many years, was turned out by the youngest of the Hamiltons—a nice boy, but hitherto unheard of in politics. He is said to have ingratiated himself first with the children, and then with the mothers, and afterwards with the voters, in a district wholly made up of working-men, by teaching the children how to toboggan on a tea-tray from the top of the stairs. And this brought him in at the head of the poll.

On the whole, the contest was carried out without much bitterness, but I was obliged to protest on one occasion with regard to a placard which had appeared on the walls of "Royle and Religion," intimating that Roscoe was an atheist, and I said that the use of the word "religion" for party purposes was altogether improper. To bring down that which was most sacred in the hearts of everyone to the level of a mere electioneering dodge filled me with disgust. I went on to say that in the Liberal programme there were four "F's"—Free trade, Free land, Free education, and Freethought—when a voice cried out "and Atheism," to which I remarked that the man who interjected the word "Atheism" wished to help the cause of Toryism by endeavouring to make people believe that everybody who was not a Tory was an atheist.

In the autumn of 1885 I not only made a series of electioneering addresses, but I spoke on different

occasions on scientific and other subjects. At the Manchester Athenæum, on October 29th, I gave a brief account of the progress made during the past fifty years in those branches of science with which the Athenæum had been intimately associated, and indicated the difference in the circumstances in which men lived when Mr. James Heywood, its first President, was in his prime. It had been said that the true test of the civilisation of a nation was its progress in science. Although science was cosmopolitan, Manchester might well be proud of her position in respect of scientific attainments. If we looked back fifty years we found that the first railway in the world for passenger traffic had only for a few years been established between Liverpool and Manchester, the first steamer had not yet passed between the shores of the Old and the New World, the electric telegraph was unknown. That which had revolutionised Manchester trade was not accomplished till 1851, when the first submarine cable was laid between Dover and Calais. The connection of the American continent with our own country was not effected till 1866. The names of John Dalton and James Prescott Joule stood pre-eminent among the men of science of this century. In applied science we had no reason to be ashamed of the work done in Manchester. We had had among us Eaton Hodgkinson, Richard Roberts, James Nasmyth, William Fairbairn, Joseph Whitworth, Charles Beyer, Peacock, John Platt, Daniel Adamson, and Sharp Stewart and Co. But physical science was only one branch of the great study of Nature. It had been well said that the "noblest study of mankind is man." The laws regulating society, trade, and the intercourse of nations were not a less important study than the laws of the physical

universe. In this respect we in Manchester had no need to hide our heads. The Manchester School of Economists had made for themselves a noble place in the history of our country. Richard Cobden, John Bright, Henry Ashworth, Stanley Jevons, George Wilson, and might I not add the name of one who was near and dear to me—Edmund Potter—were the names of men whose labours had changed the face of society and brought comfort and happiness to every home in the land. Those were some of the things Manchester had accomplished. Still, they must not rest on their laurels. Manchester had indicated her desire for education, and her wish to take a leading place among the cities of the world, by the position she had taken up in respect of various educational institutions, including a University which she would by and by recognise as one of the brightest jewels in her crown.

In my election address in November, 1885, I spoke on the proposals which had then been made on the possibility of returning to a retaliatory and protectionist policy. I then held as strongly as I still hold that freedom of trade is the safeguard of British industry and commerce, and for the country to forsake this spells ruin. Protectionist countries were at that moment in a worse position than ourselves. What we needed was a more extended and more exact knowledge of everything relating to the raw materials we use in our industries, of the products of the industry of other nations, and of the requirements of those peoples with whom we deal. That could be furnished by the Government ; for our Consuls residing all over the world could readily supply the Foreign Office, not only with reliable information and statistics, as they do now, but with actual samples, of all the raw and

manufactured articles used in particular districts. I had experience of the appreciation with which such collections of raw and manufactured articles are regarded by our continental neighbours, and I could vouch for the importance which foreign manufacturers attached to such museums. I added that Manchester had, through the Ship Canal, a direct shipping trade with all parts of the world, and this rendered it all the more necessary that our manufacturers should be able to examine at home specimens of the goods which were most in demand even in the most distant foreign market.

About this time came the great split, the Home Rule Bill, Mr. Gladstone's manifesto to the electors of Midlothian of June 12th, 1886, and John Bright's address to the electors of the Central division of Birmingham, dated from Rochdale, 24th June. It was this latter that did more than anything else to decide the majority of the electors in the 1886 campaign.

My Conservative opponent on this occasion was my neighbour Colonel Thomas Sowler, afterwards Sir Thomas, the well-known and respected proprietor of *The Manchester Courier*. At that time the Liberal Unionists had not completely amalgamated with the Tory party, and therefore they were not satisfied unless in some constituencies they could bring forward a candidate of their own against both Liberal and Tory. The electors of South Manchester on their way to church on June 27th discovered some large parti-coloured placards, half red and half blue, which had been pasted over mine, and which meant that a third candidate had appeared to ask their suffrages. The placards bore the name of North Dalrymple, and were dated from the Queen's Hotel, and I had the honour

of being introduced to Mr. Dalrymple at the Reform Club, of all places in the world, the next day. In his address he said that Mr. Gladstone's policy was only based on sentiment, and at one of my meetings I desired to ask him whether Catholic Emancipation and the abolition of slavery, two of the greatest measures that had ever been passed, were not also based on sentiment. Every great measure had some foundation of sentiment in it, but there was a great deal in Mr. Gladstone's proposal besides sentiment, as in those other great measures. The subject of self-government for Ireland was one of the greatest national questions which had come before the country in our time. On Monday, the 28th, the Hon. North Dalrymple held a meeting which was characterised by great disorder, and was the only one at which he was present, for he quickly retired, and the contest became a square fight between Colonel Sowler and myself, the result of the poll being that I was returned by a majority of 335.

On June 26th Mr. Gladstone made a great speech in the Free Trade Hall. The heat in the building, which was crammed to suffocation, was intense. I sat next to Mrs. Gladstone on the platform, and after Mr. Gladstone had spoken for three-quarters of an hour, the perspiration was running down his face, not in drops but in streamlets, and it seemed as if he could not possibly continue to speak, and there was considerable interruption from people at the back of the hall, who were packed like herrings in a barrel. I whispered to Mrs. Gladstone: "Do tell him to conclude. I am sure it is not fit for him to continue." And she said a few words to him to that effect, upon which he turned round and in a somewhat loud voice said: "Stop! I can't stop. Who is there to tell them these

things? I must go on." And he finished with the following admirable peroration:

> And what, gentlemen, will be the end? What will be the end? I don't think that even our opponents believe it possible for them to win. They do believe, or think they believe, that they can delay the triumph of the cause; they know they cannot prevent it. They can delay it by every means; they may perhaps destroy some of its grace, something of its dignity, something of its freedom. They may produce further controversy, further exasperation. What is the good of results like this? Is it desirable that you should now give the boon of your own spontaneous will to Ireland thankful and grateful, in the anticipation of a future of loyalty and joy, or that you should wait until difficulty gathers round you, and until it is extorted from your hands, as Roman Catholic Emancipation was dragged from out of the hands of the Duke of Wellington in order to avert civil war? Now, gentlemen, be wise, and be wise in time. Rekindle the ancient fire which was the beacon from Manchester forty and thirty years ago, blazing throughout the land. Again set the example to England and lead us on to victory, to a bloodless victory, to a victory without tears or shame, to a victory where, after a short time of happy retrospect, the conquered will join with the conquerors in the rejoicing it brings about, and will recognise what has been done as for the whole Empire, a common triumph and a common joy.

In a few words I proposed a vote of thanks to Mr. Gladstone and pledged the meeting to support his policy.

The next morning I was invited to breakfast with Mr. Agnew (now Sir William) at Somerville, Pendleton, and here Mr. Gladstone received a large number of deputations. The scene, as he stood bare-headed on the lawn, receiving the addresses and replying in touching and forcible language to each, was one which all who witnessed it will not forget.

In my election address of 1886 I formulated my views on Home Rule as follows:

> As regards the all-absorbing question of the day, my vote on the Government of Ireland Bill has already indicated that,

whilst not binding myself to details, I accept heartily Mr. Gladstone's proposal to grant to Ireland her just demands for a distinct legislative body, to deal with affairs exclusively and specifically Irish. In doing so, I am only carrying out the programme which I suggested in my address last November, viz., that of governing Ireland rather according to Irish than according to English ideas. It is my earnest conviction that in thus giving to Ireland the right of self-government, we are endangering neither the supremacy of the Imperial Parliament nor the unity of the Empire. On the contrary, I believe that the delegation to Ireland of the management of her own local affairs by a body subordinate to Parliament will tend not only to strengthen our Imperial Legislature, but will increase the power and welfare of the Empire by uniting Ireland to us by ties of friendship and interest far more binding than those of a paper union upheld by force against the wishes of her people.

I deny that those who support this policy are Separatists, for I do not believe that self-government in Ireland will ever lead to separation; nor am I the least inclined to share the gloomy views entertained by some of the future of the Protestant minority under the proposed new Constitution. I see no reason to doubt that their rights will be duly respected, and I believe that in due course they will work loyally with their fellow-Irishmen for the welfare of their common country.

From 1886 to 1892 I sat on the Opposition benches, and I frequently went down to Manchester to speak on political questions.

On April 28th, 1887, a great meeting was held in the St. James's Hall, Manchester, to protest against the Coercion Bill of the Government. There was an enormous attendance, and the proceedings were harmonious and enthusiastic. Mr. H. J. Roby was in the chair, and I seconded a resolution condemning the Coercion Acts. I said that the whole difference between the two contending parties in the State, for there were in reality only two parties, might be summed up in very few words: we trusted the Irish people to work out their own salvation, and our opponents

were determined that they would still keep them in English leading-strings. I stated that when on a visit to Dublin some time ago, a Protestant of high standing, Dr. Robert Maguire, who had lived in Dublin all his life, and was intimately acquainted with every condition of society from the Lord Lieutenant downwards, told me that he was a Home Ruler, though not a Parnellite, because he was convinced that to make Ireland a nation responsibility must be thrown upon the people, and he added that England had demoralised the Irish. The Irish bar was a demoralised bar, and what the Irish had to learn was to keep their hands out of English pockets.

I also quoted some words of John Bright's speech made in Dublin in 1886: "You will recollect that when the ancient Hebrew prophet prayed in his captivity, he prayed with his window open towards Jerusalem. You know that the followers of Mahommed when they pray turn their faces towards Mecca. When the Irish peasant asks for food and freedom and blessing, his eye follows the setting sun, the aspirations of his heart reach beyond the wide Atlantic, and in spirit he grasps hands with the great Republic of the West!" I then added that the love of their country on the part of the Irish all the world over had been termed sentimentality. Sentiment is one of the most powerful incentives to human action, and to it is due some of the greatest benefits that the human race has received.

When, as often, I felt annoyed with the rough and tumble life of politics as compared with the more peaceful atmosphere of one's scientific work, I remembered the Grand Old Man's words, written some time before and probably for another purpose: "The free expression of opinion, as our experience

has taught us, is the safety-valve of passion. That noise when the steam escapes alarms the timid; but it is the sign that we are safe." And again: "I have lived now for many years in the midst of the hottest and noisiest of the workshops of constitutional freedom, and have seen that amidst the clatter and the din a ceaseless labour is going on; stubborn noise is reduced to obedience, and the brute powers of society, like the fire, air, water, and minerals of Nature, are, with a clamour indeed, but also with might, educated and shaped in to the most refined and regular forms of usefulness for man."

On August 15th I opened the Rusholme Liberal Club, in honour of which a garden-party was given at "The Firs," in Fallowfield, by my friend Mr. C. P. Scott, the editor of *The Manchester Guardian*, and for many years Liberal Member for the Leigh division of Lancashire. And here let me bear my meed of praise for the work done during many years under the ægis of the late Mr. John Edward Taylor and Mr. C. P. Scott. Faithful to Liberal principles, this great newspaper has upheld the torch of freedom often with, but also sometimes against, the dominant opinion of the moment, but always with high-minded intent. The debt which the Liberal party owe to *The Manchester Guardian* is a heavy one.

Whilst in the House of Commons I had frequent occasion to bring forward various scientific questions of general interest. One of these arose in 1888 on the discussion of the Customs and Inland Revenue Bill. Clause 5 gave power to the Treasury to prohibit the use of a substance know as saccharine in the manufacture of beer, which acted in restraint of revenue. The late Lord Playfair and myself were much interested in this matter. I had paid particular

attention to the subject, and had delivered a lecture at the Royal Institution on the manufacture of this singular substance derived from coal-tar, which is many hundred times as sweet as sugar. It is also said to possess antiseptic properties useful for preserving light beer, to give "body" or palate-fulness to that beverage, and as one of the Members jokingly observed, "People who went to the public-house desiring to get drunk would be kept fraudulently sober." It was argued that it was inexpedient to cripple brewers by denying to them the use of ingredients which upon the whole have a tendency to improve the quality and palatableness of beer. An amendment was therefore moved to limit the power of the Treasury to interfere only in cases where the ingredients were noxious or injurious. The avowed object of the power which the Inland Revenue claimed was to prevent the use of materials which tend to limit revenue. Mr. Goschen said that the introduction of the twelve tons of this saccharine, which would be needed for all the brewers in the kingdom, would entail a loss of a million sterling to the revenue, and so the amendment was lost.

In connection with saccharine I may tell the following story about Tennyson. In the autumn of 1890, which we spent at a charming house, Hollowdene, at Frensham, near Farnham, my friend William Summers was staying with us. He was then Member for Huddersfield and Junior Whip for the Liberal party, a man universally popular, and of great intelligence and political insight. The news of his sudden death in India from smallpox was a sad blow to all his friends and a great loss to his party. When staying with us, he asked me whether I should object to driving him over to see Lord Tennyson at Blackdown.

He had a note from Sir Lewis Morris introducing him to the poet. At about half-past two we arrived at his beautiful house, the situation of which is so well known. My wife and daughter preferred to remain in the carriage. I was averse to intruding on Tennyson myself, but after much persuasion I consented to go.

On sending in our cards and the note, Mr. Hallam Tennyson came forward to meet us, saying that his father was just finishing his lunch, and if we did not mind coming into the dining-room, Lord Tennyson would be glad to see us. And so Mr. Summers and I went in. Tennyson at once asked me to sit by him, whilst Mr. Summers was held in conversation at the other side of the room by Lady Tennyson. The old man began with the words, "Your name has been before me at every meal," at which I expressed great astonishment, not thinking that he had ever heard of me, and thereupon he produced a small phial containing saccharine, on the outside of which was an advertisement containing a few lines of some appreciatory remarks respecting saccharine which I had made in a lecture at the Royal Institution. This notice I had never seen, and on my return home I wrote to the proprietors requesting them to stop issuing such notices, as I could not have my name used for advertising purposes, and this they did.

In a few minutes, without further conversation, Tennyson rose and said: "Well, I must bid you good-bye, for I must now lie down. I am going to smoke a cigar and go to sleep." Upon which he walked out of the room, giving a distant nod to my disconsolate friend Will Summers, who had come on purpose to interview the poet, but with whom he had not exchanged a single word. The party then broke up; Hallam Tennyson almost carried his mother, who appeared to

me to be one of the sweetest women I ever saw, into the drawing-room, whither he desired us to follow them. However, remembering that my wife and daughter were sitting in the carriage, I thought it was best to make our exit. Nothing could exceed the politeness and kindness of the present Lord Tennyson and his wife. On driving home poor Will came in for a good deal of chaff on the outcome of his visit and introduction to the great poet.

Another legislative measure which I endeavoured to promote was a Bill for the better sanitation of dwelling-houses, schools, colleges, hospitals, work-shops, hotels, lodging-houses, and other buildings. I was aided in this by Dr. Farquharson, Sir Guyer Hunter, and Dr. Cameron, and our object was to establish a complete system of sanitary registration, especially with regard to the sanitary arrangements and drains of each house, and it was proposed that after the 1st of January, 1890, no such building should be used unless it had received a sanitary certificate. It appeared to me that this was a very necessary piece of legislation, but, like many proposals of the kind, it went by the board.

In 1888 I was entrusted with a Bill for the amendment of the Pharmacy Acts. This had for its object to secure that those who compound prescriptions are fully qualified, but this was opposed on the ground that it tends to create an unnecessary monopoly, and also came to nothing. In connection with this I asked the Vice-President of the Committee of the Council of Education whether the statement reported to have been made at an inquest held at Lewisham on June 20th, that the son of a chemist and druggist had dispensed eight grains of strychnine in one dose of medicine instead of $\frac{1}{24}$th part of a grain, was

correct; whether the statements that the son of the chemist was often left in charge of his father's branch shop, and that he passed his examination when he was fifteen years of age, were also correct; and whether, in view of such an alarming accident, the Government would give facilities for the consideration of the Pharmacy Bill now before the House, which was intended to provide against such accidents by requiring all managers of branch shops to be qualified and registered. The following comment appeared in a newspaper of June 30th, 1888:

> Sir W. Hart Dyke had no reason to doubt the accuracy of the statements, &c., but in the present state of public business, &c., he could not undertake, &c. In fact, the Vice-President gave the usual answer in the well-known way. Now this is too grim a subject to joke about, but it must have reminded readers of *Pickwick* of the swearing-in episode in the trial of Bardell *versus* Pickwick. To wit: "'I am to be sworn, my lord, am I?' said the chemist. 'Certainly, sir,' replied the testy little judge. 'Very well, my lord,' replied the chemist in a resigned manner. 'Then there'll be murder before this trial's over; that's all. Swear me, if you please, sir,' and sworn the chemist was before the judge could find words to utter. 'I merely wanted to observe, my lord,' said the chemist, taking his seat with great deliberation, 'that I've left nobody but an errand boy in my shop. He is a very nice boy, but he is not acquainted with drugs; and I know the prevailing impression on his mind is that Epsom Salts means oxalic acid, and syrup of senna, laudanum. That's all, my lord.'"

To match fiction with fact, I will now relate an incident of a similar kind which came under my notice many years ago in a Northern village. A pedlar sold peppermint lozenges to some children, of whom several died after eating them, and the post-mortem examination showed that arsenic was the poison. It came out in Court that the manufacturer of these lozenges was in the habit of adulterating

them with plaster of Paris, which when used for such purposes was known as "daff." The shopboy, at eighteenpence a week, went down into the dark cellar where two sacks alike in appearance were placed side by side, one containing plaster of Paris and the other white arsenic. The boy took up his scoop and carefully measured out half a pound of white arsenic, which he served to his customer, and the consequences were what have been related.

On another occasion I drew attention to the ventilation of the House of Commons, and especially to the deteriorating effect of the burning of gas on the internal stone fretwork of the room and passages of the House of Parliament. I advocated the complete introduction of electric light, and showed that great destruction was caused by the existing system. Mr. Plunkett, who was then the First Commissioner of Works, gave the usual official answer; but this at any rate was a beginning, and I commenced an agitation which after a few years was effective, so that at the present time the whole of the gas lights in the Palace of Westminster have been replaced by electric illumination, with the exception of the House of Commons itself, where the light is derived from gas-burners, placed in the roof of the Chamber, and separated from it by a glass ceiling, so that none of the products of combustion can pass into the air of the room.

Whilst describing the steps I took with regard to the ventilation of the Palace of Westminster I may refer to a question of more general importance, that is, of the ventilation in schools, in a lecture which I delivered before the College of State Medicine in 1889. The subject of house ventilation had interested me for more than thirty years, and I had long been of opinion that, in the words of one of her Majesty's

inspectors of schools, "with all our scientific progress we are practically ignorant, we might say helpless, in regard to the right ventilation of schools." And even in spite of much work which has been done since that time, very little appreciable progress has been made in this most important and indeed essential matter; for it has been clearly shown that the mental activity and general alertness so necessary for the scholar are dimmed and almost destroyed in badly ventilated schools. The work done by my late friend and pupil Carnelley for the Dundee School Board, and the continuation of the work, by Drs. Anderson and Haldane, published in the *Philosophical Transactions*, have done much to show the importance of proper ventilation both for schools and for private dwelling-rooms. In my opinion the Board of Education ought to insist upon regular determinations of the amount of chemical as well as of bacterial impurities in all schools, and to fix limits of such impurities which must not be exceeded. To show that this latter is not an impracticable proposition I need only mention the fact, to which I shall subsequently refer, that, through the labours of the committee of which I was chairman, an official limit has been placed upon the amount of air-impurities contained in weaving sheds in the Lancashire cotton mills.

I may now shortly describe the work I accomplished with regard to the drainage of the Palace of Westminster. Great complaints had for many years arisen that foul smells were noticed in the various rooms both of the Lords and the Commons. A committee, of which I was the chairman, was appointed to go into the whole subject. It is scarcely credible that on inquiry it was found that there were not any plans of the drainage of the Houses of Parliament to be found, either at the

Office of Works or in the possession of my old friend Dr. Percy, who was at that time in charge of the ventilation and general sanitation; the fact being that when Sir Charles Barry had finished the building there was some kind of quarrel between him and the Office of Works, and the authorities were never able to get from him a plan of the drains. The consequence was that when we came to examine into the drainage, we had to cut up the thick bed of cement on which the Palace was built, and had, in fact, to investigate the drainage of every closet and slop-stone in the place.

The condition of things was frightful: in many cases there was no fall; there were cess-pits in the spaces under the House of Commons from which the air for the Chamber was obtained. These pits were filled with foul matter, and, in short, the state of things inside the building was about as bad as it could be. But outside the arrangements were equally defective. The whole of the drainage of surface-water and of sewage passed through a penstock in the Speaker's garden into the metropolitan main sewer running down the Embankment. This sewer was thus in direct communication with the sewers of the House, and when, as was often the case, this main sewer became water-logged, the foul gases were bottled up past the penstock, and were forced up into the sewers under the Houses of Parliament.

We at once took the bull by the horns, and made a complete change in the arrangements, (1) by having a plan of the whole of the drains within the building, and (2) by adopting Shone's method of air-displacement of the sewage. According to this plan, which has been found to work admirably, the sewage and the rain-water together flow into several large iron

vessels which were placed in an underground chamber excavated in the Speaker's garden. As soon as one of these is filled, air pressure is automatically put on, and the whole of the contents of the vessel pass through a pipe directly into the main sewer, so that there is absolutely no connection between the main sewer on the Embankment and the drains of the Palace of Westminster. As regards the sewers, all risk of contamination of the air from outside sources is now avoided.

In addition to this, many improvements were made in the ventilation of the Palace at my suggestion, especially with regard to the filtration of the air, and I made experiments on the composition of the air entering the building before and after filtration through cotton-wool. I determined the number of micro-organisms present, and showed that a considerable diminution of these organisms occurred by the filtration of the air. The Speaker, Mr. Peel, was much interested in these experiments, and I exhibited to him the results we obtained. I may add that my late friend Carnelley, whose premature death science had subsequently to deplore, made some interesting observations on the number of organisms present in the air of the main sewer in the building, and, corroborating the results of other experimenters, he found the somewhat remarkable fact that in the sewer air the number of microbes is very much smaller than in the air of the street above, doubtless due to the fact that, the surface of the sewer being moist, the microbes remain in the liquid, whereas in the street, the air being dried, the microbes float about in the dust.

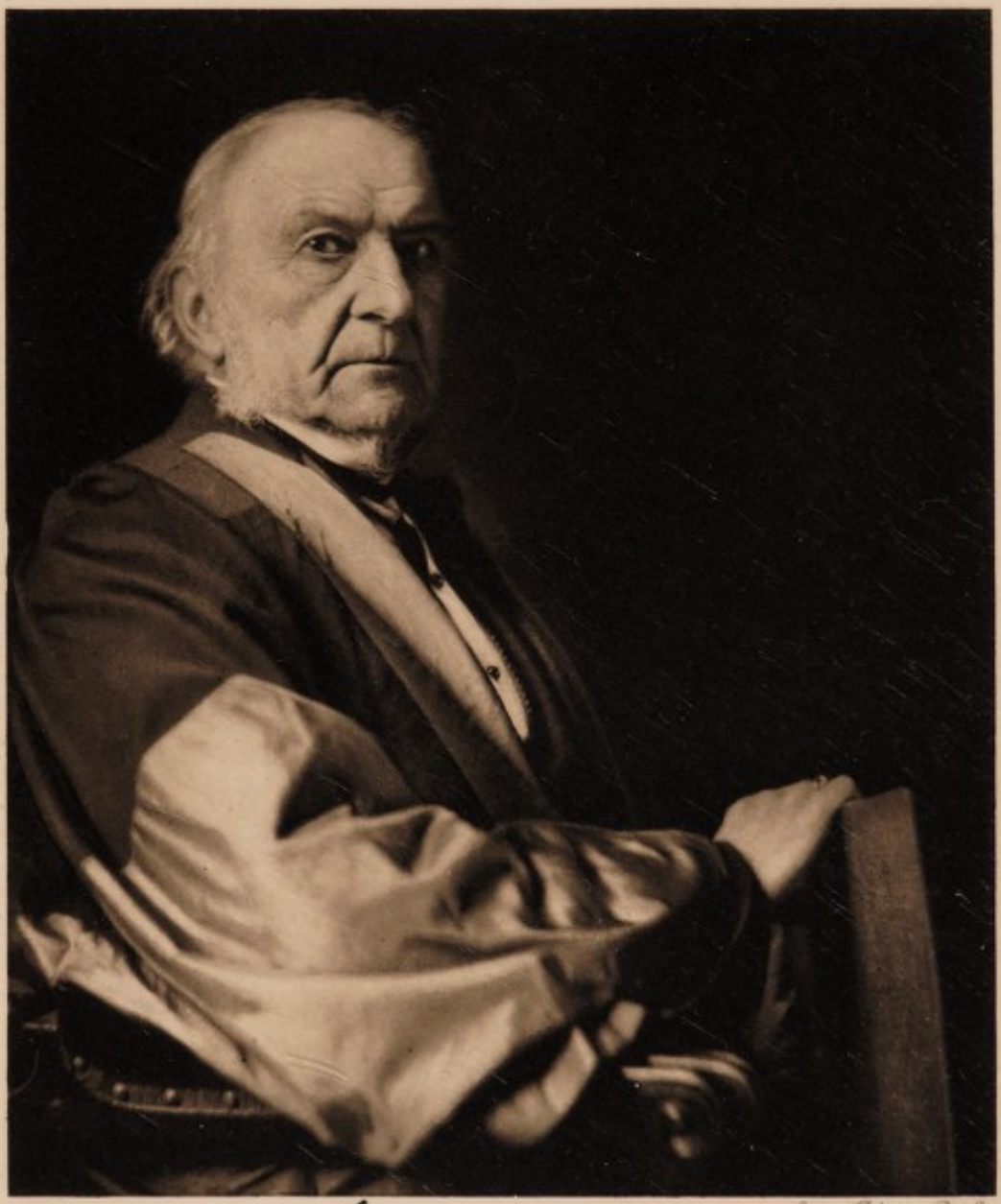
As regards my Parliamentary efforts in the cause of technical education an account has already been given in Chapter VIII.

In one of my addresses to my constituents, I remarked that, although I had gone into the House of Commons with a feeling antagonistic to the Irish Members, from my subsequent personal knowledge of them I came to regard them more favourably. I saw that among them were some of the brightest intellects and sharpest wits of modern political life. I came to honour their persistent, if at times somewhat irritating, methods of advocating what they honestly believed to be for the good of their country. I was more than shocked at the treatment they received at the hands of the Tory Government. I became intimate with many of them, although not with Parnell, as his character was not one to encourage acquaintanceship on the part of the English Members. One day he appeared with his arm in a sling, and I was told that he had had an accident in performing a chemical experiment. This, of course, interested me, so in passing out of the House of Commons one day close to him I asked him how the accident had arisen, and he replied: "I was making a wet assay of some gold which I found on my estate at Avondale when I burnt my hand rather seriously with nitric acid."

When Mr. William O'Brien was married he was good enough to invite my wife and myself to be present at the wedding breakfast at the Alexandra Hotel. My wife was seated at table between Mr. Parnell and Mr. Pope Hennessey (who, singularly enough, afterwards both died on the same day), and I sat next to Mr. John Dillon. It was a very interesting occasion, and the speeches were uncommonly good, the Bishop of Tuam especially making an excellent one. A few days afterwards I was at a very different gathering, that of a garden-party at Devonshire House, and when my wife my daughters, and myself had shaken hands with Lord

Hartington, he said to me in his gruff way, but with a smile that turned up the corners of his mouth : " I see you have been in very queer company lately." " Yes," said I, " I am seeing life in all its aspects."

On the evening of February 4th, 1889, a meeting was held in the Free Trade Hall, Manchester, to protest against the indignities heaped upon Mr. William O'Brien. The Hall had rarely been so packed as it was that night. I took the chair on the occasion and expressed my opinion strongly, but not more strongly than the occasion deserved ; for now, as then, my whole nature revolts against the idea of harsh treatment to political offenders, and that the treatment was harsh, not to say brutal, especially in the case of William O'Brien, there can be no shadow of doubt.



Emery Walker Ph. Sc.

W. Gladstone

Photographed by Mr. Rupert Potter: July 1884. Copyright

CHAPTER XII

POLITICAL LIFE (*continued*)

Mr. Gladstone—Committee on the Metrical System of Weights and Measures—Friendships in the House—Reform of Parliamentary Elections—Opening of Museums on Sunday—Committee on Science Collections, South Kensington—Grants to University Colleges—Legislation on the Use of Steam in Weaving Sheds—Adviser to the Metropolitan Board of Works—Sewage Pollution of Rivers—1851 Science Scholarships—Address from Constituents on Retirement.

It is a truism to say that Mr. Gladstone, whose portrait from a photograph by Mr. Rupert Potter faces this chapter, was the life and soul of the House of Commons in my time; and more able pens than mine have striven, and striven successfully, to place before the world the extraordinary character and wonderful powers of that great man. One of his most remarkable characteristics was his personal influence over men at variance with him on many fundamental points. I have often wondered, and still wonder, how it was that men differing so widely from him in habit of mind should have followed his political lead so completely. For example, Gladstone's ecclesiasticism was altogether foreign to my ideas. The secret of his influence, and of the almost magical fascination of his personality, lay, I venture to think, not merely in his great oratorical and persuasive powers, nor even in his grand courage, but rather in his high ideals and his unselfish devotion to the cause of freedom all the world over.

