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# Historical Group

## NEWSLETTER and SUMMARY OF PAPERS

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**No. 82 Summer 2022**

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### From the Editor

Welcome to the summer 2022 RSC Historical Group Newsletter. The group's next meeting "Women in Chemistry" is on 13 October 2022 and we hope that you be able to join us in-person at Burlington House. The meeting's focus is the 'hidden' women of chemistry. It will explore the barriers they faced, their roles and contributions to chemistry, and how information about their pioneering efforts can be uncovered.

This issue contains four short articles and one book review: Keith Parry writes about the pigment Maya Blue; John Nicholson highlights the life and death of John Masson Gulland, FRS (1898-1947); Stephen Cohen discusses the process behind writing and illustrating a graphic novel on the history of chemistry; and Peter E. Childs provides insights into the seaweed and kelp industries in Scotland and Ireland. Peter Morris reviews *Scientific Sleuthing: Chemical Discoveries Made in New Zealand* and there are reports on the group's meetings on George Porter and Geoffrey Wilkinson and summaries of recent talks given in its webinar series

Finally, I would like to thank everyone who has sent material for this newsletter, particularly the RSCHG Committee and a wider group of colleagues who have contributed to its contents. I also want to thank the newsletter production team of Gerry Moss and Bill Griffith, and John Nicholson, who liaises with the RSC regarding its online publication. Particular thanks to Charlotte New at the Royal Institution Archive for providing images to accompany the report on the George Porter meeting.

Contributions of articles of around 2,500 words in length on topics of current interest in the history of chemistry are warmly invited for inclusion in future newsletters. I'm very happy to discuss possible contributions in advance so please get in touch. The deadline for the winter 2023 issue will be **Friday 2 December 2022**. Please send your contributions, to [a.simmons@ucl.ac.uk](mailto:a.simmons@ucl.ac.uk) as an attachment in Word. The newsletter usually appears on both group websites [www.rsc.org/historical](http://www.rsc.org/historical) and <https://rschg.qmul.ac.uk> in January and late July/August of each year, with members informed through the monthly e-alert sent out via the RSC.

Anna Simmons

## ROYAL SOCIETY OF CHEMISTRY HISTORICAL GROUP NEWS

### Letter from the Chair

As I have said in my letters in the last two years, the good continuing health of all of us remains important and I hope that you and your loved ones are keeping well. I am glad to report that our in-person meetings are continuing to be held at Burlington House. The meeting to mark the centenary of Sir Geoffrey Wilkinson, organised by Henry Rzepa, took place on 23 March 2022 with the generous financial support of the Wilkinson Foundation. The last of our postponed meetings, “Women in Chemistry”, organised by John Hudson, will take place on 13 October 2022 at Burlington House. A notice about the “pot pourri” meeting in March 2023 appears later in this issue. We aim to keep all our members informed about our meetings by email and via our website.

We will continue to produce the newsletter and the monthly online talks on Zoom. Please look out for the e-alerts from the RSC, posted out in the first week of every month, which tell you the topic of the forthcoming talk and a joining link. Recently we have enjoyed talks on “Alchemy, or How to Make Gold” by John Hudson, “Sir John Brunner and Henry Brunner: Their Life And Legacy” by Diana Leitch, “Insulin, the Crooked Timber: From Thick Brown Muck to Wall Street Gold” by Kersten Hall, “Discovery of the Elements Predicted by Mendeleev’s Table – Scandium, Gallium, and Germanium” by Mary Virginia Orna, “Pills, Powders and Purgatives: The Story of How Drugs from a London Livery Company Were Used throughout the World” by Anna Simmons, and “Developments in the Application of Science and Technology for the Technical Study of Paintings” by Aviva Burnstock from the Courtauld Institute. In recent months, we have also had talks on twentieth-century chemistry by myself and on nineteenth-century chemistry by Peter Ramberg. These online talks have been very successful, attracting audiences of up to seventy-two listeners, and I would encourage members to continue to log on to the forthcoming talks for the rest of 2022.

Our treasurer, Richard Buscall, has recently stepped down from his post for personal reasons and he will be greatly missed. I must thank him for all his hard work as our treasurer over the last three and a half years, especially during the Covid pandemic. I am happy to announce that Stanley Langer,

who will be familiar to many of you as one of the organisers of the RSC Annual Congresses (which regrettably no longer take place), will take over as treasurer on 1 October. Sadly, it is also time to say goodbye to John Hudson, who is leaving the committee at the end of the year, having served as a committee member for thirty years, and as our treasurer and as my immediate predecessor as our chair. He will be much missed by all.

I myself will be stepping down as chair at the end of the year, having served a full term of four years. I think it is important to have a regular rotation of the chairpersonship and I look forward to serving under my successor, I have enjoyed serving the group in this way, although the pandemic was a major challenge for us, which was met by holding committee meetings online and instituting our regular online lectures. I wish to thank John Nicholson for being such a good secretary and for all the committee for the assistance they have given me over the last four years. I must also thank Anna Simmons for her continuing excellent work as editor of the newsletter despite her heavy commitments elsewhere. We are all greatly in her debt.

Peter Morris

### Online Seminar Series

The Historical Group’s webinars will be taking a break in August 2022 but will resume in September, in their usual slot at 2 pm on the third Tuesday of the month. Recordings of some past talks can be found on [www.rsc.org/historical](http://www.rsc.org/historical).

## ROYAL SOCIETY OF CHEMISTRY HISTORICAL GROUP MEETINGS

### Women in Chemistry

*Thursday 13 October 2022, Royal Society of Chemistry, Burlington House, Piccadilly, London W1J 0BA*

200 years ago there were very few opportunities for women to study or practise any form of science. By the late nineteenth century, the door was beginning to open for women to study for a university degree. Since the dawn of the twentieth century there has been a huge change in the career opportunities available to women. This one-day symposium focusses on the ‘hidden’ women of chemistry, their roles and contributions to the field, the

barriers faced and how their pioneering efforts can be uncovered.

### Programme

- 10.15 Registration and coffee
- 10.55 Welcome and Introduction - Peter Morris.  
First Session – Chair: John Hudson
- 11.00 Anne Barrett, Imperial College, London:  
*How Archives Can Reveal Hidden Women in Chemistry*
- 11.35 Presentation of Wheeler Award to Sally Horrocks – Peter Morris.
- 11.45 Sally Horrocks, University of Leicester:  
*Women in Industrial Chemistry in inter-war Britain*. (Provisional title).
- 12.30 Lunch. This is not provided but there are many cafés and bars close by.  
Second Session – Chair: Anna Simmons.
- 14.00 Patricia Fara, Clare College, Cambridge:  
*Listening to the Canaries: Munitions Workers in World War One*.
- 14.35 Annette Lykknes, NTNU, Trondheim, Norway:  
*A Seat at the Table: Women and the Periodic System*.
- 15.10 Tea Interval.  
Third Session – Chair: Helen Cooke.
- 15.45 Marelene Rayner-Canham and Geoff Rayner-Canham, Grenfell, Campus, Memorial University, Newfoundland, Canada:  
*“Let us in!” – The Opposition to the Admission of Women to the Professional Societies*.
- 16.20 Prof. Gill Reid, University of Southampton, President Royal Society of Chemistry:  
*My Journey with Chemistry*.
- 16.55 Closing Remarks - John Hudson.
- 17.00 Close of meeting.

### REGISTRATION

There is no charge for this meeting, but prior registration is essential. Please visit <https://events.rsc.org/rsc/2584/register>. Event information:

<https://www.rsc.org/events/detail/74348/women-in-chemistry>. If, having registered, you are unable to attend, please cancel through the link provided in the confirmation e-mail or by email to RSCHG Secretary John Nicholson ([jwnicholson01@gmail.com](mailto:jwnicholson01@gmail.com)).

### Call for Papers; Pot-Pourri Meeting in March 2023

As our meetings for several years have had a theme, we wish to have a meeting without a specific theme (a “pot-pourri” meeting) to enable our members to give a paper on their topic to a wider audience. It will be on Wednesday 15 March 2023 and held in-person at Burlington House, Piccadilly, London. Your paper can be on any theme you wish, it could be a work-in-progress or a topic you have already completed but never given a talk about before. The key thing is that it should be a subject about which you are both passionate and knowledgeable. Preference will be given to Historical Group members who have not given a paper before (or at least not for several years). The talks should not be more than twenty minutes long and there will be five minutes afterwards for questions. We hope to have at least six papers and, if there are more, we may begin the meeting in the morning. Please send your proposal to the programme committee chair, Peter Morris ([doctor@peterjtmorris.plus.com](mailto:doctor@peterjtmorris.plus.com)), in an email, giving a short biography, a title for your paper and a short (150-200 words) summary of its content. A final decision on which papers to include will be made by the end of 2022.

Peter Morris

### 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.

Michael Jewess, “The ‘Great Renaming’: Locating History of Science in London”, *Viewpoint* (British Society for the History of Science), No. 125, October 2021, 6-8.

Unfortunately, due to an issue during production, an incorrect version of the article was published in hard copy, but the *Viewpoint* editor has kindly corrected No. 125 in the (open-access) online version at <https://www.bshs.org.uk/wp-content/uploads/No-125-October-2021-for-web.pdf>.

From the coming into force of the Metropolis Management Act 1855 to the year 1939 there was a “great renaming” of thousands of London streets so as to avoid duplication that had been inconvenient for postal deliveries. For instance, sixty “George Streets” were renamed; and sometimes, a distinctive street name was extended to an adjacent block so that the numbering had to be changed even in the part of the street originally bearing that distinctive name. These processes are illustrated with respect to (i) the famous “Broad Street Pump” of Dr Snow’s epidemiological research on cholera transmission (location now in “Broadwick Street”), and (ii) Michael Faraday’s place of apprenticeship in Blandford Street (renumbered from “2” to “48”). Researchers are advised on the resources available to overcome the problems created and a summary of the general development of London from 1855 to 1965 is given.

Michael Jewess, two related articles “Snippets from the Archives: A Look back at the Federation’s First Hundred Years”, *IP Federation Review*, December 2020, 6-9 and “IP Federation Archive made available to the Public”, *IP Federation Review*, December 2021, 16-17. Both issues of the *Review* are open-access at <https://www.ipfederation.com/publications/?cat=37>.

Since 1920, the IP Federation, previously the Trade Marks Patents and Designs Federation (TMPDF), has represented the interests of commercial enterprises (*not* legal professionals) which use worldwide intellectual property rights in their business. Its archive 1920-1989 has been donated to the Weston Library (part of the Bodleian, University of Oxford). Legal scholars, business historians, and others now have access to a wealth of previously unavailable material (i) showing how business reacted to and lobbied on intellectual property (IP) law and (ii) relating generally to the exploitation of technology (*e.g.* as affected by the Second World War, the establishment of the National Research Development Council in 1948, and the entry of the UK into the European Common Market in 1973). The internal Federation documents such as minutes and private newsletters are unusually detailed. Many third-party documents will be the only ones in the public domain – or even the only copies in existence.

Pioneers of Science Education (PoSE) – published in *Science*, the journal of the Irish Science Teachers’ Association (ISTA)

In this series, Peter E. Childs looks at some of the pioneers of science education, either in terms of pedagogy, curriculum development or science

education research. Some of them have an Irish connection, but all have had an influence on the teaching and learning of science in Ireland and globally. Available at: [www.cheminaction.com](http://www.cheminaction.com).

PoSE No. 1 covered Maria Edgeworth, Irish author and educator. PoSE No. 2 looked at Richard Dawes, a pioneer of child-centred science in context. PoSE No. 3 looked at the life of Mrs Jane Marcet, one of the earliest popularisers of science, especially for women. PoSE No. 4 looked at J.M. Wilson, who served on a Royal Commission with Thomas Huxley (PoSE No. 5), and who also promoted technical education as did Brother James Dominic Burke in Cork (PoSE No. 6). Burke also used enquiry in science teaching as did Henry Armstrong (PoSE No. 7). Armstrong’s ideas were brought to Ireland by William Mayhowe Heller (PoSE No. 8), one of his early disciples of science by enquiry. In England, Christ’s Hospital School was important as a test-bed in putting Armstrong’s ideas into practice, and through the work of Gordon von Praagh (PoSE No. 9), learning by discovery found its way into the Nuffield Chemistry courses. In PoSE No. 10 the series moved to a more contemporary Pioneer, Alex Johnstone, who only died in 2017. He had a major effect on improving chemical education worldwide from the 1970s onwards through his research. PoSE No. 11 featured Justus von Liebig, a pioneer of laboratory teaching, and PoSE No.12 the Irishman John Tyndall, a noted researcher and populariser of science. PoSE No. 13 features David Waddington, Emeritus Professor Chemical Education at the University of York, who is still alive, and is a pioneer in introducing context-based science courses into secondary schools. PoSE #14 will look at the contribution of the late Peter Fensham to ‘Science for all’.

## **OBITUARY – G. Jeffery Leigh (1934-2022)**

Professor G. Jeffery Leigh, OBE, a long-standing member of the Historical Group passed away on 1 February 2022. He was formerly of the University of Sussex, which he joined in 1965 as part of the Nitrogen Fixation Unit. Under his direct supervision, the chemistry group at the unit became the leading laboratory on dinitrogen chemistry. He left the Nitrogen Fixation Laboratory as Deputy Director in 1994 to become the first professor of environmental science at the University of Sussex. His book *The World’s Greatest Fix: A History of Nitrogen and Agriculture* was published by Oxford University Press in 2004 and in recent years he published in both the *RSC Historical Group Newsletter* and the *Bulletin for the History of*

*Chemistry* on Jane Marcet. An interview by Jonathan Hare with Jeff Leigh on his life in science is available on the University of Sussex's website: <https://www.sussex.ac.uk/geoset/scientists>

## PUBLICATIONS OF INTEREST

*Ambix*: The Journal of the Society for the History of Alchemy and Chemistry February 2022, volume 69, issue 1 – Special Issue: Alchemical Practice and the Chemical Humanities

Megan Piorko, Marieke Hendriksen and Simon Werrett, “Alchemical Practice: Looking Towards the Chemical Humanities”.

