

## Geoffrey Malcolm Badger 1916–2002

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Geoffrey Malcolm Badger was Professor of Organic Chemistry at the University of Adelaide from 1955 to 1964 and, after serving briefly as a member of the CSIRO Executive, Vice-Chancellor from 1967 to 1977. Elected to Fellowship of the Australian Academy of Science in 1960, he served on the Council and was President of the Academy from 1974 to 1978. He was President of the Royal Australian Chemical Institute in 1965 and Chairman of the Australian Science and Technology Council (ASTEC) from 1977 to 1982. During the Second World War, while working as a Lieutenant Instructor for the British Navy, he developed an interest in maritime navigation, and especially in Captain James Cook. Later, he edited the book *Captain Cook: Navigator and Scientist* and, in retirement, he wrote two books, *Explorers of the Pacific* (1988) and *The Explorers of Australia* (2001). He was admitted to the order of Australia (AO) in 1975 and knighted in 1979.

### Family Information

Geoffrey Malcolm Badger was born in Port Augusta, South Australia, on 10 October 1916, second child of John McDougall Badger (1880–1949) and Laura Mary née Brooker (1884–1979). His sister, Kathleen Woodford Badger, had been born two years earlier and his brother, Hugh Gibson Badger, was born in 1921. Both parents came from large South Australian families, the father being the second of seven children of Gibson Badger (1853–1889) and his wife Annie (1857–1946), second of nine children of Scottish immigrants, Rev. and Mrs John McDougall (Badger 1985). Geoffrey's mother was the daughter of William Brooker (1847–1935), an Adelaide businessman, and his wife Sarah Elizabeth (1857–1947) née Boundy.

In the late 19th century, the Badger family found themselves in straightened circumstances, and so John was obliged to leave school at age nine for paid employment. In ensuing years, he studied part-time and eventually became a chartered accountant. In 1914, he was employed as Senior Clerk by the Commonwealth Railways, which was extending the Trans-Australian

Railway across the Nullarbor Plain to Western Australia, and so the family moved to Port Augusta, the eastern depot for the project (Luke 1997).

In 1920, the family moved to Geelong, Victoria, where John Badger had been appointed as Company Secretary at the Commonwealth Woollen Mills at North Geelong (Geelong Business 2007).

### School Education

Soon after reaching the age of four, Geoffrey went off to school at North Geelong Primary School, walking each way about a kilometre through the business district. 'School' meant classes of about forty pupils, writing on slates, and standing to attention for the morning flag-raising ceremony. Both parents had strict moral values that they passed on to their children, and these were reinforced by weekly attendance at a nearby Presbyterian Sunday School and later by the choice of Christian schools for their children. The Scottish belief in the value of education had been inherited from immigrant grandparents and reinforced by John's achievements, with the result that all three children went to Presbyterian colleges for



their secondary schooling. Such education was costly, of course, and John Badger's family made sacrifices; for example, not owning a car despite his managerial position. John Badger could give his time, however, and he served as Chairman of the Parents and Friends organization at Morongo College, where Kathleen was a pupil. To jump ahead in our story, all three children graduated from the University of Melbourne—Kathleen as Bachelor of Arts with Honours in 1935, Geoffrey in Science, and Hugh as Bachelor of Mechanical Engineering in 1944, following which he worked for the Commonwealth Department of Supply. Kathleen worked in Geelong for some years before completing a library science degree in Canada and serving as a librarian for the United Nations in a number of overseas locations.

Geelong College accepted Geoffrey into its preparatory year in 1927. While remaining a shy boy, he quickly put aside his apprehension about joining such a school although he was categorized with the 'swots' because of his love of reading. Joining the Boy Scouts and collecting stamps were fairly normal activities for a teenaged boy, and his interest in shipping was kindled by the proximity of home and school to the Geelong harbourside. Within a few years, Scouts had been replaced in his life by the school cadet corps, always a strong feature of Victoria's private school system. Geoffrey enjoyed the drill (with Lee Enfield.303 rifles) and the camps, but not the boots or the puttees, and felt that he was doing his duty by learning to defend Australia. These founding influences would bear fruit in later life, as we shall see.

At Geelong College, he concentrated on Mathematics, Physics, Chemistry and English, along with French, Latin, Geography and History. In later life, and especially in view of his research into biologically active chemicals, he regretted that the school, like most boys-only schools, did not offer Biology as a subject. Sport was

compulsory and so (without notable success) Geoffrey played cricket and football in house teams, and competed on the track. He enjoyed tennis on the church courts at weekends, and took day trips on his bicycle into the nearby countryside.

Although John Badger was never unemployed during the Depression, like many others he suffered salary cuts. It had been intended that Geoffrey should complete his studies at Geelong College, but once he had completed his Public Intermediate Certificate at the end of 1931 there was some pressure from home for him to get a job. The Headmaster, Rev. Frank Rolland, suggested a career in business as a manager or perhaps in a bank. Geoffrey's preference for science, and in particular for chemistry, which had been his best subject, would have meant continuing at school, but a visit with his father to the Shell company's laboratories in Melbourne and a conversation with the Chief Chemist there brought out another solution—transfer to a technical college to study for a diploma in industrial chemistry. Geoffrey's younger brother, Hugh, who had just begun at Geelong College, stayed on through the end of 1939, following which he studied at the University of Melbourne.

Following this advice, Geoffrey started at the Gordon Institute of Technology in Geelong where he came under the influence of the head of chemistry, J. M. Hennessey, a qualified public analyst. He completed the diploma course in 1934; chemistry was the main subject but there was also some engineering. As the award of the certificate required industrial experience, it was several years before all the requirements for award of the diploma were completed.

Since the economic situation had begun to improve, John Badger supported his son's desire to continue his education at the University of Melbourne, and they were both grateful for the support of a scholarship awarded by Trinity College that enabled Geoffrey to live in a residential college. The University gave credit for first year

Chemistry, Natural Philosophy (Physics) and Mathematics on the basis of his diploma studies, thus enabling him to begin in the second year of the BSc course.

