



# Historical Group

## NEWSLETTER and SUMMARY OF PAPERS

No. 68 Summer 2015

Registered Charity No. 207890

### COMMITTEE

<b>Chairman:</b>	<b>Dr John A Hudson</b> Graythwaite, Loweswater, Cockermouth, Cumbria, CA13 0SU [e-mail: johnhudson25@hotmail.com]	<b>Dr Chiara Ceci</b> (RSC) <b>Dr Noel G Coley</b> (Open University) <b>Dr Christopher J Cooksey</b> (Watford, Hertfordshire)
<b>Secretary:</b>	<b>Prof. John W Nicholson</b> 52 Buckingham Road, Hampton, Middlesex, TW12 3JG [e-mail: jwnicholson01@gmail.com]	<b>Prof Alan T Dronsfield</b> (Swanwick, Derbyshire)
<b>Membership Secretary:</b>	<b>Prof Bill P Griffith</b> Department of Chemistry, Imperial College, London, SW7 2AZ [e-mail: w.griffith@ic.ac.uk]	<b>Prof Ernst Homburg</b> (University of Maastricht)
<b>Treasurer:</b>	<b>Dr Peter J T Morris</b> Science Museum, Exhibition Road, South Kensington, London, SW7 2DD [e-mail: Peter.Morris@sciencemuseum.ac.uk]	<b>Prof Frank James</b> (Royal Institution) <b>Dr Michael Jewess</b> (Harwell, Oxon) <b>Dr David Leaback</b> (Biolink Technology) <b>Mr Peter N Reed</b> (Steensbridge, Herefordshire)
<b>Newsletter Editor</b>	<b>Dr Anna Simmons</b> Epsom Lodge, La Grande Route de St Jean, St John, Jersey, JE3 4FL [e-mail: a.simmons@ucl.ac.uk]	<b>Dr Viviane Quirke</b> (Oxford Brookes University) <b>Prof Henry Rzepa</b> (Imperial College) <b>Dr Andrea Sella</b> (University College)
<b>Newsletter Production:</b>	<b>Dr Gerry P Moss</b> School of Biological and Chemical Sciences, Queen Mary University of London, Mile End Road, London E1 4NS [e-mail: g.p.moss@qmul.ac.uk]	

<http://www.chem.qmul.ac.uk/rschg/>  
<http://www.rsc.org/membership/networking/interestgroups/historical/index.asp>

# RSC Historical Group Newsletter No. 68 Summer 2015

## Contents

From the Editor	2
ROYAL SOCIETY OF CHEMISTRY HISTORICAL GROUP MEETINGS	3
ROYAL SOCIETY OF CHEMISTRY HISTORICAL GROUP AGM	3
ROYAL SOCIETY OF CHEMISTRY NEWS	6
RSC Chemical Landmark Plaque for Humphry Davy	6
Wikipedia Editathon	6
Members' Publications	6
PUBLICATIONS OF INTEREST AVAILABLE ELECTRONICALLY WITHOUT CHARGE	7
FEEDBACK FROM THE SUMMER 2014 NEWSLETTER – Alwyn Davis	7
CAN YOU HELP?	8
NEWS AND UPDATES	8
SOCIETY NEWS	8
SHORT ESSAYS	9
The Life of Carl Friedrich Claus: A German-British Success Story – Ralf Steudel and Lorraine West	9
Alfred Henry Allen: An Introduction – Peter Clare and Michele Clare	12
Animal Glue: A Traditional Technological Product – Frederick G Page	16
Alchemist in Residence: Artist Hilary Powell on her One-Year Artist Residency in UCL Chemistry – Hilary Powell	19
BOOK REVIEWS	20
Peter J.T. Morris, <i>The Matter Factory. A History of the Chemical Laboratory.</i> – Peter Reed	20
Kenneth Bertrams, Nicholas Coupain and Ernst Homburg, <i>Solvay: History of a Multinational Family Firm</i> – Peter Reed	21
Marco Fontani, Mariagrazia Costa and Mary Virginia Orna, <i>The Lost Elements: The Periodic Table's Shadow Side</i> – Alan Dronsfield	22
Eric R. Scerri, <i>The Periodic Table – A Very Short Introduction</i> – Bill Griffiths	23
Carl Djerassi, <i>In Retrospect: From the Pill to the Pen</i> – Derry W Jones	23
MEETING AND CONFERENCE REPORTS	25
The Life and Work of Sir John Cornforth AC CBE FRS	25
FORTHCOMING MEETINGS	27
FORTHCOMING CONFERENCES	28

## From the Editor

Welcome to the summer 2015 RSCHG Newsletter. If you have received the newsletter by post and wish to look at the electronic version it can be found at:

<http://www.rsc.org/historical> or <http://www.chem.qmul.ac.uk/rschg/>

The autumn RSCHG meeting will celebrate the Centenary of the award of the Nobel Prize to William and Lawrence Bragg for their work in crystallography. It will be held on Tuesday 13 October at the Royal Institution, 21 Albemarle Street, London. In the morning, Frank James will give the Wheeler Award Lecture entitled "Where Humphry Davy Learnt to be a Chemist: Thomas Beddoes and the Medical Pneumatic Institution in the 1790s". Full details on how to register for the meeting can be found in the flyer enclosed with the hard copy newsletter and also in the online version.

This issue contains a wide variety of news items, articles, book reviews and reports. The first short essay, "The Life of Carl Friedrich Claus: A German-British Success Story" is by Ralf Steudel and Lorraine West. This is followed by a biographical study of the nineteenth-century public analyst, Alfred Henry Allen, written by Peter and Michele Clare. Fred Page's article entitled "Animal Glue: A Traditional Technological Product" then follows. Hilary Powell has also contributed a fascinating piece on her work as artist in residence in the Chemistry Department at University College London.

There are four book reviews in this issue. The first is of a new book by the RSCHG Treasurer, Peter Morris, entitled *The Matter Factory: A History of the Chemistry Laboratory*. This is followed by reviews of Kenneth Bertrams, Nicholas Coupain and Ernst Homburg, *Solvay: History of a Multinational Family Firm*; Marco Fontani, Mariagrazia Costa and Mary Virginia Orna, *The Lost Elements: The Periodic Table's Shadow Side*; Eric R. Scerri, *The Periodic Table – A Very Short Introduction* and Carl Djerassi, *In Retrospect: From the Pill to the Pen*. A report also appears of the RSCHG meeting held in March 2015: "The Life and Work of Sir John Cornforth AC CBE FRS".

Finally I would like to thank everyone who has sent material for this newsletter, with particular thanks to the newsletter production team of Bill Griffith and Gerry Moss. If you would like to contribute items such as news, articles, book reviews and reports to the newsletter please do contact me. The guidelines for contributors can be found online at: <http://www.chem.qmul.ac.uk/rschg/Guidelines.html>

The deadline for the winter 2016 issue will be Friday 11 December 2015. Please send your contributions to [a.simmons@ucl.ac.uk](mailto:a.simmons@ucl.ac.uk) as an attachment in Word. All contributions must be in electronic form.

Anna Simmons  
University College London

## ROYAL SOCIETY OF CHEMISTRY HISTORICAL GROUP MEETINGS

### Wheeler Lecture and Bragg Nobel Prize Centenary Meeting

Tuesday 13 October 2015 at the **Royal Institution**, 21 Albemarle Street, London, W1S 4BS

11.00 Coffee

11.25 Welcome: John Hudson, Chair RSC Historical Group

11.30 **Wheeler Award Lecture.** Frank James

*Where Humphry Davy learnt to be a Chemist: Thomas Beddoes and the Medical Pneumatic Institution in the 1790s*

12.30 Royal Society of Chemistry Historical Group AGM

12.45 Lunch break.

Lunch is **not** provided, but there is a café/restaurant at the RI, and there are plenty of sandwich bars, etc., nearby.

### Meeting to mark the centenary of the award of the Nobel Prize to William and Lawrence Bragg for their work in X-ray crystallography

Session 1: Chair - Anna Simmons

14.00 Jennifer Wilson (University College London)

*The Early Career of Kathleen Lonsdale in X-ray Crystallography working with Sir William Henry Bragg*

14.45 Michael Glazer (University of Oxford)

*Lawrence Bragg's Role in X-ray Crystallography*

15.30 Tea

Session 2: Chair - John Nicholson

16.00 Rupert Cole (Royal Institution / University College London)

*Bragg and the Beeb: Lawrence Bragg, the Royal Institution and Televising Science, 1938-1965*

16.45 Richard Catlow, FRS (University College London)

*Using Synchrotrons, Neutrons and Computers to Unravel the Atomic Architecture of Matter*

17.30 Informal tour of RI

### REGISTRATION FORM

There is no charge for this meeting, but prior registration is essential. Please use the form below or the flyer included with the hard copy version of the newsletter and send it to Professor John Nicholson, 52 Buckingham Road, Hampton, Middlesex, TW12 3JG, [jwnicholson01@gmail.com](mailto:jwnicholson01@gmail.com), by **6 October**. **If having registered, you are unable to attend, please notify Professor Nicholson.**

I wish to attend the HG meeting on 13 October 2015 at the Royal Institution, London.

Name.....

Address.....

Email.....Acknowledgement required: Yes/No

## ROYAL SOCIETY OF CHEMISTRY HISTORICAL GROUP AGM

The fortieth Annual General Meeting of the Group will be held at the Royal Institution, 21 Albermarle Street, London, W1S 4BS at 12.30 pm on Tuesday 13 October 2015.

### Agenda

1. Apologies for Absence.

2. Minutes of AGM at Burlington House, 22 October 2014.
3. Matters arising from the Minutes.
4. Reports:
  - Chairman's Report.
  - Secretary's Report.
  - Treasurer's Report.
5. Future Meetings.
6. Election of Officers and other Members of the Committee.
7. Any Other Business.
8. Date, time and place of next meeting.

## Accounts 2014

Group Name: Historical Group		APPENDIX F		
		Key	£	£
<b>Receipts</b>				
Interest:	Current Account	1	0.00	
	RSC Deposit Account	1	74.75	
	Business Reserve Account	1	0.00	
Annual Grants		2	4,075.00	
Grants:	Outreach	3	0.00	
	Travel	3	0.00	
	Dividends	3	0.00	
	Other	3	7,000.00	
Donations		4	204.00	
Meetings and Conferences		5	600.00	
Other		6	0.00	
<b>Total Income</b>			<b>£12,153.75</b>	
<b>Payments</b>				
Meetings & Conferences:	General	7		4,826.10
	Committee meetings	7		320.10
	External Events Service	7		0.00
	RSC Events Service	7		0.00
Donations/Sponsorship		8		4,000.00
Committee Travel Expenses		9		125.00
Stationery/Postage		9		326.63
Committee Lunches at RSC		9		43.20
Audit		9		0.00
Other Expenditure		10		0.00
<b>Total Payments</b>				<b>£10,442.43</b>
<b>Surplus/(Deficit) for the year</b>		11		<b>£1,711.30</b>
<b>Check</b>				
Balance at 1st January 2014				11,062.64
Surplus (Deficit) for 2014		11		1,711.30
<b>Balance at 31st December 2014</b>				<b>£12,794.14</b>
<b>Balance Represented by Deposits in the Bank</b>				
Balance in Current Account				8,127.06
Balance in Savings Account				0.00
Balance in RSC Deposit Account (Wheeler Request)				4,667.08
<b>Balance as at 31st December 2014</b>				<b>£12,794.14</b>

Hon. Treasurer

Chairman

Auditor



## Minutes of the Thirty-Ninth Annual General Meeting of the Royal Society Historical Group

Held in the Chemistry Centre, Burlington House at 10.30 am on Wednesday 22 October 2014

1. **Apologies for Absence:** None received.

2. **Minutes of AGM** at Burlington House, Wednesday 23 October 2013. These had been published in the summer 2014 issue of the *Newsletter* and were accepted as a true record with one minor amendment.

3. **Matters arising from the Minutes:** There were none.

4. **Reports:**

### **Chairman's Report (Dr John Hudson)**

The Chairman reported on another successful year, in which Group numbers rose to 656. He remarked that as members of the RSC realise they can join groups for free, this number is likely to rise.

Dr Hudson noted that during the year three members of the Group had been honoured. Professor Ernst Homburg had been awarded the HIST award of the American Chemical Society in recognition of his work on the history of chemistry. Dr Diana Leitch and Dr Peter Wothers had both been awarded the MBE for services to chemistry.

During the year, the Group, jointly with the *Chemical Information and Computer Applications Group*, had launched a permanent exhibition on the origins of the elements and provided support for weekend workshops for families at the Catalyst Centre, Widnes, using a grant of £10,000 from the RSC. The exhibition had been opened officially by the past President of the RSC, Professor David Phillips, and was proving very popular.

The main activities during the year have been to run three conferences, as follows:

*Revolution in Analytical Methods* (18 March 2014).

*Chemistry as a Hobby* (18 June 2014).

*Wartime Research* (22 October 2014).

All were held at Burlington House (The Chemistry Centre) and were well attended. Attendance at the latter was particularly gratifying as, for the first time, we had introduced a registration fee of £15 for the day.

Two Newsletters were produced during the year, edited by Anna Simmons. They included a wide variety of items, with meeting reports, summaries of papers, book reviews and other articles. The Group has continued to be involved with the RSC's *Landmark Scheme*, which is being expanded to approximately six new ones per year.

Finally, the Chairman thanked the officers and committee members of the Group, who have supported him through the year

### **Secretary's Report (Professor John Nicholson)**

The Secretary reported that he had little to add, other than to report the attendance figures for the three conferences, which attracted between forty and sixty delegates per meeting.

### **Treasurer's report (Presented by Dr John Hudson)**

Dr Hudson gave the Treasurer's Report, as it covered the last year for which he was treasurer. As in recent years the Group's funds remain healthy, with £6490.49 in the current account and £4592.35 in the deposit account. The latter is ring-fenced money from the Wheeler bequest, which is used to fund the award of the Wheeler lectureship to mark outstanding scholarship in the field of the History of Chemistry. The Treasurer noted expenditure had exceeded income by a modest amount in 2013 (£143.32), but this was mainly due to a late bill for printing the January 2012 Newsletter.