He was altogether innocent of a knowledge of science or of scientific method, and indeed he may with truth be said to have belonged to a pre-scientific age, and the following incident is interesting as indicating his views on such subjects. He was good enough to ask me to dine with him whilst he was living in St. James's Square. I entered the drawing-room rather before the rest of the company, when he said with the usual *empressement*, "Ah, I have long wished to ask you two questions in physical science." Before he could put his questions the rest of the guests arrived and dinner was proceeded with. I imagined that Mr. Gladstone had forgotten all about the physical science. But not a bit of it. After dinner, when we retired into the drawing-room, he at once came up to me and said: "Now, come and sit by me on the sofa. I'll ask you those questions on physical science. The first is this. There are two bodies in space, highly heated; they are both cooling down; one is smaller than the other; and my question to you is this: 'Which of these two bodies will cool down the sooner, the smaller or the larger?'" "Well, sir," I said, "I presume that the smaller body would cool down sooner." "Ah, well," he said, "I fancied so too, but I thought there might be some physical law," with that peculiar screw of the mouth and that blinking of the eyes which his friends knew so well, "by which the larger body would cool down sooner. Thank you very much. The second question is this. You know at Hawarden we have coal-pits. I have been down them, and there I have seen coal measures, and in the middle of these measures I noticed bands of harder material, a hard concretionary mass. Very singular, is it not?" "Well, sir," I said, "I don't know about that, they are very common, those bands of hardened under-clay; they always accompany the

coal measures." Then he added, "But do you know, some little time ago I was invited by our good friend Sir Edward Watkin to be present at the opening of the Metropolitan Railroad, and at one of the stations, the Mansion House Station, I think, we had an excellent collation. The work was not quite finished, and I noticed, as I sat at the luncheon table, the round boulders which occur in the London clay. I then said to Sir Edward, who is always very kind, 'Would you be so good as to ask one of the men to take one of those boulders that I see out of the clay and to break it in two, for I am most anxious to see what is in the centre?' And this was done; and now what do you think I found in the centre of the boulder?—a hard concretionary mass. Is not that very strange?" So I tried to explain to him that these boulders were first formed by a deposit round some central harder object. He seemed to think it was very remarkable; and then he concluded by the observation: "Don't you think that both in the case of the coal measure and in the case of the boulder that the central hard portion holds the softer portions together, just exactly as our bones hold together the softer parts of the animal body? What do you think of that?" Here I felt astonished, as I recognised that my host belonged to the bygone age of Oken and the "Natur Philosophen" in his views of physical science. These men insisted upon analogies existing between the inorganic and the organic world; the crystal had its analogy in the flower, and so forth.

A propos of the question of the influence of the study of science, it occurs to me to mention that many years ago a gentleman called upon me in Manchester and asked me what I thought would be the effect of their studies in practical chemistry upon the hundred young men who were working in my laboratory.

I said I could not tell, but that I thought that in after life, perhaps, they would not make fools of themselves. I had forgotten all about this until, many years afterwards, I met the same gentleman again, and he recalled to my mind our interview, and said he had always remembered my answer; and I suppose that is about the truth, and that if our statesmen in the last generation had been brought face to face with Nature by even an elementary course of instruction in practical science, the effect on the country might have been far-reaching. I do not speak without experience on this point; for, whilst I was in the House, after much trouble we induced Sir William Harcourt, who was then leading the House, to get the Government to grant permission for a Select Committee to inquire into the present anomalous system of English weights and measures. It was late in the session, and the motion had to come forward after twelve o'clock, so that it was in the power of any Member to object. A very prominent Member on the Opposition front bench had intimated his intention of objecting, so I went up to him one evening and said I regretted to learn he was about to oppose the motion, and tried to explain to him that the object of the Committee was simply one of inquiry. "I shall certainly continue my opposition," said he. "Why, the fact is that you will be introducing some damned thing like decimal fractions"!

Another extraordinary instance of ignorance of matters scientific in high places occurred to me in 1876. We were arranging for an exhibition of scientific apparatus, historical and otherwise, in one of the South Kensington galleries, and it became my duty to get funds, so an interview was accorded by a Treasury official, who of course had to object to all

expenditure, and remarked to me in perfect good faith and sincerity: "I don't see for what you can want a grant. I suppose all you have to show would go into my hat"!

In the last session of my Parliamentary career, a Select Committee was appointed to inquire whether any and what changes in the present system of weights and measures should be adopted. I served as chairman, and the evidence which was given before us by competent witnesses was of an interesting and convincing character; all, with one exception, expressed strong views in favour of the adoption of the metrical system, which has long been employed by scientific men all the world over. This exception was the late Sir Frederick Bramwell, who was well known as a stickler for vulgar fractions, the pound, and the two-foot rule. Sir Frederick, the most genial of engineers, was conservative to his finger-ends and firmly believed that nothing could be better than our present system, or rather want of system. All the other engineers who were examined expressed themselves in favour of the adoption of the metrical system, and men engaged in commerce and in industry were of the same opinion, whilst schoolmasters and members of school boards agreed that much time could be saved to school children by the adoption of a simpler system of weights and measures.

The evidence further showed that, not only is our foreign trade in every branch seriously handicapped, but that the home trade would be greatly benefited by the change. It was also clearly proved that the change from an old complicated system to the metrical had taken place without serious opposition or inconvenience in most of the European States, no attempt having been made to return to the

ancient methods. Even in Turkey and the French possessions in Northern Africa, the change had been made, much to the contentment of the natives, who, in a short time, used the metrical nomenclature with ease. One witness remarked that the system is so simple that a child can understand it, and what the negroes and Arabs in Tunis can easily learn, the British public should be able to comprehend. The Committee recommended (1) that the metrical system of weights and measures be at once legalised for all purposes; (2) that after a lapse of two years the metrical system be rendered compulsory by Act of Parliament; (3) that the metrical system of weights and measures be taught in all public elementary schools as a necessary and integral part of arithmetic, and that decimals be introduced at an earlier period of the school curriculum than is the case at present.

The publication of the Report created much interest, and, in consequence of the recommendations contained in it, Mr. Balfour next session brought in a Bill for legalising the use of the metrical system throughout the country for all purposes. Half a loaf is better than no bread, and if this Bill had passed it would have been a step in the right direction. But the House of Commons seemed incapable at that time of passing any measure, however useful, which did not influence party spirit. I cannot, however, doubt that before many years are over the pressure of public opinion, and the fact that all other civilised countries have adopted the metrical system, will force even a supine Government to effect this absolutely necessary reform in our system.

Considerable progress has now been made in the popularisation of the metrical system of weights and measures, and this has been mainly brought about

by the activity of the "Decimal Association," of which I am one of the Vice-Presidents. In a Report of the above Association, dated January, 1905, it is stated that, "The growth of the popular feeling in favour of the change has been so marked, that the Executive Committee gladly decided, in October 1903, to take advantage of an offer made by Lord Belhaven and Stenton to attempt the passage of a Bill through the House of Lords to render the metric weights and measures compulsory in this country, and Lord Kelvin supported the Bill on its introduction."

A Bill was accordingly drafted by counsel, and on the occasion of the second reading in the House of Lords on the 23rd February, 1904, it was supported by the Lords Rosebery, Spencer, and Tweedmouth. With the concurrence of the Government, the Bill was read a second time, and was referred to a Select Committee for consideration. After revision in Committee, and the acceptance of certain amendments suggested by Government departments, the Bill was read the third time on May 17th, and sent to the House of Commons. Simultaneously with the progress of the Bill through the Lords, the Association sought to obtain the views of the Members of the House of Commons, and more than 330 Members promised to support the Bill.

We may thus hope that, in spite of opposition, which no doubt will occur in the House of Commons, a measure will ere long be passed, not merely to legalise the metrical standards—for this has already been accomplished—but to make their use compulsory.

It is here interesting to note that the late Mr. Herbert Spencer wrote a series of letters in *The Times*, signed "A Citizen," against the metric system, and that I endeavoured to combat his arguments in

another series of letters to *The Times*, appearing under the signature of "Another Citizen." So determined was Mr. Spencer in his opposition that his will actually contained a codicil making provision for reprinting and distributing gratuitously as a pamphlet his arguments against the system. Accordingly this pamphlet was reprinted and distributed in the spring of 1904, but it does not appear to have created any strong feeling in favour of the views therein propounded.

Among the many intimate friendships which I formed in the House there are none I value more, among men still living, than that of Leonard Courtney, John Morley, James Bryce, Henry Hobhouse, Henry John Roby and Arthur Acland; whilst among those friends who are gone before, I mention first Anthony John Mundella. No one was a more faithful friend or more welcome guest in our house. He possessed a warm and generous heart, and when he cast off the official manner, which he thought it was his duty sometimes to assume, he was simplicity itself. The wags at South Kensington, when as Vice-President he accompanied the Lord President, used to say jokingly (for he was most popular in the office), "Here come Lord Mundella and Mr. Spencer."

We saw much of him both at home and at Camfield Place, my father-in-law's house near Hatfield. He was brimful of anecdote, well versed in standard English poetry, especially in Shakespeare, which he would recite *ore rotundo*, much to the delight of his hearers. When at the Board of Trade he used each morning to feed from his window the pigeons which fly about the gardens at Whitehall. Night after night we used to come home together from the House in a growler, often in snow and storm and rain, at one in the morning, and he would then say: "Let us give the

poor beggar an extra shilling, it is a cruel night." Mundella was indeed a true man, and it is a proof that England is really a democracy when we hear that he left school at ten years of age and worked his way up by sheer force of character to the position of Minister of Education. Nor need we wonder that when he attained the distinction of Cabinet rank he exclaimed, "At last!" I felt his loss keenly, and my wife and I were among the crowd of mourning friends who paid their respects to his memory in St. Margaret's.

Of three other valued friends, viz., Bernhard Samuelson, John Slagg and William Woodall, who have also joined the majority, I have already spoken as having been my colleagues on the Technical Commission.

Another interesting personality which it was my good fortune to meet whilst a Member of Parliament was Sir Isaac Holden, than whom no one of the self-made men of the past had a history more notable or an individuality more marked. He raised himself entirely through his own exertions to the position of, not only a millionaire, but the founder of a great industry. He was a good mechanician, and by his improvement in the machinery for wool-combing, combined with extraordinary activity and business-like habits, he succeeded in establishing an immense business, not only in Yorkshire, but also in France. As a proof of his untiring energy, I may mention that, when no longer a young man, he used to start from Bradford in the afternoon, reach London in time for the night mail to Calais, and without previous notice turn up at his mills at Roubaix at six o'clock in the morning to look after things, returning the next night to London and reaching his home in Keighley the same afternoon. This he did regularly and not merely occasionally. He was a small man but with a back as

straight as a rod, and at eighty-five years of age would walk out in any weather without a great-coat or umbrella. As a proof of his agility, my wife saw him when he was eighty-three vault over the bench in the gallery of the House of Commons. He was a great believer in careful dieting and almost a vegetarian, living chiefly upon fruit. He was in his way a philosopher and held remarkable views on all sanitary matters. After walking in the rain for three hours he would come home and take a Turkish bath. On one occasion when we were staying at Oakworth, Mrs. Holden asked her factotum Barry where his master was. "Oh," said he, "he is taking a Turkish bath." "Umph!" said she, "he is always a-rubbing and a-scrubbing."

On several occasions my wife and I enjoyed the hospitality of Mr. and Mrs. Holden at Oakworth House. This was a remarkable building, erected in the village close to the high road and between a Wesleyan Chapel (for the family were ardent Wesleyans) and a row of cottages. It was very elegantly furnished and decorated by Parisian artists without thought of cost. The front faced south; at the back was situated a huge winter-garden connected with the billiard-room, and also a most perfect form of Turkish bath. The site of the winter-garden was originally a quarry, which supplied stones for the building of the mansion, stables, large schools and a neighbouring factory. Beyond the winter-garden on a slope of the hill was an extensive range of conservatories and vineries, among the most perfect in the country. These were approached through caverns hewn out of the rock forming winding steps among the tropical plants and ferns, disclosing statuary and romantic forms of animals. A cascade poured over a similar rock amid plants and stones, giving a most

natural impression to the scene. This fairyland was approached, not only from the central hall but from all the chief reception rooms of the house.

The hot-houses, about forty in number, contained not only tropical fruits and flowers, but those of temperate climates. The vineries were so complete as to provide fruit for nearly all the year; and peaches, apricots, and figs had each their separate house. I was stopping at Oakworth House on one occasion when Lord Ripon was also a guest. One morning Mr. Holden took Lord Ripon and myself through all these hot-houses. When we had got to the end, Lord Ripon, with his glass in his eye, looking down on his host, said, in a tone of banter: "Mr. Holden, I understood you had got a large number of hot-houses; where are they?" Mr. Holden, not quite seeing the joke, was at first rather dumbfounded, and answered: "Well, my lord, I think I have shown you a pretty good number," upon which Lord Ripon, dropping his joking manner, said: "Indeed you have, Mr. Holden." On returning to the house Mr. Holden, who was always fond of describing the precautions he took for preserving his health, told Lord Ripon at the luncheon table of the nature of his underclothing, and how important it was that there should be a film of non-conducting air between the skin and his garments, and he said: "Do you, my lord, wear cellular underclothing?" To which Lord Ripon replied: "Upon my life I don't think so; what is it?" "Oh!" said Mr. Holden, "I will show you," and then, *sotto voce*, to his devoted manservant, "Barry, fetch his lordship down one of my undergarments." In a few minutes down came the faithful Barry bringing the garment in question. This he handed to Mr. Holden, who held it up before Lord Ripon. It was a combination

garment, of cellular material, and Lord Ripon looked at this through his eyeglass with an amusing expression of bewilderment, and said: "What *is* this?" "Oh!" replied Mr. Holden, "it is my cellular underclothing; your lordship should wear some like it."

Holden was devoted to tobacco, smoking the strongest and longest cigars of anyone I know, and many a good story have I heard, and many a pleasant chat I have had with him in the smoking-room of the House of Commons, where he used to sit after his frugal meal, drinking a large glass of what looked like foaming London stout, but which in reality was a mixture of black coffee and Apollinaris water, a drink I once, and only once, essayed. I must not forget to mention that Holden had not only been a classical and mathematical tutor, but had also had considerable practice in, and had always displayed much interest in, chemistry; indeed, he asserted that he had discovered the lucifer match, though I must confess I was not quite able to corroborate the historical information which he gave me on this point. The old man was very fond of talking about his discoveries in all branches of science, which I will not say were altogether imaginary.

Mr. Holden was a staunch Liberal, and no one ever earned the honours of a baronetcy by a more loyal adherence to a political faith. A fresher man, both in brain and limb, at eighty-nine I do not think ever breathed. He had a most scientific method of warming his house, which was sometimes almost too scientific for his friends. In front of the dressing-table of the bedroom which we occupied when we stayed at Oakworth House there was a perforated grid, up which such a current of hot air passed as almost to scorch

one's feet. The ventilation was so arranged that, in Mr. Holden's view, no windows required to be open, but we decided we could not sleep in the room without fresh air, and had to summon the housemaid to show us how to open them. The ventilation was, in his opinion, so perfect that he not only permitted, but rather encouraged, his friends to smoke all over the house, telling us that no smell was ever left, and no inconvenience ever experienced even by those who disliked smoking, when a number of persons were indulging in their favourite weed. I, however, noticed that when several of us were smoking, the atmosphere of the ventilated smoking-room became so dense that we could scarcely see the ceiling, which gave me the idea that, however perfect his system might be in theory, it was somewhat lacking in practice.

Apropos of the subject of ventilation, I remember on the occasion of the visit above referred to Lord Ripon related the case of an outbreak of fire caused by the breaking of a burning oil lamp in the morning-room at Studley. The table-cloth, carpet, blinds and window curtains were burnt, a parrot in a cage died, and yet when the room was opened the conflagration was over. The Marquis said that he could never understand it. I replied: "It seems to me quite simple. The first blaze exhausted all the oxygen contained in the air of the room, and there being no opening for its renewal the fire went out. The parrot was not burnt, it died of suffocation in the absence of oxygen." Lord Ripon laughingly remarked, if Studley had been ventilated like Oakworth House (where the air of the entire house was said to be changed every thirty minutes) it would have been burnt to the ground; and added, "What a splendid argument in favour of no ventilation!"

Sir Isaac had an idea that the usual weaknesses and dangers attending old age could to a great extent be prevented by careful dieting, his belief being that senility both of brain and body is caused by the deposition in the brain and along the course of the arteries, the veins and other vessels, of calcareous matter. That the hardening of these vessels is often the cause of senile decay is well known.

The death of no Member of the House of Commons was more deplored than that of Frank Lockwood. His geniality, good temper, and wit made him a favourite with all parties, whilst his wonderful artistic power as a caricaturist would have won a fortune had he chosen to cultivate it. His humour was, however, not confined to paper. One day, when dining out with his wife, a Scottish Laird and his lady were of the company. The Laird, according to custom, was announced by the name of his holding: "Lochdhu and Mrs. Macbain," upon which Sir Frank told the servant to announce them as "36 Lennox Gardens and Lady Lockwood."

In December, 1888, I gave notice of my intention to introduce a Bill for reforming the present method of holding Parliamentary elections and other purposes. The principal provision was that the Register of Parliamentary voters revised during the early part of the autumn should come into force on the first day of November instead of the first day of January, and further, that all Parliamentary elections in a general appeal to the country should be held on the same day, as is now the case in municipal contests.

In the same year a Bill was brought forward by Mr. Samuel Smith, myself and others for continuing the education of children who are either wholly or partially exempt from attending day-schools, and were

beginning to be employed in manual labour. Although this Bill did not become law it is gratifying to think that now continuation schools are very largely established in all our great centres. I took part in the same year in a conference convened by the London Chamber of Commerce to consider the best means of introducing a system of commercial education which would meet the requirements of modern business. The Committee of which I was a member did much to stimulate action in this important matter. About the same time I was asked whether I would consent to have my name put forward as an Alderman for the County Council of London. This honour I felt obliged to decline.

I also took much interest in the question of the opening of museums on Sundays, and as President of the Sunday Society presided at an evening party at the Freemason's Tavern. I stated that great progress was being made with regard to this matter in Manchester, and it was remarkable to see the thousands of people who patronised the Free Library and the Art Gallery in that city on Sundays; and I proposed to bring forward a resolution in the House of Commons to the following effect: "That a Royal Commission having declared that Sunday opening of Museums and Galleries had exerted a salutary influence on the moral and intellectual condition of the people and upon the industrial progress of the country, this House recognises the justice and expediency of opening the Natural History Museum at South Kensington and the Bethnal Green Museum on Sundays without further delay, thus extending to London the advantages already provided at Kew, Hampton Court, Greenwich, Dublin, Birmingham, Manchester, and ten other provincial towns where the most admirable

results have followed the opening of these educational and recreational institutions on Sundays."

It is interesting to note the movement of public opinion in this matter. This resolution was not brought forward, for I found that a very large number of my friends, Members of Parliament, otherwise Liberal, were altogether opposed to the terms of the resolution, this, not so much because they were personally averse to the proposals of Sunday opening of Museums, but because they had many of them been obliged, by the strongly expressed views of their constituents, to promise to oppose any such proposals. A counter-proposal did, however, meet with the approbation of the House, viz., that the British Museum should be open during the evening, which hitherto had not been the case. This necessitated the expenditure of a very considerable sum in electric lighting, whereas the opening on Sunday afternoons could have been accomplished at a merely nominal cost. Public opinion, as I say, rapidly changes, and we had not to wait many years before we got what we wanted, and now all these Government Institutions are opened to the public on Sunday. Foreigners have, with justice, complained of the *tristesse* of our English Sunday. I should, however, be sorry to see the Continental Sunday system adopted in its entirety; the great point to remember is that the seventh day should be set apart as a day of rest from the ordinary occupations as much as possible, if only as a matter of health and social economy. The delivery of lectures on Sundays in the Queen's Hall, at Toynbee Hall, and other University Settlements in the East End, as well as the concerts in the Royal Albert Hall, in the Queen's Hall, and in other places, shows the trend of public opinion. I am afraid, however, that much remains to

be done to draw the masses, especially the young folk in our crowded East End and manufacturing districts, from objects which have a debasing tendency. On the whole, all well-wishers to humanity may congratulate themselves on progress in this direction, among which free libraries and reading-rooms are working in the right direction.

The subject of museums reminds me that in 1889 the Government appointed a private committee, consisting of Lord Francis Hervey, the late Sir Bernhard Samuelson, and myself, together with General Sir John Donnelly, to consider and report on the condition of the Science Collection at South Kensington, some depreciatory remarks on these Collections having been made by an influential Member of Parliament, who remarked that he thought a great deal of space was wasted by the exhibition of a quantity of old iron and worn-out models that ought to be consigned to the rubbish-heap. He was, however, ignorant of the fact that these are historical monuments of the greatest possible interest, being in many cases the actual machine as originally invented, and thus presenting a record of inestimable value for the history of English scientific invention.

In answer to a question asked me by Mr. W. H. Smith, who was then the Leader of the House, I said that I had consulted with Lord Francis Hervey and Sir Bernhard Samuelson on the question. We considered that there should be more effective superintendence of the Science Collections at South Kensington than had been the case hitherto, more especially in the Machinery and Inventions portion. We did not think ourselves authorised to consider in detail how this could be best effected, but we suggested the appointment of a permanent committee of five to

eight members, each of these members being well conversant with some particular branch of the Collection and this committee to be charged with responsible duties. For the filling up of the post vacant by the resignation of Colonel Stuart Wortley we proposed that a first-rate expert should have control of the machinery and inventions. This officer would only have to attend once a week, which would considerably reduce the cost of his services, but a second official would have to be constantly in attendance. With regard to the Science Collection in the Western Gallery we propose to leave them under the control of the committee composed of the Professors of the Royal College of Science. All these different persons would report from time to time to the responsible committee and thus the Collections would be placed under an efficient system.

I now pass on to another important innovation, which has greatly influenced the higher scientific education throughout the country. In the same year the Chancellor of the Exchequer reported to the House of Commons that the Government were prepared to include in their estimates a grant of £15,000 per annum for the purpose of assisting the provincial University Colleges, especially in their scientific departments, and a committee was appointed consisting of Sir John Lubbock, Mr. Mowbray, M.P., Dr. Percival (the Headmaster of Rugby and now Bishop of Hereford), the Rev. G. F. Browne, of St. Catherine's College, Cambridge (now Bishop of Bristol), and myself, to consider how this sum should be apportioned. The committee were guided by various considerations in recommending the allotment of the grants. They bore in mind the necessity of giving proportionately larger aid to the younger and poorer institutions, but they were not blind to the justice of determining the

grant in accordance with the work done. Hence they first gave a fixed sum to each, together with a grant to each Professor or Head of a department, these two sums together forming a sort of equipment fund ; and they then added a percentage on the ordinary income of the college from students' fees and local subscriptions. One excellent result of the scheme was, that colleges wishing for a share would be required to furnish particulars of their income and work, and also to submit to a periodical inspection of their appliances and methods.

The amount of the grant was fixed for five years, at the expiration of which term the colleges were to be visited and a report sent in to the Government. The amount of the grant has since been frequently increased, until at the present moment (1906) it stands at £56,000, with a promise from the Treasury that this amount will shortly be doubled. That Government aid to the higher University education in the country is a legitimate action of Parliament, is a most important admission, and in all probability Goverment grants to Universities will be more largely increased in the future as the national importance of the higher education comes to be more generally recognised.

About this time I took part in a movement for the purpose of starting industrial employments for poor people in the West of Ireland. The "Carna Industrial Fund" was commenced in Manchester with the benevolent object of finding work and wages for the inhabitants of one of the bleakest and most sterile regions on the Galway coast, and it produced results of a most gratifying and encouraging kind. Upwards of 600 women and girls were engaged in knitting and the men were trained as fishermen. The poor people were exceptionally teachable and eager to help themselves

when put in the way of it. Like many attempts to assist Irish labour, however, this movement, though successful for some years, eventually died out for want of a local leader.

As a Lancashire Member I attended, in 1888, a meeting at the Westminster Palace Hotel of the Lancashire mill-owners and operatives to discuss the question of the use of steam in the cotton-cloth weaving sheds. Great complaints had been made by the operatives that their health was injured by the use of steam, which was introduced into the shed for the purpose of enabling heavily sized goods to be woven. At the meeting I asked for information as to whether any method was adopted for the purpose of estimating the amount of moisture present, and I learnt, to my astonishment, that this was not the case; that no limit was placed upon the amount of steam admitted, and that this had naturally given rise to complaints; that the moisture was frequently excessive, and that the health of the operatives suffered in consequence.

The remedy for this was easy, and forcibly illustrated the benefits to be derived from the application of simple scientific principles to industrial affairs. I suggested that it would be perfectly possible to determine by means of hygrometers the amount of moisture present in the air of the shed, and therefore to fix a definite limit which should not be exceeded. For this purpose I drew up a table which was afterwards inserted as a schedule to the Act, and is to this day acted upon, showing how the amount of moisture must be regulated under seasonal and other changes of temperature, inasmuch as during the hot weather a larger absolute amount of moisture can be brought into the air of the weaving shed than

during cold weather, without any inconvenience being experienced. These proposals were adopted by Government and became law in 1889. By these means a limit was fixed restricting the amount of moisture present in weaving sheds, this limit being controlled by the inspector and open to the observation of both masters and work-people. Still the operatives were dissatisfied, and, after a time, demands arose that Parliamentary action should be taken to secure the abolition of steaming in the weaving sheds. I attended a large meeting held early in 1896 of Members of Parliament and representatives of both employers and employed (I was no longer a Member), at which it was decided to ask the Secretary of State to appoint a committee to inquire into the subject. As was natural, owing to my former interest in the matter, I was requested by the Secretary of State to undertake the chairmanship of such a committee, and this I agreed to do on the understanding that I nominated the other members; and I was fortunate in securing the services of my friends the late Sir William Roberts, F.R.S., the eminent physician, and Dr. Ransome, F.R.S., the well-known authority on hygiene. On the 28th of March, 1896, the committee was appointed to inquire into the working of the Cotton Cloth Factories Act of 1889, and into the question of steaming and introduction of artificial moisture in cotton-weaving sheds. We met both in London and in Lancashire, we examined eighty-five witnesses, and the evidence was supplemented by independent determinations of the moisture contained in the various sheds, and, what was of equal importance, the character of the ventilation. In order to control this latter a maximum limit of respiratory impurity, as measured by the presence of carbon dioxide, was recommended. The amount of this gas

contained in the open air is from 3 to 4 in 10,000 volumes; in enclosed inhabited spaces this amount is, of course, much exceeded, and we determined that the limit of 9 per 10,000 should be adopted.

In the following year another Act was passed, empowering the Secretary of State to issue an order making regulations embodying the recommendations, and in 1901 a Factory and Workshops Act was passed which is now part of the statute law. With regard to the effect of our recommendations, the inspector writes to me "that it is not too much to say that, as a direct effect of the committee's work, the health conditions of not less than 20,000 workers have been enormously improved, the improvement in some instances amounting to quite a revolution."

The very satisfactory results of this legislation with regard to moist weaving sheds encouraged the Government to apply similar methods to factories and workshops in general, and a committee, of whom Dr. Haldane, F.R.S., was the most important member, was appointed for this purpose. This committee recommended a lower limit of impurity than we had done, and therefore the question arose whether it was desirable, in the interests of the health of the people, in like manner to lower the chemical standard of ventilation in the case of the weaving sheds. This matter came up for discussion between the employers and the employed; the workers, of course, wished to maintain the higher standard; the manufacturers, on the other hand, were desirous of relaxing conditions which they considered too stringent. In consequence of this it was arranged that an independent inquiry should be made as to how far this higher standard was under all conditions attained, and the Home Office and the manufacturers agreed that Mr. Frank Scudder, F.I.C.,

should collect a series of samples, and report on the question. In his report, delivered on May 20th, 1904, he states that out of 287 samples of air collected from thirty weaving sheds, 282 complied with the higher standard, whilst the worst result recorded was 10·1 instead of 9 per 10,000 of air. Hence it appears that with proper ventilation appliances the air of the weaving sheds can be maintained satisfactorily within the limits determined by the committee of which I was chairman.

About this time (1889) I was appointed chemical adviser to the Metropolitan Board of Works, which was then nearly moribund. I was called in to advise as to the methods for improving the condition of the Thames, which, owing to the high summer temperature and loss of fresh water, had become very foul. The matter was of immense difficulty, comparable, indeed, with the labours of Hercules in cleansing the Augean stables. Complaints of sewage smells were numerous and constant from all parts of the metropolis, and no less than £100,000 had been spent in the previous year by the Board in endeavouring to stop these complaints by the addition of a very powerful though very expensive oxidising agent, namely, manganate of soda. This, however, I found was only a sop to Cerberus, as the quantity of the material added was altogether insufficient to effect any permanent purification. I put a stop to this lavish expenditure, and took measures to improve the ventilation of the local sewers and to attack the question of purification at the outfalls on both sides of the river. It was evident to me that no immediate cure for the evil was possible, and that only palliative measures could for the moment be attempted, and I carried out these to the best of my ability. It was clear that a system of treatment of the whole sewage, before it was allowed

to enter the river, must eventually be undertaken, if permanent improvement was to be effected. Under the County Council and its able adviser Dr. Clowes, this is now (1906) in a fair way of being accomplished, and the river has within the last few years been much improved, although with a high temperature and limited rainfall its condition still leaves much to be desired.