### **University Education and Beginning Research**

Geoffrey's record at school had been solid but undistinguished, and his university career continued that level of performance until he was able to concentrate on chemistry alone. In 1935, he achieved passes in Pure Mathematics and Chemistry, Honours in Natural Philosophy, and passes in both French and German language studies. He repeated the Chemistry and language scores in the third-year course in 1936 and also gained Honours in Metallurgy I, thus completing his Bachelor of Science degree. At the university, Geoffrey continued his military involvement by joining the Melbourne University Rifles in April 1935, for a three-year term. Technically, he was voluntarily enlisted in the Militia.

In 1937, Badger conducted research for his MSc degree at Melbourne, under the guidance of Associate Professor William Davies. Along the way, he was awarded a Minor Research Grant (£25) and in 1938 a Major Commonwealth Research Scholarship (£40). He finished with First Class Honours and was awarded the Bartlett Scholarship (£50) for research in chemistry. His thesis, completed in 1937, was entitled 'Synthetic Plant Growth Hormones: The Acetic Acid Derivatives of Thianaphthene'. The synthesis of thianaphthene-acetic acids and exploration of their activity as synthetic plant hormones was Davies' major interest at the time, although Badger's contribution to this research programme was not published until twenty years later (95). There were continuing common interests, however, for example Davies' research on the isolation of carcinogenic compounds from over-cooked foodstuffs (Anon 1966) that he began some years before Badger's

experiments on the formation of polycyclic hydrocarbons by high-temperature treatment of simpler organic substances (183).

Having completed his MSc, Badger was determined to continue with university research, but to do this he had to proceed overseas since the PhD degree was not to become available in Australia until after the war. On Davies' recommendation, he was accepted by Professor J. W. Cook at the Chester Beatty Research Institute, Royal Cancer Hospital, London, and his research there was to set a pattern that he followed for many years. The University of Melbourne generously allowed Badger to continue to receive his scholarships during his first year at London, but his father had to pay for the voyage. In the later stages of his PhD research, he was supported by a Finney-Howell Research Fellowship.

As well as sharing Cook's interest in chemicals that produce cancer, Badger sought chemicals that might inhibit tumour growth. New substances were synthesised in the laboratory and injected into rats and mice that already had tumorous tissue. The work produced a steady stream of publications (1–9) and after two years of intensive effort Badger was awarded the PhD degree in December 1940 for his thesis, 'The Synthesis of Growth-inhibitory Compounds Related to the Carcinogenic Hydrocarbons', supervised by Professor Cook and Dr C. L. Hewitt.

Badger had no trouble securing a position in the chemical industry with Imperial Chemical Industries (ICI) in the Manchester area, and on the strength of his new salary (£325 a year) he was able to marry Edith Maud Chevis, whom he had first met at the Chester Beatty Institute where she worked as a secretary. They spent a honeymoon in Huddersfield, the unlikely location being explained by his need to inspect ICI factories there as part of his induction into the industry. Seeing that he had expressed an interest in medicinals, ICI put him to work on a new plant for the production of

sulphamerazine, which had antibiotic and was thought to have anti-malarial properties. It was in great demand in tropical theatres of war. Badger would not have known that at about this time Australian chemists were manufacturing sulphamerazine, having begun the project without British assistance, but with advice from the Adelaide professor whom Badger was eventually to succeed, A. Killen Macbeth (Weickhardt 1947).

Badger played his part in war-time civil society, first as a Gas Identification Officer in Chelsea (1939–1941) while he was studying in London, and then as a member of the Manchester Home Guard (1941–1943). Despite this and his industrial chemical contribution to the war effort, he hankered after a more direct involvement, but on application to join the forces he was told to return to his scientific work. Undaunted, he answered an advertisement placed by the Royal Navy in *Nature* for men with at least two years of university mathematics to serve as instructors in navigation. After an interview and a medical examination, he was accepted as an Acting Temporary Instructor Lieutenant to teach navigational methods, both coastal and astronomical, to naval recruits. The relevant teaching tool was the *Admiralty Navigation Manual*, published in three volumes by His Majesty's Stationery Office, 1938–1939. Sporting a brand new officer's uniform, he reported for three months' training at Bristol while his wife returned to live with her parents in London. After a week's leave, he then reported for work at HMS *Dauntless*, a light cruiser launched in 1918 and used from 1943 as a training vessel based at Inverkeithing near Edinburgh. Subsequent periods of leave meant a train trip to London to spend the weekend with Edith, and an early morning return to duty.

Once the war ended, Badger wanted to return to civilian life, but he was not released until 1946, well after the war's end, and only then when his old mentor, Professor Cook, wrote to the Admiralty. Badger

was the recipient of one of the first ICI fellowships (Rae 1994), which enabled him to embark on a postdoctoral career with Cook who had by then moved to a Chair at the University of Glasgow. The Badgers rented a flat for the three years they were in Glasgow, and Geoffrey's career advanced steadily as he worked under Cook's direction and also provided day-to-day supervision of many of the professor's graduate students. His published work (10–33) showed the concentration on polycyclic aromatic compounds and their biological activity that had begun with Cook in London. As Badger set sail for Australia in 1949, he was awarded the Glasgow DSc for a thesis entitled 'Studies on the Relationship Between Chemical Constitution and Biological Action'.

### Return to Australia

Towards the end of his three years in Glasgow, Badger began to explore opportunities in Australia. He was, for example, an unsuccessful applicant for the Sydney Chair of Organic Chemistry in 1948. He also wrote to all professors of chemistry in Australia asking whether there were or were likely to be vacancies for which he could apply. The only response came from Professor A. Killen Macbeth at the University of Adelaide, and it was followed by an assessment of Badger by a Glasgow physicist contacted by the Adelaide hierarchy to 'look over' the prospective staff member. The report must have been favourable because Badger was offered a Senior Lecturer position that he took up in 1949.

