

Severyn Marcel (Sever, Sev) Sternhell 1930–2022

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ABSTRACT

Sever Sternhell DSc AO FAA FRACI CChem was a prominent figure in Australian organic chemistry, academia and public life for more than forty years. He held the Chair of Organic Chemistry at the University of Sydney from 1977 until his retirement in 1998. He was very influential, not only directly through his science and his leadership in Australian Chemistry, but also indirectly through the graduate students that he inspired and mentored, and the thousands of undergraduates he taught over the years. Sev undertook his PhD with Professor D. H. R. Barton (later Sir Derek Barton) at Imperial College, London, and it was there that he was introduced to NMR spectroscopy: NMR would become Sev's major research area for the rest of his career. He was appointed as senior lecturer in organic chemistry at the University of Sydney in 1964 and, in 1977, he was appointed to the Chair of Organic Chemistry and Head of Department. Sev served as Head of the School of Chemistry at the University of Sydney on two occasions. He is probably best known for his pioneering research into the use of NMR as a tool to unravel the structures of organic compounds. His seminal monograph (with Lloyd Jackman), *Applications of nuclear magnetic resonance spectroscopy in organic chemistry*, published in 1969, became a 'bible' to generations of organic chemists.

Keywords: chemistry, organic chemistry, nuclear magnetic resonance, NMR spectroscopy, memoir, Sydney University, long range coupling, physical organic chemistry.

Early life and education

Sever Sternhell (Fig. 1) was born on 30 May 1930, in Lwow in the part of Poland annexed by the Soviet Union in 1945, and now known as Lviv in Ukraine. His father, Dr Samson Sternhell, was a lawyer and his paternal grandparents were landowners of an almost feudal sort, which was unusual for Jews in Poland. Due to the outbreak of World War II, he only completed four years of primary school, and this was the only formal education he received until he arrived in Australia as a sixteen-year-old in 1947.

Because his family was Jewish, his experiences during World War 2 in Nazi-occupied Europe were horrific, and he escaped death on several occasions by very narrow margins. He related his family history, particularly the Holocaust, in *Our Mob—a Family Chronicle*¹ and in two shorter articles in the *Quadrant* magazine.² Most unusually, he (an only child) and both of his parents survived the war: they emigrated to Australia in 1947. Helped by his two uncles, Dr Arthur Sternhell (a veterinary surgeon) and Dr Zygmund Wachs (later Charles Walker, a dermatologist), already in Australia, he adjusted to his new homeland quickly and enthusiastically.

He was enrolled as a boarder at Newington College, Stanmore, in February 1947, and completed his Leaving Certificate in November 1947 (five A and one B grades). He compressed some two years of primary education—and all his secondary education—into just nine months and before enrolling in the Faculty of Science at Sydney University in March 1948, at age seventeen, having fully made up the loss of the war years.

He chose organic chemistry in 1951 as his Honours year specialisation, and Francis Lions, then a Reader in Organic Chemistry was his supervisor. After gaining First Class

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¹Sternhell and Sternhell (2002, 2005).

²Sternhell (2008a, 2008b).