Dr Hudson reminded the meeting of the decision that had been taken to distribute our Newsletter electronically to as many members as possible, though we continue to offer a hard-copy version to those who specifically request it. As noted previously, the majority of members now receive the Newsletter electronically, and the resulting savings to the Group are substantial.

## **5. Future Meetings**

We have plans for meetings in 2015, as follows:

The Life and Work of Sir John Cornforth, Nobel Laureate (for 18 March 2015).

Anniversary meeting celebrating the centenary of the Braggs' Nobel Prize (for October 2015, possibly at the Royal Institution).

## **6. Election of Officers and other Members of the Committee**

The Chairman, Secretary and Treasurer positions were not due for re-election at this AGM, so the current incumbents in these roles will continue for 2014/15. It was proposed from the Chair that the Committee be re-elected to serve for a further year, and this was agreed by the meeting *nem. con.*

Gordon Woods asked if there were RSC guidelines about the size of the committee. In reply, Dr Alan Dronsfield informed the meeting that our numbers were relatively high for an RSC committee, but not unacceptably so, and as each member plays an active role, he felt we had got the number about right.

**7. Any Other Business:** There was none.

**8. Date of Next AGM:** It will form part of our autumn 2015 meeting in October 2015, and details will appear in the Newsletter once they have been finalised.

John Nicholson

## ROYAL SOCIETY OF CHEMISTRY NEWS

### RSC Chemical Landmark Plaque for Humphry Davy

On Thursday 17 September 2015, an RSC Chemical Landmark plaque will be presented to the owners of the building in Penzance where Humphry Davy (1778-1829) was apprenticed to an apothecary from 1795 to 1798. Davy began his chemical self-education and performed his first experiments in this period. His master, John Bingham Borlase, recognised Davy's outstanding ability and released him early from his indentures to move to the Medical Pneumatic Institution in Bristol, where among other things he investigated the properties of nitrous oxide, including as a recreational drug. In 1801 he left for the Royal Institution in London, where his work on electrochemistry (a term he coined) brought him fame, including through the isolation of the elements sodium, potassium, magnesium, calcium, strontium, and barium. He also established the elemental nature of (and named) chlorine. In 1813 he recruited Michael Faraday, who himself had benefited from a benevolent master while an apprentice, and at whose place of apprenticeship in Marylebone a plaque was erected in 1875-6 (*RSCHG Newsletter*, summer 2013). 140 years later, at the suggestion of the Historical Group, a similar plaque will be erected for Davy. This will be on the 200<sup>th</sup> anniversary of Davy's invention of the miner's gauze safety lamp. Professor Frank James of the Royal Institution will give a talk on Davy's life and work.

### Wikipedia Editathon

A Wikipedia editathon – a collaborative event to improve Wikipedia content - will be held both at Burlington House, London and at Catalyst, a museum of the chemical industry, Widnes, and hosted by the Royal Society of Chemistry's Wikipedian in Residence, Andy Mabbett. All are welcome, but places are limited and advance booking is required. The focus will be on chemistry-related topics; including both scientific and non-scientific content (the latter including biographies, for example). The day will involve not only work on Wikipedia, but also on sister projects including Wikimedia Commons, Wikidata, Wikisource and others. Assistance will be available for people who have not edited Wikipedia before. Participants will be able to access the society's extensive library and RSC staff will be able to provide access to papers from the society's journals.

The London event will be held at Burlington House on 29 July 2015:

<http://www.rsc.org/events/detail/18874/wikipedia-editathon>

[https://en.wikipedia.org/wiki/Wikipedia:GLAM/Royal\\_Society\\_of\\_Chemistry/BH-2015](https://en.wikipedia.org/wiki/Wikipedia:GLAM/Royal_Society_of_Chemistry/BH-2015)

The Catalyst event will be held on 8 August 2015: <http://www.rsc.org/events/detail/18911/wikipedia-editathon>

[https://en.wikipedia.org/wiki/Wikipedia:GLAM/Royal\\_Society\\_of\\_Chemistry/Catalyst](https://en.wikipedia.org/wiki/Wikipedia:GLAM/Royal_Society_of_Chemistry/Catalyst)

### Members' Publications

If you would like to contribute anything to this section please send details of your publications to the editor. Anything from the title details to a fuller summary is most welcome.

E.J. Behrman, a book review of A.G. Davies and P.J. Garratt, *UCL Chemistry Department 1828-1974*, in *Bull. Hist. Chem.*, 2014, **39**, 101.

Chris Cooksey, *A Dyeing Industry* (book review): *The Coloration of Wool and Other Keratin Fibres*, eds. D.M. Lewis and J.A. Rippon; (Wiley with the Society of Dyers and Colourists, 2013, 439 pp), in *Chemistry & Industry*, February 2015, 48.

Keith Ramig, Olga Lavinda, David J Szalda, Irina Mironova, Sasan Karimi, Federica Pozzi, Nilam Shah, Jacopo Samson, Hiroko Ajiki, Lou Massa, Dimitrios Mantzouris, Ioannis Karapanagiotis and Christopher Cooksey, "The Nature of Thermo-chromic Effects in Dyeings with Indigo, 6-Bromoindigo, and 6,6'-Dibromoindigo, Components of Tyrian Purple", *Dyes and Pigments*, 2015, **117**, 37-48.

Thirteen fabrics are each dyed with either indigo, or 6-bromoindigo, or 6,6'-dibromoindigo. When the dyed fabrics, which had not undergone any finishing procedures, are boiled in water for 10 min, colour changes are observed: many indigo- and 6-bromoindigo-dyed fabrics turn more blue, while many 6,6'-dibromoindigo-dyed fabrics turn redder. These colour changes are characterized by reflectance spectra and colorimetry data. Evidence



is presented that the colour changes are related to particle sizes of the dyes: 6,6'-dibromoindigo-dyed carbon nanotubes, used as a fabric surrogate, show an increase in dye particle size upon heating, as judged by electron microscopy. Because we have shown previously that 6-bromoindigo-dyed carbon nanotubes give decreased dye-particle size when heated, we infer that, no matter the indigoid or fabric, smaller particles tend to cause a bluer fabric shade, while larger particles cause a redder shade.

Chris Cooksey and Alan Dronsfield, "Quirks of Dye Nomenclature: 4. Fuchsine, or Four Shades of Magenta", *Biotechnic & Histochemistry*, May 2015, **90**(4), 288-293 (doi:10.3109/10520295.2014.989543)

Fuchsine, also called magenta, was the second coal tar dye to be produced after mauveine. Fuchsine is composed of a mixture of up to four triphenylmethane dyes that differ only in the number of substituent methyl groups. Unlike mauveine, fuchsine still is widely used today as a biological stain. We describe the progress of fuchsine from its birth as the second coal tar dye, through a variety of modes of manufacture and industrial application, to its current use. We discuss complexities of nomenclature and identification, and the hazards and risks of its various applications.

Peter J.T. Morris, *The Matter Factory: A History of the Chemistry Laboratory* (London: Reaktion Books, 2015).

Peter Morris' new book looks at the series of shifts in laboratory design from eighteenth- and nineteenth-century furnace-centred, classical and industrial research laboratories to the creation of the modern laboratory at the end of the twentieth. It examines the laboratory space itself and the way it is used, from the scientists who developed it to its architectural design, layout and the materials used in its construction. A review by Peter Reed can be found later in this newsletter.

Marelene F. Rayner-Canham and Geoffrey W. Rayner-Canham, "Early Practical Chemistry at British Private Girls' Schools", *Bull. Hist. Chem.*, 2014, **39**, 131-137.

In this paper, we show that there has been a rich forgotten history of chemistry laboratory work at British independent girls' schools. This latest publication is the sixth part of a series on aspects of the history of women in British chemistry. The previous parts (all published in the *Bulletin for the History of Chemistry*) were: "British Women Chemists and the First World War", (1999, **23**, 20-27); "Pounding on the Doors: The Fight for the Acceptance of British Women Chemists", (2003, **28**, 110-119); "British Women and Chemistry from the 16th to the mid-19th Century", (2009, **34**, 117-123); "The Teaching of Tertiary-Level Domestic Chemistry in England in the Early 20th Century", (2011, **36**, 35-42); and "Chemistry in English Academic Girls' Schools, 1880-1930", (2011, **36**, 68-74).

## **PUBLICATIONS OF INTEREST AVAILABLE ELECTRONICALLY WITHOUT CHARGE**

Brian Halton, *A Legacy of Lancashire: Its Chemists, Biochemists and Industrialists*

This booklet give the names of the chemists in sequence from William Henry (b. 1774) to the present with a profile of each that provides some indication of the person and the work for which they are recognised. The early scientists attract a more detailed account than those who are still practising the profession and adding to the kudos that they already have gained.

The booklet is available direct from Brian Halton by emailing: Brian.Halton@vuw.ac.nz in any one of PDF, EPUB or your Mobi Kindle formats OR from the RSC Library where it has been uploaded and recorded in their catalogue with the PDF as an attachment by David Allen, the Library Collections Coordinator.

Alan Rocke, *Chemical Atomism in the Nineteenth Century, From Dalton to Cannizzaro* (Ohio State University Press, 1984). This book has long been out of print, and the few copies that are available from out-of-print dealers are very expensive. The copyright, which for many years was owned by the press, recently reverted back to the author, Alan Rocke, who has the authority to make the book available on the web to anyone. It is now available on the "Digital Case" website, Case Western Reserve University's open-access digital repository. The URL to take you to a pdf of the book is <http://digital.case.edu/concern/texts/ksl:x633gj985>.

## **FEEDBACK FROM THE SUMMER 2014 NEWSLETTER**

### **The Solution to a Problem**

In the summer 2014 edition of the Newsletter I asked for suggestions regarding the use of two silver conical flasks and some unidentified silver devices which we had found in our departmental safe at UCL. Alex Jones seems to have found the answer in a paper by Edgar Philip Perman in *Transactions of the Faraday Society*, 1921, **27**, 59-69.

Perman (1866-1947) had been a Clothworkers Exhibitioner at UCL and in 1889 published a paper on determining the boiling point of sodium and potassium, thanking William Ramsay for advice. He then appears to have spent all his subsequent career at what is now Cardiff University, working on the physical properties of liquids. His 1921 paper is in part on the vapour pressures of aqueous solutions of sodium hydroxide: he draws air through bubblers

containing the solution and estimates the weight of water which evaporates by absorbing it in concentrated sulphuric acid.

The last three (bubblers) were made all in one piece of pure silver, the makers being Walker and Hall, Sheffield. It was essential that they should be made of pure silver to ensure that the solutions should be free of all traces of silicates which would be formed by the action of the strong caustic soda solutions on glass at the high temperatures of the experiments.

He does not show a picture of the bubblers but their capacity of about 30 mL is similar to that of our devices which presumably were intended for some similar purpose.

This identification is strengthened by the fact that he prepared his caustic soda solution in pure silver flasks fitted with a rubber stopper. These could be the equivalent of the silver conical flasks which we found together with the bubblers. The hallmarks on our flasks date them from 1923 but what we now recognise to be the bubblers are not hallmarked.

The question remains as to what these flasks and bubblers, which appear to be unused, were doing in our safe. At the time, F.G. Donnan was Professor of General Chemistry and Norman Collie was Professor of Organic Chemistry, but this silver apparatus does not appear to be immediately relevant to any work which they or their colleagues were publishing.

Alwyn Davies  
a.g.davies@ucl.ac.uk

## CAN YOU HELP?



Doug Crump writes: A colleague, Tony Woolhouse, who died recently, had an extensive collection of photos of notable chemists. A number of these were unlabelled and we have managed to identify all but this one. Tony gained his PhD in 1973 and was a postdoc at Liverpool in 1974. Any help will be gratefully received. Please contact the RSCHG Secretary, John Nicholson, on [jwnicholson01@gmail.com](mailto:jwnicholson01@gmail.com).

## NEWS AND UPDATES

### Liebig's Extract of Meat Company Factory placed on World Heritage List

On 5 July 2015 UNESCO announced that the factory set up at Fray Bentos on the River Uruguay in 1865 by the Liebig Extract of Meat Company was approved as a cultural site on its World Heritage List. The citation reads:

*Fray Bentos Cultural-Industrial Landscape (Uruguay)* – Located on land projecting into the Uruguay River west of the town of Fray Bentos, the industrial complex was built following the development of a factory founded in 1859 to process meat produced on the vast prairies nearby. The site illustrates the whole process of meat sourcing, processing, packing and dispatching. It includes buildings and equipment of the Liebig Extract of Meat Company, which exported meat extract and corned-beef to the European market from 1865 and the Anglo Meat Packing Plant, which exported frozen meat from 1924. Through its physical location, industrial and residential buildings as well as social institutions, the site presents an illustration of an entire process of meat production on a global scale.

The site apparently includes the laboratory originally designed by Liebig for testing the quality of meat extract. The listing is due to the efforts of the philosopher of chemistry, Lucia Lewowicz, Professor of the History and Philosophy of Science at the Universidad de la República in Montevideo. See her “Justus von Liebig in Uruguay? His last ten years of research” on her website: <http://uruguay.academia.edu/LuciaLewowicz>.

## SOCIETY NEWS

### Académie Internationale d'Histoire des Sciences

Professor Frank James has been elected as a Membre Effectif (full member) to the Académie Internationale d'Histoire des Sciences. He was previously a Membre Correspondant.



## History Division of the American Chemical Society

The History Division of the American Chemical Society is delighted to announce that Professor Dr. Christoph Meinel has been awarded the HIST Prize for 2015. Dr. Meinel's extensive body of historical work has earned him a position at the centre of the international community of historians of chemistry. His research interests include the emergence of chemistry as a discipline, its social history, communication and publication networks. He has also published on various aspects of early modern natural philosophy. In addition to scores of articles in journals such as *Ambix*, *Hyle*, *Isis*, *Angewandte Chemie*, and *Berichte zur Wissenschaftsgeschichte*, Meinel's work has appeared in dozens of multiauthor books, both as an author and editor. His monographs include a major series of books on Joachim Jungius (1587-1657). He has served as president of the German Society for the History of Science, and was the founding president of the International Commission on the History of Modern Chemistry. From 1990 through 1997 and again since 2014 he chairs the History Division of the German Chemical Society (GDCh) and is editor of the Division's journal *Mitteilungen*.