During the last quarter of a century the question of sewage pollution had attracted considerable attention owing to the fact that the rivers were foul; especially in manufacturing districts and in densely populated centres, and a remedy for this state of affairs had to be found. In 1891 I was consulted by Sir John Hibbert, chairman of the Lancashire County Council, with regard to the condition of the rivers in the administrative area of the Mersey and Irwell Watershed, and I supported the authorities in obtaining a special Act of Parliament for dealing with the questions of river pollution on that area. The Act, known as the Mersey and Irwell Joint Committee Act, came into force in 1892; I was then appointed the scientific adviser to the Joint Committee. In that capacity I advised that, in order to free the rivers from trade pollution, the Joint Committee should act in co-operation with the manufacturers. And the outcome of this advice resulted in a series of conferences being held with the various manufacturers concerned, at which the ways and means of purifying the trade effluents of their particular industry was discussed, and undertakings obtained that efficient means would be adopted for purification. The policy of securing the goodwill of the manufacturers still continues, and has proved to be a wise one; and the result has been that substantial purification has been obtained without litigation: no less than 306 works out of a total of 444 have erected efficient purification works,

and the rivers on that water-shed are now much more available than formerly for manufacturing purposes.

To treat successfully sewage pollution from towns is a much more difficult matter. In this case it has been necessary to insist on processes of purification being adopted which will render the sewage non-putrescent, and for this purpose some form of filtration must be adopted in addition to subsidence and chemical precipitation.

The development of the system of filtration has been gradual, and in 1895 at the request of the Manchester Corporation I undertook an investigation of the question as to the comparative value of land—as against artificial—filtration, the result being entirely in favour of the latter. This conclusion is clear from the fact that under favourable conditions land is capable of dealing with not more than 20,000 gallons of clarified sewage per acre per diem, whereas an equal area of artificial filters will deal with 250,000 gallons in the same time. The successful working of the filters which I designed for Manchester, and which have been in action ever since, attracted the attention of other sanitary authorities, and they were largely adopted. On the Mersey and Irwell water-shed in 1898 the area of filter-beds in use was 6·5 acres, whereas in 1904 there were 105 acres in use. It must not be supposed that these filters are used for removing the grosser solid impurities; this is accomplished by subsidence, with or without chemical precipitation. The essential value of the filter-bed is to get rid of the putrescible material known to chemists as soluble organic matter. This purification is entirely effected by micro-organisms, which serve as Nature's scavengers, and transform a foul liquid into one which is non-putrescent, and may therefore be allowed to flow into any stream not used for drinking purposes.

As regards the question of water supply I have long held the view that a National Water Board should be appointed for the whole of the United Kingdom. This view is confirmed by the recent determination of the Government to refer the question of the National Water Supply to the Royal Commission on Sewage Disposal now sitting, and this Commission has already suggested the appointment of a central authority.

At the present moment this question is chaotic. It is now a case of the early bird. Manchester is early afield, and possesses itself of Thirlmere. Other great cities, in like manner—Birmingham and Liverpool, for example—monopolise by *force majeure* other water-bearing districts, and this is done without the slightest consideration of the wants and rights of other people, who have an equally just claim but a less powerful hand. The claim of London is, of course, more powerful than in any provincial city; but hitherto, though the discussion has been long and, I almost might say, angry, no steps have been taken to secure a pure water supply from a distance; thus the metropolis is still dependent upon sources which cannot be considered, from a hygienic point of view, as altogether satisfactory.

In my opinion, London, either through the newly constituted Metropolitan Water Board or otherwise, ought to possess itself of a tract of high-lying country in Wales, the situation of which has long been pointed out, and which may in the future serve as a gathering ground for the metropolitan water supply, when the Thames and the Lea and the New River and the chalk springs are found wanting as regards either quality or quantity.

As everyone knows the first great International Exhibition in 1851, unlike any of those that followed,

was a great financial success, and a Royal Commission was appointed to manage the funds thus acquired. The late Prince Consort conceived the happy idea of purchasing the whole of the land of the Kensington Gore Estate, the value of which has enormously increased since the date of the purchase. This is not the place to enumerate the various undertakings of the Commission, but I may refer to one of these which has had a very important educational influence and with which I have been intimately connected. In 1889 the Commission having decided that it was desirable to apportion a grant for the establishment of research scholarships, a committee of scientific men, including myself, was appointed to act with the Commissioners for the purpose of drawing up a scheme for the foundation of such scholarships. It was decided that these should be of a higher order than most of those then existing; in fact that their functions should begin where the ordinary educational curriculum ends, this system having been adopted with excellent effect in the French Ecole Pratique des Hautes Etudes. In other words these scholarships were to be entirely confined to research, and strict conditions were laid down as to the capability of the candidate to carry out original investigation. The scholarships were to be £150 a year in value, tenable for two years, and to be limited to those branches of science the knowledge of which is specially important for our national industries. The Commissioners from time to time were to select a number of institutions throughout the Empire in which high scientific instruction is given. Each university or college was to have the power of nominating a student to a scholarship on the condition that he exhibited capacity for advancing science or its applications; these scholarships when awarded were to

be tenable in any university, either at home or abroad, or other approved institutions. This system has now been at work for many years and with most satisfactory results. Every year a grant of £5,000 is distributed among deserving candidates, who carry on original investigations, and many of the scholars have already obtained positions in industrial or manufacturing concerns, as well as scientific teaching posts in universities and colleges.

In 1896 Lord Playfair resigned the chairmanship of the Scholarships Committee, and I was appointed in his place. In reference to this I may quote his kind letter to me :—

68 ONSLOW GARDENS,
SOUTH KENSINGTON.
June 2, 1896.

MY DEAR ROSCOE,

At a Meeting at Marlborough House to-day, H.R.H. the Prince of Wales in the Chair, of the Board of Management of the 1851 Commission, it was agreed to propose your name to the next Meeting of the Royal Commission as a *Member of the Board of Management*, and to ask you to succeed me as Chairman of the Committee on Scholarships. I will still remain on the Committee, and Lord Rayleigh will take Huxley's place as a Member. The Prince entirely approves of the arrangement and proposed your name.

I go down voluntarily from the throne, as I think younger men should take up my work. I also resign the Deputy-Chairmanship of the Board of Management (Prince Christian is Chairman) and my successor will become "Chancellor of the Exchequer" (probably Sir Henry Fowler), feeling satisfied that I have paid off our debt of £180,000 and converted an annual deficiency of £3,000 into an annual clear revenue of £15,000.

But my reign has been practically personal and it is no longer required. You would have nothing to do with finance. I hope you will like the proposed arrangement.

Yours truly ever,

PLAYFAIR.

The fact that a large number of the nominating institutions are situated in the Colonies, and that the scholars from these institutions come to the mother-country to carry out their scientific work, must exert an important influence in strengthening the relations between the different parts of the Empire. The value of this system is fully appreciated by the authorities at home and abroad, and many are the instances in which men of ability who would otherwise have been unable to follow a scientific career, or to assist the progress of our national industries, are now coming to the front in both respects. It has been well remarked that if in the course of a century even one Faraday should have been discovered, the sum spent would have been amply repaid. Although this, perhaps, cannot yet be said to have been accomplished, yet the Commissioners may point with satisfaction to many of their scholars who have already done epoch-making work for science. In proof of this I need only mention the name of Rutherford of New Zealand, now of McGill University.

In the year 1891–1892 I served as President of the Manchester Reform Club, and perhaps the pleasantest among other pleasant duties was that of entertaining Mr. John Morley at dinner. I applied to him the fitting words which Lord Derby, some little time before, had used when unveiling the statue of John Bright, which stands opposite the Town Hall in Manchester. Like John Bright the name of John Morley is known and honoured among all English-speaking people. But we in Lancashire claim him especially, not only because he is a Lancashire man, but because he embodied those qualities which are characteristic of Lancashire, namely, strong and clear opinion, determined purpose and plain, uncompromising speech. I welcomed him not only as

one of the leaders of Liberal thought and action, but as one who had drunk deeply from the well of English literature pure and undefiled.

I fought the election of '92 with Lord Emlyn, now Earl Cawdor, when I was again returned, but by a somewhat diminished majority. The last few years of this Parliament were very trying, especially to Liberal Members. Attendance had to be almost continuous, an endless number of divisions occurred, and so far as the political part of the matter was concerned with but little satisfaction. Moreover, the task of constantly visiting one's constituents was beginning to be irksome; not that I have any right or desire to find fault with them, for I always experienced at their hands kindness and consideration. My supporters were anxious, of course, to see me frequently in their midst and were desirous that I should not lose touch; but not infrequently one went down, perhaps at considerable inconvenience, to a tea-party or bazaar or local gathering and found the room half-full. The fact is that it is difficult, or almost impossible, to keep up for any length of time local interest in political life, unless some serious or exciting conflict is on the carpet.

Thus it came about that in the spring of 1895 I felt desirous of retiring from Parliamentary life, and went so far as to intimate to some of my friends my wish to do so at the end of that Parliament. I had hoped to find a successor in a man of high repute and position in the division, a man of advanced Liberal views and a keen politician. I had never concealed my opinion that for a constituency like South Manchester, a person who represented the local interests, especially in their commercial aspect, would prove more useful than one like myself.

The dissolution came suddenly on the well-remembered "Cordite" vote in July, and as no successor to myself could be found at the moment, I was obliged to stand again. My opponent was the Queen's son-in-law, the Marquis of Lorne. For two years he had assiduously nursed the constituency. His engaging manners and his high position naturally favoured the Conservative cause in a constituency which, though Radical, was not unappreciative of the attentions of a Marquis. A domestic occurrence told against me, for the marriage of my elder daughter to Mr. Charles Mallet (now, 1906, one of the two Liberal members for Plymouth) had long been fixed for the 11th of July, and the election took place on the 13th. Obliged to be present at the wedding in London and at the reception in the afternoon, I hurried back to Manchester by the five o'clock train, arrived there in pouring rain at ten o'clock, and visited a number of the committee rooms, but, of course, was unable to attend the meetings which had been held earlier in the evening. The next day being the last before the poll, no public meetings were held, all efforts being devoted to the preparation for the next day's fight. The Marquis and I were on excellent terms. I was defeated by seventy-six votes, and thus my Parliamentary career came to an end; for though frequently pressed to re-enter Parliament, both by my former colleagues and others, I felt that I had had enough.

I was touched and gratified to receive the following address from the Liberal Association of South Manchester on the occasion of my retiring from political life:—

To Sir HENRY ENFIELD ROSCOE, Knight,
B.A., Ph.D., D.C.L., LL.D., F.R.S., &c.

Upon the conclusion of the ten years during which you have served as Member of Parliament for the South Division

of Manchester, the Members of the Liberal Association of that Constituency desire, in this Address, to place in your hands the written expression of their appreciation of your regard for the public weal in having devoted so large a portion of your valuable life to the service of the State as their Representative.

Their thanks are tendered not only for the length of the term, but for the quality of that service, and they take pride in having had as their Representative one so renowned in the world of Science and Learning as well as responsive to the highest demands of Liberal principles and policy.

True to the traditions of your family you have enriched the libraries of the Nation, whilst the records of Parliament bear testimony that your political actions, happening in one of the most arduous and anxious periods in the history of the House of Commons, has ever been in the direction of the enlargement of popular liberty.

In matters affecting trade, manufactures, health, and educational interests of the country, your high scientific attainments have found a fruitful field of practical utility in Acts of Parliament bearing upon those departments of national life.

In both of these aspects your representation of the Constituency has been peculiarly appropriate. It is a University Division. It is the home of many whose lives are engaged in those trades and manufactures wherein Chemistry, and the kindred services in which you hold a foremost place, have direct application. It lies in the midst of that energetic area in which the greatest political reforms have been initiated.

It is also a matter of gratification that not only the Colleges, Universities, and learned Societies of Great Britain, Ireland, and the British Colonies have conferred upon you the highest degrees and honours at their disposal, but that you have been the recipient of distinguished honours bestowed upon you by similar learned Societies in other countries.

It has been, however, in the sphere of Politics that the Members of this Association have been most closely allied with you, and they hereby convey to you their heartfelt acknowledgment of your steadfast adherence to those Liberal principles of which you have been the faithful representative.

It may truly be said that so long as the best men of any nation are willing to devote their lives to the direction of its political life, and the people exercise their franchise in the selection of their best men for such service, that nation

may be happy in the realisation of the best hopes that may be entertained in its behalf. In your willingness to serve, and in your selection as member for the division during so long a period, this felicitous representation was attained.

That period will ever be looked back upon with feelings of gratification, and you may ever be assured of the cordial goodwill and best wishes of your old constituents, for yourself, Lady Roscoe, and the other members of your family.

Signed on behalf of the Members, Council, and Executive Committee of the South Manchester Liberal Association.

EDWIN GUTHRIE, *President.*

MANCHESTER,

20th December, 1895.

CHAPTER XIII

PASTEUR AND PREVENTIVE MEDICINE

Pasteur Commission—Paris Exhibition 1889—Prince of Wales's Visit to Institut Pasteur—Anti-rabic Treatment—Pasteur's letters—Speech on Anti-vivisection—Pasteur's Character and Work—The Lister Institute—Election to French Academy—Centenary of the Institut de France.

I WAS fortunate in making the acquaintance of Pasteur, whose portrait faces this chapter, as far back as the early 'sixties, and when in Paris in the year '82, as a member of the Technical Instruction Commission, I took the opportunity of renewing my friendship with him. I also made the acquaintance of Roux, Metchnikoff, and others of his collaborators and pupils. At that time he had astonished the world with his remarkable discoveries relating to the cure of chicken cholera anthrax or Russian cattle-plague and the silk-worm disease, and he was beginning his researches on that most terrible of all maladies, hydrophobia. Some years after 1882 I again visited Pasteur, then installed at the new Institut Pasteur in the Rue Dutot. Here I found the most ample provision made for both investigation and the treatment of disease. Everything had largely developed except the physical strength of the great discoverer himself. The wear and tear of constant study and unremitting work had told upon a constitution never vigorous, but

Pasteur's scientific enthusiasm, his devotion to the cause of humanity, and the gentleness of his demeanour, were still unchanged. In the year 1886 I was successful in obtaining the appointment of a Government Commission for investigating and reporting on the efficacy of Pasteur's treatment of hydrophobia. Great opposition to his methods had arisen in England from the class of people known as anti-vivisectionists, and as all Pasteur's statements and statistics were looked upon by such persons as totally untrustworthy, it appeared to me important that Englishmen of known position and character should undertake the investigation of the subject. Mr. Chamberlain, who was then the President of the Local Government Board, gave me every assistance. The Commission consisted of Sir Joseph (now Lord) Lister, Sir James Paget, Professor Ray Lankester, and myself, with Sir Victor Horsley as Secretary. We visited Paris as well as the French provinces, and reported fully on the whole subject, coming to the conclusion, supported by distinct and irrefragable proof, that Pasteur's treatment had been the means of saving a large number of lives which otherwise would have been sacrificed to a dreadful and torturing death. And here I may parenthetically remark that the gratification with which I look back on the work in which I took part is greatly increased by the fact that I then formed a friendship with Lord Lister which has continued ever since.

Being in Paris during the great Exhibition of 1889, I learnt that the Princess of Wales and her daughters were anxious to visit the Pasteur Institute, and as I was well acquainted with the whole method of treatment of hydrophobia, I thought that perhaps I might be of service to her Royal Highness in explaining matters.

I sent a message to the Embassy that I would be very glad, if the Princess desired it, to be present, and as she expressed her wish that I should do so, I attended at the Institute on the morning fixed for their visit. The party soon arrived, the Prince of Wales unexpectedly accompanying them. Pasteur, who was much flattered by the visit, received the Royal party at the entrance, and conducted them through the laboratories. When this had been accomplished he said :—"We will now proceed to the anti-rabic department." I then asked the Prince of Wales whether the young ladies would care to see the operations performed, to which the Prince replied :—"Of course ; the girls will go to see everything." The Princess and her daughters took the greatest interest in the cases. The scene was certainly a remarkable one. The room was filled with more than fifty persons, men, women and children, of all ages, and of every nationality, all of them having been bitten by dogs either known to be or supposed to be suffering from rabies. As Pasteur was not a surgeon, he did not operate himself, the operator in this case being a young Englishman, with whom I have since been intimate, Dr. Armand Ruffer. Nothing could exceed the skill and the gentleness, as well as the quickness, with which he inoculated the patients as they passed before him. Every operation was practically painless, and scarcely anyone flinched, with the exception of a few of the children, who cried when the needle was inserted, and in these cases it was touching to notice with what tenderness Pasteur endeavoured to soothe and comfort them. The Princess took one of the little children from its mother's arms, kissed it, and gave a sovereign to the woman, whose child had been bitten ; she was the wife of an English policeman. Many of the cases

were most affecting and interesting. I need scarcely add that this is not a description of an occasional scene, but that the same has occurred day after day, and still takes place, the number of patients remaining almost as large, which indicates that the number of persons bitten continues to be very considerable.[1]

As an instance of the value of this treatment, I may mention that on my return to London a friend of mine, a well-known Manchester merchant, called upon me to ask my advice. Two days before, he had been walking in the crowded streets of Salford, when suddenly he felt his thumb wrenched. He looked down and saw it had been bitten by a strange dog, and was bleeding. The dog rushed away with its tail between its legs among the carts and carriages in the road. Being somewhat disturbed by this, my friend went to an apothecary, who cauterised the wound, and then consulted his doctor, who treated it in a similar way, but advised him to see me as to whether or not he should submit himself to Pasteur's treatment. He put the question to me: "Do you think the dog was mad? If so, what would you do yourself under similar circumstances?" I replied: "Of course I cannot speak positively as to whether the dog was suffering from rabies, because that could only be told by the examination of the dog's medulla after death; but under the circumstances you describe I should certainly, if I were you, at once go to Paris, and place myself under Pasteur. Still," I added, "I am not a medical man. I will give you a letter to Sir James Paget, upon whose advice you may safely act." I also handed him a letter to Pasteur. On being consulted, Paget at once

[1] I find that the number of persons treated in 1904 was 755, of whom 3 died, the rate of mortality being 0·33 per cent., whilst as an average for the last 10 years the death-rate has ranged from 0·18 per cent. in 1902 to 0·39 per cent. in 1897 and 1904.

told him to go that night by the mail. So he went, informing his wife that business had called him to Paris, and that he should be obliged to remain there for ten days, not choosing to tell her of the cause of his decision. I may add that he suffered no evil effects.

In all treatment of disease there is a certain risk of failure. Prior to the introduction of Pasteur's method, the rate of mortality was about 15 per cent. It is now, as I have stated, less than 1 per cent.; that is to say, out of 200 persons bitten in various ways, through the clothing, on the hands, or on the face, by rabid animals, about 30 were found to die before Pasteur's discovery, whilst if these 200 persons are treated according to his method, the probability is that only one will succumb. At the commencement of the practical working of Pasteur's method, a large number of Russian peasants who had been worried by rabid wolves came to Paris, and I went to the hospital to see them. It was a horrible sight. Some of their faces were almost eaten away by the wolves, and the worst cases had a fatal end. They had been sent from the remote parts of the Empire to Paris, and by that time the virus had taken such a hold upon them that in many cases cure was impossible.

I once saw in Manchester a case of hydrophobia at the Royal Infirmary, but this was before Pasteur's time. It was a dreadful sight. My friend and former pupil, the eminent Manchester surgeon, the late Mr. Collier, who at that time was the house-surgeon and had the case under his care, told me that some few years ago he had been treating a similar case when, in administering some anæsthetic, he incautiously placed his thumb in the patient's mouth, who bit it through the nail. It is more easy to imagine than to

describe what his feelings must have been, and how for months he must have had the horrible feeling of uncertainty hanging over him.

Another important part of Pasteur's discovery is that it is now possible to ascertain with certainty whether or no the animal inflicting the bite was really mad or not; for this purpose an examination of the medulla of the animal has to be made. This is not only carried on in Paris, but also at the Brown Institute in London. In those cases in which the dog is proved not to be mad, there is not the slightest danger of hydrophobia to the person who has been bitten; for, though a common, it is an altogether false idea, that a dog which is not mad is able to cause the disease.

Sir James Whitehead, when he was Lord Mayor, became much interested in Pasteur's anti-rabic treatment. He called a meeting in the Mansion House for the purpose of raising a fund. This fund was to serve the double purpose of making an acknowledgment of the indebtedness of the English people to Pasteur and his Institute, no less than 200 cases of English persons having been gratuitously treated up to that time by Pasteur's system, and of defraying the expenses of the journey to such of our poorer countrymen as might hereafter need treatment. The Royal Society, in a letter from the President, Sir Gabriel Stokes, assured Pasteur of the warm interest which the Society took in the recognition of his services in carrying out so remarkable an extension of that natural knowledge which the Society was founded to develop. To express their approval in a more formal manner, the Society appointed their officers, together with Sir James Paget, Professor Lankester, and myself, to represent them at the meeting. A considerable

sum was raised, and since that time a large number of English patients have gone over to Paris, the poorer ones having their expenses defrayed from the fund.

In 1889 the Royal Society invited Pasteur to deliver the Croonian Lecture. Unfortunately his health did not permit him to undertake the duty, but he appointed Roux, his chief assistant, in his place. Since that time, mainly through the influence of Mr. Long, then President of the Local Government Board, this dreadful disease has been effectively stamped out in England. This has been accomplished by the humane system of a careful and systematic muzzling of all dogs in the country. Of course an outcry was raised even against this measure by the so-called friends of the canine race, but in spite of this it came into force. I remember asking Pasteur why preventive measures of this kind were not adopted in France. He replied that the French public would not stand such coercive measures, and therefore it was necessary to abide by the curative system.

On May 4th, 1889, I was asked by Lord Leighton, the President of the Royal Academy, to respond for Science at the Academy dinner, and, speaking of the close alliance of art and science, I referred to Pasteur's work in the following terms: "The labours of both the artist and the man of science have the same end in view. Both serve the same goddess—Nature—both strive to discover her secrets; the aim of both is to express, whether by the brush or chisel, or by the written and spoken word, the truths which Nature thus reveals. Only to those who serve her faithfully, whether in the studio or in the laboratory, does she unfold her secrets, and only those whose pride it is to incite in others the love of Nature which they themselves enjoy can clearly expound her ways. Moreover,

it is to that true insight into Nature's works, which we term imagination, that not only the artist, but also the man of science owes his power. This intimate alliance between art and science meets us at every step. When lately in Paris I saw an impressive sight, namely, the institute founded by French foresight and generosity to carry on the work and immortalise the name of Pasteur. In front of the Pasteur Institute stands a statue worked with consummate skill in bronze. It is the figure of a boy struggling heroically with a mad dog. Nor does this statue represent a mythical act of heroism, but one which actually took place only a few short months ago. The French boy in killing the dog without assistance or weapon was horribly bitten, but his life was preserved from the certain fate of the most fearful of all fearful deaths, by being one of the first out of the now many hundreds of human beings successfully inoculated against hydrophobia by Pasteur, one of the foremost living men of science. If on this occasion I refer to this subject, it is because the statue of the boy struggling for life with the rabid dog serves as a typical instance of one way, at least, in which art assists science. For surely that is the noblest form of art which appeals to one of the highest and deepest feelings in man—that of human sympathy—sympathy which more than any mere material reward encourages the labourer in the fields of scientific investigation, and enables him to carry on his researches to a successful issue."

Referring to the above, I received the following letter from Pasteur :

PARIS, *le* 15 *mai*, 1889.

CHER CONFRÈRE ET AMI,

J'ai été particulièrement sensible à l'hommage que vous avez rendu à l'art et la science après votre retour à Londres et que l'Institut Pasteur ait servi en partie de tente à votre

pensée. C'est un nouveau témoignage de sympathie qui m'a beaucoup touché, parce qu'il servira certainement au succès de l'œuvre que vous avez bien voulu entreprendre déjà. Une idée juste fait toujours son chemin, surtout quand elle est mise en avant par une parole autorisée qui prend souci de suivre son progrès. Vous en pouvez juger dès à présent. Je vous prie de lire la copie d'une lettre toute récente de M. Ray-Lankester que je vous envoie ci-joint. En effet, le Lord Maire a visité nos laboratoires et assisté à nos inoculations antirabiques dimanche de 11 heures moins ¼ à midi ¼, avec une suite nombreuse. Il a paru fort intéressé et très bienveillant. Tout cela est déjà, cher confrère et ami, une suite de votre initiative.

Votre très affectionné
L. PASTEUR.

J'ai dû écrire à Sir James Paget mes regrets définitifs de ne pouvoir me rendre à Londres avec M. Roux. Afin de prendre rendez-vous avec le Lord Maire j'ai accepté l'invitation au banquet donné par M. le Président Carnot et à celui du Conseil Municipal de Paris. Cet essai de mes forces m'a bien prouvé que le voyage de Londres serait presque impossible pour moi. J'ai été entièrement fatigué par cette double sortie du soir.

The following letters to me from Pasteur are also of interest :

INSTITUT PASTEUR,
45, *Rue D'Ulm.*

PARIS, *le* 23 *décembre*, 1888.

CHER SIR,

Une réponse favorable du Chancelier de l'Échiquier se traduisant par une participation effective du parlement ou par toute autre voie dans votre pays, aurait un effet moral considérable. Mais que penser de la réponse qui vous a été faite ? Est-ce une fin de non-recevoir ? Laisse-t-elle quelque espoir d'une issue favorable ? Se traduira-t-elle par une souscription publique parmi les hommes de science, parmi les savants et les médecins ? Il n'y a rien à attendre des personnes traitées. La très grande majorité des personnes mordues par les chiens enragés sont des ouvriers ou même des indigents. Et puis, la proximité de Londres et de Paris évite au gouvernement anglais à la dépense d'installation et de fonctionnement d'un laboratoire antirabique à Londres. Non seulement la Russie a fait les frais de 7 cliniques de la

rage, mais le Tsar a souscrit pour cent milles francs. La Turquie qui a peu de rage a fait les frais d'un laboratoire antirabique et a souscrit pour 10,000 fr. L'Italie a cinq laboratoires antirabiques. Milan a souscrit dix milles fr. également, &c., &c. Veuillez bien lire d'autres détails dans la brochure de l'inauguration du 14 novembre. En ce moment nous avons plusieurs anglais en traitement.

Votre très dévoué confrère,

L. PASTEUR.

PARIS, *le* 15 *janvier*, 1889.

MON CHER CONFRÈRE,

Depuis que j'ai reçu votre lettre du 9 et la communication personnelle très importante que vous avez faite au journal le *Times*, j'ai tout-à-fait confiance dans le succès de votre initiative auprès de la Chambre des Communes.

En outre, l'aide que Sir J. Paget et vous avez l'idée de demander au conseil de la Société Royale ne pourra pas manqué d'être décisive. J'ai eu à Paris l'écho de l'effet produit au parlement par votre proposition. J'ai reçu la visite de M. Balfour, gendre de la comtesse Lytton, également celle de M. Ferdinand de Rothschild, votre collègue aussi à la Chambre des Communes, qui s'est intéressé beaucoup aux inoculations antirabiques et à "l'Institut Pasteur." Il doit conférer avec vous et avec Sir Paget.

Quelle que soit la résolution à laquelle vous vous arrêterez, vous aurez à lutter contre une grande opposition de la ligue anti-vaccinatrice et anti-vivisectioniste. Jamais, par exemple, ses membres n'accepteront l'idée de créer à Londres un laboratoire antirabique. Certains d'entre eux préfèrent la vie d'un lapin à celle d'un homme, aussi, je pense que l'Angleterre continuera de nous envoyer ses mordus et ne fondera pas de laboratoire antirabique. Elle peut très bien prendre ce parti. Aussitôt après la réception de votre lettre, j'ai demandé au Crédit Foncier de France, où ont été concentrées toutes les souscriptions en faveur de l'Institut Pasteur, que l'on dressa la liste de toutes les sommes recueillies à l'étranger, provenant des gouvernements, des sociétés, ou des particuliers. Dès que ce travail sera prêt je vous l'enverrai.

Ce qu'il faut remarquer toutefois c'est que les dépenses faites à l'étranger l'ont été surtout pour la fondation et l'entretien des laboratoires antirabiques créés.

Recevez, mon cher confrère et très obligeant ami, l'expression de mes sentiments dévoués et reconnaissants.

L. PASTEUR.

On May 30th, 1889, I made the following remarks in the House of Commons with regard to vivisection and to Pasteur:

I rise to oppose the amendment, and I do so, in the first place, because I believe that the Acts referred to are worked honourably and honestly by all the men of science who obtain their licences or certificates under them, and that the inspection and registration are carefully done. I was glad to learn from my hon. friend [Mr. J. E. Ellis] that he does not object to the Acts if they are properly carried out; but I think that is not altogether the case with many of those who speak on the question. A great number of those who are agitating on the matter desire the entire abolition of vivisection, that is, of experiments on living animals whether effected under anæsthetics or not. I believe those experiments are of the very greatest value, and both medicine and surgery have highly benefited from them, both in this country and abroad. They are experiments which give but little pain to animals, but are conducted under such restrictions and with such care that the animals do not suffer. My hon. friend mentioned the name of Professor Ferrier. The results following on the experiments made by that gentleman have, in the hands of many distinguished surgeons, and especially of Mr. Victor Horsley, actually effected the alleviation of one of the most dreadful diseases to which flesh is heir—the disease of epilepsy. Professor Ferrier's experiments proved that epilepsy is caused by the irritation of the surface of the brain as opposed to that of its mass. And it is now possible, solely owing to these experiments, to localise in an epileptic patient the actual seat of the pressure on the brain. In many cases a portion of the skull has been removed and the epilepsy has been cured. In fact, in the same way, owing to previous experiments on animals, a diseased kidney can now be removed with ease, and thus the life of the patient saved. There is not a page in any manual of physiology of which the principles laid down are not in some way connected with, or dependent upon, these experiments on animals. Then again, there is no doubt that the principles of antiseptic surgery, which have been laid down by Lister, have been ascertained by experiments of this kind. In the early years of the 'forties the deaths in the Vienna Lying-in Hospital from puerperal fever were 92 per 1,000. In 1863, in consequence of the adoption of an antiseptic treatment, the death-rate had diminished to 13 per 1,000, and in 1881,

through the introduction of stringent aseptic methods, it was still further reduced to 4 per 1,000. In the same way in the York Road Lying-in Hospital in this neighbourhood, in 1838, 26 per cent. of the patients died from this complaint. The hospital was often closed, but was re-opened in 1879 on strict antiseptic principles. The result has been that there has been only one case in three years, or less than 1 per 1,000. I might continue to quote an almost endless number of cases in which humanity has benefited to an undreamt extent by experiments on animals, but now I will content myself by reminding the House of the most remarkable of all, namely, the cure and prevention of that most horrible of all maladies, hydrophobia, by the discoveries of Pasteur. Not one of these cases of cure could have been effected without experiments, for the most part painless, on animals, which the amendment now before the House asks us practically to discontinue. But, Sir, it has been said by the opponents of these Acts that animals are thus sacrificed to the selfish interests of man. Such a statement only shows an entire ignorance of the fact, because the knowledge obtained by these experiments has been of the greatest value to animals themselves. Take the case of anthrax. Through the labours of M. Pasteur again, we know that that disease—Russian cattle plague—can now be actually overcome by inoculation, and that every year hundreds of thousands of sheep and cattle are now saved by inoculation from a painful death. I trust that those who think of supporting the reduction of the Vote will bear in mind that to stop those experiments will be to arrest the progress of scientific and modern medicine and surgery, and that by voting for the reduction they attempt to throw a most undeserved slur on the character of a high-minded, conscientious, and eminent man.

