

George William Kenneth ‘Ken’ Cavill 1922–2017

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Ken Cavill knew from his high school years that his career lay in science. Whilst completing his Bachelor of Science at the University of Sydney he chose to focus on organic chemistry and made his academic career in that field. Ken gained his PhD at Liverpool University in England in 1949 and was awarded a DSc from that university in 1957. He was employed during World War 2 at W. Hermon Slade & Co., and then as a lecturer in chemistry at Sydney Technical College, becoming a senior lecturer at the newly formed University of New South Wales (UNSW), where he had a distinguished career in research and teaching until his retirement in 1982. He received the first personal chair awarded by the university in 1964 and was made a Fellow of the Australian Academy of Science in 1969. He was made an emeritus professor by UNSW in 1983. He actively pursued collaboration between chemistry and biology, and pioneered studies in Australia on the chemistry of insect venoms, attractants and repellents, leaving a legacy of a well-respected body of work in this field. Ken was awarded a Centenary of Federation Medal in 2001 for his service to Australian society and science in the field of organic biological chemistry. Pursuing his love of Australiana, he devoted his retirement to researching and writing about Australian silverware and jewellery manufacturers of the nineteenth and early twentieth centuries.

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Preamble

After his retirement in July 1982, Ken Cavill completed a series of interviews in 1986 for the University Oral History Project of the UNSW Archives¹ and again in 1996 for UNSW 50th Anniversary History.² These interviews provide a framework for this memoir, together with information found in Ken’s personal archives, family documents and his personal photo collection. To Ken’s own voice are added the recollections of colleagues and friends.

Family Background, Early Childhood and Education

Ken Cavill was born on 23 April 1922 in the inner Sydney suburb of Dulwich Hill. His father registered his birth under the name George William Cavill, ‘George’ after the King of the time, George V, and ‘William’ after himself. When Ken was baptized at St Andrew’s Church of England in Summer Hill in October 1922, he was baptized as George William Kenneth Cavill. The last name in the list was added by his mother Alice. It was her preferred name for her son, and ‘Ken’ was the name that he was known by throughout his entire life. He was born eleven years after his parents married. An only child, he remained close to both his parents until their deaths in the 1960s.

Ken’s heritage was English and Scottish. William Henry Cavill, Ken’s father, was a salesman at Peapes & Co., a very well-known gentlemen’s outfitters in George Street, Sydney, when he married Alice Naylor, a tailoress, residing in Newtown, Sydney, on 17 June 1911. Ken’s father was born in 1886, the son of Francis Walter Cavill, also a salesman, whose father had migrated from England in the 1850s, and Elizabeth Jane Morgan (the second wife of Francis, whose first wife, Hannah R. Forbe had died). They married in 1883. Alice Naylor, Ken’s mother, was the daughter of Thomas Naylor, a bricklayer born in Liverpool, England, and Jane McIntyre, born in Glasgow, Scotland.

Ken had a traditional Anglican upbringing. He was confirmed at St John’s Anglican Church at Ashfield on 26 September 1937,



and took his first communion in October 1937. His mother gave him his own bible in August 1936, writing to him that it would be a ‘guide and help through life’. He attended Thornbury Primary School in Ashfield, which was associated with the Anglican Church, although it was not a ‘church school’, and moved to Haberfield Demonstration School for the last two years of primary school. In his final examinations he achieved second place in his class but was warned by his teacher, Mr Wiltshire, that he would have to work very hard to get a bursary and High School Pass to a selective school.

Neither of Ken's parents had gone beyond what was known as superior public school; however, in some notes about his life, Ken commented that he had grown up in an atmosphere that encouraged learning. His parents were both well read, his mother played the piano whilst his father was a fine speaker who also enjoyed the company of people. During the Depression, protecting shoes from wear and tear was very important. By 1930, William Cavill had invented a metal shoe protector for the toes and heels of shoes and applied for a trademark using the brand name 'Durabel'.³ He left Peapes & Co. to start his own business, Durabel Metal Products, based in Enmore, Sydney. During World War 2 he kept the business going by returning to work at Peapes & Co., leaving a trusted staff member to run the factory as most of his staff had enlisted. Ken worked in his father's factory during school holidays, operating a dye-stamping machine and working in sales. His father expected him to take over the family business, but Ken had already decided during his high school years that this was not his favoured career option.

Secondary School Years—a Vocation and Lifelong Interests Form

Ken was offered a place at Fort Street High School, a selective secondary school for boys at Petersham, not far from his home in Ashfield. He attended Fort Street from 1934 to 1938, obtaining his intermediate certificate in 1936 and his leaving certificate in 1938. His results indicated his growing interest in science and mathematics. In the intermediate certificate he gained A grades in mathematics I and II and elementary science (physics and chemistry). In his leaving certificate, he gained an A in modern history and honours class II in chemistry and mathematics. Ken knew that he had already formed a strong interest in chemistry and in retrospect he tried to explain what it was about chemistry that attracted him: 'I don't think there was any philosophy to chemistry, ... I was interested in the materials involved; I was presumably interested in the way in which chemistry, as chemistry, was presented both as a practical and theoretical subject'.⁴ In a vocational guidance report prepared by the Department of Labour and Industry when Ken was 16 years 5 months old, dated 29 September 1938, his suggested occupations were listed in the following order: '1. Teaching, 2. Industrial or Analytical Chemistry, 3. Medicine, 4. Draftsmanship'. This report proved to be a perceptive prediction of Ken's career path and interests.

Growing up through the Depression years also left its mark on Ken and was particularly reflected in his strong work ethic and in his approach to material possessions. Although he was well fed and clothed during the Depression, he remembers looking after his clothes and taking care with them, never wasting money, and above all not expecting to get something just because he desired it. He saw himself as part of a generation that shared these values and behaviours. In the reference provided to Ken when he left Fort Street, his headmaster described him as an intelligent lad, of splendid character who would give loyal and efficient service in any position he may be asked to fill.

As well as living through the Depression, one of the major influences on Ken's life was his membership of the St John's Young Men's Club at Ashfield throughout his teenage and early adult years. The goal of the club was to 'band together young men for spiritual,



Figure 1. Ken on a road trip to Tasmania with St John's Ashfield friends, Graham Cocks (left) and Ron Mohr (right), Christmas 1951.

intellectual, physical and social development'. Ken formed friendships there that endured throughout his life and he attended annual reunions for decades after. Under the 'hands off' guidance of the Reverend Leonard N. Sutton, Ken organized and participated in debates, games nights, and social evenings with the Young Women's Club. The distinguished chemist Ron Nyholm was a member of this club, as was Graham Cocks with whom Ken shared his passion for collecting Australian silver and ceramics after his retirement from UNSW. Ken was part of a group of Young Men's Club members that, as they acquired cars, pursued the pleasures of the road trip. Ken's first car was a 1930 DeSoto roadster, followed by a 1948 Austin A70. Many trips were organized for Christmas, Easter and long weekends to destinations such as the Blue Mountains, Rose Valley and the Shoalhaven on the South Coast of Sydney, the Jenolan Caves, the Snowy Mountains and Tasmania (Fig. 1). The pleasures of those trips involved camping by rivers and in paddocks, pushing their cars on rough country roads, up mountains and across river fords, boiling the billy and enjoying a freedom away from family.