## SHORT ESSAYS

### The Life of Carl Friedrich Claus: A German-British Success Story

The important *Claus Process* is carried out on a very large scale in refineries to convert hydrogen sulfide from oil desulfurization into very pure elemental sulfur with the help of a metal oxide catalyst. H<sub>2</sub>S extracted from sour gas is also treated in this way. The first patent on this process was granted to C.F. Claus in 1883 when he was living in England as a highly creative freelance chemist. However, Claus had his roots in the former Electorate of Hessen-Cassel, now a State of the Federal Republic of Germany; his family always kept strong ties to Hessen.

#### Family Life

C.F. Claus (CFC) was born on 9 November 1827 in the city of Cassel (since 1926: Kassel) as a first child of "Oberpostmeister" (senior post master) Christian Claus and his wife Elise. His brother Wilhelm Heinrich was born in 1830. At that time Cassel had around 30,000 residents. The family was living in Cassel-Oberneustadt, Am Königsplatz 160, which is located right in the centre of the city. In present-day Germany, Kassel is located close to the geographical midpoint of the country and has around 194,000 residents.

In 1832 Christian Claus was granted a new position at the postal service in Schmalkalden (94 km south-east of Cassel), and the family moved to this charming town of 5,000 residents, also located in Hessen (today it has around 20,000 citizens and belongs to the State of Thüringen, neighbouring Hessen). In Schmalkalden two more children were born to the Claus couple. In 1834 Christian Claus died and his widow Elise Claus moved with the four children to Marburg where she evidently had relatives. Marburg, also in Hessen, has always been best known for its famous University founded in 1527 [1].

Thus, it seems quite natural that C.F. Claus, at the age of nineteen, was enrolled at this university as a student of chemistry (in 1846). At that time Robert Bunsen was teaching chemistry and physics there. According to the university archive, CFC interrupted his studies for a longer stay in North America but was enrolled in Marburg again in the fall of 1848. Interestingly, at that time John Tyndall and Edward Frankland were also students in Marburg. In the summer of 1852, at the age of almost twenty-five, CFC had obviously graduated from the university (but without a doctorate) although corresponding documents are missing.

In August 1852 CFC moved to Liverpool, England, where he subsequently applied for citizenship. This was granted on 10 December 1855 after the waiting period of three years of continuous residence within the United Kingdom was over. From that time he used the name Charles Frederick Claus in British documents. In his application he declared that he wanted to establish himself as a "Manufacturing Chemist". At that time, he was already married to Mary Brown, born in 1825 in Sunley-Court, Yorkshire. Five children were born to the couple: Pauline (born 7 July 1855 in Liverpool), Elizabeth (born 21 July 1857 at Latchford, Warrington), William Henry (born 4 April 1860 at Fearnhead Hall, Fearnhead near Warrington, Lancashire), Carl Friedrich (born 14 October 1861 also at Fearnhead), and Catherina Louisa (born 10 July 1868 at Grove Hill Marton, Middlesbrough, Yorkshire). From the various birthplaces of the children it can be seen that the family moved around, but by 1871 they had settled at Grove Hill Marton near Middlesbrough. In 1876 CFC's address was listed as Great St. Helen's, in the City of London, which was possibly his office. However, in a patent of 1895 his address was given as 88 Yeldham Road, Hammersmith, while in a patent of 1898 his address was mentioned as 9 Oxford Road, Gunnersbury. Altogether, eleven residences in England can be found for CFC. In the 1861 Census his occupation was listed as "Analytical Chemist".

C.F. Claus's wife, Mary Claus, passed away in Wiesbaden, Germany, on 25 April 1880 at the age of almost fifty-five. She had been living in Wiesbaden for some years already together with her daughters Pauline and Elizabeth. Interestingly, her son Carl Friedrich Claus junior also became a chemist, educated partly at the Technische Hochschule München, where he was enrolled in 1883. However, later he was working in England. He died in 1904. Both father and son Carl Friedrich Claus were members of the *Society of Chemical Industry* (SCI) in 1898. In this context, CFC jr. was listed as "Electrochemist and Metallurgist of Clifton Junction, Manchester".

On 14 June 1900, the widower Carl Friedrich Claus senior, aged 72, married his second wife, the spinster Caroline Barry, who was forty-eight years old at the date of marriage, in Hammersmith. On this occasion, the address of their residence was given as 110 Godolphin Road. In the marriage certificate, Claus is mentioned again as “Chemist”. The couple may have lived together for several years already. Ten weeks after marriage, on 29 August 1900, Carl Friedrich Claus died at 9 Oxford Road, Gunnersbury, as a well-off businessman. According to his will of 22 July 1900 his much younger wife inherited his “various houses”; Caroline Claus died in 1926. Descendants of CFC are now living in England and most probably in Germany since his daughter Pauline got married in Frankfurt/Main in 1882 to the chemist and hotel owner Dr. Friedrich Ludwig Roser; they had four children and lived in Wiesbaden. Pauline died in Wiesbaden on 20 January 1924.

### Professional Life of C.F. Claus Senior:

Relatively little is known about the professional life of C.F. Claus senior except for the many patents he applied for from 1855. Only some were granted to him over the years (see below) since some of his applications became void as he either did not have the money to continue or decided not to follow through. At a time he was an insolvent debtor, so he must have been struggling financially during the first few years he was in England. He even spent time in Lancaster Jail around 1860 [2].

In one of his patents CFC sr. is mentioned as “Consulting Chemist”. Eventually, he may have been working as a patent agent in the City of London. He was also involved with the company *Ammonia Gas Purifying and Alkali Company Ltd.* in London, which used his invention to make elemental sulfur from the hydrogen sulfide recovered from coal gas. This company had been formed in 1881 “for the purpose of acquiring four patent rights, dated 1877 and 1881, and carrying out the inventions of Mr. C.F. Claus for purifying crude coal gas by the application of ammonia gas”; CFC was employed as a “Manufacturing Chemist” at this company [3]. His son William Henry Claus was also a “Manufacturing Chemist” and director of *Claus & Co Ltd., Aniline Dye and Chemical Manufacturers*, at Clayton near Manchester in 1889. It seems possible that CFC had a financial stake in it too. William Claus died on 17 April 1936 in Wiesbaden, Parkstrasse 5.

Most important among CFC’s patents is the one describing the production of elemental sulfur by oxidation of hydrogen sulfide with air at elevated temperatures in what has later been called a “Claus kiln” (furnace) using a metal oxide catalyst (German Patent nr. 28758, and British Patent 5958, both of 1883). Today this method (after considerable modifications [4]) is known as the “Claus process” [5]. It is applied worldwide on a large scale to process hydrogen sulfide from the desulfurization of crude oil by hydrogenation, especially in oil refineries. Figure 1 shows sections of a modern Claus plant at the refinery of *Bayernoil* in Bavaria.



**Figure 1:** Claus plant of the *Bayernoil* refinery in Bavaria, Germany.

Hydrogen sulfide extracted from natural gas (“sour gas”) is also oxidized to elemental sulfur by the Claus method, and the very pure sulfur obtained is usually termed as “Claus sulfur”. The term “Claus process” was first used in patent GB189807269 granted to Wladimir von Baranoff, Eugene Hildt and C.F. Claus senior in 1898 (see below).

In this context it is interesting to note that only in 1777 naturally occurring elemental sulfur was recognized as a chemical element by Antoine de Lavoisier (1743-1794) in Paris [6]. The molecular size  $S_8$  in solution was first determined correctly by cryoscopy and ebullioscopy in 1890 [6], and the crystal structure of sulfur was first resolved in 1935 by X-ray diffraction on a single crystal [7]. However, only in 1988 it was discovered that both Claus sulfur and many naturally occurring sulfur crystals contain traces of  $S_7$  molecules built into the crystal structure of  $S_8$  as a kind of solid-state defect [8]. It is this  $S_7$  content of ca. 0.5% which is responsible for the well-known bright-yellow colour of pure elemental sulfur prepared from either liquid or gaseous sulfur which both contain other sulfur rings in equilibrium with  $S_8$  [9]. However, for CFC sulfur was just “S” in the chemical equations given in his patents.

In Figure 2 [10] a deposit of sulfur crystals on the island of Vulcano (Italy) is shown, formed by air-oxidation of hydrogen sulfide as a component of hot volcanic exhaust gases; the sulfur at this location is also known for its relatively high selenium content of up to 680 ppm [8]. In Figure 2 the gas vents can be recognized from the surrounding orange-red coloured sulfur which evidently is hotter than 25°C since sulfur is a thermochromic material.



**Figure 2:** Sulfur deposits on the slopes of the volcano on Isola Vulcano (Italy)

Before C.F. Claus senior turned to the chemistry of sulfur he took out patents for bricks made from slag in the early 1870s. At this time he may have worked for the steel industry in Middlesbrough. Earlier, he seems to have already been associated with the Leblanc industry as he patented a process for making chlorine in 1867 [11]. In the *London Gazette* dated 29 August 1876 C.F. Claus sr. is mentioned as one of three inventors for “improvements in the manufacture of salts of barium and other salts, which improvements are also applicable to the extraction of silver from argentiferous pyrites”; dated 14 November 1870 [11].

In addition, the following patents (in chronological order) granted to Carl Friedrich Claus sr. during the period 1877-1899 have been found in the literature [12]; they are all dealing with sulfur compounds.

1. British Patent GB 18780816:  
C.F. Claus (1878): *Improvements in the Manufacture of Sulphide and other Compounds of Zinc, and in the Production of By-products Resulting Therefrom*
2. German Patent DE 6733 18790220:  
C.F. Claus (1879): *Mixture of Zinc Sulphide and Barium Sulphate as a Base for Paint*
3. U.S. Patent 264 801:  
Roger W. Wallace and Carl F. Claus (1882): *A Utilization of By-Products in the Manufacture of Coal-gas*. Patented in England on 20 January 1877, No. 273.
4. German Patent 23763:  
C.F. Claus (January 1883): *Verfahren der Reinigung von Leuchtgas mittels Ammoniakgas (Process for the Purification of Coal-gas with Ammonia)*
5. U.S. Patent 272 375:  
C.F. Claus (February 1883): *Manufacture of a White Paint*
6. German Patent 28758:  
C.F. Claus (November 1883): *Neuerung bei dem Verfahren zur Gewinnung von Schwefel bzw. Schwefliger Säure aus Schwefelwasserstoff (Invention concerning the Production of Sulfur resp. Sulfurous Acid from Hydrogen Sulfide)*
7. U.S. Patent 349 981:  
C.F. Claus (September 1886): *Obtaining Sulphur from Hydrogen Sulphide*
8. U.S. Patent 354 393:  
C.F. Claus (December 1886): *Process of Obtaining Sulphur from Sulphureted Hydrogen*
9. British Patent 1895 21380:  
C.F. Claus (1896): *Improvements in the Roasting of Sulphide Ores and Mattes*
10. British Patent 1898 07269 (A):  
Wladimir von Baranoff, Eugene Hildt, and Carl Friedrich Claus (1899): *Improved Processes for Producing the Sulphides of the Alkalies and of the Alkaline Earths from the Sulphates thereof, and for Obtaining from such Sulphides, Free Sulphur, Sulphurous Acid, Sulphide of Hydrogen, and Carbonates of the Alkalies*.

Several of these patents have been granted to him in other countries too, sometimes even earlier than the ones mentioned here. But at present the full texts are available to the authors only for the patents mentioned as numbers three to ten [13].

From the many different addresses CFC sr. had in England one may conclude that he worked mainly as a freelance chemist. However it is not exactly known which of his many inventions enabled him to make the money that allowed him to buy several houses which he owned when he died in 1900. While white paint based on BaSO<sub>4</sub> and ZnS is still in use today (Lithopone), the large scale production of sulfur from H<sub>2</sub>S by the Claus method started only with the boom of the oil industry in the twentieth century. However, since 1881 the Claus process has been applied for the desulfurization of H<sub>2</sub>S containing gases from soda production by the Leblanc process and from coal processing [3] since 1890 on a much larger industrial scale [4,5]. Therefore, the corresponding inventions may well be the origin of his much improved financial situation at the end of his life. Today, single Claus plants with a capacity of 2,000 tons of sulfur per day exist, especially in the Middle East and at the Caspian Sea, and it has been estimated that ca. 1,600 Claus plants were operating worldwide in 2007. The high capacity is partly the result of a better catalyst (TiO<sub>2</sub> instead of Al<sub>2</sub>O<sub>3</sub>) and of oxygen enrichment in the combustion air [4].

## References

1. Some of the information about CFC's life in Hessen was obtained by personal communication from the city archives of Kassel, Schmalkalden and Marburg. The authors acknowledge the assistance of Lina Haier (Kassel), Birgit Werner (Schmalkalden) and Carsten Lind (Marburg).
2. *London Gazette*, 4 December 1860.
3. *London Standard*, 10 December 1881; see also *The Western Daily Press* (Bristol), 6 March 1883.
4. B. Schreiner, *Chemie in unserer Zeit*, 2008, 42, 378-392; A. Piéplu, O. Saur, J.-C. Lavalley, O. Legendre, C. Nédez, *Catal. Rev., - Sci. Eng.*, 1998, 40, 409-450; W. Nehb, K. Vydra in *Ullmann's Encyclopaedia of Industrial Chemistry*, 5<sup>th</sup> ed., Vol. A25 (Weinheim: VCH, 1994), 507-567. [http://en.wikipedia.org/wiki/Claus\\_process](http://en.wikipedia.org/wiki/Claus_process)
5. For the first report on the modern improved Claus process invented by I.G. Farbenfabriken A.G. in Germany, see: H. Baehr in *Refiner & Natural Gasoline Manufacturer*, 1938, 17(6), 237-244 as well as U.S. patents 2200529 19400514 (1940) and 2123224 19380712 (1938) by H. Baehr *et al.*
6. *Gmelins Handbuch der Anorganischen Chemie*, 8. Aufl., „Schwefel“, Teil A, Lieferung. 3 (Weinheim: VCH, 1953), 728-729.
7. J. Donohue, *The Structures of the Elements* (New York: Wiley, 1974), 328.
8. R. Steudel, B. Holz, *Z. Naturforsch. Part B*, 1988, 43, 581-589.
9. R. Steudel, R. Strauss, L. Koch, *Angew. Chem. Int. Ed. Engl.*, 1985, 24, 59-60.
10. Foto: Alexander Buinger, Germany.
11. Personal communication with Peter Morris, Science Museum London.
12. Sources: *SciFinder*; *Chemisches Zentralblatt*; <https://depatisnet.dpma.de>; [https://www.google.co.uk/?tbn=pts&gws\\_rd=cr,ssl&ei=rWeqVKbLBOuN7Aai04GgDg#tbn=pts&q=Carl+Friedrich+Claus](https://www.google.co.uk/?tbn=pts&gws_rd=cr,ssl&ei=rWeqVKbLBOuN7Aai04GgDg#tbn=pts&q=Carl+Friedrich+Claus); <http://worldwide.espacenet.com>.
13. From the first author (R.S.) on request.