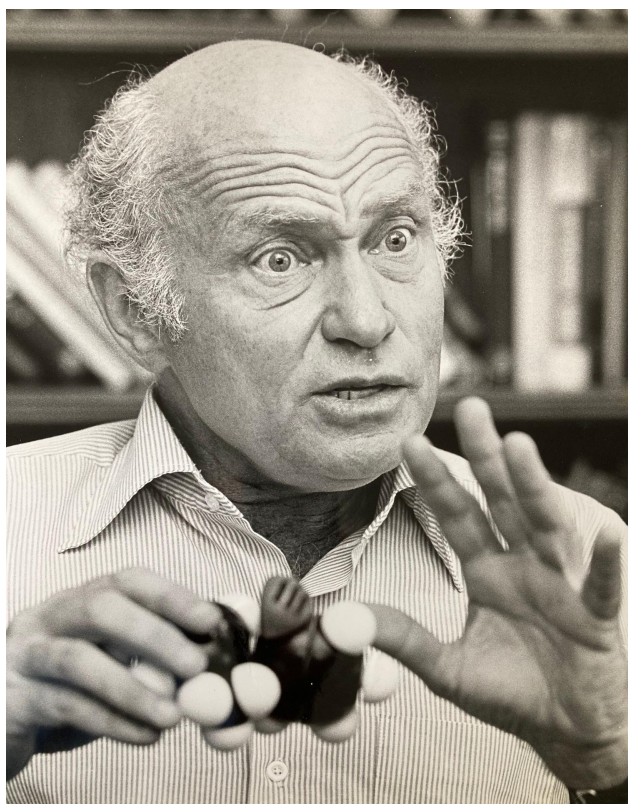


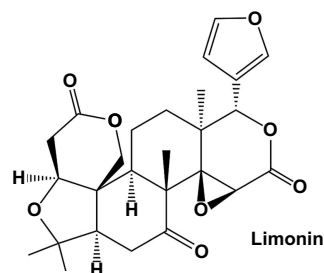
Fig. 1. Sev Sternhell at Sydney University, c. 1980s.

Honours (equal top of the year with Frank Eastwood, later Reader at Monash University), he gained his MSc under the supervision of the recently arrived Professor of Organic Chemistry, Arthur Birch. Sev's work with Lions dealt mainly with aspects of the Mannich reaction, while his MSc work with Birch was concerned with the classical Birch reduction.

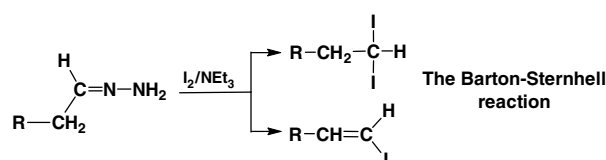
Despite holding a scholarship which would have enabled him to proceed to a PhD, he elected to leave the University to take up an appointment in the Research and Development section of what was then Beetle-Elliott Plastics (later taken over by Monsanto) in Rozelle, Sydney. Although his career in the polymer industry was relatively brief (two and a half years), he acquired a life-long appreciation of the importance of disciplines like chemical engineering, project management and finance, or as he put it, 'there is more to chemistry than the laboratory'.

In 1953, he became a Research Officer in the CSIRO Division of Coal Research, North Ryde, NSW, and in late 1958, he won an overseas CSIRO scholarship. This permitted him to enrol in a PhD course at Imperial College, London with D. H. R. Barton (later Sir Derek Barton and 1969 Nobel Laureate), who became his principal mentor and probably the most significant influence on his career. Sev completed the work, *Studies in the Chemistry*

of Limonin, and submitted it for his PhD in 1960. Some of his PhD work was published in a series of papers³ where the main paper (more than forty pages) described the chemical degradation of limonin (oxidation, hydrolysis, ozonolysis and other reactions), careful identification of the degradation products, and then logically pieced together the structure of limonin from the fragments. Sev was one of an impressive line-up of authors (including Barton, Arigoni and Corey) in what was a heroic effort to establish the structure of limonin.



Sev completed his work on limonin in some fourteen months, and used the remaining few months of his enrolment to work on a novel reaction that he had serendipitously discovered. It involved treatment of hydrazones with iodine and a base to yield *gem*-diiodides and vinyl iodides under very mild conditions,⁴ and this reaction became known as the 'Barton-Sternhell' reaction.⁵



Late in 1960, Sev returned to Sydney and to the CSIRO, where he was rapidly promoted. Sternhell had become immensely impressed with the power of nuclear magnetic resonance (NMR) spectroscopy at Imperial College, where NMR was being pioneered by a fellow Australian, a young Reader—Lloyd Jackman (later Professor at the University of Melbourne University and at Pennsylvania State College). At CSIRO, Sev lobbied successfully for the purchase of one of the first NMR instruments in Australia (a Varian A60) for the Division of Coal Research, and this effectively opened the major research field that he pursued for the rest of his career. Years later, in 1968, he repeated his lobbying success as he led the push for the purchase of the first high-field (superconducting magnet) NMR instrument in Australia and the National NMR Centre in Canberra, where it was located,

³Arigoni and others (1960). Barton and others (1961).

⁴Barton and others (1962).

⁵Pross and Sternhell (1970, 1971).

