Chemistry in soft focus

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Chemistry seems to have more than its fair share of romance. Who can resist the story of Kekulé's sleep-drenched vision of carbon chains on the last bus to Clapham before "the cry of the conductor… awakened me from my dreaming"? Or Louis Pasteur picking apart tiny crystals of tartaric acid with tweezers in hand before verifying his intuition of chirality, shrieking "Eureka!" and running out of the lab to embrace a bewildered Dr Bertrand in the corridor?

These stories, repeated endlessly and uncritically, have entered the mythology of chemistry. It is only in recent years that a more careful dissection of the discipline's history has revealed how flimsy is the evidence to support many of them. Some of chemistry's popular tales are probably outright fabrication, the product of wishful thinking, over-embellished recollection, wilful self-aggrandisement or a skewed historical agenda.

Even if the record is slowly being put straight, Romanticism retains its allure for popularizers of science. Kekulé's dream is now with us come what may. In many such cases we can hardly hope to know now what really did happen—to unravel the true chain of cause and effect leading to the great discoveries of nineteenth-century chemistry. Maybe it is more instructive to ask instead why it is that the chemistry of that age was seen, both by its contemporary practitioners and by later chroniclers, through the soft-focus lens of Romanticism.

This is not, after all, just a matter of misty-eyed retrospection. Some of the great names of chemistry were avowedly and unashamedly Romantics. None fits the mould better than Humphry Davy, who aspired to be a serious poet and befriended Coleridge and Wordsworth. There's no mistaking the impassioned spirit in Davy's vision of science:

> To scan the laws of nature, to explore
> The tranquil reign of mild Philosophy;
> Or on Newtonian wings to soar
> Through the bright regions of the starry sky.

His verses hardly reached the lyrical heights of those by his friends, but Wordsworth and Coleridge thought well enough of them to publish one of Davy's poems in their *Annual Anthology* of 1799.

James Kendall, in his lectures for children at the Royal Institution in 1938, was still in thrall to the romantic image of Davy—you could easily mistake him for Byron in Kendall's description of the Cornish-born chemist:

> No matinée idol of the last generation, no film star of the present day, ever created such a furore as this young 'Pirate of Penzance' when he first burst upon the delighted metropolis. "Those eyes were made for something more than poring into

> crucibles", said the fashionable ladies who swarmed to his lectures, and his desk was littered with anonymous sonnets from his fair admirers.

It is hard to imagine any speaker at the RI cutting such a figure today. Nor was this sheer hyperbole; the crowds thronged to Davy's Friday evening discourses in such numbers that Albemarle Street was forced to become London's first one-way street. And if we can judge from Thomas Lawrence's portrait of Davy in 1821, he was every inch the George Clooney of his day. His speaking skills were no less admirable: Coleridge is said to have attended the lectures to swell his stock of metaphors.

Wilhelm Ostwald, in a 1909 book called *Great Men* (*Grosse Maenner*), claimed that such people can be categorized as one of two types: romantic or classical. Davy is the archetypal romantic: intuitive, blessed with the ability to make discoveries as if they were handed to him from above. The classical type is exemplified by Davy's protégé Michael Faraday, a more earnest, phlegmatic sort who achieves greatness by hard work. All the same, Faraday's humble beginnings and the story of his bold letter to Davy seeking employment were never hard to weave into chemistry's romantic tapestry.

Ostwald's own protégé Jacobus Van't Hoff is from the same mould as Davy: "a dreamer with a mind that leaped above the commonplace facts of chemistry" is how Bernard Jaffe characteristically portrayed him in his influential and deeply romantic book *Crucibles* (1930). Van't Hoff wrote poetry too, and adored Byron. For his inaugural address at the University of Amsterdam he chose to speak on 'The Role of Imagination in Science', quoting the English historian Henry Thomas Buckle:

> There is a spiritual, a poetic, and for aught we know, a spontaneous and uncaused element in the human mind, which ever and anon, suddenly and without warning, gives us a glimpse and a forecast of the future, and urges us to seize truth as it were by anticipation.

Which brings us back to dreams. How much, by conventional accounts, chemistry owes to them. Before Freud muddied the waters, dreams still retained a medieval association with miraculous visions and revelations from a supernatural source. By imbuing their recollections with a dream component, both Mendeleev and Kekulé were, wittingly or not, mining a powerful and ancient vein.

That their dream accounts surfaced only later in their respective lives is one reason to treat them with caution. Mendeleev's notes also reveal ample reworking of his Periodic Table after the 'dream' allegedly showed him where to put the elements. Indeed, even Mendeleev's solitaire-style shuffling of element cards has been called into question recently by Michael Gordin of Harvard University. William Brock, an emeritus historian of chemistry and the University of Leicester, says that Mendeleev's later accounts of his discoveries contained a strong element of fancy. "Mendeleev seems to have taken a long time to recognise the importance of the periodic law and it did not figure centrally in his writings. Hindsight revealed its central significance and the embellishments began."