In 1890 a memorial expressing the high appreciation of the services Pasteur had rendered to mankind was presented to him, in the form of an album, through the exertions of Lady Priestley. I brought it down to the House of Commons and obtained a large number of signatures, including that of Mr. Gladstone.

On a Sunday afternoon in March of the above year I delivered a lecture at St. George's Hall, Langham Place, on Pasteur and his discoveries, and mentioned that no fewer than 200 fellow-countrymen had crossed

over to Paris to be treated by his anti-rabic system, and since July of the past year as many as eighty persons had been so treated.

Pasteur began life as a chemist; as a chemist he ended it. For although his most important researches have entered upon fields hitherto tilled with but scanty success by the biologist, yet in his hands, by the application of chemical methods, they have yielded a plentiful harvest of new facts of essential service to the well-being and progress of the human race. And, after all, the first and obvious endeavour of every cultivator of science ought to be to render service of this kind. For, although it is foolish and short-sighted to decry the pursuit of any form of scientific study, for the reason that it may be as yet far removed from practical application to the wants of man, and although such studies may be of great value as an incentive to intellectual activity, yet the statement is so evident as to amount almost to a truism, that discoveries which give us the power of rescuing a population from starvation, or which tend to diminish the ills that flesh, whether of man or beast, is heir to, must deservedly attract more attention and create more general interest than others having no immediate bearing on the welfare of the race. "There is no greater charm," says Pasteur himself, "for the investigator than to make new discoveries, but his pleasure is more than doubled when he sees that they find direct application in practical life." To make discoveries capable of such an application has been the good fortune—by which I mean the just reward—of Pasteur. These discoveries have not been, in the words of Priestley, "lucky haphazardings," but the outcome of patient and long-continued investigation.

The whole secret of Pasteur's success may be summed up in a few words. It consisted in the

application of the exact methods of physical and chemical research to problems which had hitherto been attacked by other less precise and less systematic methods. His early researches were of a purely chemical nature. It is now sixty years since he published his first investigation. But this pointed out the character of the man and indicated the lines upon which all his subsequent work was laid.

Of all the marvellous and far-reaching discoveries of modern chemistry, perhaps the most interesting and important is that of the existence of compounds which —whilst possessing an identical composition, that is, made up of the same elements in the same proportions —are absolutely different substances as judged by their properties. The first instance made known to us of such isomeric bodies, as they are termed by the chemist, was that pointed out by Berzelius. He showed that the tartaric acid of the wine-lees possesses precisely the same composition as a rare acid having quite different properties which is occasionally found in the tartar deposited from wine grown in certain districts of the Vosges. Berzelius simply noted this singular fact, and did not attempt to explain it. Later on, the celebrated French physicist Biot observed that not only do those two acids differ in their chemical behaviour but likewise in their physical properties, inasmuch as the one (the common acid) possesses the power of deviating the plane of a polarised ray of light to the right, whereas the rare acid has no such rotatory power. It was reserved, however, for Pasteur to give the explanation of this curious and at that time unique phenomenon, for he proved that the optically inactive acid is made up of two compounds, each possessing the same composition, but differing in optical properties. The application of the same method

of exact observation to biological questions gave him an insight into the workings of that most mysterious of all poisons, the virus of hydrophobia.

Of the magnitude and far-reaching character of Pasteur's work we may form a notion when we remember that it is to him that we owe the foundation of the science of bacteriology, a science treating of the ways and means of those minute organisms called microbes, upon whose behaviour the very life—not only of the animal, but perhaps also of the vegetable kingdom depends—a science which bids fair to revolutionise both the theory and practice of medicine, and one which has already, in the hands of Lord Lister, given rise to a new and beneficent application in the discovery of aseptic surgery.

On October 7th, 1889, as President of the Midland Institution in Birmingham, I also delivered an address on Pasteur termed "The Life-work of a Chemist."

About this time I wrote several articles for *The Speaker* on the subject of the application of bacteriology to the prevention and cure of disease. One of these, entitled "New Developments of Vaccination," gave a history of Pasteur's discoveries as regards the immunity brought about by inoculation with various anti-toxins. Another was a description of Koch's supposed discovery as to the cure of consumption. In a third article, under the title of "The New Battle of Life," I explained the recent discoveries with regard to the germ theory of disease, pointing out the importance of Metchnikoff's discovery of phagocytosis, viz., that the blood of animals, as is well known, contains white blood corpuscules which are endowed with a life of their own and make war upon any foreign and toxic bacteria which may have gained entrance into the body. These may be termed, indeed, the out-lying posts

THE LISTER INSTITUTE, CHELSEA GARDENS, LONDON, S.W.

of an army which, on the approach of the enemy, tries to destroy them. Should the number of the attacking host be too large the disease progresses ; if, however, the defending party is in excess, the body retains its normal condition of life. This may well be termed a marvellous revelation of science, or, to quote the words of Lord Lister in his presidential address at the Liverpool meeting of the British Association in 1896, "If ever there was a romantic chapter in pathology, it has surely been that of the story of phagocytosis." The following words conclude Metchnikoff's volume on Immunity: "Within a very short period, immunity has been placed in possession not only of a host of medical ideas of the highest importance, but also of effective means of combating a whole series of maladies of the most formidable nature in man and the domestic animals. Science is far from having said its last word, but the advances already made are amply sufficient to dispel pessimism in so far as this has been suggested by the fear of diseases, and the feeling that we are powerless to struggle against them." [1]

To establish an institute in London having similar aims to the Institut Pasteur in Paris was long the wish of many men interested in the progress of preventive medicine. Thanks to the efforts of Lord Lister, Sir Joseph Fayrer, and others, including myself, this wish has been fulfilled, and the Institute of Preventive Medicine in Chelsea is now housed in an appropriate building (see illustration), with appliances and laboratories not inferior, in many respects, to its sister Institute in Paris. Here researches on questions relating to preventive medicine are carried out by scientific men versed in the several branches of chemistry, bacterio-

[1] For a full account of immunity in infective diseases see Metchnikoff's volume (translation), published by the Cambridge University Press, 1905.

logy, and pathology, and already many results of importance with reference to the scientific basis of the prevention of disease have been arrived at. And if as yet a panacea for the prevention of many dreaded scourges of humanity has so far baffled endeavour, it is well to remember that science, like art, is long, whilst life is short, and that we are only building the sure foundations upon which the superstructure of knowledge is to be placed. To assist in the prosecution of these endeavours to benefit humanity, Lord Iveagh stepped forward and by the munificent—almost unprecedented—gift of a quarter of a million sterling enabled the Institute, which now bears the honoured name of its president, Lord Lister, to extend its sphere of usefulness in a way that otherwise would have been impossible.

Among the recent discoveries in preventive medicine none is more important than that of serum therapeutics. Thus it is a well-known fact that many thousands of lives, especially of children, have in the last few years been saved by the use of diphtheric serum. To prepare this serum with every scientific precaution is, of course, of the greatest importance. This work, a sample of many similar operations, is carried on by the Governors of the Lister Institute, at their farm at Elstree, in Hertfordshire. Two of the Lister laboratories are here shown. As an instance of the beneficent work which the Institute undertakes, I may refer to its recent action in the study of the etiology of the plague in India. Millions of natives have lately died from this disease. Attempts, followed by greater or less success, have been made with various anti-plague sera to cure the disease, or to prevent the attack of the malady. But our knowledge of the mode of propagation of the disease is yet incomplete. How does the poison pass

A Laboratory at Chelsea.

A Laboratory at Queensberry Lodge.

from the rat—the animal which appears to be the first to be attacked—to the human being? Some think that the intermediary is the flea, but no one knows. A Commission has been appointed by Government to investigate the question, upon the scientific solution of which, it is clear, any method of preventing or curing the disease depends. The Lister Institute has sent out its Director, Dr. Charles Martin, in charge of this Commission, together with two others of its scientific staff, and we entertain the best hopes of the success of this enterprise.

The Governing Body of the Institute consists of Dr. J. Rose Bradford, Major Bruce, Sir Michael Foster, Lord Iveagh, Professor Osler, Mr. J. L. Pattison, C.B., as treasurer, and myself as chairman, whilst Lord Lister is our president. I may add that it is the unanimous determination of the Governing Body that the work of the Institute shall be prosecuted with a zeal proportional to the generosity of its benefactor, so that this country may truly ere long be said to be in possession of an Institute not second even to the Institut Pasteur of Paris. This Institute does not, however, undertake to inoculate persons bitten by rabid dogs, as the rapid means of communication between England and Paris renders this unnecessary, and since at present, as I have already stated, hydrophobia no longer exists among us. Unlike the recently discovered antidote to snake poisoning, the inoculation for rabies may be successfully carried out even a week after the bite has occurred.

Unfortunately the anti-vivisectionist fanatics in England have done all they could to thwart these most beneficial discoveries of Pasteur in their application to suffering humanity. They raised violent opposition to the building of the Institute of Preventive Medicine in Chelsea. But, fortunately for the

sake of the progress of science and that of humanity, their endeavours proved futile; but there is always a danger in this democratic country that ignorant fanaticism may have a temporary success.

One of the most active and unscrupulous of these opponents was a late well-known divine. He wrote several offensive letters to *The Times*, containing statements of the most unwarrantable character. As some of these statements impugned the nature of the work which we were doing at the Institute, I ventured one day to call upon him to ask him upon what authority he made them, informing him that if he had taken the trouble to inquire from myself or others connected with the Institute he would have found that his allegations were altogether devoid of foundation. As one example of the absurd ideas which he held, I may mention that he described as a danger to the neighbourhood the existence of an imaginary insect which he termed "the hydrophobia fly." This would, in his opinion, inoculate and poison the whole district with this dreadful disease. I told him that this was a mere figment of his morbid imagination, and that, moreover, there was no intention on our part of having anything to do with the cure of hydrophobia for reasons which I have already mentioned. His wife, who appeared even more *entêtée* than he, became abusive; but this did not affect me, and I left with the satisfaction of having, at any rate, given these people a piece of my mind—not that for a moment I imagined that anything one could say would change their opinion. Argument has no effect upon fanatics, and as for reasoning with them, you had better, as the North-country people say, "Save your breath to cool your porridge."

Good sense, however, in the long run prevails. And

this is strikingly shown with regard to the progress of the Institute, and of its beneficent work in the alleviation of human suffering.

On December 27th, 1892, the French nation celebrated Pasteur's seventieth birthday. I very much regretted that I was unable to accept the invitation to be present on that occasion, and I was grieved to receive not long afterwards the intimation of his death, which occurred on September 28th, 1895. The mortal remains of this great benefactor to mankind rest in a beautiful mortuary chapel erected in front of the Institute where his great work was carried on, and where his devoted pupils still labour in the good cause.

To learn what the French themselves think of Pasteur and his work, the words of M. Gaston Paris may be quoted :

"No one claimed more insistently for science the honour and the place to which it has a right, or became more indignant with the misunderstanding which refuses to it the means of action of which it stands in need. In a brief publication entitled *Le Budget de la Science* published in 1868, Pasteur appealed to his fellow-citizens to take more interest in those sacred abodes known by the expressive name of laboratories. 'Ask that they should be multiplied and adorned. They are the temples of the future. It is there that humanity becomes greater and stronger and better.' Paris concludes in the following words: "Science, in the circles where it is honoured and understood, does not restrict to men of science the moral benefit which it confers. It diffuses in wider circles the love of truth and the habit of seeking it without bias, or recognising it only by unalloyed proofs, and of submitting docilely to it. I think that no loftier or more fruitful virtue can be inculcated in a nation. Pasteur had the joy and the supreme honour of seeing the most magnificent of these temples of the future arise at his invocation owing to the munificence of the entire nation. There he reposes to-day in his glory, and about his tomb has been formed, like

an order of the new *régime*, a militant, truly spiritual band, which fights under his banner, to extend his conquests, and which will remain faithful to the motto which he gave it, working unremittingly 'Pour la Science, la Patrie, et l'Humanité.'"

In July, 1904, France honoured the memory of her great citizen. This was by the erection of Pasteur's statue, which exhibits in its artistic beauty the value of the life-work of its great original and was unveiled by the President of the Republic in the presence of statesmen and scientific men from all parts.

In 1889 I received the honour of being elected a corresponding member of the French Academy of Sciences, and doubtless my friendship with Pasteur, who was the secretary of the Institut, had much to do with this. Among the other candidates for the distinction was Cannizzaro, the eminent Italian chemist, from whom I was pleased to receive a congratulatory message on my election.

Here may appropriately follow a short account of the celebration of the centenary of the Institut de France, which took place in October, 1895.

I take the following extract from their *Annuaire*, which gives particulars of its foundation and object:

L'Institut national de France, fondé par l'article 298 de la Constitution du 5 fructidor an III (22 août 1795) avec la mission de recueillir les découvertes de perfectionner les arts et les sciences, a été organisé d'abord par la loi du 3 brumaire an IV (25 octobre 1795) et par celle du 15 germinal an IV (4 avril 1796).

Maintenu par l'article 88 de la Constitution du 22 frimaire an VIII (13 décembre 1799) il a été réorganisé par l'arrête consulaire du 3 pluvoise an XI (23 janvier 1803).

Une nouvelle organisation lui a été donnée par l'ordonnance royale du 21 mars 1816, complétée par l'ordonnance royale du 26 octobre 1832.

The following characteristic letter of invitation was

sent to the foreign associates and the corresponding members of the various Academies :

PARIS, *le* 5 *août* 1895.

MONSIEUR ET CHER CORRESPONDANT,

L'Institut de France célébra, du 23 au 26 octobre prochain, le centième anniversaire de sa fondation. Vous trouverez sous ce pli le programme des Fêtes que nous organisons à cette occasion. Nous avons cherché à les rendre dignes de ce grand événement. Mais ce qui donnera à ces Fêtes le plus d'éclat, ce sera la réunion de tous les savants et artistes français et étrangers qui appartiennent à l'Institut et dont les travaux font la gloire de notre compagnie

Nous avons la confiance que vous voudrez bien répondre à notre convocation pour reserrer les liens qui nous unissent. Nous serions heureux de savoir le plus promptement possible vos intentions pour prendre les mesures nécessaires.

Agréez, Monsieur et cher Correspondant, l'assurance de nos sentiments tout dévoués.

Le Président de l'Institut,
AMBROISE THOMAS.

Le Secrétaire de l'Institut,
C. HRI. DELABORDE.

The programme of the proceedings was varied and included a gala representation (a *matinée*) in the Théâtre Français, when the three pieces given were *Le Cid, Ecole des Femmes,* and *Les Femmes Savants.* A poem written by Sully Prud'homme was recited by Mounet-Sully in the presence of all the artistes of the Théâtre Français. Those who were more familiar with the language than I can claim to be said that these representations of Molière's plays were perfect, as they clearly brought out the style and tone of the Molière period, so different from that of the modern French drama. In the evening we were received at the Elysée by the President of the Republic, and the ladies of his Court were much amused at the manner in which the two English girls accompanying me warmly shook him by the hand, a proceed-

ing utterly at variance with the *convenances* which usually govern the doings of a French *jeune fille*.

The most interesting of all the fêtes was on October 26th (the last day), when the whole of the members visited the Château of Chantilly. This magnificent château, the seat of the old Comtes de Condé, had been restored by the Duc d'Aumale, and the whole of the buildings and parks adjoining, together with the rare objects of art and *vertu*, valued at many millions of francs, were made over by the Duke to the French nation, under the sole care and management of the Institut de France. A special train was placed at our disposal, and a large number of four-in-hand char-à-bancs met the train at the station, and, preceded by outriders in the Duke's livery, took us through the woods to the château, driving on our way through the enormous stables where, it is recorded, the Comte de Condé entertained the Czar Peter the Great at a banquet. On reaching the château we went up the magnificent white marble staircase, where we were received by the old Duke, a martyr to rheumatic gout, seated in a bath-chair. He cordially grasped our hands and most graciously bade us welcome. A description of the art treasures contained in these noble galleries is beyond my powers, although I was able to appreciate their beauty. The fact is certainly a remarkable one, that the whole of these buildings and their contents were handed over, not to any Government institution, but to a society entirely formed of artists and men of science and literature. This more than anything else, perhaps, indicates the difference between the stability of our English Constitution and that of our French neighbours, which has undergone so many changes in the last hundred years.

CHAPTER XIV

UNIVERSITY OF LONDON

Chemical Examiner—Elected Vice-Chancellor—Reorganisation of the University—Medical Education in London—Removal to the Imperial Institute—Addresses on Presentation Day—Address to King on his Accession—Incorporation of University College—Proposals to found an Imperial Technical University—My Jubilee.

FROM the year 1874 to 1878 I acted as examiner in chemistry to the University of London; this was during Carpenter's registrarship. It was whilst I held this office and chiefly owing to my recommendation, that practical laboratory work was included in the curriculum in chemistry for Science degrees. I remember well the first examination in which simple quantitative analysis formed a part of the practical examination. One of the problems set to the candidate was to determine the quantity of metallic iron contained in a solution of ferric chloride. To indicate the notions concerning quantitative analysis held by some of the candidates at that time, it is worth while to mention that I noticed one of them, who, having precipitated the hydrated oxide by means of potash, and having thrown this on a filter and washed it, endeavoured to estimate the amount of iron by placing the wet filter, with the moist precipitate inside it, on the pan of the balance and then proceeding to weigh it. I don't suppose that any boy at the present day who had been taught

chemistry at an elementary school would display such ignorance.

During the time that I had a seat in the House of Commons I was asked to join the Senate of the University of London, but I declined in consequence of Parliamentary work. After retiring from Parliament I consented to act on the Senate, to which I was duly elected. When Sir James Paget vacated the Vice-Chancellorship in 1895, he was succeeded by Sir Julian Goldsmid, who served for a short period only, as he died soon afterwards.

On February 19th, 1896, I was elected in Sir Julian Goldsmid's place and served as Vice-Chancellor for six years.

Sir James Paget was one of the most charming of men. His biography by his son Stephen is as instructive as it is interesting. There one learns what trials and self-sacrifices a surgeon may have to go through before he rises to the head of his profession. I consider myself fortunate in reckoning him among my friends. He came down on one occasion to Owens College to deliver an address and to distribute the prizes to the medical students. I presided at a dinner given in his honour, and I remember vividly the perfect finish and delicate flavour of his speech.

Many years ago I noticed a little swelling on the tip of my tongue. I suppose everybody has at one time or another fancied they have a cancer; at any rate I did, so I went to see Paget—it was about the time of the Emperor Frederick's illness. "No, my dear man," he kindly said, "cancer of the tongue does not begin there; if it bothers you get your colleague W. C. Williamson to cut it off with a pair of scissors."

A lady patient of Paget's told my wife that it was worth while being ill to be attended by such a man.

As Vice-Chancellor of the University of London, and Paget's successor, I acted as pall-bearer at his funeral in Westminster Abbey on January 4th, 1900.

During the first three years of my service as Vice-Chancellor I had the great advantage of having the advice and co-operation of Lord Herschell as Chancellor, and of forming a friendship with so able a man. He was a great leader, and his early death, which occurred in America during a visit on State affairs, amounted, as Lord Rosebery has said, to a grave national misfortune. In the difficult days of University business, Herschell's tact and persuasive power kept the ship off the rocks and brought her safe into port. He was not only the Chancellor of the University, but the most distinguished of her alumni, and, as Fellow and Senator, he had devoted much of his valuable time to her service. On March 21st, 1899, a memorial service was held in Westminster Abbey, and I represented the University as a pall-bearer. It was a touching ceremony.

Lord Kimberley, who followed Herschell, was of a different stamp, though he likewise was a man not only to be respected but to be loved. He was for no less than forty-three years a Senator and took a great interest in University affairs. A lively *raconteur*, Kimberley loved to fight his battles o'er again, and he was always interesting and instructive. I was much attached to him. Lord Rosebery is now our equally distinguished Chancellor.

The work during my Vice-Chancellorship was somewhat difficult, as the University, under the Act of 1898, was in course of reconstitution as a teaching and not merely an examining body. The question of this reorganisation was one which for many years previous to that date had created much public interest,

and two Royal Commissions had reported on the question ; the first of these, under the presidency of Lord Chancellor Selborne, made its report in 1888, The recommendations did not meet with general approval, and consequently a second Commission was appointed in 1892, consisting of a larger number of members, with the late Earl Cowper as its chairman. This Commission reported two years afterwards. It recommended that the existing University should be reorganised, and that, while continuing to discharge all its present functions as an examining body for collegiate students in London and for non-collegiate students in all parts of the Empire, it should also establish closer relations with the great London colleges and medical schools, give to the authorities of those institutions a larger share in the government of the University, and seek in other ways to co-ordinate and control the higher education of London.

In March, 1893, I had put before Lord Cowper's Commission suggestions for the establishment of a Teaching University for London on lines which I venture to think would, if they had been acted upon, have created a machinery of a less cumbrous and perhaps a more satisfactory character than that which became law in 1898. The latter scheme was the result of a compromise between the views of those who held the function of the University as an examining body was the important factor, and of those who believed that a higher aim of a University was teaching rather than examining.

Proposals were made by me when acting as vice-president of an association, of which Professor Huxley was president, for the promotion of a Professorial (Teaching) University for London, supporting the idea that both the branches under discussion are

necessary functions of the University of London and that the foundation of two universities, as had been suggested, was to be deprecated. A Bill was subsequently introduced into Parliament by the Lord President of the Council, the Duke of Devonshire, for the purpose of giving effect to the general recommendations of the Cowper Commission, but it was not until 1898 that the "University of London Act" received the Royal assent.

The following particulars of the difficulties which surrounded the passage of the Bill through the Lords, owing to the opposition of the Bishops and those representing the Church party, are sufficiently significant to be worth stating. On Friday, July 24th, 1896, the Duke of Devonshire moved the Second Reading of the London University Bill in a speech in which he strongly supported the scheme of the Cowper Commissioners, and emphatically "repudiated and disowned any responsibility such as that which the opponents of the scheme appear in the statement (circulated by those opponents) to place upon him." Lords Herschell, Kimberley, Cowper, Playfair, Reay, and Kelvin spoke in support of the Bill, which was read a second time without opposition. On the 25th of July the Bill passed through Committee and was reported to the House without amendment. On the 31st of July the Bill was read a third time, and on the question that the Bill do pass, after a formal amendment moved by the Duke and agreed to, the Bishop of London moved to insert in Clause 3 (providing that statutes and regulations made under the Bill shall have effect notwithstanding anything contained in any Act of Parliament, Charter, Deed, or other Instrument) the following words:—"Provided that no Statutes or Regulations shall inflict any disability on

any College or Institution on account of its religious character." The Amendment thus proposed at the last moment and after the Bill had passed through Committee the Duke of Devonshire was unable to accept, stating, among other reasons, that the motion "was couched in terms which were in direct opposition to the University Tests Act," but he offered, in lieu of it, an Amendment following the language of the protest appended to the Report of the Commission signed by Bishop Barry, a former Principal of King's College, in whose interest the Bishop of London had moved his Amendment. The Duke's Amendment was as follows :—

> Provided that no Statute or Regulation shall preclude the University from accepting, if it sees fit, the administration of funds for every university purpose, whatever may be the conditions attached to such administrators.

The Bishop of London would not, however, entertain the suggestion. The Bishop's own Amendment was then negatived without a division, whereupon he stated that he "must be content to endeavour to secure justice in the Lower House." On August 1st the Duke's Amendment was moved and agreed to without opposition, after which the Bill passed in the House of Lords. The threat of the Bishop of London was, however, for the time effectual, for in the House of Commons, on August 12th, the Bill was withdrawn. The effect of the two Amendments may be thus shortly stated in reference to the appointment of professors. That of the Bishop of London would deprive the University of the right to refuse recognition of a professor, who, without being the most competent among the candidates for the vacant Chair, had nevertheless been preferred by a constituent college on an exclusively religious ground. That of

the Lord President would enable, but not require, the University to accept University funds upon the condition of recognising such an appointment. In the one case the University would be compelled, in the other it would be empowered, if it thought fit (in certain cases), to recognise a professorial appointment made by a constituent college upon sectarian grounds, that is upon other than grounds of superior literary or scientific competence.

It is curious to observe in the Bishop's speech that immediately after declaring that King's College was a "Church college," he stated that the college had used a convenient "conscience clause," which exempted students, if they desired it, from attending any religious instruction or observance whatsoever. A Professor of Chemistry therefore might preside over a class consisting entirely of Agnostics, or Turks, or Jews, but the Professor himself, according to the practice of the college, must nevertheless declare himself an Anglican. This requirement has since been removed, and no theological tests are now required at King's College for either professors or students, except in the Faculty of Theology.

On January 25th, 1898, I had the honour of introducing a large deputation on the question of the University to the Lord President of the Council. This deputation not only represented the University, but a large number of other educational bodies, the object being to urge the importance of the reconstitution of the University, as also the appointment of a Statutory Commission to draw up the regulations for the carrying out of the object of the Act. This Statutory Commission was duly appointed under the Chairmanship of Lord Davey, but certain directions as to important details were contained in the Act, chiefly

relating to the constitution of the new Senate, of which the first had reference to the religious freedom of both teachers and taught, and the second, that no disability shall be imposed on the ground of sex. The Statutes laid down by the Commissioners were approved by Parliament on June 29th, 1900, and the new Senate met for the first time on October 24th of that year. To indicate the importance I attached to the passing of the Bill I append a note I wrote to the Duke of Devonshire, the Lord President of the Council :—

July 21st, 1898.

MY DEAR DUKE,

As Vice-Chancellor of the University of London I write to express the confident hope shared by almost every member of the Senate that the Bill now in report stage may this Session pass into law. The chances and dangers at this period of the Session are always so serious that although the Opposition has proved abortive, one naturally feels anxious. It will be a most serious blow to the University should we again be thrown back. Indeed it would greatly imperil our future. I know that there will be a second slaughter of the innocents before many days are over, and I venture to appeal to you as the author of the measure to see that the University of London Bill is not one of these last children.

I am, my dear Duke,

Yours very truly,

HENRY E. ROSCOE.

With regard to the important question of the improvement of medical education in the metropolis, efforts had been made, and by none more strenuously than by Professor Huxley, to concentrate and improve the teaching of the preliminary scientific subjects. It was recognised that if medical education in London is to hold its own as against the new and flourishing schools of medicine in the North of

England and the older ones in Scotland, the medical teaching of science up to, but not including clinical and hospital training at, the various medical schools attached to the London hospitals must be brought to a focus for the first three *anni medici*, so that the scientific subjects may be taught more effectively than is possible under the present conditions. In this connection I may quote a letter which I wrote to Mr. Balfour :—

July 17th, 1898.

DEAR MR. BALFOUR,

May I express the keen satisfaction I felt on reading the report of your excellent speech at Guy's Hospital on Research in Medicine? Your remarks are exceedingly well-timed and will be of great service to the cause of medical progress, in which I, for one, am deeply interested. Lord Lister and I are doing what in us lies to help the good cause in establishing the "Jenner Institute of Preventive Medicine," which bids fair to do excellent work in medical research. Another matter about which much interest is felt in medical and scientific circles is the University of London Bill now just emerging from Grand Committee. In my opinion no measure of equal importance for the furtherance of medical research has ever been brought forward, and I most fervently hope that your great interest in this matter may ensure the Bill passing into law this Session. It would be a blow from which the University might never recover should the Bill, after all our efforts, fail to pass. The Opposition, though peristent, is feeble and represents neither scientific nor medical nor University opinion, which is unanimously and strongly in favour of the measure, as being the first and the necessary step towards raising the character of the highest Education in the Metropolis.

I am, Yours most truly,

HENRY E. ROSCOE.

In connection with this proposal for the reorganisation of medical education in London, it is clear that whilst the preliminary and intermediate courses of study may properly be carried on at institutes

unconnected with hospitals, there are others in which hospital attendance is necessary. Among these are not only the usual clinical instruction in medical and surgical wards, but also such subjects as Pathological Anatomy. This view I had occasion to enforce when in July, 1901, I opened the new Pathological Institute of the London Hospital, now a school of the University, a department certainly equalled by few, either at home or abroad. The pathological anatomist, unlike the chemist, the physicist, or even the physiologist and the pure anatomist, stands in the closest possible relation to hospital practice. It is to the hospital that he has to look for his material of study, and it is upon his dictum as to the cause of death, and therefore as to the treatment or possible cure of the disease, that the physician or surgeon has often to rely, so that again the necessity for the close connection of the hospital with this particular department of medical study becomes apparent. There will therefore still be need for laboratories and practical teaching in the London schools of medicine in direct contact with the hospital itself, even if the subjects of the earlier years' study be removed to central institutes.