While Badger was establishing a research group in Adelaide, publications arising from his work in Glasgow continued to appear in the journals (39, 46, 49, 54). Chemists traditionally list authors in alphabetical order and Badger benefited from this convention. The publication of his first 'Adelaide' research (34) was based on the work of his first Honours student, Ronald Pearce. Badger soon gathered around him

an active group of Honours and PhD students and his and their interests were served by his attention to publishing their work (34, 37–38, 41, 45, 49, 50 and 55 with Pearce, for example) in multiple instalments. Like Cook, with whom he had spent two periods of research, and other organic chemists of the time, Badger established series of papers under common headings—substituted anthracene derivatives (eight papers), polynuclear heterocyclic systems (fifteen papers), aromatic azo compounds (eight papers), desulfurisation with activated metal catalysts (twenty-three papers), formation of aromatic hydrocarbons at high temperatures (twenty-nine papers), porphyrins (eight papers) and photochemical reactions of azo compounds (six papers). In a few cases, numbered papers in the series appeared not over Badger's name, but over those of his co-workers, who acknowledged his continuing interest. A Badger student from those early years whose subsequent career reached great heights was Rowland Pettit, who had completed an Honours degree with Macbeth then became Badger's first PhD student (49, 50, 52, 55, 57, 58, 69). Later, as a professor at the University of Texas, Pettit was responsible for the synthesis of the iconic molecule, cyclobutadiene (Gilbert 1995).

In 1951, Badger was promoted to Reader, the senior sub-professorial grade, and then upon Macbeth's retirement in 1955 he was appointed to the newly-created Chair of Organic Chemistry. In the preceding year, D. O. J. Jordan (1914–1982) had been appointed to the parallel Chair of Inorganic and Physical Chemistry and was probably responsible for ensuring that each of them was able to head a separate department, of organic chemistry and inorganic and physical chemistry, respectively. Such a division was seen in a number of British universities, although at Cambridge the division was between physical chemistry in one department and organic and inorganic chemistry in the other, while at Oxford there were

four departments (inorganic, organic, physical and theoretical). In establishing departments and chairs, Australian universities had generally held to the one-professor-one-department rule, according to which the establishment of a second chair in a discipline automatically led to the fission of the existing department. This may have been the driving force at Adelaide, as it had been at Sydney in 1915 when Robert Robinson was appointed to a new Chair of Organic Chemistry, and was certainly the case at the University of Western Australia, although a compromise was adopted there with the two departments (inorganic and physical chemistry, and organic chemistry) forming a school with common technical services and budget (Bayliss undated). The new Adelaide professors worked harmoniously together, providing great strength for chemistry in such arenas as the Professorial Board, and providing a model for the later separation of Pure and Applied Mathematics (Best 1987; Edgeloe 1987).

Much of Badger's research in subsequent years was performed in conjunction with Graham Lewis, who shared with Badger a service background and research experience at the Chester Beatty Institute, and a great interest in the chemistry of aromatic azo compounds. Lewis served in the Royal Australian Air Force in the Second World War, afterwards entering the University of Adelaide under the Commonwealth Reconstruction Training Scheme and completing his BSc at about the time Badger took up his appointment. He was Badger's Honours student of 1951 (44) and completed his PhD in 1955 (60, 65, 66, 67, 71). He was appointed to the Adelaide staff in 1956 after a postdoctoral period at the Chester Beatty Institute, and promoted successively to become a Reader in 1966.

Badger's British experience and the prestige of Britain's Chemical Society led to his publishing his research, apart from some specialist contributions, in the Society's *Journal of the Chemical Society* until 1962

(last paper 133). Thereafter, however, his major publication vehicle became the *Australian Journal of Chemistry* (first paper 136). There is an obvious connection with Badger's membership of the editorial board of the Australian journal 1960–1964, but CSIRO (publishers of the journal) were also asking leading Australian scientists to publish in their journals so as to lift their international profile (Walby 1976). Former colleagues at Adelaide recall that Badger encouraged them to follow his lead and publish the results of their research in the *Australian Journal of Chemistry*. The support by many of Australia's leading chemists resulted in a rapid growth of the number of papers published in the journal, from 73 in 1960, to 157 in 1963, and 256 in 1965, and a change from quarterly publication to bimonthly in 1963 and then monthly from 1964.

Towards the end of his laboratory career, Badger produced what he regarded as his best work, the synthesis of a series of annulenes, organic substances with alternating double and single bonds in an eighteen-membered ring. The parent substance had been synthesized by the English chemist Franz Sondheimer (Jones and Garratt 1982) and found to possess aromatic character, resembling in that respect the benzene ring of six carbons when represented as having alternating bonds. Best (1987, p. 145) reports Badger as saying 'I was sitting having coffee with Graham Lewis one morning. We were talking about the structure of 18-annulene. It has 6 hydrogen atoms inside the cyclic system and 12 external to the ring ... Graham Lewis said it would be interesting to replace the six internal hydrogens with three atoms such as sulfur or oxygen. I agreed and went away. A short time later I returned with a possible method to synthesise such a compound'. The synthesis of 18-annulene trisulphide was effected by PhD student Jack Elix and reported in a short communication (156) and then in full detail (175). Subsequent syntheses by Elix

of the oxygen analogue (189) and by U. P. Singh of a mixed oxide-sulphide (192) and a bridged disulphide (195) were reported, the last of these some years after Badger had left to take a senior position with CSIRO and then returned to lead the university.