Umberto Veronesi and Marcos Martín Torres, “The Old Ashmolean Museum and Oxford’s Seventeenth-Century Chymical Community: A Material Culture Approach To Laboratory Experiments”.

Lyke De Vries, “Protecting Academia and Religion: Andreas Libavius’s Criticism of a General Reformation”.

Fabiana Lopes da Silveira, “In the Melting Pot: Cultural Mixture and the Presentation of Alchemical Knowledge in the *Letter from Isis to Horus*”.

Sarah Lang, “A Machine Reasoning Algorithm for the Digital Analysis of Alchemical Language and its *Decknamen*”.

*Ambix*, May 2022, volume 69, issue 2

Bruce T. Moran, “Medical Performance and the Alchemy of Plants in the Ventures of Leonhard Thurneisser zum Thurn”.

Aurélien Ruellet, “The Pewterer and the Chymist: Major Erasmus Purling and his Refined Tin”.

Leticia Dos Santos Pereira, Olival Freire Junior and Gisela Boeck, “Wilhelm Ostwald’s Pedagogy: An Analysis of the Nobel Prize Nomination Letters”.

John Considine, “The Beginnings of English Paracelsian Lexicography: Two Collections of Words from Elizabethan Cambridge”.

*Ambix* Article Collection: The Apothecary beyond the Shop: Chemistry, Medicine and Laboratories from the Seventeenth to the Nineteenth Centuries

Contributors to *Ambix* have long been interested in examining the relationship between the apothecaries of London and their Society. Founded

in 1617, the Society of Apothecaries had responsibility for examining apprentices and regulating apothecaries’ activities in the City of London and within a seven mile radius. This collection of papers from *Ambix* and *Annals of Science* marks the 350<sup>th</sup> anniversary of the opening of a laboratory for manufacturing chemical medicines at Apothecaries’ Hall in 1672 and one hundred years since the Hall pharmaceutical trade’s closure in 1922. It places pieces specifically about the Society alongside articles which explore the broader social, economic and intellectual contexts of chemistry, medicine and laboratories from the seventeenth to the nineteenth centuries and includes papers by Maurice Crosland, Barbara Di Gennaro Splendore, Marieke Hendriksen, John Perkins, P.M. Rattansi, Anna Simmons and Charles Webster.

<https://www.tandfonline.com/journals/yamb20/collections/the-apothecary-beyond-the-shop> . All papers are free access until the end of July 2022. After this date selected papers will remain available for free.

*Bulletin for the History of Chemistry*, vol. 46, number 2, 2021

Aliyar Mousavi, “The Compounding of Cinnabar (Red Mercury(II) Sulfide) in the Persian Poetry of the Eleventh Century”.

Peter E. Childs, “The History of the Chemicals from Seaweed Industry in Ireland”.

Mary Virginia Orna and Marco Fontani, “Commemoration of Ernest Rutherford on the 150th Anniversary of his Birth, Part I: 1871-1907”.

David R. Manke, “Fritz Reitzenstein: A Little-Known Figure in the Werner-Jørgensen Controversy”.

Sergey Teleshov, and Agnė Šulčiūtė, “The Prototype of Mobile Laboratories for Chemical Education Algirdas Šulčius”.

Joop A. Peters and Herman van Bakkum, “Pioneering Molecular Models for Cycloalkanes by Derx in Böeseken’s Laboratory at Delft, A Century Ago”.

Jeffrey I. Seeman, “George Bernard Kauffman (1930-2020): A Unique Chemist, Educator, Critic, and Historian. An Obituary-Tribute”.

Book Review

Sibrina N. Collins (ed)., *African American Chemists: Academia, Industry, and Social Entrepreneurship*, reviewed by Marquita M. Qualls

## SOCIETY NEWS

### Division of the History of Chemistry of the American Chemical Society (HIST)

The Division of the History of Chemistry of the American Chemical Society (HIST) is 100 years old in 2022. For this anniversary year, it has prepared an extra issue of the *Bulletin for the History of Chemistry*, available open access and edited by Carmen Giunta and Jeff Seeman. Prominent chemist historians and historians of chemistry were invited to contribute essays on the theme “Novel Insights in the History of Chemistry: Looking Back Yet Mostly Looking Forward”.

*Bulletin for the History of Chemistry*, vol. 47, number 1, 2022,

[http://acshist.scs.illinois.edu/bulletin\\_open\\_access/bull22-vol47-1.php](http://acshist.scs.illinois.edu/bulletin_open_access/bull22-vol47-1.php)

Roald Hoffmann, “Foreword”.

Jeffrey I. Seeman and Carmen J. Giunta, “Preface: Happy Centennial to the ACS Division of the History of Chemistry”.

Robert G. W. Anderson, “Epitomizing Chemistry for Changing Audiences in Britain, 1820 -2020”.

Arthur Greenberg, “Mendeleev's ‘Problems’: A Means to Engage Students and Teachers in the History of Chemistry”.

Mary Virginia Orna, “Archaeological Chemistry: Past, Present, Future”.

David Allen Cole, “Can We Bring Chemistry Back? Exploring the Potential of ‘Gateway Artifacts’ at the Science History Institute”.

Anthony S. Travis, “Historiography of the Chemical Industry: Technologies and Products versus Corporate History”.

David E. Lewis, “A Future History of Selectivity in Organic Chemistry: Whence, Where, and Whither?”

John Parascandola, “The Development of Medicinal Chemistry as a Disciplines: A Topic Ripe for Historical Exploration”.

Seth C. Rasmussen, “Moving Beyond the Intersection of Chemistry and History: Evolving Multidisciplinary Approaches to the Historical Study of Chemistry”.

Guillermo Restrepo, “Computational History of Chemistry”.

Sibrina N. Collins, “History of Chemistry as a Tool for the Engagement of Underrepresented Students in Chemistry”.

Marelene F. Rayner-Canham and Geoffrey W. Rayner-Canham, “Out of Obscurity: Contextualizing Forgotten Women Chemists”.

Stephen J. Weininger, “ ‘The Poor Sister’: Coming to Grips with Recent and Contemporary Chemistry”.

Peter J.T. Morris and Jeffrey I. Seeman, “The Importance of Plurality and Mutual Respect in the Practice of the History of Chemistry”.

William H. Brock, “The Long and Short of It: The Future Writing of History of Chemistry”.

William B. Jensen, “Does History of Chemistry Have a Future?”

Jeffrey I. Seeman, “Remote Interviewing and the History of Chemistry”.

Carmen J. Giunta, “Is There Room for the Present in the History of Science?”

Alan J. Rocke, “Reflections on the Last and the Next Hundred Years”.

Jeffrey I. Seeman, “The Back Story: Steve Weininger, Comfortable in Many Disciplines”.

Readers can also view thirty years of open-access issues of the *Bulletin*, which are free to all after a three-year window of access exclusively by HIST members and subscribers:

[http://acshist.scs.illinois.edu/bulletin\\_open\\_access/bull-index.php](http://acshist.scs.illinois.edu/bulletin_open_access/bull-index.php)

More information about HIST, including how to join is available at: <http://acshist.scs.illinois.edu/index.php>

The HIST Award for Outstanding Achievement in the History of Chemistry

The winner of the HIST Award for 2022 is Marco Beretta of Bologna University for his numerous critical works covering an impressive timespan of history, as well as his noteworthy leadership in the history of the materiality of chemistry and service to the field. Professor Beretta received his BA with honours in the History of Science from Milan University in 1986 and his PhD from Uppsala University in 1994 for his thesis: “The Enlightenment of Matter: The Definition of Chemistry from Agricola to Lavoisier”. Professor Beretta is considered a leading Lavoisier scholar and

is also a leading scholar of the history of glass in art and technology. He joined the University of Bologna in 2000, where he is now Professor of the History of Science. He was the editor of the journal *Nuncius* and has become a highly sought-after editor and collaborator for important publications in the history of science, including the *Cultural History of Chemistry*. He is considered one of the leading scholars on ancient chemistry and has helped to create a vibrant research field of young and productive scholars.

## SHORT ESSAYS

### Maya Blue

My first research project in 1965, was a study of the tautomerism of indoxyl in various solvents. In solution, indoxyl was yellow with a greenish tinge, but its ready aerial oxidation to indigo, particularly under basic conditions, made me all too aware of the colour blue. Indigo had left its mark, maybe staining me for ever! A casual reference to indigo and Maya Blue triggered my curiosity. What was Maya Blue? [1]

#### Introduction and Early Work pre-2000.

The Mayans were a civilisation based in the Yucatan in Central America from 250AD to the Spanish Conquest around 1500AD. They constructed many buildings, one of which is the Temple of the Warriors at Chichen Itza in the Yucatan (Fig. 1.) [2]. This temple, a large stone building, was built in 800-1050AD and its walls were adorned with coloured images. In 1931, H E Merwin was the first person to describe the blue pigment found in the wall paintings of the Temple of the Warriors at Chichen Itza [3].

He noted that in contrast to the black, orange and yellow pigments, the blue pigment formed fairly coherent films which could be isolated by dissolving away the plaster. The blue pigment was resistant to boiling nitric acid, so he believed it was inorganic in nature. X-ray powder photography failed to distinguish the blue pigment from other clays such as beidellite and a blue chromiferous example.

Some ten years later, in the 1940s, Gettens and Stout named the blue pigment Maya Blue [4]. The pigment was pleochromic; thin sections under transmitted polarised light were blue in one direction and yellow in another. Gettens found a small painting, now held in the Fogg Art Museum, Harvard, contained a blue pigment that was weakly pleochromic, stable to 5% caustic

soda, hydrochloric acid, and boiling nitric acid [5]. He concluded that it was Maya Blue, indicating that the pigment was used in other places than walls of temples. He also suggested that Maya Blue was an inorganic pigment that owed its green-blue colour to the presence of iron [6]. X-ray diffraction analysis of a sample of Maya Blue showed it to be essentially a zeolite clay, palygorskite [7].



Fig. 1. Temple of the Warriors at Chichin Itza.

Source:<https://commons.wikimedia.org/w/index.php?search=Temple+of+the+Warriors&title=Special:MediaSearch&go=Go&type=image>

However, further work led him to change his mind about the role of iron. He identified samples at a range of further sites all in the Yucatan: Bonampak, Chiapas, the Sacred Cenote at Chichen Itza, Cozumel Island and Mayapan (fig. 3) [8]. Six samples from these new locations were analysed and four of these had no iron present. Gettens concluded that whilst all the samples were Maya Blue, iron was not the cause of the colour.

Shepard and Gottlieb proposed an alternative hypothesis. They knew that palygorskite could absorb organic materials as it was a decolourising agent for oils and sugars and had been used in the fulling process for wool [9]. They also knew that an organic blue dye, indigo, could be obtained from local plant sources. Could palygorskite absorb indigo? If it did, would the adduct be stable to acidic conditions that would normally lead to destruction of indigo and loss of colour? However, their analyses for organics were inconclusive owing to problems of ensuring no contamination with stray organic material and/or detecting a low concentration of organics.



Olphen and Deeds approached the problem from a different perspective. They synthesised materials from indigo or indigo precursors and palygorskite and compared the products with Maya Blue [10]. They had three approaches: alkaline hydrolysis of indoxyl acetate in the presence of palygorskite followed by aerial oxidation; heating indigo directly with palygorskite; and reducing indigo to leucoindigo with sodium hydrosulphite and contacting the reduced material with palygorskite followed by aerial oxidation. In all three approaches, heating the final solid product for several days at 75°C or shorter at a higher temperature of 105-115°C was found to be an essential step to get a product that was stable to boiling acids and could be considered very similar to Maya Blue.

Structurally, palygorskite has surface channels and tunnels running through the matrix. Olphen and Deeds suggested that the surface channels could bind indigo tightly and render it resistant to acid but suggested that indigo was too large to be accommodated in the tunnels.

In 1967, Kleber et al. reported the synthesis of Maya Blue after Olphen by treating palygorskite with leucoindigo followed by aerial oxidation and heating [11]. They found that stronger heating was required than was suggested by Olphen and used temperatures of 190°C for five hours. Milder conditions were not effective. Comparison of their material with a sample of Maya Blue from a piece of pottery from Tlatelolco (Mexico City) by infrared spectroscopy showed common characteristic indigo peaks in the 1300-1500cm<sup>-1</sup> range. However, they were cautious in their interpretation as the amount of indigo needed to give the blue colouration was small and at the limits of detection using their method.

Using thermo-gravimetric analysis, they showed that palygorskite lost the water bound in the tunnels at around 100-120°C thereby making the tunnels more accessible; there was little change to the overall clay structure. Was the coincidence of this temperature and the temperature required to fix the indigo-palygorskite complex significant? As the cross-sectional size of the tunnel was 10.5Å by 6.45Å, running the length of the crystal, Kleber et al. suggested that the indigo molecule, sized at 6.21Å by 3.40Å by 8.48Å, could fit into the opened tunnel thereby rendering the indigo much more resistant to chemical attack.

### How Did the Maya Source the Palygorskite?

Shepard examined the range of clays used for pottery available in the Maya heartland in the Yucatan and concluded that palygorskite appeared to be an

uncommon mineral in the Yucatan though it was found in a small area around Ticul.

At Sacalum, near Ticul, the local inhabitants recognised a 'white earth' called 'sak lu'um' [12]. In the late sixties, Folan identified a sample from the side of the local cenote as palygorskite [13]. Later, in 1975, Arnold found a mine at the bottom of this cenote, obscured by rock falls where considerable amounts of palygorskite had been removed. Unfortunately, no artefacts were found to date the mine. However, Sacalum is listed in Spanish tax returns of 1549, only seven years after the conquest of the Yucatan by the Spanish which with some textual evidence implied the use of the mine in pre-Spanish conquest times. A further ancient mining site was found at Yo' Sah Kab near Ticul [14].

### How Did the Maya Source the Indigo?

Two early sources from the 1570s, Hernandez in the Natural History of New Spain, [15] and Sahagan in the Florentine Codex [16] describe a blue colour which they call 'tlacevilli' (one of various spellings). Hernandez named the source plant as 'xiquilti' or in Spanish 'anil'. He described the production of the blue colour.