Ralf Steudel, Techn. Univ. Berlin ([www.sulfur-research.de](http://www.sulfur-research.de))  
Lorraine West, Scotland ([lorrainewest03@gmail.com](mailto:lorrainewest03@gmail.com))

## Alfred Henry Allen: An Introduction

### Summary

Alfred Henry Allen was one of the first analytical chemists to be appointed as a Public Analyst in the United Kingdom and the first appointed by the City of Sheffield. He was a founder member of the Society of Public Analysts and served as its President in 1887-1888 and was also a founder member of the Institute of Chemistry. Through his work as an analytical scientist he played a major role in the battle against food adulteration and in promoting food and water safety in Victorian Sheffield and Britain. His many achievements were published in scientific papers and books which recorded the results of his and other public analysts' work. Tragically he died at the early age of fifty-eight years on 14 July 1904 [1].

### Introduction

Alfred Henry Allen (1846–1904) was an extraordinary Victorian Chemist and Public Analyst, who practised from premises in the centre of Sheffield, in the latter part of the nineteenth century. This was a period of great change in society, both industrial and domestic. The industrial revolution continued to gain momentum and shifts in population placed a considerable strain on the resources, including food and drink, of towns and cities. People moved from the countryside to the cities. The population of Sheffield grew from 60,000 in 1801 to 451,000 in



1901. This had major effects on the quality of the food and potable water supplied. Allen's skills as an analytical scientist provided a much needed ability to investigate the wholesomeness of food and water.



Allen, from his busy practice on Surrey Street in Sheffield, published over 150 scientific papers, thirteen volumes and three editions of *Commercial Organic Analysis*, and books on the chemistry of urine and on milk and milk products. The events that undoubtedly influenced him include his early work with Dr Arthur Hill Hassall and the comments of the Parliamentary Select Committee which investigated food adulteration in 1874. These comments were made to the analysts, who gave evidence.

Around the time of Allen's birth, the corn laws were being repealed by the Conservative administration of Prime Minister Robert Peel. The impact of the industrial revolution and the repeal of the corn laws resulted in food being more available and less expensive but manufactured rather than locally sourced and domestically prepared. The population was largely reliant on suppliers and thus had, in the main, lost control of their food preparation.

#### **The Influence of Hassall, the First Food Analyst**

By the mid-nineteenth century concern about the quality, contamination and adulteration of food had grown, particularly amongst the medical profession. The secretary and founder of the *Lancet*, Thomas Wakley, commissioned Hassall in 1850, to investigate and report on the composition of food. Earlier Frederick Accum, a chemist of German origin who was resident in London, had

published his *Treatise on Adulterations of Food and Culinary Poisons* in 1820. Alexander Wynter Blyth in his book *Foods: Their Composition and Analysis* provides an extensive list of general treatises on food adulteration. Hassall was regarded as both the first food analyst and an enthusiastic microscopist. He set about his task in a systematic manner, and reported on the analysis of 2063 foods and 324 drugs and presented his evidence of food adulteration.

Hassall's book, titled *Adulterations Detected*, contained the analytical methods and microscopical details of his work on samples of food. The analytical scientific work involved microscopy together with extraction procedures using decanting techniques, combustion methods, spot tests and drying operations. The standard of microscopy was surprisingly high and the published diagrams of microscopical findings were of excellent quality, being the result of engraving techniques.

Examples of Hassall's investigations include:

- i) the presence of strychnine in beer as a bitter
- ii) mineral acids such as sulphuric acid in vinegar
- iii) copper salts being used as food colours
- iv) alum as a whitener in flour and in bread
- v) infestations
- vi) red lead in cayenne pepper
- vii) potato starch in many foods as a diluent

In 1862, Allen (aged around sixteen) joined Hassall at his laboratory in Wimpole Street, London, as a laboratory assistant. For two years he gained invaluable experience of food analysis at a time when Hassall's influence on events was considerable. During this period Allen gained certificates of education in Mineralogy (1863 and 1864), Geology (1863), Inorganic Chemistry (1865) and Applied Mechanics (1865). These certificates were awarded under the Science and Art Department of the Privy Council on Education. By 1864 he was keen to move into metallurgy. To achieve this he relocated to join the practice of James Allan, who was not a relative, in the centre of the steel city, Sheffield. In 1866 James Allan contracted diphtheria and died but was able, before death, to pass the practice into Allen's hands. Allen was twenty years old. As Pasteur commented in 1854, chance favours the prepared mind.

#### **Allen's Domestic Life and Popular Lectures**

Allen's first Sheffield Residence was the second floor flat at the Surrey Street premises. His last house was at 8 Broomfield Place where his household included his wife, Mary, whom he married in 1871 and his three daughters Maude, Emily, and Amy. In addition, the household included a cook and a housemaid and Mr. Scott-Smith, who was to marry into Allen's family. This last house is now a part of a hotel, the "Rutland". Allen was well known for his lectures and regularly gave talks and entertainments. The following are examples of the titles of his lectures:

A Box of Matches  
Alchemy and the Alchemist  
Visible Sound  
Chemistry of Explosives  
Artificial Light  
Humbug: Ancient and Modern

### **The Parliamentary Select Committee of 1874**

By 1874 general dissatisfaction with earlier food acts was put forward, especially from members of the food trade who alleged that poor analysis was resulting in unfair prosecutions. A Parliamentary Select Committee, which sat in 1874, was formed to take further evidence. Allen along with other analysts gave evidence to this committee and was described as pugnacious in his delivery. The committee expressed concern to the analysts. They deplored their lack of experience and also the lack of a definition of "adulteration". Furthermore the committee suggested that the analysts consult amongst themselves on these matters. A preliminary meeting was held at the City Terminus Hotel in London in July 1874 with six analysts, including Allen, present. The main meeting in August of that year was attended by twenty-five analysts, again including Allen. These meetings led to the formation of the Society of Public Analysts and a definition of "adulteration" was completed. Noteworthy public analysts of this era included Theophilus Redwood, the first president of the Society of Public Analysts, who was also professor of chemistry at the Pharmaceutical Society, and Otto Hehner, who initially worked with Hassall after Allen. Augustus Voelcker was the advisor to the Royal Agricultural Society. A. Wynter Blyth, Public Analyst for the county of Devon was also a Barrister and a Medical Officer of Health. Bernard Dyer, who earlier had worked under Voelcker, had the presence of mind to record much of the early life of the public analysts' world. Noteworthy also was Emil Reichert who found fame with his butter fat analysis method.

### **Some Examples of Allen's Scientific Work**

#### **The Nitrometer**

Allen devised and marketed a glassware apparatus, which he called the Nitrometer, which was used for the determination of the strength of the medicinal preparation Spirit of Nitrous Ether. This was used as a stimulant and carminative and was listed in the *British Pharmacopoeia* of 1867. In this apparatus, the chemicals potassium iodide and sulphuric acid were used to liberate nitrous oxide from the preparation as a measure of its strength. This nitrous oxide was in the enclosed environment of his nitrometer. In 1885 he read his paper on "The Determination of Ethyl Nitrite and the Change Undergone by the Spirit of Nitrous Ether on Keeping" to the British Pharmaceutical Conference. This subsequently appeared in the *Pharmaceutical Journal* in February 1885. His new method was adopted by the editors of the *British Pharmacopoeia* and it appeared in the next edition of 1885.

#### **Whisky**

The higher alcohols of butyl and amyl alcohol comprise what was traditionally termed fusel oils, the thick and viscous residue left after ethyl alcohol and similarly volatile components had evaporated from whisky and other spirit drinks. They affect the flavour of spirit drinks. Quantification of these was approached in the laboratory of Allen's era by dilution of the whisky with water, extraction of the fusel oil into chloroform and subsequent oxidation of the alcohols to the acids such as valeric using chromic acid. Allen's contribution to the procedure was to use carbon tetrachloride as the extracting solvent rather than chloroform because it had a higher boiling point, making it more suitable for the oxidative step, and it was also lower in impurities, which produced mineral acids during oxidation. The proportion of organic acids so produced were determined either by gravimetric procedure using barium carbonate or by titration.

In a footnote on the matter in the third edition of *Commercial Organic Analysis*, Allen relates the following:

Early in last summer I was led to look carefully into the published statements respecting the proportion of fusel oil and amyl alcohol in whisky, and it was then that I discovered the paucity of information on the subject. A well-known firm of Irish distillers supplied a cask of whisky to a customer. When he had drunk the greater part of the whisky the customer refused to pay for it, alleging that it had made him ill; and when sued for the amount due brought a counter action for the injury to health, owing to his having been supplied with whisky containing a large percentage of fusel oil. This statement was hardly borne out by his analyst, who had found 0.22 per cent of amylic alcohol, while I, (Allen), who had analysed the spirit on behalf of the distillers, had found but 0.07 per cent. In consequence of this discrepancy, the judge, at my suggestion, instructed us to make a joint analysis, the result of which was that we agreed that 0.07 was the correct figure.

As the amyl alcohol in spirits rarely exceeds 0.1 per cent, 70 grains per proof gallon, it seems highly improbable that it can produce the local effects sometimes attributed to it. Its effects on the general system have been probably greatly exaggerated. A pupil of mine informs me that some years ago he took a teaspoon of fusel oil, mixed with water without any ill effect. Recently for three weeks I took every evening, with few exceptions, a wine glass full of whisky to which crude fusel had been added to the extent half, one and ultimately two per cent. The spirit was extremely nauseous, but produced no headache or other ill effects.



## **The Action of Water on Lead**

In 1888, and during his presidency of the Society of Public Analysts, Allen read his paper “The Action of Sheffield Water on Lead, and its probable Cause and Cure” to the Sheffield Literary and Philosophical Society. Allen was a supporter of this society and indeed served as its President during 1881. Sheffield mains water had been found to contain elevated concentrations of lead at around 0.2 grains per gallon, (2.8 mg per litre) and up to 0.7 grains per gallon (10 mg per litre). Lead poisoning had been found in many of the population of Sheffield, the symptoms including aching joints, blue lines on the gums and kidney damage. In 1882 Allen had explored the influence of sulphuric acid in water on lead and found that lead was dissolved into the water. Concentrations of around 0.5 grains per gallon could result, equivalent to around 7 mg of lead per litre.

Indeed Allen had noted that water delivered by the mains supply to Surrey Street, was relatively free from lead whereas water delivered to the Wesley College, where he had teaching duties was contaminated. These two different locations were supplied from different reservoirs to the west of Sheffield. At the time different theories concerning the origin of the lead in the mains water existed, including the action of silica, the presence of waste from lead mines and interactions with sulphate. Allen noted that the water from the Bradfield reservoir, which supplied Surrey Street, was free from lead whereas water from the Redmires reservoir, which supplied Wesley College, was able to dissolve lead from pipework and other fittings. He concluded that the water from Redmires was acidic because of the nature of the surrounding flora and the absence of neutralising matter such as mortar, whereas that from the Bradfield area was surrounded by grassland and passed through mortar lined culverts on its journey to Sheffield. He advocated the use of blocks of limestone and doses of slaked lime to counter the plumbosolvency of supply. He also patented a method to remove lead from contaminated water whereby this water was passed through animal charcoal, the phosphorus in the charcoal capturing the lead.

## **The Glasgow Lecture**

Allen travelled to Glasgow to read his paper before the Society of Public Analysts in 1876 on “The Solution of Difficultly Soluble Substances”. This paper was significant as Allen was the first to effect the decomposition of minerals, slags etc. by heating the finely powdered material at 100°C with fuming hydrochloric acid in a sealed tube. This work demonstrated his ability in the field of inorganic chemistry, in addition to the well-documented organic analytical chemistry. Hamence and Chirnside refer to this paper in their book *Practising Chemists* in 1974 and made reference to Allen as “one of the society’s most distinguished founder members”[2].

## **Cider**

The quality of drinking water in Victorian times was at best variable and consequently fermented drinks such as beer, cider, and wines were considered safer. In a series of letters to *The Times* and other newspapers during the autumn of 1901 aspects of cider, including both the alcohol content and the cleanliness the drink, were addressed by Allen and others. Allen wrote to the editor of *The Times* in early September and expressed concern about the cleanliness of the production of cider especially where apples had been transported in carts which had previously been used to transport farmyard manure. He wrote “unfortunately much of the cider produced in the west of England is made in a slovenly and ignorant manner. The fruit is by no means always sound and the greatest carelessness is shown in many cases as to its condition. Carts which hold manure one day are used for apples the next”.

Later Alban E. Bellairs, a resident of Lyme Regis, on 23 September 1901, commented to the editor of *The Times* that “purity, delicacy and non-alcoholic properties are important especially with the medical profession who safely prescribe pure cider to their patients for sundry disorders, in a measure, containing a lower alcoholic strength than other fermented beverages. Such cider comes within the limit (4 per cent) of recognised teetotal drinks permitted by their leaders”. Allen’s letter to the editor of 2 October 1901 listed the alcoholic properties of a number of ciders some of which were well above 4% and were strong! His paper, “A Contribution to a Knowledge of the Chemistry of Cider”, which appeared in *The Analyst* in 1902 included data on the composition of apples, apple and pear musts, and ciders, including alcohol contents.