Having decided on a career in science, Ken persuaded his father that rather than joining the family manufacturing business, a university education was the best choice for him. His father agreed,

provided he could support himself. His only option was to attempt to win a very competitive Public Exhibition Scholarship to the University of Sydney, which he did, and held from 1939 to 1942. In 1942 he also won a Timbrol Scholarship (Timbrol Ltd were Chemical Manufacturers and Merchants) that was offered to students proceeding to the fourth year (honours) course in organic chemistry at the University of Sydney.⁵

By the time Ken reached university, the key passions and interests that would punctuate his life had largely been decided upon. Science would be the core of his life, playing tennis was one of his greatest pleasures, and his love of driving and the outdoors were developing as key elements.

The War Years

Sydney University

Ken attended the University of Sydney from 1939 to 1942, graduating in May 1943 with a Bachelor of Science (Hons. 1) in organic chemistry. In his first two years Ken became very interested in geology as well as chemistry; however, his passion for organic chemistry grew under the influence of his lecturers, Frank Lyons and Victor Trikojus, and he made the decision to take only chemistry subjects in his third year, chemistry III and organic chemistry, pure and applied. The Second World War engulfing the Western world was also an important influence on this choice to pursue organic chemistry as Ken felt that it would be a more useful way to contribute to the Australian war effort than geology. His fourth year's honours project, 'Atebrin and the Side-chain of Atebrin', researched ways of producing the drugs needed to protect Australian soldiers fighting in the tropics where Atebrin was the key anti-malarial drug in use at the time.

Ken was year 4 representative to the Sydney University Science Association through the Student Chemical Society, and gave a lecture to the society entitled 'Chemical Industry in War'. A summary was later published in the Science Association newsletter.⁶ Ken discussed the production of explosives and poisons by German chemists during World War 1, and the work of American and English chemical companies in the current war effort, mentioning particularly that the manufacture of drugs was inadequate. He mentions the work of the CSIR as gradually being recognized and the role of chemical industries in a post-war world as being important in using the world's resources for the benefit and good of mankind.

During the war, science, engineering and medical courses were classified as 'reserved occupations' and enlistment in combat forces was prohibited. Ken was under the command of the Australian Manpower Organisation through the National Security Act.

W. Hermon Slade & Co. Pty Ltd

In December 1942, before graduation, Ken was assigned to work with W. Hermon Slade & Co. as a senior research chemist. During the war the chemical manufacturing company founded by W. Hermon Slade in 1900, was developing paint products for use on Australian military equipment as well as investigating synthetic fuels for military use. Ken gained valuable research experience whilst working for this company and was involved in several key projects, including laboratory investigation through to production of certain oil-soluble phenol modified resins and investigating the commercial production of styrene starting from alcohol and benzene. He conducted research

on the synthesis of various polyethyl benzenes using Friedel-Craft catalysts. He also carried out preliminary research on the production of *p*-hydroxybenzoic acid, and some esters derived from this acid were subjected to a qualitative study of their fungistatic properties.⁷

The Pursuit of Academia

During his university years Ken had discovered that he enjoyed teaching, having tutored students in the years below him to cover some of his living expenses. He had also worked as a demonstrator in his honours year. A position for a teacher in chemistry at the Sydney Technical College was advertised in 1943. Ken also knew that he wanted to do a higher degree, as research was definitely his goal. W. Hermon Slade & Co. reluctantly released him in March 1944, and would have opposed his release under the National Security Act, 'were it not for the fact that we know his heart lies in the field of academic chemistry including the teaching of science'.⁸ Ken joined Technical Education at Sydney Technical College in the Department of Chemistry and Chemical Engineering under Dr R. K. Murphy. He was twenty-two years old when he was appointed as a teacher in April 1944. His appointment as a lecturer in chemistry was approved in February 1947 and approved as a permanent position in May 1948 (whilst Ken was doing his PhD at the University of Liverpool).

Ken arrived at the Department of Chemistry, also known as 'Murphy's Palace', at an interesting period.⁹ Murphy was such a great supporter of research that he unofficially encouraged staff to undertake research projects. He had assembled a formidable group: V. S. Rawson was head of analytical chemistry, Frank Dwyer (often a collaborator of Ken's) was head of inorganic chemistry and Ronald Nyholm, a close friend of Ken's from St Johns, was head of physical chemistry. Dr F. H. Reuter was in charge of organic and biological chemistry. This experienced group was responsible for the high quality of the courses offered at the college. By 1945/46 such was the reputation of the college that a diploma in chemistry and chemical engineering gave the holder admission to the Royal Institute of Chemistry in England without examination. As a teacher, Ken also regarded his students as exceptional. They had come through the Depression and the Second World War and were very motivated. Ken taught twenty-eight hours a week, mostly at night. That certainly curbed his social life so that took place mainly at weekends: tennis on Saturdays, and social events on Saturday evenings and Sunday. However, there were also benefits, as Ken had plenty of time to gain a higher degree. In 1944, he began to study for a MSc at the University of Sydney under Professor John Campbell Earl.

Post War: Higher Degrees and Early Research

The University of Sydney

Ken took his thesis subject from research he had commenced at W. Hermon Slade, and continued at Sydney Technical College, on a series of compounds, *p*-hydroxybenzoates, originally used as preservatives in cosmetics. Parts of his MSc research were carried out in collaboration with J. M. 'Jim' Vincent, a lecturer in microbiology at the University of Sydney, and A. J. Friend. Ken synthesized various esters of *p*-hydroxybenzoic acid and their ring-substituted derivatives and an initial article was published in July 1945.¹⁰ In collaboration with Jim Vincent he investigated the relationships between chemical constitution, physical properties and fungistatic

activity for *p*-hydroxybenzoic acid and derivatives. Friend provided the physical measurements, whilst in section C of his thesis, Ken worked with Ronald Nyholm (who had already completed his MSc) on a 'Theory of Nuclear Aromatic Halogenation', arising from experimental work on the bromine substitution products of *p*-hydroxybenzoic acid. Ken also submitted some introductory work on the esters of *p*-aminobenzoic acid, a collaboration with Jim Vincent.¹¹ Ken's collaboration with Jim Vincent was fruitful. Between 1945 and 1949 they published a series of papers that explored structure-activity relationships relative to fungistatic activity.¹²