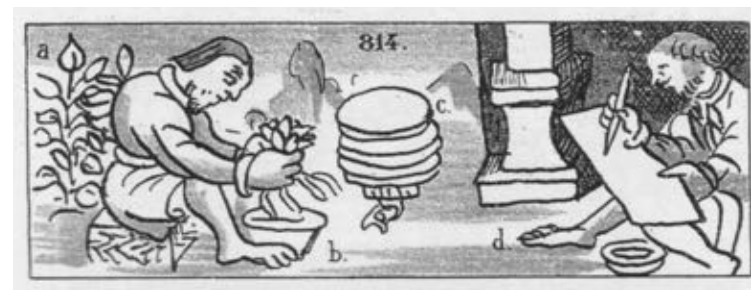


Fig 2. Production of 'tlacevilli' as illustrated in the Florentine Codex [17].

Thanks to University of Utah Press for permission to publish this image.

The plants were identified as *Indigofera* species of which the best source for indigo was *I. suffruticosa* [18].

*The shredded leaves of the 'anil' plant are thrown into a pot or kettle of boiled water; they are shaken vigorously with a wooden shovel and the stained water is allowed to spill through some holes in the vessel at a given height and what came out to settle away from the leaves. The sediment is the*

dye. It is dried in the sun, strained in a hemp bag, shaped into small wheels and hardened on plates over coals and stored for use.

Whilst the Florentine Codex is less detailed it does illustrate the production showing a drawing of the plant (a), the maceration/squeezing of the leaves (b), the small pigment wheels drying over a fire (c), and a painter using the pigment (d). (fig. 2)

### Mayan Preparation of Maya Blue.

There is no contemporary evidence describing the making of Maya Blue. Any record could have disappeared in general destruction caused by the Spanish Conquest. Additionally, the local dyers may have kept details of their preparative methods secret to their profession, a common practice amongst dyers in Europe.

In 1993, Reyes Valerio demonstrated practically that Maya Blue could be made using a four-step process. 'Anil' leaves (*Indigofera suffruticosa*) were macerated in water in the presence of palygorskite for less than twenty-four hours (steeping). The mix was stirred frequently, acquired an iridescence and a greenish or light blue tone. The leaves were separated off using a colander – the filtrate was a pale-yellow suspension. This suspension was then oxygenated using a paddle and allowed to settle (oxidation). A blue green foam was produced which subsequently subsided. The blue-green sediment was filtered off and heated to 100°C. It changed colour to a lighter shade of blue which was identified as Maya Blue by virtue of its resistance to acids [19]. Torres et al. repeated the process in 1988, compared the product with original Maya Blue, and found it to have identical properties [20]. Both parties reported that the preparation required experience and skill to judge the times and temperatures needed for each stage.

A more recent synthesis of Maya Blue used indigo sourced from woad (*Isatis tinctoria*) has been described and photographed by Holmwood [21]. She also illustrated the change in colour to a lighter shade of blue on heating. Thus, techniques familiar to the Maya could successfully produce Maya Blue using local materials: *I. suffruticosa* and palygorskite

The chart below shows the basic indigo chemistry underpinning the work of Reyes Valerio. (Chart 1)

The sole indigo precursor within the *Indigofera suffruticosa* is indicant [22]. In the first stage, steeping, enzymatic cleavage by plant enzymes of the glucose from indican yield indoxyl, which gives the greenish yellow

colour. In the second stage, oxidation is encouraged so that full conversion to indigo is achieved, ideally under alkaline conditions [23]. The indigo precipitates out of solution adhering to the clay present. The final heating stage fixes the indigo into the clay matrix.

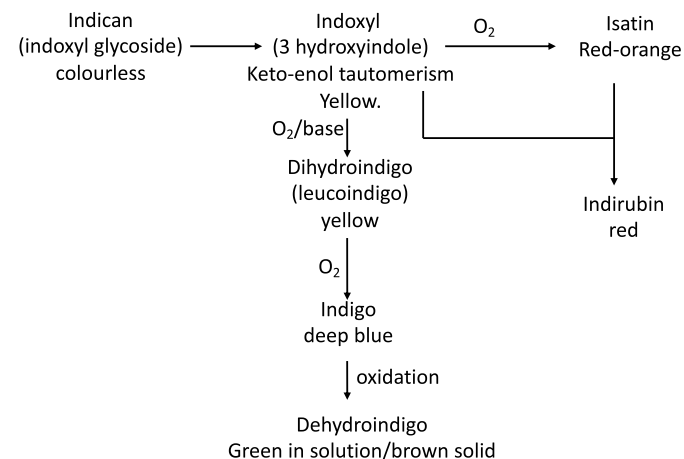


Chart 1: Chemical Process Diagram for Indigo Preparation.

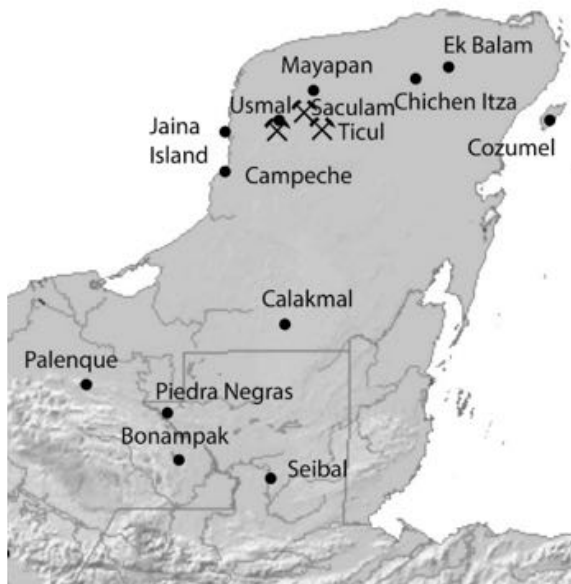
The nature of the product can be affected by poor control over the conditions. If the solution during the oxidation stage becomes too alkaline, the indoxyl will react directly with oxygen to yield isatin (orange red) and by reaction of isatin with indoxyl, indirubin (deep red) [24]. In the final stage overheating and oxidation may encourage the formation of dehydroindigo, identified in the last twenty years as the potential source of the varying green hue in the final product.

Beyond the Yucatan, Reyes Valerio reported finding Maya Blue in several convents in Hidalgo province just north of Mexico City [25]. Samples have also been found in Mexico City and in the province of Vera Cruz, the large coastal region east of Mexico City and adjacent to the northwest of Yucatan. Further afield outside Mexico in Cuba, Tagle found a pigment called 'Havana Blue' to be Maya Blue [26]. He proposed that the strong commercial links between Cuba and Campeche, a port relatively close to the Maya lands offered the opportunity to import Maya Blue from the Yucatan.

Elsewhere, Haude examined the colorants on six early colonial maps created between 1578 and 1585 [27]. Seven green, blue, and blue-green samples were found to be identical to a Maya Blue reference.

Figure 3: The Geographical Spread of Maya Blue.

There are several sites in the Yucatan, southeast Mexico where Maya Blue was identified in wall paintings before 2000. The dots, ●, show places where Maya Blue has been found and the crossed hammer and pick, ✂, mark the locations of the palygorskite deposits mentioned in the article.



Adapted by author with addition of symbols and places, map from

[https://upload.wikimedia.org/wikipedia/commons/b/b4/Map\\_of\\_Mexico\\_De\\_mis.png](https://upload.wikimedia.org/wikipedia/commons/b/b4/Map_of_Mexico_De_mis.png)

### Post 2000

The focus of this article has been work before 2000. Many of the themes covered, have shown significant developments in the last twenty years and there is room here to comment briefly on three areas of research. Firstly, the nature of the interaction between indigo and the clay, palygorskite, has been extensively investigated using a range of spectroscopic techniques and molecular modelling. On balance, the current view favours that of Kleber that the indigo is locked up in the tunnels in the clay interacting through hydrogen bonds with the clay lattice. In parallel studies, several alternative

molecules to indigo, such as thioindigo and methyl red have been incorporated into the lattice to give stable adducts. Secondly, the range of shades in Maya Blue from blue to bluish green in the wall pigments and artefact colours has been the subject of many papers by Doménech. He has proposed that the presence of dehydroindigo is a major cause of the colour shade changes. Lastly, the range of sites where Maya Blue has been identified has expanded significantly, stimulating much discussion about the significance of the colour blue in Maya culture. It may have been associated with the rain god, and by extension with the importance of rain to the cultivation of maize, the essential Maya crop, and hence to life itself.

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Keith Parry

### **The life and death of John Masson Gulland FRS (1898-1947)**

On Sunday 26 October 1947, a major rail accident occurred near the village of Goswick in Northumberland [1]. Twenty-eight people were killed. Among them was the chemist-turned-biochemist John Masson Gulland FRS. Both Gulland and the train crash are largely forgotten today, but in this short article I shall give an account of both.

#### **The Train Crash**

The Goswick rail accident has a small claim to fame in that it was the last major train crash in Britain before the railways were nationalised, an event which occurred formally on 1 January 1948 [2]. The accident involved the *Flying Scotsman* traveling from Edinburgh Waverley to London King’s Cross, and was operated by the London and North Eastern Railway company (LNER). The particular train left Waverley station at 11.15, and was scheduled to divert from the fast main line onto the goods loop at Goswick about an hour and a half into the journey. This was to by-pass

engineering works on the main line. The diversion required the train to slow down to 15 mph from the usual 60-70 mph but, because neither the driver, the fireman nor the guard had read the appropriate notice posted at the Edinburgh Haymarket depot, the diversion came as a surprise to them all and the train was still travelling at high speed. The result was that it jumped the points, causing most of the carriages to be derailed and overturned, with some falling down the adjacent embankment. Most of the twenty-eight people killed died more or less instantly and there were also ninety casualties, including the driver and fireman.



John Masson Gulland (1898-1947)

The subsequent enquiry concluded that the primary causes of the crash were driver error and excessive speed, with fireman error and guard error being contributory factors [3]. The driver, Thomas Begbie, was experienced and in good health. However, he not only failed to read the diversion notice at the depot, but he also failed to see the warning signal just before the train reached Goswick. These errors were compounded by the fact that he had allowed an unauthorised passenger to travel on the footplate, a young man called T.A. Redden who, at the time, was a Leading Stoker in the Navy. Redden's brother worked as a fireman out of Haymarket depot, and was known to driver Begbie. Begbie seems to have agreed to take Redden to London as a favour to his colleague, and there was speculation that

Redden's presence was a distraction that caused driver Begbie to miss the important signal.

### **John Masson Gulland**

Which leads us to the particular victim of the Goswick train crash, John Masson Gulland. Who was he, and why was he significant? By way of answer, we will first consider his life and career, including his move from chemistry into biochemistry, and then look at the contribution he made to both of these subjects.

Gulland came from a notable Scottish family. His father, George Lovell Gulland (1858-1937) was a distinguished medical academic who held the Chair in Medicine at Edinburgh from 1915 to 1928. In addition, he was President of the Royal College of Physicians in 1923 [4]. An uncle on his father's side was a Liberal MP, and an uncle on his mother's side was Sir David Orme Masson FRS, Professor of Chemistry at the University of Melbourne between 1886 and 1923 [5]. His mother also had two distinguished sisters, Rosaline, a successful writer and novelist, and Flora, a writer and high-profile campaigner for women's suffrage [6].

Gulland went to school at Edinburgh Academy, and it was there that he developed his enthusiasm for science. He won numerous prizes for science and also became proficient at shooting, winning several trophies. In 1917, he went to the University of Edinburgh to study chemistry. His studies were interrupted briefly by war service in France, but he returned to the university and graduated BSc in 1921. He was awarded a Carnegie Scholarship and went to study for the newly instituted PhD degree at St Andrew's University under the supervision of Professor (later Sir) Robert Robinson. The first year of his studentship was spent at St Andrew's, but when Robinson moved to the Chair at the University of Manchester in 1922 [7], Gulland went with him and completed his PhD there in 1925. Despite the fact that most of the work was carried out in Manchester, the degree was actually awarded by the University of St Andrew's.

Gulland's PhD was mainly concerned with the morphine bases [6, 8], and resulted in the proposal of the currently accepted structure in two classic papers published, respectively, in 1923 [9] and 1925 [10]. We shall return to these papers shortly.

Following Gulland's time with Robinson, in 1924 he moved to Oxford to take up the role of Demonstrator in Organic Chemistry. In this position, he

worked under the Waynflete Professor of Chemistry, W.H. Perkin Jr (1860-1929) [11], becoming involved in the latter's work on strychnine and brucine, and also finding some time to work on morphine in continuation of his PhD topic. Around the time of his move to Oxford, Gulland married Ruth née Russell, an Edinburgh graduate (MA, LLB) and daughter of the late Sir James Russell (1846-1918), a noted pioneer in the field of public health [12]. With Ruth, he had two daughters.

In 1926, Gulland was appointed Lecturer in Chemistry at Oxford, and his duties included developing and delivering courses in organic chemistry to students of biology and medicine [6]. This seems to have stimulated his interest in biochemistry and may have influenced his decision to join the Lister Institute of Preventive Medicine in London as Senior Biochemist, which he did in 1931. This position also carried with it the appointment as Reader in Biochemistry at the University of London.

Gulland's sojourn in London was primarily scientific. However, the move coincided with his giving up carrying out his own practical experiments, though he had a high reputation as a neat and methodical laboratory worker [6]. Instead, he supervised a number of assistants, and it was they who did the practical work. Among these assistants, he was widely regarded as a fair and sympathetic supervisor.

During his time in London, Gulland became increasingly involved in administrative work, not only at the Lister Institute, but also with the Chemical Society, where he was one of the Assistant Secretaries (1933-1936), and the British Association, where he was successively Secretary (1932-1934) then Recorder (1935-1937) of Section B (Chemistry).