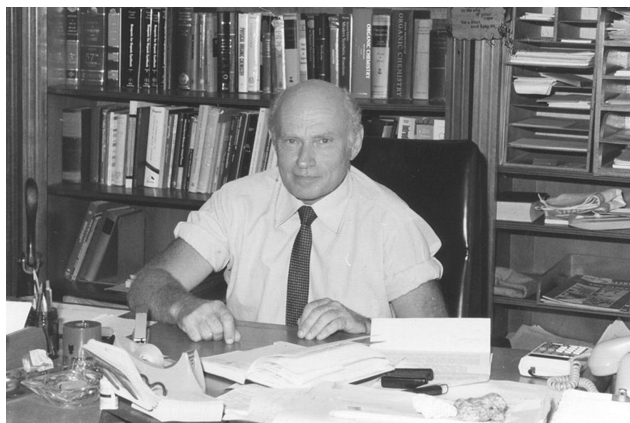


Fig. 2. Professor Sev Sternhell, in the office he occupied as Professor of Organic Chemistry and Head of the Department of Organic Chemistry, University of Sydney. Photo taken c. 1981.

and on whose Management Committee he served from 1972 till 1978.

In April 1964, Sev accepted an offer of a Senior Lectureship in the Department of Organic Chemistry at the University of Sydney. He became a Reader in 1967 and, after the untimely death of the Head of Department (Professor Ern Ritchie), he was appointed Professor of Organic Chemistry and Head of Department in 1977 (Fig. 2). He remained in that position till his formal retirement in July 1998, but continued his active connection with the University of Sydney and the School of Chemistry.

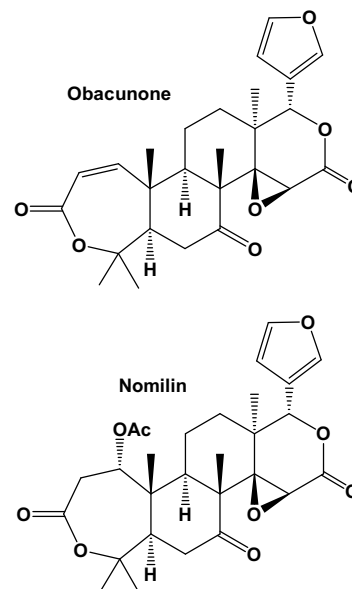
Scientific research

Sternhell's work on NMR spectroscopy, particularly on correlations between the magnitudes of interproton spin-spin coupling constants and molecular structure, is undoubtedly his best-known contribution, and amongst his most cited works.⁶ Over the years, Sev worked broadly in the areas of mechanistic and physical-organic chemistry.

Early work

Sternhell's MSc work with Arthur Birch concerned aspects of the scope and mechanism of the classical Birch reduction,⁷ while his PhD project with Barton was the successful determination of the structure of Limonin and the related bitter

principles Obacunone and Nomilin.³ This problem was at that time (in 1960) over one hundred years old and had already been the subject of over thirty PhD theses.



This was the moment in the history of structural organic chemistry when new physical techniques, particularly NMR spectroscopy and small-molecule X-ray crystallography, came of age and drove the future direction of Sev's research. The bulk of his research at the CSIRO Division of Coal Research between 1953–8 and 1961–4 concerned the chemistry of Victorian Brown Coals,⁸ and included the development of a scheme for the genesis (coalification) of all types of coals from the common precursor lignin.⁹ There was also a collaborative project with the CSIRO Division of Forest Products,¹⁰ concerning the structure of lignins, and a number of studies of relevant model compounds.¹¹

NMR spectroscopy

Sev was fascinated by the power of NMR spectroscopy in general, especially by the unique structural information available from inter-proton spin-spin coupling constants (Fig. 3). Sev's synthetic ability differentiated him from most other researchers in the field, who were typically physical or theoretical chemists reliant on commercially available or donated compounds to study. Sternhell, with his organic chemistry

⁶Sternhell (1969).

⁷Birch and others (1954).

³Arigoni and others (1960). Barton and others (1961).

⁸Brooks and Sternhell (1957, 1958). Brooks and others (1958a, 1958b). Durie and Sternhell (1958a, 1958b, 1959a, 1959b). Sternhell (1958). Lynch and others (1960). Brooks and others (1960). Durie and others (1960, 1966). Jones and Sternhell (1962). Sternhell (1964a).

⁹Sternhell (1964a).

¹⁰Bland and Sternhell (1962, 1965). Bland and others (1968).

¹¹Conrow and others (1963). Rottendorf and Sternhell (1963). Milne and others (1965).