Another piece of chemistry for which Badger is remembered, together with his then student Wolfgang Sasse (PhD 1957), is the coupling of two molecules of pyridine by dehydrogenation over finely divided, activated nickel metal (84). The product of the reaction, 2,2'-bipyridyl, was at that time of great interest as a precursor to substances with herbicidal activity, but no convenient synthetic routes to it were available. ICIANZ chemists in Melbourne recognized the significance of the Adelaide work, improved on it and patented the process in Australia and twenty-eight other countries (Varco 1960). It was subsequently employed on an industrial scale by their parent company, ICI UK, to produce the herbicide Diquat (Kolm 1988). Sasse was appointed to a lectureship after completing his degree, and was soon promoted to Senior Lecturer. In his research work, he collaborated extensively with Badger on work with activated metal catalysts (97, 98, 107, 109, 115, 118, 122, 129, 130, 152, 155, 157, 158, 159) before leaving Adelaide in 1964 for a position at CSIRO. Sasse was also the sole author of several papers in this numbered series. In Badger's final chemistry publication, a whimsically-entitled article 'Three Princes of Serendip: Chemical Discoveries by Accident and Sagacity' (202), he reviewed a number of chemical discoveries that fitted his twin themes. He ended the piece with his own and Sasse's work on active metal catalysis leading to the formation of 2,2'-bipyridyl, noting that 'the first commercial production of diquat therefore resulted from serendipity' since the 2,2'-bipyridyl had been formed from the solvent (pyridine) they chose in which to undertake a completely different reaction.

While most of Badger's Adelaide research was classical organic chemistry, his eye for developing fields was exemplified by a number of publications in physical organic chemistry, especially spectroscopic work that was made possible by the increasing sophistication of scientific instruments and advanced techniques (45, 71, 81, 82, 83, 106, 111, 133, 153, 155, 197). In his extensive work on pyrolysis of organic compounds, the studies of mechanisms of reaction were facilitated by the use of  $^{14}\text{C}$  labelling that enabled the fate of particular carbon atoms to be established (145, 161, 184, 185, 193, 194). A few papers reported work on Australian natural products (85, 114, 148). Badger wrote a number of reviews of fields of chemistry where he had established expertise (42, 43, 47, 63, 73, 86, 91, 96, 100, 134, 183, 198) and he published four books that were written for advanced undergraduate students and research scientists (74, 127, 128, 200). *The Structure and Reactions of Aromatic Compounds*, published in 1954, was republished in 1957, and was followed by *The Chemistry of Heterocyclic Compounds* (1961) and *Aromatic Character and Aromaticity* in 1969 (reprinted in Japanese and in Polish in 1971). In between came *The Chemical Basis of Carcinogenicity* (1962, reprinted in Russian in 1966).

Badger's early interest in chemical carcinogenesis continued into his Adelaide years, but he could trace the field back beyond J. W. Cook, with whom he had first encountered this research field while studying for his PhD degree. Ernest Laurence Kennaway (1881–1958) had demonstrated that the tars produced in reactions of organic chemicals, and fluorescent hydrocarbons in particular, would produce cancers in experimental animals (Kennaway 1955). After Cook joined him in the late 1920s, they were able to show that certain polycyclic aromatic hydrocarbons were responsible, and that 3,4-benzopyrene was especially potent. Badger noted this in his obituary of

Kennaway (112) and in the 1960s conducted extensive experiments, published in collaboration with Dr Tom Spotswood, on thermal routes to aromatic hydrocarbons.

Badger enjoyed socializing with his graduate students and postdoctoral fellows. Best has reproduced a 1964 document in which Badger listed his associates and annotated the list with notes about their countries of origin and the names of girlfriends (Best 1987, pp. 146–147). We shall see the same attention to detail when Badger later walked a larger stage. His final lecture each year to the first-year class, no doubt intended to encourage them to proceed to second-year chemistry, was replete with jokes and anecdotes and illustrated with black-and-white slides. It was also widely attended by students who had enjoyed previous years' performances. Text and slides for a number of these lectures are held by the University of Adelaide archives. Within the Department of Organic Chemistry, however, Badger, like his predecessor A. Killen Macbeth, ran a tight ship. Everybody was encouraged to work hard, and in consequence Badger was admitted by his graduate students to The Most Noble Order of the Grindstone. On Friday afternoons Badger toured the laboratories, conducting what was referred to as 'Captain's Inspection', no doubt an echo of his Royal Navy days.

### CSIRO and the ARGC

In 1964, Badger resigned from the University of Adelaide to become a member of the CSIRO Executive, chaired by Sir Frederick White (1905–1994). As Badger took up his appointment, the Executive was in the process of moving from Melbourne to Canberra, and so he and his wife relocated to the national capital and sold their Adelaide residence.

Badger was with CSIRO for only two years before he returned to the University of Adelaide. Although his work in Canberra and visits to universities and CSIRO



Divisions around the country kept him in close contact with active researchers, Badger found that he missed the contact with students that he had had during his own research career, and this was an important factor in his decision to return to university life. The ‘student factor’ emerged again during his years as Vice-Chancellor.

In April 1965, while Badger was in Canberra, the Minister-in-Charge of Commonwealth Activities in Education and Research, Senator John Gorton, appointed him to the newly-formed Australian Research Grants Committee (ARGC), ostensibly as a ‘non-university person’ although he had only recently left the education sector for CSIRO. Badger’s accession to the position was no doubt due to the foundation chairman of the committee, Professor Rutherford (Bob) Robertson, who had been Professor of Botany at Adelaide and hence Badger’s colleague for some years. The duties of the ARGC involved assessment of applications for grant support and campus interviews with researchers, mainly from the sciences, but also from the humanities and social sciences. When it was announced that he would be returning to Adelaide, Badger resigned from the ARGC to avoid a conflict of interest, and another chemist, D. L. Ford, was appointed in his place.

### **Back to Adelaide**

Badger accepted an invitation to become Deputy Vice-Chancellor at the University of Adelaide at a time when universities around Australia were strengthening their senior executive ranks by appointing deputy and pro-vice chancellors to share in the academic leadership of the institution and leave the vice-chancellor free to play a broader role. Simon Marginson, writing about this in his history of Monash University (Marginson 2000), ascribes the change to the influence of the American management expert, Peter Drucker, and his advocacy of ‘a small elite of visionary

manager-leaders’. Adelaide had more than duty-sharing in mind, however, since the then Vice-Chancellor, Henry Basten, was to retire within about six months of Badger’s arrival and it was clear that succession planning was the reason for Badger’s recall.