After five years in London, Gulland was appointed to the Sir Jesse Boot Chair of Chemistry at University College, Nottingham. In this role he succeeded the illustrious Frederic Stanley Kipping FRS (1863-1949), who retired in the summer of 1936 [13]. This position obviously involved considerable teaching and research but, in addition, Gulland took on a variety of other administrative roles. For example, when war broke out, he became Senior Gas Advisor for the north Midlands region, work which was concerned with possible gas attacks by Germany and the provision of an adequate supply of gas-masks for the civilian population. Then, in 1943, he was seconded to the Ministry of Supply as Assistant Director of Chemical Research and Development. This was a full-time role that caused Gulland to become involved with a wide range of supervisory activities, ranging from

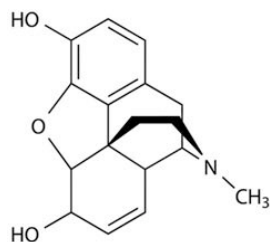
novel explosive intermediates to new ways of retting flax (i.e. teasing the fibres out of the plant material). He also oversaw a project on the production of fibres of alginic acid from seaweed. This work eventually led to the establishment of the Scottish Seaweed Association, and Gulland remained a member of various management committees of this association until his death. After about a year at the Ministry of Supply, Gulland returned to Nottingham and resumed his academic duties.

In 1947, Gulland accepted the role of Director of Research for the newly established Brewing Industry Research Foundation, BIRF, and resigned his Chair at Nottingham. His appointment dated from 1 October 1947. The BIRF was established by the Institute of Brewing, and the aim was to set up their own research laboratories to undertake fundamental studies in support of the industry. This was part of what was widely referred to as "the post-war reconstruction". Sadly, as we have seen, Gulland was killed within a month of taking up this role. In his place, the Institute of Brewing appointed Sir Ian Heilbron (1886-1959) who, in 1948, left his Chair in Organic Chemistry at Imperial College to take the job. A site was purchased in the same year, Lyttel Hall at Nutfield in Surrey and, after considerable development, with laboratories and other facilities installed, the BIRF was opened formally by Prince Philip in 1951 [14]. It still exists, though it is no longer independent and has been part of Campden BRI since 2008 [15].

### **Gulland's Work in Chemistry**

When Gulland went to St Andrew's, he joined Robert Robinson at a time when the latter's views on the structure of morphine and its related substances were becoming fully formed. This led to Gulland's PhD work being of rare significance, since it solved the question of the structure not only of morphine, but also codeine, thebaine and codeinone. Gulland and Robinson published their ideas on the structures of these substances in two papers which appear together in the 1923 issue of the *Journal of the Chemical Society Transactions* [9, 16]. Both papers are long and closely argued, with insights gained from both synthetic and degradative studies. Not surprisingly, they bear the strong hallmark of Robinson, whose deep knowledge of the field and brilliant deductions from a mass of published results shine through the very detailed text. The first paper of the two deals with the general structural problem of compounds of the morphine type, and goes on to propose the structure illustrated, while the second covers the specific related compounds thebainone, thebainol and dihydrothebainone.

Gulland and Robinson's proposed structure for morphine is shown below, and that of codeine differs only in that the upper -OH group is replaced by -OCH<sub>3</sub>.



morphine

These ideas were quickly accepted by chemists. However, it was more than twenty-five years before the structure was finally confirmed, when Marshall Gates and his co-worker Gilg Tschudi at the University of Rochester, USA, carried out the total synthesis of morphine. They reported this in 1952 [17], and their paper was followed in 1955 by further confirmation of the structure, this time in an X-crystallographic study by Dorothy Hodgkin and her student Maureen MacKay [18].

In the 1920s, Gulland turned his attention to the aporphine bases. These are fused ring aromatic compounds, one ring of which contains a nitrogen atom attached to a methyl group. These studies generated a number of papers [for example 19, 20] in the years up to 1930, after which Gulland's interests became increasingly biochemical. In the next few years, mainly at the Lister Institute, he carried out investigations of pharmacologically active compounds, mainly of yew [21, 22], and of the reducing substances in pigeons' blood [23]. He also became interested in the nucleic acids, a topic he pursued on moving to his Chair at Nottingham [24-27], with publications on these substances continuing to appear throughout the war [28-32]. After the war, Gulland began to apply physical methods to the problems of the chemistry and structure of these substances, notably absorption spectroscopy, viscometry and electrometric titration [33, 34].

#### **Gulland and the Structure of DNA**

The work on nucleic acids was Gulland's second major contribution to science, and led to ideas worth considering in detail. Having started his studies of these substances around the time of his move to the Chair at

Nottingham, in 1947 Gulland co-authored three classic papers that came close to solving the structure of DNA [33-35]; they certainly contributed important ideas that led to the eventual solution of the structure. By the late 1940s, interest was growing in DNA as the possible substance associated with genes and inheritance [36]. The fact that DNA is polymeric had been known since the later 1930s, as was the fact that it comprised deoxyribose molecules joined together by phospho-diester links in unbranched chains. DNA was also known to include two sorts of bases, namely purines and pyrimidines. The purines were adenine, A, and guanine, G, and the pyrimidines were thymine, T, and cytosine, C. However, another five years were to pass before Chargaff reported the important finding that the amounts of A and T were the same, as were the amounts of C and G [37, 38].

Gulland's group made two distinct advances in their 1947 papers, namely (i) showing that DNA was a rigid macromolecule and (ii) that this rigidity was maintained by hydrogen bonds [33-35]. Indeed, as shown by a diagram in his PhD thesis, Gulland's student J.M. Creeth (1924-2010) partly anticipated Watson and Crick's structure for DNA. He drew the molecule with two chains of phosphate-sugar on the outside of the structure, and the bases, connected by hydrogen-bonds, on the inside. Unfortunately, Creeth's model lacked key features of the later Watson-Crick structure; it was not helical; it could not take account of Chargaff's later finding on the base pairs; and it assumed the deoxyribose-phosphate units were oligomers [39].

The latter aspect was a result of misinterpreting the data on changes in viscosity of solutions of DNA as pH was changed. More recently, these data have been re-evaluated and shown to be capable of interpretation without the need to assume an oligomeric structure for the main polymer component [36].

In 1947, Gulland and his team had another disadvantage, namely that the widely accepted structures for thymine and guanine were wrong [36]. At the time, both of these substances were widely believed to exist in enolic hydroxyl tautomeric forms, i.e. as -C(OH)=N-. This mistake was included in Davidson's classic text on the nucleic acids, published in 1950 [40]. It was an error that came close to throwing Watson and Crick off the scent in the search for the structure of DNA [41]. As Watson recounts, he and Crick were attempting to account for the equivalent amounts of A and T, and C and G, by fitting them into a helical structure. However, they could not do so without distorting the deoxyribose-phosphate polymer chains. Fortunately, they shared an office in Cambridge with Jerry Donohue (1920-

1985), an expert on tautomerism. He told them that Davidson was wrong and that, at physiological pH, both thymine and guanine existed in the keto form, -CO.NH-. This altered the sizes of these particular base molecules and the orientation of their hydrogen bonds. This meant that the A-T and C-G pairs both became the same size and could then fit comfortably between the polymer chains in the DNA molecule.

There is no doubt that Gulland and his team were onto something and that they provided important insights into the structure of DNA. Watson certainly credits them with the conclusion that hydrogen-bonding of base pairs was a crucial feature [41]. However, it would be wrong to argue, as Manchester did in 1995 [42], that Gulland's death delayed the discovery of the structure of DNA. For one thing, the small group in Nottingham was breaking up, and there is no evidence that Gulland planned to continue to study DNA when he took up his appointment with the BIRF. For another, Gulland's work concentrated on solution properties of DNA, and seemed to take no account of X-ray diffraction studies in the solid state. Such studies had been undertaken in the late 1930s by Astbury at the University of Leeds [43] and, without those and the later work of Franklin and Wilkins, it is unlikely that Gulland would have come up with a helical structure for DNA.

### Conclusion

Gulland was an exceptional scientist who made contributions of high importance to both chemistry and biochemistry. His PhD project made a considerable impact, and his last scientific work provided a number of key concepts that eventually proved important in solving the structure of DNA. The obituary notices that followed his untimely death showed that his loss was felt deeply. They go out of their way to mention his engaging personality, his tact and his charm [6, 8]. Gulland's achievements were towering and there is no doubt that his tragic death at Goswick was a considerable blow to British science.

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John Nicholson

### ***O Mg! How Chemistry Came to Be: The Creation of a New Graphic History of Chemistry***

This year my new comprehensive history of chemistry, *O Mg! How Chemistry Came to Be* (World Scientific Press, 2022), appears in print. Starting with the four-element theory of the ancient Greeks and the five-element theory of the ancient Chinese, the book travels through up to the present day's lithium-ion batteries and nanostructures. The book is in graphic-novel format a currently popular method of bringing esoteric

themes to the layperson. The target audience is teens, but also includes adult non-experts and even chemists themselves, for chemists' education includes only the dimmest, vaguest notion of how various chemical ideas, principles, and laws evolved into their current form. This essay is a brief recounting of the process required to create such a book.

I have always drawn and doodled my way through life filled with humour. In kindergarten I was unhappy with drawing because the school's crayons were fat with a semi-circular cross-section (so as not to roll off the desks), which didn't allow me to draw carefully with a finely-sharpened point. At a parent-teacher conference, the teacher remarked that I had no art talent. By primary school I was creating flip-books of letters and numbers morphing into each other in my workbooks, and divers arcing down the right margin of notebooks. For a time, I toyed with the idea of becoming an animator (in the days of pre-digital graphics). In my early teens I taught myself italic calligraphy by doing all my homework in that script for an entire year (teachers loved it, for they could actually read my work), and then, using instructional art books, learned the technique of linear-perspective drawing. In high school I drew classmates if I was bored in class, and began a series of editorial cartoons for the school newspaper. One of my editorial comics won a Philadelphia regional competition in 1980. I created covers for school musical programs, a masthead for the school newspaper, and a variety of single-panel comics on school life for my private (and close friends') amusement.

At the University of Pennsylvania (Philadelphia, Pennsylvania, USA), where my major was chemistry, I became Art Editor of the student humour magazine *Punch Bowl*, designing a masthead that was used for over forty years [1], and drew a daily comic strip for the student newspaper, *The Daily Pennsylvanian*, entitled *Buffer's Solutions* (one draws what one knows) [2]. I continued creating program covers for the choir I joined. In graduate school at Rice University while doing physical chemistry research (Houston, Texas, USA) I began professional calligraphy, specializing in Judaic documents and topics. I published a couple of articles in *Journal of Irreproducible Results* while in graduate school [3]. Later I was a finalist in a Union of Concerned Scientists contest for science editorial cartoons, which was included in their calendar [4], and have continued to create professional calligraphy to the present day [5].

The book's origin rests with an attempt that my father (Dr Paul S. Cohen, Professor of Chemistry at The College of New Jersey, USA) and I began

about two decades ago, to write a textbook of chemistry, in comic-book style. We modelled the idea after Gonick and Huffman's *Cartoon Guide to Physics* [6]. At the end of the 1990s, Gonick's *Cartoon Guide* series included a variety of science topics such as the environment, sex, genetics, and statistics, but no chemistry [7]. This topical "hole" beckoned to us to be filled. We wrote a couple of sample chapters for our book, which I drew, and sent them off to several publishers—none of whom was interested. A second book that affected my work more indirectly was Weller's *Science Made Stupid*, a semi-cartoon book that lampooned all of natural science, but especially its technical nomenclature [8]. (Interestingly, Weller's book avoided much of chemistry.)

Sadly, my father passed away suddenly in late 2004 [9], and in grief I put aside the comic-book textbook. In fact, only a year later, in 2005, *The Cartoon Guide to Chemistry* appeared, which placed the final nail into the coffin for our idea [10]. Instead, I became involved in revising and expanding my parents' science-travel guide, *America's Scientific Treasures* [11]. The second edition of this work appeared in 2020 through Oxford University Press [12].

As the final drafts of *America's Scientific Treasures* wound down in the late 2010s, I chanced upon a Facebook post by Rachel Field Kutzik, the wife of an acquaintance. At that time, Ms Field Kutzik was an acquisitions editor at World Scientific, searching for new titles. I began wondering if there were a way to revive the chemistry in graphic format idea without stepping on *The Cartoon Guide's* toes. Pictures are a particularly apt way of explaining scientific ideas. I realized that merely bringing chemistry to the forefront itself was important, given the constant complaints from chemists around the world that chemistry was ignored. I took a side-step from actual chemical principles to chemical history.

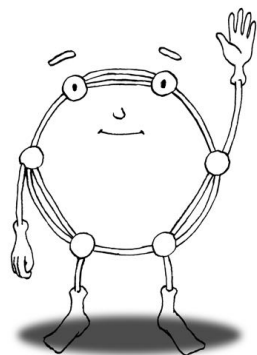
I contacted Ms Field Kutzik, pitched the idea of a chemical history in graphic-novel format using the old sample chapters, and we agreed to a contract for me to create a book of 150 pages in full colour. We signed the contract in March 2019, with three years for me to finish the book. I was able to supply about 180 pages within two-and-a-half years. I consulted with my niece about a name to attract the younger set (she is in her early twenties), and we settled on *O Mg! How Chemistry Came to Be* as the working title.

With a contract in hand, I suddenly needed source material for my book. While I had touched on chemical history in a paper co-authored with my late father [13], and made a specialty of reviewing chemical literature in Yiddish [14], I was no expert in general history of chemistry. Luckily my late father, whose chemistry books I inherited, had a collection of chemical-history volumes. My main reference was Asimov's *A Short History of Chemistry* [15], supplemented by Brock's *The Norton History of Chemistry* [16], Salzberg's *From Caveman to Chemist* [17], Farber's *The Evolution of Chemistry* [18], and Greenberg's *A Chemical History Tour* [19]. From these I compiled a list of chapters for the forthcoming work. But Asimov's book ended with transuranium elements; Asimov also pointedly avoided most chemical weaponry, which I felt needed an honest treatment; and any topics past the mid-twentieth century were obviously missing. My father's books were older: from the 1960s to 2000. The lack of a comprehensive yet new chemical history only made my research more difficult: what about the *latest* chemical interests? I reviewed Nobel Prizes from the last several decades, plus general-chemistry textbooks, to see what their new topics were. From these sources I decided to make chapters on environmental chemistry and an umbrella topic I called 'nanochemistry', into which was subsumed much of what one might consider macromolecular or supramolecular chemistry. Of course, trying to decide what current chemical topics prove of lasting historical value was hard.