Fig. 3. Sev Sternhell at the controls of a Varian HA100 NMR spectrometer in the School of Chemistry at the University of Sydney. Photo taken c. 1975.

background, could design and synthesise the molecules he needed to obtain meaningful correlations between NMR parameters and structure in a systematic manner. In addition, he scoured the literature for data and for molecules with significant structures to obtain samples for detailed study by NMR.

Sternhell extensively studied allylic coupling (coupling across three single and one double bond), $\text{H}-\text{C}=\text{C}=\text{H}$, and he defined the correlations between stereochemistry and the magnitude of the allylic coupling constants summarised in his much-cited review¹² with Michael Barfield and Robert Spear. Barfield, a professor at the University of Arizona, also became Sev's 'theoretical collaborator' over a long period of time, adding a theoretical rationalisation to the structural correlations that Sev had observed experimentally. Sev and his students synthesised or collected hundreds of compounds to map out the structural dependence of long-range proton-proton coupling constants in small organic molecules (Fig. 4).

Sev had a familiar instruction to his students—do this 'it's a cheap experiment', which translated roughly to 'stop procrastinating and worrying about why this might not work and just get on and try it'.

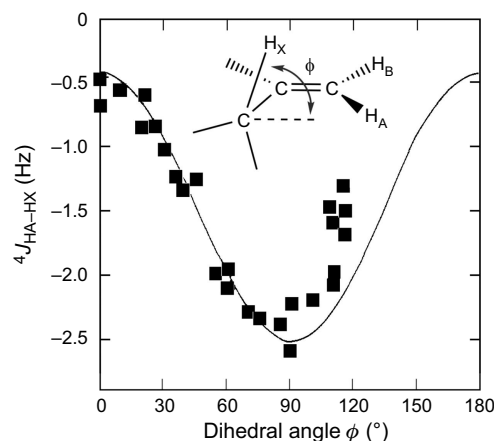


Fig. 4. The variation of allylic coupling constants with stereochemistry. $J_{\text{AX(cisoid)}}$, black squares experimental data, solid line calculated values (adapted from reference 12).

He collected an incredible amount of NMR data on individual compounds onto filing cards, which were indexed by punching holes around the card's edges according to its key data. By inserting a steel rod through the holes in the deck of cards he could extract out all the compounds with some relevant property—a crude but effective data base that could be mechanically filtered.

Sev published extensively on allylic coupling,¹³ and he was the first to note the homoallylic coupling across five bonds in the fragment $\text{H}-\text{C}=\text{C}=\text{C}-\text{H}$ ¹⁴ and to systematically investigate this area.¹⁵ He also studied the coupling across two bonds (geminal coupling)¹⁶ and the experimental and theoretical studies on the influence of substituents on chemical shifts.¹⁷

Sev developed a major interest in benzylic coupling (the coupling between protons on an alkyl sidechain and the protons on an aromatic ring). He also investigated benzylic coupling from a variety of perspectives,¹⁸ in particular, the coupling involving a methyl group and the adjacent *ortho* proton in the aromatic ring,¹⁹ where there was a strong correlation to the bond order of the carbon-carbon bond in the aromatic system.

Sev also studied dynamic systems (molecules undergoing inter- and intra-molecular exchange processes²⁰), and he

¹²Barfield and others (1976).

¹³Collins and others (1963a, 1963b). Brookes and others (1965). Shoppee and others (1965). Collin and Sternhell (1966). Nilsson and Sternhell (1965). Norris and Sternhell (1966a). Newsoroff and Sternhell (1968a). Newsoroff and others (1972). Newsoroff and Sternhell (1972). Spear and Sternhell (1973). Barfield and others (1975a). Collins and others (1987).

¹⁴Pinhey and Sternhell (1963). Sternhell (1964b).

¹⁵Bauer and others (1971). Barfield and others (1971, 1989). Barfield and Sternhell (1972).

¹⁶Macdonald and others (1964, 1966). Lacey and others (1970). Spear and Sternhell (1985).

¹⁷Caddy and others (1968). Matter and others (1969a, 1969b). Beeby and Sternhell (1970). Beeby and others (1973a, 1973b). Fay and others (1973). Sternhell and Westerman (1974). Bubbs and Sternhell (1976).

¹⁸Collins and others (1963b). Rottendorf and Sternhell (1964). Newsoroff and Sternhell (1964). Rottendorf and others (1965). Newsoroff and Sternhell (1966). Newsoroff and Sternhell (1968b). Huitric and others (1975). Barfield and others (1975b). Barfield and others (1983).