Badger was Vice-Chancellor for ten years (1967–1977), a period when Australian universities had to respond to calls at two levels for greater participation in university governance. The two were linked, but played out under quite different circumstances. There was resistance from members of the University Council to changes that would see non-professorial staff and students elected to Council by their various electorates, but Badger was successful in bringing about this reform, which was enshrined in the *University of Adelaide Act* (1971) brought down by South Australia’s Dunstan government. Further down the university hierarchy, there were pressures to allow non-professorial staff to become heads of departments. Badger opposed this change, on the old-fashioned ground that a professor chosen for excellence in subject matter should be capable of running a department. He pointed out that junior staff could not be expected to exercise the same degree of care for governance and finance, career development and all the other responsibilities that had been devolved over the years to departmental level. The battle was lost in 1974, and while departmental governance was generally in the hands of senior academics with sub-professorial appointments, in a few cases even such junior staff as lecturers were elected to head departments. A profile published at the end of Badger’s time as vice-chancellor (Cockburn 1977) noted ‘the resignation of some first-class academics who found they could not mix scholarship with politicking’, but that regarding the expansion of participation in university governance, Badger felt that democratization had not been a recipe for mediocrity and that ‘in most departments the quality was very high’.

The other push for more involvement came from students, radicalized by Australia's involvement in the Vietnam War and especially by the introduction in the late 1960s of selective (ballot-based) conscription of young Australian men for military service. Opposition to the war was a catalyst for the expression of other concerns, and Badger received delegations of students who came to his office to complain about the university's lack of overt opposition to conscription and about social conditions that they said demanded the university's attention. As at most Australian universities, there were large meetings in open spaces on the campus and, like most vice-chancellors, Badger was often in attendance and recognized by the students although choosing not to address the meetings. Universities must allow free speech, he felt, but their tradition of scholarship must be protected. The stance taken by Professor Bruce Williams, Vice-Chancellor of the University of Sydney at the time, was that the university was obliged to obey the law although it might test the law in court if it felt that this was warranted. Students, as citizens, could make up their own minds, but it was not in the power of the university to accede to their demands that the university defy the law concerning disclosure of information, for example (Williams 2005). Badger, however, was praised for risking prosecution under the Crimes Act when he (allegedly) 'told the then federal Government that he'd go to gaol rather than let Government officials see student files to help them identify draft dodgers' (Cockburn 1977).

It is fair to ask why Adelaide escaped the violence and prolonged disruption that marked student protest at some other Australian universities. Louis Matheson, Vice-Chancellor at Monash University, used words like 'rebellion', 'occupation' and 'insurrection' when he came to write about the troubles at Clayton, and he conceded that he had 'allowed himself to become too personally involved' (Matheson

1980). Matheson addressed student meetings, thereby aligning himself with the 'authority' that radical students had chosen to oppose, and he faced a more determined student ginger group led by Albert Langer and the university Labor Club than existed at other Australian universities. In commenting on student unrest at Adelaide, Duncan and Leonard in their history of the University commented extensively and favourably on Badger's 'perceptive and sympathetic address' at a Commemoration ceremony in May 1971, in which he advised that 'both generations ... need to be patient and tolerant' and to keep open the channels of communication (Duncan and Leonard 1973). Leonard would have been among the 'substantial proportion of sub-professional staff' who supported many of the students' demands, and so it is perhaps not surprising that the authors were prepared to praise Badger for trying 'to practise what he preached in his Commemoration address'.

An aspect of university life at which Badger excelled was wide-ranging informal discussion among colleagues. It was his custom to lunch each day at the Staff Club and to make a point of sitting with different people, discussing university business with them and seeking their points of view. Also, among the less confrontational aspects of his vice-chancellorship, Badger placed special importance on the establishment of an Aboriginal Music centre. His interest had been aroused by a staff member in the Department of Music whose specialty it was, and by a visit he paid to the Indulkana people in Central Australia. After several visits from tribal elders and meetings at which everyone including Badger sat on the floor of his office, the University accepted his proposal to establish the centre in North Adelaide.

An interesting evidence of Badger's rapport with students was his contribution to a seminar organized by Friends of the Earth in 1972, when he posed the question 'is modern technology a blueprint for destruction'

(205). Noting ‘that we are rapidly increasing pollution of the atmosphere, the seas and rivers, and the general environment’, Badger presciently went on to describe carbon dioxide as a serious pollutant because of the ‘glasshouse effect’, which could lead to ‘increase in ocean levels, flooding of coastal areas, and considerable changes in climate’. He took a similar line the following year in his Presidential Address to Section 2 (Chemistry) of the 44th ANZAAS Congress in Sydney, but also included remarks about the consequences of the dispersal in the environment of pesticides such as DDT. The address was published by ANZAAS under the heading ‘The Quality of the Air: A Study of Pollution’ (201).

As Vice-Chancellor, Badger was very much a public figure. He helped to found the Friends of the Art Gallery of South Australia, and was the body’s inaugural President. As a further illustration of his interest in the visual arts, he played a crucial role in the purchase for the University in 1971 of a significant sculpture by Henry Moore, *reclining connecting forms*. He served on selection committees for a number of awards, and chaired a committee on worker participation in management, the report of which was adopted by the Dunstan government (206).