## **Commercial Organic Analysis**

Allen was a prolific publisher of scientific papers, but his greatest work was the volumes of *Commercial Organic Analysis*. As he noted in his first preface of 1879 “While the libraries of chemists are replete with manuals and treatises on inorganic analysis and the number of these works is being increased almost monthly, books on organic analysis are chiefly conspicuous by their absence”. He wrote and had published some 150 to 200 papers, articles and notes. These works were of benefit to laboratories and manufacturers. “Organic analysis emerged from his hands as an orderly and manageable science” Hehner wrote in Allen’s obituary notice. He also recalled that “the task of keeping up the continually required new editions overwhelmed him and ruined his health”. Eventually the American academic, Dr Leffman, and Mr Tankard, his senior laboratory assistant, and others played a role in the further revisions, resulting in the third edition.

The subject matter of these volumes was deliberately from a broad spectrum of goods and materials: foods, drugs, oils, tars, dyes, tannins, resins, proteins, to name but a few examples. Both composition and analysis were covered and much of the data was confirmed in his own laboratories.

### **Milk and Milk Products**

A part of volume four of *Commercial Organic Analysis* dealt with milk and milk products. Allen decided to also publish this as a separate book in 1897. As he explains in the preface:

It occurred to me that the chapters on *Milk and Milk Products* would be welcomed by magistrates and others concerned with the administration of the Adulteration Acts. I have therefore with the consent of the publishers had a limited number of extra copies of these chapters printed and believe the contained matter will prove of service in affording information as to the difficult – not to say disheartening – conditions under which Public Analysts have hitherto performed their duties. It is to be hoped that some of these difficulties will be removed before long by legislation.

It is most likely that the difficulties to which he referred were those associated with the interpretation of data and the establishment of base data for unadulterated milk and its products. Individual public analysts such as C.A. Cameron and A. Wynter Blyth, as well as the Society of Public Analysts, also studied this topic.

### **The Chemistry of Urine**

In 1895 Allen produced his book *Chemistry of Urine a Practical Guide to the Analytical Examination of Diabetic, Albuminous and Gouty Urine*. He, himself, suffered from diabetes and it was to end his life. He also published “The Examination of Urine for Small Quantities of Sugars” in *The Analyst* in 1894. He used hydrometry and chemical analysis for the estimation of sugars in urine and for determining their nature. His contribution to the subject is also recognised in the publication “Practical Methods of Urine Analysis” published by the Offices of *The Chemist and Druggist* in 1902. This sets out a diagram of the apparatus used by Allen for the determination of sugar in urine - the apparatus permitted the exclusion of air in the redox titration involving a modification of Fehling’s method.

The life and work of Allen and his contemporaries is noteworthy in that they started with almost no knowledge of the composition of food and equally almost no knowledge of reliable methods of analysis. They responded to the criticism of the second Select Committee on Food Adulteration in 1874 with the constructive formation of the Society of Public Analysts, the publication of the *Analyst* and a definition of adulteration. Eventually a professional qualification was agreed. All this was necessary to avoid unsafe prosecutions and to provide reliable scientific enforcement of food legislation. Truly today’s practitioners sit on the shoulders of these giants. Allen worked tirelessly providing a platform for scientific advances through his *Commercial Organic Analysis* and through his papers and lectures. In doing so he shared his knowledge with his colleagues and brought it to the attention of the public.

A longer version of this article has appeared in the *Journal of the Association of Public Analysts* and this version is reproduced with the permission of its editor.

### **References**

1. Peter Clare and Michele Clare, “The Life and Times of Alfred Henry Allen, Sheffield’s First Public Analyst”, *Journal of The Association of Public Analysts*, 2012, **40**, 39-59.  
[http://www.apajournal.org.uk/html/japa\\_vol\\_40\\_pg\\_39-59.html](http://www.apajournal.org.uk/html/japa_vol_40_pg_39-59.html)
2. R.C. Chirnside and J.H. Hamence, *The ‘Practising Chemists’: A History of the Society for Analytical Chemistry, 1874-1974* (London: The Society for Analytical Chemistry, 1974).

Peter Clare, BSc, PhD, MChemA  
Former Partner at A.H. Allen and Partners  
Michele Clare, BSc, PhD

### **Animal Glue: A Traditional Technological Product**



When I was at secondary school in the 1940s, the woodworking shop always had a certain aroma. It was a mixture of fresh wood shavings and the glue pot! The latter stood proudly on what we would now call a wood-burning stove and in those days used that convenient fuel called coke. The pot was in fact a traditional ‘double boiler’ made of cast-iron. The outer pot contained water and the smaller inner pot held the glue. As the water heated, so the glue together with an equal amount of water would gradually provide a workable glue. Sometimes the inside water would boil over, spilling onto the hot stove. This was more often than not the source of the so-called workshop glue aroma. Some glue often found its way into this water jacket, thus adding to the all-pervading familiar odour.

Early references to glue date from antiquity, but it was not until 1500-1700 that glue of animal origin was commonly used in furniture jointing although evidence shows the use of animal glue, and sometimes casein glue, in earlier violin making.

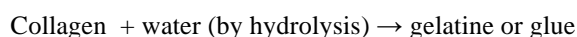
The first European commercial glue making from animal remains and hides appears to have been in Holland, dating from the end of the seventeenth century, followed by a works in England at about 1700 [1]. Nevertheless, the early history of violin making from the Brescia area of northern Italy in the early sixteenth century (other stringed instruments date from as early as the ninth century) shows the Brescian and Cremonese master craftsmen used glue prepared from animal remains. To the present time such glue remains the traditional choice on the basis of certain properties required not only by the violin maker but also by the cabinetmaker or restorer. Because of the development of structural jointing in cabinet making and the treatment of surfaces with veneers in the seventeenth century onwards, the reliance upon animal glue developed. The first British patent appeared in 1750 for fish glue and was soon followed by others involving animal remains and bones.

### Glue Making

Animal glues are made from the protein material extracted from the bones, hides and other animal remains by boiling in water. This extracted material is cooked to form a gelatine-like material that can be re-liquefied by heat; in effect, a reversed thermo-setting glue having a fairly fast setting time. Its major use up until the 1950s was in furniture jointing (particularly piano and violin making) and also in book-binding etc. Sight of a simmering cast iron glue pot with its familiar brush almost certainly points to an animal or hide glue, and no doubt jogs many youthful memories.

The process of manufacture depends upon the desired product; gelatine and glue are very similar materials but the latter is much less refined. Both are produced from the insoluble fibrous protein, collagen, of which connective tissue and bone consist. Uncontrolled heating of such residues in water produce glue whereas more sophisticated controlled hydrolysis and processing produces gelatine, which, like glue is readily soluble in hot water. It should be noted that hydrolysis is a distinct chemical reaction and not mere dissolution. In gelatine or glue production any extraneous material such as meat etc. would be removed from the crushed bone after degreasing with benzene or other solvent, followed by further division and grading, depending on whether gelatine or glue is to be the outcome of the original animal matter. The raw materials for the production of glue or gelatine undergo de-hairing and mechanical loosening followed when necessary by bleaching and sterilisation using sulphur dioxide. Treatment with lime followed by dilute acid might follow in order to convert calcium phosphate and other mineral salts to a soluble form. The remaining insoluble sponge-like material, known as ossein, is further hydrolysed in an autoclave at 30 psi pressure under controlled conditions of pH, followed by filtration etc. and finally concentrated to form a gel for possible further drying.

The final filtration, concentration, gelling and drying, leads to an acceptable grade of gelatine or glue. For the sole production of glue the animal matter follows a similar course of less sophisticated control and as a consequence its jellifying properties and water absorption capacity are less than those of gelatine. In simple terms it is the collagen, whether obtained from bones or other waste animal products, that provides glue through the process of hydrolysis. It is in these processes that the peptide bonds within the collagen break down but then reform when water is removed during the later gluing process. As a simple chemical equation one could write:



Bones contain about one third of collagen by weight whereas that of skin and other tissue may be seventy-five per cent dry weight. According to Riegel (1942), hoofs yield no gelatine [2]. Nevertheless, hydrolysis of keratin (the main constituent of hooves) does result in a glue perhaps of reduced gluing strength than true animal glue. Glue (or gelatine) may be thought of as a combination of two protein chemical constituents, viz. gluten and chondrin. The gluten comes from the skins and osseous parts, while the chondrin is mainly found in the cartilage of the various animal parts. Gluten has a greater adhesive power than chondrin, and therefore selection of the raw material can increase gluten content and thus produce stronger glue. These controlled processes may be applied only where gelatine is the desired end product. For ordinary glue the process remains simply one of extracting the maximum amount of collagen from whatever source is available by intermediate stages of hydrolysis, and concentrating the final liquid to about fifteen per cent solids, which on further air drying produces the solid plate glue.

The final liquors at this concentration are run into trays containing a metal grid divided into squares. Once the glue has cooled and set to a jelly, usually overnight, these squares would be cut with a knife and placed on a wire grill tray. By stacking these on trolleys with spacers to allow free circulation of air they would be placed in drying tunnels having extractor fans at one end and steam-heated coils at the other. The trolleys would travel very slowly from the extractor end to the steam-heated exit. Here, the product emerging, if of sound quality, will be free of impurities and should be a transparent uniform light-brownish colour, and should break with a glassy fracture. At this point the glue should have a moisture content of not less than eight per cent and not more than sixteen per cent, but is typically at fifteen per cent.

To make pearl glue there is an additional stage involving a tower in which very cold white spirit or benzene is circulated. At the top is a perforated plate through which the warm liquid glue flows. As it drips through the plate it forms pearls which chill as they fall through the solvent and on removal by sieving are afterwards turned frequently in a current of warm air until the pearls are dry.

## Testing Glues

This may involve a simple procedure such as gluing two wooden blocks together for breaking by measured mechanical means. One important laboratory test called a 'Bloom' test (or gram test) appears in various BSI publications [3], but a simple practical method of testing is described by Schofield [4]. In his report, animal glue was compared with modern PVAs and polyurethanes by measuring the force necessary to break a glued standardised joint.

Not unexpectedly the animal glue joint proved the least effective but had the great advantage in that the breakage occurred at the glue line, there being no damage to the timber which was not the case with other adhesives. Reproducible laboratory measurements of the jelly strength and the viscosity of glue also show a direct relationship to adhesive strength. Indeed, glue is sometimes graded on the basis of its gel strength – this is a measure of how many grams of force are needed to achieve a 4 mm depression by a plunger of fixed diameter into a 12.5% gelled solution of the glue at 10°C and is known as the Bloom Gelometer test. Grades may vary between 32g and 512g by this method and a measure of 192g is judged best suited for woodworking joints. The higher the gram strength the stronger the glue and its higher molecular weight – but its gelling time is shortened. Clearly, animal glue is strong glue as proved in Schofield's tests in which he showed its computed bonding strength to be seventy-six per cent of the best modern PVA.

With cold-setting glue, the bond strength develops with loss of moisture through the wooden interfaces or directly to the atmosphere. Variations in joint strength do occur dependent upon the nature and species of timber used. Nevertheless, in the limited variation of humidity and temperature that a piece of furniture might normally experience, animal glue has value. Here, the bond's moisture content fluctuates with ambient temperature and humidity in a similar way to that of the wood. Consequently, there is a uniform moisture content equilibrium across the entire glued joint. This may result in lower stress than in the case of an impermeable glue line given by, for example, a cured PVA bond at nil moisture content. Whilst remaining susceptible to excess moisture this aspect of animal glue becomes an advantage to the violin repairer or woodworker, inasmuch as a joint can be re-opened if needs-be by application of moisture and heat. For most applications the main requirement of any joint is that the adhesive should not give way, but in areas of repair and restoration where a joint can thus be re-worked, this characteristic is of immense value. One can imagine the chaos caused if a violin maker were to use irreversible PVA!

## Qualities

Of the other valuable properties of animal glue, one is the way the joint sets up. The glue has a three-stage action. Hold two pieces of wood together bonded by animal glue and it will be found that they will easily rub together within the first few seconds, followed quickly by a considerable holding. This is very desirable in a wood-bonding glue. Of course such an early bond is of no great strength but this is often sufficient and useful in a difficult gluing-up operation. The third stage achieves final bond strength usually by overnight drying involving the loss of moisture either into the timber or atmosphere depending on the nature of the work.

Adhesion is a property of glue by virtue of the intermolecular forces within the glue (cohesion) which attract and cling to (adhesion), in this case, wood. For greatest bonding the glue must penetrate the cellular structure. Because of the hydrogen bonding capacity of water and related capillarity and wetting properties, the hot glue when first applied hopefully reaches the cellular levels of the wood. The cohesion within the glue itself does the remainder of the job. Of course animal glue will fail if these cellular levels already contain an incompatible residue of earlier PVA or other adhesive (polyurethane etc.), but a further advantage of animal glue is that it will bond to itself; another reason why it is so favoured by restorers.

In keeping with present day trends the manufacture of glue from animal waste is an environmentally-friendly process. Allowing that some heat is used in the various stages of hydrolysis, and there may be a small negative aspect from waste filtrates, the process overall self-contains the original carbon content of the animal waste. There can be valuable by-products, for example in grease for the soap industry and certain animal feeds and fertilizers. Sadly all UK production of animal glue has now ceased, although imported glue as powder or pearls remains available.

Various advantages of animal glue over other modern formulations have been mentioned. In each instance chemistry is involved and this is particularly highlighted in what is probably the unique property of animal glue in offering a reversible process to allow dis-assembly. It remains an age-old product that now enjoys modern technologies of production and chemist control and understanding.

Animal or Scotch glue as it is sometimes called is no longer the empirical concoction of the seventeenth century.

## References

1. H.B. Sweatt, *J. of Chem Education*, 1946, **23**(4), 192.
2. E.R. Riegel, *Industrial Chemistry* (New York, 1942), 640).
3. *Methods of Sampling and Testing* (ISO 9665:1998, 2000).
4. M. Schofield, "How Strong is your Glue?" *Fine Woodworking Magazine*, 2007, **192**, 36-40.