And of course there was the issue of prior work—by John Newlands and others in Mendeleev's case, by Josef Loschmidt in the case of Kekulé's rings—that could have exerted more subliminal influence than either chemist might have been keen to acknowledge. (Mendeleev was not reluctant to cite the ideas of Lothar Mayer and Newlands. Kekulé was less generous both to Loschmidt and to Archibald Couper, who first suggested to no acclaim that carbon was four-valent. Couper, a potentially unstable character at the outset, was driven over the brink by the neglect of his work caused by its delayed publication, and was institutionalized in the 1850s.)

But there is, in Kekulé's accounts of his dream visions of carbon chains and benzene rings several years apart, such a similarity of form that it is hard to believe these were independent events. The first of these, in 1854, runs thus:

> I fell into a reverie and lo, the atoms were gambolling before my eyes!… I saw how, frequently, two smaller atoms united to form a pair; how a larger one embraced two smaller ones…I saw how the larger ones formed a chain, dragging the smaller ones after them…

Compare the ring dream a decade later, which allegedly overtook Kekulé not on the bus but by a comfortable fireside in Gent:

> Again the atoms were gambolling before my eyes… But look! What was that? One of the snakes had seized hold of its own tail, and the form whirled mockingly before my eyes.

What is striking is not just the resemblances but also the banality: not much allegorical imagery here, despite the snakes, but rather a mundane juggling of ball-like atoms until they fall into the appointed places, as if in a computer simulation. Maybe Kekulé was simply astute enough to realise that a good story is more likely to stick. The chemist John Wotiz pithily cites another reason why Kekulé may have decided to cast his insight in this form: you don't have to give footnotes for a dream.

Peter Ramberg of the Max-Planck-Institut für Wissenschaftsgeschichte in Berlin has provided one of the most thorough analyses of how a romanticized myth can evolve. Ramberg has cast a sceptic's eye over the familiar story of how Wöhler's synthesis of urea from cyanic acid and ammonia in 1828 dispelled the notion of vitalism by creating an organic compound from inorganic components.

By the late nineteenth century, the legend was firmly established that Wöhler's experiment sounded vitalism's death knell. But it seems that this conclusion owes more to hindsight than to Wöhler's perspicacity at the time. True enough, he famously wrote to Berzelius explaining with some excitement how he could "make urea without need of a kidney or even an animal, be it man or dog." But Wöhler nowhere mentions any implications for the concept of vitalism, and neither did Berzelius in his response. "All chemists have applauded the brilliant discovery", Dumas averred in 1830—but none saw fit to regard the 'vital force' as moribund.

What Ramberg calls 'The Wöhler Myth' began to appear two decades later, first in Hermann Kopp's *Geschichte der Chemie* (1843) and then in a more fanciful form in

Hermann Kolbe's chemistry textbook of 1854. Once the story had crossed into scientific pedagogy, there was no stopping it. Edward Frankland included it in his lectures at Owens College, Manchester in the 1850s, and Wöhler's biographers after his death in 1882 were eager to cast the synthesis of urea as epochal.

But the story itself grew legs once it was made truly romantic by adding the narrative of a quest. And that was Bernard Jaffe's forte. Here he is, then, casting Wöhler as the Wagnerian hero:

> He was standing upon the threshold of a new era in chemistry, witnessing 'the great tragedy of science, the slaying of a beautiful hypothesis by an ugly fact'… The pregnant mind of young Wöhler almost reeled at the thought of the virgin fields rich in mighty harvests which now awaited the creatures of the crucible. He kept his head. He carefully analyzed his product to verify its identity. He must assure himself that this historic crystal was the same as that formed under the influence of the so-called vital force.

How can one resist such a dramatic picture? The Wöhler Myth could only have got so far from a mere exaggeration of the facts; once recast as a romanticized, Herculean triumph, it fits the template that had been created for nineteenth-century chemical discovery.

So why create these tall tales? For popularizers and educators like Jaffe and Kendall, the value of a good yarn is obvious. "Chemistry is not easy to make interesting, and historians and popularisers have tried to humanise", says Brock. Chemistry Nobel laureate Roald Hoffmann agrees that dramatic narratives are valuable in talking about science. "Telling stories is human and absolutely essential when we talk and write to and for each other", he says. "Story-telling provides psychological satisfaction, the drive to go on."

But the danger of using such devices is apparent from Jaffe's book: the history of science becomes Whiggish, a positivistic, inexorable march towards the truth:

> Slowly, carefully, laboriously, Wöhler worked away in the sacred temple of his laboratory. If he could only make one of those innumerable substances which until now only the intricate chemical workshop of the living organism has fashioned! What a blow he could strike at this false idea [of vitalism].