While he was Vice-Chancellor, he still found time for some chemistry, continuing his interest in aromatic molecules and writing his book *Aromatic Character and Aromaticity* (1968). He enjoyed the personal assistance of Jillian Teubner (née Donnelly) who had done research under his supervision for her BSc Honours and PhD degrees. Jillian and her husband Peter Teubner (Professor of Physics at Flinders University) remained close personal friends of the Badgers’ until Jillian’s untimely death in 2002. Following his retirement as Vice-Chancellor, Badger held a position as Research Professor in the Department of Organic Chemistry although he was no longer involved in experimental

science. In November 1985, a dinner was held to commemorate the centenary of the teaching of chemistry at the University, which began with the appointment of Edward Rennie in 1885. Badger was the guest speaker at the dinner, and his remarks—including the claim that the Adelaide chemistry school was ‘better than most of the chemistry schools in the British provincial universities’—were reported in the campus newspaper (*Lumen* 1985). As part of the commemoration, the laboratories of the Department of Organic Chemistry were named the G. M. Badger Laboratories. Also marking the centenary, the University held a special meeting of the Assembly, chaired by Deputy Chancellor Hon. Justice Roma Mitchell, at which the oration was delivered by the Master of Christ’s College, Cambridge, Lord Todd. The connection with Badger would have been obvious to most, since Todd was the doyen of the world’s organic chemists and an old friend of Geoffrey Badger.

### **Australian Academy of Science**

Badger was elected to Fellowship of the Australian Academy of Science in 1960 and served the Academy as a member of Council (1964–1967), Secretary (Physical Sciences) (1968–1972) and President (1974–1978). In 1967, the Academy established its Science and Industry Forum that brought together leaders from industry, government and science. At its first meeting, it resolved to prepare reports for consideration at further meetings and promulgation as expert advice to the nation (Fenner 2005). Badger led a group to ‘study and assess the need for a national science policy’ and their report was published as Report No. 1 of the Forum (203). The report formed the basis for discussion at the October 1968 Forum meeting, and attracted the attention of the Minister for Education and Science, Malcolm Fraser. Fraser spoke on ‘Government approaches to science’ at the Forum’s subsequent meeting in February 1969 but, to the disappointment

of some, without expressing support for the establishment of an advisory body. Fraser's address was published by the Academy later that year as a National Science and Industry Forum Report.

Badger had a strong interest in science policy, and as President he led the Academy to devote more of its efforts to developing independent advice to government. His first Presidential Paper (207) took a broad approach, while his second (208) emphasized the importance of basic science for Australia's future. The views of the Academy were readily transmitted to the Australian Science and Technology Council (ASTEC) discussed below, but it is sufficient to note here that Badger was also the chairman of ASTEC.

In 1975, Badger's strong stand on the importance of science to technology brought him an invitation to speak at a conference in Chile organized by the Australian Society for Latin American Studies. He and his wife spent a few days in November at Viña del Mar on the coast west of Santiago, then went on to Brazil as guests of the Brazilian Academy of Sciences, visiting universities and research establishments. In 1979, he and his wife were guests of the USSR Academy of Sciences as they visited Moscow and St Petersburg, pausing on the way to visit universities in the Tokyo region. The Australian Academy of Science holds extensive reports written by Badger on these 1970s visits.

Badger was a popular speaker in Australia. As well as serious addresses that served to promulgate his views on science and technology, there were addresses to a range of audiences on less serious or social occasions. The texts of a number of these witty talks are held by the Academy, and they reveal the careful preparation of material with jokes and other cues written on the manuscripts. His light-hearted talks were usually accompanied, however, by serious messages such as 'there are no utopias' and 'as cynics have said, technology

enables us to be more miserable in greater comfort'.

### **Australian Science and Technology Council (ASTEC)**

The formation of a body that would be charged with providing advice to government on science (and later technology) was not supported by all sectors of the scientific community. Johnston and Buckley (1988) trace the origins of the idea back as far as 1951, and mention that the first formal proposal was made by the Academy of Science in 1957. They further note that CSIRO was concerned that, to the extent that they had played this advisory role in Australian science and technology, their influence would be diminished if a separate body were to be established. This view was expressed strongly by Sir Frederick White, with whom Badger had worked as a member of the CSIRO Executive, but later White became a supporter of the formation of ASTEC.

Agitation for the formation of an advisory body persisted through the 1960s, with approaches to government by senior figures in the science community such as Sir Mark Oliphant and Sir Leslie Martin, both Fellows of the Australian Academy of Science. The interest in science policy by the Academy was shared by other professional bodies, notably the Royal Australian Chemical Institute and the Australia and New Zealand Association for the Advancement of Science (ANZAAS), and the breadth of this support was influential in the decision of the McMahon coalition government in 1972 to set up an Advisory Committee of Science and Technology. Badger was a member of this committee, which was chaired by Louis Matheson, Vice-Chancellor of Monash University. The committee was dissolved upon the change of government later that year. Badger and some other fellows of the Academy were involved in discussion with the new Prime Minister, Gough Whitlam,

about the terms of reference for a successor body, but it was not until March 1974 that the Minister for Science, William Morrison, produced a green paper, *Towards an Australian Science Council*. Prime Minister Whitlam announced the terms of reference for ASTEC at the January 1975 ANZAAS Congress. This was followed soon afterwards by a white paper, *Science and Technology in the Service of Society: The Framework for Australian Government Planning* and in the same month the establishment of an Interim Australian Science and Technology Council.

In mid-1975, the Royal Commission on Australian Government Administration established a Science Task Force chaired by the chairman of the Commission, Dr H. C. Coombs, who in introducing it said that ‘It is important that scientists have the independence necessary for effective work but at the same time do not lose sensitivity to the needs of users of their work. We must seek the right way to organise science to meet the problems of the next decade.’ Shortly before the December 1975 election, the Government received the report of the Science Task Force, which recommended that ASTEC should report to the Prime Minister or a Minister assisting him, and that ‘there should be no Department of Science and no specifically designated minister for science’ (Royal Commission 1975). This was clearly intended to free ASTEC from particular departments so it could play a ‘supra-departmental’ role.

The election brought another change of government and this led to changes being made to ASTEC, which remained an interim body for some time. The Act to establish the permanent ASTEC was not passed until 1978 (incidentally expanding its full title to Australian Science, Technology and Engineering Council), although the members were appointed in April 1977. Badger was its chairman and three other members—Robertson, Nossal and Street—were Fellows of the Australian Academy of Science.