The challenge was to create a work in which each cartoon panel represented a 'bullet point' of chemical history. The goal was to present the overarching ideas of chemistry without the mathematics or homework. Instead, the topics should be related with a general good humour and some sight or verbal gags (often called 'dad jokes'). The reader's educational level assumes a minimal but essential knowledge of chemistry that an early teen (in the U.S., an eighth-grader) might have encountered in school. To link the chapters together into a coherent story, I employed a cartoon character I originally invented for the unsuccessful comic-style textbook: a molecular-shaped 'Ben Zene'.

Each chapter is roughly a dozen pages long. Early on I realized that the earlier histories of chemistry (and particularly Asimov's book) ignored the contributions of women (except for Marie Curie, who could not be dismissed). Therefore, I made a special effort to see if I could include women whose names were unfamiliar even to chemists, but still along the overall progress of chemistry. Of value here was *Chemistry World's*

monthly column “Significant Figures”, on women chemists, as well as Greenberg’s *A Chemical History Tour*. Much of my research involved the mundane: what did people wear in the eighteenth century? What kinds of labware were used in the 1800s? Can I accurately draw a Crookes tube?



The cartoon character Ben Zene  
(copyright © 2000 by Stephen Michael Cohen).

Each chapter is roughly a dozen pages long. Early on I realized that the earlier histories of chemistry (and particularly Asimov’s book) ignored the contributions of women (except for Marie Curie, who could not be dismissed). Therefore, I made a special effort to see if I could include women whose names were unfamiliar even to chemists, but still along the overall progress of chemistry. Of value here was *Chemistry World’s* monthly column “Significant Figures”, on women chemists, as well as Greenberg’s *A Chemical History Tour*. Much of my research involved the mundane: what did people wear in the eighteenth century? What kinds of labware were used in the 1800s? Can I accurately draw a Crookes tube?

Each page took two to three days of work: sketching in pencil on scrap paper, then drawing in pencil on art paper, and finally inking. The contract stated that each page is 7.5” × 9” (19 cm × 23 cm). I decided to draw each page larger than the actual size, so that all mistakes would be shrunk (thus less visible) in the final product. The paper of choice was Strathmore 400 series 11” × 14” (27.9 cm × 35.6 cm), 80 g m<sup>-2</sup>. The final version was carefully laid out and drawn in black ink using a Staedtler Mars matic 700 technical pen with nib 0.7 mm in diameter. Each page was scanned in two passes (the scanning bed was too small for one full sheet of large paper),

which I combined together using Photoshop. After cleaning up each black-and-white page, I added in colour, backgrounds, and other visual effects via Photoshop. Many cartoonists create a personal typeface which they use for text. Given my background in calligraphy, I decided against this, and only cleaned up the text as drawn. Looking back, I might have done the text differently.

As I designed the story, I found that I could occasionally bring back Democritus, the Greek philosopher who postulated the existence of atoms, as confirming what later scientists discovered. Eventually I found him to be a useful foil for Ben Zene, acting as the stereotypical ‘eccentric uncle’, punctuating the story with occasional triumphant exclamations like, “See? I was right!”

Because this was a chemical history, not a textbook, I forged connections to other areas of history contemporaneous to the chemical topic under discussion. In the book I created sidebars pointing to history, politics, art, music, and poetry intersecting the chemical sciences. In this way I endeavour to engage the less-scientifically minded readers. For example, one fact I include is that the U.S. President Herbert Hoover was, by trade, a mining engineer, and his wife, Lou Henry Hoover, was a geologist who knew Latin. Together they translated Agricola’s *De Re Metallica* into what is considered the definitive English version [20]. In another section I noted how Alexander Borodin, Dmitri Mendeleev’s friend, was a chemist by education but a composer by hobby. I introduced many scientists with a word or phrase in their native language, to engage readers interested in foreign languages. I even made a joke or two about the difference in American versus British spelling.

In this image-based book, I included what are often termed ‘Easter eggs’, i.e., unexpected gags requiring background knowledge to understand. For example, instead of a Ford Model T, the logo on the front of the car I drew was *Ferd*—which means “horse” in Yiddish. This is a double reference: to the jeers that early automobilists endured when their cars broke down (“Get a horse!”), and to the antisemitism espoused by Henry Ford himself [21]. There are several other such visual jokes I added to the story, but (as the cliché has it) I leave it to the reader as an exercise to find them, though sometimes there are clues in the index.

There were compromises in the final version. The largest is that of length and depth. Including every chemist’s pet chemical discipline was

impossible—not even mine, which is surface chemistry. By necessity the material was pared to a bare minimum along the most general chemical historical path. I avoided biochemistry and analytical chemistry, and lacked space for nomenclature. With all the topics I included, there was no way to go into them in any kind of detail. Essentially the book runs through all of chemical history in 200 pages. A second compromise was that of specific topics. Because the target audience was American teens, I rejected including any controversial topic dealing with sex (i.e., birth-control pills). A third compromise was vocabulary: I rejected vulgarity. This created an interesting problem. Certain chemists were scooped or their research was ignored; for example, Mikhail Lomonosov rejected phlogiston theory well before Lavoisier but was ignored; and Carl Wilhelm Scheele discovered a variety of gases later attributed to Joseph Priestley. I wanted them to say “Damn!” in Russian and Swedish. Apparently many other languages are strikingly more vulgar, and the equivalent phrase in English might cause American parents to hunt me down with pitchforks and torches for corrupting their dear children. In the case of Swedish, I contacted my niece in Stockholm, who gave me equivalents for “Damn!” that were unacceptable. After several back-and-forth tries, she discovered that Pippi Longstocking says, “*Fy bubblan!*” (“Oh, bubbles!”) in the original Swedish [22]. That epithet was acceptable, and hence Scheele uses it in my book.

Regarding changes after the manuscript was completed, I offer two examples. As I reached the end of the manuscript, I read one of the “Significant Figures” columns in *Chemistry World* concerning Stefanie Horovitz [23]. Dr Horovitz’s story seemed important enough to me to revise the manuscript to include her. Revising an entirely image-based book is not a matter of deleting text; such revision affects the entire page. The easiest way to include her was to add an entire page to a chapter, and revise the bottom panel of the previous page. Because she was murdered in a Nazi concentration camp, I asked Yad Vashem for permission to reproduce her Page of Testimony [24]. After the manuscript was complete, I learned that Nobel Laureate Mario Molina, in the chapter on environmental chemistry, had died, so I had to add that datum.

The last parts of the book to be completed were the cover, table of contents, and index. For the cover, I studied a number of superhero-based comics covers for a more dramatic, enticing image, but using famous chemists instead. I then included a key in the back of the book to help readers identify who is on the cover.



Sample page from *O Mg! How Chemistry Came to Be*.  
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The overall aim of the book is to bring the full spectrum of chemistry back into the forefront of science for the public, having been displaced for many decades by physics and biology in most bookshops’ science sections. A subordinate goal is to include more women in the historical chemical canon. I hope to have achieved those goals in at least a small way.

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Stephen M. Cohen

## The Seaweed, Kelp and Iodine Industries in Scotland and Ireland

In 1998 I gave a talk on the history of the chemical industry in Ireland for a conference in Dublin [1], later published in its Proceedings. In preparing this I came across a reference to an iodine factory in Ramelton, Co. Donegal and this sparked an interest in the history of this industry. For the past twenty years or so I have been researching this largely forgotten industry in Ireland and Scotland and in 2021 started publishing a series of general articles [2,3] on the industry, and a series focusing on local areas in Ireland – Co. Galway [4], Co. Donegal [5] and Co. Clare [6]. Glasgow was the centre of the global iodine from seaweed industry until the 1880s and a further article [7] on “The Iodine Industry in Glasgow and Scotland” has been submitted for publication.

The use of seaweed as a source of chemicals for industry goes back at least 200 years to the late seventeenth century. The use of seaweed as a sustainable raw material falls into several phases (Table 1), although the dates are approximate.

Table 1: The Phases of the Seaweed and Kelp Industry

Phase 0	Green manure – <17 <sup>th</sup> century - today
Phase 1	Soda (alkali) – ~1700-~1840
Phase 2	Iodine and potash – 1811 - ~1950
Phase 3	Alginates – 1881- today
Phase 4	Fuel, food, cosmetics etc. 20 <sup>th</sup> and 21 <sup>st</sup> century

Seaweed was harvested and burnt in open kilns to produce a glassy ash known as kelp, as far back as the beginning of the eighteenth century. Kelp was used as a source of alkali (soda) for the glass, soap, alum and textile industries and was widely traded within Great Britain. Its peak years were during the French revolutionary wars, when annual production hit 20,000 tons, worth up to £20 per ton. This was a bonanza for the landowners in Scotland and produced a kelp boom, leading to over population. The industry collapsed from 1820 onwards when first, supplies of barilla became available again (a soda rich plant) and then second, the introduction of the LeBlanc process making soda from salt. The kelp industry collapsed almost

overnight, although it continued to be used on a smaller scale by soap and glass manufacturers.

Iodine had been discovered by accident by Bernard Courtois in 1811 in kelp residues and within quite a short time, iodine started to be produced on a small scale in Glasgow and in Brittany. It was a new element and a chemical curiosity and there was a feeding frenzy amongst chemists to investigate its chemistry and to find uses for it. Another use had now been found for kelp as a source of iodine, although it required harvesting different types of seaweed, which were iodine and potash rich. Quite soon iodine was found to have use in medicine (against goitre and as an antiseptic), in early photography and for making dyestuffs. This increased demand and from around 1840 there was a boom in iodine production in Glasgow. Potassium salts were an important by-product, and later bromine was also extracted from the kelp liquor, although seaweeds only contain about a tenth as much bromine as iodine, the opposite to that in the oceans. Seaweed has the ability to concentrate iodine, although the iodine content depends on the species, the season, the location and how the seaweed is burnt. The traditional method of burning seaweed to a slag in primitive open kilns, also lost at least half the iodine. The second half of the nineteenth century saw many attempts in Scotland and France to devise alternative methods of extracting iodine, to produce higher yields and reduce costs.

One of the most important names in this search was Edward Charles Cortis Stanford [8, 9]. He was a young pharmaceutical chemist, brought up in Worthing, and destined for an academic career. He became interested in devising a better way of extracting iodine from seaweed and in 1862 he won a Silver Medal from the Society for Arts for a new process [10] (Stanford, 1862), which he patented. This involved heating seaweed in an enclosed kiln, collecting the gases and liquids which came over, and the resultant charcoal contained the valuable iodine and salts. This doubled the yield of iodine but was never a great commercial success, although Stanford opened a factory on the island of Tiree which operated from 1863 to 1901.

The main stages in the traditional kelp process are as follows:

- 1 Wet seaweed harvested from driftweed, in the intertidal region or from a boat.
2. Wet seaweed is dried on the beach or over kelp walls.

3. The dry seaweed is burnt to a slag (or ash) in circular or rectangular kilns.
4. The kelp (slag) or ash is shipped, usually by sea, to the factories for processing.
5. The kelp slabs are crushed into a coarse powder (not needed for ash).
6. The kelp is lixiviated with water in a Shanks system to extract soluble salts.
7. The solution is heated and potassium and sodium salts crystallised out and filtered off.
8. The final liquor is treated with sulfuric acid to remove sulphides, and oxidised with more acid and MnO<sub>2</sub> to produce iodine in an iodine still. Bromine can be made by further oxidation.
9. The impure iodine is dried and purified by sublimation if needed.
10. The iodine is either converted into salts or shipped to the end-users in 1 cwt kegs.

Stanford's modification using enclosed kilns was known as the char process, producing a charcoal from which iodine and salts were extracted in the same way. Later Stanford developed a wet process, without any heating, and thus discovered alginates [11].

Glasgow and the lowlands of Scotland became the major centre for the production of iodine. At its height there were twenty companies but by the start of the twentieth century this had dwindled to three. At its height the industry consumed around 14,000 tons of kelp a year. Ireland produced about sixty percent of the kelp used in Scotland in the mid-nineteenth century, and small iodine manufactories were opened in Ireland in Ramelton, Co. Donegal [6], and Galway [4], but they did not survive the nineteenth century. Kelp was still being produced and shipped abroad, to Scotland and France, well into the twentieth century. In the last twenty years there has been considerable interest in the archaeology of the industry in Ireland, of which there are some physical remains and strong folk memories [12].

The iodine from seaweed industry was undermined by the discovery and production of iodine from caliche in South America from 1874 and by the production of cheaper potash from Stassfurt in the 1860s. The industry struggled on into the twentieth century, thanks to an iodine cartel between

the Chilean, Scottish and French produced which lasted until the 1930s. Kelp was still being produced in Ireland and Scotland until World War II and iodine was still being made in France in the 1950s. There is a seaweed harvesters museum in Plouguerneau in Brittany which describes the history of the industry. (Plouguerneau's Eco museum, the museum dedicated to seaweeds and seaweed gatherers, maritime heritage in Finistère, Brittany (ecomusee-plouguerneau.fr))

The history of the kelp industry as a source of chemicals is a fascinating, but largely unrecorded, industry which stretches back over 200 years and at one time employed thousands of people in Scotland, Ireland and France.

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Peter E. Childs

## BOOK REVIEW

Rebecca Hurrell, Andrew Muscroft-Taylor, Glyn Strange and Bryce Williamson, *Scientific Sleuthing: Chemical Discoveries Made in New Zealand* (Celestary Press, Christchurch, New Zealand, 2017).