The University of Liverpool

Having been awarded his MSc in May 1946, Ken set his sights on gaining a doctorate, regarded as an essential step to a career in a tertiary institution in Australia. At that time the only viable option was to study overseas, usually in England.¹³ From 1944, Imperial Chemical Industries (ICI) in Britain had been offering doctoral and post-doctoral fellowships for overseas students.¹⁴ Between 1944 and 1950 Liverpool University received eight fellowships and one of those was awarded to Ken. He was one of a unique cohort that represented not only the high quality of chemistry education in Australia, but in particular the strength of the Sydney Technical College Chemistry Department. Several graduates from this department travelled overseas to complete doctorates at the University of Liverpool under the distinguished Professor of Organic Chemistry, Alexander Robertson (1896–1970) and at other institutions.¹⁵ Ken was awarded leave for three years, from September 1947 to September 1950, on a stipend of £600 a year plus £100 travelling expenses. He travelled to England on a New Zealand refrigerated meat ship called *Rakaia* in the company of Ronald Nyholm, also on an ICI Fellowship and bound for University College London. They arrived in post-war England where the wounds of the war still affected many aspects of daily life. Ken had been forewarned about the essential supplies to bring: tinned meats and fruits, sugar, sweets and plenty of soap; also, woollen clothes and socks and hiking gear if possible. Ken settled in, obtaining his English driving licence, coupon books for clothes and food. He joined the 'Vagabonds' Lawn Tennis Club and played cup competitions and tournaments. The expatriate Australian chemists were headed by Ron Nyholm and his wife Maureen. They hosted parties in London and organized walking trips through the Lakes District. In August 1949 Ken went on a tour through France, Switzerland and Austria. In July 1950 he joined the Nyholms, Ron Eade, Betty and Barry Hook (all chemists) on a visit to Paris. He wrote a postcard to his parents whilst sitting in a cafe, exclaiming, 'the scene one has viewed so often on the films has come to life!'

Alexander Robertson headed one of the largest schools of organic chemistry in England. He was a formidable academic who had worked with Sir Robert Robinson at Manchester University in the period 1924–8, a golden period in organic chemistry. He went to Liverpool in 1933 to take up the Heath Harrison Chair in Organic Chemistry that he occupied with great distinction until he retired from academic life in 1957.¹⁶ Robertson was interested in structural organic chemistry and the determination of chemical structures by degradation. Ken worked on a fungal metabolite called citromycetin, a yellow pigment isolated from the metabolic liquors

of various species of *Penicillium* by Hetherington and Raistrick and named by them in 1931. It was a compound of fifteen carbons in a complex heterocyclic aromatic structure. He discovered a new method of degradation for this molecule, using the oxidative agents, lead tetra-acetate and ozone. These studies revealed that the structure of an important degradation product of citromycetin, O-dimethylcitromycinol, thus allowing a determination of the final, revised structure of this metabolite. Ken submitted his doctoral thesis, simply entitled *Citromycetin*, in October 1949. He spent his final year continuing his research, in collaboration with other students. Two papers related to the work of his thesis were published in the *Journal of the Chemical Society*.¹⁷

While Ken was completing his PhD, the Sydney Technical College was in the process of becoming the New South Wales University of Technology (NSWUT).¹⁸ F. H. Reuter, senior lecturer in organic chemistry, maintained a regular correspondence with both Ken and Ron Nyholm. They played a part in the recruitment of key senior staff and provided advice about equipment and information about course requirements in English universities.¹⁹ Ken was also in contact with Professor J. P. Baxter and Professor A. E. Alexander. In June 1949, Ken accepted an invitation from Baxter to visit him and his family at the ICI Widnes facility where he was director of the General Chemicals Division of the company. Baxter was preparing to move his family to Australia to take up the position of professor of chemical engineering and head of the department in the newly created NSWUT.²⁰ Reuter kept them up to date about the progress of the transition, problems, issues and internal workings. As the time drew closer for Ken to return to Australia, he wrote to Reuter in a letter dated 12 December 1949,²¹ about his ideas for future research: in addition to continuing his work with Jim Vincent on fungistatic activity (a further three papers had been published during his time in Liverpool),²² Ken's use of lead tetra-acetate as a degradative agent whilst researching citromycetin had opened up 'a very interesting field in its further application to active methylene groups'. Ken was also interested in commencing work on some Australian natural products from plant and mould sources, and he asked Reuter whether the CSIRO collected and/or isolated such materials and made them available to people outside their organization. In a further letter from Reuter to Ken dated 20 March 1950, almost one year to the day since the establishment of the NSWUT, Reuter describes the progress of the new department under the leadership of Baxter and Alexander. Ken arrived back in Sydney at a time of tremendous change.

The 1950s: a Productive Decade

In 1951, although the Sydney Technical College was now NSWUT, and would become the University of NSW (UNSW) in 1954, organic chemistry remained at Ultimo and would not shift to the Kensington campus until 1962. Ken took up his appointment as a senior lecturer in organic chemistry, with A. E. Alexander as head of department. Despite remaining in 'Murphy's Palace' at Ultimo, some conditions had improved with more funding for equipment and staff. Chemical supplies were back to normal although most of the organic chemistry students were cramped into one laboratory. The department was transitioning to full undergraduate degrees. In 1959, Ken was appointed associate professor upon the recommendation of Vice-Chancellor Baxter. He had been awarded his Doctor of Science degree from the

University of Liverpool in 1957. His one disappointment in 1959 was that he was not successful in his application for the chair of organic chemistry, despite references from Sir Robert Robinson in London and R. B. Woodward at Harvard University, where he had spent his sabbatical leave in 1958. In 1960, the Chair went to Stephen Angyal, and Ken wondered at that stage what the future held for him.