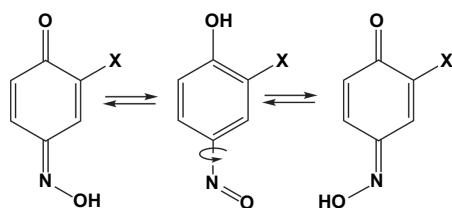
¹⁹Collins and others (1987, 1990a, 1990b, 1992). Barfield and others (1983, 1989a, 1990). Gready and others (1990a, 1990b, 1992). Hambley and others (1990). Sternhell and Tansey (1990). Cosmo and others (1990). Sternhell and others (1990). Craw and others (1992). Hatton and Sternhell (1993). Sternhell (1993a).

²⁰Newsoroff and Sternhell (1967). Gerteisen and others (1971). Gall and others (1972). Bott and Sternhell (1980). Crossley and others (1986, 1987a). Cosmo and Sternhell (1987b). Cosmo and Sternhell (1987a). Crossley and others (1987b). Cheung and others (1995a).

contributed a chapter dealing with rotation about single bonds to a monograph on dynamic NMR spectroscopy.²¹

Mechanistic and physical-organic chemistry

A major early theme, much of it in collaboration with Robert Norris, concerned the structure, chemistry and NMR spectroscopy of derivatives of 1,4-benzoquinones. This work solved the classical problem of the tautomeric equilibrium between benzoquinonemonoximes and *p*-nitrosophenols and uncovered a novel substituent dependence of the syn/anti isomerism in oximes.²²



Sev initiated a significant project dealing with non-bonding interactions, that is, steric hindrance,²³ and much of this work was carried out in collaboration with Les Field.²⁴ One of the publications in this area²⁵ has become Sternhell's most cited work, as it established a practical method for estimating the 'effective size' or 'bulk' of common structural fragments and calculating the 'energy penalty' associated with repulsive steric interactions. One table in this publication contains a 'ranked list' of common organic groups with their 'effective sizes', and this table has become a seminal reference for anyone needing to ascribe steric size to an organic fragment.

Just before retiring from active research, Sev developed an interest in mechanochemistry, a neglected field even though mechanical force had been postulated as early as 1916 as a potential source of energy to break bonds in organic compounds. In collaboration with Les Field and a

single research student, Howard Wilton,²⁶ Sev embarked on a systematic study of the mechanochemistry (ball-milling) of aromatic compounds which was a promising new field of research.

Monographs, textbooks, major reviews

Sev is probably best known for his research into the use of NMR as a tool to unravel the structures of organic compounds. His seminal monograph (with Lloyd Jackman), *Applications of Nuclear Magnetic Resonance Spectroscopy in Organic Chemistry*, was published in 1969.²⁷ This book was one of the first well-organised compilations of NMR parameters (chemical shifts and coupling constants) in different classes of organic compounds, and became a 'bible' of reference material for generations of organic chemists.

His undergraduate textbook (with Les Field and John Kalman), *Organic Structures from Spectra* (first published in 1986), went into five editions with Sev as a coauthor,²⁸ and this book has now been extended into a sixth edition.²⁹

Sternhell's own research interests are more closely associated with a 1964 review,¹⁴ focussed on 'long-range' (coupling across four or more bonds). In 1988, he published a general review of the correlations between inter-proton spin-spin coupling and structure.³⁰ Both reviews have been extensively referenced and have become 'citation classics'.

Collaborative studies

Sev's rapid development of the then rare NMR expertise in the early 1960s, combined with his access to one of the first NMR instruments in Australia, led to a number of collaborative projects. These included studies of the NMR spectra of porphyrin derivatives³¹ mainly carried out in collaboration with Maxwell Crossley and his group.

A brief foray into the mechanism of the Wessely acetoxylation,³² combined with the realisation³³ that lead tetrakis(trifluoroacetate) (LTTFA) was a more powerful oxidising agent

²¹Sternhell (1975).

²²Norris and Sternhell 1965, 1966a, 1966b, 1967, 1968, 1969, 1971, 1972a, 1972b, 1973).

²³Newsoroff and Sternhell (1967). Cosmo and Sternhell (1987a, 1987b, 1987c, 1987d). Hambley and others (1985). Cosmo and others (1987a, 1987b). Park and others (1998).