A while ago, I contacted several chemical societies in the Commonwealth to find out if they had a historical group. I did not get many responses and the ones I received were generally negative, but the New Zealand Institute of Chemistry sent me the book under review. New Zealand has a record of producing such books. Back in 2002 I reviewed a similar book, *New Zealand is Different: Chemical Milestones in New Zealand History*, for the *British Journal for the History of Science*. New Zealand’s biggest problem in this field is that the most important scientists from there have made their mark elsewhere as in the case of Ernest Rutherford, Maurice Wilkins and Alan MacDiarmid. As I commented in my earlier review, what has happened in New Zealand is for better or worse mainly of interest to those chemists who live there. I also pointed out that while the editors had sought to make the earlier book accessible to non-chemists, it is not likely that many would read it. This book is on the whole rather technical, but has similar ambitions to make the text accessible, for example explaining the difference between Celsius and Kelvin. Where this book does appear to be better than its predecessor is in the level of documentation.

Does this book cover a number of exciting chemical discoveries made in New Zealand? It is not a series of major chemical breakthroughs, but rather descriptions of chemical research carried out in New Zealand, involving a number of smaller improvements. The one exception, namely the invention of spreadable butter (which personally I find a great boon), is an invention rather than a discovery. One of the most interesting papers, at least to me, is at the very beginning, namely the search for the origin of toxic honey which has popped up there from time to time. The offender was the toxic tutu shrub which is endemic in these islands. But how could it be connected to honey as it does not produce pollen? It turns out that sap-sucking passionvine hopper insect produces an “honeydew” excretion which is then eaten by the bees. The other fifteen papers cover topics such as advanced

ceramics and high-temperature superconductors to the problem of cementing geothermal wells. The book is nicely produced and filled with colour photographs. Unfortunately it is likely to be of limited interest to any British chemists unless their own research overlaps with one of the chapters. If you would like a copy I would suggest contacting the New Zealand Institute of Chemistry as it does not seem to be available outside the country.

Peter Morris

## RSCHG WEBINAR REPORTS

### **Alchemy, or How to Make Gold – John Hudson (January 2022)**

This talk was aimed at those with an interest in the history of chemistry but with little or no knowledge of alchemy, and took a light-hearted look at the long history of the subject. It discussed the various phases of alchemy – in Alexandria, Ancient China, the Islamic world, and in Europe. It described what the alchemists were trying to achieve (not only the production of gold), and discussed some of the ways they went about their quest. Finally, the presentation considered whether or not the modern chemist is in any sense indebted to the work of the alchemists.

### **Sir John Brunner and Henry Brunner: Their Life And Legacy – Diana Leitch (February 2022)**

This talk traced the ancestry of John Tomlinson Brunner from his birth in Liverpool in 1842 to parents of Swiss and Manx origins, through his early education and entry to business in Widnes in 1861, with his brother, Henry (born 1838), at Hutchinson’s alkali works. Here they met Ludwig Mond. John and Ludwig’s subsequent creation of the great works of Brunner Mond at Winnington, near Northwich in the 1870s and its development to be the richest industrial company at the end of the nineteenth century were covered, as were the great philanthropic acts of Sir John Brunner across Cheshire and Lancashire before he died in 1919. Special mention was made of the Runcorn-Widnes Transporter Bridge and the many memorial halls, schools and libraries such as those at Northwich, Acton Bridge, Middlewich, Winsford, Nantwich and Runcorn. The influence John had on changes in employment conditions for his workers at Brunner Mond and his work as Liberal MP for Northwich was covered. Henry’s role as the scientific brother was explored as was his descendants’ involvement with ICI on the



Fylde. Extensive use was made of family and Brunner Mond archives held at the Catalist Science Discovery Centre and Museum in Widnes.

### **Insulin, the Crooked Timber: From Thick Brown Muck to Wall Street Gold - Kersten Hall (March 2022)**

In this talk based on his new book, *Insulin – the Crooked Timber*, released to mark the centenary of the discovery of insulin, Kersten Hall revealed a tale of monstrous egos, toxic career rivalries and unsung heroes. And perhaps the most important unsung hero of all is the humble wool fibre and how the secrets helped to unravel the chemical mysteries of insulin. One hundred years ago, a diagnosis of Type 1 Diabetes meant only one thing – certain death. Unable to control their blood sugar levels, patients withered away before sliding into a ketoacidosis coma from which they never emerged. But all this changed in January 1922, when 14-year-old Leonard Thompson was injected with extracts made from pancreatic tissue that one clinician described as simply 15cc of ‘thick brown muck’. The secret of these life-saving extracts was that they contained the hormone insulin and, nearly six decades after its discovery, this was once again causing excitement – but for very different reasons. On the morning of 14 October 1980, dealers on Wall Street watched in delight as a fledgling biotechnology company called Genentech made what at the time was hailed as the most spectacular debut in stock market history. But how was the thick brown muck that saved Leonard Thompson’s life transformed into the Wall Street gold that made founders of Genentech into multimillionaires overnight? And why, despite having made a discovery that has since saved countless lives, was Canadian scientist Fred Banting’s reaction on hearing the news that he had just been awarded the 1923 Nobel Prize in Physiology or Medicine for this achievement somewhat surprising to say the least?

### **Discovery of the Elements Predicted by Mendeleev’s Table – Scandium, Gallium, and Germanium – Mary Virginia Orna (April 2022)**

Dmitri Mendeleev (1834-1907), in organizing the periodic table, realized that there were three obviously missing elements provisionally designated eka-boron, eka-aluminium, and eka-germanium. These theoretical “discoveries” eventually led to the detection and isolation, respectively, of scandium, gallium, and germanium. Can we give credit to Mendeleev for these discoveries? Did Mendeleev ever claim these elements as his own? Can we really assign their discoveries to, in turn, to Lars Fredrik Nilson (1840-1899), Paul-Émile Lecoq de Boisbaudran (1838-1912), and Clemens

Alexander Winkler (1838-1904)? Would these elements have been found when they were if Mendeleev had not pointed the way? These are not idle questions. Nowadays, people tend to give the guide just as much credit as the explorer. But Mendeleev made no such claim – all he wanted, and somewhat ferociously, was credit for the organizing principle that chiefly bears his name, although he, too, stands on the shoulders of many others – and even perhaps should share the platform with Julius Lothar Meyer (1830-1895).

### **Pills, Powders and Purgatives: The Story of How Drugs from a London Livery Company Were Used throughout the World” – Anna Simmons (May 2022)**

From 1672 until 1922, the livery company, the Society of Apothecaries operated a pharmaceutical trade from its premises at Apothecaries’ Hall, Blackfriars. From the heart of the City of London drugs such as aloe pills, powdered Peruvian bark and the purgative calomel were sent to places as near as St Bartholomew’s Hospital and as distant as Australia. 2022 sees the 350th anniversary of the opening of a laboratory for manufacturing chemical medicines at Apothecaries’ Hall and 100 years since its closure. To mark these anniversaries, this talk examined why a laboratory was constructed, what drove its development and who were the individuals that worked there. In its productive heyday during the late eighteenth and early nineteenth centuries, the Society of Apothecaries had an unrivalled capacity to process and manufacture huge quantities of drugs for a worldwide market. Its customers included numerous hospitals and institutions, medical practitioners, the Navy, the East India Company and the Hudson’s Bay Company. In the nineteenth century, under the direction of William Brande (1788-1866), Henry Hennell (1797-1842) and Robert Warington (1807-1867), new directions of research and consultancy developed, whilst the Society of Apothecaries struggled to reconcile its new role as a medical licensing corporation with that of a wholesale drug manufacturer.

### **Developments in the Application of Science and Technology for the Technical Study of Paintings - Aviva Burnstock (June 2022)**

This talk introduced some of the methods applied to technical and material analysis and conservation of paintings, with an emphasis on how the introduction of new methods drawn from science provides information about the creation, physical history and condition of paintings. This includes examples of chemical and physical changes in materials and the impact on

their current condition. How they appear was addressed, together with a reflection on interdisciplinary research in the field.

The Courtauld Institute of Art was established in 1931, accommodated at the textile manufacturer Samuel Courtauld's residence at 20 Portman Square, together with a bequest of some of Samuel Courtauld's paintings, including important Impressionist and post-Impressionist works, to the Courtauld Institute Gallery. The focus was to support academic research in art history, drawing on a range of interdisciplinary research methods. To support that aim, modelled on the arrangements at the Fogg Art Museum at Harvard, the Technology Department was established to investigate the materials and techniques used for paintings and painted art, from the Gallery and other collections. Scientists working in the Technology Department applied a range of imaging and analytical methods to investigate artists' painting materials and techniques. This included early application of X-radiography, X ray diffraction, absorption spectroscopy of dyestuffs, ultraviolet and infrared imaging, light microscopy of surfaces and preparation of samples for microscopy and chemical analysis. In the 1970s the remit of the department extended to the postgraduate education of painting conservators and research into the stability of materials for conservation and improving conservation methods.

#### **New Historical Group Online Lecture Series**

From 22 March and every fourth Tuesday in the month thereafter (except August and December), the group has been running a new series of online lectures on the history of chemistry, starting at the present and going back to the Ancient Egyptians.

#### **Twentieth-Century Chemistry – Peter Morris (March 2022)**

While much of the chemistry carried out in 1914 will still be familiar to a chemist today, there have been many changes in chemistry in the last century. Our understanding of chemical bonding has been revolutionised and our knowledge of how reactions take place has increased enormously, even in the case of reactions which occur in milliseconds. At the same time our ability to make complex molecules has grown apace. While the laboratory itself might still look familiar to a chemist from 1914, the instruments it contains have been transformed with the introduction of infrared and ultraviolet spectroscopy, NMR spectroscopy and mass spectrometry. Furthermore, chemistry has expanded into interdisciplinary fields including macromolecular chemistry solid-state chemistry,

nanochemistry, geochemistry and astrochemistry. From being very much a European and American science in 1914, chemistry is now a global discipline with a growing presence in Japan and China. From being largely male-dominated a century ago, chemistry is now almost gender balanced in many countries although not all. The future of chemistry probably lies in the development of robotics and artificial intelligence.

#### **Twentieth-Century Chemical Industry – Peter Morris (April 2022)**

The chemical industry was dramatically affected by the outbreak of war in August 1914. The Allies had to expand their dye industries, while the Germans had to find new sources of fixed nitrogen. The development and expansion of the Haber-Bosch process in Germany, followed by the introduction of rival processes in other countries, was to shape the interwar industry. The interwar chemical industry was dominated by a small number of very large firms which were mostly confined to one country, including Du Pont in the USA, IG Farben in Germany and ICI in the British Empire. In addition to nitrogen fixation and coal hydrogenation, the major growth area was polymers with the introduction of synthetic rubber, nylon, polyethylene and the transparent polymethacrylates. During the Second World War, the key sectors were synthetic fuel, synthetic rubber and antimalarials. After the war, the industry was transformed by the availability of very cheap natural gas and petroleum. The aim was to transform these cheap feedstocks into high-value products, mostly polymers. The oil crises of the 1970s brought this era to a halt, and there was massive restructuring of the industry and a focus on pharmaceuticals and agrochemicals (including genetically-modified seeds). The period between 1990 and 2019 saw the disappearance of several iconic firms, most notably ICI, and the arrival of new companies which were largely unknown to the public. The issue of whether the chemical industry was a boon or curse as a result of this period of growth will only become clear in the decades to come.

#### **Theory, Industry, Training: Creating Modern Chemistry, 1815-1914 – Peter Ramberg (May 2022)**

During the nineteenth century, chemists established sophisticated cultures of intellectual inquiry and professional discipline formation. They established the fundamental ideas of modern chemistry that would endure throughout the twentieth century: atomism, periodicity, composition, structure, bonding, and equilibrium, and were preoccupied with the unification of diverse chemical phenomena. Nineteenth century chemists also created the

teaching-research laboratory as a “factory” for producing chemists in large numbers. These chemists would find careers in the burgeoning chemical industry, which by 1914 had been transformed in numerous ways to make possible the growth of transportation networks, industrial machinery, and consumer goods. The new dye industry, spurred by the success of the structure theory, inaugurated the modern fine chemical industry and the science-based research and development laboratory. By 1914, all the components and trends that would characterize chemistry in the modern age were in place.

### **Chemistry Becomes the Central Science, 1815-1914 – Peter Ramberg (June 2022)**

Modern chemists are fond of describing their discipline as the “central science”, because it serves as the foundation for many other sciences. The foundations for this central nature of chemistry were formed in the nineteenth century. Nineteenth century chemists were confident, that as the science of material substances, chemistry could be applied in almost every other area of science and to the material production of industry. As chemistry established itself as a new discipline, it crossed numerous intellectual and cultural boundaries, diffusing into the other sciences, into industry, and into the public sphere with popular lectures and books. Chemical analysis and theory influenced physiology, agriculture, and medicine, and sparked debates on the very nature of life. Chemists also turned their interests towards such physical phenomena as colour, light, heat, electricity and magnetism, influencing physics and astronomy. Chemistry in turn was also influenced by physics and the new science of thermodynamics that provided a method for understanding and quantifying chemical change and equilibrium. Chemists carefully cultivated the idea that chemistry was a natural philosophy with intellectual merit that also had significant economic value to society when its principles were applied to medicine, agriculture and the production of material goods.

## **MEETING REPORTS**

### **Life and Work of George Porter, Lord Porter of Luddenham (1920-2002)**

*Monday 6 December 2021, Burlington House, Piccadilly, London*

Born in Yorkshire, George Porter studied chemistry at Leeds University before serving in the Royal Navy during the Second World War. He then

worked at Cambridge University with R.G.W. Norrish, and with Manfred Eigen they shared the 1967 Nobel Prize in Chemistry for their photochemical research. Porter was Professor of Chemistry at Sheffield University until 1966 when he became Fullerian Professor of Chemistry at the Royal Institution and its second Director. He was President of the Chemical Society between 1970 and 1972 and in 1985 he became President of the Royal Society of London.

### **Living Above the Shop: Our Memories of the Royal Institution John and Andrew Porter**

*To mark what would have been their father’s 101st birthday, George Porter’s sons, John and Andrew, recalled some of their memories of life in the Royal Institution (RI) when he was director from 1966 to 1986.*

In the late 1960s and 1970s, during our school and university holidays, and for much of our time in the sixth form, we lived with our parents in the Director’s second floor flat. The flat had three historic front rooms (the study, dining room and sitting room) overlooking Albemarle Street, used by successive directors since Faraday’s time. Our parents’ bedroom was also at the front, while we occupied relatively small rooms at the back. The kitchen provided a link between the front and back rooms and was the hub of our family life. Here we had our meals and many discussions, mostly led by our father, on topics ranging from our progress at school or university to science, solar energy and the meaning of life - and many things in between.