Badger spent two days each week in Canberra attending to his ASTEC duties, assisted by a small secretariat provided by government. His secretariat colleagues found him diligent, innovative and, most importantly, politically astute. On behalf of ASTEC, Badger reported directly to the Prime Minister, Malcolm Fraser, with whom he enjoyed a good relationship. This, however, tended to put Badger and ASTEC offside with the permanent heads of Commonwealth departments, some of whom resented ASTEC’s influence. Badger moved to neutralize this opposition by inviting the heads to sit with ASTEC members at most meetings, and they were soon won over as supporters, especially as they recognized the value of having both senior industrialists and scientists as ASTEC members.

Under Badger’s leadership, ASTEC produced reports dealing with the future of the Bureau of Mineral Resources, direct funding of basic research, marine science and technology, Australian telescopes, and a snapshot of science and technology in Australia (ASTEC 1978–1979). While few in the science community outside the reviewed organizations would have read the reports in full, their contents were summarized in the ANZAAS magazine, *Search*. That publication’s editor, Ronald Strahan, congratulated Badger and his colleagues on a ‘remarkable performance’ (Strahan 1979). While it is not always easy to assess the impact of ASTEC’s recommendations, some outcomes were clear. An earlier, internal review of the Bureau of Mineral Resources had not provided government with a clear picture of the possible future of the organization, but the recommendations in the ASTEC report were ‘just what the Government had been looking for’ and their acceptance by the Australian Government led to radical change in the organization’s structure (Wilkinson 1996). The Bureau (now after several changes of name, Geoscience Australia) was ‘changed, broadly speaking, from a survey body into a

resource-oriented research organization' (Campbell 1983). ASTEC's telescope report followed on from an inquiry by an inter-departmental committee into future arrangements. It recommended the construction of a new radio synthesis telescope to be known as the 'Australia Telescope', and also that all future government-funded instruments should be national facilities (Gascoigne 1988). The ASTEC report led to provision of funding for the Australian Telescope and its completion by 1988 at Culgoora in New South Wales, and is credited as being a determining factor in the advance of Australian astronomy (Collis 2002; Frater 2008). The marine science work began with an ASTEC working party that identified the main themes, and ASTEC's 1977 annual report recommended greater co-ordination of marine science and technology and formation of a permanent co-ordinating body, the Australian Marine Science and Technology Advisory Committee (AMSTAC). This body was established in 1979 and initially reported to ASTEC, which proceeded in its Marine Science and Technology report to recommend additional funding including for a new CSIRO oceanographic research vessel. 'The Prime Minister listened' and the 'policy advice was implemented' (Watson and Baker 1988), although one of the affected bodies, the Australian Institute of Marine Science, in Townsville, was prepared to concede only that 'the impact of AMSTAC on AIMS activities was mostly positive' (Bell 1998).

ASTEC also produced discussion papers, notably one on industrial innovation and another, written for the Council by Professor Ron Johnston, on science indicators and their role in Australian science policy. The Johnston document came in for heavy criticism by the ANZAAS correspondent, David Denham (1979).

Apart from the formal presentation of ASTEC reports, Badger had many opportunities as an invited speaker to bring ASTEC's thinking before other audiences.

A major example was his opening address to the Fourth National Physics Congress, organized by the Australian Institute of Physics and held in Melbourne in August 1980 (209). Addressing 'The Role of Government in Australian Science', Badger emphasized that 'close government involvement with, and support for, science and technology is essential to the future well-being of Australia' and that what we 'can loosely call a national science policy, is now being actively developed'. Such a policy never appeared. The matter is still raised occasionally by the science community but is not acted upon by government.

Badger's health began to fail in 1982. He required open-heart surgery and was advised that in future he needed to avoid stress, so he resigned his ASTEC position. Following a review by the Chief Scientist in 1997, the functions of ASTEC were subsumed by those of the recently-formed Prime Minister's Science, Engineering and Innovation Council. At the second reading of the repeal Bill, the work of ASTEC was praised, most explicitly by Senator Stott Despoja, on account of the 'broad perspective on science, engineering and technology matters' that it brought to Parliament (Stott Despoja 1998).

### Writing about Explorers

It is the tradition of the Australian Academy of Science to hold a symposium in conjunction with their Annual General Meeting, and in May 1969 the occasion was used to prepare for the bicentenary of Captain James Cook's first visit to Australian shores. Badger's latent interest in explorers and navigation appeared in public for the first time, when he delivered a paper entitled 'Cook, the Scientist' and then acted as editor for the publication of the collected papers from the symposium (204). A review of the volume in a leading history of science journal labeled it 'a useful summary of information about James Cook, his voyages and their scientific

results', but the review devoted most space to the technical nature of Badger's paper (Bylebyl 1972).

In retirement, Badger again took up this interest, studying historical literature and visiting many places on the Australian coast and in the Pacific Islands to which Cook's voyages had taken him, with a special interest in Hawai'i. This gave rise to *The Explorers of the Pacific* (210). Badger's research covered the voyages of Polynesian settlers and Spanish explorers, but most space was devoted to French and British visits in the period from 1750 to 1850. The book was extensively illustrated with maps, botanical and zoological sketches, and photographs of paintings and Pacific locations. Historians probably saw the book as 'popular' and so their scholarly journals did not review it, but a *New Scientist* reviewer (Reader 1989) was enthusiastic, praising it as a 'substantial book ... a window on the subject which has captivated its author for years, if not a lifetime' and giving a tongue-in-cheek warning to the reader that 'such enthusiasm is contagious'. A review by a fellow organic chemist, Emeritus Professor John Swan (1989), strongly recommended it as a present for 'any budding scientist, or budding historian'. A second edition, in paperback and revised and enlarged, followed eight years later (211). The appendix on Dead Reckoning no doubt owed something to Badger's naval work in the 1940s, since in it he introduced Traverse Tables and discussed the advantages of the Mercator projection and its associated rhumb lines.