²⁴Bott and others (1980). Field and others (1977). Field and Sternhell (1981). Field and others (1985). Cheung and others (1995a, 1995b, 1997a, 1997b).

²⁵Bott and others (1980).

²⁶Field and others (1997, 1998).

²⁷Jackman and Sternhell (1969).

²⁸Sternhell and Kalman (1986). Field and others (1995, 2002, 2008, 2013).

²⁹Field, Li and Magill (2020).

¹⁴Pinhey and Sternhell (1963). Sternhell (1964b).

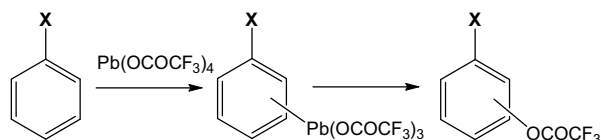
³⁰Sternhell (1969).

³¹Crossley and others (1986, 1987a, 1987b, 1988, 1992a, 1992b). Clezy and others (1978). Chakraborty and others (1982).

³²Bubb and Sternhell (1970).

³³Campbell and others (1972).

than lead tetraacetate (LTA), resulted in a long collaborative project with John Pinhey,³⁴ who was responsible for the successful development of synthetic methods based on aromatic lead(IV) derivatives. LTTFA proved to be a convenient reagent for direct introduction of an oxygen functionality into an aromatic ring.



Professional activities, distinctions and appointments

Sev was a visiting Professor at the University of Tennessee in 1969, the Eidgenössische Technische Hochschule Zurich (ETH) in 1972, the University of Arizona in 1974, and at Oxford University in 1979. He was awarded a DSc from the University of London in 1966.

As well as acting twice as the Head of School of Chemistry at the University of Sydney, Sev acted in an advisory capacity at the University of Melbourne and the Australian National University. He was a member (later, chair) of the University of Sydney PhD Award Committee for eight years, when he became the foundation chair of the Postgraduate Committee (in practice, the first Dean of Postgraduate Studies) in 1984.

Between 1988 and 1992, Sev served on three panels of the Australian Research Council, and chaired the Chemistry sub-panel and the Interdisciplinary Panel. He served on the Editorial Boards of *Nuclear Magnetic Resonance Abstracts* between 1964 and 1973, *Magnetic Resonance in Chemistry* (for several years also as the regional editor), *Magnetic Resonance Analysis* and *Methods in Stereochemical Analysis* (Verlag Chemie), as well acting as a consultant for the RIKER International Pharmaceutical Company, and as an expert witness for several court cases.

In 2001, Sev was awarded the Centenary Medal for his service to Australian Society and Science in Organic Chemistry. He was elected as Fellow of the Australian Academy of Science in 1992, and he served on the National Committee for Chemistry (1993–6) and its sub-committee for Chemical Education (1993–4). He also served

on Sectional Committee for Applied Physical Sciences, as member (1992–4) and as Chair (1994–6). He was awarded the Order of Australia (AO) in 2019 for services to Chemistry and to Higher Education.

Sev was unbelievably proud of his election to the Academy of Science and the award of an AO—the highest recognition of his success in Australia and in Australian science.

Contributions to public debate

Sev had a long connection with the *Quadrant* magazine, in which he published many articles on non-chemical topics. Most numerous of these dealt with the Australian educational and university matters,³⁵ the teaching and funding of science in Australia,³⁶ and environmental concerns.³⁷ One article, entitled, 'The Class that Cried Wolf',³⁸ received the prestigious George Watson Prize (for best political essay published in any journal in Australia) and wide circulation. Two further essays dealt with fundamental problems in science.³⁹

Sev was an avid letter-writer. He wrote letters to the press, to Chancellors and Vice Chancellors, to Deans, to ministers, and even to Prime Ministers. He was always passionate and persuasive. Eventually some of his letters would get traction, and he would gain the next level of engagement to push his cause. Once he had his foot in the door, Sev was one of those individuals who would never take a step backwards; he was focused, unyielding, tenacious, and he was a wily political animal. In several letters to editor in *The Australian*, *The Sydney Morning Herald* and to the *Canberra Times*, he expressed strong and cogent criticisms of the policies of successive governments towards Australian universities, and he was an outspoken critic of John Dawkins, who was Minister for Employment, Education and Training in the Hawke Labor government in the late 1980s and early 1990s.

