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MARTYN CHRISTIAN RAYMOND SYMONS
12 November 1925 — 28 January 2002
Martyn Christian Raymond Symons was born on 12 November 1925 in Ipswich, Suffolk. The talents he was later to develop were a reflection of his genetic and cultural environment. Thus, his grandfather was William Christian Symons, who achieved contemporary minor fame as a painter in water colour and oils even though his work is now largely forgotten. His grandmother, Cecilia Davenport, was a concert pianist before her marriage. Symons was to display both artistic attributes, for he was a skilful self-taught pianist and an accomplished water colourist. The environment was richer than that, though, for the three sons of the grandparent’s marriage were Mark, a painter, Phillip, who became a Benedictine monk and served as organist at Downside, and Stephen, Martyn’s father. Painting, as already remarked, was one of Symons’s great relaxations, and in early life (but not in middle age and after) the Catholic version of the Christian religion gave him guidance and solace. Indeed, there was a stage when he was poised to become a priest, but the passion passed and after the suffering and death of his first wife, who had become a Catholic in order to marry him, he rejected religion.

The technical contribution to Symons’s environment came from his father, Stephen White Symons, a consultant mechanical engineer, ably supported in the female manner of the day by his wife Marjorie. Here, though, the environment temporarily withdrew its support, for the young Symons entered the John Fisher School in Purley (1933–40), and hated every minute of it. Ill taught (he claimed) and bullied (he interpreted), the teachers—with the freedom of the age—almost literally hammered knowledge of a sort into him, not realizing the sensitivity of the child in their care and presumably contributing at least a little to his unusual psychology.

Relief came as the lights went out over Europe and Symons left Purley for Battersea, which cannot have been an altogether peaceful place from 1940 to 1945, but better there than being at school in Purley. Initially, following in the steps of his father, he studied engineering in alliance with chemistry and physics. At the end of the first year, he was awarded a Tait Scholarship, and took the opportunity to switch from engineering to chemistry, which he found much more interesting. Those who knew Symons in later life were not particularly
impressed with his mathematical ability, for his forte was intuition rather than calculation, and it is easy to suspect that the switch of subjects was in large measure due to his sense of mathematical inadequacy. Be that as it may, Symons now found himself in the ocean of interests that was to be his professional milieu for the rest of his life. There he came under the influence of two respected tutors, J. W. Smith and J. Kenyon FRS, and managed to achieve a second-class (undivided) degree. His somewhat muted surprise at this result (one in the direction more of pleasure, he later claimed, than disappointment) he ascribed to the difficulty of achieving any sort of classified degree from a college then examined by the University of London.

Undergraduate Symons, newly minted as graduate Symons, immediately became sapper, later sergeant, Symons. For three years he kept His Majesty’s enemies at bay, those in his own classroom at least, by giving instruction on aspects of engineering to soldiers of the Army Catering Corps in Aldershot. Promoted to Second Lieutenant, Symons went on to teach chemistry in one of the army’s rehabilitation colleges, which were intended to adjust soldiers to civilian life, at Newbattle Abbey near Dalkieth.

After three years with the armed forces, spanning that awful winter of 1947 amid the angst of immediately postwar Europe and the bleakness of 1940s Britain, Symons returned to Battersea to start work on his doctorate. He had flirted with the idea of going to Cambridge, but that plan was scotched, and an unfortunate prejudice indelibly reinforced, by the reply to his letter of enquiry which noted that his first degree was from Battersea Polytechnic, and advised him to return to whence he had sprung, with the implication that he would find it intellectually and socially more acceptable there than in the firmament that, as conceived at Cambridge, was Cambridge. Who knows where the truth lay: it is possible that the writer was attempting ham-fistedly to guide him sensitively into a different path in the light of his own judgement rather than to put him down; but misinterpretation (or it might have been accurate perception) left a scar that never truly healed, and Symons retained throughout his life a disdain for and dislike of his vision of Oxbridge.