I have said that the period of my Vice-Chancellorship was one of some difficulty; this arose partly from the change of the Constitution and the appointment of an entirely new Governing Body, and a complete alteration in the *personnel* of the University officials, and partly to the fact that new buildings had to be found for carrying on the business of the enlarged University—those which we had hitherto inhabited in Burlington Gardens being altogether insufficient for the purpose. The Government then came forward with a new offer, that a portion of the buildings of the

Imperial Institute, which as a whole had become Government property, should be handed over to the University, Objections to this proposal were raised on many sides, firstly, on the grounds of inconvenience and distance, and secondly, of holding a building in common with the Imperial Institute. On the other hand, the advantages appeared to me to predominate. In the first place the University had no funds wherewith to build. If the Government offer were refused the only course would be to continue in Burlington Gardens, an entirely impossible contingency. Again, if the University was to succeed in becoming a great teaching institution for London, the facts of the existence in South Kensington of the Royal College of Science and Art, of the Central College of the Guilds of London Institute, and of the Victoria and Albert and British Museums, and moreover the fact that a considerable amount of spare land existed as property of the Royal Commission of 1851, which under their statutes must be employed for encouraging the progress of science and art, might be devoted to University purposes, were very important arguments in favour of the proposition.

After long discussions in the Senate, and after many consultations and conferences with the Treasury and the Board of Works, an agreement was at last arrived at by which the east wing and central portion of the building was handed over to the University. His present Majesty, then Prince of Wales, took a lively interest in the proceedings and in all the negotiations which passed, showing his appreciation of our aims and difficulties; of this I had personal experience.

Another and not the least of the difficulties which arose was the question of the appointment of a chief officer who, under the Senate, should direct the affairs

of the University. I saw that the appointment of the right man for the post was a vital matter to the University at such an epoch; and I was convinced that no one in the country could be found more fully qualified to take over the onerous and difficult duties of such an office than my friend, Professor Rücker, who had distinguished himself not only as a scientific man and teacher, but as a man of energy, a cultured gentleman, and a man of affairs. I therefore induced him, with some difficulty, to become a candidate, and most earnestly and warmly advocated his claims before the Senate and its Committees. Other proposals were made, and I only gained my cause after long and serious opposition. The result of Sir Arthur Rücker's appointment has more than justified my efforts and has gained the appreciation of all interested in the University—in fact I consider that my success in obtaining his appointment as Principal was the best day's work I ever did for the University. I desire also to express my appreciation of the services rendered to the University during my Vice-Chancellorship, especially by three officers, namely, Mr. Milman, the former Registrar, Mr. Victor Dickins, C.B., who succeeded him, and Dr. Frank Heath, now of the Board of Education, and generally by all the members of the University staff.

It had long been the custom of the University on Presentation Day for the Chancellor or, in his absence, the Vice-Chancellor, to recount the progress made by the University in the past year. On several occasions this fell to my lot, and in May, 1896, I spoke to the following effect.

The work of the University of London had, during the past year, been more successful and more useful than ever before. The actual number of new graduates was larger, and the distinctions won by them no less

numerous than formerly. We were all proud of our University. It had grown from small beginnings to its present position, and now Convocation numbered over 4,000 graduates. It had taken the lead in granting degrees to women ; and with what conspicuous success all acknowledged. It was the first British University to institute degrees in science, and fought the battle of the recognition of the educational value of scientific training at a time when classics and mathematics in their most abstract forms were, like motley, the only wear. It had encouraged the study of modern languages by incorporating them in the syllabus for the Arts courses. In medicine and surgery our degrees stand second to none all the world over, and our graduates in this faculty, as also in that of science, occupy the highest position in both professions. Our success was mainly due to the examiners, and in a no less important degree to the wisdom and expert knowledge of the members of the Senate upon whom the selection of these examiners devolved. Hence our very existence depends upon our not only retaining the high standard of excellence which had hitherto marked our degrees, but upon taking care that the standard shall be still further modified and improved to keep pace with modern knowledge and modern requirements. The time had arrived when the University for its own sake, as well as for the advancement of learning in the metropolis, ought to take upon itself new duties and responsibilities. The work we had done and were doing was great and important, and must be continued. I would not curtail the functions of the University. The free admission to its examination halls of every competent citizen of the Empire was a *sine quâ non.* But holding these views I could not hide from myself the necessity of organising the higher education of

London. To co-ordinate the forces in this direction which made for progress, and for this purpose to place the several colleges and institutions, which now worked separately, under the same headship, was the problem to be solved. This was the idea which lay at the basis of Lord Cowper's Commission. The Lord President of the Council writes to me expressing the hope that those recommendations would be carried out; why should not the University do for London what the Sorbonne did for Paris? To bind hitherto unconnected efforts into an organised whole, and to place our University as the crowning point of this system, was surely both to dignify it and to increase its sphere of usefulness. We could surely satisfy the necessities of both internal and external students, and the much debated question as to whether two different sets of examinations were to be established, or whether all comers were to be treated alike, were problems which admitted of more than one successful solution.

From another point of view reforms would benefit the University. We were a Government department, but, unlike our continental compeers, we possessed none of the advantages of State support, whilst lacking the independence and self-control of the other British Universities. This wholly anomalous condition should, and indeed must, cease to exist when the proposed reforms were carried out. But we had not yet succeeded in even inducing Government to give effect to the frequent promises to supply urgent needs in the way of laboratories for carrying on the increasing demands of practical scientific examinations. We had good grounds, however, for believing that provision would before long be made for the erection of suitable buildings on the South Kensington site.

To speak the truth, our present condition as regards

the State was a source rather of weakness than of strength; all our fees were paid into the Exchequer, and the money which we thus earn practically sufficed to pay all our expenses. We had no Government grant whilst the four Universities of Scotland, supplying a population less than that of the metropolis, obtained £70,000 a year from State sources, and gallant little Wales had not been forgotten. From another point of view the University was at a disadvantage—we could not ask for benefactions from liberal donors. In the North of England as well as in Scotland and in Wales many hundreds of thousands of pounds, nay, even millions, had been subscribed to found and support flourishing colleges and universities. Why should not we in London command similar recognition? Because we were still merely a Government department. As soon as we were constituted a University in which teaching was united with examination, a University independent and governed from within itself, then we could hope that the aid which had so wisely been bestowed by private generosity on the old as well as on the new northern seats of learning would be given to us. London, the largest, the richest, the foremost city of the world, would not long consent to occupy an inferior position to her northern sisters as regards that most necessary defence of the nation, the adequate provision for the highest possible education of her sons and daughters.

On February 5th, 1897, when the Prince of Wales (the present King) distributed the prizes to the County Council scholars in the Queen's Hall, I put forward the case of the University of London towards the mass of Londoners, and stated that it was the strong desire of the Senate to see University education, learning, and research spread more widely amongst

the people of the metropolis. The degrees of the University are open to all comers, and are awarded to competent men and women without distinction or question of school or class. It is therefore a University for the people. Our highest honours are given alike to rich and to poor, and over and over again it is the poor man who carries them off against all competitors. This freedom of examination we desire to extend to teaching—for after all it is on teaching and training that progress depends.

All must rejoice to know that the Technical Committee of the London County Council take a proper view of their duties and responsibilities with regard to the highest forms of scientific instruction, not merely for its immediate application to industry, but as an essential part of our educational system.

On His Majesty's accession to the throne I had the honour, in the absence of our Chancellor, Lord Kimberley, owing to illness, of introducing a deputation from the Senate on January 23rd, 1901, to present a dutiful address from the Chancellor, Vice-Chancellor, Members of Senate, and Graduates of the University.

In his reply the King referred to the University as follows :—

"The progress of your University, from its commencement almost at the date of Her late Majesty's accession to its recent re-organisation as a teaching as well as an examining body, has been one of the most remarkable developments witnessed in a reign memorable for the spread of higher instruction among both sexes and all classes and races in my Empire.

You may feel assured of my hearty sympathy and good wishes and co-operation in the furtherance of your good work."

On May 15th, 1901, I again spoke on the presentation of degrees.

It had been the lot of our Chancellor or Vice-Chancellor for many years past to speak with hope deferred of a great teaching University in and for the metropolis. Athough the reconstitution and re-organisation had not been completed, it is chiefly the teachers, the schools, and even the Senate of the University, who will be to blame if a great centre of learning and research does not grow up in London.

And although the old work of the University will be continued in the future as it has been in the past, it is clear that if we are to meet successfully the constant changes of thought and manner of life to which a highly organised society is increasingly liable, the University must not be content with acting as an examining body, or with giving instruction or testing attainment, however high, but must make real contribution to knowledge, for this, in some form or other, is a guarantee of the stability of that society. Unless the University of London is known as a centre from which almost daily additions to our understanding of the world of thought and matter emanate, it will not have justified its existence.

If this be our policy, the University will in course of years become an Imperial University in an altogether new and fuller sense, and the reputation that it will win for itself in the world of thought will bring it those more solid rewards without the aid of which its successful working will be seriously endangered.

In February, 1902, I offered to present the University with a Mace for use on ceremonial occasions, the design for which I had had specially prepared. This proposal was accepted by the Senate, and it was resolved that the Mace be borne by a Graduate on ceremonial occasions before the Chancellor or Vice-Chancellor, and that it lie on the table during the

meetings of the Senate when either of the above officers are present. The design, as well as the workmanship, was carried out by Messrs. Omar Ramsden and Alwyn Carr much to the satisfaction of the Senate.

The important subject of the extension of University teaching in London has been warmly taken up by the University. It placed the whole subject under a special department in charge of Dr. R. D. Roberts, and absorbed the work which had hitherto been carried on by the London Society. On supporting the motion for this undertaking, I spoke of the important work which lay before the University in the spread of the taste for literature and science among the people of London.

Almost every day gives further proof of the determination of the University to be a centre of learning, teaching, and research, worthy of the metropolis of the Empire. The incorporation of University College, which for many generations has worthily upheld the flag of liberal educational progress in the metropolis, as an integral part of the University is now an accomplished fact, thanks, among others, to the generous co-operation of the Worshipful Company of Drapers, which I had in the first instance the satisfaction of suggesting.

As a proof of the interest which the great City Companies are taking in the higher education of London, and which daily becomes more evident, I need only mention the gift of the Goldsmiths' Company, of the Library of Economics by Professor Foxwell to the University, and, what is of still greater importance, the handing over of their great Institute at New Cross to the same Body.

Even of greater importance, looking to the future,

is the publication of a letter dated June 27th, 1903, from Lord Rosebery to Lord Monkswell, the Chairman of the London County Council. This contains a proposal to found, in connection with the University of London, an Imperial Technical College, after the model of the great institution at Charlottenburg, near Berlin.

An influential Committee, under the chairmanship at first of Sir Francis Mowatt and afterwards of Mr. Haldane, has (1906) issued a valuable report as to how the above proposal can best be carried out. For this purpose a new Governing Body is to be created upon whom the duty of carrying out the scheme will devolve. The Government will hand over to this Body the Royal College of Science and the new Chemical and Physical laboratories recently erected in South Kensington with a yearly grant of £20,000. The City and Guilds Institute in Exhibition Road will also become a part of the New Institution, and the County Council will, it is believed, give a subsidy of £20,000 per annum, whilst Messrs. Wernher, Beit & Co. have placed a sum of £100,000 at the disposal of the Governing Body for building purposes. The new Body will work in accord with the Senate of the University, and will in due course, it is to be hoped, be amalgamated with the University.

Other proposals of importance are now being brought forward with the view of increasing the usefulness of the University and of making it worthy of the metropolis of the Empire.

Lord Rosebery's letter inaugurated an entirely new policy on the part of English statesmen and is the crowning point of a long series of endeavours first made by the late Lord Playfair and afterwards by the Royal Commission on Technical Education (1882-84),

to which reference has already been made in these pages. These were followed by appeals throughout the country with the object of securing for England scientific and technical institutions similar to those on the Continent and in the United States which have proved so effective in promoting the national industries in those countries.

In looking back upon the rise and progress of technical education in England and in Germany, the difference in method adopted in the two countries strikes one at once. When, now more than half a century ago, Germany awoke to the necessity of establishing a higher education on modern lines, suitable for the growing industrial needs of the country and differing from that in science and literature given in the University, it was decided to erect, side by side with the institutions devoted to the older form of education, new ones in which modern methods were to be practised. Thus came about the foundation of the German Polytechnic schools, or as they have now been named, "Technische Hochschulen," that is "Technical Universities." The reasons which induced the German Governments [for Universities (Hochschulen) were always Government institutions] to set up new and distinct institutions seemingly in opposition to the old University system, apparently arose from the conservative character of these latter. The German University Professor looked with a feeling almost akin to contempt on these professorships of engineering, applied chemistry and applied mathematics. He considered these subjects as "Brotstudien" and denied to them the right of University representation. And yet these particularist ideas seemed to come with a bad grace from institutions to which the chemists and druggists (Pharmaceuten) were admitted. Surely if it were not

beneath the Universities to teach the apothecaries it could not be degrading to establish a faculty of engineering.

We in England have taken a different course, and instead of creating a duplicate system, have added on to the usual University faculties of arts, science, law, medicine and theology those demanded by modern requirements, such as engineering in all its branches mining and metallurgy, applied chemistry, applied physics, including the numerous developments of electricity and optics, dyeing and textile working, and even a faculty of brewing. The plan which we have adopted appears to me to be preferable to that of the Germans, for thus our newer universities and university colleges have not only the advantage of representing the older studies, but the still greater one of placing on the level of academic culture subjects which hitherto have failed to receive such treatment, although their importance and their capability cannot be denied.

But whilst the British universities have wisely included these practical subjects within their walls, it was clear that much more must be done to meet the demand of technical education throughout the mass of the population. Hence came the establishment of the English polytechnics and municipal technical schools, which serve the important purpose of educating the craftsman and the foreman, and act as stepping-stones to the higher and more complete education given in the modern university.

As a fitting close to the foregoing pages, I may now shortly refer to one of the most interesting events of my life—the celebration of the Jubilee of my Heidelberg degree, taken on March 25th, 1854. In the early spring of 1904 I learnt from my friend Dr. Thorpe

that some proposals were on foot for a presentation to myself, at which my presence would be necessary. This afterwards resolved itself into a delightful gathering of a large number of former pupils, my colleagues and friends, in the Whitworth Hall of the Manchester University on April 22nd, 1904. The function consisted of the presentation of a large number of addresses and congratulatory letters and telegrams from universities, university colleges, scientific societies, and friends from all the world over. The kind and far too appreciative expressions which these various documents contained were almost overwhelming. The moving spirit in the whole business was my friend Thorpe, aided by a committee consisting of Drs. Bailey and Harden, together with others of my former students.

The Hall was filled with pupils and friends from all parts, and on the platform were ranged representatives of the universities and scientific societies who personally presented their addresses.

My feelings on entering the Hall may be more easily imagined than described. My thoughts ran rapidly through the thirty years which I had spent in Manchester. I saw the small beginnings of Owens College in the house in Quay Street, and the gradual increase through years and years until it culminated in the magnificent buildings of the University of Manchester in which I stood. I recalled the faces of my old students and of my valued colleagues, many present before me and some who had taken the long journey. I thought of the scientific and educational work which we had together accomplished, and of the many happy hours which I had spent in the old laboratory and lecture-room, and in the new ones which I had designed. I remembered, with

thankfulness, my happy domestic life clouded over only by one dark shadow. I looked back with regret at the severance of the ties of interest and affection which bound me to Manchester and Owens, and I felt, for a moment, doubt as to whether it might not have been better for me to have stayed till my life's end where I had so long lived and worked.

The following is a copy of the printed order of proceedings :—

SIR HENRY ROSCOE'S GRADUATION JUBILEE.

Friday, April 22nd, 1904.

ORDER OF PROCEEDINGS.

Dr. J. Kendrick Pyne will give a short Introductory Recital on the Organ, to be followed at 7.50 by the presentation of Addresses, etc., as detailed below.

Light refreshments will be served only till 7.50, and at the close of the presentation ceremony.

	Presented by
University of Heidelberg . .	Dr. Thorpe, C.B., F.R.S.

After the presentation of the Diploma and Address from the University of Heidelberg, *Alt Heidelberg du feine* will be played on the organ.

University College, London .	Sir W. Ramsay, K.C.B., F.R.S.
The Victoria University of Manchester	The Vice-Chancellor.
The Old Students	Dr. Thorpe, C.B., F.R.S.

All old students present are requested to stand whilst this Address is being presented and replied to.

University of London	Sir Michael Foster, K.C.B., &c., and P. J. Hartog, B.Sc.
Cambridge (with letters from Prof. Liveing and Dr. Ward)	Professor Schuster, F.R.S.
The Scottish Universities . .	Prof. W. Jack, LL.D.
University of Wales	Vice-Chancellor Griffiths.
University of Liverpool . . .	The Vice-Chancellor.

	Presented by
University of Birmingham	Profs. Frankland, F.R.S., and J. H. Poynting, F.R.S.
University of Melbourne	Pres. Professorial Board, Baldwin Spencer.
University of New Zealand	Dr. Thorpe, C.B., F.R.S.
University of Montreal	
University of Tokyo	Professor Yamagawa.
King's College, London	Dr. Thorpe, C.B., F.R.S.
Yorkshire College	Prof. Smithells, F.R.S.
University Coll., Sheffield	Prof. Williams, B.Sc.
Coll. of Phys. Sci., Newcastle	Prof. Bedson, D.Sc.
University Coll., Dundee	Prof. Frankland, LL.D., F.R.S.
Royal Society	Prof. Dixon, F.R.S.
Lit. and Phil. Soc., Manchester	President and F. Jones, Esq., M.Sc.
Brit. Assoc. for the Advancement of Science	Maj. MacMahon, F.R.S., *Hon. Sec.*
Chemical Society	Sir Wm. Ramsay, K.C.B., F.R.S.
Society of Chem. Industry	President (Sir Wm. Ramsay).
Deut. Chem. Gesell.	Sir Wm. Ramsay, K.C.B., F.R.S.
Bunsen Gesellschaft	Prof. Ostwald (Leipzig).
Physikal. Verein Frankfurt	
Kön. Gesell. Göttingen	
Chem. Society of Rome	Dr. Harden, M.Sc.
The Dutch Chemists	
Lister Institute	Sir Michael Foster, K.C.B., F.R.S., M.P.
Institut Pasteur	
American Academy	Dr. Bailey.
American Phil. Society	
American Chemical Society	
Owens College Chem. Soc.	Prof. H. B. Dixon, F.R.S.
Heidelberger Studentenschaft	Jacob Schereschewsky.
Tokyo Chemical Society	Jojai Sakurai.

Congratulatory letters or messages have been received from :

Professor Berthelot (Sec. of the Institut de France).
" Moissan (Paris).
" Mendeleef (St. Petersburg).
" Beilstein (St. Petersburg).
" Cannizzaro (Rome).

Professor Helbig (Rome).
„ Von Baeyer (Munich).
„ Brühl (Heidelberg).
„ Königsberger (Heidelberg).
„ Landolt (Berlin).
Professors Curtius and Quincke (Heidelberg).
Professor Noelting (Mulhouse).
„ Lepsius (Darmstadt).
„ Lunge (Zurich).
Dr. Böttinger (Bunsen Gesellschaft).
Professor Cleve (Upsala).
Professors Arrhenius, Bjerknes, Ekholm, Carleson, Pettersson, Ekstrand (Stockholm).
Professor Löven (Lund).
„ Brauner (Prague).
„ Skraup (Graz).
„ Ciamician (Bologna).
Professors Nasini, Anderlini, Pellini, Levi, Bringhenti. (Padua).
„ Theodore Richards (Harvard).
„ Loring Jackson (Boston, U.S.A.).
„ G. F. Barker (Philadelphia).
„ Pedler (Calcutta).
„ Sydney Young (Trinity Coll., Dublin).
„ Armstrong (London).
Dr. Russell (London).
Rev. Dr. Edmond Warre (Head-Master of Eton).
Sir J. W. Swan (Faraday Society).
Chemisches Institut (Univ. of Leipzig).
Professor Liversedge (Sydney).
„ A. W. Smith (Ballarat).
Dr. Ludwig Mond (Rome).
Sir William Mather (London).
Lord Lister (London).
Mr. Günther (Chairman of Liebig Extract Meat Co. London).
Dr. Bentz (Dinting).
Dr. David Basil Hewitt (Northwich).

An abstract of the more interesting addresses will be found in Appendix II. (p. 405).

CHAPTER XV

HOME LIFE AND TRAVELS

In concluding my story I may now say a few words about my home life in Manchester and London. When I first settled in Manchester I occupied the house in which my predecessor, Professor Frankland, had resided, and here I lived happily with my mother, who was always "on hospitable thoughts intent," until my marriage in 1863. For the four previous years I passed my vacations at work in Heidelberg, but I found time to visit my sister and her husband, who generally spent their summer at the English Lakes.

In the autumn of 1861, having acted as one of the local secretaries of the British Association in Manchester, and tired out by the worry coming so soon after my sessional work, I was glad to accept the invitation of Mr. and Mrs. Edmund Potter to visit them at their house, Kinnaird, in Perthshire. I had already made the acquaintance of this family, who lived at Dinting Lodge, near Manchester, at the large calico-print works of which Mr. Potter, who had been elected a Fellow of the Royal Society as a representative of scientific industry, was the proprietor. My special interest lay with their youngest daughter, to whom in process of time, I am thankful to say, I became engaged, and on the 4th of July, 1863, we were

Emery J. Walker Ph. Sc.

"The Fisherman"

married by our friend, the Reverend Charles Beard of Liverpool. We passed a happy honeymoon on the Continent. I introduced my wife to my Heidelberg friends and to Bunsen, who gave us a true German welcome and one of those endless suppers which are so characteristic of the "Vaterland."

On returning from abroad, we went up to the North of Scotland to visit my wife's family at a shooting near Alness in Easter Ross. There we amused ourselves, among other things, by photography, at which my wife was a great adept, working at first with wet plates and afterwards preparing her own dry ones; for in those days the art and practice of photography had not arrived at the point at which "you touch the button and we do the rest."

Some years ago my wife obtained a gold medal and two silver ones from the Photographic Society for her photographs. One of these was a fisherman, of which I reproduce a copy. The other day (1905) my friend Professor Chandler of Columbia College told me that on a former visit to this country he inquired from the Stereoscopic Company for the best photograph by an English amateur, for insertion in an American journal, and they at once handed him a copy of the fisherman.

There are few things more enjoyable than a fine autumn at a hospitable Scottish house, and the pleasant time we spent at Invereshie always remains in my mind. The house was situated at the foot of the Cairn-Gorm Hills, clothed on the lower flanks with magnificent pine-woods. There it was that Landseer drew some of his best-known pictures of Highland life, and in one of the lodges in the forest I remember the rough walls were covered with charcoal drawings of stags and hounds by his master-hand. Then on the higher peaks, amidst the snow which still

lay in the ravines, we found the white grouse or ptarmigan, and many of these fell to the guns of my brothers-in-law. But too soon the time for work arrived, and we returned to Manchester to a house which we had taken in Victoria Park, and in which we passed many happy years.

Though I was much occupied with my professional work, we were able to enjoy plenty of social intercourse with many friends whom I had known, and with a greater number who were friends of my wife. In those days among the most common entertainments were long and heavy dinners, but these social joys were lightened by Hallé's concerts and by the charming balls, both private and public, to which we went.

Our son Edmund was born in 1864. His death at Magdalen is referred to on p. 370. Our elder daughter, Margaret, now married to Mr. Charles Mallet, M.P., followed in 1866, and our younger, Dora, still the joy of our home, appeared in 1870. By this time we found our house uncomfortably small, and through the generosity of my father-in-law we were enabled to buy a piece of land in Victoria Park, and on it built a very charming and comfortable house. It is said that "fools build houses for wise men to live in," but in this case the proverb did not prove true, for we lived there for about fifteen years, and then sold it for what it had cost.

We had a good lawn attached to the house, and there, in the summer, we had many pleasant gatherings: sports for the children and their friends, and lawn-tennis every Saturday afternoon for my colleagues, who much appreciated these social meetings. I also saw a good deal of my students, who came to house-parties in the winter and to garden-parties in the summer.

At that time we kept a capital pair of cobs, to wit, Pippin and Phœbe, who were certainly important members of the household, and with them in front of a light phaeton we had many charming driving tours over the Welsh hills, across the North Yorkshire moors, down the valley of the Wye, and elsewhere through some of the most picturesque parts of the country. No mode, in my opinion, of seeing the country and enjoying the air is more charming than this.

We spent the autumn of 1866 at a house in Northumberland called Roddam. And that place is memorable to me because, on working out my analytical results concerning the vanadium compounds, I found out the cause, already alluded to, of the discrepancy between the numbers I obtained and those which had been previously found by Berzelius.

Among the undoubted advantages of a professorial life is the Long Vacation. This, in my case, was spent during many pleasant summers at the English Lakes, and I still remember the joy of the first breath of pure mountain air after the smoke of Manchester and the smells of the laboratory, which, though dear to the nose of the chemist, are not altogether hygienic. As the children grew older we enjoyed ourselves at the Lakes with riding and driving about the country, with bathing and boating on Ullswater and Windermere, and generally appreciating that beautiful country, which, when the weather is fine, surpasses most places on earth, but whose climate is unfortunately marred by the very heavy rainfall. It is not generally known that there is a spot situated in the hollow of the mountains between Stye Head Pass and Wastwater in which the rainfall is absolutely tropical, amounting to an average of 190 inches per annum. When rain-

gauges were first placed in this locality by Mr. Symons, and the annual return was found to be so enormous, it was believed that the gauges had been tampered with, and four others were fixed in the same neighbourhood, all of which, however, registered a similar amount, placing the fact of this abnormal rainfall beyond doubt.

Another pleasure of a country life is the entertainment of friends, and this we accomplished to our own satisfaction and, I hope, also to that of our guests.

It was at Grasmere that a singular incident occurred to me. My wife and I were both fond of riding, and she was a first-rate horsewoman. I rode an old-fashioned cob, and my wife a blood-mare that we had lately purchased from a well-known gentleman breeder in Yorkshire. The mare was a lovely creature, with a character for good behaviour which turned out to be false. The first day her manners were admirable, but the next day she refused to pass a coach and then bolted, though in the stall she had been perfectly quiet. One morning, as was our habit, we visited the horses, and my wife went up to the mare's head, unfortunately, on the wrong side, and I followed. The animal began to kick and caught me with her hind leg as I was coming up, giving me a tremendous blow on the side with the hock and then afterwards plunging most violently. I thought I was killed, and, rushing away, rolled on the grass in agony. My wife, instead of flying to my help, as nine women out of ten would have done, had the presence of mind to remain for a few minutes at the mare's head, seizing her under-lip, until the coachman clambered over the partition and backed the mare out. If she had acted upon impulse she would inevitably have been kicked to death. What a grand thing it is to have presence of mind!

I have always held that the lot of a professor is a very happy one. If he is worth his salt, his love for his subject is a constant and abiding pleasure. It is, or ought to be, a delight to him to teach the young idea how to shoot, and especially to hit the mark of original investigation. I, certainly, fully enjoyed my work. For thirty years I left my house at half-past eight, or even before, summer and winter, and having looked over my lecture table to see that all my experiments were arranged there, I began my lecture every morning in the week, except Saturday, at nine or half-past. Then came the superintendence of the laboratory students and all that it entails, together with the College and University business, committees without number, examinations galore, interviews with inquiring parents, chemical works to be visited, lectures outside the College, in London and elsewhere, to say nothing of one's own literary and research work. The day was never long enough for all that I had to do. I usually got my lunch with my colleagues at the College refectory, seldom had time to come home, but sometimes met some choice spirits at a little luncheon club in Manchester which we founded, called Prince's. On Mondays I not only had a full day's work, but also evening classes. On those evenings I always walked home from the College in Quay Street, often through rain and storm, with my old friend the Reverend William Gaskell, the husband of the great novelist, himself a remarkable and charming character. He lectured to our evening students on English literature, of which his knowledge was profound. He was an excellent conversationalist, sparkling with wit and humour, whilst his knowledge of Lancashire folk-lore was unsurpassed.

Among his stories I remember the following. A

Todmorden man with long legs was riding a kicking pony, and, losing his stirrups, the pony's hind foot got caught in the stirrup iron. "Nay," said the man, "an' thou be cooming oop o' thot soide, I mun get down at t'uther."

Here is another one: John o' Tom's at Chow Bent lay dying. To him comes Betty, the widow of his neighbour, to say a few last words. "Well, John, and so thou'rt deein'?" "Ay, Betty, Oi'm deein'." "Well, when thou gets oop theer, mebbe thou'lt see our Tummas; thou mun tell him we's gettin' along pretty well. T'ould tit's dead and we's 'ad t'shandry mended." Poor old John raised himself on his pillow and in a peevish voice replied, "And doost thou think as Oi sall 'ave nowt better to do when Oi get oop yonder, nor goin' cloompin' about seekin' after thoi Tummas?"

The Gaskells' house in Plymouth Grove was unlike any other home in Manchester, for there, during Mrs. Gaskell's lifetime, one had the chance of meeting the literary celebrities of the time and many other interesting wayfarers, and after her lamented death—I was present at her burial in the old Knutsford chapel-yard, so familiar to the readers of *Cranford*—the house kept up its peculiar interest through the attraction of the daughters, who have always been dear friends of ours.

From 1868 to 1885 my father-in-law's houses in London at Prince's Gardens and Queen's Gate, and his country house of Camfield Place in Hertfordshire, became our southern homes, and many are the pleasant associations which these names recall. Not merely or chiefly was this owing to meeting there such men as Cobden and Bright, or Louis Mallet and Henry Fawcett, who were constant visitors, but from the charm of

the host and hostess, which in my memory I have never seen equalled.

The years 1884 and 1885 were big with fate for all of us. In the first place came our trip to Canada and the States to which I have already referred. Of course I visited Harvard University, and made friends with its distinguished President, Eliot, whom I had already met in England, and also saw the Boston Technical Institute and Yale University, where I renewed my friendship with Brush. Since that date I regret I have not again visited the States, although I had an invitation to be present at a Jubilee at Yale when they offered me an honorary degree; I should have much liked to see the evidence, borne in upon all sides, as to the enormous progress made in educational matters of all kinds in America during the last twenty years.