Our father loved the RI and greatly enjoyed ‘living above the shop’, the better to immerse himself in his research and many other scientific activities. Although he frequented all corners of the RI (lecture theatre, labs, meeting rooms, workshops etc), the famous study was the centre of his working life, and where he would usually work well into the night. In the early years, however, he shared the study with our bulldog, Spencer, who often persuaded his master to curtail his labours in favour of a night-time walk in Green Park.

The dining and sitting rooms were used for entertaining, a hugely important aspect of our father’s passion, and the RI’s remit, for sharing science with people from all walks of life. The many visitors to these rooms included children attending Schools or Christmas Lectures, members of the Davy Faraday research group, notable scientists and non-scientists, politicians and Royal patrons. In these rooms we would mingle with members of the audience invited upstairs after the Christmas lectures, and in were among

many guests who met the Queen after she opened the Faraday Museum in 1973.



The Study in Director's Flat with Sir George Porter sitting at his desk.  
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The most formal regular entertainment was the dinner for the Friday evening discourse, still a white-tie affair when we arrived. Dinner was typically for six couples, including the director, the lecturer (usually, though not always, a scientist) and guests, who were often distinguished in non-scientific fields. For the first year or two our mother, who had a particular energy and flair for entertaining, bravely took on the task of preparing, as well co-hosting, the dinners. Unsurprisingly, she soon commissioned a young and upcoming caterer (Prudence Leith) to provide the food, allowing her to properly join in the dinner conversations. This was important because, as a non-scientist accustomed to talking to scientists, she had a particular skill for putting the lecturer and guests at ease, sometimes with slightly eccentric behaviour, such as 'smoking' a clay pipe. Though not dinner guests ourselves, we did get to sample the food and would often slip into the gallery to listen to the discourse. Afterwards, we were encouraged to join the dinner guests, and many others, who were invited for drinks in the flat. As schoolboys, we

tended to feel a little out-of-place, but it was interesting to experience the buzz of these lively occasions.

The events that had most impact on us were the Christmas Lectures. These consisted of six televised one-hour lectures with many demonstrations and were broadcast just an hour or two after recording. The BBC outside broadcasting team, under producer Alan Sleith, took over the lecture theatre and surrounding areas for what seemed like most of the Christmas season. We were interested to watch the rehearsals, many hours of them for each lecture, and to visit the prep-room where the demonstrations were prepared by the legendary Bill Coates and his team. We became quite involved, helping with one or two demonstrations during the lectures, and even recreating one in the flat using materials 'borrowed' from the prep-room. We also remember meeting the lecturers when they visited the flat, often for a brief lunch in the kitchen between rehearsals. Memorable lecturers are too many to mention but include four whose the original recordings have been lost. Eric Laithwaite (Engineer in Wonderland, 1966/7), had a commanding, almost over-zealous presence, and enthused audiences with the possibility of train travel based on the linear induction motor. His second lecture series (Engineer through the Looking Glass; 1974/5) was controversial, however, suggesting that the behaviour of gyroscopes contravened central laws of physics. Our father was one of the few others who gave two lecture series (Time Machines, 1969/70; Life Under the Sun, 1976/7), memorable to us for obvious reasons, and bringing together in his own way key concepts about space, time, energy, entropy, light and chemistry. Charles Taylor (Sounds of Music; 1971/2) described the physics of musical instruments, old and modern. We still remember the theme tune he wrote and recorded based on a single taped sample of a bottle-blow. The NASA cosmologist Carl Sagan (The Planets; 1977/8) was as engaging face-to-face as he was during his lectures. David Attenborough (The languages of Animals; 1973/4) was similarly engaging and seemingly at complete ease during the recordings, although he later admitted that it was one of the most challenging presentations he had ever done.

Other notable visitors to the RI we remember meeting include Nobel laureates (Francis Crick, Max Perutz, Peter Medawar, Dorothy Hodgkin), politicians (Shirley Williams) and a comedian and Rector of St Andrews University (John Cleese).

The RI was a hive of activity during the George Porter years, which have been described as glittering. We remember many scientists and support staff

who contributed to this success, but none better than Judith Wright, our father's secretary/PA at Sheffield University who also made the move to London and the RI in 1966. Judith's office adjoined the flat and was the first stop on exiting the second-floor lift. She always provided an air of calm, good-humoured continuity and efficiency that was reassuring to us and no doubt to many others.

After a long week, our parents would escape on Saturday morning to their cottage in Kent. When we were old enough, we would often stay at the RI to revise for exams or visit friends. The RI without people was a thought-provoking if slightly eerie place to explore, involving unexpected encounters with previously unnoticed portraits or busts. Whistling in the dark was necessary when returning at night, passing moonlit statues in the foyer and waiting for the lift to come. Reaching the second floor flat could sometimes feel like an escape, but this may have been misleading. Once, when staying alone in the flat, our father was awoken by a gloved intruder, dressed in black. After the initial shock, he engaged the stranger in conversation, asking how he could help, as he was apparently lost and had been using matches to find his way in the dark. Dad went into guided tour mode, pointing out notable RI artefacts, and eventually managed to coax the intruder politely out of the building. It was later concluded that the man in black had broken in from the roof top, possibly in search of Asprey's and its jewellery. The police were notified but the case was never solved. Agatha Christie, who our father had invited to one of the evening discourses some years earlier, might have been interested!

As time went on and we started our own careers, we moved into our own rather different flats in London or the USA, and inevitably spent less and less time at the RI. With so many influences during our years at the RI, making educational and career choices was hard. Despite our father's deep love of Chemistry, we were both drawn to more to Biological subjects and eventually settled on careers in Medicine (JP) and Molecular Biology (AP). Looking back, we can appreciate what a great privilege it was to live in such a historic building in arguably its most productive and influential periods of recent times. Although some aspects of RI life (e.g. Black-tie - or any tie!) could seem to alien to temperamental teenagers in the 1960 and 1970s, science was always supreme, and there is no doubt that we learned much from our experiences there. Many of our father's private and public ideas on entropy, energy conservation and solar energy still resonate, and it was from him that we first heard about greenhouse gases, and the need to end our

dependence on fossil fuels. Furthermore, his ideas on philosophy ('we are here to find out why we are here'), education (the need to specialise later in schools) and science policy (the need to avoid over-management of scientific research, and to safeguard basic curiosity-driven research) still ring true, today more than ever.

### **'Chemistry in Microtime' – David Phillips**

The title of this talk was taken from one of George Porter's own books. The presentation began with Porter's invention (with R.G.W. Norrish) of flash photolysis in 1947, and described how free radicals and other species with lifetimes in the millisecond time-domain were studied using the 'pump and probe' technique, as well as kinetic studies which used continuous monitoring of transients. Millisecond studies are exemplified by the ClO radical.

The development of ever-faster flash photolysis from microseconds through to nanoseconds permitted studies in Sheffield on the triplet state and then excited singlet states, work for which George Porter was awarded the 1967 Nobel Prize for Chemistry. Progress to even shorter timescales was accelerated by the invention of the laser, such that picosecond then femtosecond studies at the RI and then Imperial College followed, work which focused on the photosynthetic process in collaboration with Jim Barber.

During his lifetime, George Porter saw the time-scale of pump-and-probe techniques shorten by twelve orders of magnitude, and also saw the development of powerful fluorescence techniques such as time-correlated single-photon-counting. Subsequent pump-and-probe methods to establish structural details of transients, such as time-resolved vibrational spectroscopy, time-resolved X-ray and electron diffraction were then briefly described as were coherence, and fluorescence lifetime imaging microscopy. Finally the final frontier of chemistry, attosecond laser studies, was mentioned.

### **'Popular Champion for Science's Fight': George Porter's Career as a Public Scientist – Rupert Cole (Science Museum)**

This talk gave an account of George Porter's role as a highly-visible public scientist, from the 1950s when he made his television debut to the 1990s when he was closely involved with the public understanding of science

movement. The paper was split into three sections corresponding to different phases in Porter's career.

The first, periodised as 1959-1967, explored his role as a populariser of science, which began with an appearance in 1959 on the BBC's *Eye on Research* television series. His skills as a lecturer – for adults and children – saw him being appointed as a professor at the Royal Institution, which provided him a stage to engage with debates in the early 1960s on the 'two cultures' and the Second Law of Thermodynamics – C.P. Snow's infamous test question of scientific literacy. His involvement in this debate led to both a ten-part television series that he wrote and presented for the BBC and his appointment as Director of the Royal Institution (RI).

The second phase of Porter's public career, 1968-1973, saw him engaging with a changing landscape for the cultural status of science. From his position as RI director, Porter became a vocal critic of prevailing social movements: the 'counter culture', debating Theodore Roszak, the coiner of the term, on television; the radical science movement, after inviting one of its key figures, in biochemist Stephen Rose, to give a Friday Evening Discourse at the RI in 1971; and the alternative technology communities, following a suggestion to BBC Horizon to cover this movement, which backfired for Porter as the resulting programme, 'Science is Dead, Long Live Science' (1973), did not present the critical viewpoint he had hoped.

The third and final phase, 1976-1985, tracked Porter's increasing engagement with political developments, including his campaign to promote solar energy and, later, to secure political capital and funding for science in the wake of the cuts made to university budgets under the Thatcher administration; it was in this context that Porter became the inaugural chair of the Committee on the Public Understanding of Science in 1985. The talk concluded by summing up Porter's legacy as public scientist: his work at the RI and as a figure who had been willing to engage head on with movements he profoundly disagreed with to further his positivistic and cultural conception of science.

### **George Porter: A Peer among Scientists – Mary Archer (Science Museum Group)**

I had the privilege of working for and with George Porter as one of his post-doctoral research students at the Royal Institution from 1972 to 1976. It was about this time and thereafter that I reminisced at this meeting.

My time at the RI was a golden time in my scientific life: the apprenticeship of a PhD at ICL and a JRF at Oxford behind me and the slog of a teaching fellowship at Cambridge yet to come. I had long wanted to work with George, and managed to secure a post-doctoral position with him by switching my field from electrochemistry to photoelectron-chemistry and proposing solar-rechargeable batteries as my research topic, to make myself vaguely relevant to the thrust of his photophysical research. Briefly this seemed like a backwater, but then came the oil price hike of 1973, and suddenly there was funding for novel approaches to solar energy conversion and storage.



Royal Institution Porter Staff Photograph, 1974, including George Porter, Frank Greenaway (front row, centre) and Mary Archer (second row, far right)

*Reproduced with kind permission of the Royal Institution Archive.*

George started a research programme into photochemical hydrogen production: my fellow post-doc Tony Harriman devised several ingenious hydrogen- and oxygen-generating systems, but they defied all attempts (and still do) to combine them into a closed-loop water-splitting system operated solely by sunlight.

As for me, I set to work with my first PhD student, Isabel Ferreira, importing my knowledge of electrochemistry into our work on photogalvanic cells. These batteries are based on donor-acceptor photoredox

reactions which produce high-energy but relatively short-lived products. Using the picosecond apparatus at the RI, Isabel and I came to the conclusion that such devices, relying as they do on diffusion of the photoproducts to selective electrodes to beat back reaction in solution, were unlikely to exceed 1% solar-to-electrical-power conversion efficiency and so were of no interest as practical conversion devices [1, 2].

By that time, George was in great demand to talk about how photochemistry might be applied to solar energy conversion, but he was far too busy to accept all the invitations that came his way, and so I found myself standing in for him at two meetings that were to shape the course of my professional life for the next few years.

The first was a 1973 UNESCO conference in Paris, *The Sun in the Service of Mankind*, which was organised jointly with ISES, the International Solar Energy Society. At this conference, I was surprised to find that the Society had no UK section, and with George's blessing I launched one at the RI in January 1974. George kindly allowing me to house the infant society in an attic room in the RI for several years. The UK Solar Energy Society, of which I later became president, continues to this day, among other activities running the well-regarded annual PVSAT (Photovoltaics Science Applications and Technology) conferences.

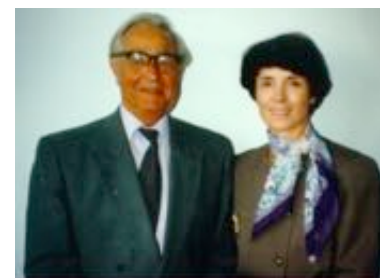
The second meeting that I went to as an understudy for George was a 1974 workshop at Boston University on the current state of knowledge of photochemical formation of fuel. This brought together some key players in this new area, in particular, Kenichi Honda and his student Akira Fujishima from the University of Tokyo, describing the photoelectrolysis of water at a titanium dioxide photoanode. That workshop turned into the long-running biennial series of IPS conferences. George joined the International Organising Committee of IPS-4 and remained a member for many years. At IPS-10 in Interlaken, he not only gave a plenary talk and a paper, but allowed me to twist his arm to star in an after-dinner cabaret: he had sung *Patience* and *Buttercup* in his youth and rose to the challenge, although it was not a Nobel Prize winning performance.

After he left the RI, George went on to several more great offices, but research was his enduring passion, and he returned to it full-time after stepping down as President of the Royal Society. He was instrumental in creating the Imperial College Centre for Photomolecular Sciences, which he chaired from 1990 until his death. The late Professor Jim Barber kindly gave

me a Visiting Professorship in ICL's Department of Biochemistry, allowing me to participate in Centre seminars. I had to brush up my Marcus theory to give a series of lectures on electron transfer.