Symons’s pursuit of his doctorate back in Battersea was not as smooth as some. His supervisor was Kenyon and his field organic reaction mechanism, but he always acknowledged the kind help and support that he got from Alwyn Davies (FRS 1989) and Malcolm Thain. Kenyon rejected the first draft of his thesis with the unhelpful dismissal that ‘If you can’t see what’s wrong with it, then you don’t deserve a doctorate’. Sent back to the drawing board, he revised the thesis but maintained what Kenyon had objected to (the involvement of radicals in a reaction pathway) and, after a further two years’ work, submitted it successfully in 1953. At the same time as doing his research, Symons was appointed as lecturer to teach some low-level chemistry.

On completion of his doctorate, Symons took up the position of Assistant Lecturer in organic chemistry at the University of Southampton. This was to be a crucial appointment for him, because it brought him into contact with David Ingram in the Department of Electronic Engineering, and thus resulted in a fruitful mingling of expertise from chemistry and physics. Ingram had worked with Brebis Bleaney FRS in the Clarendon Laboratory at Oxford and had become interested in electron spin resonance (ESR; now more commonly electron paramagnetic resonance, EPR). He had started to develop the still primitive technique at Southampton, and Symons—as was to be characteristic of his ability to identify and incorporate new techniques from disparate sources—saw that ESR (as he was always to think of it) was exactly what he wanted to deepen his insight into radicals and their involvement in reactions. More will be said of this major thread of his work below.
At about the same time, Symons realized that he was more a physical chemist than the organic chemist he had been appointed to be. The head of the department, N. K. Adam FRs, declined his request to switch to physical chemistry at much the same time as other members of the department rejected (on perfectly reasonable and proper grounds) the application of the author of this memoir to enter Southampton as an undergraduate. Fate, however, was to step in in her typically ironical manner and took the future out of the hands of mere mortals.

At the end of the 1950s, Symons had become a serious force in the application of many varieties of spectroscopy to a multitude of problems and had been awarded a DSc by his effective alma mater, the University of London. One day, a cohort of his research students marched in, led by Judah (Jud) Arotsky, armed with pen and paper, and forced him to apply for the newly created chair of physical chemistry at the University of Leicester. In due course he was appointed and took up the position that he was to hold for the following 28 years in 1960. That was just in time for this author, who had also been accepted by the same university, to consider joining him as a research student; so fate had brought us together.

Symons’s private life was no more straightforward than his academic, professional life, and is not of great public concern. Thus, his first wife, Joy Lendon, whom he married in 1950, was to die of cancer after a long and trying illness in 1963. In due course (in 1970) he married again: he had met Janice (Jan) O’Connor when protecting her from another’s harassment on a train to Leicester, and used the chivalric opportunity as an introduction. The marriage, though, was to sour, and tragedy ended it when she was murdered by a lodger in 1995. There were two children of the first marriage, Susan (Rebecca, 1954) and Richard (1957); Richard died in 1998, perhaps of variant Creutzfeldt–Jakob disease.

Symons’s career went through various metamorphoses: first a schoolteacher in a minor public school near Esher, then after a lectureship at Battersea while he was doing his doctorate, as a lecturer at the University of Southampton from 1954 to 1960. Forced by his group, as we have seen, to apply to Leicester, he was appointed in 1960 and remained there until he took early retirement in 1988. He was Head of the Department of Chemistry from August 1978 to July 1980, served in an associate capacity as Research Professor from 1988 to 1991, and continued to hold that title on an honorary basis until 1993. The five years after his retirement, when he was Research Professor of Chemistry, Cancer Research Campaign Senior Fellow, and Director of the CRC Electron Spin Resonance Research Group, saw a deterioration in relations between himself and the university, and memories of him at Leicester are not warm, except—and even then with qualification—among a number of his close colleagues. In due course, in 1993, he was to move to what he regarded as a more reasonable and supportive environment, and became a Visiting Professor at De Montfort University, Leicester, Visiting Professor of Chemistry at Nottingham Trent University and the University of Greenwich. He was also Visiting Professor of Biochemistry at St Bartholomew’s College of Medicine and the University of Essex at Colchester, where relations in due course were also to become uneasy.