Today we might hope that young people are ready for a more realistic description of how science progresses—with all its excitements and frustrations but also with its longeurs, its dead ends, its industrial-scale organization.

Brock sees some nineteenth-century chemists' inventive stories as calculatedly self-serving. "I cannot help noticing that they often occurred in attempts at autobiography. Thus Liebig's story of dancing with Gay Lussac after a successful analysis, recounted in a 1867 dinner speech. Most of these stories do seem to be romanticised hindsight as the chemist or his pupil or obituarist places the discovery in a human context that renders largely superfluous any rivals or spurious steps, or aggrandises the man into a hero."

To Ramberg, the motive may sometimes be more well-intentioned: to establish "a disciplinary founding myth". "The appeal of the Wöhler story, like many myths about origins", he says, "lies perhaps in its ability to pinpoint the beginning of organic chemistry to a single datable event." To this end, Ramberg suspects that "chemists would like it to be a true story, even if it is not."

What's more, he thinks that this myth, and presumably others like Kekulé's dreams, are passed on to new practitioners of organic chemistry almost as a kind of initiation ritual, like the 'invented traditions' that historian Eric Hobsbawm has identified in other areas of late nineteenth-century life: national holidays, monuments, sporting events. Figures like Wöhler then literally become the archetypal heroes that any community or culture craves.

Yet it is not so easy to find the same kinds of narrative in nineteenth-century physics, a subject that seems to fit more comfortably within Ostwald's 'classical' image of steady and sober advancement. Was chemistry particularly susceptible to romanticization? Perhaps so—for it was still largely an unexplored continent, lacking anything to compare with the Newtonian first principles of physics.

Chemistry, then, was romantic because it was deeply mysterious. John J. Griffin's chapter on (largely spurious) chemical theory is probably the driest section of his famous *Chemical Recreations* (1834), but nevertheless he saw fit to entitle it 'The Romance of Chemistry' because in it the reader was leaving behind the solid empirical fact of experiment and entering a speculative 'debatable ground'. In contrast, once the Periodic Table was known and almost filled, and once Lewis, Langmuir, Bohr and Pauling had more or less explained chemical bonding and aligned it with quantum physics, this mystique was gone. These are chemistry's modernists, and there has been rather little attempt to cast their great discoveries in the early twentieth century in a romantic light.

"Chemistry from around 1780 to 1830 was closely linked to electricity," says Eric Homburg, a historian of chemistry at the University of Maastricht in the Netherlands, "and the idea that forces were more important than matter seems to have been liked by many romantic minds. The special role of chemistry in that period had to do with its close links with imponderables such as ether, heat, electricity, and magnetism."

Later, says Homburg, chemistry became more positivistic and materialistic, and so the romanticism of Kekulé and his contemporaries may have been a response to this. "They were trying to show that mental inspiration was also crucial to chemistry."

In any event, there seems no doubt that chemistry *was* the science of choice for Romantics. In Germany it inspired the philosopher Georg Wilhelm Friedrich Hegel and the painter Philipp Otto Runge. The poet Johann Wolfgang von Goethe famously used its imagery in his 1809 novel *Elective Affinities*, and was drawn to the subject in part because of its alluring and mystical roots in alchemy. Coleridge even wrote to Davy saying that he and Wordsworth were considering setting up a chemical laboratory—picture that! (Sadly, it seems never to have materialized.)

But let's not forget that some of chemistry's romantic past is surely real. There is little question, for example, that the eighteen-year-old William Perkin did indeed launch the modern chemicals industry with a failed experiment in his father's shed in Shadwell, where he discovered the first coal-tar dye. There is death and madness enough to satisfy the Gothic Victorian psyche in the sad tales of Archibald Couper, Marie Curie (unquestionably from the romantic mould even if she overlapped with Rutherford) and Harry Moseley—'Balder slain by the blindman there at Gallipoli' as the poet Edwin Lewis put it.

Should we worry that romanticization distorts chemistry's past, or is a little romance a good thing? "I think it's OK," says Hoffmann, "for a perverse reason. I see romanticizing as a way for scientists—good at spotting the romanticizing of their colleagues, even as they are unable to stop doing it themselves—to acknowledge that they are human figures."

Further reading

B. Jaffe (1976). *Crucibles: The Story of Chemistry*. Dover, New York.
J.Kendall (1953). *Great Discoveries by Young Chemists*. Thomas Nelson & Sons, London.
D. Knight (1992). *Humphry Davy: Science and Power*. Cambridge University Press.
P. J. Ramberg (2000). *Ambix* **XLVII**, 170.