Our dear son Edmund was also keenly interested in all he saw and learnt, and whilst my wife and I remained in the East he, with our friend, Sir Swire Smith, made a long excursion to the West as far as Winnipeg, and contributed some really striking articles descriptive of his tour to the *Manchester Examiner*. He possessed in high degree the literary faculty of the family, but he had no special scientific tastes; in fact I am the "sport" of the family, the only other one of my Roscoe relatives who exhibited scientific ability being my cousin, the late Stanley Jevons, for whom in his early years in Manchester my mother made a home.

Returning homeward, we waited for more than a week in New York, where the temperature was from 95 to 100 degrees, and all of us, especially our son, suffered considerably in consequence, but the fresh air of the Atlantic seemed to drive all evil effects away. Edmund then returned to Magdalen, Oxford, where he had already spent a year, and I had the pleasure of

visiting him there, and of witnessing the great influence he exercised over his fellow-undergraduates. Before Christmas, however, he fell ill, and for five or six weeks lay struck down with a most painful and what proved to be a fatal malady.

He died early on the second morning of the New Year, and sleeps now in the beautiful little Holywell cemetery, within sight—as his friends here will always like to think—within sight of his own college tower, under the shadow of its walls, within sound of its bells.

So ends, prematurely, a career which seems yet in a sense not without a completeness of its own. Twenty years of life, one year—one little year, scarcely more—of Oxford, offer but scant opportunities to do anything for fame or name, to accomplish anything great in art or affairs. What beginnings could be made of these, he made. But for the life of self-education, of duty, of friendship, of affection, there is much time even in this short space, and whatever there was he used most fully.

Of early promise, of powers just beginning to open out, just between bud and blossom, it is easy to form too high an opinion. It is perhaps impossible to judge of them exactly. But goodness, sweetness, modesty, enthusiasm, loyalty, eagerness, frank generosity—these are the peculiar virtues of youth, and seem never more themselves than when, as in Edmund Roscoe, they have never lost their early bloom.

These words were written by his dear friend Herbert Warren, President of Magdalen, and I quote the closing lines :—

Those who were ambitious for him may feel moved to echo the words of an old and forgotten writer, on the tomb of an inheritor of an illustrious name :—

> Mors perfecit tua ut essent omnia brevia
> Honos fama virtusque gloria atque ingenium
> Quibus sei in longa licuiset tibi utier vita
> Facile facteis superases gloriam maiorum."

But more of us, perhaps, will say of such a life what is sung by one nearer our own day :—

> Although it fall and die that night
> It was the plant and flower of light.
> In small proportions we just beauties see,
> And in short measures life may perfect be.

This event changed the current of our lives. As has been stated, the offer came to me to stand for Parliament and, mainly for the sake of my wife and daughters, I felt that a fresh life was desirable, and so I became member for South Manchester, and resigning my Professorship, moved to London. I retained, however, my house in Manchester until after the meeting of the British Association in the autumn of 1887, living during the Parliamentary session in the house in Queen's Gate which Mrs. Potter lent us, until I took the house, 10 Bramham Gardens, which has been our pleasant London home ever since.

In the spring of 1885 my mother died at the age of eighty-seven. To those who have lived to a good old age in consonance with Nature's laws, death usually comes as a friendly visitor. Such was my mother's case, and hers was a normal end; up to the last a quiet enjoyment of life's evening, and an equally peaceful passing away.

A part of the winter of several of those years we passed at Grasse on the Riviera; a more charming or a more healthy place it would be difficult to find. Standing a thousand feet above the Mediterranean, the air is crisp and invigorating, and the drives and walks through the mountainous hinterland are most picturesque. We had the advantage there of frequently staying with our friends, the late Mr. and Miss Bowes, who had built for themselves a charming villa.

I passed some time during the summer of 1887 at a very different place, namely, Harrogate, for I suffered from my constitutional weakness—gout—and the sulphuretted hydrogen which exists in very notable quantities in the Harrogate waters is said by the profession to have a beneficial effect on that particular malady. I doubt, however, very much whether, in spite of the

many hundreds of thousands of cases of gout which doctors, through generations, have had to treat, really much is known either as to its cause or as to its cure. In my case it certainly was not brought about by port wine drinking, either by myself or by any of my forbears. Some say its cause is more mental than physical and one is abjured not to worry, which is often easier said than done. There is, however, one consolation to those of gouty tendency : it takes a long time to kill one! And there are many worse ills to which flesh is heir, though it is troublesome and inconvenient, coming, as it does, like a thief in the night and putting a ruthless embargo on one's activity. In my earlier years I fought against it and carried on my lectures and my laboratory work on crutches, but after a while I found I had to lay up during the attacks of the enemy.

In the winter of 1892 we went by sea to Egypt, and experienced the fact that the Mediterranean is the most fickle of seas, especially on our return passage from Alexandria to Brindisi, when we were caught by a savage Levanter, and the lightly laden *Hydaspes* was knocked about like a cork on the waters. One often wonders how the Phœnicians and the Greeks and Romans were able to voyage in their triremes and similar cockleshells in seas subject to these tremendous tempests. It is true that St. Paul was wrecked on the island of Malta, but otherwise the losses by shipwreck in old times do not appear to have been very serious. I suppose they hugged the shore and were thus able to avert disaster.

There is no country in the world, in my opinion, at the present time so interesting to the traveller as Egypt. Not only have we ancient history laid visibly before us to an extent impossible in any other country, for

there in the museum at Boulak we can look upon the face of the man who knew Moses. There lie Seti I. and Rameses II., and when gazing on their mummified faces we can recognise perfectly the characteristic features of the two men.

But apart from the extraordinary interest attaching to ancient Egyptian history, we have in the modern history of that country a study which, in its way, is no less instructive. When visiting, as I did, the Technical College, the Law Courts, the Barrage, the Hospitals, the Lunatic Asylums, the Schools, and observing, moreover, the general order and perfect policing of the country, and then remembering that a change from a practical barbarism to its present civilised state has been effected within the last thirty years by a body of thirty-six Englishmen under the supreme direction of Lord Cromer, a man may well be proud to belong to a nation that can produce such results. Nor is there any place where the contrast between the old Moslem civilisation and that of the present time is more vividly seen than in Cairo. On the one hand you may visit the Mosque El Azhar (the Mahommedan University), where you find the Arab teachers with their students at their feet repeating the Koran by heart, as they have done for seven hundred years, and where you may be spat upon as a cursed interloper, whilst round the corner you may visit the Khedive's Technical School, with its engineering, physical, and chemical departments all at work and the pupils in uniform as you find them in the Ecole Centrale in Paris.

The Nile voyage in Cook's steamers has been so frequently described that it is unnecessary for me to dwell upon it. All I will say is that with such pleasant companions and friends as we met it is the most delightful of tours.

We returned to England, as I have said, *viâ* Alexandria, Brindisi, and Rome, and in the Eternal City I was seized with an attack of my enemy the gout, which kept me in durance vile for some little time. My companions meanwhile visited, as ladies will, a large number of churches. On a later occasion we spent six weeks in Rome, in the spring, having taken charming rooms on the Pincian. Here we enjoyed ourselves greatly, and I made a point of frequently visiting my friend and colleague in science, Cannizzaro, and attended one of his lectures on chemistry, and was struck by his clear method of exposition. I was also present at a meeting of the celebrated Lincei Academy, one of the oldest of existing scientific societies. The recent discoveries in the Forum are certainly of interest, but really, after visiting Egypt and learning that not only the mythical Mena was a reality, but that a still more ancient dynasty than number one has been proved to exist, the antiquity of Rome seems almost like that of yesterday.

But here let me say a word about the vaunted climate of Italy. No one of a gouty temperament who is in search of warmth should venture to winter there. I do not know a country in which you can get so well starved. Spring or even early summer is the time of year to enjoy Italy. All the newly-built houses on the Pincian in Rome, for example, are devoid of flues, and hideous iron chimney pipes are seen coming out of the windows and crawling up the outside of the houses, by which means some very inefficient mode of heating the rooms by wood fires has become possible. No, if you are determined to leave your own warm fireside for foreign parts, and need to secure sunshine outside and a decent temperature inside your dwelling, then you had much better cross the "dark-blue midland sea" and get a lodging on

"Afric's burning strand." This advice we followed in the spring of 1902, when we visited North Africa and Sicily. It is amazing how nearly space is annihilated at the present day; thus, one may leave Charing Cross at 11 o'clock on Friday morning and be in the rainless borders of the Sahara, at Biskra, on Monday afternoon at 4 P.M.

We all of us knew Algiers, having visited on previous occasions my sister-in-law, Mrs. Wrigley, who had spent many winters at El Muski, in Mustapha, in a modern reconstructed Arab house with a garden and a beautiful view which defies description. As is usually the case in the Mediterranean transit, luck was not on our side, and we were knocked about in the *Marechal Bourgerau* (which had nearly been wrecked on her previous voyage) to an extent which rendered a night's rest at Algiers imperative. The line of steamers between France and its great Algerian department is, as all travellers on that route will admit, a disgrace. This is entirely due to monopoly, and it is a marvel that such inefficiency is still allowed to prevail.

The strange mixture of lethargic orientalism with the hurry scurry of Western life was illustrated at a dinner at a first-class restaurant, overlooking the harbour at Algiers. Among those dining there was a refined Arab gentleman, a tall, well-proportioned, handsome figure, with high-caste features, and dressed in an immaculate Arab costume, who with the *suavité* of the East sat among the crowd of mobile Frenchmen enjoying the various dishes of the admirable French cuisine as much as they did.

In contrast to the Arab life, which in the native town is seen to perfection, is the ceremony of the Catholic Church of Notre Dame d'Afrique, a church on the rocky eminence which runs out into the Medi-

terranean. This ceremony consists of praying for the souls of those who are lost at sea, and takes place on the first Sunday of the year. The priests, after holding service within the Church, form a procession, accompanied by acolytes, many of whom are negroes, and walk down the few steps that separate them from the end of the rock. Here a large marble sarcophagus has been constructed, and after covering it with a black pall, the priests recite the prayers for those who died at sea without the comfort of the last offices of their Church.

Determined to see something of the country on the way to Biskra we halted twice, passing the first night at Bueira, and the second at El Gueira. The accommodation at both of these places was exceedingly primitive, but the cooking was excellent. The journey was full of varied interest; in places we saw the spring wheat being sown, and were reminded that in the days of the Romans this huge expanse of country formed the granary of Italy. The husbandry is still of the most primitive character, and now and again one might see the Arab at the plough-handle, his team consisting of his wife and his ass.

The varied character of the scenes and country through which we passed needs no description from me, as it has been painted to the life in the *Garden of Allah* by Robert Hichens. The most striking point in the whole journey is, perhaps, the approach to the desert by the defile of El Kantara, where the contrast between the mountainous, sterile country and the green valley with its almost tropical vegetation is most wonderful. For there the stream from the mountains creates an oasis in the desert in which tens of thousands of date palms flourish, providing sustenance and wealth for the Arab population.

There is a wonderful charm about Biskra. The sharp air of the desert, the cloudless skies and bright sunshine, the luxuriance of the palms, the running waters flowing through the gardens, the outdoor life of the Arabs, free, but under the ever-watchful domination of the French, all tend to give an especial interest to the place.

The Sahara, which surrounds Biskra on all sides, stretching for hundreds of miles to the south and east, is by no means an uninhabited desert, for villages and towns are scattered around wherever the necessary supply of life-giving water is to be had. And streams are not scarce at the foot of the hills, whilst now, where this supply is wanting, the French engineers, by sinking artesian wells, are creating new oases and improving the old ones. They have shown that in many places below the sand and stone of the Sahara an underground supply of the precious liquid can be obtained, and modern science has thus accomplished a miracle rivalling that of Moses striking the rock.

From the descriptions of novelists, and from photographs and pictures on the spot, it might be imagined that the palm gardens were as charming as similar well-known haunts of delight on the Riviera. It is a rude awakening to find that these are anything but pleasure gardens, for round the stem of each of these gigantic palms is a deep pit, into which, from time to time, water from the river is allowed to flow. There are no grassy or mossy lawns, for between the palms the Arab grows his cabbages, maize, and tobacco. The roads in the environs of Biskra are few and bad; there are tracks which may be followed on mule or camel-back, and a few of the better sort can be used for wheeled vehicles. There is no bridge across the river, which sometimes is a roaring flood and at other

times a mere dribble, and to cross this in a carriage is often impossible and generally unpleasant, for the bed is made up of huge boulders over which one jolts. Sometimes, too, as happened in our case, the wretched, jaded beasts refuse to move from the middle of the river in spite of the application of Arab oaths and physical force. To get out of this dilemma the ladies had to be carried pick-a-back by some stalwart Arabs who came to our aid and who compelled the animals to return to the starting point.

The hospitality and good nature of the Arab are proverbial. On one occasion, returning from a drive to Sedi Okbar, where, like Dominie and her Boris, we had visited the most ancient mosque in Africa, we overtook an Arab on a mule with his small son in front of him. As we passed, the girths gave way, and the Arab, his son, and his goods and chattels fell to the ground. We stopped and helped to put him straight again, taking the child into the carriage and feeding him on oranges, conversing meanwhile in French with the father, who was a perfect gentleman. Some days afterwards the ladies met the man in the street in Biskra. He was pleased to see them, and invited them to take coffee with him in the Arab restaurant, visited us in our hotel, but refused all offers of hospitality, and finished by asking the ladies to stay with him in his home in the mountains, where he could offer them sights and scenes which he knew would be of interest to them. He expressed his regret that they found it impossible to accept his invitation.

This kindliness of the desert Arab, who is of a much finer race than the Egyptian, was also shown by the way in which the ladies could go about unmolested through the crowds in the market place. Although the guide-books dissuade ladies from passing through

the street where the dancing girls of the Ouled Nails lived, we constantly did so and never met with the slightest unpleasantness.

The great event during our stay in Biskra was the races and the Arab fantasia. The crowds of gaily-caparisoned Arab horses with their armed and turbaned riders thronged the streets and passed in grand procession to the race-course. Here one of the attractions is the assemblage of the Ouled Nails, who appear in their gayest attire and look, as Hichens says, like a troupe of magnificent macaws perching in the sunshine. The same author adds, by way of contrast, that when he was there, two solemn English ladies seated themselves on the benches in the midst of the dancers, looking like Sunday morning in Peckham Rye much to the amazement of the Ouleds and the amusement of a Frenchman who vowed he would make a sketch of "les Anglaises avec les Ouleds pour la 'Vie Parisienne.'"

After the races came the fantasia of the Mozabites and the Goums. The extraordinary antics of the former consisted in rushing forward, howling and leaping, and at the same time discharging their firearms into the ground. The fantasia of the Goums, on the other hand, was far more picturesque and exciting. Five hundred gaily dressed Arabs on their richly apparelled steeds, drawn up at the end of the course in twos and threes, galloped frantically down the whole length holding their swords in their teeth and brandishing their firearms which, whilst standing high in their stirrups, they discharged amidst cries of victory. The amusements opened with the well-known long distance camel race, and all the world and his wife went out to see them come in after their all-night journey at full speed from Tourggourt, the sacred city of the desert,

more than two hundred kilometres distant. These racing camels are splendid beasts and altogether superior to the poor creatures that bear the burdens of the day and are called the "ships of the desert," which differ as much from the racers as does a tramp steamer from a greyhound of the Atlantic.

On leaving Biskra we visited Constantine, one of the most singularly situated towns on earth, and full of strange recollections of murders and war's alarms. Thence by train to the hot springs at Hammam Meskoutin (which being interpreted means the accursed spring), the temperature of which, according to the guide-books, is 203° F. higher than that of any others except that of the geysers in Iceland and of Las Trincheras in South America. If the height at which the springs stand be taken into consideration, the temperature of the water is just about boiling point. The whole scene is most extraordinary, and a graphic description of it will be found in Murray's Guide.

Then taking up the train again we passed through a mountainous country to Tunis, the train climbing through cork woods to a height of 2,000 feet, where the ground was often sprinkled with snow. Few people have any idea of the beauty of the scenery of this part of Northern Africa, and this is not its only interest, for almost everywhere we meet with the remains of ancient Roman civilisation, much of which is as yet unearthed.

Tunis under French occupation is assuming an altogether new aspect, for whilst the old city remains with its thousands of ancient Carthaginian pillars built into the doorways, and whilst the bazaars are as completely oriental as those of Cairo, a new French town is springing up with all the amenities which that entails. The Bey is the nominal ruler and still holds an auto-

cratic court, the convenience of which amidst the unruly inhabitants the French well appreciate. One great result of French civilisation is shown in the restoration of the precious antiquities with which the whole country teems. A tumbled down palace has been repaired and is now filled with the most beautiful statues, mosaic pavements, and architectural details of temples. Parks are being laid out, good roads made, electric lighting introduced, trams run along the streets, and the Moors and Jews drive a thriving trade. Their quaint costumes (for of all these I have ever seen, those of the fat Jewesses of Tunis bear the palm) stand out in vivid contrast to the modern aspects of the city.

Every visitor to Tunis drives out through fields of flowering asphodels to the site of Carthage, for of ruins there are none to be seen, and yet remains of great interest and value have there been found in opening the tombs by the Franciscan Brothers, who live and work in the monastery built on the spot, sacred to the memory of St. Louis.

From Tunis we took ship to Trepani, in Sicily, and visited the two most remarkable sets of temples, though not the best known, namely those of Segesta and Selinunto. For their description, as well as that of Girgenti, Syracuse and Taormina, the reader may dip into the interesting and amusing recital of the tour of two energetic English ladies, who give accounts of their travels in both well-known and unknown parts of Trinacria.[1]

Among the sights of Naples none interests me more than the Aquarium on the Chiaia, founded by J. Anton Dorn. The beauty of the schools of herring and other small fry in the glass cases of the Aquarium is equalled, and perhaps surpassed, by that of the alcoholic

[1] *Sunny Sicily*, by Mrs. Tweedie.

preparations of delicate sea-animals made in the laboratories upstairs. Only those conversant with such matters can fully realise the extent and value of Dorn's labours in the cause of Oceanic Zoology, suffice it to say that they are acknowledged all the world over. Laymen, like myself, can, however, wonder at the marvellous delicacy and beauty of those dead sea shapes made permanent as in life by Dorn's skilful hands and scientific methods. The last time I was in Naples, Dorn reminded me of a story I had told him on a former visit, which he said he had many times retailed with success. I was on Vesuvius, and there met a Yankee who, as they sometimes do, was boasting about his great country. "Well," I remarked, "when all is said and done, you have nothing like this in America." "No," he replied, "but we have a river that would put the whole darned thing out in five minutes."

In travelling, especially abroad, "somebody's luggage" often contains strange matters, alive and dead, carried about by eccentric tourists both by sea and land. The most singular case of the kind I ever met with was that of a foreign gentleman resident in Manchester who travelled abroad every autumn always in the company of a lightning conductor. On arriving at his quarters for the night, he peered round to see whether the building was protected, and if not, he had his portable conductor erected. In another box he carried a long rope ladder with which he hoped to escape in case of fire!

"It's a far cry to Loch Awe," but Glasgow is only six hours from London, so that the word "travel" can scarcely now be applied to that trip. Still, I must make bold here to include certain interesting visits which I paid to Glasgow, where I was present at the celebration of the jubilee of Lord Kelvin in March,

1896. To descant upon the scientific merits of this great man would here be out of place. Suffice it to say that he has long been, and still remains, the acknowledged and beloved leader of British science. Representatives of science and learning all the world over assembled at Glasgow to do him honour, and I had the satisfaction of representing the University of London. It was a touching sight to see Kelvin, then Vice-Chancellor of Glasgow, and now its Chancellor, "capping" the distinguished foreigners in the hall of the University where he had so long lived and worked and had thus immortalised his name in the annals of British science.

A second jubilee was that of Kelvin's great friend and co-worker, George Gabriel Stokes, not only Newton's successor as Lucasian professor at Cambridge but also as President of the Royal Society and as Member of Parliament for the University. This celebration, which took place on June 1st, 1899, at Cambridge, was no less interesting and remarkable than that of Kelvin. Indeed, these two ceremonies in honour of the great British twin-brethren of science were sights to delight the heart of all lovers of humanity. On this occasion, too, I represented the University of London.

Another celebration, not of the first jubilee but of the ninth jubilee of the University of Glasgow, took place in June, 1901, when the University had reached the respectable age of four and a half centuries. Here too Lord Kelvin was naturally a prominent figure, and appropriately gave an oration on another great Glasgow man, James Watt. On this occasion the University was good enough to confer the degree of Doctor of Laws upon me.

Still another Scottish mission. Everybody has

heard of Andrew Carnegie and of his gift of two millions of money to assist the Scottish Universities. Half of the income of this, namely £50,000, was to be applied to the payment of the class fees of the students of the four Universities, and the other half to the general improvement of the Universities, for endowment, building, and research. A considerable body of trustees was appointed with an executive committee. In June, 1901, I was asked to join this executive committee by Lord Elgin, who had been appointed chairman, from whose letter on that occasion I may quote :—

> You will have seen the announcement of Mr. Carnegie's gift to the Universities, but its objects have not yet been correctly explained. As was arranged, its first purpose will be the expenditure of the annual sum of £50,000 for the benefit of Scientific Education in the Universities. Mr. Carnegie has requested me to act as chairman of the trustees, and, as my first duty, to suggest to him the names of the executive committee of nine members, by whom it is proposed to carry out the administration.
>
> Looking to the nature of the first purpose, as above stated, it is essential that some members of the committee should have knowledge of scientific requirements. We propose to include two members nominated by the University Courts in rotation, but to my mind it is even more important to have the advice of an authority absolutely impartial because not a member of any one of the Universities, and of undisputed pre-eminence. I consulted Lord Kinnear and Lord Balfour, both of whom will, I hope, be members of the committee, and we are of opinion that no one could so completely answer the description I have given of the colleague we desire as yourself. Mr. Carnegie has telegraphed this morning his hearty concurrence.
>
> I feel I need not ask you to give your sympathetic consideration to this proposal, for I know your interest in our Universities, but you may think we are making too heavy a call upon your time.

I had much pleasure in acceding to this request as I had previously taken much interest in the Scottish

Universities, having been a member of the Royal Commission to which I have already referred. The work of the committee is of a serious character, as may be imagined from the well-known impecuniosity of Universities, and the demands which professors make, all in good faith, on any grants to which they may have access. This is illustrated by the fact that on our asking the Universities to state their requirements, it appeared that their immediate demands exceeded the total capital sum at our disposal. By the wise advice of our chairman, we met such demands by a carefully considered financial system, the result of which has been greatly to assist the Universities. It is a question as to whether or not it might have been more to their benefit if the whole sum had been applied in the direction of general assistance rather than in the payment of fees, but on this point Mr. Carnegie's instructions were precise. I was particularly glad to be able to assist in the inauguration of a system of Carnegie Scholarships and Fellowships for the encouragement of original investigation, based to a considerable extent upon that of the Royal Commissioners of 1851; for the warmest admirers of the Scottish Universities, and I am one of these, cannot shut their eyes to the fact that despite short terms and long vacations, the amount of original scientific and literary work which has issued from the Universities has been in no way proportionate to the funds at the disposal of those Universities, including a Government grant of £70,000 a year, or to the amount of free time which the professors and lecturers as well as the students have at their disposal. Hence I considered it was of the highest possible importance to do something to stimulate research, and, if possible, to discourage the

inactivity which had long and injuriously prevailed in certain of these seats of learning. It is satisfactory to know that the sum set apart for these purposes by the Carnegie trustees has been welcomed by the University authorities, and is already producing results.

Home Life in Surrey

Though the delights of travel are great, there comes a time to all when the quiet pleasures of home life are more attractive, and when this day arrives there is, at least to the dwellers in London, no expenditure better laid out than in a second home, however humble, in the country. For the strain, both physical and mental, of a year of life spent continuously in London is to people no longer young often serious.

For several years we were content to take houses in Surrey, where many pleasant autumns were spent. At last, however, we were fortunate enough to obtain a permanent *pied-a-terre*, situated in what I venture to think is the most beautiful and healthy spot in the whole of Surrey, namely, at Woodcote Lodge, the property of Lord Lovelace, placed 650 feet above the level of the sea, on the summit of the North Downs, half way between Guildford and Dorking. A picture of the house and garden is shown in the accompanying reproduction of a photograph by my daughter. The situation is unique: only twenty-six miles from Hyde Park Corner, we are as far from the madding crowd as if we lived at ten times that distance. From our windows we see no houses or sign of habitation; the green woods and fields spread out before us, and we wander "fancy free" over heather and bracken and through woods of larch, oak and beech, down Combe Bottom to Shere, or along the tops, on the right to Newlands

WOODCOTE.

Corner, and on the left to Ranmore, everywhere breathing pure and invigorating highland air.

The luxuriance of the undergrowth is seen by the bracken, of which I have gathered stems seven feet in height. Such luxuriance appears to be unknown in Russia and Germany, for I remember taking my friends Beilstein from St. Petersburg and Quincke from Heidelberg through some of our woodland paths, when the former, pointing to the bracken, said: "Mein Gott, wir sind hier in der Flora der Kohlenformation." The underwood on these hills is cut down every ten years for hurdles and fagotting, and the pungent odour of charcoal burning is often noticed. I know of nothing near London like the miles of untouched natural woodland which stretches on either side of our house. The richness of flower-growth in these woods is surprising. To meet the demand for primroses wherewith to decorate the statue of Benjamin Disraeli, Dame Nature produces in our neighbourhood an inexhaustible supply. But it is only when the underwood is cut during the previous winter that the "simple flower" is seen in its full luxuriance. Why the primrose is rarely found when the undergrowth is still standing, and why it occurs in such profusion after it is cut, is a matter which perhaps the botanists can explain. Among other features of our woods are the splendid specimens of cupressus which, planted many years ago by the late Lord Lovelace, have now reached gigantic proportions.

As soon as the primroses are over, the woods are carpeted a brilliant blue by hyacinths, whilst the fields are full of yellow cowslip. Later on the rhododendrons, which have also been planted in the woods, put forth their glorious flowers, and on Netley Heath, which lies before us, plantations of rhododendrons give to

the landscape a splendid dash of purple, lending a pleasant contrast to the yellow gorse, which, as we all know is, like kissing, never out of season, and later again the foxgloves paint the woods with their dainty bells. But the declining year changes the face of Nature; the heather is in perfect bloom, the bracken has turned to a warm brown, but most lovely of all are the ruddy tints of the beech trees, which in the autumn sun shine like burnished copper.

My wife's great pleasure lies in her garden, and the sunshine repays her for the trouble and thought she expends upon it, for it is noticed by all that the tints of her flowers are deeper and of a brighter hue than is found in the same flowers grown in gardens at a lower level, so that not only to ourselves, but to our friends who participate in its abundance, is the labour returned. In the spring the special beauty of the garden lies in the daffodils; surely nothing can exceed the delicacy and the beauty of the many varieties of this flower. The wild daffodil is also found in our neighbourhood, in a field adjoining West Horsley Place, and some of these go to brighten the lives of the school children in London. Primroses and hyacinths from the woods are also sent, besides cowslips in their season, and when woodland and field flowers come to an end our garden supplies the need. The pleasure that these flowers give to the poor children can well be understood when one remembers the touching story of the city child who describes the country as "the yard in which the gentlemen played."

The pathetic sadness of a garden in autumn, when the glories of the youth and of the maturity of the year have passed away, is fortunately relieved by the blooms of the chrysanthemum, a flower which we owe to our wonderful friends the Japanese. Here the

skill of the horticulturist is perhaps more visible than in any other floral display, as shown by the extraordinary variety of colour, form of petal, and size of bloom in this singular flower of Eastern origin.

The geological character of our soil is peculiar. On most of the chalk downs in our neighbourhood the thickness of the alluvial soil reaches only to a few inches, and below this comes the hard and sterile chalk. But a few acres of ground around our house, as shown on the geological map, consist of a deposit of plastic clay which has escaped denudation. In consequence of this, our soil is a heavy but fruitful one, consisting of a mixture of clay and chalk, and reaching to a considerable depth. We also find on the top of one hill close by sharp sand mixed with clay and known as the Woolwich and Reading beds; on that of a neighbouring one are pockets of water-worn gravel; whilst near by we may dig into thick masses of stiff brick clay, and on the heath we may quarry out enormous quantities of flints, which are collected and carted away to mend the roads in the valleys. All these various deposits lie on the top of the chalk of which the mass of the hill is composed, and which comes out "today" in pits, or is seen in escarpments on the country side.

As there is a great deal that is human in every man, so there is a great deal that is vegetable in every plant. Thus we find that whilst certain varieties of apple trees, and even the more delicate pear, flourish with us, other kinds prove failures, and the one secret of successful gardening is to ascertain the species of plant which takes most kindly to its environment and then to encourage it.

It was with much diffidence that I undertook to play the *rôle* of a farmer. Although it perhaps does not

become me to say so, I had some doubts as to my ability to farm on scientific principles. In the first place my seventy acres, though in a lovely situation, were, on my arrival, from a farmer's point of view, in an almost hopeless condition. The land had been for years practically ruined, and it was the home of little else than thistles and couch-grass, and even when cleaned was anything but "fat" land. Still I determined to try to bring it into order by the application of the common rules of everyday farming.