Symons was elected to the Fellowship of The Royal Society in 1985. He had been a Fellow of the Royal Society of Chemistry (RSC) since 1960 and in due course was to become Vice-President of the Faraday Division of the RSC. In 1986 he gave the first Brucker Lecture and in 1987 the Robert Robinson Lecture. In 1997 he was Whelan Visiting Lecturer at the University of Saskatchewan. He died on 28 January 2002.
Symons published his first research paper in 1953 on ‘Potassium permanganate—a possible source of free hydroxyl radicals’ (Research 6, Suppl. No. 1, 5S). To a certain extent the title of that paper captures the theme of the greater part of his work in the following half century, during which he considered the structure and properties of transition-metal complexes, free radicals, particularly inorganic radicals, and reaction mechanisms. At this stage he was interested in the oxidation of organic compounds by oxoanions in solution and he speculated on a variety of mechanisms involving several types of reaction intermediate, such as carbonium ions, but became convinced of the importance of radicals in oxidative processes. Even at this early stage of his professional career, Symons was committed to the deployment of spectroscopic techniques, then a relatively rare approach in the generally classical chemistry of the time. Perhaps the greatest influence on Symons’s thinking at this time was C. K. (later Sir Christopher) Ingold FRS, for Ingold’s magisterial text was a constant companion.

The instrument that most directly influenced his research was the ESR spectrometer. He came across this then fledgling technique when he went to Southampton University in 1953 and met David Ingram, who had built an early version of an ESR spectrometer but had little idea of how it might be applied in chemistry and was perplexed by the type of interpretation it required. Symons pounced on the technique, which he saw would open an unrivalled window on to the world of unpaired electrons. His first paper using the technique dealt with an unusually applied topic, the ability of carbon chars to cause polymerization of acrylonitrile (J. Chem. Soc., 4344 (1955)). At about this time Symons began to detach himself from reliance on the spectrometers of the physics group at Southampton, and raised funds (from Kodak) to start building his own ESR spectrometer in collaboration with J. A. Brivati (with whom later there was also a falling out).

Symons could never have enough radicals. To generate them, he developed the technique of ultraviolet irradiation of alcohols in the presence of hydrogen peroxide and organic peroxides cooled in liquid oxygen (because liquid nitrogen was not then readily available). At the same time he developed an interest in ozonides and superoxides, among other inorganic radicals and in carbocations formed in acid media.

This interest led him into the domain of solvation studies, on which he brought a wide variety of spectroscopic techniques to bear. Iodine, for Symons, was both a hobbyhorse and an incubus. Symons recognized that it was an important probe of the influence of the solvent; indeed, the characteristic visible absorption of iodide ion in solution is due to a charge-transfer-to-solvent (ctts) transition, and he envisaged the acceptor orbital as defined by the solvent cavity. Therefore, the transition can be envisaged as an exploration of the local solvent environment and therefore of the solvent–solute interaction. He studied the dependence of ctts spectra on temperature, pressure and the composition of mixed solvents and explained the observations in terms of ion hydration, solvent-separated and contact ion-pair formation. The unfortunate face of his involvement with iodine was the presumed identification of the I\(^+\) cation in concentrated sulphuric acid; however, later work showed that a co-worker had made a crucial arithmetical mistake, and the species did not exist.

In a sense, the culmination of these studies was his interest in solutions of alkali metals in liquid ammonia, which are perhaps the embodiment of his interest in unpaired electrons and solvation, for these solutions are solutions of electrons trapped in cavities in the liquid, a kind of disembodied solvation. Here Symons perceived the excited state of the iodide–solvent sys-
tem as the ground state of the electron trapped in a cavity. This interest (which had caused
some hard feelings at Southampton, because another group was also involved in metal–ammo-
nia research) was restarted at Leicester and led to an interest in electrons trapped at F-centres
and in hydrate glasses produced by radiation damage.

As remarked above, in 1960 Symons migrated to the University of Leicester as its first
Professor of Physical Chemistry. Among his first acts there was to install a cobalt-60 γ-ray
source. A minor incident at the dockside, where the heavily shielded container slipped out of
its cradle and fell, brought this aspect of his research to brief public attention. However, the
source was soon installed in a basement room in the then new chemistry building, and Symons
was soon causing all kinds of materials to be exposed to the radiation it produced, often at liq-
uid-nitrogen temperatures, and then studying the radicals so produced by ESR. This long
series of experiments resulted in the series of over 200 papers he published under the general
title of Unstable intermediates and was recapitulated in his first book (with P. W. Atkins), The
structure of inorganic radicals (Elsevier, 1967). Rather oddly, almost all this work was per-
formed on powders, and consisted of semi-quantitative analysis of powder ESR spectra: for
some reason, Symons eschewed the much more detailed information that might have been
forthcoming from single-crystal studies, going for throughput and the global view rather than
perhaps overly detailed analysis.