Ken was able to continue his research in those areas he had written about to Reuter. With John Tetaz, his first PhD student, Ken investigated the chemistry of complex fungal metabolites, focusing on a bright red fungus found on rotting wood around Sydney that contained the phenoxazine pigment polystictin (cinnabarin). To collect the fungus Ken made weekend trips up and down the coast with John Tetaz and his wife Thelma, and fellow student David Solomon and his wife Valerie. The fungus was dried out at the Ultimo building and then ground in a grinding machine set up in a lavatory on the fifth floor. Despite the unusual location of the grinding machine, John Tetaz completed a successful thesis, determining the basic structure of cinnabarin. It was related to a group of pigments being looked at in Germany at the time, the actinomycins, with the same basic complex structure, a phenoxazone nucleus. Several papers were published in this area over the period 1953 to 1961, with collaborations between Ken, John Tetaz and several other researchers including Frank Whitfield.²³

Ken also continued to investigate the oxidation of a considerable number and types of organic compounds with the reagent he had used in his PhD thesis, lead tetra-acetate. In what he described as 'mechanistic organic chemistry', he investigated the nature of the product, the specificity of the reagent, and how to establish reaction mechanisms for the agent. In this work he was joined by his first honours student, David Solomon,²⁴ who continued on to do a MSc with Ken. They published a series of papers on the mechanisms of reaction of lead tetra-acetate that Ken regarded as 'leading' work.²⁵ Ken also supervised Solomon's PhD that David completed whilst working full-time at the Dulux Paints research laboratories pursuing a career in polymer chemistry. Dulux gave him a day off a week to work on his PhD at the university. Ken and David had opposing research styles, Ken was more 'thorough', David was more 'imaginative'. Ken was constantly urging his student to 'prove his theories'. David Solomon gained his PhD in 1959 for his thesis, 'The Chemistry of Carbonyl Compounds', and went on to a stellar career at the CSIRO working on the chemistry of organic synthetic polymers.

The Chemistry of Ants: Origins of the Research

In 1953, Ken and Doug Ford who was also doing his MSc part-time with Ken, published a short one page note in *Chemistry and Industry*, 'beautifully entitled (I thought), as if we had discovered everything: "The Chemistry of Ants"'.²⁶ Ken held Doug Ford in high regard. He was Ken's age, had lived through the Depression, had been an outstanding diploma student at the Sydney Technical College, and was a senior chemist with Taubman's Paints in Sydney. His thesis investigated plant growth regulators, focusing on compounds related to the dichlorophenoxyacetic acids. By structural modification Ken and he produced two series of compounds that were tested for their plant growth activity. Doug Ford was approached by colleagues working on the Argentine ant eradication campaign for assistance about insecticides that could be safely

sprayed to block these infestations. Although just an annoying intrusion for the residents of Sydney, they were a serious problem in agriculture where the Argentine ant (*Iridomyrmex humilis*, now named *Linepithema humile*) would defend the scale insect that attacked citrus and other fruits by raising its abdomen and spraying its foes. Ken and Doug were discussing this, and Ken asked 'why' the ant was able to do this, suggesting they get some ants and investigate further. The eradication campaign was proving successful and Argentine ants were in short supply, so they obtained a supply of a very common native ant, known as the 'meat ant', *Iridomyrmex detectus* or *Iridomyrmex purpureus*. When crushed, the ant produced what Ken described as a 'fragrance', and this was the first chemical they discovered, the subject of the note published in *Chemistry and Industry*.

As Ken noted, this observation led to bigger things. The substance they had discovered was methylheptenone (6-methylhept-5-en-2-one), a terpenoid substance with eight carbon atoms instead of ten that were expected from isoprene (C₅) biosynthesis. It was the discovery of a second substance from the meat ant, a crystalline substance called iridodial, that was ground breaking. This was an insect terpenoid, and it was a new class of terpenoids, totally different in structure, form and type from anything that had previously been found. Doug Ford took up the research as his PhD subject. They then applied the same processes to Argentine ants, producing a highly crystalline compound that they named *iridolactone*, before discovering that Italian entomologist Professor M. Pavan and Professor R. Trave, an Italian chemist, had already isolated the substance. In the USA, Professor Jerry Meinwald had established the structure of nepetalactone, derived from oil of catnip. By 1956, work being done in Australia, Italy and the USA on the structures of these substances that were all inter-related, came together in a new group named cyclopentanoid monoterpenes.

Doug Ford and Ken established the structure of iridolactone.²⁷ Hertha Hinterberger joined the team as a PhD student around 1954, working on another species of ant that produced a structurally related cyclopentanoid monoterpene.²⁸ They developed a broad pattern of structural types that correlated with other studies on nepetalactone undertaken in the USA by Professor S. McElvain in Wisconsin and Professor Meinwald at Cornell. The cyclopentanoid chemistry was directly related to the Dolichoderine group of Australian ants. Ken knew that he and his team of PhD students 'had a very novel chemical area, novel chemical structures, stereochemistry', and so, in 1957, as he was due for sabbatical leave, he decided that he needed to go back to laboratory work. He made the request to Robert B. Woodward, the foremost synthetic chemist at the time, to spend a year at Harvard in one of the leading organic chemistry schools in the world.

Sabbatical Leave at Harvard, 1958, 'A Fabulous Year'

Although Ken made visits to University College in London three times as an honorary research fellow (1963, 1970, 1977), and to Cornell University in Ithaca, USA, as a visiting professor in 1977, it was his first sabbatical leave to Harvard University in 1958 that he remembered as one of the most significant years of his life. He described it in his interview in 1986: 'I had a fabulous year. I think I was lucky.'

Ken left Australia 15 December 1957, 'kangaroo hopping' by air to London via Darwin, Singapore, Bangkok, Karachi, Athens

and Rome. He spent ten days in London at the invitation of Sir Robert Robinson, Nobel Laureate, a former professor of chemistry at Oxford, and at that time a director of research at Shell Chemicals Limited. Ken went on to Cambridge, Massachusetts, where he resided at the Harvard Faculty Club. Harvard College appointed him as a research fellow in chemistry for the year, and also as a delegate to the Eighth Quinquennial Congress of the Universities of the British Commonwealth held in Montreal in September. Although he received a stipend under the Exchange Visitors Program at Harvard, Ken also received financial support from the Union Carbide International Co.²⁹

It was an intellectually exciting environment for Ken for many reasons. Woodward and his colleagues had achieved the total synthesis of quinine, strychnine, lysergic acid, patulin, reserpine, and the first total synthesis of the non-aromatic steroids including cholesterol and cortisone.³⁰ Ken worked on one of Woodward's projects in the field of triterpene synthesis:

Ultimately it is intended to synthesise a series of pentacyclic triterpenes, employing as a common intermediate the symmetrical tetracyclic compound, α -onocerin. My period of collaboration at Harvard resulted in the successful synthesis of several C₁₃ moieties which are to be linked with a C₄ carbon chain to yield the triterpene molecule. The particular problems arising in the stereospecific synthesis of these C₁₃ units are not dissimilar from those currently involved in the synthesis of the cyclopentanoid monoterpenes from ants, so that much valuable experience has resulted.³¹

For Ken, though, it was Woodward's 'extraordinary theoretical ability, and his approach to synthetic organic chemistry', that provided the most valuable learning of his sabbatical leave. He would return to Sydney 'thoroughly updated'.