Through the 1990s, Badger worked on another 'explorer' book, this time about the land-based exploration of Australia (212). In the Acknowledgments in this work, Badger notes that his illness in 1999 and the need for several operations had meant that he needed assistance to finish the book and that this had been forthcoming. In both his explorer books, Badger provided a wealth of detail about navigation, diet and other technical matters. A number of the photographs

were his own, again attesting to his research travels.

### Recognition

Badger had a long association with the professional body for chemists in Australia, the (later Royal) Australian Chemical Institute (RACI). He joined the Institute in 1938 and became a Fellow in 1952. Soon after his return to Australia, he was awarded the RACI's H. G. Smith Medal for the best record of research conducted largely in Australia by a member of the RACI during the preceding ten years. He was president of the South Australian Branch in 1958, and RACI President in 1965. The Institute recognized his contributions with its highest award, the Leighton Memorial Medal, in 1971. The citation, read by the then President of the Institute, Professor Bruce West (an Adelaide graduate and one-time colleague of Badger's) noted that the award was 'for his leadership in Australian scientific research, for his contribution to Australian science through his active participation in the CSIRO, for his active participation in the Council of the Academy of Science, and for his leadership in guiding the University of Adelaide' (Anon 1973). His Leighton Memorial Award lecture, which included some events from his own career, was published in 1973 (202) and has been discussed above.

He was Abbott Lecturer in 1964 for the Sydney University Chemical Society, R. K. Murphy Lecturer in 1965 for the Science Association of the University of New South Wales, and in 1974 he was awarded the W. D. Chapman Memorial Lecture and Medal of the Institution of Engineers Australia. He was a Dominion Fellow at St John's College, Cambridge, during a study leave in 1958, and a Governor of the Ian Clunies Ross Memorial Foundation 1975–1978.

In 1956, he was the Liversidge Lecturer for the Royal Society of New South Wales, which published his address in its

*Journal and Proceedings* (91). Two years later, ANZAAS presented him with its Liversidge Award and published the award lecture (108). He was the Association's President 1979–1980, presiding over the 50th Congress, held in Adelaide in 1980. In 1981, he was awarded the ANZAAS Medal for service to the advancement of science.

Badger became an Officer in the Order of Australia (AO) in June 1975 and four years later was created Knight Bachelor, the citations for both mentioning his service to science and education. In the period from 1985 to 1988, he was President of the South Australian Branch of the Order of Australia Association, and he was national president of the Association from 1989 to 1992. He received the honorary degree of Doctor of the University from the University of Adelaide in 1980. In 1978, he was elected to Fellowship of the Australian Academy of Technological Sciences, and he was also a fellow of the Australian College of Education (1969) and of the Australian Institute of Management (1974).

One of Badger's ASTEC colleagues, Arvi Parbo, was responsible for his becoming a non-executive director on the Board of the Western Mining company after a vacancy arose in December 1979. The value of non-executive directors lies in their ability to ask questions, and Badger was very good at that, according to Parbo (2007). He contributed 'in this way to proper analysis of proposals put before the Board, especially their technical aspects. He also liked to visit operations, had no difficulty communicating with people of all kinds and asking them perceptive and searching questions in a pleasant and constructive manner', Parbo added. Badger served until 1988, when he reached the age of compulsory retirement for directors, 72 years.

### **Death and Biographical Detail**

Sir Geoffrey Badger AO died on 23 September 2002 and was survived by his wife, Lady

Edith Badger OAM. Her Medal in the Order of Australia had been awarded in June 1982 in recognition of her service to the community, particularly through the Meals on Wheels organization.

Brief obituaries were published by the Australian Academy of Science (Beckwith 2003–2004) and by the University of Adelaide newspaper (Anon 2002a). A more extensive piece appeared in the Adelaide daily newspaper *The Advertiser* (Brice 2002) and was reproduced by the Royal Australian Chemical Institute (Brice 2003). There was also an obituary published in Britain (Anon 2002b). The RACI also published a longer statement by a South Australian Fellow, John Mason (2003). Giving rather more detail than the others, Mason's obituary concluded by describing Badger as a 'private man who gave so much to chemistry, education and history'. This theme had been struck in a profile published in *The Advertiser* on Badger's last day as Vice-Chancellor (Cockburn 1977). Headed 'A Professor of Peace', this described Badger as an 'urbane, reticent, modest and self-controlled' man 'who had led the university with distinction and played prominent roles in Australian science'.

Despite his prominent position in the world of chemistry, as a university leader and a major figure in the work of leading scientists and industrialists to provide sound advice to government on matters scientific and technological, Badger is always described by those who knew him as a very private man. Close study of his work reveals a complementary meticulousness to which his lectures, his research publications and the documents now preserved in archives in Adelaide and Canberra all attest. In professional life, Badger set very high standards for himself and inspired others to meet them, too. They did, because his judgment was respected and his creativity admired. Very few of his colleagues would claim to have known him well, however, although a small number remained



close to the Badgers long after Geoffrey's withdrawal from public life.

### Acknowledgements

The Australian Academy of Science holds a video interview conducted with Badger, plus a transcript and two *curricula vitae*. I was pleased to have access to these documents and be able to draw on them in writing this Memoir. An extensive autobiographical manuscript is held by family members.

I acknowledge the considerable assistance in compiling this memoir that I have received from librarians and archivists at schools and universities, especially Ms Rosanne Walker of the Australian Academy of Science. I have also been helped by people who worked with Badger in a number of spheres, notably Sir Arvi Parbo, Dr Roy Green and Dr Bruce Middleton, by Sir Geoffrey's brother, Hugh Badger, and by Emeritus Professor Peter Teubner. Several chemists helped me with information about Sir Geoffrey or about the University of Adelaide or the wider world of chemistry, and I am grateful to Dr Malcolm Thompson, Dr George Gream, Dr Wolfgang Sasse and Emeritus Professor Bruce West for this. Most helpful of all was Emeritus Professor Athel Beckwith, Badger's successor in the Chair of Organic Chemistry at Adelaide and later Professor in the Research School of Chemistry at the Australian University.

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