In these studies, Symons explored the electron distributions (more specifically the spin den-
sity distribution) of a wide range of inorganic oxides and oxoanions, especially those of
Groups 15–17, including the relatively stable paramagnetic nitrogen and chlorine oxides and
the specially produced sulphur and phosphorus oxoanions. To do so, he always thought care-
fully about the significance of hyperfine interactions (drawing on many helpful suggestions
made by David Whiffen FRS) and interpretations of the g-values of the species. In each case
he was interested in the correlation of chemical properties and electronic structure, as in the
analogies between radicals produced from oxalate and dithionite (the CO$_2$• and SO$_2$• radical
anions, respectively). In the course of this work, to which numerous collaborators contributed
over the years, he was able to build up a detailed qualitative understanding of structure–prop-
erty correlations and brought himself to an unrivalled and internationally respected position to
understand radiation damage where it really matters, in living systems.

In parallel with this extensive series of studies, Symons embarked on a series of studies of
hyperconjugation in radicals containing β-halogen substituents and of the conformation of
radical centres, the structures of sulphur and phosphorus radicals, and a series of σ-complexes
such as dihalide radical anions (Br$_2$•) and R$_2$SSR$_2^+$. The long series of papers on the theme of
radical cations started in the early 1980s. The fecundity of this field stemmed from the real-
ization that it was possible to use γ-radiation to produce and stabilize radical cations of most
materials dissolved in frozen chlorofluorocarbon solvents (specifically CFCl$_3$) at 77 K.

With his interest in solvation well established, it was only natural for Symons to turn to the
solvent itself, particularly when that solvent was as intriguing and important as water. In a
series of publications he explored the role of hydrogen bonding between water and simple
solute, in a sense gearing up to tackle the hydrogen-bonded system of water itself. It is mildly
ironical that Leicester’s original founding professor of chemistry, Louis Hunter, had made
hydrogen bonding his life’s interest, but there was to be little interaction between the two
because their attitudes and achievements were generations apart.

When he turned his attention to water itself, Symons exploited an observation by I. M.
Klotz and J. D. Worley that in the infrared spectra of mixtures of water and heavy water it was
possible to identify a band due to an OH group that was not engaged in hydrogen bonding to a neighbour. The intensity of this band changed when salts were present, so it provided a potential probe of both water–water interactions and water–ion interactions. In the light of these observations and his own work, Symons developed a model in which the properties of water and aqueous solutions could be understood in terms of an equilibrium between conformations in which there were ‘free’ OH groups and similarly ‘free’ oxygen lone pairs regarded as Lewis acids and bases, respectively. These ideas and the equilibrium model became something approaching an obsession, and Symons was to become quite bitter that these ideas were not taken up by others in the general area of water and aqueous solution chemistry.

At the start of his time at Leicester, Symons was tempted into what turned out to be, in all honesty, a blind alley. In 1961 Imperial Chemical Industries decided to close the Frythe Research Laboratories and invited offers for its ultrasonic absorption apparatus, which operated in the range 1.5–270 MHz. Symons was offered the equipment, seeing its potential as a novel way to investigate hydrogen bonding in aqueous systems. However, once it emerged that the absorption maxima were more related to thermodynamic properties, such as the excess Gibbs energy of mixing, he lost interest: individual molecules were his aim, not the bulk classical properties of the crowd.

In the course of the 1980s, Symons returned to the radical cations to which he had already contributed so much structural and mechanistic understanding. Now, though, he was using solutions in chlorofluorocarbons (such as CFCl3) at liquid-nitrogen temperatures and generating the trapped radical cations by \( \gamma \)-radiolysis.

At about the same time, Symons started to turn his attention (being motivated to do so, he asserted, by the death of his first wife) to the biological systems that were to be a consuming interest for the rest of his life. He began by studying the radiation chemistry of thiols and simple primordial molecules such as cyanamide, with the hope of understanding features of the emergence of life and its early resistance to irradiation in the primordial biosphere. That interest developed into the effect of radiation on red blood cells and biologically important species, such as oxyhaemoglobin, xanthine oxidase, cancer magister haemocyanins, choline hydrochloride, and DNA itself.