There were regular dinners with visiting professors at the Harvard Faculty Club, and he attended Woodward's undergraduate lectures such as those on nuclear magnetic resonance. The seminar groups, consisting of a lecture and discussion held once a week after dinner, lasted until midnight and then continued on, with Woodward present, at one of the local coffee shops, often until three in the morning. Ken said he 'felt thoroughly activated'. Ken travelled extensively to other universities and institutions with his own lecture series: 'Chemical Extractives of Ants', 'The Cyclopentanoid Monoterpenes', 'Lead Tetra-acetate Oxidation Processes' and the 'Structure of Cinnabarin (Polystictin)'. He visited the Universities of Nebraska and California, Stanford University and the Union Carbide Chemicals Co. in South Charleston. He was well received and there was special interest in his 'Chemistry of Ants' lecture. He was invited to Wisconsin by Professor McElvain and then went on to Cornell to Professor Jerry Meinwald, both of whom he had been corresponding with over their studies in the cyclopentanoid monoterpene field. He was surprised to find that the most complete collection of Australian ants was housed in the Harvard Museum of Contemporary Anatomy, and had many discussions with Professor W. Brown, an authority on the taxonomy of Australian ants.³²

Although many of Ken's trips outside Harvard were work-related, he never missed an opportunity to include some tourism and photography. A regular companion and guide on weekend trips outside of Boston was Kevin Potts, an Australian organic chemist from Adelaide who was on Woodward's team (Fig. 2).³³ Ken recorded his travels in his pocket-sized 'Harvard Diary' and in postcards sent to his parents, Alice and William Cavill. Just as he had done in Sydney

with colleagues and friends, Ken embarked on road trips, camping and enjoying the landscapes, good food and companionship. In August 1958, in the company of Kevin Potts, Frank Finch and Brian Davis, Ken set off on a vacation, one of the highlights of his year. In a postcard sent to his mother from Portland, Oregon, dated Saturday 2 August, he writes: 'We have just picked up car—1958 Chevrolet Bel Air and are all set for the trip north to Vancouver and Rockies. Glorious weather.' Over nineteen days they drove 4,902 miles through the Banff region, experiencing the glorious scenery of the Yellowstone and Yosemite National Parks and the stunning contrasts of the Grand Canyon and Las Vegas, finishing in San Francisco. Postcard to parents: 'The vacation I will always remember!'

The Chemistry of Ants—the 'Golden Age'

Ken was appointed an associate professor in April 1959. Two further appointments, in 1964 and in 1969, were made in recognition of the significance of his research studies in organic chemistry and the chemistry of natural products, in particular that of insect chemistry. In 1964 Ken was awarded the first personal chair ever awarded by the university in recognition of his research achievements. He also became a professor. Then in 1969 he was made a Fellow of the Australian Academy of Science, and appointed to the Australian Research Grants Committee.³⁴ These appointments brought him a great deal of pleasure, and were an acknowledgement of his pioneering research with his post-doctoral, doctoral and masters students in what had become his main area of work, insect chemistry.

Ken returned from Harvard with an interest in stereospecific synthesis and he was determined to find a stereospecific route to iridodial. Together with Sjamsul Arifin 'Sul' Achmad,³⁵ his doctoral student, who had already completed a first class honours degree in organic chemistry at UNSW in 1960, they obtained a new method of approaching the stereospecific synthesis of iridodial.³⁶

Frank Whitfield,³⁷ who also completed his honours, masters and doctoral theses with Ken, undertook the synthesis of dolichodial, one of the dialdehydes that had been discovered from ants and used as a defensive secretion, and which had also been isolated from stick insects by Professor Meinwald at Cornell, called 'anisomorphal'. It was the only group of insects outside of the ant family where cyclopentanoid monoterpenes had been found. Ken developed a closer working relationship with Professor Meinwald at Cornell during this time (Fig. 3) Building on work completed by Hertha Hinterberger on dolichodial, Whitfield then completed a further series of very complicated syntheses to determine the stereochemistry of dolichodial and this became his doctoral thesis.

Frank Whitfield recalled that Ken requested many rewrites of sections of his thesis, and that he regards this as one of the greatest lessons he learnt from him: to know what was important, to express it in the simplest manner and in the fewest number of words. Frank Whitfield also credits Ken as training him to be a research scientist, describing him as inspirational to his students. It was the time of 'Cavill's Kids', an expression coined by Ronald Warrenner,³⁸ for the group of about nine masters, doctoral and post-doctoral students who studied under Ken in the 1960s.³⁹ Ken was devoted to his students and was keen to further their scientific careers. In the early 1960s, Doreen Clark, Adele Zeitlin and Ben Goodrich started their PhDs with him. Doreen Clark⁴⁰ did some general survey work to isolate other classes of products used by insects as defensive secretions, and then undertook further synthetic work related to iridolactones,



Figure 2. Ken (far left) with Robert Woodward (centre) at Harvard 1958. Kevin Potts is next to Ken.

iridomyrmecin and isoiridomyrmecin. Some of Doreen's research required bull ants and Ken organized field trips to the Royal National Park south of Sydney, and close to his home 'Shiprock' in Port Hacking. After these excursions, students would return to Ken's place for afternoon tea or supper with local oysters, enjoyed to the record of musical humourist and Harvard mathematician Tom Lehrer. A particular favourite of Ken's was 'The Elements', sung to the Major General's Song from the *Pirates of Penzance* by Gilbert and Sullivan. In the early 1970s, his last group of students working in synthetic organic chemistry were Ron Quinn, David Laing and Pat Williams. They were involved in different aspects of gaining more fundamental knowledge of the synthetic chemistry of the cyclopentanoid monoterpene group and of the insect juvenile hormone.⁴¹

During this time of intense research, Ken also experienced some changes in his personal life. His father, William Cavill, died in 1962. Ken had resided with his parents in Ashfield and moved with them to Cronulla after his father had retired from his business. He then built his home 'Shiprock' at Port Hacking, designing the house and the garden. The living room had a large 'feature window' framing the stunning view across Port Hacking to the Royal National Park. After his father's death, his mother Alice Cavill lived with him until close to her death in 1969. Ken then sold 'Shiprock' and in 1970 moved to 'Rugby', an apartment building on the Esplanade at Cronulla, where he resided until 1987.

Ken presented the Liversidge Lecture to the Royal Society of NSW in 1970.⁴² His lecture, entitled 'Chemistry of Some Insect Secretions', presented a general overview of his work on the compounds he had isolated from the anal glands of the common Australian 'meat' ant, dividing them into three categories.⁴³ He noted that whilst these secretions fulfilled the defensive needs of the ants, they were not necessarily adaptable for insecticidal purposes. Ken flagged the future direction of his research as being insect pheromones and hormones, where there were major problems of isolation and structural elucidation to be resolved. He also made clear what had become a central tenet of his research 'philosophy', the interdisciplinary nature of chemical communication in insects between chemistry and biology. 'The chemist is contributing to the solution of a problem in insect behaviour in which, say, the use of a given pheromone is but part of a complex behaviour pattern.'⁴⁴

Chemistry and Biology: the Argentine Ant Trail Pheromone, 'Some Measure of Success'

The need for a more interdisciplinary approach had crystallized in the early 1960s. Although the CSIRO Division of Entomology had been involved in an informal collaboration, Ken decided he wanted more biological collaboration, and he was successful in obtaining funding for six years for the appointment of a biologist and additional post-doctoral staff from the National Institutes of Health in America.