Frederick G. Page  
Herefordshire

## Alchemist in Residence: Artist Hilary Powell on her One-Year Artist Residency in UCL Chemistry

It began with a brick. I had been working as unofficial artist in residence on a demolition site in East London during an AHRC Fellowship in the Creative and Performing Arts at the Bartlett School of Architecture, UCL. As I was examining urban change and constant collapse and construction through the production of pop-up books, the demolition site was the ideal place to study the physical mechanics of this change close up. What began as documentation soon became a project of imaginative salvage. Amid the dismantling and sorting I saw the opportunity to reclaim the material by-products of urban transformation to develop an ‘urban palette’ where roofing zinc and copper boilers had the potential to become etching plate through experimentation with the chemistry of traditional printmaking techniques. Looking down at the coloured ground strewn with the earth tones of brick and mortar led me directly to the chemistry department at UCL and collaborator Professor Julian Evans with a quest to expand the palette with pigment production. Together we applied to the Leverhulme Trust for their artist in residence programme. The ethos behind this scheme is to foster creative collaboration and bring an artist into a research environment where their artistic form or creative art is not part of the normal curriculum or activities of the host department. It is a rare and much valued chance to support such embedded artistic practice. Increased understanding of the chemical workings of the everyday materials used translates to confident experimentation in the artist’s ‘lab/studio’, furthering the lateral thinking and imagination of science and art.



I have positioned myself provocatively as ‘alchemist in residence’ with a project that examines transformation on multiple scales - from the molecular changes of roofing zinc as it undergoes traditional etching techniques bathed in nitric acid to the wider urban transformation that the materials I use are by-products of. In the project, creative production and the poetry and politics of place combine with the science, agency and political ecology of materials alongside the often unexplored chemistry of traditional printmaking methods. The unexpected and experimental combine in a project that explores the material world through the lens of both the arts and sciences, finding ways of bringing the everyday to life. UCL itself is undergoing constant repair and maintenance, expansion and demolition and working with UCL sustainability and estates teams to access these sites of constant transition led to a close up look at the materials of our everyday environments, thinking about where they come from and where they are going as well as how I could intervene in their lifecycles and put them to creative use.

As the residency comes to an end ‘Urban Alchemy’ is the outcome. The *Urban Alchemy* book was launched on 24 June 2015 in UCL’s construction welfare building canteen. This was a fitting location for the project’s launch, as although officially artist in residence in the chemistry department I have spent much of my days in hard hat and steel capped boots meeting the demolition contractors working on various sites around the UCL campus. The book itself (first edition of 300) is a hard cover cloth-bound gilt edged volume in the traditional of an alchemical ‘book of secrets’ exposing the narratives and techniques of the transformation of these materials over this year of experimentation and exchange. It examines a core ‘family’ of demolition site materials – zinc, copper, slate, brick, stone/concrete, steel, aluminium and asbestos - through photographs from the demolition site, of the materials undergoing transformation in a chemistry laboratory and print studio, and of the image outcomes of these creative and chemical changes. This imagery sits alongside a series of poetic narratives of each of these materials.

Key to this project and my practice is a belief in thinking through making and participating, raising awareness and changing perceptions through doing. The book becomes the locus a series of print experiments held over the three days following the book’s launch as part of the UCL Institute of Making Festival of Stuff from giant wood cut



printing and ink making in the street to traditional stone lithography tested on found bricks and concrete slabs. These workshops extend the project's reach to a wider public exploring the chemistry and stories of the materials through participatory making and informal exchange.

At the core of the project is an interdisciplinary imagination and commitment to the overlap of artisan and scientific practices and methodologies. Throughout the year I have been inspired by conversations with Dr Simon Werrett and membership of the Society for History of Alchemy and Chemistry. The idea of the dual 'laborium' and 'oratorium' functions of the alchemical workshop are key to developing how this may take contemporary form through ways of performing, making, and sharing hidden techniques across the arts and sciences. At its core, the work plays with ideas of value – the way we value people, places and materials. Through imaginative salvage it explores regeneration and economic transition. It uses the demolition site as a means of connecting diverse arenas of knowledge exploring abstract concepts of economy and waste through immediate, visual and tactile methods. Through it I share my passion for the often forgotten, hidden or overlooked and an ethics of materials where the poetry and politics of place combine.



**Figure 1:** Portraits of demolition workers on the UCL campus acid etched into roofing zinc.

'Urban Alchemy' hopes to illuminate what art and science are about - our relationships and reactions within and to the made world and making – in this case bringing experimentation and insight to the often overlooked sites of transformation (of making and unmaking) of our urban environment.

See the website [www.hilarypowell.com](http://www.hilarypowell.com) for more information about the project, to see more images and for information on how to get hold of a copy of the book.

The project was made possible through the Leverhulme artist residency scheme and an artist residency in East London Printmakers. It is supported by UCL Chemistry, UCL Urban Lab, the Institute of Making, UCL Anthropology, The Journal of Material Culture, UCL Joint Faculty Institute of Graduate Studies, UCL Estates and sustainability and UCL Grand Challenge for Sustainable Cities.

Hilary Powell

## BOOK REVIEWS

Peter J.T. Morris, *The Matter Factory. A History of the Chemical Laboratory*. (London: Reaktion Books, 2015). Pp. 416 + 139 illus. ISBN: 978-1-78023-442-7. £30 (hardback).

It is perhaps surprising that historians of science have not devoted more time to the study of science laboratories and even more so for historians of chemistry with chemical laboratories. Chemistry is after all studied to a large extent in laboratories and most people who have studied chemistry at any stage of their lives will have spent time in a suitably equipped laboratory whether at school, college, university, in industry or a commercial organization. Histories have been written of individual laboratories or laboratory buildings, but the evolution of what are now known as chemical laboratories from the early alchemical laboratory or workshop have largely evaded the historian's attention. It is into this gap that Peter Morris's excellent book, *The Matter Factory* makes an important contribution.



*The Matter Factory* describes how chemical laboratories and buildings have changed to meet the differing needs of the subject between 1600 and 2000. It does not attempt to review the detailed development of the chemical laboratory but rather to show how certain features of the laboratory were important determinants in their design and operation. These features included the furnace, the supply of gas and water to the bench, the availability of reagents, the provision of fume chambers (or cabinets), the chemical balance, the polarimeter, the multitude of very sensitive instrumentation and in more recent times the over-riding importance of safety. The starting point for the author's researches are the images of particular laboratories whether paintings, engravings or photographs, and these are supplemented by visits to extant historic laboratories or modern facilities. This accounts for the large number of illustrations in the book, most of which are well produced and thus allow the reader to follow quite closely the author's analysis. The illustrations are also accompanied by an extensive list of references to enable the reader to pursue further investigations.

*The Matter Factory* is also concerned with the laboratory in its social and cultural setting across many different countries (including Russia, Australia and Japan). The offer to build a new (and more advanced) laboratory was often used to entice prominent chemists from one university to another – Liebig (Giessen and Munich), Hofmann (London, Bonn and Berlin), and Bunsen (Marburg and Heidelberg); in Germany such offers reflected the importance of chemistry (and the university) to the individual states before the country's unification. The book also shows the important part played by certain architects whose specialism was the chemical laboratory, though their ideas were often modified by the prominent chemist whose laboratory it was to be. In many cases the architect is anonymous and it would appear a modular approach was used to take the best features from several different laboratories.

Reading this book, I was struck by its ability to embed one's own experiences of working in different types of laboratories from school, industry, university and then teaching in schools. Viewing images or reading descriptions of laboratories with their particular facilities and operations brought back intense memories (most of them good) of the many years spent manipulating materials - a practical activity at the core of chemistry. On occasions it was almost possible to smell hydrogen sulphide gas from the Kipp's apparatus in the fume-chamber (which was a frequent occurrence when the tap was not turned off) or certain chemicals (usually organic, such as the mercaptans) that became such a feature of laboratory work. Smell is a powerful source of reminiscence and is also often experienced when opening old and stained laboratory notebooks or practical organic textbooks.

Buildings housing chemical laboratories in the late-nineteenth century often had a chemical museum, but not a museum in the sense we understand the word today. They were used to display sets of reference chemicals (although on occasions apparatus was also displayed), and so more in line with mineralogy collections found in geological museums. One of the more remarkable is the museum established by George Chandler at Columbia University. The museums were not generally open to the public but were used to impress notable visitors. The Science Museum in London had a chemistry section in its galleries similar in format to these chemical museums, but in 1925 it was transformed into the new industrial chemistry gallery.

As Peter Morris points out, his book focuses on the particular features he has chosen to study and write about and it does not preclude other histories of the chemical laboratory or indeed comparative studies of laboratories in different countries and in different disciplines. The book also raises many issues for further research and debate: how far do the paintings and engravings of laboratories reflect the actual laboratory and what artistic license is taken to add features that thereby raise the standing of the alchemist or chemist in an attempt to secure a more prominent and lucrative position with a better equipped laboratory?; what are the boundaries of chemical laboratories when compared with laboratories for pharmacy, biosciences and pharmaceuticals?; how do developments in the chemical laboratory reflect changes in laboratories of other sciences?

This is a fascinating and informative book that draws on a wealth of research and scholarship not just from Peter Morris's time at the Science Museum but from his life-time experiences of visiting and working in laboratories. It is thoroughly recommended to all who have studied chemistry at some time in their times but particularly to historians of science and chemistry because it should be the starting point for further work to more fully understand the development of science laboratories.

Peter Reed

A **20% discount code** for any RSCHG members wishing to purchase *The Matter Factory* has been set up on the Reaktion Books website. Anyone wishing to use this code should visit [www.reaktionbooks.co.uk/promo.asp](http://www.reaktionbooks.co.uk/promo.asp) and enter the code **MATTF20** into the promo box. This code will be valid until 1 September 2015.

Kenneth Bertrams, Nicholas Coupain and Ernst Homburg, *Solvay: History of a Multinational Family Firm* (Cambridge: Cambridge University Press, 2013). Pp. xviii + 630. ISBN 978-1-107-02480-9. £60 (hardback).

The Solvay business was formed in Belgium in 1863 but still occupies a prominent position in the global markets for chemicals to the present day, and this book provides a welcome addition to our understanding of the chemical industry. *Solvay* is divided into three parts, each with a separate author: Part 1 – The Pioneering Years (1863-1914) by Nicholas Coupain, Part 2 – The Years of Crisis (1914-1950) by Kenneth Bertrams, and Part 3 – The Era of Diversification and Globalization (1950-2012) by Ernst Homburg. It draws on extensive family and business archives as well as on interviews with many people who are, or have been, connected with the business. The

archives cover ventures not just in Belgium but also in Britain, USA, France, Germany, Russia, and more recently Southeast Asia as well as in many other parts of the world.

In the period to World War One the business focused on the soda-ash trade using Ernest Solvay's patent for the production of soda ash by the ammonia-soda process either by issuing licences (as in the case of Brunner Mond in the UK) or by developing their own plant (in many cases taking over plant from other manufacturers). It was only in the period between the World Wars that the business began to diversify into electrolytic manufacture of caustic soda and chlorine, the latter for PVC and rubber. The post-World War Two period, brought greater diversification than ever before in its history as it started production of organic solvents, pesticides, peroxides, plastics (including polyethylene and PVC), veterinary products and pharmaceuticals. In the 1960s many chemical businesses including Solvay diversified into the production of chlorofluorocarbons (CFCs) for use as propellants for aerosol sprays but the venture proved controversial and in 1996 the weight of accumulated evidence brought a total ban, at which point Solvay switched to the more benign hydrofluorocarbons (HFCs).

An important feature of the business was its initial financial structure as a limited partnership with managing partners (*gérants*) that allowed the Solvay family to retain a tight hold on the business, and the associated financial regulations did not require the accounts to be made public. *Gérants* were members of the Solvay family, and even silent partners were carefully selected against the needs of the business. This structure remained in place until 1967 when the business became a joint-stock company but with a structured share-holding that still allowed the Solvay family to retain control.

At over 600 pages, *Solvay* is a weighty tome of information, but with the text usefully divided into sections and through careful use of the thorough index the reader will find rewarding details. It is thoroughly recommended to those with an interest in the history of chemistry and the chemical industry, but it will be of particular interest to business historians.

Peter Reed

Marco Fontani, Mariagrazia Costa and Mary Virginia Orna, *The Lost Elements: The Periodic Table's Shadow Side* (Oxford: Oxford University Press, 2015). Pp. 531. ISBN 978-0-19-938334-4. £25.99.

What do the following elements have in common: *asium*, *bythium*, *columbium*, *didymium* and *euxenium*? If I add the further clues of *alabamium* and *virginium* and a reference to a Newsletter article [1] of the summer of 2013 concerning their "discovery", then most readers will have spotted that these elements, all reported in the literature, do not exist. In fact, these seven elements constitute only a fraction of those covered in this book: some 241 appearing before the outbreak of the Second World War.

Chemists have always wanted the enduring fame of having discovered a new element, but one perplexing problem was that no-one could be absolutely sure how many there were "out there" waiting to be discovered. In their tabulations, John Newlands (1864) and Dmitri Mendeleev (1869) both had vacant boxes for still-to-be-discovered elements. Chemical detectives rose to the challenge and some were filled in uncontroversially, like *germanium* (1886), but others like the candidate for the gap between molybdenum and ruthenium, gave rise to a succession of false dawns: *lucium* (1896) *nipponium* (1908); *masurium* (1925) and finally and correctly, *technetium* (1936). Actually, I feel a bit sorry for nipponium's discoverer, Masataka Ogawa, as there is considerable evidence that he had actually been working on rhenium whose discovery is now usually credited to Walter Noddack, Ida Tacke and Otto Berg (1925).

The rare earths were particularly perplexing to nineteenth-century element hunters. The early periodic tables were of little help as there was both uncertainty as to where they should be located and, indeed, also an uncertainty as to how many there were in their totality. It didn't help that they were so alike in their chemistries and tended to occur alongside each other in their host minerals. Time and time again new elements were announced, only to find that, on more careful analysis (usually carried out by someone else) they were mixtures of already-known elements. Typical is William Crookes' *victorium* (1898). The French rare earth chemist Georges Urbain immediately cast doubt on the discovery and soon was able to say that Crookes' pride and joy was a mixture of Gd<sub>2</sub>O<sub>3</sub> (2.8%) and CaO (92.2%). Things improved with Henry Moseley's ground-breaking discovery/confirmation [2] of the notion of atomic number in 1913. Every element had a unique integral number associated with it. Thus, assuming enough material was available for the determination of its X-ray spectrum, it was possible to ascertain if it was a new element filling a gap in the list of elements and their associated atomic numbers, or a mixture of two (or more) known elements.