Symons had to confront the question of radical migration when he turned his attention to biological systems. He formed the view that an anionic radical site can migrate over long distances along the polypeptide backbone of a protein until it is trapped by protonation at a carbonyl group. In contrast, a cationic radical site can migrate only a short distance because its transport is terminated by the rapid deprotonation of an amido nitrogen atom. He also identified a tunnelling mechanism in which both types of radical can be transported over a great distance within a single protein molecule. In the case of a haem protein reacting with a peroxide, a cation radical is transferred within the globin and deprotonation of a residue terminates the migration.

Symons was fascinated by DNA and saw the application of his acquired experience with radicals and their reactions to the problems associated with processes in living systems as the culmination of his own life’s work. His favoured technique was ESR, but in collaboration with others he accepted the importance of other techniques, such as electrophoresis, NMR, mass spectrometry, and ultraviolet and visible spectroscopy, as ways of identifying radiolytically generated species from DNA, the mechanism of its damage, and the mechanism of perhaps its most perplexing aspect, its protection. Among the many substances that can have an important moderating role in the radiolytic damage to DNA are transition metal ions, and although
Symons concentrated on iron and copper, he also focused on the role of organosulphur compounds, such as thiols, in the presence or absence of oxygen. The book on the role of iron in chemistry, biology and medicine edited by Symons and J. M. C. Gutteridge (Free radicals and iron: chemistry, biology and medicine (Oxford University Press, 1998)), provides a broad perspective on this topic together with comparisons with the role of copper.

Thiols can protect DNA by scavenging reactive oxygen species, such as the virulent hydroxyl radical, because the thyl radical produced is often not reactive enough to effect damage on biopolymers in its vicinity. Symons’s exploration of various aspects of DNA damage revealed important information about the formation of radical intermediates and the migration of electrons and radicals along DNA. Radicals produced by ionizing radiation lead to strand breaks, although the chemical pathways of the processes involved are still obscure. Some of his proposals, such as the postulated mechanism of strand breakage due to hydrogen abstraction from sugar by thymine radical, still await verification. Symons also performed some work on more complex materials, including chromatin extracted from cell nuclei. For instance, he reported that when DNA exists in a complex with proteins, as it is in the nuclei, the yield of electron-gain centres in DNA increases as a result of electron transfer from histone, whereas holes are not able to cross the intermolecular barrier. These findings provide significant information on the sensitivity of biological targets to ionizing radiation.

Among the last substantial work he did was an investigation of anthraquinone derivatives intercalated in DNA at ambient temperature, a system used as a bioreductive antitumour species in cancer therapy for enhancing effects of radiation. Contrary to his expectation, he found that they protect plasmid DNA against radiation-induced single- and double-strand breakage.

Thus, right to the end, in his mid-seventies he was pursuing his lifelong aim, to understand the life and times of radicals, ultimately in relation to that most important of problems: the onset and consequences of damage to DNA.

**ENVOI**

What was Symons’s lasting contribution to science? Like the man himself, it is multifaceted. Within science itself there is his exposure of the structure and reactions of radicals and their involvement in damage, particularly to biologically important systems, such as DNA. Similar, but perhaps of less importance in the long term, is his contribution to our understanding of the local environment of species in solution. If we could effectively admonish those beyond the grave, we should tell him, if he ever came back, not to publish so much, for fecundity can too easily be misinterpreted as triviality, and reputations are best made with magisterial pronouncements rather than a rush of *billets doux*, even though the latter, when viewed in the round, with the scattering of errors benignly ignored, may outweigh tomes. We should also tell him to be less sensitive to criticism and to be confident in the worth and reality of accolades received.

Beyond science itself, or perhaps more properly in the heart of it, is his inestimable contribution to the practice of science in the form of the students he has left behind to carry, as best they can, the brilliant light of insight that he brought to bear on all he touched.
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BIBLIOGRAPHY

A selection of Martyn Symons’s most recent publications appears on the accompanying microfiche. A photocopy is available from The Royal Society’s Library at cost.