Figure 3. Ken with Professor Jerry Meinwald in 1978.

He appointed Dr Phyllis Robertson⁴⁵ as a senior biologist and she collaborated with him until he retired. He managed to fund her position largely through Australian Research Grant Funding for twenty years.

Ed Houghton⁴⁶ had arrived as a post-doctoral researcher from Leeds University in 1971 and was Ken's principal collaborator on Argentine ant trail pheromones, his last interdisciplinary research project. From the beginning, the problem was to obtain enough of the actual trail pheromone, or its active substance produced in several glands, to enable the determination of its structure. By what could only be called a team effort, involving Phyllis Robertson (bioassay) and Noel Davies (gas chromatography), they obtained twenty micrograms that he and Ed Houghton could use for nuclear magnetic spectroscopy. Unfortunately, the twenty micrograms were contaminated in the process and were useless. In further attempts they accumulated enough of the substance to do mass spectrometry and were able to determine its structure and to go on to synthesize it. This synthetic compound proved to be not quite identical to the natural product, close, about ninety-five to ninety-nine percent.⁴⁷ The instrumentation was not quite sophisticated enough to examine a trailing substance where the proportion was about one part per million of bodyweight. Ken reflected that they had tried to work at the limits of what could be done and didn't quite get there, however '...the process of what we were trying to do was a reasonable one and we did achieve some measure of success'.⁴⁸

A Planned Retirement

During the 1970s and 1980s Ken held several key administrative positions. He was head of the School of Chemistry in 1971, head of

the Department of Organic Chemistry 1968–70, and 1978–82, and chairman of the School's Graduate Studies Committee. In addition to his membership of the Academy of Science (1969–2017) and the Australian Research Grants Committee (1969–74), Ken was also a member of the Council of the Hawkesbury Agricultural College (1975–81). However, when the possibility of retirement was raised in 1982, Ken decided to take it. At sixty years of age, he had started to have significant interests outside of chemistry, related to his passion for collecting English and Australian silver and ceramics, and he could see that the School of Chemistry was in the process of rejuvenation with the entry of younger researchers. Ken could envisage a different life for himself that included more time to play tennis, one of his favourite pastimes. At his Professorial Board farewell in June 1982, Ken reflected on the good fortune he had had in being able to teach, to work at the bench, to have supervised his research students and to have pursued his research goals. He said that 'Chemistry has been a "happy" School in which to work, and in particular he had appreciated his collaborations with co-workers in the fields of microbiology, biochemistry and entomology.'

Ken maintained his connections with UNSW and the Academy of Science, attending reunions and other events. He was appointed an emeritus professor of the university in 1983. Through a generous donation to the university he established the Cavill Lectures to provide an opportunity for a distinguished early career stage researcher to present their work in the field of biological organic chemistry. The inaugural lecture was given by Professor Masake Kita from the University of Tsukuba in Japan in 2011. In his nineties, he also supported Primary Connections, the science education program for primary school educators developed by the Academy of Science. As he approached his nineties, his participation in university events

and other gatherings became more limited as his increasing deafness made communication difficult unless it was on a one to one basis.

Collecting, Researching and Writing

Ken embraced the camaraderie and competition of the world of collecting, which for him was English and Australian silver, gold and ceramics of the nineteenth and early twentieth centuries. He built up his own private collection and applied his academic research skills to documenting the work of Australian manufacturing silversmiths, goldsmiths and jewellers of this period. From 1984 he published very well researched articles,⁴⁹ principally in *Australiana*, the magazine of the Australiana Society, for which he served as Treasurer from 1987 to 1991, and then as President from 1991 to 1994. From 1994 he was also a very active member of the Silver Society of Australia, contributing to the general knowledge of its members through presentations and publications in the society's newsletter.⁵⁰ In the late 1980s, Ken began a collaboration with his childhood friend from St John's Church at Ashfield, Graham Cocks, and also Jack Grace, both avid collectors of Australian silver and gold jewellery, fellow contributors to *Australiana*, and members and office-holders of the Australiana Society. They decided to pool their resources to produce a ground-breaking reference book, documenting Australian silversmiths and goldsmiths. It was a massive task involving extensive further research by the three co-authors. Ken undertook most of the writing, whilst Graham and Jack embarked on the photography. In 1992 they self-published *Australian Jewellers: Gold & Silversmiths, Makers and Marks*,⁵¹ which became the acknowledged 'bible' in this area. Ken continued researching and publishing in *Australiana*, his last article appearing in 2013 when he was 91. Ken developed an important relationship with Eva Czernis-Ryl, a Curator of Arts and Design at the Powerhouse Museum in Sydney. In 2011, the Powerhouse published *Brilliant: Australian Gold and Silver 1851–1950*,⁵² Ken co-authored with Eva the chapter on Australian gold and silver, 1901–50. Ken was able to draw on his extensive private research to write about the different aspects of handmade and commercial jewellery, along with the domestic electroplated silverware industry of that period.⁵³ He was 89 at the time and despite efforts from Eva and other close friends, he had never mastered using a computer, still researching (except for internet searches he cajoled from friends and colleagues) and writing by hand.

A Special Reunion

In 1987, five years after retiring from the UNSW, Ken moved from his apartment of nearly 20 years in Cronulla to a new home in Seaford, a beautiful waterside suburb in the inner harbour of Sydney. Built in 1926, it was full of original features and charm, with a garden. It would be safe to say that Ken fell in love with this house. He spent a year renovating the interior back to its 1926 character. The garden took a little longer. At its completion in 1992, Ken organized what he called 'A Special Reunion' that coincided with his 70th birthday, but was, in fact, a belated housewarming, a celebration of his beloved house. This was a meticulously planned, catered event to which over forty friends, neighbours and colleagues had been invited for lunch. It was also a celebration of his life and his interests as his special Welcome speech revealed. Ken spoke of his move from Ashfield to Cronulla after his father retired in 1952, and then to 'Shiprock' in Port Hacking, and to 'Rugby' in Cronulla

after his mother's death in 1969. The guest list had been carefully compiled so that all of the most important periods of his life were represented by the people associated with them.