The provision of pure water for man, beast and plant, on the top of a chalk hill above the supply of a water company, is a difficulty which must be coped with. I believe it is true that if all the rain water from the top of a house is collected the amount would be sufficient for the household's wants. But I had not only to supply the house, but the cattle, horses, and garden. For some time I relied on rain-water (which by the way, when properly stored in underground tanks, and well filtered, serves as a most excellent potable water) and on the yield from a very small spring in a field close to the house. One very severe drought, a few summers ago, caused much anxiety, as our water supply nearly came to an end and I was on the point of sending the live-stock, both man and beast, into the valley when we were saved by a thunderstorm. This induced me to look around for a further source of water, and in one of the fields I observed a moist area, and on digging I found to my satisfaction a probable supply, in a mass of quaking sand. Into this I therefore sank a well, taking care, however, only to go so far as not to disturb the water-tight basin of clay which prevented the water disappearing into the chalk. The result has been that we have now an unfailing supply of fairly good surface water, flowing from the higher land, which we pump

from the well into reservoirs on the higher ground and thus not only provide the house and the garden but also feed a fountain below which springs to the height of twenty feet.

To help to put things straight in the chaotic condition of the farm I brought down a Westmoreland man and his family, and the practical result of ten years' work is so far satisfactory that our field of swedes on several occasions has received the first prize for the best show twenty miles round Guildford; whilst our hay, potatoes, wheat and oats have done us fair credit. I bought some well-bred Jersey cows from the Duke of Northumberland's herd, and have been fortunate enough to keep up the supply and the breed, and also assured myself, by inoculation, that all the animals were free from tuberculous disease. On the whole then, without attempting anything like scientific farming, I find that my seventy acres do not run me into any serious expense, and charging the market prices for what I furnish to the house we just about make two ends meet. Though I could not do all the year round merely with pigs, poultry, and potatoes, I must admit that my small farm gives me both pleasure and employment.

Perhaps one of the greatest advantages of a country house near London is the pleasure that can be given to friends by sharing with them our country delights. Among many other visitors none were more welcome than the Rev. William Rogers of Bishopsgate. He used to drive over from his house at Mickleham to Woodcote and sit on our terrace all the afternoon, for he was very infirm in his later years. We found much to talk about. One day he asked me on whom I thought a vacant bishopric would be bestowed. "No doubt about that," I replied, "you are the man," at which

he laughingly shook his head. He was deservedly proud of his Bishopsgate Institute, and on the occasion of a lecture which I gave there on December 19th, 1895, he took the chair although the evening was a bitterly cold one. I was amused at the kindly but autocratic manner in which he treated the audience. They were marshalled into their seats, and when the time for beginning arrived, the doors were locked, no further admission being permitted, in order that perfect quiet should be maintained. Then, in his humorous and unsophisticated way, he introduced the lecturer, and I went through my performance, which seemed to meet with the approval of the audience. Shortly afterwards I was shocked to hear of the death of my old friend; and I have sometimes thought that I may have been, unwittingly, the cause, for that was the last occasion on which he appeared in public, and perhaps he caught a fatal chill sitting in the draughty room.

I attended his funeral at Mickleham Church, the old man was laid to rest, close to where he had so long lived; but I have often fancied that he would rather have lain within the sound of the busy hum of Bishopsgate than under the whispering trees of Mickleham.

My friend, the late Sir Wemyss Reid, was also a welcome guest at our house. I met him first on a political platform in Leeds when he was editor of the *Mercury*, and when he was good enough to introduce me to the audience. Long afterwards he and I became intimate, as he was my neighbour in South Kensington. We had many ideas and friends in common, and I have often spent a pleasant hour in his company, for he was a rare good fellow, and a *raconteur* of the first water. Moreover, his literary

power was great, and this was noticeable in his conversation. This power is nowhere more strikingly shown than in his life of Charlotte Brontë, in which the character of that wonderful woman is skilfully and lovingly drawn. Sir Wemyss had a brave spirit. Shortly before his last illness he told me that his doctor had warned him of his rapidly approaching end. "I came home," said Reid, "and set to work to write my monthly contribution for the *Nineteenth Century Review*, and I don't think anyone reading that article would believe that two hours before I had received sentence of death." Reid had seen life in many forms and had been intimate with many distinguished people, and his autobiography lately published gives an interesting picture of a useful life.

Of those younger friends who have passed away, the loss of none is more deeply deplored than that of Theodore Llewellyn Davies, the youngest son of my dear cousin Mary. His was a bright and brilliant nature which gave promise of a useful and even of a great future, whilst his sweet disposition and true-heartedness endeared him to a large circle of friends, to each of whom his memory will ever remain dear.

Sometimes unexpected visitors presented themselves at our doors. One of these "surprise" calls is worthy of mention. On a dark November evening, some few years ago, we had just done dinner, when a ring came to the door at Woodcote. I went myself to open it, for this was an unprecedented occurrence. A well-dressed man appeared and inquired whether Sir Henry Roscoe was at home, and I invited him in. "Very fine views about here, sir," was his first remark. "Yes," I replied, "when you can see them. How did you find your way up here in the dark?"

"Oh, I brought a guide from the village below." "Well, what can I do for you?" "I believe, sir, that you are acquainted with a young lady friend of mine (naming her) who has had a chemical education?" "Certainly, the lady is a good chemist." "Yes," he replied, "but I found that she could not answer to my satisfaction a question in chemistry, to which I desired an authoritative reply, and therefore I came from London to consult you. I wish to know, sir, what is the meaning of H_2O?" Recovering from my amazement I endeavoured to explain what this cryptic symbol meant. "I am deeply indebted to you, sir, for your lucid explanation," and he then proceeded to enlarge upon the importance of the information I had given him, to such length that I ventured to suggest that if he delayed he would miss the last train to town. "Thanks, sir," he replied, "I have taken steps to avoid the necessity of an immediate return, as I have engaged rooms for the night at a neighbouring inn!"

No visits are more welcome to us than those paid us each summer by the Mallet family, consisting of our daughter, her husband, and their two sons.

And thus my wife and I renew our youthful days in watching the happiness and progress of our grandchildren.

APPENDICES

APPENDIX I

LECTURE ON JOHN DALTON

(Delivered to the boys of Eton College)

Two marble statues are placed one on each side of the entrance to the magnificent municipal buildings in the City of Manchester. They are not statues of merchant princes or even of men who have successfully applied science to manufacture or industrial enterprise, and thus won for themselves great wealth. They are statues of men who, poor in worldly goods, were rich in fame and genius, and who, by benefiting others rather than themselves, have contributed more to the extension and development of commerce, industry, and civilisation, than perhaps any other two men of the nineteenth century.

Thus honour is done to Manchester's two greatest sons, to Dalton, the founder of the Atomic Theory, and to Joule, the discoverer of the Law of the Conservation of Energy. It is to Dalton that we owe the final and absolute proof that matter cannot be destroyed; that all the chemical changes which we observe are simply the passage of one form of matter into the other, often from the visible to the invisible; whilst to Joule we owe the foundation of the principle that in all the various modes of chemical and physical change no loss of energy takes place. That is to say, just as we cannot create or destroy matter, so also we cannot create or destroy energy. When the candle burns and the wax disappears its constituents are not lost, but escape in the form of steam and carbonic acid gas, formed by the union of the hydrogen and carbon of the wax with atmospheric oxygen; so the energy of the chemical forces locked up, or potential, in the wax and in

the oxygen, become evident or kinetic in the heat of the flame. And exactly as there is a definite unalterable relation in weight between the carbon and hydrogen of the wax and the products of their combustion, carbonic acid and water, so there is a definite and unalterable relation between the amount of chemical potential energy of the constituents of the wax and that of the heat evolved by their oxidation. Both these relations can be expressed by numbers, and these numbers are the foundation constants of Science. By the determination of the combining weights of the elements and their compounds Dalton made clear the truth of the first principle ; by rigorous experiments Joule that of the second by determining the mechanical equivalent of heat, namely, that a weight of 772 lbs. falling through the space of one foot develops a definite and unalterable amount of heat capable of raising the temperature of one pound of water from 32° to 33° Fahrenheit.

You all know something about chemistry, of what it has done for the world, how far-reaching it is, how wonderful scents are prepared by the skill of the chemist from evil-smelling tar ; how, even, a substance 300 times sweeter than sugar has been manufactured artificially from the same material—that the chemist can even do more than the busy bee, for he can manufacture honey from its constituents, whereas the bee can only sip it ready-made in the flower. There seems to be only one limit to the synthetic power of the chemist. He looks forward to the possibility of manufacturing all crystalline and liquid bodies, the one goal which at present, it appears, he cannot reach is the artificial construction of organised matter, the starch granule, or the blood corpuscle.

My object this evening is to endeavour to point out to you some of the origins of these great things ; to indicate to you the principles without which all this progress would have been impossible, and at the same time to tell you of the interesting personal history and characteristics of the man who did more to lay these foundations than any other. Before John Dalton's time, and without his Atomic Theory, chemistry, as an exact science, can scarcely be said to have existed. It is true that many facts were ascertained, but the relation between these facts was not made out. A chemist before Dalton's time might be aware of the kind of action which takes place when two chemical substances are brought together, but no one could calculate with precision how much of each ingredient was required to build up the new body,

whereas after Dalton's time such calculation became easy and certain. And this is why Dalton is honoured in the City of Manchester, in which he lived and laboured, and where we find his statue, and that of his equally great scientific son, Joule, side by side in the vestibule of the Manchester Town Hall.

Let me first tell you something of the life-history of this man. It may teach us much. It shows us what may be done by strong will, by perseverance, and by energy, in spite of serious obstacles. It shows us how the poorest, the most ill-equipped in worldly goods, may, by patient endeavour, rise to a high position, not in this instance, indeed, in the circles of what is termed "Society" or in riches or social distinction, but in what is far higher and nobler, in benefiting his species, in giving to mankind a knowledge of the secrets of Nature long hidden from mortal eye.

As a rule the life of a man of science is restricted to the chronicle of his discoveries, and to the notice of the influence which his work has exerted on the progress of natural knowledge. Most of such men live uneventful lives; their personal history is usually of but slight interest to the general public, sometimes it is even commonplace. Their work has lain in the laboratory or the observatory, where the even tenor of their days is only broken by the discovery of a new law, of a new chemical element, or of a new planet.

In Dalton's case this does not apply. For although so devoted to his science that he used to say he had no time to get married, and although, as we shall see, the greater part of his life was spent in working and teaching in a more or less humble way in a provincial town, yet his character presents so many aspects, and exhibits such originality, that apart from his scientific labours, and independently of his position as one of the world's greatest chemists, the life of the man is a study full of interest from which both rich and poor, learned and unlearned, may, if they please to do so, draw many useful lessons. John Dalton was not born with a silver spoon in his mouth. He came of a humble but thrifty North-country Quaker stock. He was born in the village of Eaglesfield, in the county of Cumberland, in 1766. There stands the first meeting-house established in Cumberland by the Society of Friends, and there, under the grassy turf, lie the forbears of the Dalton family—for on both sides he came of Quaker parents. The cottage in which he was born was then a thatched one. Since that time its exterior has been modernised, but inside it is in much the same con-

dition to-day as it was 130 years ago when occupied by Joseph Dalton, the hand-loom weaver, and his gude-wife, Deborah, the parents of the great chemist. On opening the door is seen the house-part where the family lived and where stood the hand-loom at which the father worked to gain daily bread for his wife and children. Here may also be noticed the recess in which was placed the chaff bed where the couple lay and where their son John was born.

The independence of spirit and determination of mind shown by the boy were soon noticeable. One day, when only between eleven and twelve years of age, he pasted up a notice on the door of his father's barn to the effect that John Dalton had here opened a school for children of both sexes, on reasonable terms, and containing another piece of characteristic information, viz. "that paper, pens, and ink," articles not frequently met with in Eaglesfield in those days, "could be purchased within."

Some strange scenes were witnessed in that school. The boy's pupils were of all ages, from infants to big boys and girls of sixteen or seventeen. The infants sat on the "Principal's" knee, to learn their a-b, ab. The big boys were often not only crassly ignorant but some were rough and bad. John Dalton, in the exercise of his authority, desired to chastise these unruly ones, but this was sooner said than done, the boys rebelled and offered to fight their small master. How the matter ended history sayeth not, but I will wager that the pluck and Quaker firmness of the young master was equal to coping with the bluster of the ignorant and ill-bred bully.

Dalton thus describes his own early years: "The writer of this was born at Eaglesfield, near Cockermouth, in Cumberland. Attended the village school there, and in the neighbourhood till eleven years of age, at which period he had gone through a course of mensuration, surveying, navigation, &c." So you see he knew something, this weaver's son, when eleven years old. His schoolmaster used to set him questions in mathematics, stiffish problems they were. "Now, John," said the master, "hast thou done that?" "No," said John, "but" (speaking in his native Cumbrian dialect) "yan med dew it." Again, an hour after, the same question was asked, "No," he replied, "I can't dew it to-neet, but maybe i'th'morn I will," and, true enough, sleep helped the work, and in the morning the answer was forthcoming. This story gives the keynote to the character of the boy and the man. It was indomitable perseverance,

and to this faculty he himself ascribes his success in life. He was fond of making meteorological observations; he began them early in life and continued them (from 1787) for more than half a century, day by day, at the same hour, until the very evening before his death, in 1844, making altogether no less than 200,000 observations.

When he was fifteen he left his native village for ever to join his brother, who had established a school in Kendal. His outfit was not a luxurious one. For the first time he saw, in a Cockermouth shop, an umbrella, and bought one, thinking, as he said, that "an article of the kind was becoming a gentleman!" So, with a bundle of underclothes in one hand and his umbrella in the other, John started for his walk of forty miles to Kendal, and this was nothing to the young stalwart boy. Indeed, up to the last almost, Dalton was a sturdy walker—"Why, John, what are thy legs made of," said, in after years, one of his companions on a walking tour, "I cannot keep pace with thee."

Passing through lakeland, which throughout his life was his happy hunting ground, he arrived at Kendal. Here he found a community of 5,000 souls, many of them Quakers, driving a flourishing trade in homespuns, and Kendal green, the packs being sent to Liverpool by hundreds of horses, for of coaches, let alone railroads, in those days there were none.

Here he kept school for twelve years with his brother. They did not make their fortunes. The fee charged was 10*s.* 6*d.* per quarter, and so hard up were the brothers that they at one time had to borrow a few pounds from their poor parents to keep things going. But whilst he was employed in teaching the "young idea how to shoot," Dalton was also busily engaged in self-improvement. Not a minute was lost; and by degrees, by hard and unremitting toil, he became a good mathematician and was acquainted with the works and writings not only of Newton, and of our other great English men of science, but also with what continental philosophers thought and did, and thus he laid the foundation of his future greatness.

In 1793 Dalton came to Manchester as teacher in the Manchester Academy. He got £80 for the session of nine months, out of which he had to pay £27 10*s.* for board and lodging, so that his income was £1 per week, a sum which, however small it may seem to us in these degenerate days, was to Dalton more than he expected and more than he had ever before received. After holding this post of College

Tutor for six years, having to teach mathematics and natural philosophy, he resigned this situation and devoted himself to the prosecution of scientific inquiry, earning his bread by teaching private pupils, and this mode of living he carried out until his death in 1844. So simple were his requirements, and so inexpensive his tastes, that it was only in the last few years of his life that he bought himself six silver spoons, deeming pewter good enough for him. In fact his riches consisted not in the greatness of his means but in the fewness of his wants. His habits are well illustrated by the following anecdote: In the year 1826, when Dalton had achieved a European reputation, a well-known Parisian *savant* came to Manchester with the express purpose of visiting the illustrious author of the Atomic Theory of Chemistry. Doubtless he expected to find the philosopher well known and appreciated by his fellow-citizens, probably occupying an official dwelling devoted to the prosecution of science, like the noble buildings to which he had been accustomed in France. There he would expect to find the great chemist lecturing to a large and appreciative audience of advanced students. Judge of the Frenchman's surprise when on his arrival in Cottonopolis he discovered the whereabouts of Dalton only after diligent search and inquiry, and found the Manchester philosopher in a small room in a back street engaged in looking over the shoulders of one small boy who was working his "cyphering on a slate!" "Est-ce que j'ai l'honneur de m'addresser à Monsieur Dalton?" said the polite Frenchman, for he could hardly believe his eyes that this was one of the first chemists in Europe, teaching a boy the four first rules of arithmetic. "Yes," said the matter-of-fact Quaker; "wilt thou sit down whilst I put this lad right about his sums?"

But as I have said, whilst teaching these boys, and girls also, his mind was intent upon great problems of science. He was always meditating and experimenting upon the composition of the air, upon the constitution of gases. Thus he lived two lives, one that of the teacher, the other that of an experimental philosopher. By the one he got his daily bread; the other was to yield that higher prize of an immortal name in science.

Dalton's mind was a speculative one; he was characterised by independence of spirit, fearlessness of inquiry, clearness and straightforwardness of vision, indomitable perseverance, and entire unselfish and lifelong devotion to the prosecution of scientific truth for its own sake, and for its own sake alone. "If," said Dalton in later life, "I have succeeded better than

many who surround me, it has been chiefly—I may say almost solely—from unwearied assiduity ; this not so much from any superior genius that one man possesses over another, but more from attention to study and perseverance in the objects before them that some men rise to a greater eminence than others."

If, as has been said, genius may be defined as "an infinite capacity for taking pains," then Dalton was, unquestionably, a genius.

He was a follower of our great countryman, Newton. You know that the old Greek philosophers put forward what they called "an Atomic Theory of matter"—that is to say, they believed matter to be composed of very small indivisible particles. Newton also was an atomist, but he did what no one else had done—he explained how those atoms are attracted and repelled according to fixed laws, and then explained the motions of the heavenly bodies. What Newton did for astronomy Dalton did for chemistry. He said—these atoms exist ; by their coming together they produce chemical change. But he did more, he said—the atoms of the different elements do not weigh the same. Each chemical element consists of atoms uniform in weight but differing in this respect from those of the other elements. He thus introduced an idea which laid the foundation of our modern theory of chemistry. John Dalton exhibits in high degree that power of spiritual insight into the secrets of Nature which is an essential attribute of the true philosopher. No one who lacks the faculty of scientific imagination can wrest from Nature her greatest, her sublimest, secrets.

Perhaps Dalton's apparatus was the simplest anybody ever employed ; and it is most remarkable, in reading his original memoirs, to see with what simple apparatus he worked, and from what simple materials he was able to draw such great conclusions. I have before me some of Dalton's original apparatus lent to me by the Literary and Scientific Society of Manchester. It consists of a penny ink-bottle with a tube fixed in the cork, and a couple of ordinary apothecaries' scales.

Here are also some weights he made. I found these wrapped in a piece of paper on which was written, in his beautiful hand, part of a note expressing his regret at not being able to wait upon someone, on account of his going to Liverpool with some friends to try the effects of travelling by the newly made railway, between Liverpool and Manchester, on the occasion upon which Huskisson was killed.

The turn of mind and character of a man depend much on his physical constitution. Dalton in one respect was singular, he was colour blind ; that is to say, his perception of colour was abnormal ; thus, for example, he could not distinguish the red berries on a green tree, and hence his outlook was different from that of other men. This peculiarity, which is now well known, has sometimes been called Daltonism from the fact that Dalton was the first to investigate it. It is curious that he was twenty-six years old before he noticed this abnormality ; and yet it is not so strange when we think that thousands of persons must have suffered the same lack of perception all their lives and yet remained in ignorance of their defect. It was not till October, 1794, that the first scientific communication on the subject was made by Dalton under the title of *Extraordinary Facts relating to the Vision of Colours.* The fact of his colour-blindness was first brought home to him in an amusing fashion. He bought a pair of stockings for his mother, which he believed were of a drab colour, but on receiving the gift she said, " Thou hast bought me good hose, John, but what made thee fancy such a bright colour? Why, I can never show myself at Meeting in them." Her son, disconcerted, replied that to his eyes these stockings were of a dark bluish-drab, a very proper go-to-meeting colour. " Why, they're red as a cherry, John," said his mother, applying for confirmation to her other son, who agreed with John in the matter. On consulting her neighbours the verdict was unanimously given in her favour ; " Verra fine stuff but uncommon scarletty." Thus the peculiarity of both brothers' vision was ascertained.

The cause of colour-blindness is not yet definitely known. It is, however, certain that it is not due to any defect in the lens or aqueous humour of the eye, and Dalton's eye, after death, was found in this respect to be normal. It is now known that a very considerable number of persons, as many in some places as one in fifty-five, are found to be colour-blind. It is evident that the safety of travellers, both by sea and by land, is jeopardised if the conduct of the train or the steering of the ship is in the hands of men whose eyesight is thus defective, and the testing of persons thus employed as to their perception of colour is now universally enforced.

My friend, Sir William Abney, has written a book on colour-vision, in which the whole subject is ably discussed.

Dalton's habits were, as I have said, of the simplest, most methodical, and uniform kind. He lived for his science. Every day, and all day long, he spent in his laboratory, except

Thursday afternoons, when he enjoyed a game of bowls with a party of friends and afterwards refreshed himself with a pipe of tobacco. He rose early, and directly he had finished his breakfast repaired to his laboratory, where he had lighted the fire prior to taking that meal. His life went like clockwork. A lady who lived opposite Dalton's laboratory, in Manchester, said that she knew the time to a minute by seeing the Doctor open his window to read his thermometer. For some years he lived with the family of Mr. Johns, and how this came about is told in the following manner by Miss Johns.

"As my mother was standing at her window one evening she saw Dr. Dalton passing on the other side of the street, and on her opening the window he crossed over and greeted her. 'How is it you come so seldom to see us, Dr. Dalton?' said she. 'Why, I don't know,' said he, 'but I have a mind to come and live with you.' My mother thought at first that he was in jest; but finding that he really meant what he said, she asked him to call again the next day, after she would have consulted by father. Accordingly he came and took the only bedroom at liberty, which he continued to occupy for nearly thirty years."

He was not only methodical in his work, but the same punctuality and method prevailed in his holidays. He was in the habit of spending them at the English Lakes, and there he always occupied himself in the same way—ascending the mountains, measuring their heights by his self-made barometer, ascertaining the dew-point, and collecting air at different heights, to be analysed on his return to Manchester.

He came to London to lecture on chemistry at the Royal Institution, but he did not like the bustle and stir of our great metropolis. "London," he writes, "is a most surprising place, worth one's while to see once, but the most disagreeable place on earth for one of a contemplative turn to reside in."

Though, as he said, he never had time to get married he was not insensible to female charms. In an old botanical book I came across a dried specimen of the "Ladies' Slipper," a charming orchid, now scarce, and under this was written, in Dalton's handwriting, "Presented to me by Nancy Wilson of Thornton-in-Craven." That Nancy had touched the staid Quaker to the heart's core is certain, and he used to read with a faltering voice some lines by the lady, with eyes suffused with tears, repeating as he ended, "Poor Nancy, poor Nancy!"

Dalton received scientific honours from all parts of the world. The French Academy made him an Associate, the highest dignity which is awarded to foreigners. The Royal Society presented him with a Royal Medal. He was presented to the King, William IV., and his description of the interview showed his uncompromising habit of mind and his sturdy outspokenness.

"Well, Doctor, what said the King?" he was asked, on his return home.

"Why," said Dalton, "he asked me how we were getting on in Manchester, 'All quiet, I suppose?'" (alluding to the recent Peterloo riots). "To which I replied, 'Well, I don't know, just middlin', I think.'"

"Why, Doctor," said his companion, "thou hardly showed Court manners in addressing the King in such common parlance."

Speaking in his broadest Cumbrian, Dalton replied: "Mebby sae, but what can yan say to sic like fowk?"

I am reminded of a singular occurrence which took place, in 1876, in connection with this great man. An important exhibition of scientific apparatus was inaugurated that year at South Kensington; among the exhibits was one which I had arranged, consisting of the barometers, thermometers, and other apparatus made and used by Dalton in his researches, and now the property of the Literary and Philosophical Society of Manchester. The Queen, one day, expressed a wish to visit this Exhibition, and all those in charge of apparatus were requested to be present, and the designation of each exhibit was written up legibly, among others mine, viz., "Dr. Dalton's Apparatus." As the Queen approached, one of her equerries preceded her in order to inform himself of what was exhibited, and, as Her Majesty passed by, he did me the honour to introduce me as Dr. Dalton!

I would only say a word, in conclusion, as regards the moral which we must draw from John Dalton's life and labours. What lessons do they teach? Surely this—that in order to flourish and produce fruit such as we have been studying, science must be free—free to experiment and to observe without let or hindrance; free to draw the conclusions which may flow from such experiments or observation; free, above all, to speculate and theorise into regions removed far beyond the reach of our senses.

APPENDIX II

MY JUBILEE

To give all the Addresses and my replies thereto would occupy too much space ; I may, however, be allowed to refer to those of special interest. The first item on the programme was the renewal of the Diploma of Doctor of Philosophy, granted, after the lapse of half a century, by the University of Heidelberg. My official reply to the pro-Rector was as follows :—

To His Serene Highness the Grand-Duke of Baden, Rector of the University of Heidelberg, the Professor Czerny, Pro-Rector, to the Senior Dean, and the other Professors of the Philosophical Faculty of the University :—

With grateful heart and with ever-abiding memories of the happy years spent within your hospitable walls in conjunction with that greatest of Chemists and most noble of men, your Bunsen, I tender to you and to the whole of your University my sincere thanks for the honour you have done me by your renewal of my Diploma of Doctor Philosophiæ Naturalis, after the lapse of half a century. *Floreat in Æternum Universitas Ruperto-Carola.*

Naturally, the next after Heidelberg was the welcoming Address from the Council and Senate of Owens College, in which they referred in kind terms to the work which I had done, both for Owens College and Victoria University of Manchester, in the thirty years during which I was connected with them. To this I replied :—

I thank you, my friends, for the warm welcome which you, through the Vice-Chancellor, have given to me and my Jubilee. Thirty happy, and I hope useful, years were passed by me in your midst. I have seen Owens College rise from insignificant beginnings to the proud position of a stately national University. To have had a hand in the production of this unique transformation scene I look upon as one of the chief privileges of my life, and if the work was laborious, it was a labour of love.

I tender you all my best and most cordial wishes for the continued success of our great Institution of which we have good reason to be proud.

Vivat Universitas Mancuniensis.

Of all the Addresses, that which touched me most nearly, and was at the same time the most beautiful and artistic, was that presented to me by my students in the form of an illuminated book containing the following words with the signatures of a great number of my pupils.

Address from Old Students of Owens College :—

We, the undersigned, all of whom have the honour to number ourselves among your pupils, desire on the occasion of the celebration of the Fiftieth Anniversary of the date of your Graduation as a Doctor of Philosophy of the University of Heidelberg to offer you our hearty congratulations, and to express our pleasure that you are able to be with us in health and strength to receive this testimony of our gratitude and esteem.

The half century which has elapsed since the day of your 'Doctor promotion summa-cum-laude' has witnessed an extraordinary development in that branch of natural knowledge to which you have particularly devoted yourself. We recall with pride in how large a measure your own labours have contributed to that growth—by your work as an original investigator, by your literary productions, by your remarkable and almost unexampled success as a teacher, by the influence you have exerted in the organisation and direction of Societies concerned with Science, by your unceasing and well-directed efforts to secure for Science its due position in the scheme of national education, and the fuller recognition of its relations to the well-being of civilised communities.

It was your good fortune at the outset of your career to come under the influence of illustrious chemical philosophers—Graham, Williamson, Bunsen. Your good fortune has been our great gain. You have not only worthily upheld the traditions associated with such names, but you have inspired others by your example. Your influence is to be seen in the creation of the great School of Chemistry in which you laboured for thirty years and in which you taught hundreds of pupils ; it is equally felt in the many similar places throughout this kingdom which are modelled upon the lines which you indicated, and which are to-day actuated by your method and example.

We gratefully recall the obligations that we are under to you as our teacher, and we cherish the memory of the signal services you have rendered to the Institution of which we are proud to be members. You came to it in the days of its precarious infancy, you assisted to rear it into a vigorous youth, sharing its aspirations and stimulating its endeavours ; you behold it now of age and entering upon a great career.

That you should have lived to see and enjoy this fruition of your labours is a matter of special gratification to us as it must be to you. Blessed with continuing health and happiness may you long be spared to witness its growth in prosperity and usefulness.

My reply was as follows :—

Of all gratifying and far too flattering Addresses which I am to-day receiving, none come so near to my heart as that signed by 300 of my former students.

What can a teacher value more than the sympathy and good opinion of his pupils, and this you have given me in full measure.

If I succeeded in forming a School of Chemistry at Owens, it was because, in the first place, I learnt from Bunsen how the foundations of such a school must be laid; secondly, because I fortunately secured the co-operation in the task of good men and true like Schorlemmer and Dittmar; and last but not least because I was surrounded by an ever increasing band of young men imbued with the true scientific spirit, able and anxious to devote themselves to the study and to the advancement of their Science.

Well aware of my own deficiencies, and recognising the gulf which lies between promise and performance, I yield to none in the personal interest which I take in your progress and welfare, and in the affectionate remembrance in which I hold each and all of you. Many, many thanks.

Of the many Universities which addressed their congratulations to me I will only quote two, the first being from the University of London and the second from that of Tokyo. The London Address was as follows :—

When the world of learning is about to congratulate you on the fiftieth anniversary of your admission to the Degree of Doctor of Philosophy in the University of Heidelberg, the Senate of the University of London desire to join in the many and hearty felicitations which you will receive.

The Jubilee of your attainment of a degree in the University of London is already passed; and for more than half a century you have shown yourself a worthy son of your Alma Mater.

As a man of Science you have won a place among the leaders of your generation; the success of the great foundation at Manchester, which owes so much to you, was the beginning of a movement in University Education of which the end is not yet. In later life you returned to the service of the University whose degree crowned your early efforts; and as our Vice-Chancellor you presided over the Senate during the difficult period in which the University of London received the Commission to teach as well as to examine.

With abilities which all admire you combine the power of attracting to yourself the respect and affection of your fellow-workers; and the Senate with and for whom you have laboured so long, have commissioned us to express to you their cordial congratulations on your past, and their sincere hope for the happiness of the future.

ROSEBERY, *Chancellor.*
T. H. PYE-SMITH, *Vice-Chancellor.*
EDWARD H. BUSK, *Chairman of Convocation.*
ARTHUR W. RÜCKER, *Principal.*

In thanking Sir Michael Foster (M.P. for the University), who presented the Address, I said :—

As Vice-Chancellor during six strenuous years, the work though arduous was rendered comparatively light by the help and guidance granted to me by all, but especially by our late Chancellors, Lord Herschell and Lord Kimberley.