Passions, interests and obsessions

Sev Sternhell had a variety of interests besides science, his Department (to which he was fiercely loyal), and to his family: his wife Alice, (also a Holocaust survivor, b. Zalcberg) (Fig. 5) whom he married in 1953, and his sons Peter, James and Roger, who were all graduates of Sydney University in Pharmacy, Medicine, Dentistry and Agricultural Economics, respectively. In time, his family grew by the addition of eight grandchildren. Sev never tired of pointing

³⁴Kalman and others (1972). Bell and others (1974a, 1974b, 1974c, 1976, 1979a, 1979b, 1979c, 1982). Greenland and others (1975). Greenland and others (1986a, 1986b, 1987). Kalman and others (1999).

³⁵Sternhell (1990a, 1993b, 1998, 2002, 2006a).

³⁶Sternhell (2000, 2001, 2006b, 1991).

³⁷Sternhell (1990b, 1992, 2008c).

³⁸Sternhell (1990b).

³⁹Sternhell (1992, 1994).



Fig. 5. Sev and Alice Sternhell. Photograph by James Sternhell c. 2004.

out that for him to have survived, gone on to success and to have a strong family must have caused Hitler to turn in his grave - 'if he only had a grave'.

Travel was an abiding passion of the Sternhell family. Particularly notable were epic car trips in the USA and Europe that always retained a 'cultural pull' on Alice and Sever.

Sev was never a sportsman in a conventional sense, but he led an unusually physically-active life. He was an enthusiastic surfer, squash player, bushwalker, and canyoner. With his passion for the great outdoors, he walked, climbed, and abseiled through most of the canyons, valleys and peaks in the greater Blue Mountains.

Sev took part in innumerable walking trips in NSW, Victoria, Tasmania, New Zealand, the European Alps, the Dolomites and in other locations in Western Europe. He was also an active member of The Sydney Bush Walkers for over thirty years. Not satisfied with the 'ordinary' adventure, challenge and hardship this provided, he became associated with a group of cavers and canyoners led by his academic colleague, Julia James.

Sev's true obsession was with the Himalayan high peaks and mountain passes in Nepal. In his fifties and sixties, he took up trekking in the Himalayas, and eventually completed fourteen treks, each seventeen to forty days long, all but two of them in Nepal, and ten of them self-organised (Fig. 6). Sev nearly died at least twice in the harsh blizzard conditions on the high passes in Nepal, and he credited his survival to his Sherpa guide, Bir Bahadur Sarki Tamang, with whom he struck a lifelong friendship. The accounts of two of these trips, both forty days long, were published in *The Sydney Bushwalker* magazine.⁴⁰

Following a decline in his health and a battle with dementia in his final months, Sev passed away on Friday 18 November 2022 at age 92. He was a very down-to-earth, pragmatic man of keen intelligence, persistence and dogged



Fig. 6. Sev trekking in the Himalayas. Photograph by James Sternhell c. 1990s.

determination. He always identified himself among the 'sincere chemists'—he kept a mental list of those he considered 'sincere chemists'—those with a deep understanding of the discipline who literally lived and breathed chemistry. Sev left an incredible legacy—the students and researchers who can be identified as part of the 'Sternhell academic family tree' occupy positions in academia, in government, and in industry throughout Australia and all over the world.

Sev is survived by his sons, James and Roger, and his eight grandchildren Elizabeth, Robert, Leanne, Samson, Lucy, Molly, Leo and Eddie. His son Peter sadly, predeceased him in 2015, and his wife Alice passed away in 2024.

Supplementary material

Sev was interviewed by Sophie Caplan in 1980 on his experiences as a Jew during the Second World War in Poland, his time in Bergen-Belsen, and his migration to Australia. The interview is available on the United States Holocaust Memorial Website: (<https://collections.ushmm.org/search/catalog/irn50943>). Supplementary material is available online including copies of Sev's Honours thesis (University of Sydney 1951); Masters thesis (University of Sydney 1953); and PhD thesis (Imperial College 1960); a full CV; a full list of Scientific publications; and a copy of 'Our Mob—a family chronicle' (S. Sternhell and A. Sternhell, 2005).

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⁴⁰Lippiatt and Sternhell (1989). Sternhell and Finch (1995).

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Conflicts of interest. The author notes that Sev was a mentor and PhD supervisor, as well as the Head of the Department at Sydney University, where the author held academic positions. He was a long-time collaborator and co-author of multiple publications over many years.

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