In attendance was Brian Jones who, in 1952, as a student of chemistry at Ultimo, had introduced him to the Whitehurst family. Four decades of tennis were played at their family tennis court at Cronulla. Helga and Stephen Angyal, Mary and Bob Martin, Vois and Jim Shannon, Doreen and Pat Clark, all colleagues from the University of NSW also attended. After retirement, Doreen Clark had also invited him to participate in a regular game of tennis with her circle of friends. Bernard Ralph and Betty and Barry Hook, from Liverpool University days were also in attendance. They were friends from the early 1940s, who studied with Ken at Sydney University. And then there was Fred Ayscough who worked with Ken at W. Hermon Slade & Co. Apparently, Fred and his wife Mavis were also Ken's neighbours at Port Hacking for some years. Fred joined the Chemistry Department at the Sydney Technical College and then at UNSW. Other colleagues were Ron Eade, Jack Symes and Bill Dunstan (all were also bushwalkers in the 1940s at the Sydney University Bushwalking Club). Ron Eade had sent his apologies but Jack Symes and Bill Dunstan were present at the lunch. Ken then moved on to the 'St John's years' at Ashfield. Ken grew up living next door to Aubrey Juleff who was present. They had known each other for 65 years. Also present was Dorothy Sanders (née Wheelwright) who used to walk Ken to 'Thornbury School' around the corner from Chandos St in Ashfield when he was a very young boy, Cedric Board and Nell Sandiford. There was Neville Gibson from Haberfield Demonstration School who also attended Fort Street and Sydney University with Ken. Also from the Ashfield years, Ann and Graham Cocks. Ken first met Graham at the 'Comet' Tennis Club at Ashfield, and this friendship continued at St John's. They had all been friends for fifty years at that time.

In Conclusion

Ken's life was closely linked with the foundation and development of UNSW. It was an exciting time to be at the university after the Second World War, and the new School of Chemistry was developing its own identity to rival that of the School of Chemistry at the University of Sydney, established in 1851. He grew up at a time when going to university was a privilege of the wealthier classes; however, he was one of the growing number of exceptions to the rule. As he said in discussing the number of brilliant chemists in his generation, 'there were no silver spoons amongst us'. There was a path for those who showed academic merit, he took it and followed it, through the Depression and World War 2 and its aftermath, and was part of the generation of academics who pioneered the independence of the Australian university system.

He was lucky in that he knew what he loved and he set about finding a way to achieve his goals, both at university and in retirement. He made decisions that affected his personal life, such as not marrying and having children, but he was comfortable with them and had accepted the outcomes. Ken was immensely loyal to his beloved UNSW, he was immensely proud of the achievements of his students and was happy to take some credit for their success. Ken was modest about his own achievements, yet he left a great legacy, best summed up in the memorial addresses of two close colleagues. The first of them, Emeritus Professor David St Clair Black, stated: 'Ken's entire

work was characterized by thoroughness, meticulous precision and integrity. His chemical legacy is a superbly detailed body of work on insect chemistry that will be of great value to future scientists'. The second colleague, Dr Doreen Clark, added: 'Ken Cavill was a perfectionist, a high achiever, a meticulous record keeper and a private person. He was a 'man with a plan' for his activities and his life.'

Conflicts of Interest

The authors declare no conflicts of interest.

Acknowledgements

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Endnotes

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24. David Henry Solomon is known as the father of Polymer Research in Australia, with a distinguished research career at the CSIRO where he invented living radical polymerization. He is the principal inventor of the world's first polymer banknotes. He is a fellow of both the Australian Academy of Science and the Australian Academy of Technology and Engineering. He is a Fellow of the Royal Society in London. He was invited to take up the position of Head of the School of Chemistry at the University of Melbourne, and after retirement from this position, he set up Polymer Research in Chemical Engineering at the University of Melbourne where he is also Emeritus Professor.
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33. Kevin Potts became Professor and Department Chair of Chemistry at the Rensselaer Polytechnic Institute, Troy, USA. <https://archives.rpi.edu/blog/2008/05/01/mystery-image-4-two-for-one/>, viewed 13 February 2018.
34. Ken served on different Academy committees including Sectional Committee 3: Chemistry (1971–5 and 1981–5, Chair from 1982–3) and Sectional Committee 8: Applied Sciences (1976–80). He also served on the Council of the Academy as an ordinary member representing the Physical Sciences (1972–5).
35. Sjamsul Arifin Achmad is Emeritus Professor in Chemistry at the Bandung Institute of Technology in Indonesia. His research areas are organic chemistry, phytochemistry and medicinal chemistry (www.researchgate.net/profile/sjamsul_Achmad). In addition to a distinguished academic career, Professor Achmad has been President of the Indonesian Chemical Society and President of the Indonesian Society of Natural Products Chemistry. He established a post-graduate programme at the Bandung Institute of Technology and has worked with the Indonesian Ministry of Trade. He proposed the UNESCO Regional Network for the Chemistry of Natural Products in South-East Asia that was inaugurated in 1975. Professor Emeritus Sjamsul Arifin Achmad, 'Brief Notes on Professional Pathways', Bandung 11 April 2004. (From Ken's personal papers).
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38. Professor Ronald Warrenner specialised in molecular architecture, and was at the Centre for Molecular Architecture, Central Queensland in Rockhampton, and the Molecular Architecture Section at the Intelligent Polymer Research Institute, University of Wollongong, NSW.
39. Members of the group, according to Frank Whitfield included: Frank Whitfield, Doreen Clark, Hertha Hinterberger, David Solomon, Doug Ford, H. D. Locksley, Sul Achmad, Ben Goodrich and Adele Zeitlin.
40. Dr Doreen Clark AM, completed her PhD with Ken and went on to have a distinguished career in business and science education. She was founder and Managing Director of Analchem Bioassay Pty Ltd (1969–98). She is currently on the Science Advisory Council of the University of NSW, Chair of the Board of the Children's Discovery Museum Ltd, and founding Director of Organic Crop Protectants Pty Ltd. Doreen is a Fellow of the Australian Academy of Technology and Engineering. UNSW Sydney 'Science Advisory Council Members', <https://www.science.unsw.edu.au/our-faculty/dr-doreen-clark-am>, viewed 11 February 2018. G. W. K. Cavill,