This book is remarkably good value. Each chapter is well referenced, mainly to original sources and I see this book as being 'the last word' on this topic as it is so comprehensive. The authors' style is very readable. Possibly to cover its 531 pages from end to end at a single sitting might be asking a bit much, but it certainly encouraged me to dip into it on a regular basis. Well recommended.

## References and Notes

A. Dronsfield and M. Hill, "Whatever Happened to Alabamium and Virginium?", *Historical Group Newsletter*, 2013, **64**, 27-34.

The concept of atomic number was first proposed by Antonius van den Broek in 1911 and subsequently Moseley was happy to say that his work confirmed van den Broek's hypothesis.

Alan Dronsfield  
University of Derby

Eric R. Scerri, *The Periodic Table – A Very Short Introduction*. (Oxford University Press, 2011). Pp. xv + 147. ISBN 978-0-19-958249-5. £7.99 (paperback).

There are now many books on the Periodic Table and its history, a very welcome situation. This modest – and modestly priced – handbook on the subject forms part of OUP's *Very Short Introductions*, of which there are now over 400 volumes, aimed at those 'wanting a stimulating and accessible way in to a new subject'.

Scerri's approach is broadly the classic historical one. Chapter 1 ("The element") briefly considers historical (Aristotle, Lavoisier) and modern (names, symbols) examples of elements. There follows an overview of the Table – material which would have been better placed I think in the final chapter which also concerns this aspect. There is then a sequence of chapters on historical developments: Dalton's atom, Richter's notion of equivalent weights, Prout's hypothesis and Döbereiner's triads. The contributors of the 1860s are discussed – de Chancourtois, Cannizzaro, Newlands, Odling, Hinrichs and Lothar Meyer. Rightly, chapter 5 is devoted entirely to Mendeleev ("The Russian Genius"), and the novel, much more chemical and insightful approach which he adopted. Much is made of the predictive powers of Mendeleev's tables, quoting both his celebrated successfully predicted elements (scandium, gallium, germanium, technetium, rhenium, polonium, francium and protactinium) and some unsuccessful ones too. "Physics Invades the Periodic Table" covers radioactivity, Rutherford's theory of the atom, X-rays, the discovery of isotopes and Moseley's crucial demonstration that atomic numbers rather than atomic weights are central to the Table. Two succeeding chapters cover quantum numbers, electronic structures and electronic configurations, the Bohr atom, the G.N. Lewis approach, and the quantum-mechanical arguments of Schrödinger. The penultimate chapter on "Synthetic Alchemy" concerns the three 'missing' examples of the mid-1930s: the man-made technetium and astatine, and the last element to be discovered in nature, francium. Transuranium elements are discussed: all the elements from atomic number 1 – 118 inclusive have now been identified, though the last few await IUPAC verification and naming. The final chapter, "Forms of the Periodic Table" presents some traditional and possible new arrangements of the table. Interestingly this mentions the possibility that lawrencium (element 103) could legitimately be considered, with lutetium, as a group 3 element under scandium and yttrium: a recent *Nature* paper reports measurements of the first ionisation potential of Lr, which supports such a suggestion.

Bill Griffith  
Imperial College

Carl Djerassi, *In Retrospect: From the Pill to the Pen* (London: Imperial College Press, 2014). Pp. 388. ISBN 978-1-78326-532-9. £19 (paperback).

Carl Djerassi, born on 29 October 1923 and who passed away earlier this year on 30 January, was one of the world's most distinguished organic chemists (1200 publications and his face on an Austrian postage stamp) without a Nobel Prize. I came across his name in the early 1960s through his first monograph *Optical Rotatory Dispersion: Applications to Organic Chemistry* and later his co-authored books on mass spectroscopy. He was then working at Syntex, a pharmaceutical company in Mexico which was also developing X-ray crystallography equipment (another field of interest). Many years later, I corresponded with him over a staged version of his play with Roald Hoffmann, *Oxygen*, about the chemists Priestley, Lavoisier and Scheele that we were putting on at Bradford University. In the meantime, Djerassi had synthesized from plant material cortisone, a steroid for rheumatoid inflammation treatment (its discoverer had been awarded a Nobel Prize in 1950), and then the oral contraceptive or Pill, for which he is best known. From the 1980s he turned from being a director of organic chemistry research into, most unusually, a novelist and playwright. *In Retrospect* is better described as autobiographical rather than an autobiography; indeed it contains excerpts from his previous writings. The biographical books include (in the American Chemical Society's 1992 organic chemistry series) *Steroids Made it Possible*, an account of developing the contraceptive Pill aimed at chemists, and his lengthy 1994 *The Pill, Pigmy Chimps and Degas' horse* (he had a talent for titles) for more general readers. *This Man's Pill: Reflections on the 50<sup>th</sup> Birthday of the Pill* in 2001 was as the subtitle indicates. These and his other writings have been widely translated. *In Retrospect* has ten headed chapters but each may be regarded as a collection of reflections and reinterpretations, with many lengthy but interesting asides, and overall what the author calls a retro-autobiographical account starting with the last two decades. The diverse range of topics vigorously covered means that the 13-page index is inadequate. Although irreligious himself, Djerassi has one chapter titled "Jew", in which heading, the author insists, the quotation marks are integrated to make a five-character word; this may underlie a search for identity in his Heimat chapter.

Djerassi was the only child of two Jewish medical doctors who met in Vienna, the Bulgarian Samuel Djerassi (Sephardic), who specialized in Venereal Diseases, and the possessive Alice Friedman (Ashkenazi), who never learned Bulgarian and later lived in Vienna and resumed her Austrian citizenship after the divorce. Samuel at sixty married a woman of forty, became a frequent swimmer at eighty-five, and lived to ninety-five. Djerassi married

three times, all to gentiles, the first, Virginia, when he was barely twenty. Immediately after the amicable divorce, he married Norma, by whom he had a daughter, Pamela, in 1950 and a son Dale, a filmmaker. This marriage ended in 1976 and in 1985 he married Professor Diane Middlebrook, Dean of Arts at Oregon (she later taught at Yale and Stanford), whose death in 2007 was greatly lamented and remembered. Having been brought up largely in Vienna (with summers in Sofia), Djerassi and his mother were expelled from Austria in 1938 and soon went to the USA. Graduating in chemistry from Kenyon College, he followed his 1945 PhD at Wisconsin by working at the pharmaceutical company CIBA, New Jersey, gaining familiarity with new analytical techniques. In 1949, despite discouragement from his mentors, he went, intending to establish his scientific reputation, to Mexico City as Associate Research Director at Syntex. While training Mexicans in experimental chemistry, Djerassi was able to publish prodigiously. Only in 1972 were his links severed as a consultant with Syntex; this company was swallowed by Roche in 1994, and the highly productive Mexican organic chemical research group disbanded (thus amputating organic research in Mexico), and was eventually acquired by Pfizer.

The long chapters of most immediate interest to chemists and historians are probably those titled “The Bitter-sweet Pill” and “Writer” which cover the synthetic chemistry of cortisone and norethindrone and the later transition to a writer of fiction-in-science (emphatically not science fiction). Djerassi notes that fictional literary themes often arise, albeit unconsciously, from examining the writer’s own life under the anonymity of fiction; smuggling of science and scientists’ behaviour into fiction aims to overcome the public’s resistance to science. Within two years of Djerassi’s arrival at Syntex, his group was the first to synthesize cortisone from diosgenin. The chapter “Professor of Professional Deformation” recounts setting up, with Rockefeller support, academic centres for elucidating the structures of local natural plant products in Mexico and Brazil (Amazonian alkaloids). Working on routes to estrogens, the Syntex chemists had already aromatized ring A of conventional steroids, and in 1951 prepared gram quantities of 19-norprogesterone. (Norethindrone has the three-ring phenanthrenic skeleton with a cyclopentane ring (whose exposed carbons are numbered 15, 16 and 17) fused on. The first oral contraceptive synthesized at Syntex was 19-nor-17alpha-ethynyltestosterone. The aim was not birth control by an oral progestational compound but to treat menstrual disorders, female cervical cancer, etc. Djerassi emphasizes that his wealth did not derive directly from the Pill – patents were the property of Syntex - but by investment in Syntex. After 1952, he no longer worked at the bench but directed many academic and industrial researchers.

Early in 1952 at the age of twenty-eight, Djerassi forsook his well-paid productive research career in sunny Mexico and moved his family, again against the advice of academic friends, to what was to become in 1956 Wayne State University in slushy Detroit, Michigan. Despite dingy accommodation in a former high school, grants from many sources soon supported an international array of post-docs in analysing the structures of plants, especially with CD, UV, IR, NMR and MS. Three years of absence from Wayne as Syntex Research Vice-President (with the value of Syntex stock growing enormously as the company developed a flow of new drugs) was followed by an invitation to a professorial appointment at Stanford, together with chemist William S. Johnson as departmental head of a new 1960s Chemistry Building. Although he never taught chemistry to undergraduate students, Djerassi immediately felt at home teaching graduate students at Wayne, mainly advanced physical methods courses. At Stanford, he began in 1962 a course in steroid synthesis but got all sixteen students to look up references within the last decade to an individual topic in a range of journals. Worldwide distribution to steroid chemists and much discussion led to the 1963 book *Steroid Reactions: An Outline for Organic Chemists*; royalties financed a seminar building. This led to wider student-participation and computer-based courses on structures consistent with limited data and in the 1970s to teaching (again collaborative) of undergraduates in public policy, as described in the “Professional Deformation” chapter. Inevitably, Biosocial Aspects of Birth Control figured and by the 1990s he was offering a course “Ethical Discourse through Science-in-Fiction” in the Medical School.

Wealth enabled Djerassi to become a serious art collector, especially of early Columbian art, Paul Klee’s paintings, and the American George Rickey’s sculptures; subsequently he became an art donor to galleries and a philanthropist. He regarded art as indispensable to humanity and was a long-time opera- and theatre-goer. The early disposals were linked to the setting up and support of the Djerassi Resident Artists’ Program and artists’ colony, after his beloved daughter Pamela’s tragic suicide in 1978. This was expanded in memory of his late wife Diane Middlebrook; it houses stays by about forty artists each year

Consistent with his warning about Wikipedia (better the original sources), Djerassi begins and ends the memoir with short chapters labelled “Caveat Lector” and “Caveat Emptor”; the book is also prefaced by a warning quotation “The past cannot move into the present uncorrupted”. Leaving aside the Nobel (not lamented here), Djerassi has a number of regrets and is at pains to respond to misinterpretations of his views, especially about the implied influence of birth control. He was not invited to the memorial gathering of Diane’s salon of London friends (perhaps because of a sugar-daddy misperception), or to lecture in Vienna until 1992, and, despite his long service, Stanford showed little appreciation on his retirement in 2002 or eightieth birthday in 2003. Mature chemists, instead of retiring, often graduate to chemical history; few write short books on art and turn to fiction or science-in-fiction. Having excelled at organic chemistry, Djerassi wanted to be remembered for his novels, plays and poetry. To the many facets of his polymath virtuosity – organic synthesis and structure elucidation, fiction composition, art appreciation and collection, philanthropy – *In Retrospect* requires one to add entertaining and illuminating memoirist.

Derry W. Jones  
Applied Sciences, University of Bradford

## MEETING AND CONFERENCE REPORTS

### The Life and Work of Sir John Cornforth AC CBE FRS

Royal Society of Chemistry, Burlington House, London, 18 March 2015

The Nobel-prize winning organic chemist Sir John Cornforth died aged ninety-six on 13 December 2013. This meeting, attended by over seventy-five people, was held to honour Sir John's memory and to recognise his intellectual achievements in synthetic and biosynthetic chemistry.

The four speakers and two Chairs (Sir Alan Battersby and Professor Chris Willis) all had a close scientific association with Kappa, (a nickname acquired by Cornforth from his first forays in laboratory work in Australia), and were able to add their own personal anecdotes and reminiscences. Kappa's three children attended the meeting, and our understanding of the nature of the man was further extended by his son (another John Cornforth), who described his father's prowess outside chemistry – as a chess player, a gardener and a tennis player – and his love of poetry. Tributes were paid to Rita, Cornforth's wife, who was an outstanding organic chemist in her own right. As well as fulfilling the role of wife and mother, she co-authored about thirty of Kappa's papers. But above all she enabled her husband to succeed in spite of the handicap of total deafness. They made a remarkable team, and we hope our meeting was a fitting tribute to both.

The meeting also served to reunite a number of former co-workers and colleagues. The Group is grateful to Rupert Purchase and Jim Hanson from the University of Sussex for conceiving the meeting and organising the panel of speakers.

John Hudson

### Sir John Cornforth: Early Years - Australia, Oxford and National Institute for Medical Research

*Douglas Young, University of Sussex*

Cornforth's studies at The University of Sydney led to three publications on heterocyclic chemistry from his B.Sc. and a further five on natural product chemistry, two as sole author, from his M.Sc. His lifelong interest in the field of terpenes and steroids was sparked by his final publication from Sydney, suggesting a triterpene structure for the Australian plant product sarcostin. Cornforth returned to sarcostin nearly twenty years later in a solo publication, which helped finally to prove its correct (steroidal) structure. He and his wife Rita were both awarded 1851 Exhibition Scholarships to pursue research with Robert Robinson at Oxford and sailed from Australia just as war broke out in 1939.

Kappa completed his thesis on sterol synthesis and then joined ongoing research at Oxford on the isolation and structure determination of the antibiotic penicillin. His suggestion for the structure of the penicillin degradation product penicillamine had been dismissed on the basis of a low value in a Kuhn Roth determination for C-methyl groups but he provided a rationale for this and, within six weeks, confirmed his structure by total synthesis.

The oxazolone structure suggested for penicillin led Kappa to examine the chemistry of this and related heterocyclic compounds and resulted in his discovery of a novel rearrangement, now known as the "Cornforth Rearrangement".

The Robinson–Cornforth total synthesis of cholesterol with its eight asymmetric centres was begun before knowledge of the relative stereochemistry and without the spectroscopic and other tools that would be used today. The synthesis, continued when Cornforth moved to the National Institute for Medical Research in 1946, was successful and was so flexible that it could be used to prepare other metabolically important steroids.

On meeting George Popjék at the National Institute for Medical Research in 1946, Cornforth embarked on a study of the biosynthesis of cholesterol and was able to show the origin of each of the thirty carbon atoms of the triterpene squalene and the twenty-seven individual carbon atoms of cholesterol from the two carbon atoms in acetic acid.