*Left:* The International Organising Committee of IPS-4 in Jerusalem. George is standing second from the left, and Mary Archer is fourth from the left. *Right:* Line-up for the after-dinner cabaret of IPS-10 in Interlaken, 29 July 1994. *From left to right:* Frank Wilkinson, Colin Grubb, Mary Archer, John Kerry Thomas, George Porter. *Photographs courtesy of Mary Archer.*



George Porter with Mary Archer after a seminar she gave on her research work in the RI's Bernard Sunley Lecture Theatre. *Photograph Courtesy of Mary Archer.*

After I left full-time teaching in 1986, I continued my interest in renewable energy, becoming the founder chair of the National Energy Foundation. George – in a further act of kindness – became the first president of this charity, which promotes energy literacy. I maintained a connection with the RI by serving on its Council for several years, and another with Imperial by co-editing a book series on the photoconversion of solar energy, published by IC Press.

In 1976, the year I left the RI for Cambridge, George and I wrote a review [3] of *in vitro* photosynthesis. Reading this again after more than forty years, I am relieved that our early exposition of the principles and possibilities of this fertile field still appears broadly right.

So that is the George Porter I had the privilege of knowing. I remember him as the chief scientific influence on my life, and as a guide, mentor and friend.

### References

1. M.D. Archer, M.I.C. Ferreira, G. Porter and C.J. Tredwell, "Picosecond Study of Stern-Volmer Quenching of Thionine by Ferrous Ions", *Nouveau J. Chimie*, 1977, 1, 9–12.
2. M.D. Archer and M.I.C. Ferreira, "Photogalvanic Cells and Effects", in *Photochemical Conversion and Storage of Solar Energy*, ed. J.S. Connolly (New York: Academic Press, 1981), 201–228.
3. G. Porter and M.D. Archer, "*In Vitro* Photosynthesis", *Interdisc. Sci. Rev.*, 1976, 1, 119–143.

After her lecture, the Wheeler Award was presented to Mary Archer, by Peter Morris Chair of the Royal Society of Chemistry Historical Group. This Award is funded by the Wheeler Bequest with the lecture celebrating the outstanding contributions of an individual to the history of chemistry. The Lecturer is an eminent historian or chemist.



### Sir Geoffrey Wilkinson: An Anniversary Celebration

A Joint Meeting of the Royal Society of Chemistry Historical Group and Imperial College London Chemistry Department

Wednesday 23 March 2022, Burlington House, Piccadilly, London

### Conference Overview

Henry Rzepa (Imperial College)

Fourteen speakers, ten in person and four attending remotely, addressing a remarkably young capacity audience at Burlington House gave a delightful blend of historical reminiscence and cutting-edge new science. Many speakers showed a connection in their current work to Wilkinson, reminding that his deep influence continues to this very day. The spirit and approach to research that Wilkinson imbued in his group continues, both in industrial and academic settings. The other common theme in almost all of the talks was how the concept of combining experimental with computational and theoretical analyses is now embedded in modern research in organometallic chemistry, and we are left to wonder what Wilkinson himself, a famous sceptic of theoretical approaches in his time, would make of the modern incarnation.

### 'Not hot potatoes': The Early Days with Geoffrey Wilkinson at Imperial College – Martin Bennett (ANU Australia)

The Biographical Memoir for Geoffrey Wilkinson in the *Proceedings of the Royal Society* likens the spirit in his research group during the earliest days at Imperial College to that of an urgent gold rush in the Wild West. In this talk Martin Bennett recalled some of the events and personalities in the group at that crucial time in Wilkinson's career and his unceasing, competitive drive for novelty in research.

### Small Molecule Scission and Homologation Using Coordinatively Unsaturated Complexes – Deborah Kays (Nottingham)

The use of sterically demanding ligands enables the isolation of highly unsaturated complexes that can exhibit very unusual reactivity towards small molecules. Kays' research group is particularly interested in the use of *m*-terphenyl ligands ( $2,6\text{-Ar}_2\text{C}_6\text{H}_3^-$ ) for this purpose, the steric bulk or electronic properties of which can be conveniently manipulated by changing the flanking aryl groups or the substituents on the central aryl ring, respectively. Low-coordinate complexes can lead to novel reactivity, driven by their unusual structures. Whilst Co(II) terphenyl complexes undergo insertion reactions with carbon monoxide, the iron(II) complexes cleave the  $\text{C}\equiv\text{O}$  bond, with subsequent and homologation affording squaraines where the  $\text{C}_4$  core is derived completely from carbon monoxide, through a selective homologation reaction. Through various analytical and theoretical techniques the group is able to explore this reactivity and propose a mechanism. Extending the reactivity to isolobal gallium(I), cobalt(II)



terphenyl complexes can react with “GaI” affording a new metal-gallium cluster motif.

#### **Reactivity of $[(\eta^6\text{-arene})\text{RuCp}]^+$ Complexes and Catalysis Via Arene Exchange. – James W. Walton (Durham)**

$\eta^6$ -Coordination of aromatic molecules to transition metals alters the reactivity of the bound arene. Typically this  $\eta^6$ -coordination will increase the electrophilicity of the arene and stabilise negatively charged reaction intermediates. This paper presented examples of  $S_N\text{Ar}$ , C–H activation and trifluoromethylation reactions of aromatics bound to ruthenium as  $[(\eta^6\text{-arene})\text{RuCp}]^+$  complexes. While  $\eta^6$ -coordination gives access to exciting new reaction of arenes, the requirement for stoichiometric metal is a drawback. To address this issue, the research also focusses on reactions that are catalytic in the activating metal fragment. Following reaction of  $\eta^6$ -bound arenes, exchange between the bound product and starting material will lead to catalytic systems. The talk reported on attempts to achieve catalytic reactions.

#### **Coordination of Li–H and Li–C Bonds to Hydride Complexes of Mo–Mo Quadruple Bonds –Ernesto Carmona (Sevilla)**

The reactivity of the bis(hydride) complex  $\{\text{Mo}_2(\text{H})_2[\mu\text{-HC}(\text{NDipp})_2](\text{THF})_2\}$  (Dipp = 2,6-*i*-Pr<sub>2</sub>C<sub>6</sub>H<sub>3</sub>; THF = C<sub>4</sub>H<sub>8</sub>O) towards Li–H, Li–C and other main-group metal E–H and E–C bonds was presented. In particular, coordination of Li–H and Li–C bonds results in the formation of H–Mo $\equiv$ Mo–X–Li (X = H, C) metallacycles that feature non-negligible covalency of the Li–H and Li–C interactions.

#### **A Coordination Chemistry Approach to Optical Imaging of Uranium Biotransformations in Model Conditions – Louise Natrajan (Manchester)**

The assessment of long term nuclear waste repositories requires an absolute knowledge of radionuclide mobility reactivity and bioavailability. Of particular threat are the actinides, as these constitute the greatest long-term radiological hazard of high-level waste. In order to address these issues, this group have been involved in a programme of work to establish a comprehensive understanding of the electronic properties and physical and chemical properties of the radioactive actinide metals using state of the art emission spectroscopic techniques. The group’s approach to this is firstly to use coordination chemistry to synthesise uranium compounds with ligands

that model environmentally complexed species and use optical spectroscopy to understand and map both the chemical and physical behaviour of these species. The group have recently established that uranyl(V) and U(IV) complexes are emissive and will demonstrate that uranium in the +IV and +VI oxidation states can be detected simultaneously at relatively low concentrations. Furthermore, the form of the emission spectra of uranyl compounds are sensitive to the nature of the ligand bound in the equatorial plane and the complex nuclearity (extent of aggregation), potentially giving a sensitive method of assessing the solution forms of uranium in environmental conditions. This talk discussed how the optical properties of these model compounds can be extended to the *trans*-uranics and applied to disproportionation reactions and redox events in solution and finally how this knowledge can be applied to the bacterial reduction of uranium using optical imaging techniques.

#### **Geoffrey, the Family Man. – Anne Hardy**

As Geoff’s eldest daughter, Anne was asked to give an account of his family life. She began with their return to London in 1955, but their family life was spent between London and Denmark – Geoff had met her Danish mother in California during World War II – where Geoff invariably spent his time working on Cotton and Wilkinson or other writing projects. It was a pattern that continued through the rest of his life.

#### **Iron Catalysed Hydrogenation and Deuteration Reactions – Ruth Webster (Bath)**

The reduction of carbon-carbon double bonds remains a fundamentally important transformation in organic synthesis. Transfer hydrogenation (TH) offers a mild approach, alleviating the need for high pressures of hydrogen gas whilst improving chemo- and regioselectivity. This group have developed a mild, iron-catalysed TH of alkenes using an alcohol/amine as the proton source and borane/silane at the hydride transfer agent. Using a D+ or D- source, complete selectivity for mono-deuteration of the resultant alkane product is achieved. The ability to selectively mono-deuterate at the internal position of the C=C is thus far limited by the paucity of routes to prepare deuterated silanes. Although there are handful of catalytic methods for deuterating silanes, these mostly employ expensive precious metals and are limited to tertiary silanes: we sought to resolve this bottleneck in synthesis. Using exactly the same iron pre-catalyst, under an atmosphere of deuterium gas, the substrate scope of H/D exchange of silanes was

discussed. Using both experimental and computational studies this group have developed mechanistic understanding, unearthing the potential of the iron(II)  $\beta$ -diketiminato pre-catalyst in isotopic labelling chemistry.

**Some Adventures with Early Transition Metal Pincer Complexes. – Mark Chadwick (Imperial College)**

Pincer complexes hold a privileged position in organometallic chemistry, however their use tends to be dominated by the late transition metals. Arguably the archetypal pincer complexes are those of PCP or POCOP, where a central arene is flanked by two phosphines via either a methylene or an oxygen linker. Across the first row of the transition metal this ligand has been widely used with Nickel, and there are rare reports of its use with chromium, manganese, iron and cobalt, but there are no reports of its use with titanium – until now. This group have been investigating the synthesis and properties of Ti(PCP) and Ti(POCOP) complexes, and their ability to undergo interesting reactivity with small molecules.

**Well Defined Catalysts for Azide-Alkyne Cycloadditions, The Good, the Not So Bad and the Unexpected – Silvia Diez-Gonzalez (Imperial College)**

Copper(I)-mediated azide-alkyne cycloadditions are considered the most powerful Click reaction to date. Despite this popularity, relatively little efforts have focused on developing efficient catalytic systems, preventing numerous applications from meeting the stringent criteria of Click chemistry. This talk discussed their contribution to the field detailing the influence of the ancillary ligand in terms of reactivity and selectivity in cycloaddition reactions.

**From Aluminum Catalysts to COVID – Andy Barron (Swansea and Rice):**

Research into alumoxane co-catalysts defined a new structural model and demonstrated the then unknown structure of alumina nanomaterials. Investigations into surface functionality allowed for superhydrophilic functionality that can be used to collapse aspirated water droplets. The presence of viruses such as COVID-19 can be immobilized and destroyed on these surfaces in combination with iron oxide analogues. A new approach to anti-viral PPE was presented.

**Solution NMR Studies of Transition Metal Alkane – Gregory Girolami (Illinois):**

This talk described recent work on transition metal coordination complexes in which one of the ligands is a light alkane (methane, ethane, propane, n-butane, and iso-butane). Low temperature NMR studies allowed the determination of the exact binding mode and the changes in the C-H bonding that occur upon binding.

**Geoffrey Wilkinson and Me - The Story So Far. – Bob Tooze (St Andrews)**

Things learnt during the speaker's PhD profoundly shaped the thirty-seven years he has subsequently spent in the Chemical Industry. As a homage to Geoff's lecturing style this short talk comprised of anecdotes punctuated by catalytic chemistry in which the speaker showed how Wilkinson continues to influence him more than forty years after they first met.

A mini-exhibition of Wilkinson memorabilia attracted a lot of attention. It included the famous portrait of Wilkinson, the complete set of editions of his text book, *Advanced Inorganic Chemistry*, a set of file cards for his book with annotations/suggestions for his co-workers and mineral rocks used as paperweights on his desk.

## FORTHCOMING MEETINGS AND CONFERENCES

### Dyes in History and Archaeology

The forty-first annual meeting of Dyes in History and Archaeology is being organised by the Swedish National Heritage Board, from 11-13 October 2022. It is a hybrid event with workshops and guided tours in Visby and lectures both on site and online. For more information: <https://www.raa.se/in-english/events-seminars-and-cultural-experiences/dyes-in-history-and-archaeology/>

### International Conference on the History of Chemistry (13ICHC)

Since 1991, the Working Party on History of Chemistry (WPHC) of the European Chemical Society (EuChemS) has organized international conferences on the history of chemistry to bring together historically interested chemists, chemistry educators and historians of chemistry from all over Europe and beyond. Thirty-two years later, 13ICHC will be held in Vilnius (Lithuania) from 23-26 May 2023. The conference will be hosted by

Vilnius University (established in 1579), where the Department of Chemistry was established in 1797. The conference will include scientific sessions, key-note lectures, a poster session, the WP business meeting, as well as social events such as excursions, receptions, and a conference dinner. Further information: <https://www.ichc2023vilnius.chgf.vu.lt/>

### **Call for Papers: Proposal Guidelines**

The Steering Committee encourages the submission of panel/session proposals, but also accepts the submission of stand-alone papers. It welcomes proposals on any topic on the history of chemistry, broadly understood, including historical works on molecular sciences, life sciences, industry, technology, and education. It also welcomes papers on the teaching of the history of chemistry. The deadline is 1 December 2022. All proposals must be in English and use the templates on the conference website. Submitted abstracts and session proposals (max. 200 words) will be subject to review by an International Advisory Committee For more information: <https://www.ichc2021vilnius.chgf.vu.lt/call-for-papers>

### **STOP PRESS**

Recordings of some of the talks given to the RSC Historical Group are now grouped together in a single playlist in the RSC YouTube Channel at:

<https://www.youtube.com/playlist?list=PLLnAFJxOjzZu7N0f5-nVtHcLNxU2tKmpC>

The talks have been given since July 2020, with regular recording commencing at the beginning of 2022. Currently there are two series, the main series which takes place each third Tuesday of the month (except August) and a series covering the history of chemistry between 2019 and 3000 BCE, loosely based on the Bloomsbury *Cultural History of Chemistry*, which is on the fourth Tuesday of each month (except August and December). This is a work in progress, with some videos waiting to be uploaded.