- D. V. Clark and H. Hinterberger, 'Some Volatile Constituents of Terrestrial Slaters', *Australian Journal of Chemistry*, 19 (1966), 1495–1501. G. W. K. Cavill and D. V. Clark, 'Insect Venoms, Attractants and Repellants. VIII. Isodihydronepetalactone', *Journal of Insect Physiology*, 13 (1967), 131–135. G. W. K. Cavill, D. V. Clark and F. B. Whitfield, 'Insect Venoms, Attractants and Repellants. XI. Massoialactone from Two Species of Formicine Ants and Some Observations on Constituents of the Bark Oil of *Cryptocarya massoia*', *Australian Journal of Chemistry*, 21 (1968), 2819–2823. G. W. K. Cavill, D. V. Clark, M. E. H. Howden and S. G. Wyllie, 'Hydrocarbon and Other Lipid Constituents of the Bull Ant, *Myrmecia gulosa*', *Journal of Insect Physiology*, 16 (1970), 1721–1728.
41. Dr Patrick Williams AM was scientific researcher and was a former Deputy Director of the Australian Wine Research Institute. He was made a Fellow of the Australian Society of Viticulture and Oenology in 2009 for an outstanding and meritorious contribution to the grape and wine industry. He was Oenology Editor of the second edition (1999) of *The Oxford Companion to Wine* published by Oxford University Press. (<http://asvo.com.au/about-the-society/asvo-fellows/>, viewed 30 March 2018). He was awarded a member of the Order of Australia in 2003 for service to oenology and to flavour science. (www.itsanhonour.gov.au/honours/honour_roll/, viewed 30 March 2018). Professor Ronald Quinn AM was the Foundation Director of the Eskitis Institute for Drug Discovery at Griffith University in Brisbane Queensland (2003–2016). This organization is now known as the Griffith Institute for Drug Discovery. Professor Quinn joined Griffith University in 1982, after postdoctoral studies in the USA and working in the pharmaceutical industry. He is a leader in the development of therapeutic compounds from marine organisms and plant materials and is one of the key researchers behind the Nature Bank, the world's first integrated drug discovery platform. He was made a Fellow of the Australian Academy of Technological Sciences and Engineering in 2003 (<https://experts.griffith.edu.au/academic/r.quinn>; <https://www.scimex.org/newsfeed/professor-quinn-recognised-for-outstanding-career>, viewed 30 March 2018). David Laing was the Foundation Professor of Food Technology at Western Sydney University and is an Emeritus Professor in the Dean's Unit, School of Science and Health, also at Western Sydney University (www.researchgate.net/profile/David_Laing; www.westernsydney.edu.au/staff_profiles/uws_profiles/emeritus_professor_david_laing, viewed 30 March 2018). He is a Professor of Neuroscience in the Faculty of Medicine at UNSW. He has published extensively throughout his career on the psychological, anatomical and physiological aspects of the developing senses of smell and taste in humans with a particular emphasis on understanding the senses of smell and taste in children. He has investigated the relationship between chemosensory disorders and nutrition and dietary management at the Sydney Children's Hospital (<http://research.unsw.edu.au/people/professor-david-laing>; <https://theconversation.com/profiles/david-laing-1214>, viewed 30 March 2018). For a complete list of articles co-authored by Dr Williams, Professor Quinn and Professor Laing with Ken Cavill please consult the Bibliography in the Supplementary Material.
 42. G. W. K. Cavill, 'Chemistry of Some Insect Secretions', *Journal and Proceedings of the Royal Society of New South Wales*, 103 (1970), 109–118. Liversidge Research Lecture, No. 18, 1970.
 43. '(a) terpenoids and steroids, (b) aliphatics and (c) aromatics', as above, p. 117.
 44. As above, p. 118.
 45. Dr Phyllis Robertson worked as a researcher in the Schools of Chemistry and Biological Sciences. She is listed as an Honorary Visiting Fellow in the School of Chemistry in 1990 (<http://www.handbook.unsw.edu.au/archive/historical/UNSWScienceHandbook1990.pdf>, viewed 2 March 2018). Papers co-authored with Ken were: G. W. K. Cavill and P. L. Robertson, 'Ant Venoms, Attractants and Repellants', *Science*, 149 (1965), 1337–1345. G. W. K. Cavill, P. L. Robertson and N. W. Davies, 'An Argentine Ant Aggregation Factor', *Experientia*, 35 (1979), 889–890. G. W. K. Cavill, P. L. Robertson, J. J. Brophy, R. K. Duke, J. McDonald and W. D. Plant, 'Chemical Ecology of the Meat Ant, *Iridomyrmex purpureus sensu strictu*', *Insect Biochemistry*, 14 (1984), 505–513.
 46. G. W. K. Cavill and E. Houghton, 'Hydrocarbon Constituents of the Argentine Ant, *Iridomyrmex humilis*', *Australian Journal of Chemistry*, 26 (1973), 1131–1135. G. W. K. Cavill and E. Houghton, 'Some Pyrazine Derivatives from the Argentine Ant, *Iridomyrmex humilis*', *Australian Journal of Chemistry*, 27 (1974), 879–889. G. W. K. Cavill and E. Houghton, 'Volatile Constituents of the Argentine Ant, *Iridomyrmex humilis*', *Journal of Insect Physiology*, 20 (1974), 2049–2059. G. W. K. Cavill, E. Houghton, F. J. McDonald and P. J. Williams, 'Isolation and Characterization of Dolichodial and Related Compounds from the Argentine Ant, *Iridomyrmex humilis*', *Insect Biochemistry*, 6 (1976), 483–490.
 47. Cavill, Oral History, pp. 118–119, already cited (n. 1).
 48. As above, p. 120.
 49. John Wade, 'Tribute: GWK (Ken) Cavill, 1922–2017', *Australiana*, November 2017, 34–35. Some of Ken's subjects were: W. J. Sanders (1984 & 1998), Magnus Goldring (1985), Stokes and Sons (1986), Willis and Sons (1988), Angus & Coote (1988), Aronson and Company (1990), The Phoenix Manufacturing Company (1993), William Proud (1996). He also wrote about significant silver trophies and individual craftsmen. His last published article was about the French Australian craftsman, Louis Somme (2013).
 50. Ken made presentations to the Society on the topics of 'Australian Colonial Silver, 1800–1850' (January 1996), 'William Proud, Prouds and their Australian Silverware' (March 1996), 'Symbols in Silver and Gold' (May 2001) and 'Boxed in Silver – a Century of Matches and Match Containers' (May 2002). Further publications are to be found in the Supplementary Material.
 51. Kenneth Cavill, Graham Cocks and Jack Grace, *Australian Jewellers. Gold & Silversmiths, Makers & Marks* (Roseville, NSW, 1992).
 52. Eva Czernis-Ryl, *Brilliant. Australian Gold and Silver 1851–1950* (Sydney, 2011).
 53. In 2002 Ken donated a collection of silver and EPNS (electroplated nickel silver) tableware, trophies, napkin rings and spoons made in or used in Australia from the 1890s to the 1950s to the Museum of Applied Arts and Sciences (MAAS) (<http://collection.maas.museum/search?q=silver%20cavill>, viewed 14 February 2018).