His interest in squalene led him to devise a general stereoselective synthesis of di-, tri- and tetra-substituted olefins and to apply it to the synthesis of *all-trans*-squalene. In the course of these studies his explanation for stereoselective addition of nucleophiles to the carbonyl group of  $\alpha$ -haloketones and aldehydes became known as "Cornforth's Rule".

The discovery of mevalonic acid by the Merck Company and its stereochemistry by Arigoni led to his only joint publication with Prelog, his co-recipient of the 1975 Nobel Prize in Chemistry. He showed the sites of incorporation of labelled mevalonic acid in squalene and cholesterol, and used  $^{13}\text{C}$ -labelled mevalonic acid to elucidate the nature of methyl rearrangement in the biosynthesis of cholesterol. This is now regarded as one of the classic studies of the use of labelling in biosynthesis.

## **The Popják-Cornforth (PopCorn) Collaboration on the Stereochemistry of Biosynthesis: NIMR and Milstead**

*Tom Simpson, University of Bristol*

Cornforth's collaboration with the biochemist, George Popják, in unravelling the pattern of incorporation of acetate and mevalonate units *via* isopentenyl diphosphate, dimethylallyl diphosphate, farnesyl diphosphate and squalene into cholesterol, was one of the landmarks of chemistry in the mid-twentieth century. The work was initiated in 1948 at the National Institute for Medical Research in London and continued in the 1960s at Shell's Milstead Laboratory of Chemical Enzymology at Sittingbourne in Kent, which were known colloquially as the PopCorn labs. Cornforth's logical analysis of this biosynthetic sequence involved a deep understanding of the possible stereochemical outcome of each stage. The elucidation of this stereochemistry required the preparation of stereospecifically deuterated and tritiated mevalonates and the development of novel stereochemical methods of analysis of the products of the enzyme reactions. The results, which contributed to the award of the Nobel Prize for Chemistry in 1975, provided an understanding of the mechanism of many of these enzyme reactions. However, the principles that Cornforth developed in this work had a much wider impact on biosynthetic studies. Terpenoids are characterized by the retention of hydrogen from their early precursors such as mevalonate through to the final natural products. Consequently, the fate of stereospecific labels from mevalonate has shed considerable light on the mechanism of the intervening stages in many terpenoid biosyntheses.

## **Kappa's Application in Biosynthetic Studies of all the Isotopes of Nature's Simplest Element**

*Bernard T. Golding, Newcastle University*

The discovery of deuterium ( $^2\text{H}$ , D) by Urey, Brickwedde and Murphy reported in 1932 immediately spawned a wealth of chemical and biological studies derived from incorporation of this hydrogen isotope into organic molecules. Lord Rutherford and his co-workers then converted deuterium into tritium ( $^3\text{H}$ , T), which was shown to be a radioactive  $\beta$ -emitter (half-life 12.3 years) by Alvarez and Cornog in 1939. The young John Cornforth would have noted these discoveries, which later made possible his studies of chiral methyl groups. Kappa considered whether the stereochemistry of an enzymatic reaction that converted a methyl group ( $\text{CH}_3$ ) into a methylene group ( $\text{CH}_2$ ) could be determined. He synthesised the enantiomers (mirror image forms) of chiral acetic acid in which the methyl group contained hydrogen, deuterium and tritium (i.e.  $\text{CHDTCO}_2\text{H}$ ), and showed that the enzyme malate synthase combines glyoxylic acid with acetyl-coenzyme A, a thioester derivative of acetic acid, by inversion of configuration at the methyl group. To accomplish this feat, not only were the three isotopes of hydrogen required, but a significant primary kinetic isotope effect ensured that the rates of cleavage of the critical bonds were  $\text{C-H} > \text{C-D} > \text{C-T}$ .

My collaborations with Sir John concerned the attempted synthesis of vitamin  $\text{B}_{12}$ , via Kappa's ingenious route using oxazoles, and application of the chiral methyl group to elucidate the mechanism of the coenzyme  $\text{B}_{12}$ -dependent reaction catalysed by the enzyme 2-methyleneglutarate mutase. The postulated mechanism of this reaction, in which 2-methyleneglutarate equilibrates with 3-methylitaconate, features substrate-derived and product-related radicals, which interconvert via an intermediate cyclopropylcarbiny radical. Calculations and experiments had shown that there is a low energy barrier to rotation about the carbon bearing the free electron and the cyclopropyl carbon to which the radical centre is attached. Hence, it was expected that degradation of 3-methylitaconate with a chiral methyl group derived from 2-methyleneglutarate stereospecifically labelled in its 3-methylene group with deuterium and tritium would yield racemic chiral acetic acid, which was indeed observed. This experiment demonstrated that coenzyme  $\text{B}_{12}$  is an initiator of a reaction pathway via protein-bound free radicals and that cob(II)alamin arising from cleavage of the coenzyme's cobalt-carbon  $\sigma$ -bond is primarily a spectator of chemistry via intermediate radicals.

## **Models of Enzyme Action: Organic Synthesis at Sussex University**

*Tim Wallace, University of Manchester*

Sir John Cornforth [Kappa] began his artificial enzyme project while at Shell in the late 1960s. After spending decades unravelling the details of enzymic reaction pathways, he was uniquely placed to design catalysts with enzyme-like properties. His chosen objective was a small molecule that would mediate olefin hydration under mild aqueous conditions. This choice and the enabling strategy are explained in detail in a review lecture (Sir J. Cornforth, "The Imitation of Enzymic Catalysis", *Proc. R. Soc. London, Ser. B*, 1978, **203**, 101).

The catalyst design called for a phosphinic acid group to be located at the base of a shaped hydrophobic cleft formed from substituted aromatic rings, and required the synthesis of increasingly elaborate 4,6-diaryl-5-hydroxydibenzophosphole 5-oxides. The non-arylated parent system had been prepared at Shell, but arylation at the 4- and 6-positions had proved difficult. When Kappa moved to Sussex in 1975 he made two postdoctoral appointments, Andy Sierakowski and myself, and asked us to build dibenzophospholes with the required aryl substituents in place at an early stage of the synthesis. We started the work in 1976, in Lab 6 of the School of Molecular Sciences alongside Kappa and his assistant Janet Buckingham. We established an efficient way of coupling *m*-dinitrobenzene with iodoarenes to give 2,6-dinitrobiaryls, and of using the nitro groups to set up the required functionality. Over the next decade and with various changes of personnel, modified designs were sought and the associated synthetic problems were tackled. The methodology allowed a choice of 'walls' for the



hydrophobic cleft, the attachment of groups to ensure water solubility and the delivery of cofactors (water, hydronium ion) to the phosphinic acid 'active site' of the catalyst. NMR and X-ray spectroscopy provided glimpses of the hydrophobic cleft, e.g. its distinctive magnetic anisotropy and ability to 'host' a molecule of diethyl ether. In the laboratory, the team was enriched throughout by Kappa's skill, sense of humour and companionship. When we took to the streets of Lewes for the renowned 5 November (Bonfire Night) rituals, we were sustained by the hospitality and sanctuary provided by Rita and Kappa at their home overlooking the town.

The progress of the artificial enzyme project is documented in nine publications. In the last of these (Sir J. Cornforth, "Synthesis of Substituted Dibenzophospholes. Part 9. Preparation of Two Water-Soluble Phosphinic-polyphosphonic Acids"; *J. Chem. Soc., Perkin Trans. 1*, 1996, 2889), Kappa reports a 3-fold increase in the rate of hydration of 2-methylbutene in water at pH 3.9, induced by a phosphinic acid that he designed specifically for this purpose. The rate enhancement is described by Kappa as "unremarkable" but the ideas on catalyst design and structure are a pioneering example of an important contemporary strategy.

## FORTHCOMING MEETINGS

### Royal Society of Chemistry Historical Group Meetings

#### Gilbert N. Lewis Meeting

*Wednesday 23 March 2016, Royal Society of Chemistry, Burlington House, Piccadilly, London*

In 1916, Gilbert N. Lewis published a paper entitled "The Atom and the Molecule" that for the next century had enormous influence upon many areas of chemistry. To celebrate this centenary, we will be holding a one day meeting with an introductory talk covering Lewis' overall contributions to chemistry and the interactions he had with his peers during his life. Other speakers will address areas such as the impact of his ideas on modern quantum mechanics and bonding across the spans of physical, inorganic and organic chemistry, how the modern chemistry text book and university courses have been built on this backbone, and how the working language of organic chemists in their synthetic and mechanistic explorations has developed from Lewis's concept of the shared electron bond. More details will appear in the winter 2016 *RSCHG Newsletter*.

#### H.G.J. Moseley (1887-1915), Lost Nobellist for 1916

*19 October 2016, Royal Society of Chemistry, Burlington House, Piccadilly, London*

Moseley, although originally intending to read chemistry at Oxford, became a physicist whose work revolutionised chemistry. He determined atomic numbers of elements, the charge on the nucleus, identical with the number of electrons in the neutral atom. Atomic number correlated universally with the chemically-necessary positions of elements in the periodic table, unlike atomic weight (which would interchange the pairs K and Ar, Co and Ni, Te and I, and Th and Pa). It also confirmed that elements remained to be discovered: those with atomic numbers 43 (Tc), 61 (Pm), 72 (Hf), and 75 (Re). Moseley laid the foundation for X-ray fluorescence spectroscopy, now a routine analytical tool. His death in the ill-fated Dardanelles campaign against Turkey in 1915 invalidated Arrhenius' nomination of him for the 1916 Nobel Prize for Physics. Full details on the meeting will appear in the summer 2016 *RSCHG Newsletter*.

### Society for the History of Alchemy and Chemistry Meeting

#### Chemistry and its Audiences

*Saturday 14 November 2015, Royal Institution, 21 Albemarle Street, London*

#### Programme

10.30: Registration

11.00: Welcome and introduction

11.10: Oliver Marsh (University College London)

*Who are the Audiences for Science Communication in the Twenty-First Century?*

11.50: Hattie Lloyd (University College London)

*Press Cuttings and Personal Accounts: How to Build a Picture of Humphry Davy's Audience*

12.30: SHAC AGM

1.00: Lunch – a sandwich lunch will be provided

2.00: Tour of the Royal Institution led by Frank James

2.40: Robert Anderson (Clare Hall, Cambridge)

*Facts or Fantasies in the Lecture Theatre?*

3.20: John Perkins (Oxford Brookes University)

*The Audiences for Chemistry in 18th-Century Paris*

4.00: Tea and coffee

4.30: Melanie Keene (Homerton College, Cambridge)

*Familiar Chemistry and its Family Audiences*

5.10: Meeting ends

The registration fee for the meeting, including a sandwich lunch and refreshments is £15 for SHAC members and £20 for non-members.

*To participate:*

**Either** send your name, address and email, along with a cheque drawn on a UK bank for £15 or £20 as appropriate payable to “Society for the History of Alchemy and Chemistry”, to Dr Michael Jewess, SHAC Treasurer, The Long Barn, Townsend, Harwell, Oxfordshire, OX11 0DX, UK.

**Or** (suitable for those not having a UK bank account) make a PayPal payment for £15 or £20 as appropriate to the account “treasurer@ambix.org” (quotation marks are not part of the account name) and *then* send your name, address and email, by e-mail to treasurer@ambix.org. (For this, you will have to create your own PayPal account if you do not already have one.) (In case of difficulty with payment, e-mail treasurer@ambix.org.)

A registration form for the meeting can be found at

<http://www.ambix.org/wp-content/uploads/2015/06/SHACAAutumn2015Form.pdf>

### **Institute of Physics History Group**

50 years of Dilution Refrigerators (organised jointly with the IOP Low Temperature Group)

*16 September 2015, University of Manchester*

[www.mub.eps.manchester.ac.uk/50-years-of-dilution-refrigeration](http://www.mub.eps.manchester.ac.uk/50-years-of-dilution-refrigeration)

### **Farewell to Magnox**

Organised jointly with the IOP Nuclear Industry Group

*Wednesday 28 October 2015, Wylfa, Holyhead, Anglesey*

<http://www.iop.org/activity/groups/subject/hp/index.html>

## **FORTHCOMING CONFERENCES**

### **Tenth International Conference on the History of Chemistry**

#### **Chemical Biography in the 21<sup>st</sup> Century**

*9-12 September 2015, Aveiro, Portugal*

Biographies – whether in the form of books or articles – have always been an important genre in the history of chemistry. However for several decades in the latter half of the twentieth century, professional historians of chemistry avoided the biographical approach as being inherently too hagiographical and ‘Whiggish’. However following the pioneering work of scholars in the history of physics, the biography has been taken up anew as a framework for analysing thematic problems and social-cultural questions. This conference will critically examine this conceptual ‘turn’ in the historiography of chemistry and explore ways in which the biographical approach can be fruitfully employed by historians of chemistry. The keynote speakers include Professor Jorge Calado, Professor Bernadette Bensaude-Vincent and Professor Michael Gordin.

The 10ICHC, organised by the Working Party for the History of Chemistry of EuCheMS, will start on Wednesday 9 September 2015 with the traditional welcome reception. There will be two and a half days of sessions and keynote lectures, and also an excursion to the University of Coimbra. On Sunday 13 September there will be an optional excursion to Douro.

Further information on the conference can be found at: <http://10ichc-2015.web.ua.pt/>

### **34<sup>th</sup> International Conference for Dyes in History and Archaeology (DHA34)**

The conference will take place from 21-24 October, 2015, in the city of Thessaloniki, Greece. The Department of Management and Conservation of Ecclesiastical Cultural Heritage Objects at the University Ecclesiastical Academy of Thessaloniki is delighted to host DHA34. Presentations will take place on Thursday 22 and Friday 23 October, in the main hall of the University campus. The optional social programme includes a welcome reception (Wednesday 21 October) and an excursion (Saturday 24 October).

DHA is an annual series of conferences that covers all areas concerning dyes and organic pigments including their history, production, application, characterisation and analysis, properties and identification. Consequently, DHA34 aims to attract conservators, curators, art historians, craftsmen, artists and scientists from museums, universities, research institutions and other public or private entities as well as independent scholars. For more information please see: <http://web.aeath.gr/jaeath/dha2015/>

Chris Cooksey