The University has high aspirations; it intends to become a seat of the

higher learning and research worthy of the Metropolis of the Empire. That it will succeed in its great task I have no manner of doubt, and one good reason for this belief is that we have for our first Principal, Sir Arthur Rücker.

The next Address comes from a still newer University, the seat of an unparalleled revival of learning and scientific education in that most marvellous of countries, Japan.

Translation of the Address of Congratulation from the Imperial University of Tokyo to SIR HENRY E. ROSCOE.

SIR,

The Imperial University of Tokyo is gratified to learn that your friends and former pupils have determined to celebrate the completion of fifty years of your graduation as a Doctor of Philosophy of the University of Heidelberg.

Your long and untiring devotion to the cause of Science and Education has won for you the highest respect and profoundest admiration of all, and we desire to associate ourselves with the celebration, and to offer you on our behalf our heartiest congratulations on so auspicious an occasion, as well as to express our earnest hope that you may enjoy health and strength for many years to come.

I have the honour to be, Sir,
Your obedient servant,
KUIJIRO YAMAGAWA,
President.

In my reply I said :—

You will believe me when I say that none of the many Addresses from Universities and Scientific Societies which I have received have been more welcome to me than that which your University has sent.

Especially at the present time I consider it an honour that your University has remembered me, for your nation is occupied with other thoughts and deeds.

We in England look with admiration, not unmixed with surprise, on the patriotism and noble devotion to duty which your nation is exhibiting in the face of the world, and we cannot fail to see in all this a dependence on scientific training and an application of scientific method to national wants which may well serve as an example to European nations.

I beg that you will present to the University of Tokyo, over which you preside, my warmest thanks for the honour which it has done me.

Among the scientific Societies which honoured me comes first of all that, from the Mother of them all, signed by the President, Sir William Huggins :—

Burlington House,
London,
April 18th, 1904.

DEAR SIR HENRY ROSCOE,

The approaching celebration of the Jubilee of your Doctorate gives me the opportunity to send you the cordial congratulations of the Royal Society, and to express the high esteem in which they hold the contributions to scientific progress and to the public well-being which have been

the result of your life's work. We recall your early researches, in conjunction with your illustrious friend Bunsen, into photo-chemical phenomena which illuminated a new department of chemical philosophy, one that is destined to even wider development in view of recent discoveries. To your thorough researches on the compounds of Vanadium the scientific world has been indebted for the knowledge of the properties of that element. We recognise that, in addition to these and other important researches of your own, it has been granted to you to establish and foster that great Laboratory at Manchester, from which for a long series of years a succession of brilliant investigators has been sent forth to uphold the fame of British Chemical Science. The value of the services you have rendered to your own University of London, to the Victoria University, to our Society by your contributions to its Transactions and your services on the Council, to the Nation by your efforts for the improvement of education and for social progress is widely recognised.

It affords me very great pleasure to transmit the congratulations of the Royal Society and to express the hope that before you and, may I be permitted to add, Lady Roscoe, there is still a long period of happy and honourable activity.

Believe me to remain,
Yours most faithfully,
WILLIAM HUGGINS,
President R. S.

To which I replied :—

To the Fellows of the Royal Society, and especially to my old and respected friend our President, Sir William Huggins, of 'Starlight' renown, my most grateful thanks are due, and although I feel my own deficiencies I accept the kind expressions as one who has at any rate always had the promotion of natural knowledge at heart.

Another came from the Society of Chemical Industry.

The Society of Chemical Industry founded in 1881 has had nearly 23 years of usefulness, and has grown into a large and widely spread Association of men eager to further the interest of technical or professional Chemistry. To you, Sir Henry Roscoe, as its first President, the members of the Society feel that this prosperity is due. It was by your wise advice that the Society adopted the constitution which it now possesses, and which has proved so admirably suited for the duties which it performs,—the form of its Journal, which appeared for the first time in January 1882, during the year of your Presidency; but it has naturally grown with the times, and it now constitutes an admirable record of the progress of chemical technology in all its branches.

In offering their most cordial and heartfelt congratulations, the Council only acknowledge a part of the debt of gratitude which they owe to you; and they trust that you may yet be long spared to enjoy many happy and useful years of life, and to aid them with your advice.

WILLIAM RAMSAY,
President.

Among the foreign addresses that which I prize most is that from the great German Chemical Society, of which I have been honorary member for twenty-five years.

HOCHGESCHÄTZTER JUBILAR!

Die deutsche chemische Gesellschaft, welche mit Ihrem gefeierten Namen seit nunmehr bald 25 Jahren die Liste ihrer Ehrenmitglieder schmücken darf, entbietet Ihnen zu Ihrem fünfzigjährigen Doctorjubiläum herzlichen Glückwunsch. Sie schätzt in Ihnen einen der wenigen und einer der glücklichsten Vertreter der anorganischen und physikalischen Chemie zu einer Zeit, in der die chemische Forschung fast ganz durch die organische Chemie beherrscht wurde.

Waren Ihre Untersuchungen der Wolframchloride für den Vallenzbegriff von Wichtigkeit, so hatten anderseits Ihre Arbeiten über das Vanadin für die Kenntniss der Verbindungen dieses Elements grundlegende Bedeutung. Bei der Ergebnissreichen Durchforschung der wässerigen Sauerelösungen lehrten Sie ein neues Merkmal zur Unterscheidung von Mischung und Verbindung kennen. Ein Musterbild physikalisch-chemischer Methodik, welches Ihren Namen für alle Zeiten mit demjenigen Bunsens verknüpft hat, boten uns Ihre photochemischen Studien am Knallgase.

Aber wir erwähnen auch dankbar Ihre reiche Lehrtätigkeit, die sich nicht auf den unmittelbaren Verkehr mit Schülern beschränkte, vielmehr durch berühmte Lehrbücher die auch in deutscher Bearbeitung hochgeschätzt sind, sich weitesten Kreisen erfolgreich zuwendete.

Möge es Ihnen vergönnt sein, von dem neuen Aufblühen Ihrer Forschungsrichtung noch auf lange Zeit hinaus Zeuge zu sein.

BÜCHNER (*Präsident*)
VAN 'T HOFF (*Vize-Präsident*).

Another came from the Italian chemists resident in Rome, beautifully illuminated.

La Società Chimica di Roma informata dal suo Presidente Prof. Cannizzaro che nel prossimo Marzo sarà sollennemente festeggiato a Manchester il cinquantesimo anniversario della laurea dell' illustre Chimico Sir Henry E. Roscoe volendosi associare a tali meritate onoranze che si rendono all' eminente Professore il quale con le sue magistrali ricerche, con le varie importanti opere pubblicate e con l'insegnamento dato ha tanto contribuito al progresso della Chimica.

Delibera: di destinare una apposita sua adunanza a svolgere l'opera scientifica dell' illustre scienziato.

Delibera altresì che tale risoluzione sia a Lui partecipata, esperimendo la profunda ammirazione dei chimici italiani residenti a Roma per l'illustre Uomo e i loro fervidi voti per la sua prosperità.

STANISLAO CANNIZZARO, *Il Presidente.*

Roma, 28 *Febbraio*, 1904.

My answer was as follows:—

To my friends Cannizzaro, Paternò, and Ulpiani as representing the Italian chemists resident in Rome, I return my hearty thanks for the honour they have done me.

To receive the congratulations of the scientific countrymen of Leonardo, Galileo, Volta, Avogadro from Italia Liberata must be a satisfaction to every Englishman, but a still greater one is it to myself when first amongst

the signatories of the Address I find the name of your President, who may truly be said to be the founder of our modern system of Chemistry.

My best wishes come to you from the City of Dalton and Joule for the progress of Italian Chemistry and the welfare of the Chemical Society of Rome.

The following characteristic letter from Monsieur Berthelot, the permanent Secretary of the Institut de France, delighted me as showing the affectionate regard of my friends across the Channel.

Paris, 15 *Mars*, 1904.

CHER ET HONORÉ COLLÈGUE,

Je suis heureux de m'associer à vos amis, collègues et élèves, pour vous adresser mes vœux à l'occasion du cinquantième anniversaire de votre réception comme Docteur en Philosophie a l'Université d'Heidelberg.

Il y a la pour chacun de nous une double coincidence. En effet c'est en 1854, que j'ai été reçu, moi-même, Docteur ès Sciences à l'Université de Paris ; et trois années après j'ai eu le plaisir de faire votre connaissance au laboratoire de Bunsen. Depuis lors, nos carrières se sont poursuivies parallèlement avec le même zèle pour la science, et je suis heureux de le dire avec les mêmes sentiments d'estime et d'amitié reciproque. Espérons que nous continuons encore pendant quelques années à jouir de la plenitude de notre activité, de la gratitude du monde scientifique.

Veuillez, cher et honoré collègue, agréez de l'hommage de ma haute considération et de mes hommages affectueux.

M. BERTHELOT.

The following letter is from Monsieur Moissan, the discoverer of fluorine :—

Faculté des Sciences de Paris,
11 *Mars*, 1904.

MON CHER CONFRÈRE ET MON CHER MAÎTRE,

Permettez-moi d'adresser au savant, dont les recherches fines et délicates ont puissamment aidé au progrès de la Chimie Minérale, un souvenir bien affectueux et des vœux cordiaux pour que les années qui suivront soient pour lui heureuses et prospères.

HENRI MOISSAN.

From St. Petersburg the distinguished chemist, Mendeleeff, wrote :—

HIGHLY HONOURED FELLOW AND DEAR OLD FRIEND,

During fifty years I see under your name appearing a long series of splendid experimental researches in our Science, and I am very desirous to see for many years to come investigations of the same kind and with the same signature, because then eternal scientific truth will easily triumph over mystical essays and give a useful and vigorous direction to Natural Philosophy.

Ever yours,
D. MENDELEEF.

The Address from the Göttinger Gesellschaft der Wissenschaften closed with the following charming words :—

Wir wollen es nicht unternehmen über den vielseitigen Inhalt Ihrer wissenschaftlichen Lebensarbeit uns hier eingehender zu verbreiten. Aber davon können wir bei dieser Gelegenheit nicht schweigen, dasz Sie das, was Sie einen deutschen Lehrer vielleicht verdanken, mit reichem Zinsen zurückgegeben haben. Ihre durch Klarheit der Darstellung und Methodik so ausgezeichneten Lehrbücher haben in unserem Vaterlande eine fast beispiellose Verbreitung gefunden und gehören seit Jahrzehnten zu den geschätztesten Lehrmitteln fur unsere Chemie studierende Jugend. So ist mit Ihnen populären Namen englische und deutsche Forschung, englische und deutsche Lehre auf das innigste verknüpft, und mit den Gefühlen aufrichtigste Verehrung nehmen wir an Ihren Ehrentage teil und senden Ihnen aus unserer niedersächsischen Stadt die herzlichsten Wünsche in Ihre angelsächsische Heimat.

In my reply I remarked :—

I warmly reciprocate the feelings so well put forward that Germany and England may long continue to enjoy that community of aims and interests which Science has done so much to encourage.

From the American Academy of Science and Arts I received the following Address :—

On this memorable anniversary of the beginning of a life-work, rich in fruitful research and helpful service in the advancement of science, the American Academy of Arts and Sciences sends warmest greetings and enthusiastic congratulations.

JOHN TROWBRIDGE,
Acting President.

Voted at a Meeting of the Academy held in Boston, March 9th, 1904.

Similar Addresses were sent from the American Philosophical Society and the American Chemical Society, and to each of these I sent this answer :—

To my Friends and Brothers in Science living and working in New England, New York and Pennsylvania, I from Old England send my affectionate greetings and best thanks.

It is pleasant to receive, as I have done to-day, assurances of appreciation from those speaking other tongues than English, and living in other environments than those to which one is accustomed, but it is a still greater pleasure to hear in familiar accents from people of the same blood, having aims and sympathies closely akin to one's own, words of encouragement and good-will.

Such words you have sent me.

English men of Science look with brotherly admiration, sometimes, perhaps, not unmixed with envy, on the wonderful progress which America is wisely making in the provision for teaching and research of the highest kind, thanks to the open-handed liberality of her wealthy citizens.

With this union of mind and matter who can place a limit on the work which America will produce?

A particularly interesting Address was that which I received from the Dutch chemists :—

March, 15th, 1904.

DEAR SIR,

On this memorable day—a day on which you enjoy the rare privilege of being able to look back upon fifty years of honourable scientific activity—we, the Dutch Chemists, desire to offer you our congratulations, and to add our meed of appreciation to the many similar tokens, which will no doubt reach you from all parts of the world.

Although we did not sit immediately at your feet to be initiated by you into Chemistry, we yet would wish to range ourselves among your pupils.

Your researches on the laws of gaseous solution, on the composition of the aqueous acids at their boiling-point as affected by pressure, on vanadium and other elements, on the chemical intensity of light—these are among the classics of our science and are known to every chemist.

They afford proof of how exact observation, founded upon carefully devised experiments and combined with logical thought, leads to permanent results, and as such constitute examples to be followed by all subsequent investigators.

Your lectures on spectral analysis, which have contributed so much to the propagation, development, and application of this branch of inquiry ; your treatises which in various translations and editions have been for so many years the chief text-books in schools of chemical instruction—these also give us the right to call you Our Master.

We ask you to accept our grateful thanks and homage.

May you enjoy for many years to come the memory of a half century so assiduously devoted to the service of Science, so rich in endeavour and so fruitful in achievement.

Signed by ten Dutch Professors.

I finally quote the translation of three letters. The first is from perhaps the most eminent of all living organic chemists, Professor von Baeyer, the successor to Liebig at Munich ; the second is from Professor Beilstein, of St. Petersburg, the author of the great *Dictionary of Organic Chemistry* ; the third from Professor Quincke, the distinguished physicist at Heidelberg, a life-long and intimate friend. All three studied with me under Bunsen half a century ago.

Translation of PROF. VON BAEYER'S *Letter of Congratulation.*

HIGHLY HONOURED FRIEND,

Among the many Anniversaries in his own career a man of Science may live to see, there is only one which we in Germany are in the habit of celebrating : it is the fiftieth return of the day on which he took his Doctorate, the first step in his Academic career. In conformity with this charming custom your many friends and admirers have this day combined to testify their appreciation of your achievements and to express their hope that a serene and restful evening may follow the day of strenuous endeavour.

Among the multitude of your admirers I beg to number myself as one of the oldest and warmest.

When I entered Bunsen's Laboratory in the Easter of 1856 as a novice of twenty years of age the sight of the wealth of chemical appliances was so overwhelming that I nearly burst into tears. Bunsen appeared to me like a being from another world, and Roscoe, his co-worker, who had taken his degree two years before, as one sent from a distant sphere. To be their equal was the highest object of my ambition. How am I to describe the delight that seized me when Bunsen proposed, in my second Semester, as an acknowledgment on his part of good progress made, that I should work on "Idio-Chemical Induction," a theme, in some measure, complementary to your photo-chemical researches? My anticipations were not realised, but your investigations made a deep impression on my mind and had a lasting influence upon my subsequent life.

And at a later period of your activity, when your work was receiving its due acknowledgment in your own country, your example again exerted a profound influence upon me. It was in attempting to raise the character of the instruction in Analytical Chemistry in our German Universities by the foundation of the "Verband von Laboratoriumvorständen an deutschen Hochschulen" that I was swayed by the example of the persistency and energy which you displayed in the cause of reforms of Technical Education in England.

Thus, my highly-honoured Friend, twice during my life have you influenced my action and helped me to find the right path. My congratulations to you on this day of your jubilation spring therefore from a grateful heart, and as such will, I trust, not be unwelcome.

ADOLF VON BAEYER.

Munich, *March* 1904.

Translation of PROF. BEILSTEIN'S *Letter of Congratulation.*

HIGHLY HONOURED COLLEAGUE, DEAR FRIEND AND FELLOW-STUDENT,

To-day, when so many of your Colleagues, Scholars, and Friends are tendering you their congratulations, you may not be unmindful of the voice of one who is far away, but who has been privileged to follow the development and outcome of your career for fully fifty years. Only a few remain from that happy time, but for that very reason their voices may have the greater weight.

It was in the Winter Semester of 1853–54 that I came to Heidelberg to listen, in the class-rooms in the old cloisters, to the teaching of our revered Master, Bunsen, at the end of which Semester you took your Degree. This occurred soon after the beginning of that brilliant period of the academic activity of that immortal man which attracted the enthusiastic youth of the whole world. A kind fortune enabled you to work under his direction longer than many of us. But that was not mere chance. Among the great number of his scholars the Master soon recognised one of the most gifted, and had selected him as a well-trained and trustworthy assistant. He was not deceived in his anticipations. What he expected, you have fulfilled. The loud acclaim which is rendered to you to-day only confirms what Bunsen had foreseen and predicted. In April 1856, when I returned to Heidelberg from Munich, where I had listened to Liebig and worked with Jolly, you and I were colleagues in the new Laboratory, then just finished, and where later on you were a frequent and welcome guest.

In June 1856, we—the senior pupils in Bunsen's laboratory—were photographed together. In this picture, which lies before me, I see the

forms of many dear old friends who are now no more. Yes, most of them —Bahr, Carius, Kekulé, Lothar Meyer, Pebal—have gone. Besides we two, our excellent and honoured comrade Landolt is the only one remaining.

Returning to your own country you continued to delight and astonish us during many succeeding years by your admirable discoveries and investigations. The seed which our great master implanted in you has fructified, and you may look back with satisfaction upon your life's work.

And now I turn to another picture which is also before me. It shows yourself surrounded by your family and in your own home. It was in August 1894 that, in company with our mutual friend Quincke—still an ornament to our Alma Mater in Heidelberg—I was a guest in your house at Horsley. You then took a photograph of us, and the picture vividly recalls those old memories. There, too, I perceived how all-comprehensive your activity was. We foreigners recognise you as one of the most representative men of our Science. Your excellent manuals and text-books have long since carried your name to the remotest parts of the civilised world. But you have rendered services to your country in many other ways. Others better qualified than I will offer you their thanks for such work. But to me, as one of the oldest witnesses of your services and of your success, it is a welcome opportunity to publicly state that in you we honour one of the most distinguished of men of Science, a devoted teacher and a noble fellow.

F. BEILSTEIN.

St. Petersburg.

Translation of Extract from Letter from PROF. QUINCKE, F.R.S.

Before I leave for Naples to-morrow with my wife and daughter I must send you my heartiest congratulations on the Jubilee of your Doctorate of fifty years' standing, which you are about to celebrate on the 15th of this month.

I got to know you 97 Semesters ago, when you were already on a higher shelf, adorned with a Doctor's hood. Since that time much light and shadow has passed over us both ; many good comrades who fought with us for their Doctor's Degree and for the progress of Science have gone to join the majority, and now they can make observations on Stella Spectra in other Worlds ! But we, who remain here on Earth, we have the pleasure of recollection, and you can look back upon a life of useful work under the ægis of the Heidelberg Doctorate—both with Bunsen and alone. As for me personally, through your whole life you have proved yourself a true friend, and I should like to express my thanks for this on your Jubilee, and also for the introduction to many friends, both past and present, and for many happy hours we have spent together ; and not I alone, but many others too.

INDEX

A.

Address on retirement from Parlialiament, 312.
Airy, Sir George, 118.
Allerton Hall, 2.
American friends, 227.
Apprenticeship and trade-schools, 198.
Arsenic-eating in Styria, 93.
Artificial indigo, 219.
Art schools in Paris, 200.
Asa Gray, 233–236.
Ashton, Thomas, 111.

B.

Baeyer, 219.
Balfour Stewart, 109.
Balmain, 15, 16.
Bartholomew's Hospital, offer of lectureship, 157.
Berthelot, 165.
Berzelius, 142, 144.
Birmingham, Mason College, at, 224.
Booths, the, 19.
Braid, Dr., and Mesmerism, 22.
British Association, 1864, Bath, 133.
Dublin, 163.
Glasgow, 1855, 67.
Liverpool, 1870, 156.
Manchester, 1861, 117.
Manchester, 1887, 229–236.
Montreal, 1884, 226.
Brodie, Sir Benjamin, 40, 43.
letters from, 181, 182.
Bunsen, 47.
absent-mindedness of, 57.
"Burner," "Photometer," 52.
death of, 79.
and gas analysis, 53.
Gesellschaft, 80.
and Kirchhoff, visit to England, 72–74.
letters from, 60, 81, 82, 83.
Bunsen, letter from Dr. Thorpe on, 84–89.
and his portrait, 75.
in retirement, 78.
mode of teaching, 49.

C.

Cambridge, Hon. LL.D., 226.
Carlsruhe, meeting of chemists, 68.
Carna Industrial Fund, 299.
Carnegie Trust, member of Executive Committee, 384.
Chemical Society of London, 171.
Jubilee of, 172.
Clark, Sir Andrew, 17.
Clerk Maxwell, J., 152.
Clifton, R. B., 109.
Coal-tar colours, 219–221.
Continuation schools for children, 294.
Cottage industries in Thuringia, 195.
Cotton famine in Lancashire, 1862, 124.
Creevey Papers, extract from, 8.
Crefeld, textile school at, 193.
Cromptons, the, 31, 59.

D.

Dalton, John, 113, 263.
lecture on, at Eton, 395–404 (Appendix).
picture of, 113.
Scholarship, 251.
Dalton, John, and the Rise of Modern Chemistry, 113.
Dalton's Atomic Theory, a New View of the Origin, 112.
Darbishire, Mr. S. D., 22.
Davies, Theodore L., 393.
Dittmar, Professor, F.R.S., 104, 106.
Drainage of the Palace of Westminster, 276.
Dublin, Hon. LL.D., 163.

Dumas, 164.
Dundee University College, at, 222.

E.

Eclipse expedition to Sicily, 158–161.
Enfield, Dr., 12.
  Edward, 59.
Eton, nominated to Governing Body of, 253.
Experimental lectures, difficulties of, 168–170.

F.

Fairbairn, Sir William, letter from, 148.
Faraday, last years of, 136.
  letters from, 139.
  picture of, 133.
Filtration of the air in the House of Commons, 278.
First Steps in Chemistry, Roscoe and Lunt, 243.
Fletcher, Thomas, 9, 12.
Foster, G. Carey, 30.
Friendships in the House of Commons, 288.

G.

Gaskell, Rev. William, 367.
Gateacre, life at, 11, 12.
German Chemical Society, hon. mem., 170.
Germany and the Germans, 98.
Gladstone, W. E., characteristics of, 281.
  portrait of, 281.
  and science, 282–285.
  speech by, 266.
Glasgow lecture, 128.
Government and Excise Officers, 34.
Graham, Thomas, 28.
Grants for Higher Scientific Education, 298.
Greenwood, Principal J. G., 104, 109, 184.
Guthrie, Dr., 104, 106.

H.

Harden, Dr. A., 112, 154.
Heidelberg, 44.
  fellow-students at, 48, 54, 55.
  degree, 58.
  400th anniversary, 75.
  laboratories, 51.
Helmholtz, 89–95.
Herschel, Sir John, 137, 141.
Hodgson, W. B., 16.
Holden, Sir Isaac, 289–294.
Holidays abroad, 371–382.
  whilst at Manchester, 365–366.
Holland, Sir Henry, 40.
Home life, 362–394.
  in Surrey, 386–394.
Home Rule, 265.
Hutton, Richard, and his wife, 33.
Huxley, T. H., letters from, 127, 147, 229.

I.

Investigation on Ventilation, 100.
Irish Members, 279.

J.

Jevons, Stanley, 39.
Joule, J. Prescott, 120, 121, 122, 123, 263.
Jubilee of Heidelberg degree, 358–361.
  addresses and letters received on the occasion of, 405–415 (Appendix II.).
  of Lord Kelvin, 382.
  of George G. Stokes, 383.
  Queen's, 1887, 237.
  1897, 238.

K.

Kimberley diamonds, 145.
King's Coronation, 238.
Kirchhoff and Bunsen, 69.
Kirchhoff, death of, 74.
Knighthood, 228, 229.
Kopp, 96.
  letters from, 77, 78, 97.

L.

Leo X., 2.
Lessons in Elementary Chemistry, 149.
Letters, curious, 114, 115, 116.
Liebig, 67.
Lister Institute, 329–331.
Liverpool Institute, 14.
  public lectures at, 170.
  Science and Art Classes, 165.
Lockwood, F., 294.

Long, W., and muzzling, 320.
Lorenzo de' Medici, 2.
Lowell, Augustus, letter from, 226.
Lyell, Charles, 135.

M.

Macmillan & Co., 155.
Magnus, Philip, 190.
Malden, 27.
Manchester, foundation of University of, 175–186.
resignation of Professorship of Chemistry at, 240.
review of work done at, 244–252.
University staff, 184.
Manchester Guardian, The, 270.
Manchester Philosophical Society, 112, 113.
Martineau, Dr. James, 21.
Metric system of weights and measures, 285–288.
Metropolitan Board of Works, 303.
Mohls, the von, 45, 46.
Morgan, De, 25.
Mundella, A. J., 288.
Museums, opening of, on Sunday, 295.

N.

National Science Union, 156.
Newman, Francis, 26.
Nottingham University College, 224.
Noxious Vapours Commission, 162.

O.

Original Research as a Means of Education, 1874, 218.
Owens College, appointment to, 102.
new laboratories, 110.
Oxford Professorship, offer of, 147.

P.

Paget, Sir James, 338.
Pasteur Institut, 314.
Pearson, 105.
Penny Science Lectures, 126.
Pharmacy Acts, amendment of, 273.
Philosophical Club of R. S., member of, 171.
Photography, 363.
Poggio Bracciolini, Life of, 12.
Political life, contest in 1886, 265.
my constituency, 260.
entrance into, 257.
meeting against Coercion Bill, 268.
my opponent in 1885, 261.
my opponents in 1886, 265.
election of 1892, 310.
retirement from Parliament, 1895, 311.
Polytechnics, English and German, 356.
Portrait by Burgess of H. E. Roscoe, 242.
by Herkomer of H. E. Roscoe, 242.
Publication of work with Bunsen, 60.

Q.

Queen's funeral, 238.

R.

Reform Club, Manchester, President of, 309.
Reform of Parliamentary elections, 294.
Reid, Hugo, 16.
Sir Wemyss, 392.
Rogers, Rev. William, 390.
Roscoe, Frank, 31, 32.
Henry, 10.
Mrs. Henry, 11.
H. E.
attends Birkbeck Lab., 33.
birth, 10.
B.A. degree, 44.
own family, 364.
lecture on "Bunsen and Kirchhoff's Spectrum Observations," 69.
lectures on Spectrum Analysis published, 140.
marriage of, 131.
matriculation of, 30.
private assistant to Williamson, 37.
reported death, 10.
researches on Tungsten, &c., 146.
Vanadium, 142–144.
taste for chemistry, 18.
tour in N. Germany, 1854, 58.
visits to Bunsen, '57–'63, 75.
work with Bunsen, 59.
work in London, 1856, 100.
pedigree of family, 7.
Dr. Richard, 12, 30.
& Whitbread, 6.
William, 1–6.
Wm. Caldwell, 31, 32.

Royal Commission for English Section of French Exhibition, 1878, 163.
Royal Commission of the Exhibition of 1851 Research Scholarships, 307.
Royal Institution, lectures at, 131, 132, 136, 139.
Royal Society, Fellow of, 131.
Rusholme Liberal Club, opening of, 270.

S.

Saccharine in beer, 270.
Samuelson, Sir Bernhard, 190.
Sandbach, Margaret, 20.
Sanitation in dwellings, 273.
Schorlemmer, 107, 154, 249.
Science Primers, 151.
Scientific Adviser to the Mersey and Irwell Joint Committee, 305.
Scotch Universities Royal Commission, 225.
Scott, A. J., 27, 102, 104.
Secondary Education, 215–217.
letter on, 208.
Sheffield, Firth College at, 223.
Shepherd, Dr., 12–14.
Silk-reeling mills of Italy, 196.
Slagg, John, M.P., 190.
Smith, Sir Swire, 190.
Society of Chemical Industry, 173.
Speech at Royal Academy Dinner in response for "Science," 320.
Stas, 96, 145.
Steam in weaving sheds, 300–302.
Stephen, Leslie, 64.
Stokes, George G., letter from, 70.
Student life, German, 62–65.
Suguira, 113.
Superintendence of Science Collections at South Kensington, 297.
Switzerland, education in, 191–193.

T.

Taylors, John, the, 20.
Technical Education, Royal Commission on, 187–217.
legislation upon, 209–211.
National Association for the Promotion of, 208, 211.
Report of Royal Commission on, 201–202.
speeches upon, 202–207.
Tennyson, meeting with, 271.
Thorpe, Dr. T. E., 35, 84–89.
Treatise on Chemistry, 153.
Tyndall, John, 129.

U.

Universities, German *v.* English, 65.
University College, London, 24.
University Colleges, 167, 168.
University of London, Chancellors of, 339.
change of quarters, 346.
and City Companies, 354.
deputation to King on his accession, 352.
examiner in chemistry, 337.
change from examining to tutorial system, 340–344.
Imperial Technical College to be founded, 355.
and medical education, 344–346.
member of Senate, 338.
Presentation Day, 348.
presentation of Mace, 353.
Vice-Chancellor of, 339.
University Teaching, Extension of, 354.

V.

Ventilation of dwellings and schools, 276.
of the Houses of Parliament, 275.
in workshops, 302.
Vittoria Colonna, Life of, 11.

W.

Ward, Professor A. W., 184.
Washington Irving, extract from *Sketch Book*, 9.
Water supply in London, 304.
Watts, Henry, 34.
Williamson, Professor A. W., 34.
Woodall, William, 190.
Würtz, 164.

Y.

Yateses, the, 19.

THE END

R. CLAY AND SONS, LTD., BREAD STREET HILL, E.C., AND BUNGAY, SUFFOLK.

LIBRARY

WORTHING,
BOGNOR,
Thomas's Library
Littlehampton.